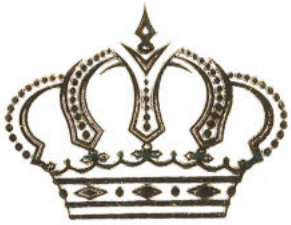
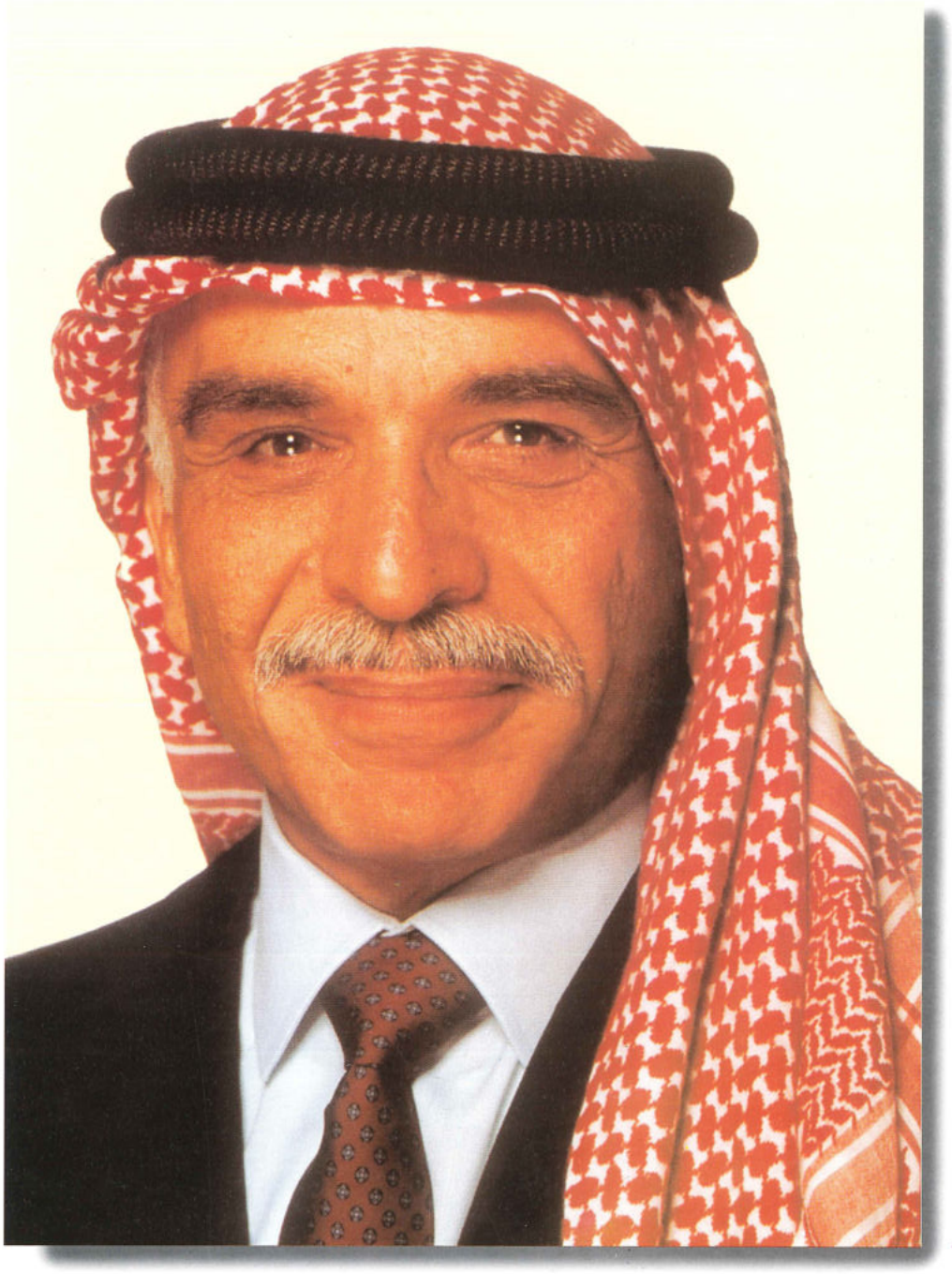
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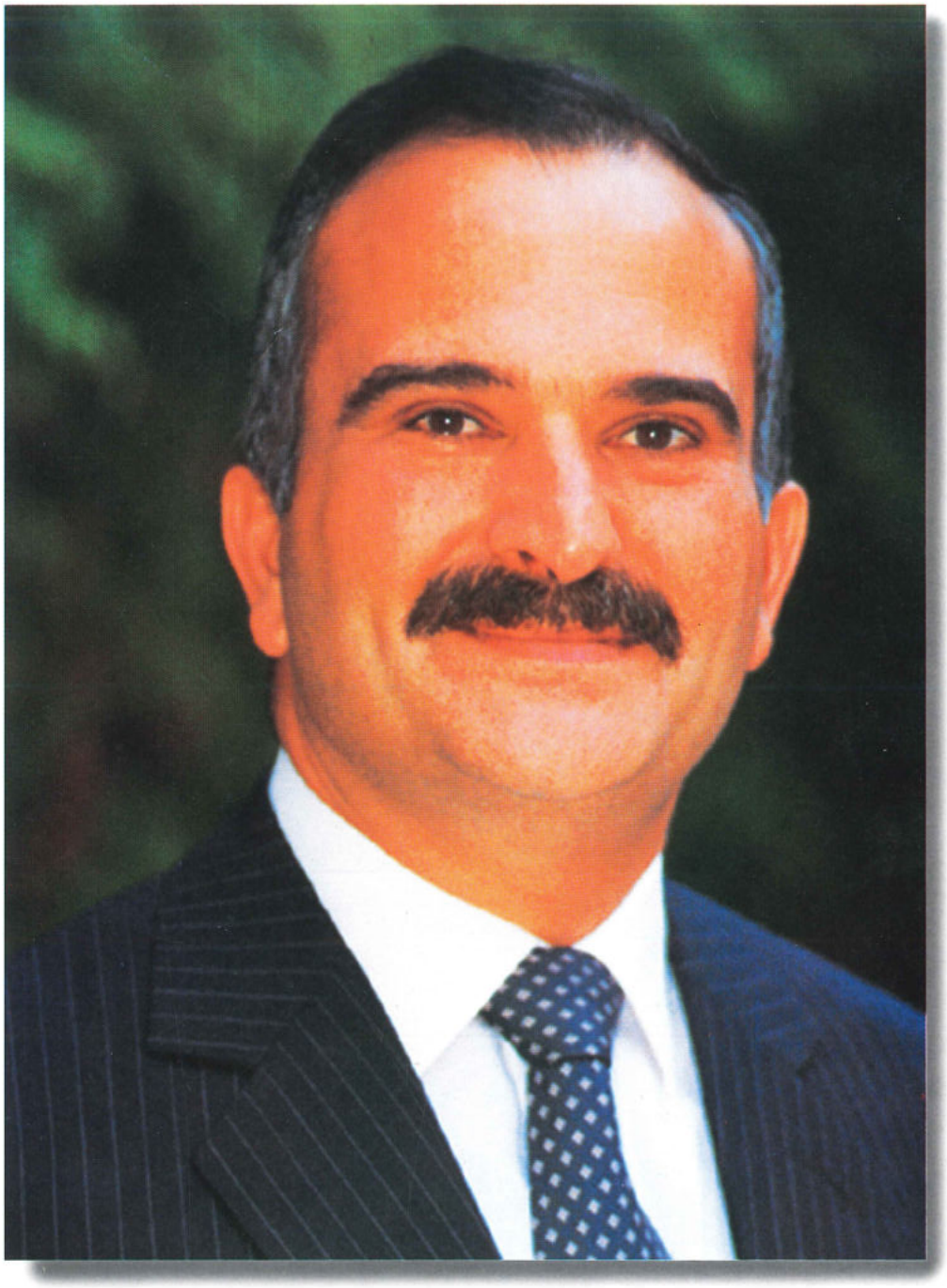
STUDIES IN THE HISTORY AND ARCHAEOLOGY OF JORDAN VI



This volume
is dedicated to
His Royal Highness
Crown Prince Al-Hassan,
the initiator of the series of
triennial conferences on the
History and Archaeology
of Jordan, on his
fiftieth birthday



His Majesty King Hussein
of the Hashemite Kingdom of Jordan



His Royal Highness
Crown Prince Al - Hassan

THE HASHEMITE KINGDOM OF JORDAN

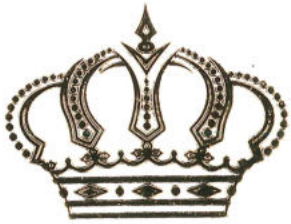
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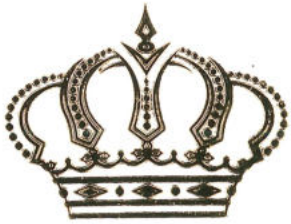
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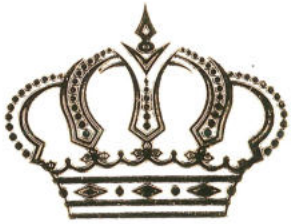
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STUDIES IN THE HISTORY AND ARCHAEOLOGY OF JORDAN VI: LANDSCAPE RESOURCES AND HUMAN OCCUPATION IN JORDAN THROUGHOUT THE AGES

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System of Transliteration from Arabic

Consonents

ء	' (except where initial)	ض	ḍ
ب	b	ط	ṭ
ت	t	ظ	ẓ
ث	th	ع	‘
ج	j	غ	gh
ح	ḥ	ف	f
خ	kh	ق	q
د	d	ك	k
ذ	dh	ل	l
ر	r	م	m
ز	z	ن	n
س	s	هـ	h
ش	sh	و	w
ص	ṣ	ي	y
ـة ة	a or at	ـه ه	a or ah

Long Vowels

ا،ى	ā
و	ū
ي	ī

Short Vowels

ـَ ـِ	a
ـُ	u
ـَ	i

Common Nouns

تل	Tall	دير	Dayr
جبل	Jabal	عين	‘Ayn
خربة	Khirbat	وادي	Wādī

List of Abbreviations

AA	American Antiquity
AAA	Annals of Archaeology and Anthropology
AAAS	Annales Archéologiques Arabes Syriennes
AASOR	Annual of the American Schools of Oriental Research
ADAJ	Annual of the Department of Antiquities of Jordan
AfO	Archiv für Orientforschung
AJ	Antiquaries Journal
AJA	American Journal of Archaeology
ANRW	Aufstieg und Niedergang der Römischen Weolt
ASAE	Annales du Service des Antiquités de l'Egypte
AUSS	Andrews University Seminary Studies
BA	Biblical Archaeologist
BASOR	Bulletin of the American Schools of Oriental Research
BEO	Bulletin d'Etudes Orientales
BIA	Bulletin of the Institute of Archaeology, University of London
BIES	Bulletin of the Israel Exploration Society
CRAI	Comptes Rendus de l'Académie des Inscriptions et Belles Lettres
EI	Encyclopaedia of Islam
IEJ	Israel Exploration Journal
JAP	Jarash Archaeological Project
JAOS	Journal of the American Oriental Society
JARCE	Journal of the American Research Center in Egypt
JDAI	Jahrbuch des Deutschen Archäologischen Instituts
JbRGZM	Jahrbuch des Römisch-Germanischen Zentral Museums
JNES	Journal of Near Eastern Studies
JRA	Journal of Roman Archaeology
JRAS	Journal of the Royal Asiatic Society
JRS	Journal of Roman Studies
JSS	Journal of Semitic Studies
LA	Liber Annuus
PEFA	Palestine Explortion Fund Annual
PEFQS	Palestine Explortion Fund, Quarterly Statement
PEQ	Palestine Exploration Quarterly
PSAS	Proceedings of the Seminar for Arabian Studies
QDAP	Quarterly of the Department of Antiquities in Palestine
RB	Revue Biblique
RDAC	Reports of the Department of Antiquities of Cyprus
REA	Revue des Etudes Anciennes
REI	Revue des Etudes Islamiques
SHAJ	Studies in the History and Archaeology of Jordan
WA	World Archaeology
ZDPV	Zeitschrift des Deutschen Palästina-Vereins

Your Royal Highness,
Your Excellencies,
Ladies and Gentlemen,

It is indeed a distinct honour for me to stand here in the presence of Her Royal Highness Princess Sumayya Al-Hassan and distinguished guests and participants to welcome you all to the opening of the Sixth International Conference on the History and Archaeology of Jordan whose theme is "Land Resources and Human Occupation Throughout the Ages in Jordan".

As the place " where the mandates of heaven and history coincide" as His Royal Highness, Crown Prince Al-Hassan so effectively reiterated at Oxford University during the First Conference, Jordan can assume a special role in land-use practices. Linking the physical and cultural features of the country, Jordan – through the millennia – has microcosmically exhibited environmental and landscape phenomena which can be studied uniquely well. Beyond even such remarkable features as the lowest point on earth, flora and fauna from the Mediterranean basin, the Red Sea and Arabian Peninsula, Jordan's human environment raises profound questions and gives us hope. Land-use patterns are closely related to the environment, and the quality of humanity's environment is no " merely academic" subject in these critical times.

A conference of this kind would not have been possible without the support, help and co-operation of many academic institutes and individuals. It is my pleasant duty to acknowledge some of them here.

To His Royal Highness, Crown Prince Al-Hassan, who initiated the idea of triennial conferences to promote active research in the history and archaeology of Jordan, we are particularly grateful for his unfailing support and continuous interest. Our sincere thanks are also extended to the Center for Archaeololgical Research and Science of Torino for the kind invitation to host the Sixth Conference in Torino. To Their Excellencies, Ambassadors Romualdo Bettini and Hassan Abu Na'meh, we express our appreciation for their help and support. The efforts of the members of the organizing committee are gratefully acknowledged .

Last, but not least, I would like to pay special tribute to the director of the Center for Archaeological Research and Science of Torino, Professor Giorgio Gullini and the colleagues who collaborated with him, for the tremendous efforts they put into the preparation and organization of this conference.

The fact that this conference is being held here in Torino is an eloquent testimony to the many diverse friendly relations which have grown over the years between Jordan and Italy and which, we trust, will continue to improve in the future.

Dr Ghazi Bisheh
Director-General of Antiquities
Ministry of Tourism and Antiquities, Amman

Your Excellencies,
Ladies and Gentlemen,

It is a great pleasure for me to be here in Torino on the occasion of the Sixth International Conference on the History and Archaeology of Jordan. The theme of the conference is interesting, shedding light on the manifold aspects of land - use and human occupation, and serving as a springboard for a variety of new studies in agriculture, irrigation, hydrological engineering, technological advances and so on.

Jordan is a land of sharp contrasts: of surprising fertility and extreme barenness, of cultivable plains and high plateaus broken by deep canyons and innumerable dry stream beds. But most of this land is situated in arid regions where the annual precipitation rate is less than 100mm. Yet it was in the midst of these arid regions that settlements flourished, asserting a creative strength in the face of harsh environment and adverse climatic conditions. For example, excavations at Jāwā which lies in northeastern Jordan in an arid desert of black basalt, have shown that an urban settlement of considerable complexity existed there as long ago as the fourth millennium BC and a sophisticated water retrieval system supported a large urban population. I have been informed that Jāwā is the best preserved fourth-millennium town yet discovered anywhere in the Middle East, paradoxically in a place where it could hardly exist today. The discoveries at Jāwā – which may not be unique in the region – are important not only as a prehistoric legacy of man's achievement, but also as being of primary relevance to the present. Just recently the Higher Council for Science and Technology of Jordan has launched the Eastern Badiyā Project which aims at promoting modern human settlements in that region. To achieve this, research is being carried out in water harvesting, pasture improvement, combating desertification, and reintroducing extinct fauna and flora species. Jordan has no Euphrates or a Nile, but the inhabitants of the country knew how to wrest a hard livelihood from an inhospitable environment. Those ancient inhabitants dug cisterns and reservoirs, built dams and diversion walls, laid our terraces, and engineered channels and acqueducts which brought water from distant springs to the heart of their towns and settlements. The Nabataeans who built flourishing cities in southern Jordan and the Negev desert are a case in point. Their agricultural pursuits were maintained in close conjunction with trading activities which required peace and stability. Now as then stability and peace are essential for developing agriculture and promoting trade, and as I said on an earlier occasion – geopolitically our present position in Jordan is pivotal to conflict resolution as the middle ground in both geographical and political terms. The Middle East is the cradle of civilization and the birthplace of the great monotheistic faiths. Its people share a great deal in the way of history, beliefs and culture. A broader understanding of this

common ground is the greatest weapon in the armoury of peace-makers. For tolerance and coexistence are guaranteed not by the might of armies, but by the friendships of children. Now that peace is dawning on our region, the challenge before us is to translate the slogan of peace into the reality of progress and prospertity on the ground. Peace must spark our innovative abilities and make the desert a success story to be remembered by succeeding generations.

Your Excellencies,
Ladies and Gentlemen,

Jordan has experienced in the past fifteen years a number of highly specialized conferences starting with the First International Conference on the History and Archaeology of Jordan which was held at Oxford University in March 1980. The idea behind these conferences is to take pause and recognize the achievements of the past and their relevance to the present. It is hoped that, as we look at the humanitarian requirements of identifying our past and present, such conferences will serve areas of commonality: to think and act in terms of universal values and with a sense of common humanity.

Judging by the list I have received, I see that you have a very full programme; so I wish you all a vibrant exchange of ideas and pleasant encounters in the course of the next few days.

In conclusion I would like to extend my heartfelt thanks to all those who have prepared this conference and to the scholars whose contributions will further its success. In particular, I would like to thank the Center for Archaeological Research and Science of Torino for the kind invitation to host this conference, and to Professor Giorgio Gullini and the colleagues who collaborated with him for the efforts they put into the preparation and organization of the conference.

Opening address by His Royal Highness, Crown Prince Al-Hassan (delivered in his absence by Her Royal Highness, Princess Sumayya Al-Hassan).

GIORGIO GULLINI

History from the Earth: Meanings, Methodological Aspects and Aims

Archaeology aims at the individuation and exhaustive interpretation of artifacts and marks of the environmental transformations made by man to realize the complete and full historical reconstruction of material and cultural aspects of the human society with reference to a certain time and place: the last one is actually our place of research.

Artifacts and marks are the means through which we can get in touch with the protagonists of that human society we are trying to survey and to reconstruct. Its way of living and its cultural forms are the necessary basis to understand ours deeply as, today, we are the result of the many different human experiences to which that society we are surveying has surely given its tribute.

If we set these aims as our main purpose it will be clear that the complete and full reconstruction will not take place if the basic data are collected by chance and their interpretation is widely interpolated. We can appreciate how the collected items look like, but this is not so important as their contribution to the historical reconstruction which require all the available data to be complete. These data – that is artifacts and marks of the environmental transformation made by man – are the remains of the human presence on the territory, that is the discards of the daily life, of the production and commercial activity, otherwise left as a necessary consequence of abandoned settlements or of catastrophic events caused by nature or by man.

All this is included in the upper levels of our planet, wherever human settlements can be found, in very different ways and density according to the production ability and the intense and general use of natural resources or artifacts made by the settled society. This means that the territory is also a big container of all those evidences left by the human society settled there but it is also the supporting cultural space of present and past societies, settled on the territory.

Starting from this consideration we have to assert that the study and the survey of the territory to identify the human presence in the past is the necessary presupposition of the main territorial activity of the archaeologist: the excavation. Recognition has become more and more the essential part of archaeological research and the most suitable way to realize it has been, and still is, the most important element of its methodology.

The methodology has actually been developed greatly in the last decades and the tribute of statistics and computer science have enabled big progress. But these last improvements cannot get rid of the two conditioning components of direct recognition: the limiting conditions to the movements over the area especially when, as it usually occurs, the area to survey is very large and the possi-

bility to survey and take note of only those traces on the surface which are usually scant of past societies.

Since the beginning of this century we can say that the research on the field has actually been supported very much by aerial photography , especially by the possibility of interpretating photographs taken from an elevated, not very high, platform of the surveyed area. We are talking of interpretation because, beyond the synthesis obtained by an aerial view of the surface, we can also get information by those marks connected with human artifacts buried in the soil taking into consideration the varying humidity and vegetation references.

These are the marks which are recognized and underlined by the expert eye of the interpreter, whose correct acquisition and explanation of the photographs are stricly linked to his ability.

To those human interpretation "limitations" we have to add the important fact that the marks are related to artifacts buried close to the surface. This means that the essential condition to obtain good information is that the amount of discards is near to the surface and the surface itself has not been changed much, if we think of the natural stratification of discards left by humans. For example, agricultural use of the territory can confirm this explanation only if the interventions are little and not much influencing the territory itself, otherwise every possible superficial sign could be cancelled.

Later we shall see how the aerial photograph is used in a new way according to the operating process of remote sensing which is actually very important to get precious documents before those transformations, due to sophisticated means, but obstructing a sure interpretation of all the past use of the territory.

Our need to collect systematically the information on the past human presence in the surveyed area, within geographical and historical limits, would not be satisfied, or only partially satisfied without assuring the necessary base for the historical reconstruction as we need real improvement of the research quality.

The introduction and the diffusion of multispectral images, and especially of those taken from orbital platforms, have definitely changed our possibility to know better the resources of our planet and also that particular section intended for the study of the territory concerning the anthropized areas and, finally, for archaeological research.

We can, actually, receive a wider range of wavelenghts of the energy reflected and emitted by earth, so that we are able to acquire not only everything on the surface, in connection with the wavelenghts received by the human eye, but also under the surface. What we see can be a typical natural feature of the surveyed soil, but it can also represent discards or accumulations gradually formed on the terrestrial surface as a consequence of human activity. The distinctive feature of these accumulations is the regular patterns designed by the variations of the emitted energy quantity.

This means a possibility to acquire information, by simple selection, when interpreting the image, on everything contained in the soil and due to human activity. All this information is shown on the same level: but we have consequently to explain it within a reconstructing frame.

Our discoveries are no longer adventurous and accidental but are now the result of the analysis of everything that man has left. We have to distinguish, by logical process and by using other analytical methods of the territory, those links connected with the different information, in order to restore the sequence that is usually shown by excavation in the stratigraphy.

We can now use those advanced methodologies for direct recognition and cataloguing of the already available knowledge, to obtain a sure frame of the spatial distribution, that is what I call the "previous knowledge".

Some of the reports presented during this conference have given very satisfactory and interesting examples of how we can organize what we already know to advance our knowledge of the past.

I have talked about multispectral images without specifying what a platform is: the most known available platforms are the orbital ones that is the satellite images which will be later explained in detail. Their first great tribute to the historical study of the territory is the synthesis of an area within geographical and historical limits. This synthesis has given us the possibility to find out the real marks of the human presence on territory from distant to recent times, that is the settlements intended as the relationship of man-territory.

For the archaeological aims the orbital images are presently used on more occasions, but, almost always, as an extension of the interpretation of the aerial photographs. I would like to underline how useless and expensive it is not to use such an important instrument taking full advantage of the most advanced, and still developing possibilities it offers for scientific research in order to get the best results.

The new aim of the methodologies and procedures we want to propose is that they exploit, in the best way, the possibility of the means of giving the most satisfying answers.

We think that this can be obtained by the procedure, we have decided, consisting of the use of work stations with a big memory and capable of dialogue with many peripherals, for a total interpretation of the orbital images: these are selected, for the chosen area, on the basis of the best quality and visibility and data, close to the times when, for the natural evolution, we can have the geatest difference both for reflection and especially emission of energy. In other words in spring and autumn rather than summer or winter.

When we try to interprete, through treatment to underline some marks, it is possibile to find out areas whose forms are incoherent or different, from the superficial organization. These can be referred, as they are regular, to human interventions under the actual surface and related to all the discards of past accumulated presences which have been gradually buried during times.

These surveyed areas are carefully studied and interpreted for their intrinsic features by connecting and comparing them with the cartography of previous information as you will hear later on, following the main ideal guiding thread for the human settlement, the orientation. We have now set the first interpretation of the human presence on the territory which has to be controlled, organized and defined by a series of operations to be carried out on the field.

First of all the georeference: this is made, for a first approximation, on the existing cartography and then by a considerable series of ground points by means of a GPS, which is an essential operation to assure the correct identification of how all the surveyed areas actually are and to use those images taken from low altitude to superimpose them to the satellite images so that we can obtain the most detailed resolution of those areas that are so important to a settling system.

Thus, we are able to start the comparison, which is so important for the success of our research, between the control on the field and the reading and interpretation of the image; all these operations cannot be unified in only one intervention: it becomes a dialectic, carried out for a certain time, between the field observations and the laboratory processes.

While going on with the detailed acquisition, the topographical points become more and more important, so that we can get large and largest scale plottings of the most interesting structures.

As regards the inserting of images taken at lowest altitude we have to mention two kinds of images taken from an aerial platform. On one hand normal aerial photographs covering the involved area: as in many regions we can dispose of aerial photographs taken sixty or more years ago as they give a precious series of acquired data belonging to previous times, that is before the most recent transformations of the territory. Though they are only photographs and are not multispectral they can nevertheless provide us with information concerning past and

lost documents that are precious for the reconstruction. We have got some interesting examples explained in some reports during this conference.

Nowadays we can get multispectral images from multichannels sensors on aircraft. This means that we can have images taken, between 1000 and 500 metres, at a highest resolution. We began to use MIVIS images; later they will be shown and explained, because we have started research aiming at the discovery whether so different and many channels can bring us to distinguish the acquired information according to the nature of the artifacts or their stratigraphical location. At the moment it is being studied and is only a research programme and we are not able to give you any result.

The interface of photogrammetric surveys and thermal images at the highest resolutions can take place from a platform at very low altitude, about 200 metres, expressly set up by Centro Scavi di Torino. It is a ULM aircraft carrying a photogrammetric camera and a thermal camera in parallax, as well as a normal telecamera and a GPS antenna in a coaxial position with the centre of the taken image. The images are trasmitted to control monitors in order to check the integral covering and the implementation of the flight plain. Thus we can obain plotting at a scale 1:50 and, if necessary, at larger scales. We hope to show you tomorrow a demonstration of how this equipment works.

The ground control can be now very precise and is better realized, together with the direct recognition, through the geophysical detection, allowing a further deepening and reading which can indicate a human presence on the field but which can also give suggestions about its nature. The electronic elaborations and the computerized tomography also offer the possibility to obtain precious stratigraphic information.

These last ones are especially clear through mechanical detections that is the undisturbed core drill sampling we have successfully tried by freezing the soil.

I cannot now speak outside the theme of remote sensing: it could require another workshop. The micro-excavation we can obtain by core-drill sampling also opens the application of that essential aspect of the systematic land approach, the so-called "biological archive", the complete study of all the human, animal and vegetal remains, so that we can reconstruct the environment where man has lived as well as his quality of life.

All this huge and complex data get into a computerized databank we can use every time to obtain thematic maps according to the specific field of a research; the scale of these maps can be built according to the extension of the available information.

In conclusion: what is the meaning of what we have said on archaeology? no longer a conclusion, it is a series of obtained results to be presented and discussed, it opens a new frontier. The big amount of data that the systematic land approach enables to acquire is a challenge, on one hand, and a certainty, on the other: it is a challenge because we are totally engaged to interprete, to organize and to reconstruct data; it is a certainty because we are sure that our efforts are concentrated on all the available data, so it has a holistic feature that could not be possible before. Will archaeology of the 21st century win the challenge and get certainty ? I really think so.

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Topographic References and Plotting

Introduction

Before starting a photogrammetric survey we need to know some ground points. There are many different ways of finding the position of these points: each way is differently precise and requires more or less difficult operations and resources. Here are some examples of different ways of preparing a topographic network of ground points and control points on earth, and at the end is shown an example of the network realized on the Jordanian territory which aimed at the orientation of satellite images and the plotting of aerial photographs.

Features of Ground and Control Points

Under "ground point" we understand those references taken from the ground and very visible on the (photographical or digital) image and which are used to make projective transformation or real plottings. Under "control point" we understand the comparison between the real position and those data obtained by rectifing the image or by plotting the survey in order to check the work carried out .

In both cases these points are known plano-altimetric points (i. e. taken from cartography); otherwise they can be obtained by a topographical survey.

The scale of photographs as well as the satellite image resolution are the presupposition for the precise determination of ground points. It is clear that photographs at a scale of 1:40.000, for instance, which can be used for survey at a scale of 1:10.000, will require preciser ground points than necessary in order to rectify a SPOT image with an average 10x10 m^2 pixel. Should digitized aerial photographs be used to improve their resolution, ground points will be related to the scale of the aerial photographs.

The number of ground points has to be fixed on the base of different principles whether it is a question of aerophotogrammetry or of satellite images. According to the rules of topography at least three ground points are required to realize the absolute orientation phase of a stereoscopic pattern. In case of many following patterns the technique of aerial triangulation enables the reduction of direct ground points. The processing of satellite images, according to the used algorithm, requires different numbers of ground points (usually fifteen). In both cases it is very important that the georeferenced processing is very precise as well as the measuring of ground points and their consequent localization. The validity of the metric information deriving from the image depends on this orientation phase as well as the reliability in searching particular elements from the ground during the post-interpretation.

As regards those points obtained from cartography we have to underline two aspects concerning the updating of the maps and the scale.

One usually has to use old maps which are very different from the actual territory. In this case we run the risk of making mistakes if the careful transformations have not changed so much those features that are usually used as references (for instance crossroads).

The points are read with the approximation determined by the scale: should a digitizer with a 0.1 mm resolution be used, the points will be read with the 2.5 mm approximation on a base of a scale of 1:25.000. The intrinsic error of the map, generally equal to 0.2 mm, will give precise points with a 5 m error, using a map at a scale of 1:25,000; that is a bearable value when using satellite images.

Should these ground points be used for photogrammetric plotting, such an approximation is no longer enough: we have to make use of ground points (for example trigonometric or cadastral points) or to prepare a network with vertexes suitably positioned in the area.

In conclusion the problems with map-making are as follows:

- updating
- intrinsic error
- availability of the required scale.

On the other hand we have the following advantages:

- immediate availability of information
- references for toponyms
- cheap method.

The survey is realized via topography. It can be carried out traditionally by means of optical-mechanic or electronic theodolites, total stations or GPS (Global Positioning System) receivers. The network must follow topographic criteria by trying, then, to put it into the car-

tographic reference system and also by realizing many different and various measurements in order to obtain the position of vertexes. The disadvantages of topography during surveying are:

- realization times that, sometimes, are quite long
- logistic problems such as moving from a control point to the next one, equipment and so on ....
- financial burden.

But we also have many advantages:

- choice of suitable points
- possibility of carrying out an accurate recognition on the ground
- precise ground points which can be defined before projecting.

Topographic Survey

Traditional topographic measurements make use of the classic survey method that is the intersection and the space resection, the trilateral measurement and the survey with the polar coordinates. The limits of these methodologies are well known: the biggest limit is the mutual visibility between station and collimated point.

Sometimes when the ground is hilly, it is difficult to find a suitable station point. In this case it is convenient to make use of the GPS (Global Positioning System): it is a survey technique that uses those signals transmitted by the NAVSTAR satellite network (consisting of about thirthy satellites) which are received and processed on earth. This method is quite simple also for non-experts: the receiver is positioned in the network vertex then it begins to receive signals for a period of time which has to be decided upon when planning, according to the displayed parameters.

The obtained data can be stored differently (memory card, hard disk) and stored later on so that the user can finally know the station point of the reference system WGS84.

This abbreviation means a precise reference surface, the geoid, and the coordinates refer to a geocentric cartesian tern. The big problem that the user usually has to face concerns the transformation of coordinates obtained with system WGS84 into coordinates referred to the used map-system.

The reference surface as well as the rototranslation have, then, to be changed, also by varying the scale, and related to the projection system.

This last operation is still possible if we know the coordinates (in the final reference system) of a convenient number of points.

The problem of adjusting the network also concerns the classic method of survey, that is when using ordinary equipment.

Plotting

The operations connected with territory surveying are usually carried out by aerial photogrammetry both for average and big areas. However, we take advantage of photogrammetry also on earth in other fields such as: architecture, industry, astronomy and many others. The used equipment is quite simple if we compare it with that one used for aerophotogrammetry, that is why this technique is broadly available to those who are not acquainted with photogrammetry.

As regards aerial photogrammetry the plotting of aerophotographs is usually carried out via analogical or digital operations, however, satellite images can also be applied to cartography at average and small scale. As regards terrestrial photogrammetry (also called "close-range") the plotting equipment is generally analytic, some models are very simple and cheap, and they can also be applied to archaeology.

By means of photogrammetry it is possible to obtain the following products: tridimensional scale drawing, section, retification, orthoprojection, a particularly complete information and metric product.

The working images are usually photographs taken with both metric and halfmetric aerial cameras or terrestrial cameras. These last ones in comparison with metric cameras are much easier to handle and cheaper also.

Photography is being changed from analytic into digital: this is quite a recent revolution of the photogrammetry survey. As a matter of fact, the used image is a digitized analogical image intended as a photograph or video signal coming from a video camera. The advantage is great: the user can decide at the very moment whether the image quality is good enough or the acquisition has to be repeated once again.

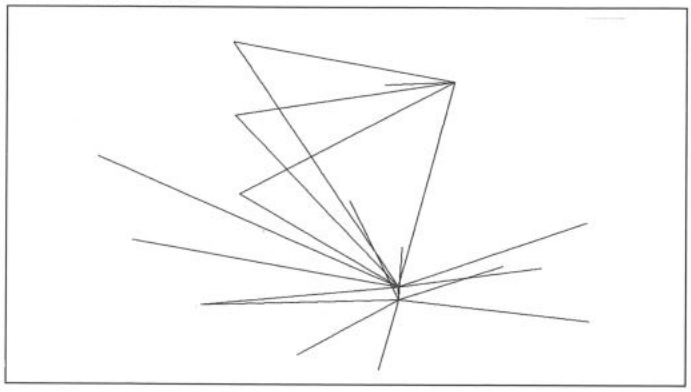
On the other hand, the limits of the resolution of the digital image still exist.

Recently, this sector has been growing very quickly and many manufacturing industries have already studied and launched, on the market, different products for the realization of both architectural survey (for example digital rectification and orthophotography) and territory survey (digital stereoplotter for aerophotogrammetry). Also, during plotting we need a series of ground points, conveniently distributed, which are used for the so-called "orientation" operation (we have already talked about the adopted choice criteria).

The Network of Jarash

This is to present an example of our recent realization of the topographic network which was carried out around Jarash in Jordan, in the district of 'Ajlūn. Our main purpose was to provide a series of ground and control points for the rectification of SPOT and LANDSAT TM images and the plotting of aerial photographs. The available cartography is at a scale of 1:50.000, updated in 1960, which does not suit our purpose. However, as we have already said, the network has to be related to a cartographic reference, because we have to use points, meant as vertexes, which can be easily read on the map, on the photographs

and on satellite images. As there was not much time to realize the project, taking into consideration the orography of the country, we had to use the GPS technique for the topographic survey. One can see the structure of the network on (FIG. 1): many different directions start from the central core.



1. Network structure (Tetrapylon, Jarash).

The core has a fixed point, the centre of the South Tetrapylon of Jarash. We have chosen this point because it is easy to find on the map, even if only planimetrically.

As regards other points we found the most reliable crossroads, because they can be easily found on the map but are only visible on the digital image.

We needed to take five different measurements and made an 11 hours simultaneous acquisition: we could find the position of 18 vertexes by measuring 22 base lines (under base line we understand a segment, or, better, a vector whose extremes are the fixed station point of the reference receiver and the other changing station point).

The measurements have been carried out with the GPS Geotracer 2000 receiver and processed with the Geotracer Postprocessing Software. Our purposes have already been shown at the beginning when we also limited them to obtain the required precision.

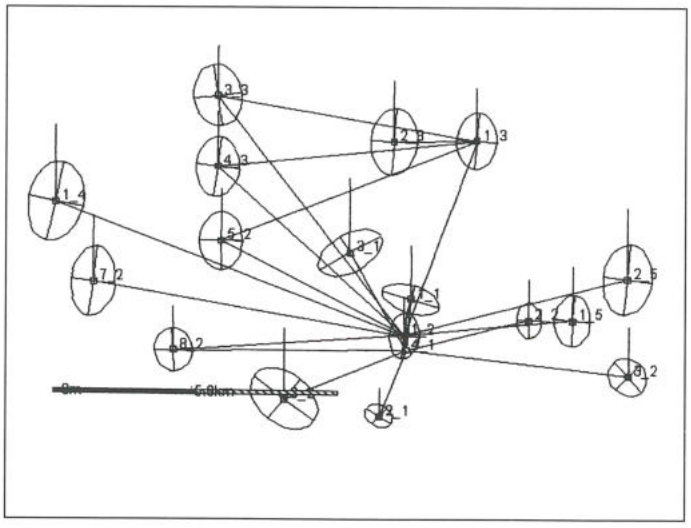
Starting from the features of the SPOT image and photographs we set a tolerance of 50 cm in the point position. At the end of the first (measurement) session we learnt the possible reception conditions and we fixed 30 minutes for each measurement. As we could dispose of no less than six satellites it has been possible to measure the base lines with average squared differences of about one centimetre (TABLE. 1) It was possible to improve the precision by longer observation times but, as was already said, there was not much time.

Table 1. Measurements of base lines.

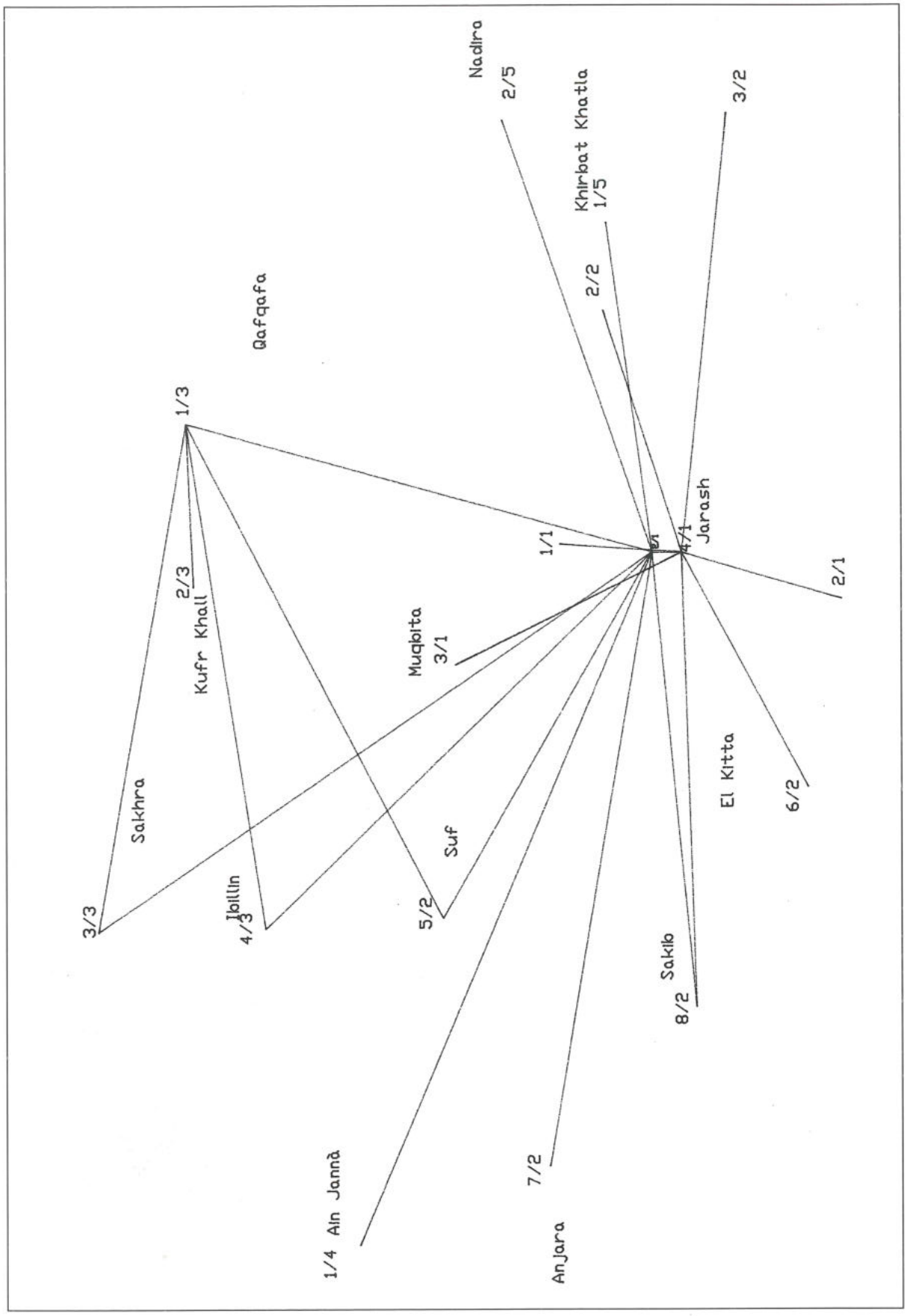
Baseline	σx	σy	σz
4_1/2_1	0.5	0.7	0.6
4_1/1_1	0.8	1.5	0.7
4_1/3_1	2.1	0.8	1.0
4_1/3_2	1.0	1.0	0.8
4_1/6_2	1.4	1.7	1.0
4_1/8_2	1.5	2.9	1.4
4_1/2_2	0.9	0.8	0.6
1_2/4_1	1.2	0.6	2.0
1_2/7_2	1.2	1.0	0.8
1_2/8_2	1.4	1.3	0.9
1_2/1_3	1.6	1.1	1.3
1_2/3_3	1.5	1.6	0.8
1_2/4_3	1.3	1.0	1.2
1_3/4_3	0.8	0.7	0.6
1_3/5_2	1.7	0.9	1.0
1_3/2_3	0.7	0.6	0.5
1_2/8_2	1.1	0.9	0.8
1_2/1_4	1.1	1.2	1.5
1_2/5_2	0.9	1.1	0.8
1_3/3_3	1.3	1.3	0.8
1_2/2_5	1.4	0.8	1.1
1_2/1_5	0.8	0.7	0.5

The acquired measurements have always been integrated with the equipped software: our results bear the greatest determination error of the coordinates of different vertexes which is less than half a metre, which is satisfactory (see FIG. 2).

In the light of the obtained data and our experience we can say that if we had used the classic topographic method we could not have measured such an extended area (about 300 km^2) with such an outstanding orography during such a short time and with so many points.



2. Coordinates of vertexes.



3. Plan of extended area using topographic references and plotting.

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Landscape Resources and Human Occupation of Ancient Jordan : A Perspective From Subsurface Mapping Techniques Utilized by the Mādabā Plains Project

The Mādabā Plains Project (MPP) research design has for two-and-one-half decades guided exploration of portions of the region encompassed by the Mādabā Plains in central Jordan (FIG. 1), paying particular attention to food systems and broad occupational patterns. Major talls (Ḥisbān, al-'Umayrī, Jāwā, Jalūl), forts, farmsteads, cemeteries, and other hinterland sites and features constitute a rich database for investigating and understanding in an integrated fashion landscape resources and human occupation in ancient Jordan.

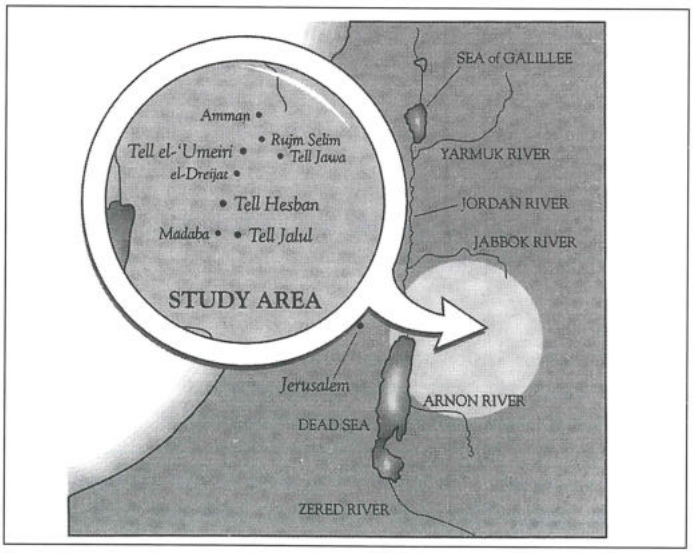
One emerging scientific endeavor which has contributed significantly to our research in the Mādabā Plains is the use of geophysical survey methods to perform subsurface mapping. In the context of the objectives of this conference and of the research design of the Mādabā Plains Project, this presentation initially summarizes the geophysical subsurface mapping techniques the Mādabā Plains Project has utilized since beginning excavations and surveys at and around Tall al-'Umayrī in 1984. It then focuses on the varied sites investigated and results obtained from subsurface mapping endeavors to this point in time at those locations. Of the techniques described below, ground-penetrating radar receives the greatest attention, especially its use in conjunction with the Iron Age excavations at Tall al-'Umayrī. Finally, we explore the implications of subsurface mapping investigations for the– continued study of natural and human resources in the Mādabā Plains region.

Development of Subsurface Mapping by the Mādabā Plains Project

Geophysical techniques used in subsurface mapping have included seismic refraction (SR –1984, 1987 and 1989 seasons), ground-penetrating radar (GPR –1989, 1992 and 1994) and electromagnetic induction (EMI –1992). GPR potentially provides the highest resolution of the three techniques, hence the greatest emphasis on its use by MPP. Seismic refraction does not reveal subsurface features to the same level of resolution as GPR, but it is not limited by a high soil conductivity as is GPR. EMI also provides subsurface detail to a much lower resolution than GPR, but more land area can be explored in the same period of time, with the potential of following with GPR for higher resolution where features indicate the need. All three techniques are non-invasive and non-destructive of the site.

Seismic refraction. In the course of developing subsurface mapping techniques for MPP, we began with SR because of its relatively inexpensive equipment. With it we investigated several sites. Our approach to SR employs a 4-pound hammer on a steel plate for signal production. Vertically oriented geophones receive the refracted sound waves, convert them to electrical signals and send them to a single-channel enhancement seismograph for display. Subsequently, the signals are digitized and recorded on a portable computer. We have used SR successfully at locations where GPR results were seriously limited by soil type. The technique shows promise for greater depth penetration, although, as noted above, resolution of the results is significantly lower than with GPR, making interpretation of the results more difficult.

Ground-penetrating radar. Thus far, we have collect-



1. Mādabā Plains Project Study Area Map.

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[3] Gerald A. Sandness has done GPR with the Mādabā Plains Project for three seasons.

ed data at six different sites which have a variety of soil types and potential subsurface features. These include two rural areas and four ancient urban sites within the Mādabā Plains. The hinterland areas are Wādī al-Bishārāt, located approximately 2 km southwest of Tall al-'Umayrī, and a Bronze Age cemetery (Boot Hill) on property belonging to the al-Bishārāt family about 2 km south of the tall. The urban sites include Mādabā, Jāwā, Jalūl, and al-'Umayrī. A Geophysical Survey Systems, Inc., GPR controller and antennas transmitted and received broad-band signals centered at 300 and 500 megahertz (MHz). The reflected wave forms were recorded by a personal computer (PC) on removable hard disks. We used survey grids with intervals of 0.5, 0.6 and 1.0 m, as appropriate to the area, to determine the location of subsurface structural features. The radar data were subsequently analyzed as transect profiles using a 486 PC. Computer software enhanced the data and interpolated between radar profiles, when appropriate, to produce two-dimensional maps of the subsurface features.

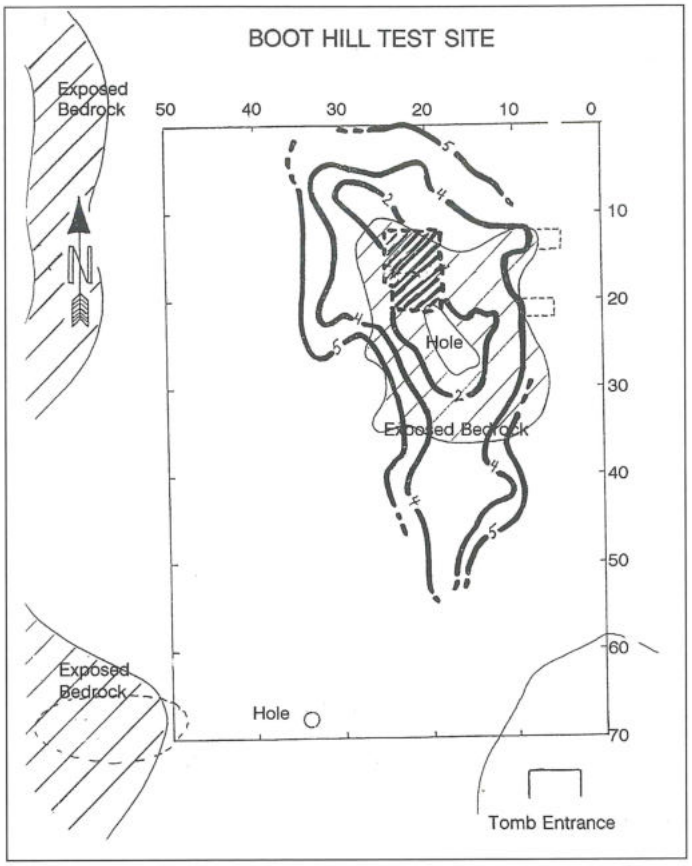
Electromagnetic induction: We explored the use of a Geonics EM -31 Ground Conductivity Meter as a means of locating large caves, caverns and tombs. The sensor consists of a horizontally held boom, 0.10 m in diameter and 4 m long, containing transmitting and receiving coils at opposite ends of the boom. Data were recorded by a battery-powered digital data logger, and were transferred in the field onto floppy disks for storage and transport using a notebook computer. Post-season signal processing used MATLAB, in addition to lab-developed software, on 386 and–486 PCs. The EM-31 transmits a time-varying magnetic field that induces electrical current in the ground. The associated induced magnetic field can be measured at the ground surface. The amplitude of the induced signal is recorded at regular intervals as the investigator carries the sensor along a predetermined track. The orientation of the coil, whether parallel or perpendicular to the direction of motion, will also impact the strength of field reading. We compared the results of EMI with those of GPR in a 30 x 30 m area of the al-Bishārāt Bronze Age cemetery.

MPP Sites Investigated by Subsurface Mapping Techniques and Results

Boot Hill

The detection and analysis of tombs are important to any investigation of ancient human occupation. On the site of this Bronze Age cemetery, we employed GPR to identify the shape of a large known cave and to detect previously unknown tombs . A 30 x 30 m area of the cemetery was mapped using 300- and 500-MHz antennas with 0.5 m transect separation. We also mapped this site with an EM-31 ground conductivity meter, basing a grid on transects 1 m apart.

Our analysis of the GPR data proved our ability to identify the depth and shape of caves and tombs. As (FIG. 2) demonstrates, GPR results confirmed a correlation with surface features and indicated the contours of a subterranean cave. Comparing tombs located by GPR, but otherwise unknown in the current era, with those which had been found and robbed, provided an opportunity to develop EMI and GPR siting techniques. The strategy of locating tombs with large-scale EMI surveys, leading to more specific GPR mapping, receives our continued attention in Wādī al-Bishārāt as well as in the vicinity of al-'Umayrī. In addition , these non-intrusive technologies allow us time to plan excavations without revealing tomb locations to potential grave robbers.



2. Boot Hill GPR Top Plan.

Wādī al-Bishārāt

SR has been used in Wādī al-Bishārāt to define one of several ancient stone-core earth dams which help control erosion and retain water for soil moisture build-up during winter rains. Such ancient dams, which are without question extremely significant for exploiting landscape resources, abound in wadis of the hilly region on the northern fringe of the Mādabā Plains. Many are successfully operating today, while erosion has exposed the retention structures in isolated instances. We used SR in 1987 and GPR in 1989 to gain a better understanding of their size and nature. The SR effort was partially successful in producing a low-resolution description of one dam. Clays

mixed with other fine-grained soils, typical of those deposited in wadi bottoms, proved impenetrable to GPR signals. Thus, the higher resolution GPR technique was unsuccessful in this location.

We have also initiated an EMI project in Wādī al-Bishārāt to locate shallow subsurface caverns that could be opened to the surface and used as cisterns for supplying water for agricultural purposes during the summer growing period. Prime candidate locations include areas not far above fertile wadi bottoms with exposed bedrock or shallow soil coverage. Directing runoff water toward an open cistern with rock channels or barriers or shaping the surface to funnel runoff water toward a cistern opening was a common method in antiquity and is still used in some places today.

The loss of valuable surface water through runoff carries significant implications for land use. Efforts at renovating and maintaining water retention structures for use in the present era have already begun. And combining the results of geophysical exploration with our current knowledge of ancient cistern use for agricultural purposes could be the basis for more extensive modern local projects to retain seasonal runoff water for enhancement of summer crop production.

Mādabā GPR was also employed in the modern city of Mādabā to search for a cistern donated to the city by the Emperor Justinian. We were unsuccessful in these GPR investigations due to electromagnetic interference and reflections from a variety of above-surface structures. Additional software development for signal enhancement may be helpful in clarifying subsurface reflectors.

Jāwā

In considering a variety of sites and conditions during our 1989 GPR feasibility survey, we investigated three areas on tall Jāwā. In that first season of GPR use by MPP, we recorded the radar reflections on audio cassette tapes. Unfortunately, although observations at the time of data collection indicated significant subsurface features, the tapes for Jāwā were later damaged and provided no useful information when we sought to retrieve and analyze the data on our return to the United States. Subsequently, we have recorded all of our geophysical data exclusively on digital media with more reliable backups.

Tall Jalūl

Occupying a prominent position in the center of the Mādabā Plains, Tall Jalūl must have played a significant role in the region in antiquity. The site is large (19 acres) and, although excavations have only begun at this point, it is clear the site had major economic and political status. Archaeological interpretations of a large surface feature just inside the apparent south gate at Tall Jalūl indicate the possible presence of a water structure. A south-to-north transect passing through this feature and extending nearly 200 m in length was outlined, starting midway up the south gateway ramp and extending down the north slope nearly to a cistern at the bottom. As a result of clay-rich soil, GPR penetration at Tall Jalūl was limited to about 0.5 m in depth along this transect for the 500 MHz antenna. Radar penetration by the 300 MHz antenna over the southern 95 m of this line was only slightly greater.

We obtained good GPR reflections at depths greater than 1m adjacent to Field B excavations near the east gate using the 300-MHz antenna. While it was possible to observe structural features in the GPR profiles, the penetration depth was only slightly greater than the depth of overlying wind-blown deposits, limiting the usefulness of GPR in describing the location of subsurface features at this site. We anticipate the need for further improvements in sensor capability before we employ GPR extensively at Tall Jalūl.

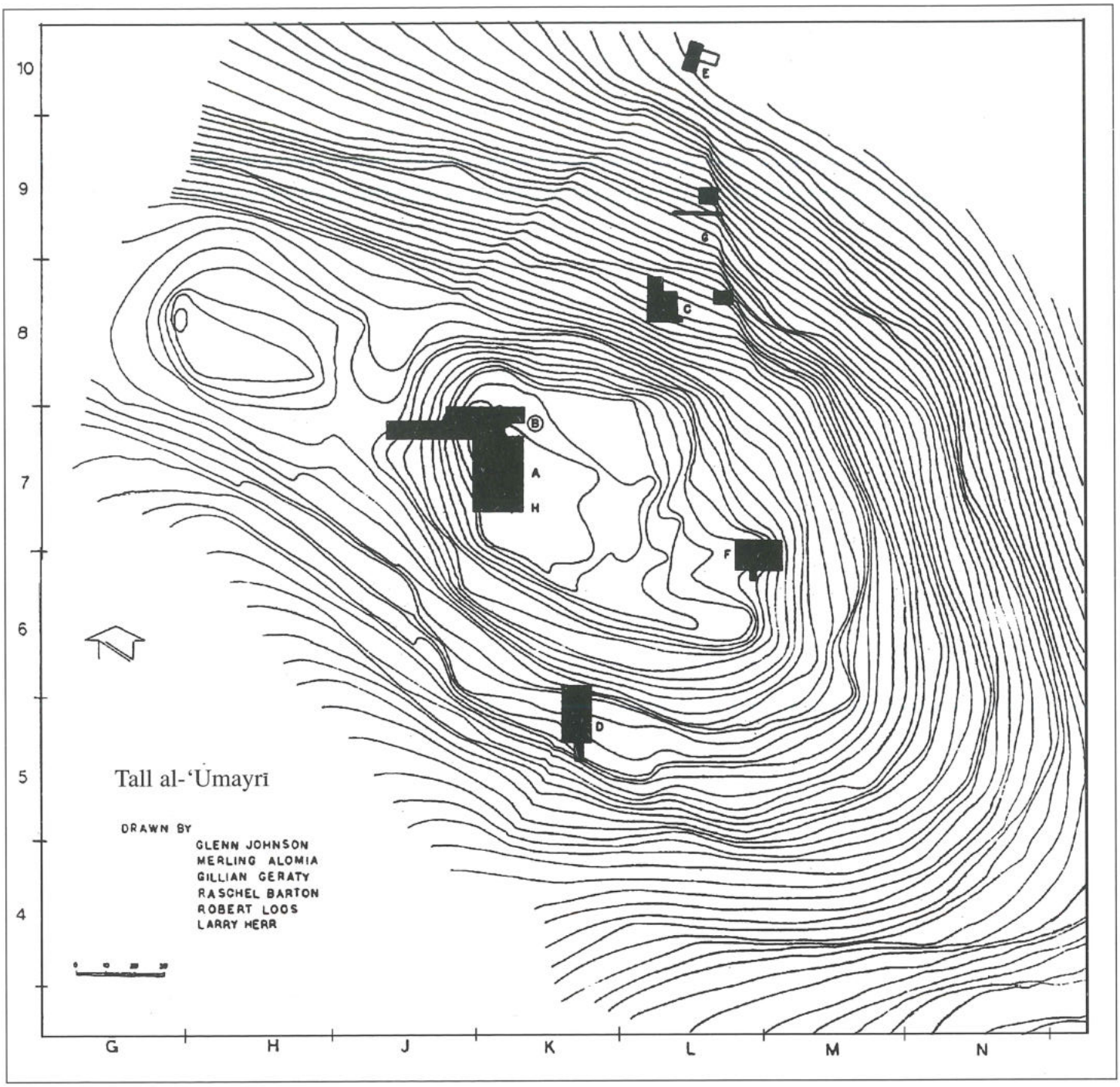
We also used SR on the southern 70 m of the south-north transect. More data will be necessary in order to make definitive interpretations of the results, but significant subsurface information is apparent to depths well below the radar penetration. The success of SR investigations indicated promise for further exploration by this technique.

Tall al-'Umayrī (FIG. 3)

The region of Tall al-'Umayrī has received the greatest attention in terms of geophysical investigation by MPP. Starting with the 1984 season, SR provided low-resolution descriptions of the subsurface structure of three apparently agricultural terraces on the southwest flank of the tall. It also revealed the probable depth of human occupational debris to limestone bedrock in the region east of Field A to be in excess of 8 m. The knowledge gained by correlating EMI and GPR signals at Boot Hill has also been put to use in searching for possible tombs along the hillside south of the tall below the 'Ammān National Park. Further analysis of recorded data is necessary to assess the results.

Water source: It is likely that the water source at the northern base of the tall has been a major reason for long-term occupation of the site. We have mapped a portion of the area around this facility using GPR and SR. In seven GPR profiles of the vicinity, radar penetration obtained reflections indicating the presence of subsurface features. These included probable piping or channels adjacent to the existing opening, which might otherwise have been located only with extensive excavation. Features up to 2-3 m deep were detected by radar, clay deposition not presenting the serious limitation we feared. Additional transects, possibly combined with further excavation, would be helpful in describing more completely subsurface features in the area surrounding the water source.

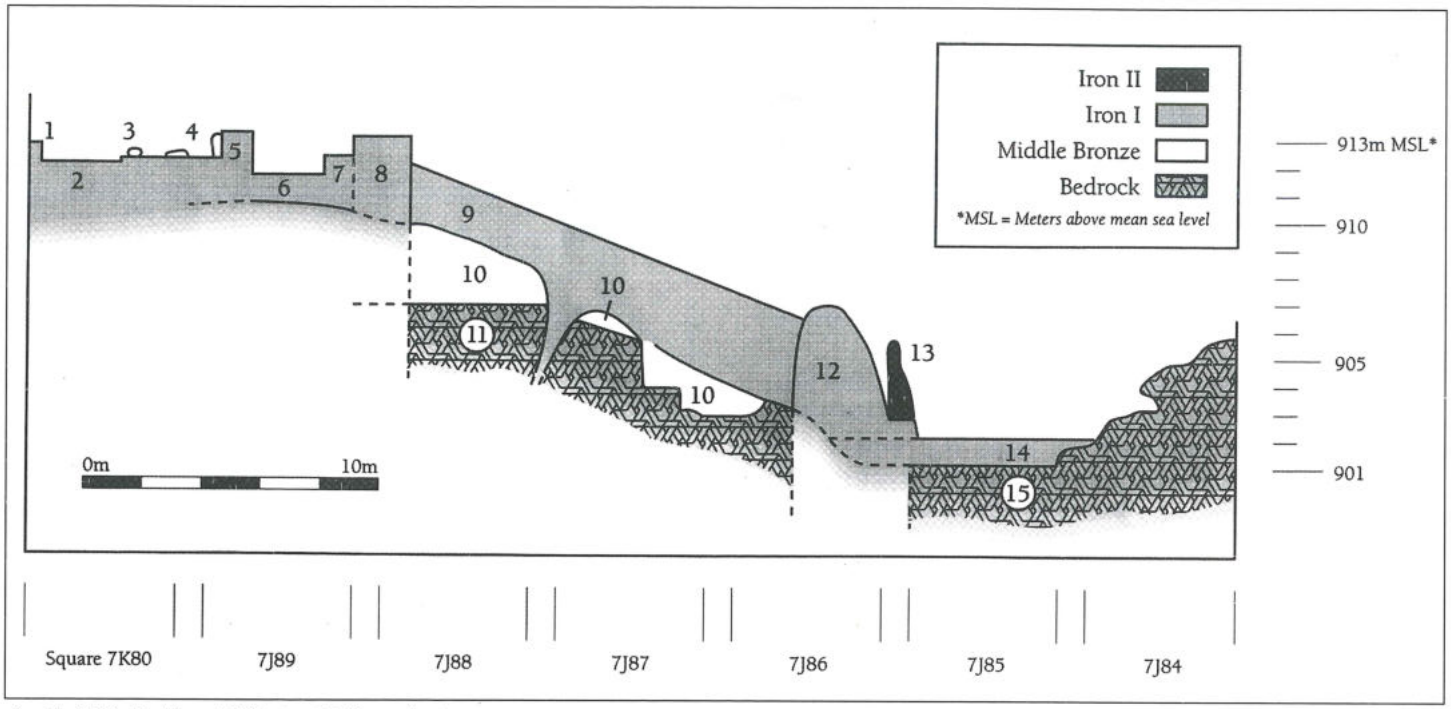
Western defenses: Perhaps the most intriguing use of GPR at al-'Umayrī is tied to the western defense system (Field B). It dates to the early Iron I period and represents one of the earliest and best preserved casemate wall sys-



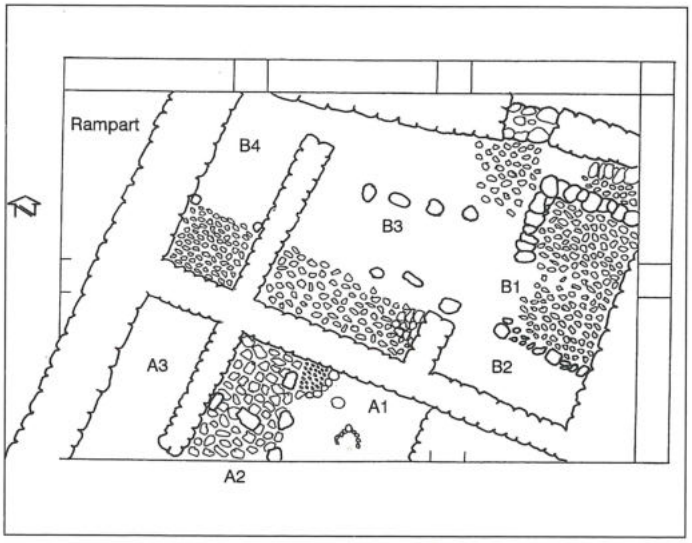
3. Topographic Map of Tall al -'Umayrī.

tems extant anywhere in Palestine. Its construction following an earthquake around 1200 BCE included a casemate wall, a beaten-earth rampart which incorporated a lateral pyramidal row of revetment stones embedded into and across the surface of the glacis, a large retaining wall at the base of the rampart, and a dry moat (FIG. 4). A massive and fiery destruction a few decades later preserved the system and adjoining buildings inside the wall.

Given the nature of the transition between the Late Bronze Age and the early Iron I period in the hill country of Palestine, characterized predominantly by the establishment of small agrarian settlements, a site with defense expenditures of this magnitude signals tremendous economic and political significance. Two buildings thus far excavated inside the wall (FIG. 5) significantly enhance our understanding of resource exploitation and human occupation at the site. Building A encompassed a domestic food-preparation area (A1), separated in antiquity by posts and (likely) a curtain wall from a room with religious significance (A2), and a casemate storeroom (A3)



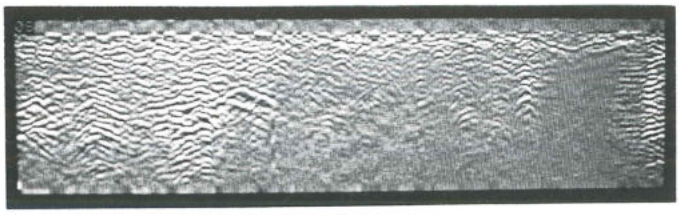
4. Field B: Section of Western Defense System.
Key:
(1) Eastern wall of building.
(2) Beaten-earth surface of food-preparation area.
(3) One of three post-bases (perpendicular to the section), likely supporting a curtain wall between food-preparation area and cultic room .
(4) Flat stone (altar?) on pavement facing standing stone against inner casemate wall.
(5) Inner casemate wall.
(6) Beaten-earth surface of casemate storeroom.
(7) Ladder platform for access to upper story.
(8) Outer casemate wall.
(9) Iron I rampart.
(10) Middle Bronze rampart (fractured by earthquake).
(11) Bedrock .
(12) Iron I defense / retaining wall .
(13) Iron II defense / retaining wall.
(14) Iron I moat base .
(15) Bedrock beneath Middle Bronze moat base.



5. Field B: Western Perimeter Early Iron I Buildings A and B .

containing 12-15 collared pithoi used for grain storage. Building B, adjacent to Building A on the north, incorporated additional rooms, including a large pillared room (B3) and an additional casemate storeroom (B4) holding over 30 pithoi.

The western defense system provided a ready test case for evaluating the usefulness of GPR at al-'Umayrī. In 1992 we made a GPR transect along the south balk of the already exposed defenses (casemate wall, rampart, revetment row of stones, retaining wall, but not the dry moat, which was not yet excavated). This process allowed us the opportunity to correlate GPR results with what we knew from excavation. Twenty additional 30 to 40 m transects were run up the western slope and radially from the northwest corner of the acropolis. Not only did the findings correlate positively (FIG. 6), they also provided the basis for adjustments to the GPR profiles which has helped us calibrate subsequent results. In addition, GPR

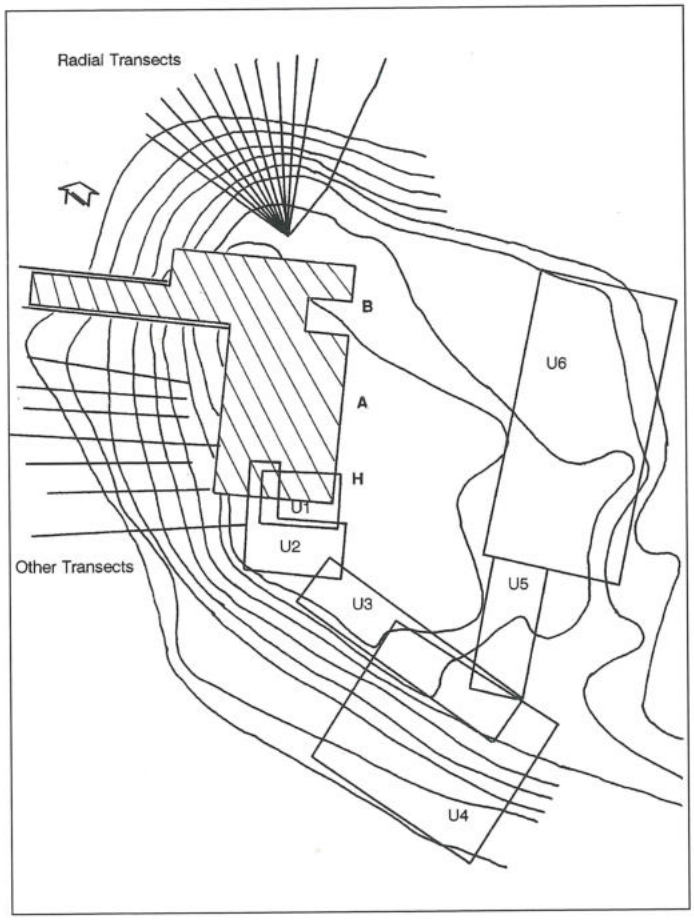


6. Field B: GPR Section of Defense System.

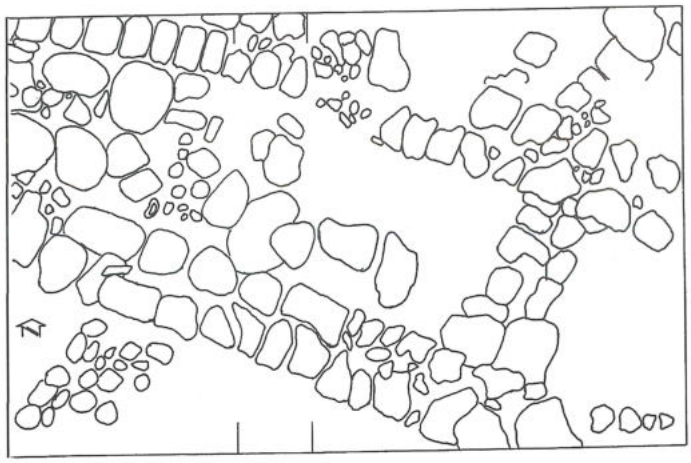
indicated the presence of a deep structure at the base of the defenses, a structure that, when excavated, proved to be the massive dry moat.

Ammonite Citadel: Two areas (U1, 10 x 15 m and U2, 18 x 20 m) adjacent to Field A on the south (covering part of what was later excavated as Field H), were criss-crossed with GPR transects in a grid on 0.6 m centers (see FIG. 7). Analysis of the GPR data for the area and production of a resultant map revealed subsurface walls similar in width and orientation to those excavated in Field A. Subsequent excavations in the newly opened Field H in this area have confirmed the presence, size and location of the walls (FIGS. 8 and 9).

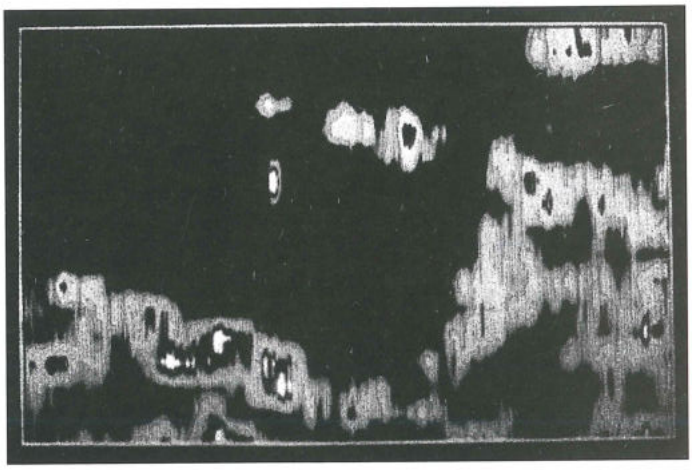
Southern Perimeter: A 10 x 44 m area (U3) on a 0.5 m grid along the south rim of the tall (FIG. 10) tied together the region south of Field A and a 30 x 35 m pattern (U4) on the upper south slope. The U3 pattern has shown that



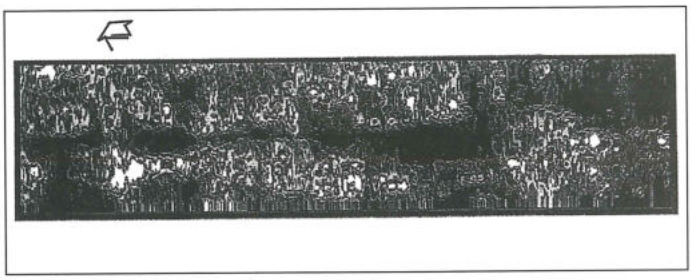
7. Al-'Umayrī Topographic Map With GPR Grids.



8. Field H (eastern half): Architectural Top Plan.



9. Field H: GPR Top Plan.



10. Al-'Umayrī South Rim GPR Top Plan (U3).

the excavated walls in Fields A and H are parallel to an apparent casemate wall extending east along the south rim of the acropolis. A possible gate post appears at the east end of U3 and in the U4 upper south slope area of GPR investigation.

Trans-acropolis Area: North from the east end of U3, a 10 x 24 m (U5) and a subsequent 25 x 53 m pattern (U6) traversed the central portion of the acropolis and the upper north rim using a 0.5 m grid. Thus, we have mapped several portions across the acropolis of the tall (north-south), including some parts of the southern and northern perimeter defenses. Although preliminary findings are tentative, expansion of the use of GPR and

improvements in GPR technology and computer software have drastically enhanced detail and have cleared "noise" from the readings, allowing us a much more accurate picture of subsurface architectural structures. Initial assessments of collected data for this part of al-'Umayrī are extremely promising, but demand more time for analysis.

In the future we plan to examine more of the acropolis of the tall, paying particular attention to perimeter walls and other major observable features and focusing on Iron I structures if possible. It appears that only the southern half of the acropolis was occupied to any significant extent with buildings following the destruction of the Iron I site, leaving virtually untouched the northern half of the tall. This factor will be extremely helpful as we attempt to map out the Iron I settlement.

Implications of Subsurface Mapping for Understanding Landscape Resources and Human Occupation in Ancient Jordan

Traditional methods of excavation and survey will continue to serve archaeologists well in their attempts to explore landscape resources and human occupation in ancient Jordan. Each year, field projects yield new insights into agricultural practices, hydrological exploitation of annual rainfall, pastoral strategies, and other economic structures of subsistence and marketing. These all have to do with the utilization of landscape resources. The Mādabā Plains Project has added the technology of subsurface mapping in its endeavor to reconstruct a picture of ancient resource management. Thus, in a non-destructive fashion, one can examine data which will contribute to our understanding and assessment of water and land management. In the process, areas deserving excavation can be identified with greater certainty and more efficiently than by means of traditional methods alone.

Subsurface mapping technology has also supplemented our knowledge of human occupation in both rural and urban contexts. Although no substitute for careful excavation, these techniques can extend the range and scope of our awareness of occupational features such as architecture, defenses, and cemeteries in minimal time, with little or no disruption of existing conditions, and in a fashion consistently growing more reliable.

Acknowledgements

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Using a Geographic Information System to Create Probability Models for Sites with Tombs from the al-'Umayrī Regional Survey

Archaeologists have long been interested in the interplay between ancient humans and their environment. In an attempt to better understand this relationship, the Mādabā Plains Project has included a geographic information system (GIS) in its research design since 1992, using it to create, among other things, environmental probability models for various sites from the al-'Umayrī regional survey. These models focus on groups of sites selected from the survey database which share either temporal or functional similarities. For example, models have been constructed for sites with Iron II pottery and for sites identified as farmsteads. For this paper, environmental probability models will be created for Classical period sites from the al-'Umayrī regional survey, focusing on those sites with tombs. Tombs were selected because research into funerary customs is becoming an increasingly important component of the Mādabā Plains Project and because they are one of the few archaeological features from the survey that can be characterized as fundamentally non-agricultural, providing an opportunity to test the effectiveness of environmental probability models for non-agricultural sites.

During the course of this study, two questions will be answered. First, is it possible to identify an environmental signature for sites with tombs? In archaeological terms, an environmental signature is an identification of the environmental variables which were factors in the selection of a particular location for a particular type of archaeological site. For example, a farmstead should be located in an environmental setting best suited for agriculture, while a city might be situated in an environment best suited for its military and economic survival. The second question is dependent on a positive response to the first. If it is possible to identify an environmental signature for sites with tombs, can we be sure that this signature actually reflects the tombs? In other words, is it the tomb which determined the environmental signature, or was it the other components of the site? In order to answer these questions, this paper will begin with brief discussions of the archaeological material and of GIS, and then move to the creation of probability models.

The Archaeological Material

The al-'Umayrī regional survey has been examining the area contained within a five kilometer radius of Tall al-'Umayrī since 1984. A large project, run in conjunction with the excavation at Tall al-'Umayrī , this survey has fielded several teams, each concentrating on different aspects of the region. These teams have included hydrologists, ethnographers, artists, geologists, architects, linguists, GIS programmers, and archaeologists. During five field seasons, survey teams have located and recorded 133 sites. Of this number, 42 sites had funerary features, that is cemeteries, isolated tombs, and occupational sites with one or more tombs (Boling 1989; Christopherson 1996; Geraty *et al.* 1989; LaBianca 1991; Younker 1991).

The most intensive involvement with funerary remains in the region has concentrated principally on the excavation of Bronze Age tombs. In 1992, excavation took place at a relatively small cemetery at Umm al-Kundom (Site 73) 3 km south of Tall al-'Umayrī (Waterhouse and Krug 1993). A larger cemetery, half a kilometer south-east of Tall al-'Umayrī (Site 135), was excavated by the Department of Antiquities of Jordan in 1992-1993 by Waheeb and Palumbo (Waheeb 1994; Waheeb and Palumbo 1993). It produced one of the richest EB IV tomb repertoires in the southern Levant. During the 1994 field season, survey and excavation of this cemetery were continued by the Mādabā Plains Project with another 10 shaft tombs and 20 cistern-shaped installations either identified or excavated. Additionally, an isolated Early Bronze I megalithic tomb was discovered in 1994 and partially excavated on the southeastern slope of Tall al-'Umayrī . It contained an impacted bone heap of some 20 individuals along with 20 vessels dating to EBIB (Dabrowski *et al.* 1994). Finally, a hewn cave/tomb with a stepped entrance dated to MB IIC was also found on the southeastern slope of Tall al-'Umayrī and partially excavated in 1994. It contained at least 15 articulated skeletons.

In addition to these excavations, the al-'Umayrī regional survey has also located and recorded numerous Classical period tombs during the course of its work. Of the 42 sites with funerary components, 30 had Roman/Byzantine tombs. Given the low numbers of sites boasting tombs from other periods, these 30 sites provide the only sample of sufficient size to provide a statistically valid model.

For this reason, models constructed for this paper concentrated on sites with tombs from the Classical period.

Geographic Information Systems

Of great importance in government agencies and in the private sector, geographic information systems are quickly infiltrating academic circles, including anthropology and archaeology departments. A GIS can be defined as a system of computer hardware and software components arranged around digital databases which store, manipulate, capture, analyze, create, and display spatially referenced data. Because they reference data spatially, GIS are easily adaptable to many different disciplines, including archaeology where location information for everything from individual artifacts in an excavation to sites in a regional survey are recorded. Unlike paper maps which store multiple data themes on a single sheet (e.g. roads, cities, hypsography, etc.), GIS store data themes in individual layers. A layer for roads, a layer for elevation, a layer for Iron Age sites. Because these map layers are referenced to a common coordinate system, they can be electronically overlaid to create user specific maps which can include any combination of data themes.

Geographic information systems come in two basic types, vector and raster. Because of the differences in how they manage spatial data each has its own particular strengths and weaknesses, and for this project a raster GIS was used. In a raster GIS, data are stored in a grid of columns and rows, much like a spreadsheet, which correspond to X and Y coordinates. The intersection of each row and column forms a cell which represents a specific area in the real world and contains a Z value, or number which can represent anything from elevation, to sites, to soil types. In essence, in a raster GIS, maps can be seen as a large sheet of numbers. Because these numbers can change continuously across the surface of the map a raster-based GIS is good at modeling the environment, which also changes continuously across the surface of the earth.

Modeling the Environment

As the name suggests, environmental probability models require the capture and manipulation of environmental data. This generally means using GIS or CAD software to digitally encode the data contained in paper maps. Data for natural and cultural features in the al-'Umayrī region were digitized using Auto CAD 10.0 (Autodesk Inc. 1989) and PC ARC/INFO 3.4D (Environmental Systems Research Institute 1990), the basic map being the Jordan 1:25,000 series. Data for hypsography, hydrography, and roads were taken from the following map sheets:

- 'Ammān: 1:25,000 Topographical Map 225-145 (D. Survey 1958a)
- Nā'ūr: 1:25,000 Topographical Map 225:135 (D. Survey 1958b)

Additionally, surficial geology and soil maps were created by the Project's geologist, Douglas W. Schnurrenberger, based on 1:10,000 aerial photographs and field samples.

All coordinate information for this project was based on the Palestine Grid System. The digitized area was contained within the following coordinates:

Minimum X = 228000 m East
Maximum X = 240000 m East
Minimum Y = 136000 m North
Maximum Y = 148000 m North

GIS software imposed a grid with cells of 50 x 50 meters onto the 144 square kilometers contained within these coordinates. This raster contained 240 rows and 240 columns, creating 57,600 cells. Of the cells in the grid, 31,253 are contained within the five kilometer radius of the al-'Umayrī regional survey. All statistical analyses were carried out based on values found inside this radius.

The creation of environmental probability models necessitates the building of a number of environmental map layers in a GIS. In all, fourteen such layers were constructed for the al-'Umayrī region in ARC/INFO 7.0.2 (Environmental Systems Research Institute 1995) running on a UNIX platform. Brief descriptions of each variable follow.

Elevation: this map layer contained a digital elevation model (DEM) of the 144 square kilometers digitized for the project. Using the elevation contours contained in the 1:25000 maps, ARC/INFO interpolated elevation values for those cells lying between contours to create the DEM. The importance of this map layer cannot be overstated since many of the environmental variables used in this study model some aspect of the region's topography and were derived from this DEM.

Aspect: interpolated from the DEM, the grid cells in this map layer contained numbers which reflect the direction each cell faces. Aspect measurements are typically made on a 0-360 degree scale, but using these numbers in a quantitative analysis creates a problem since both 1° and 359° indicate a north facing slope, but quantitatively 359 is much greater than 1. Following Kvamme (Kvamme 1988), this problem was overcome by creating two aspect maps, one measuring north-south aspect and one measuring east-west aspect. For example, in the north-south aspect map, a score of '0' indicates north, '180' south, and scores between could be either east or west.

Relief: also derived from the DEM, three measures of relief, detailing differences in elevation, were calculated within a 200 m radius of each grid cell. Relief above subtracts the elevation in the target cell from the highest elevation in the search radius. Relief below locates the cell within the 200 m radius with the lowest elevation and subtracts it from the target cell. Maximum relief subtracts the lowest elevation from the highest elevation within the neighborhood.

Texture: texture is the standard deviation of all cells within a 200 m radius of the target cell in the DEM. Increasing

variation amongst elevation values in this neighborhood delivers a larger standard deviation, while uniform terrain leads to a smaller standard deviation. Thus, smooth surfaces will yield low texture scores and rough terrain high texture scores.

Ridge Index: this index describes the position in relation to ridges and drainages by interpolating the viewing angle possible for each cell in the DEM. Scores close to 360 indicate hilltop and ridge locations with their wide view angles, low scores correspond to drainages and their narrow view angles, and scores around 180 are indicative of sites located mid-slope or in plains settings.

Shelter: this measure indicates the relative exposure of a particular cell within a 200 meter radius of the target cell. Higher scores indicate exposed areas, rims or hilltops, lower scores indicate sheltered areas, valleys.

Slope: also based on the DEM, this variable is a measurement of the slope of each cell in the raster.

In addition to these topographical themes, four maps based on distance were created. SOIL 1, SOIL 2, SOIL 3: these variables are distance measures to each of the three soil types in the al-'Umayrī region. The GIS calculated the Euclidean distance from each cell in the grid to the soil type in question.

Wādī: this variable is another distance measurement. In this case, the distance measured was to the nearest wadi channel.[1]

Three additional maps were necessary for the construction of the models. The first was sites with Classical period tombs. This layer was created by extracting coordinates for these sites from the al-'Umayrī survey database and exporting them to the GIS. These sites could then be queried against the environmental map layers to discover the environment at sites with tombs. The second layer was sites with Roman or Byzantine pottery. The probability model based on these sites could serve as a control, demonstrating whether or not the environmental signature for the tomb sites was based on the presence of tombs or on some other aspect of Classical period culture. The final map was a random sample of 250 non-site locations within the survey region. This layer was created in Idrisi (Eastman 1992), a PC based GIS developed and distributed by the Clark University Graduate School of Geography. These non-site locations could also be queried against the environmental layers to discover the environment at a random sample of non-site locations.

The Probability Model for Tombs

Archaeological probability models are based on the assumption that ancient humans did not choose the locations for their sites randomly. Although there are a number of ways to approach this question, a proven method is the construction of probability models based on logistic regression (Kvamme 1988 and 1992; Warren 1990). In an archaeological context, this would involve comparing the environment at a sample of archaeological sites to the environment at a sample of randomly located non-sites. For this study, a stepwise logistic regression was used to create the probability model for Roman/ Byzantine period tombs. Stepwise logistic regression compares a site sample to a non-site sample for all available environmental variables and, based on predetermined significance levels, the stepwise process begins adding and subtracting variables in order to create a maximum-likelihood model. Using aggressive significance levels, 0.15 for adding a variable and 0.20 for removing a variable, the fourteen environmental variables in the al-'Umayrī GIS were subjected to the stepwise procedure using STATA, a PC based statistical software package (Computing Resource Center 1992). Within these parameters, four variables, ridge index, distance to type 1 soils, slope, and distance to wadi channels, were found to be significant. (TABLE 1) lists these variables, along with the Y-intercept constant, in the order of their importance to the model.

Table 1. Stepwise logistic regression coefficients for Tomb Model.

Variable	Coef.	t-score	P >|t|
Slope	0.2913825	3.501	0.001
Ridge Index	0.0114524	2.823	0.005
Distance to Wadis	0.0025553	2.150	0.032
Distance to Type 1 Soil	0.0013228	1.988	0.048
Intercept Constant	-7.0896240	-5.481	0.000

The coefficients and t-scores seen in TABLE 1 are products of the logistic regression, and are indicative of the environmental signature of the site sample. Positive coefficients indicate a preference for high values of the corresponding variable, while negative coefficients indicate a preference for low values. Based on the coefficients returned by this regression, it is clear that Roman/Byzantine tombs tended to be located on steeper slopes, near ridges, and away from both type 1 soils and wadi channels. The t-scores indicate the importance of a particular variable within the model. The farther this score is from zero, the more important it is to the model. In this example, slope is more important to the model than is distance to type 1 soils. This importance is reflected in the final column of TABLE 1, which lists the probability of this t-score occurring by chance.

The coefficients in (TABLE 1) also allow the creation of probability models in the GIS. Creation of these models involves rather straightforward math. As noted above raster maps are like big sheets of numbers, and multiplying these numbers by their corresponding regression coefficients creates new maps which are weighted in

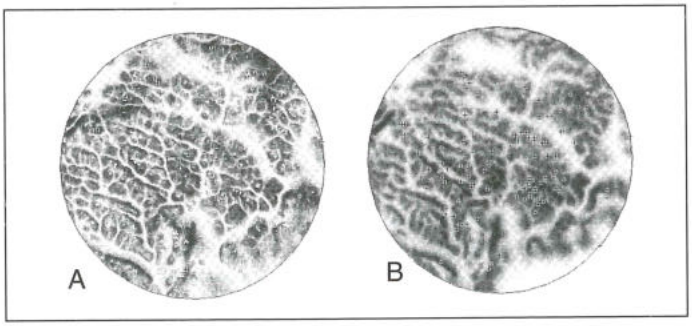
[1] The creation of most of these environmental data themes was accomplished using standard raster GIS manipulations of the digital elevation model (DEM). Additional information concerning the specific algorithms used to create them is available from the authors. Also, since many of these variables have been thoroughly discussed by Kenneth L. Kvamme, additional information about their characteristics and function is available in his publications (Kvamme 1983, 1985, 1989, 1990 and 1992).

favor of the areas most like the site sample. These weighted variables can then be summed on a cell-by-cell basis across the raster. In addition to the weighted variables, the Y-intercept constant of the regression was corrected, to eliminate bias inherent in a differently sized sample, and added to the sum of the weighted variables. Following Warren (Warren 1990), the corrected intercept constant for our model was -4.9693606. Thus the equation for creating the tomb model, was:
D = -4.9693606 + 0.2913825 * (Slope) + 0.0114524 * (Ridge Index) + 0.0025553 * (Distance to Wadi) + 0.0013228 * (Distance to Soil 1) where D represents the model.

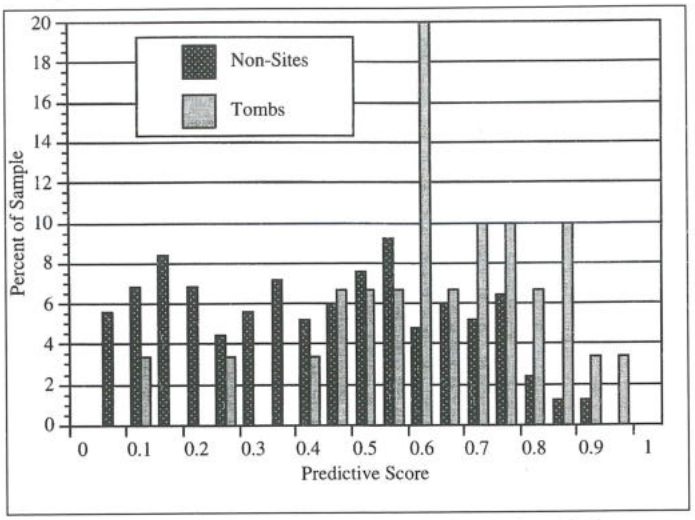
Finally, to clarify the results and facilitate comparisons with other models, it was logistically transformed to rescale the values of the model to a probability score between zero and one for each cell in the raster.[2] These scores indicate trends over the entire surface of the project area, with scores close to zero representing areas dissimilar to the environmental signature of tomb sites and those close to one representing areas similar to the signature of sites with tombs. The resulting GIS map can be seen in (FIG. 1A), with darker areas representing higher probability scores and lighter areas lower scores.

To test the ability of the model to predict the most favorable areas for Classical period tombs, it was queried by both the tomb and the non-site samples. These queries produced the distribution of scores seen in (FIG. 2). If the site selection process for tombs had been random, the scores for both samples would approach a normal distribution. Instead, the tomb sample lies primarily on the right side of the distribution, while the non-site sample is found mainly on the left. This indicates that the site selection process for the tombs in our sample was not random, but tied to the environmental variables discovered in the stepwise logistic regression.

The mid-point in this distribution can be used as a cut-point for predicting site or non-site dividing the probability scores into two groups. Looking at samples to the right of 0.5, those predicted to be sites, we find that the model



1. Probability maps for sites with Classical period tombs (A) and sites with Byzantine pottery (B) . In these maps, dark colors indicate areas with high probability and light colors areas with low probability.



2. Distribution of probability scores for non-sites and tomb sites.

correctly predicted 76.67% of the site sample. The price it paid for this level of prediction was that it incorrectly predicted 36.4% of the non-site sample to be sites. Again, if they were selecting locations for tombs at random, you would expect these percentages to be similar. The fact that 76.67% of the sites are correctly predicted while just 36.4% of the non-site sample was incorrectly predicted indicates that this model represents a 40.27% improvement over chance. In practical terms, if you were interested in finding more sites with Classical period tombs, this model would allow you to concentrate your search in the relatively small portion of the region with high probability scores, just 36%, with the promise that you will find about 76% of the sites you were interested in. The strength of this model answers our first question. Environmental probability models can be used to discern the environmental signature for sites with Classical period tombs.

A Probability Model for Roman/Byzantine Sites in General

Having answered the first question, attention can now be focused on the second, that is, does the model for Roman/Byzantine tombs reflect an environmental selection process specific to these tombs, or merely the selection process for Roman/Byzantine period sites in general? This is an important question since most sites with Classical period tombs also have non-funerary features from the same period. In order to pursue this question, an environmental probability model was constructed for the 112 sites with either Roman or Byzantine pottery. Using the same non-site sample, a stepwise logistic regression was carried out for these sites, yielding the results in (TABLE 2). The regression coefficients indicate that these sites were located atop east facing slopes, at relatively low elevations, near type 3 soils, and away from type 1 soils.

Following the methodology outlined above, the map in

2 A discussion of the procedures used to create logistic regression models, along with further explanation of the various equations used in this paper can be found in works by Warren and Kvamme (Kvamme 1988 and 1992; Warren 1990)

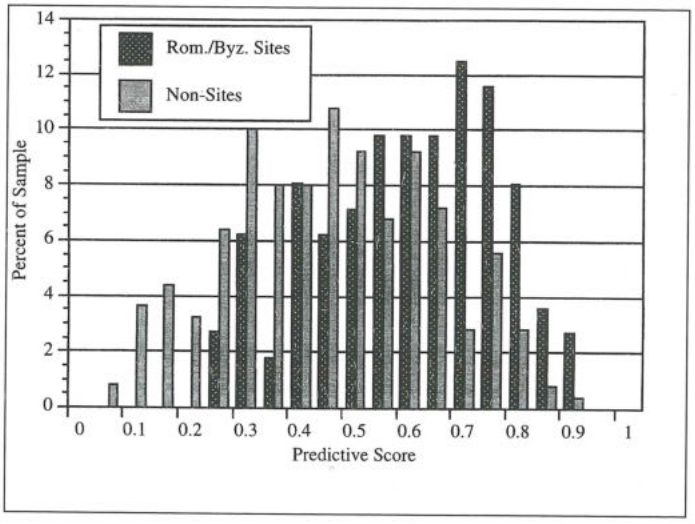
(FIG. 1B) and the histogram in (FIG. 3)were constructed and clear differences between the two models emerged. Most obvious of these differences was that the model for

Table 2. Stepwise logistic regression coefficients for all sites with Rom/Byz Pottery.

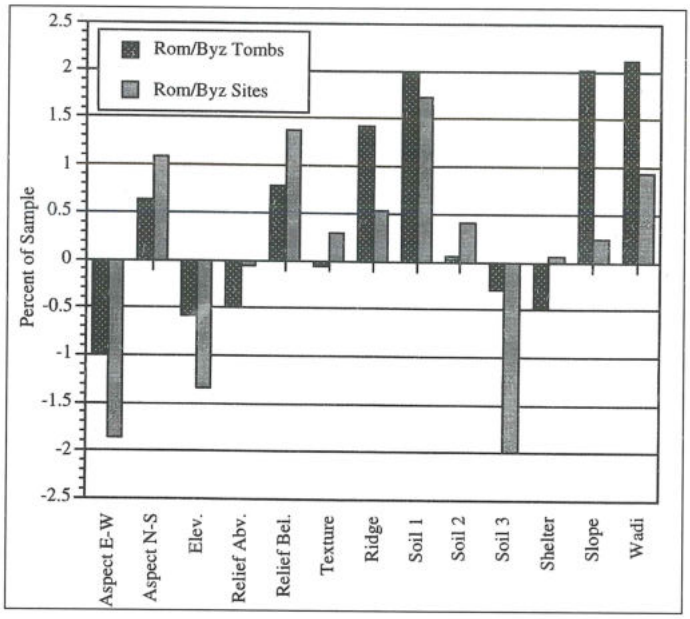
Variable	Coef.	t	P >|t|
Relief Below	0.0718237	4.424	0.000
Distance to Type 3 Soil	-0.0039869	-2.104	0.036
Aspect E-W	-0.0025341	-1.804	0.072
Distance to Type 1 Soil	0.0007943	1.794	0.074
Elevation	-0.0069786	-1.613	0.108
Intercept Constant	5.7457558	X	X

sites with Roman/Byzantine pottery was less efficient. This model correctly predicted only 67.9% of the site sample, while incorrectly predicting 35.6% of the non-sites to be sites, giving it an improvement over chance of 32.3%.

This difference in the efficiency of the two models is indicative of separate agendas used in selecting site locations. In order to highlight these different agendas, an additional logistic regression was performed on both site groupings in which all variables were included. This regression provided a ranking of all variables from most important to least important for both groups. (FIG. 4) is a histogram of the t-scores produced by the regressions. In essence, this graph details the environmental signatures for these two site types, signatures which are characterized more by their differences then their similarities. In all but one instance, variable pairs match in their negative or positive direction, and both models have very similar scores for distance to type 1 soils, but there are striking differences between the two samples for elevation, relief below, distance to soil type 3, distance to wadis, and to a lesser degree for aspect E-W and ridge index. Clearly the



3. Distribution of probability scores for non-sites and Roman/Byzantine sites.



4. Histogram of environmental signatures for tomb sites and Roman/Byzantine sites. Signature based on t-scores returned by logistic regression.

selection process for sites with Classical period tombs was following a different agenda than that for sites with Classical period pottery.

What these agendas were has proven illusive, but some general conclusions can be drawn based on the relative strengths of the models, and on the variables most important to the two site types. The greater strength of the tomb model indicates that the environmental signature for these sites was more focused. That is, there was a clear idea about where tombs should and should not be located during the Roman/Byzantine period. Sites with Roman/Byzantine pottery, on the other hand, had a less restrictive signature, finding suitable locations in a greater variety of environments. This is not unexpected because the sites with tombs are actually a subset of the larger group of sites with Classical period pottery. Since the larger group includes many different site types, indicative of a full-blown, complex society, its environmental signature will naturally reflect this diversity.

More difficult to understand is why particular environments were preferred over others. There are, however, some inferences that can be drawn from the variables most important to the site samples. The signature for tomb sites makes sense given the funerary function of the sites. Based on the variables most important, it seems that they were locating their tombs in areas which avoided both drainages and the best agricultural land. Type 1 soils are located in the wadi bottoms where problems with water run-off and thick alluvial soils are found. Given these conditions, it is not surprising that tomb locations indicate a preference for areas away from both type one soils and wadi channels. This preference is supported by the ridge index and distance to wadi channels for these sites which also suggests an attempt to keep the

tombs out of drainages. Also, by locating tombs on steep slopes they were placing them in the least desirable land agriculturally. Steep slopes require extra effort to farm, since both the construction and maintenance of terraces are labor intensive tasks. Placing tombs on the steeper slopes would not involve this kind of labor intensive work, and, at the same time, would preserve the more gentle terrain for agriculture. Finally, by locating tombs in these areas with this environmental signature, they were placing them in areas of ready-made tomb building material, that is, areas of exposed bedrock. Although it is not certain, it is probable that by the time these tombs were being built, much of the natural vegetation in the region was gone, leaving bedrock exposed as the soil eroded (Christopherson *et al.* 1996). Since the tombs used to create this model were all rock-cut, this ready availability of raw material would surely have been an important consideration to their location.

Sites with Roman/Byzantine pottery are more difficult to characterize. As noted above, this period was one of great economic diversity, a diversity reflected in the lack of a focused environmental signature for these sites. Still, there are a few things that can be said about them. Perhaps most important is their preference for type 3 soils. These soils have the best water and nutrient retention qualities (Christopherson *et al.* 1996) and comprise the best agricultural land in the region. Their preference for locating near these soils, indicates the importance of agriculture in their economy. Their preference for lower elevation and east facing slopes is more problematic. These preferences may reflect a desire to moderate local weather conditions, such as westerly winds or afternoon temperatures, but this is far from certain and it may simply be a social preference for eastern orientation and a desire to avoid climbing the hill every day. Beyond this, it is difficult to say very much about the site selection process for these sites, but what is clear is that the environmental signature for these sites is markedly different from that for sites with Classical period tombs.

Conclusion

This exercise has demonstrated several things concerning archaeology in general and funerary customs specifically, three of which we want to briefly highlight. First, even though tombs are not typically thought of as environmentally dependent, the models discussed here demonstrate that the environment played a significant role in shaping funerary customs in the region of Tall al-'Umayrī. Decisions about tomb location were clearly dependent on environmental factors specific to tombs. Second, geographic information systems provide archaeologists with a new tool for understanding the environment. They provide a level of access to the complexities of environmental interactions that previously were physically impossible. Finally, if even in death the long term structures of the environment were important, as archaeologists we cannot afford to ignore the natural world as we attempt to write archaeological history.

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The Electronic Elaboration of Images: A Rapidly Developping Field

Remote sensing, as one of the computer sciences applications, gives the necessary correct and balanced evaluation within the whole cycle of data processing.

In fact, during the input phase, we need to operate on equipments which can make it possible to acquire information by analogical supports (transparents, maps, photos), and digital supports (cd-rom, tapes, cartridges) in different formats, where format indicates the type of package used in the file creation.

In the processing phase, we have to take into account the need of working on large amounts of data. Then, we need hard disks which are able to contain many gigabytes of information and cpu with such a speed as to minimize the stand-by time between a processing phase and the next one.

Here, too, while choosing the processing software, we have to take into account many aspects, such as the availability of suitable tools for manipulation and image processing execution speed, which does not only depend on the hardware possibilities of the computer, but also on the correct design of the processing software.

The acquisition of software and format which are widely used can be advantageous for a more flexible cooperation within the same work group and between different research organizations. Many of the above considerations are also valid for the output phase. We need to have the possibility to plot, print and memorize the processed products on different supports according to the product we want to produce and this has to be done in such a way as to make it possible to export it to any other computer.

It may serve well to in detail the three phases: input, processing and output. It is difficult to establish the order of importance of the output main devices which contribute to a larger flexibility of data acquisition.

Scanner is a kind of photocopying machine able to read the colours of a picture or a film through digital selection filters and to transform them into figures by scanning its tone and number of colours.

Most suitable scanners for these purposes usually work in the 24 bit true colour mode (that is 16 million colours). Regulation parameters have to allow scaning the image up to the resolution of 1200 dpi supplying files in the most common format. During this operation, one has to keep in mind the final target. If we want to screen the image digital copy, in the original image's size, it is enough to acquire a 72 dpi resolution, that is the resolution of the processor monitor. If we need to print the image or the results of its processing, it is necessary to acquire data at least with a 150/200 dpi resolution for average/low quality printers, as laser or ink-jet. If we want to obtain photographic-quality products with thermal or sublimation full colour printers, we have to acquire data with 400/600 dpi resolution.

It is interesting to see that, increasing scanning resolution, it is possible to obtain on the screen images much more detailed than the original ones. The image acquired at a high resolution will appear larger than the coefficient depending on the quality of the supplies to be digited, as the film characteristics on the file space in the memory.

By acquiring this image at high resolution and visualizing it according to monitor resolution, we have a zoom effect before we apply any kind of processing. During the acquisition phase, it is possible to interact both on the resolution and the parameters which are in charge of brightness and contrast. Furthermore, very important device is the cd-rom reader. It became a standard memorizing system for many companies and organizations who use it in order to distribute their data.

Cd-rom can only be read and this characteristic may appear disadvantageous, but at the same time it guarantees the non-deformability of data. Furthermore, it owns the considerable capacity of about 600 megabytes. Such spaces are necessary, if we consider that memory space of SPOT or TM satellite images can be about 40 megabytes large for each band of the same scene. The seven images of the TM shot bands can then cover more than 300 megabytes equivalent to the available space on the whole disk of a small pc. Magnetic tapes, too, offer a similar availability; and in addition they are rewritable and therefore they are useful tools for memorizing and data exchange.

There exist also rewritable cartridges, back-ups, external hard disks and many other supports. The difference between them is mainly in the different access time to information and in the eventual possibility to rewrite the

support itself. We recommend the use of cd-rom for final storage and cartridges or tapes for exporting or temporary storage.

One has to underline that networks are vey useful as further vehicles for data exchange, both in local (lan) and in the remote (wan) environment. Connections between different processors, personal computers or work stations make information exchange possible between units located in the same laboratory or building and also in different countries.

In the first case, this can give us the possibility to carry out work, where data are acquired, processed and produced distributing specific tasks and responsibilities among the value units of the group or work groups.

In the second case, network communication creates immediate comparison and cooperation between research centres located in different countries, promoting a mutual growth. At a local level, there are many solutions which are feasible by exploiting a software, peculiarities of which range from the simple file transfer to the complete visibility of the connected equipment's features.

In contrast' for a connection at remote level, we need international networks. The most significant one, today, is Internet, whose potential is considerable. At present, it represents a virtual space shared by several millions of users. Internet connects local networks located all over the world.

The update evaluation is of 3 million connected processors and 30 million users. It is difficult to imagine what Internet really is just by giving a simple definition; it would be just like saying that a book is a set of words.

Let us say that Internet consists of a community of individuals in continuous evolution, searching for information, sending messages, supplying data, exchanging ideas, carrying out commercial transactions and so on. Particularly interesting, in Turin, is the project, which is now being carried out, of a town-network via Internet. This idea is the fruit of the cooperation between public and private bodies. The purpose is the distribution of information in a comprehensive way and the re-establishment of a contact between citizens and public administration.

The data, processed in our field, are mainly consisting of large images. The processing phase, therefore, requires fast computers and suitable software. Personal computers have not the sufficient power for responding to our demand. Even by using 486 processors or pentium, we find ourselves in long stand-by times, that is several minutes, for a simple visualization of 50/100 megabyte images. Stand-by times may become considerably longer when particular 'processings' are applied.

Dos is probably the most widespread operative system in the world. It represents a very good standard example, but it has some limitations which derive from the very first design and today evident. According to the different needs and work phases, the choice of computers, operative system and packages is important.

To process a small image (10/20 megabytes) it is enough to use a pc featured as follows: 20 megabytes RAM, 486 processors or more, 1 megabyte hard disk, a true colour video card.

A work station is more suitable for the elaboration of large images. Someone said that a work station is a computer with a big screen, a mouse and a keyboard. If so, a pc might be considered in the same way, but a fan of Unix would not agree. On the contrary, we think that a computer with the Unix operative system is a work station, indeed, like Sun, Digital or, better, Silicon Graphics.

The Unix operative system performed a great evolution in the last 20 years. At the moment, there are many kinds of Unix which share several characteristics but, at the same time, present a few differences in the release that creates obstacles even to the experts. Fortunately, although this system is not a friendly one, many environments similar to MS-Windows have interfaces in their metaphor but not in their philosophy.

Data processing speed depends also on their storage site. RAM is where operations are executed. Access to RAM is at least 10 or 20 times faster than the access to the hard disk. Therefore, the larger the file portion in RAM, the faster the process. If the size of the data to be processed is larger than RAM, data are divided in small blocks which can be contained in RAM. Obviously, the smaller the space at our disposal, the larger the number of blocks transferred from hard disk to RAM. This operation is called SWAP. SWAP operation takes time and makes the execution of image operations slow down. Visualization time can be considerable, too, especially with true colour video cards. Then, we need to have graphic cards connected to fast communication bases.

It is evident that processing speed is not the only responsible for the performance increase, other factors contribute to it: memory availability, access time to hard disk, RAM, graphic cards, data transmission speed between the system units, the system architecture itself. This architecture varies considerably from computer to computer, but differences become much more relevant between a computer and a work station.

Written application for pc and work station are designed in a different way. Some routines, in particular those for memory management, or swap are optimized in the case of the Unix system. The same application written to MS-DOS, MS-Windows, Windows-NT, Unix, etc., can have the same interfaces, although the working engine has a completely different nature.

In remote sensing we have many softwares ranging from applications oriented also to GIS functionalities as Ilwis or Macroimage, up to many others, lacking in features, linked to the data base management, but with the support of more detailed processing tools, as PCI, Er Mapper, or Erdas.

Erdas is the tool we work with: this choice is due to the

same fundamental features that a software should have to be suitable for remote sensing in archaeological environment.

Geometric registration allows us to correct the landscape distortions on satellite images or geometric distortions on aerial photographs, due to unintentional variations of the aircraft route during the shot.

Georeference allows us to attribute to each point of the image a couple of coordinates belonging to a projection system (utm, kilometric).

This operation is useful, as it gives us the possibility of having the real position of the ground object within the required reference system. It enables us to find the visible element on the image but not on the ground, or, on the contrary, to search in the image certain patterns as a result of checking on the ground.

Depending on the work phase or on the target we want to achieve at that precise moment, we will have a different approach. Georeference is an important operation to check if interpretation is correct. Furthermore, the site has to be put on a topographic map, that is why we have to know its exact position on the image in the required reference system, especially in those areas where the anthropic action is dynamic. A clear example is the experience in Jordan.

Software has to be equipped with a complete set of tools which can enable operations as filtering, geometric elements emphasizing, spectral analysis, radiometric analysis.

Image processing, which should not be confused with computer graphics, varies according to the application field. Advertisement, medicine, remote sensing and others use different processing tools. Then, within each discipline, there can be many research fields: as far as remote sensing is concerned, for meteorology, geology, environmental protection, archaeology. For example, the execution of processes, as automatic classification, does not seem so useful in the archaeological field, as it is usually in other fields.

Remote sensing can be defined as an euristic science, where, because of the high variability level of analysed situations, the observer's experience plays a fundamental role.

Then, it is necessary to read images identifying the eventual areas of interest having in mind their morphology, the different kind of vegetation, the geometric data, the elements spatial disposition according to the site history.

The interdisciplinary grade related to this application is evident. Remote sensing, when used by the archaeologist, involves a synergy between different professional identities.

Archaeologists supply ideas and indications about characteristics of the elements in the area. Processing and interpretation produce, as a result, the best indication about the objects on the ground.

This data has to be read again and interpreted by 'the eye' of the archaeologist himself, who, within this armonic cooperation, can free himself from the intrinsic meaning of concepts as pixel or byte.

In any case, we have to briefly explain the pixel concept. Image processing through computer involves a passage from the analogous world (real) to the digital world (image representation in the computer). Cinema represents an example of a passage from real to imaginary. The human eye is satisfied with a perception of about 28 photograms per second to have a full motion vision. This means that, by choosing only 28 photograms, we are able to reconstruct, or better, to have the illusion of reconstructing, an infinite number of photograms in that second. It is just like trying to represent a function describing only a few values. If we look at the scene in the slow-motion, that is, if we try to see what is happening between photograms, we notice we need more than 28 photograms. Let us say that cinema samples reality.

We carry out a similar operation when making the passage from analogous images to digital images. We sample the real image by choosing to represent a certain number of points per inch. The larger the number of points, the better the image definition; so, as a consequence, information loss in this analogous-digital passage is less.

Every point of the image is represented by a pixel. Pixel consists of three integer values (x,y,i) where 'x' and 'y' represent the spatial coordinates of the point in the image and 'i' represents the value of the point brightness intensity.

Pixel is the fundamental element of image. A TM scene, about 180 km large, is represented by a set of 7000 lines which are themselves of about 7000 pixels. In this case every pixel represents an area 30 m x 30 m large, equal to 900 sq. m. The information contained in a pixel is not easily retrievable. Anyway, it is possible to obtain interesting information, if the element contained in those 900 sq. m is sufficiently reflecting so as to influence the near pixels. Every kind of images represents reality with a resolution which can range from the TM 30 m to the SPOT 20 m, to the panchromatic 20 m and so as on up to resolutions of a few centimetres in low altitude shots.

The concept of 'infinite' is an abstraction that comes very useful in mathematics. Unfortunately, within a computer we are tied up in finite spaces and quantities. This gives rise to some limitations in the representation of images. The most evident one is the space they occupy in the memory. An image in grey scale (256 tones) needs 256 different representations per pixel. Then we must be able to attribute one of those 256 available colours, chosen in an infinite set of colours, to every pixel of the image.

To be able to represent different combinations of 'n' with exponent 'm', we need 'n' objects to be permuted in 'm' different positions. In the binary system, adopted by computers, we have at our disposal 2 objects: 0 and 1.

Then, we need 3 positions to obtain 256 combinations. This means that an image consisting of 512 lines and 512 columns in grey scale occupies 512 x 512 x 8 bit = 2 w.e. 9 x 2 w.e. 9 bytes = 2 w.e. 8 x 2 w.e. 10 bytes = 256 kbytes.

A TM scene has a size of about 7000 lines x 7000 columns and therefore is 50 Mbytes large for each of the 7 bands. Any additive synthesis will be about 150 Mbytes large and the 7 bands all together will be about 350 Mbytes large. Any processing on each band costs at least 7000 x 7000 = 14 million operations.

If we apply a filter with 3 x 3 kernel to an additive synthesis, we will have about 756 million operations. Such an amount of data and operations can be managed only by particular softwares and hardwares.

If the computer is able to carry out a million operations per second, this simple processing costs about 12 minutes. By using a work station, this working time is reduced to about one minute with a processing power of about 20 million operations per second.

A further necessary characteristic for a software is the possibility of vectorializing the available digital data. Vectorialization of raster images is an old problem. There are softwares designed exclusively for this problem, which has not been definitively solved, yet. It is very useful to supply vectorial data in the output phase. Then, they can be processed by softwares as Autocad or also plotted in order to obtain maps, the reading of which is interesting if compared or overlaid to raster prints.

Many of the considerations made about input are valid for output, too. It is useful to be able to produce both paper and digital results in a large number of formats.

We recommend sublimation full colour printers or printers that can contain the information loss in the lesser possible extent during the digital-analogical passage (opposite to the previous one). It is also useful to produce prints in grey scale only if these have a photographic quality obtained with a thermal printer. For the production of large prints we can use raster or vectorial plotters.

Unfortunately, the cost of this equipment is rather high but often, when equipping a laboratory, we are obliged to make very definite choices. External rewritable units and tape readers are indispensable for digital output. The possibility to export with different support and format makes exchange and information storage flexible.

It is clear that, today, space and time concepts should be reinterpreted. Computer science proposes solutions and work methodologies, which although they do not escape from the above mentioned bounds, they themselves influence these bounds. The above represents an evolution of the communication.

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Use of SPOT Satellite Data for the Mapping of Floods in the Archaeological Site of Petra

Introduction

At the time when economic development in the Hashemite Kingdom of Jordan (HKJ) is the priority for a successful peace process, the Royal Jordanian Geographic Center (RJGC) is giving the utmost importance to the use of remote sensing and Geographic Information System (GIS) techniques in several areas of applications :

- Topographic maps updating
- Ground water recharge areas delineation
- Surface water management
- Dam sites location
- Desertification process monitoring
- Agricultural land suitability maps compilation

One of the vital components of the economic development in the HKJ is water resources management and the preservation of antiquities, cultural heritage and environment in the Petra region. Several times, the Wādī Mūsā area, including the archaeological site of Petra, was devastated by floods from heavy rains and/or snow. The most recent floods affected Petra in November 1994.

As a contribution to the large national action required for the preservation of the archaeological site of Petra, RJGC is carrying out a study for the delineation of areas subject to floods in the Wādī Mūsā Basin. The results of this study will consist of a map locating the extent of areas endangered by floods. Such a map constitutes an important input for decision makers to undertake measures in order to minimize damage and environmental degradation caused by eventual floods. This map is also very useful for other applications such as better resources management including location of sites suitable for dam implementation in order to supply water for Wādī Mūsā Basin inhabitants and tourists needs, as well as to protect areas endangered by floods in Petra

The delineation of areas endangered by floods in the Wādī Mūsā Basin is based on a mathematical model which takes into account the parameters affecting run-off potential. Investigations carried out until the writing of this paper are presented in the following sections. Final results and other investigations required for flood modelling will be published elsewhere.

Schultz (1993) mentioned fields of application of remote sensing in hydrology as being: rainfall, evapotranspiration, soil moisture, groundwater, surface water, snow and ice, sediments and water quality as well as hydrological modeling. A discussion of hydrological modeling is given by Schultz (1994). In this discussion, examples of the use of remote sensing data for the estimation of parameters and model input are given. Also, examples of models where remote sensing data and GIS play a dominant role are shown.

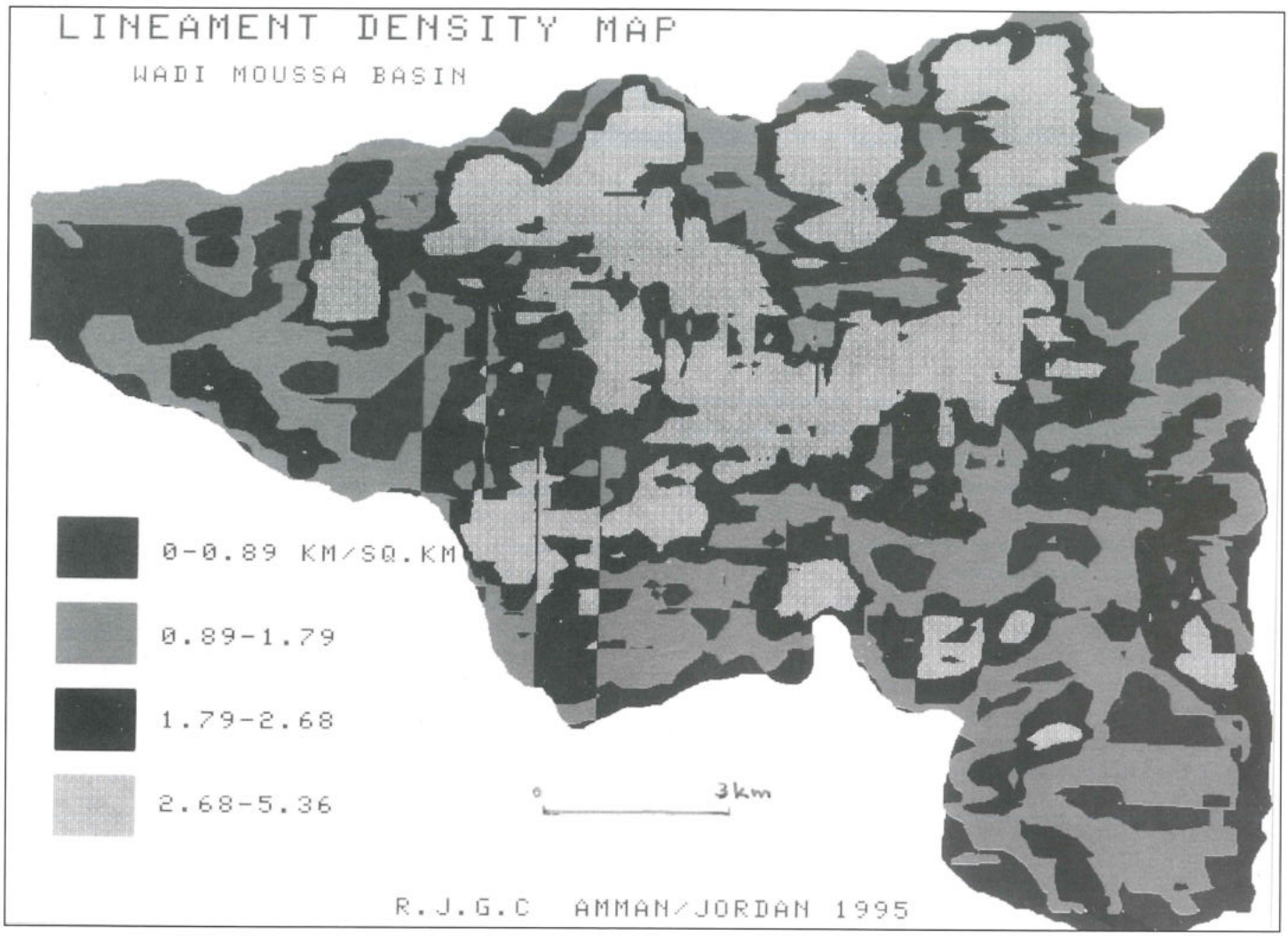
In a brief review of research in remote sensing of water resources, Rango (1994) stated that remote sensing data was being used operationally in precipitation estimates, soil moisture measurements for irrigation scheduling, snow water equivalent and snow cover extent assessments, seasonal and short term snow melt run-off forecasts, and surface water inventories. Rango (1994) indicated that the use of LANDSAT-MSS data as input to produce flood flow curves reduces the cost of obtaining required land cover data to one-third of the cost of conventional techniques for basins larger than 25 sq. km. It is also stated (Rango 1994) that the use of LANDSAT-TM and SPOT reduces the effective basin size to at least 10 sq. km-and possibly smaller. One of our study objectives is to determine the accuracy of SPOT-XS data for a basin size equal to 174 sq. km which is approximately the size of the catchment where the archaeological site of Petra is located.

Lineament Density Map Compilation

The lineament density map is obtained using SPOT-XS image band 2, on which a directional filtering is applied in 4 directions; north-south, east-west, north-east and north-west with a filter size of 3 X 3. These filters provide lineaments in different directions. A manual drawing of lineaments is done and then the lineament density map is compiled. Results show that the lineament density values vary between 0 and 5.36 km/sq. km. The lineament density values are subdivided into 4 classes of values. FIG.1 shows the resulting lineament density map and TABLE 1 contains the classes and percentage of the area corres ponding to each class relative to the total area of the catchment.

Land-Use Classification

The land-use map is produced from SPOT-XS imagery. The method consists of a manual classification on the



1. The resulting lineament density map.

Table 1. Lineament density values.

Class	Density (km/sq. km)	Percentage
1	0 - 0.89	46.77 %
2	0.89 - 1.79	20.42 %
3	1.79 - 2.68	18.98 %
4	2.68 - 5.36	13.83 %

principal component of the SPOT-XS three bands in order to extract rocky and alluvial land classes. Other classes are obtained by a supervised classification using maximum likelihood algorithm. A median filter of 5 X 5 size is applied in order to remove irregularities. FIG. 2 shows the resulting land-use map and TABLE 2 contains information relative to each land-use class.

Vegetation Cover Map Production

The vegetation cover map is produced by the extraction of a vegetation index from SPOT-XS imagery. A threshold of vegetation is done by a visual interpretation of the vegetation index combined with a false color composite of SPOT-XS bands 3, 2, 1. This threshold is done to separate

Table 2. Land use values.

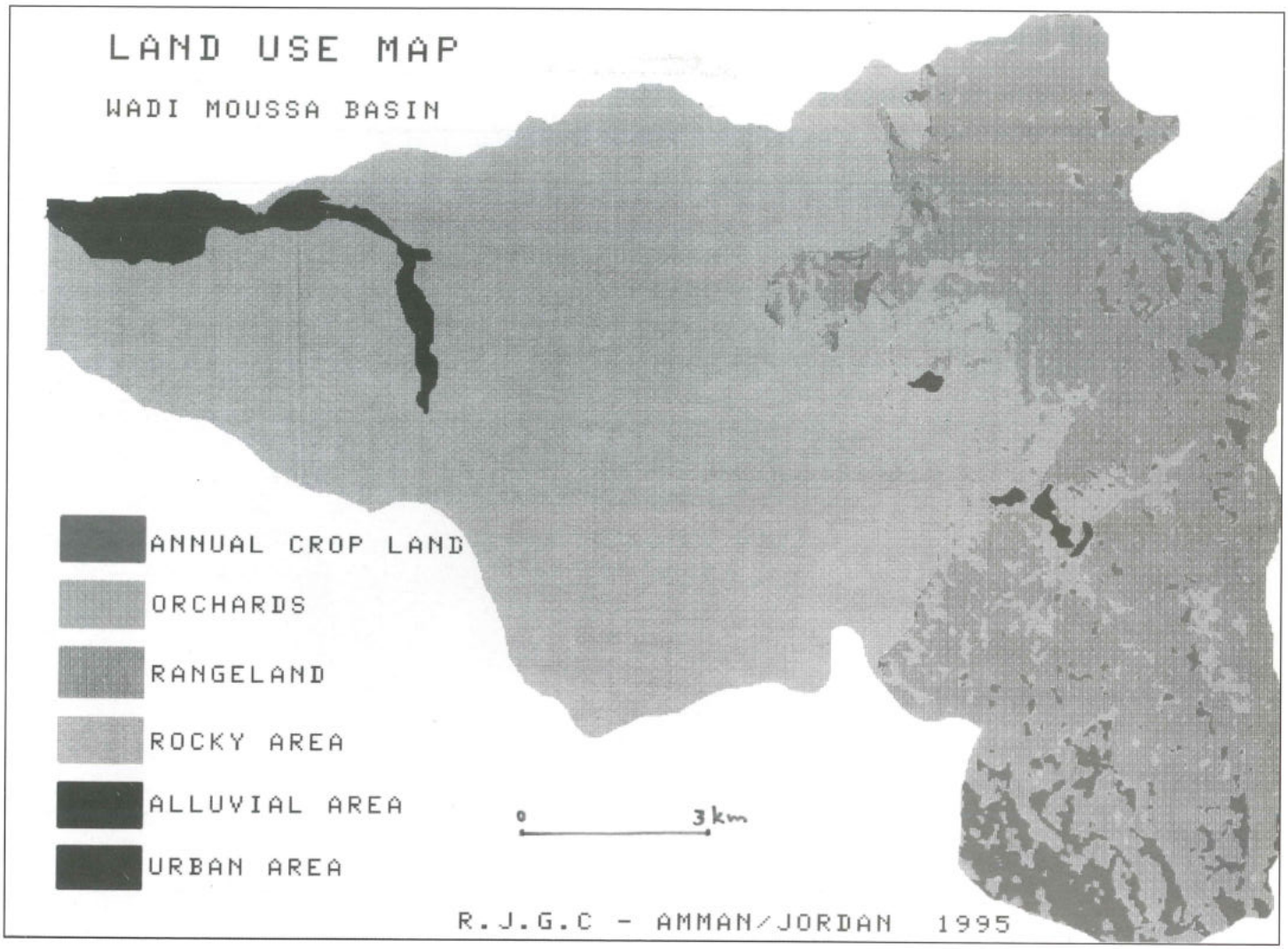
Class	Area (sq. km)	Percentage
Annual Crop	9.7	5.6 %
Orchards	2.5	1.6 %
Range Land	55.4	31.7 %
Rocky	101.0	58.0 %
Alluvial	4.5	2.7 %
Urban	0.5	0.4 %

lands covered by vegetation from other types of land. A density slices classification is then applied to land covered by vegetation in order to subdivide the land into 2 classes: low and high density vegetation. A median filter (5 X 5) is applied to generalize the classes. TABLE 3 provides information on the area corresponding to each class. The resulting vegetation cover map is shown in FIG.3.

DATA

Remote sensing data may be used by hydrological models in two distinctly different fashions (Schultz 1994) :

- as a basis for model parameter estimation



2. The resulting land use map.

Table 3. Vegetation cover values.

Class	Area (sq. km)	Percentage
Low Vegetation	11.8	7 %
High Vegetation	6.6	4 %
No Vegetation	155.2	89 %

- as model input

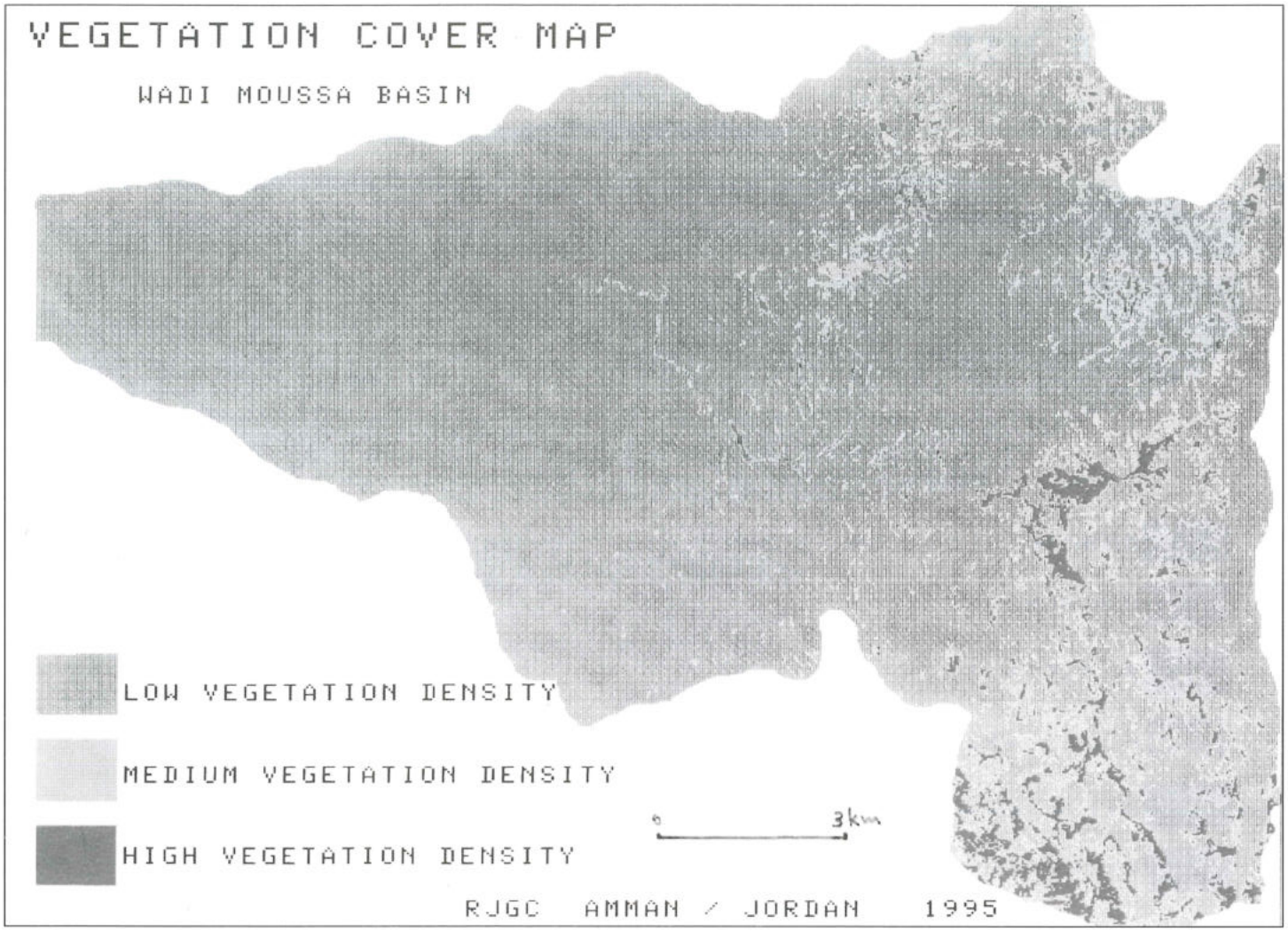
Satellite data, combined with other data derived from maps are used to specify catchment characteristics which are hydrologically relevant. The data which is used in this study consists of :

1. *Topographic Maps of Petra and Bi'r-Khdad (1:50,000):* A digital terrain model (DTM) is extracted from these maps. This DTM is used to derive hydrologically relevant information such as land slope (relevant for flow velocity) and exposure to the sun (relevant for evapotranspiration).

2. *SPOT Images :* A SPOT-XS image of 7 April, 1986 and a SPOT-P image of 18 August, 1990 are used to derive a land-use classification and a vegetation index which are both related to evapotranspiration and soil water storage model parameters. The SPOT-XS band 2 image is used to extract lineament information which is relevant for infiltration.

Flood Modelling

Flood mapping can be done using multitemporal analysis of satellite data recorded before and during/after floods, if such data is available. Satellite images (SPOT, LANDSAT, ERS-1) archives have been consulted for the period between January 1986 and February 1995, taking into consideration precipitation and run-off measurements collected over the Wādī Mūsā Basin during the same period. It was not possible to find any cloud-free image when floods occurred. It is not always easy to acquire a real-time image of floods, as clouds frequently are present when floods occur, and the use of Radar images may require to program the satellite before an eventual flood which increases image cost. Therefore, a flood modelling technique, which transforms rainfall input



3. The resulting vegetation cover map.

into run-off data must be made available in order to overcome the difficulties encountered when the multitemporal analysis method is adopted.

Generation of a Flow Direction Map

This map can be generated from elevation values of the DTM which is obtained from digitized contour lines of the 1/50,000 topographic map. The flow direction map is used to extract the water route downhill from pixel to pixel, eventually reaching the nearest wadi, and then reaching main wadis until arriving at the catchment outlet.

Hydrologically Similar Units (HSUs) Map Extraction

A HSUs map can be extracted from merging different hydrological parameters affecting the run-off potential. Pixels which behave in a similar way are aggregated into HSUs consisting of pixels which are similar in their land use, lineament density and other parameters. Run-off modelling for the catchement area is done by a combination of the direction flow data with the HSUs map. This results in the computation of the quantity of run-off in each wadi and the total flow in the outlet of the catchment area.

Conclusions and Possible Future Work

Remote sensing and GIS tools are used in flood modelling which results in speeding up the process of floods monitoring. SPOT satellite data are of a great benefit for the estimation of parameters required in flood modelling. GIS techniques allow linkage of data corresponding to different sources of information (images, maps, etc.).

The model for transforming rainfall data into run-off curves, which is the subject of this study, is in the final stage of development. Investigations for the study area are recommended in the field of the production of a flow accumulation map and a HSUs map and the use of measured rainfall/run-off data as input to the flood model for the computation of flood hydrographs and comparison with observed run-off values.

Acknowledgements

Dr Talal Akasheh of the Higher Council for Science and Technology supplied the SPOT-XS image used in this study.

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Al-Lāhūn : A Geo-Archaeological Approach of the Belgian Excavations in Jordan [1]

Introduction

A geo-archaeological project started in autumn 1994 at al-Lāhūn and was continued in spring 1995. It examined the archaeological site and the surrounding region of the Wādī al-Mūjib valley (biblical Arnon), east of the Dead Sea. This region corresponds to the ancient Moab kingdom, often mentioned in the Bible and in the Assyrian texts in the first millennium BC.

The geomorphological part of this investigation was done by Morgan De Dapper with the assistance of Beata-Maria De Vliegher, in connection with the archaeological excavations at al-Lāhūn, directed by Denyse Homès-Fredericq.

Geo-archaeology is the study of the mutual relationship between man and his environment in the past: what was the influence of the physical environment on the activities of man and what was the influence of man on changing the physical environment?

The latter took place in this area since the Neolithic Revolution, some 10,000 years ago and continues till now, as is attested by the ancient caves of al-Lāhūn, used as shelter in Antiquity and still in use as a granary today. The influence of man on nature led to one of the oldest humanised landscapes in the world.

However, the change of man's environment is in fact the result of a complex interplay between natural factors (such as climatic shifts leading to changes in the vegetation pattern) and human factors (such as deforestation accelerating soil erosion). The assessment of the contribution of both parts is of utmost importance in the frame of the International Global Change Investigations. The al-Lāhūn area offers a unique chance for such an assessment. To achieve these goals Archaeology and Earth Sciences have to combine in a joint interdisciplinary effort: geo-archaeology.

Location and Archaeo-Environmental Settings of the al-Lāhūn Area

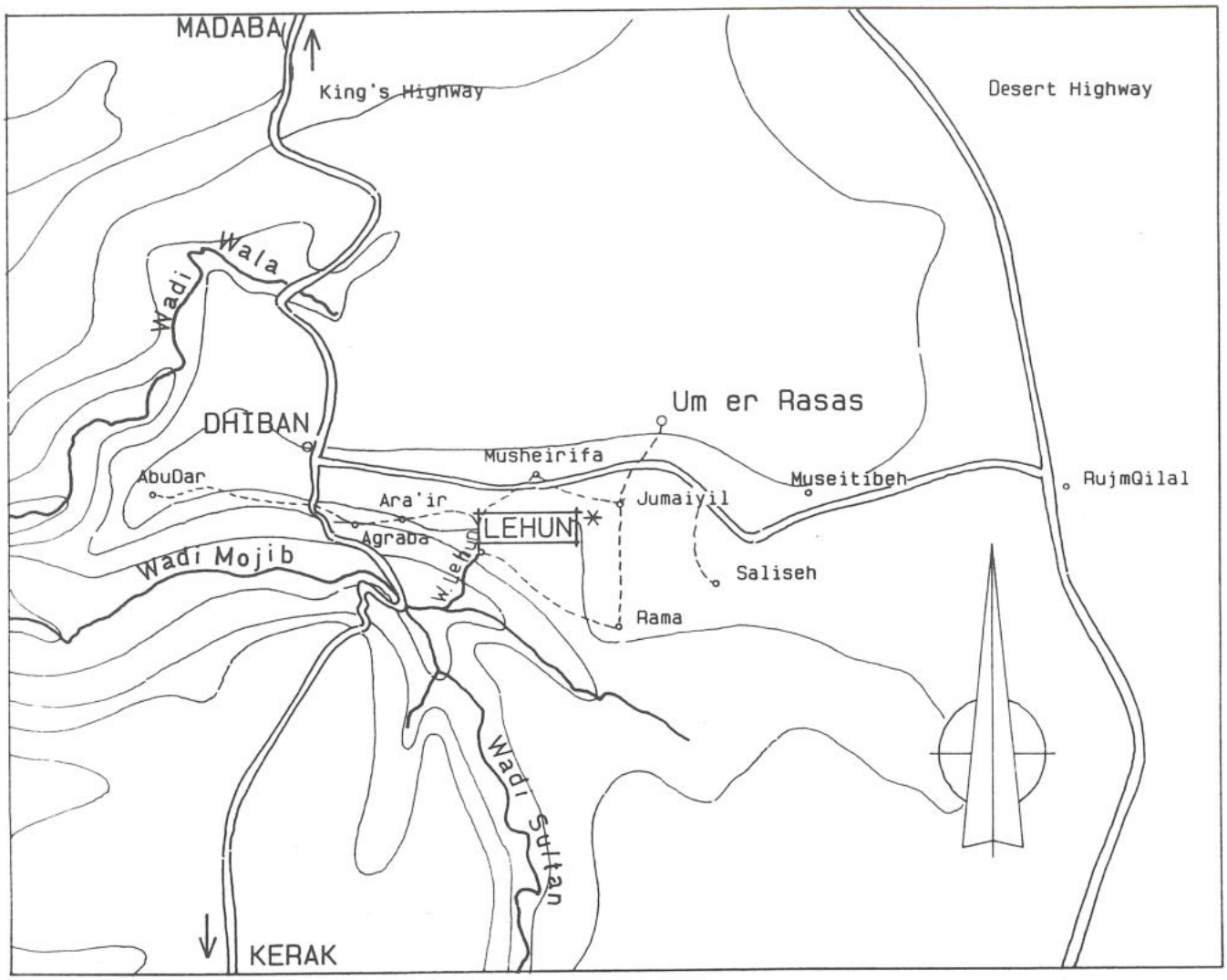
Al-Lāhūn is located in the Mādabā district between the King's Highway and the Desert Highway, some 80 km south of 'Ammān (FIG. 1). It lies 7 km east of Dhibān, the former capital of King Mesha of Moab (850 BC), who was a contemporary of Salmanasar III of Assyria, and 3 km of this military fortress of Ara'ir (the biblical Aroër). When we visited the site for the first time, we followed an ancient track along the border of the Moabite plateau, probably used by king Mesha's soldiers. It passed through Ara'ir and reached al-Lāhūn with its fortress built for military and economic purposes, and as a granary to collect the caps of the surrounding area. Now, a modern asphalt road leading to the site changes completely the aspect of the landscape.

Al-Lāhūn is quite extensive with its 66 ha of surface area. The hilly landscape has a denivellation of nearly 40 m. Small natural sectors are delimited north-south by the Wādī al-Lāhūn and a seasonal wadi, and east-west by other rivers. The site has been almost continuously inhabited, with more or less intensive occupation, from the Palaeolithic till modern times. The ancient settlers chose various sectors to built their dwellings. In the southern part, well protected by the cliffs of the Wādī al-Mūjib plateau, we find the earliest remains, including prehistoric artefacts, an Early Bronze Age town and cemetery (contemporary with the Mesopotamian Djemdet-Nasr period), a Late Bronze/Iron Age I village (end of the Medio-Assyrian and Neo-Assyrian period) and an Iron Age 2 fortress of the period of the Neo-Assyrian kings of the ninth century (FIG. 2). In the northern part, near the fertile fields and the antique trade roads of the Moabite plateau, as well as along the slopes of the Wādī al-Lāhūn (where the humidity and the vegetation are longer kept), settlements appeared in more peaceful and commercial periods: Nabataean and Roman temples, a Mamluk mosque near a small agricultural village of the same period, Ottoman houses and modern constructions were successively built.

An excellent satellite photograph recently published in the *National Geographic*,[2] shows clearly the physical

[1] We would like to thank Dr G. Bisheh, Director-General of the Department of Antiquities and his staff, who encouraged us greatly in our investigations as well as the different institutions who gave us financial and logistic support since the beginning of the excavations, as the National Foundation of Scientific Research Flanders, the Free University of Brussels, the University of Ghent, the Royal Museums of Art and History, the Ministry of the French Community and the Ministry of the Wallonne Community.

[2] *NGM* 187/6, June 1995:100-101.

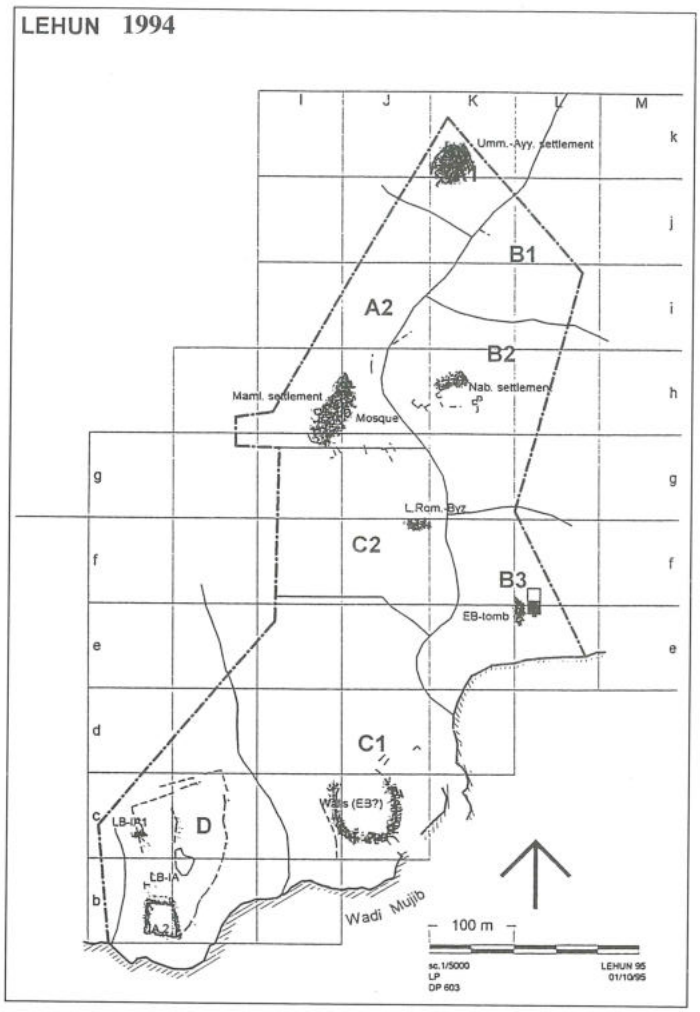


1. General map of the region of al-Lāhūn.

environment of the area: it is dominated by the canyon of the Wādī al-Mūjib which was deeply incised during the Quaternary in subhorizontal layers of marine sediments of Late Cretaceous age, with younger local basalt sheets on top.

On the northern rim of Wādī al-Mūjib, at an altitude around 700 m asl, al-Lāhūn overlooks the canyon of the river which is some 500 m deep and 5 km wide. 25 km further to the west the Wādī al-Mūjib flows into the Dead Sea at an altitude of 400 m below sea level. The river bed drops 600 m over a distance of 25 km. This means that it has a mean slope of 2.4 %, which is quite important. The depth of the canyon and the steep profile of the river bed are indicators of the high geomorphodynamic forces involved in the al-Lāhūn area. They are enhanced by the fact that the area (close to the rift) is tectonically unstable.

This deep natural incision separates two very contrasting environments: on the one hand the "man-friendly" plateau covered with fertile soils and the terra rossa typical of the Mediterranean region, expressed by the brown colours on the satellite image; on the other hand the "man-hostile" canyon, expressed by the grey colour of the bare rocks. Al-Lāhūn is situated at the very boundary of those two extremely opposite environments and has been, without doubt, selected for this double function; in the oldest period, during troubled times for its man-hostile character, at the rim of a steep escarpment allowing a strategic position, overlooking the southern Moabite plateau and the Dead Sea; and in peace time for its man-friendly function, with its good climatological conditions and its average rainfall of about 200-300 mm per year in this region. After a rainy season, the northern part of the site is very fertile, allowing barley and wheat to grow. Al-Lāhūn has also a semi-arid Mediterranean micro-climate, between the mild coastal and the dry desert climate. This is certainly one of the reasons why al-Lāhūn has been chosen alternatively by nomads and agricultural populations during the ages: even at the end of the last century

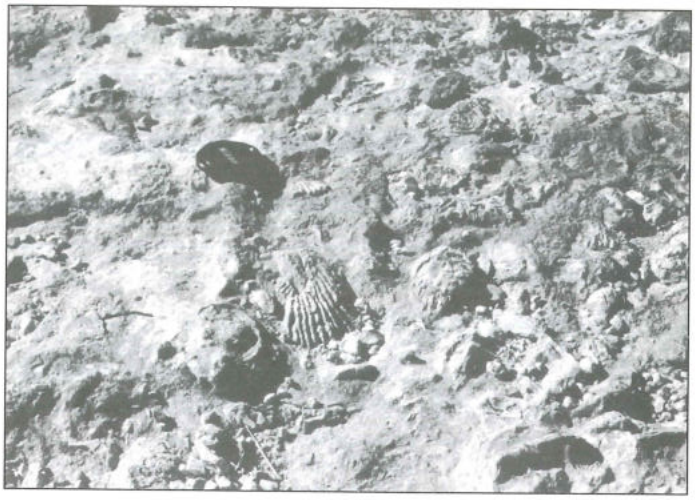


2. General map with sectors and periods represented in al-Lāhūn till 1994.

the site was again settled by some nomads coming from the Wādī al-Mūjib: ancient prehistoric caves were used as the main chamber while some front wall enlarged their houses.

Al-Lāhūn: A Journey in Time and Space

The sediments which form the geological substratum of the whole al-Lāhūn area were deposited in a sea during the Late Cretaceous some 100 million years ago.[3] Their marine nature is testified by numerous fossils. Some of them have conspicuous sizes such as the oysters of the *Actinostreon species* (FIG. 3). Banks of those shells may be easily observed in the bed of the Wādī al-Lāhūn, close to the Dighouse. Those marine sediments consist of an alternation of harder rocks like limestone and softer rocks like marls. The limestone blocks were often used by man in the different periods: for instance in the walls of the Late Bronze Age village or of the Iron Age Fortress (FIG.



3. Bank of oyster fossils of Late Cretaceous age exposed in the bed of the Wādī al-Lāhūn.

4) or for making their tools (grindstone etc.). In the Nabataean temple of the first century AD with embossed façade (as the stone is easy to cut) the inclusions of marine fossils are still visible in the Cretaceous limestone, while the interior walls (which were once plastered) expose now the formation of the fallen, local blocks.

The geological strata underwent only minor folding and faulting. They show an almost horizontal layer, corresponding to the original deposit by the sea. In some layers cherts and flints are included (FIG. 5). They formed an important raw material for prehistoric toolmakers. Scrapers, blades, points and other tools were surely locally made. They proved a long, but often discontinuous occupation of the site, till the beginning of sedentarisation in Jordan, as proved by the survey made by G. Rollefson at al-Lāhūn, where he gathered nearly 1000 flints on an area of 225.000 sq. m.[4]

From the Lower Miocene, 25 million years ago, till the Pliocene, 3 million years ago, large tectonic crustal movements led to the progressive sinking of the Jordan rift and the rising of the marine deposits. On the newly formed landsurface a drainage network was formed including the proto-Wādī al-Mūjib.

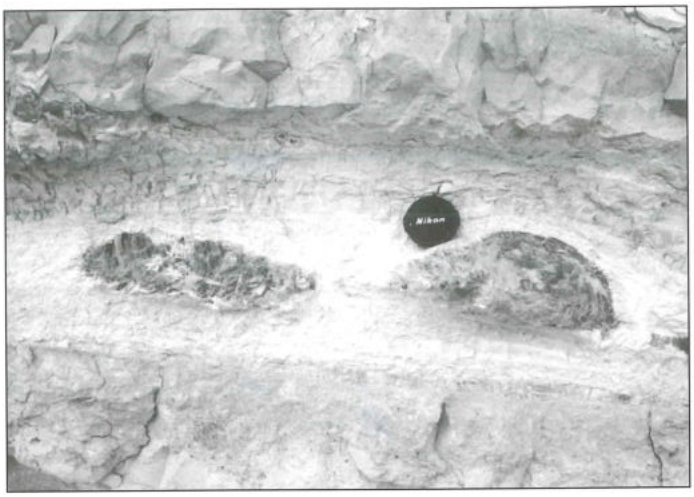
During the Early Quaternary, some 1.8 million years ago, sheets of molten basalt lava poured out in fissure eruptions. Part of them were flowing into the shallow valley of the proto-Wādī al-Mūjib and baked the marine sediments (FIG. 6). They solidified and since then rest on the Cretaceous substratum. Those basalt sheets occur on the southern rim of the canyon almost opposite of al-Lāhūn (FIG. 7). Since the molten lava has not streamed into the canyon, the deep incision of the Wādī al-Mūjib canyon must be younger than the basalt formation itself. One can conclude that the canyon and the landforms within it are

3 Bender, F. *Geologie van Jordanien* . Berlin-Stuttgart: Geber. Borntraeger.

4 We take this opportunity to thank Prof Dr G. Rollefson and Dr G. Finkhauser who made a survey at al-Lāhūn in 1980. (see also D. Homès-Fredericq and H.J. Franken, eds, *Pottery and Potters. Past and Present. 7000 Years of Ceramic Art in Jordan.* Tübingen 1986:66-67; D. Homès-Fredericq and P. Naster, *Rapport préliminaire sur la deuxième campagne de fouilles belges en Jordanie (automne 1980)*, Bruxelles 1981:13-14 (Unpublished manuscript at the Registration Centre, Department of Antiquities).



4. Late Bronze Age village and Iron Age fortress.



5. Chert and flint formation included in marine marls of Late Cretaceaous age.



6. Baked horizon on the contact between Early Quarternary basalt and the Late Cretaceous substratum.

Pleistocene. It is a quite young geological and geomorphological phenomenon linked to the formation of the Jordan rift system. Those basalt stones, too, were often used by the inhabitants of al-Lāhūn to make mortars for their daily life or to consolidate their walls.

During the geomorphological field surveys of autumn 1994 and spring 1995 at least three river terrace levels could be distinguished within the canyon: T1, T2 and T3. At the al-Mūjib-Nukhayla confluence (close to the new bridge on the King's Highway) the erosive base of the oldest terrace (T3) stands some 40 m above the present-day 'talweg' (T0). The alluvial deposits are at least 40 m thick and are composed of a large amount of well-rounded basalt boulders set in a matrix of finer gravel and sand showing current bedding features. The lower parts of those fluviatile deposits are cemented by calcium carbonates. It is obvious that the basalt boulders were transported by the Wādī al-Bālū' whose catchment comprises extensive outcrops of basalt sheets.

The base of the youngest river terrace (T1) is at the level of the 'talweg' but its top stands 5 to 10 m above it. The river deposits are mainly composed of gravels and sands with only a minor amount of boulders. Most of the material was transported by the upstream section of the Wādī al-Mūjib. Only few basalt boulders are present here. This is due to the fact that no basalt outcrops occur in the upstream reaches of the Wādī al-Mūjib. The few basalt boulders which are present are derived from the erosion of the oldest terrace level.

An intermediate river terrace level (T2) could be traced 2 km upstream in the Wādī al-Mūjib. It is composed of boulders, different kinds of gravel and sand. These coarse deposits are well cemented by calcium carbonates and therefore take the aspect of conglomerates (FIG. 8). This level is not present at the al-Mūjib-Nukhayla confluence but is testified by huge conglomeratic boulders present in the youngest terrace deposits. The "conglomerate"- terrace was also observed in the lower reaches of the Wādī al-Qaṭṭār and at the Nukhayla-al-Bālū' confluence. In the latter, important travertine formations are linked to it.

Till now, only a relative terrace chronosequence (T1, T2, T3) could be established. However, it is obvious , as argued above, that the observed terraces are all Quaternary and date most probably from the Middle to



7. Thick basalt sheet of Early Quaternary age exposed on the southern rim of the Wādī al-Mūjib canyon.



8. Conglomeratic aspect of the intermediate river terrace T2 incised by the present-day river bed T0 at the Wādī al-Mūjib.

Late Quaternary. Absolute dating of the terraces will probably be difficult due to the lack of absolute dating evidence. However, it must be possible to frame the terrace sequence, by comparison with other regional studies, into the general Quaternary geological history of Jordan.

The gentle sloping top surfaces of the terraces are used for irrigated cultivation. The basalt boulders of the oldest terrace show a typical black colour when they are exposed at the surface. The specific spectral reflectance of those phenomena may be useful to trace the river terraces on aerial photographs and satellite imagery, thus allowing for efficient geomorphological mapping.

The Holocene legacy of the Wādī al-Mūjib valley is present, amongst others, in numerous small patches of loose fine alluvial deposits along the 'talweg', testifying to repeated deposition and erosion. Those alluvial deposits are without any doubt closely linked to environmental changes due to the impact of man. Those took place almost continuously in the area since the Neolithic Revolution 10,000 years ago.

In some of those alluvial patches, organic materials such as charcoal and shell fragments could be sampled. Radiocarbon dating of those materials will allow for absolute dating. The bed of the Wādī al-Mūjib and its tributaries such as the Wādī al- Lahūn, is in many cases cut in hard rock and shows the typical riffle-and-pool morphology. In the pools flacks of water remain long after the end of the winter rainy season. In those temporary closed systems special micro-environments develop, including a typical micro-fauna. Those micro-organisms are very sensitive to environmental changes and thus may serve as indicators. Moreover, their fossil remains are conserved for a long time. As a result their study, as well in present-day environments as in stratigraphic sequences, may be an important tool for reconstruction of environmental history.

After important rainfall, muddy water stays in the pools allowing for sedimentation of the clay. This natural phenomenon allowed people to use this clay to produce their local hand-made ceramics: in the Early Bronze I A-B period, the fact is demonstrated by the analyses of Prof. H.J. Franken (of the "Instituut voor Aardewerktechnologie", University of Leyden), proving that the clay was extracted from the potholes in the riverbed of the Wādī al-Lāhūn. This was also the case in the Late Islamic period, where the pottery was hand-made, too. Sedimentation of clay in the Wādī al-Mūjib is, of course, far more important. In the Late Bronze and Iron Age the inhabitants of the fortified village and of the fortress selected the more convenient clay of the Wādī al-Mūjib to throw their wheel-made pottery.

The canyon walls are very steep and show a dynamic equilibrium: material which is accumulated at the foot of the slope is carried away by the river and is replaced by new material eroded from the top of the canyon wall. For that reason there is a continuous transport of material along the slope ("dynamic"). At the same time the canyon is widening and the slope conserves its steepness ("equilibrium").

The slope dynamics are testified by numerous minor



9. Minor landslide on the canyon wall of the Wādī al-Mūjib; the landslide breaks the continuity of a hard limestone bank.

landslides (FIG. 9). Some landslides, however, involve huge volumes of rocky material and may have been triggered by earthquakes which, without doubt occur in this tectonically active area (FIG. 10). However, deforestation may have accelerated the process.

Due to the fact that the Cretaceous substratum shows an alternation of harder and softer rocks, erosion on the slopes works selectively. Softer parts are easily eroded while harder banks resist longer. As a result "abris sous roche" are formed which served, and still serve, as shelter for man (FIG. 11). Banks of hard rock which are undermined, finally detach and tumble down. Those huge blocks eventually come to rest in a chaotic stapling at the foot of the canyon wall. Also here the space below the blocks is arranged by man to serve as a shelter (FIG. 12). He builds little walls to protect himself and his presence is still attested by black smoke stains. This kind of shelter has not yet been excavated in the al-Lāhūn area and their investigation may lead to interesting results.

A special form of chemical weathering leads to the formation in the rock of hollows, called "taffoni". Some become so huge that they too may be used as shelter or a granary (FIG.13).

One of the most destructive geomorphological forces on the canyon walls are formed by man's herds of goats and sheep which graze even on the steepest slopes. The daily passage of the cattle, and this since centuries, is a tremendous form of accelerated slope erosion. Every slope is attacked by their trampling: vegetation and the few remainders of fertile soil are destroyed and their tracks form a dense network of scars, the so called "terracettes", on the slopes (FIG. 14).

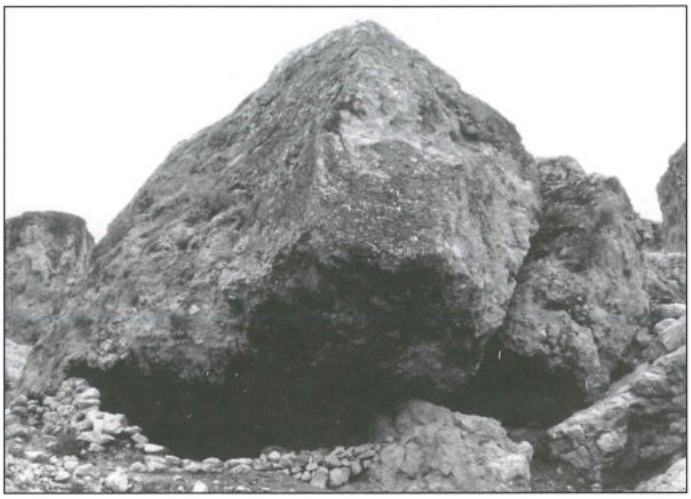
Collecting water has always been of life-importance for man in the al-Lāhūn area. Most of the water storage works are mere adaptations of the physical terrain features. Caves and cisterns make use of the regular subhor-



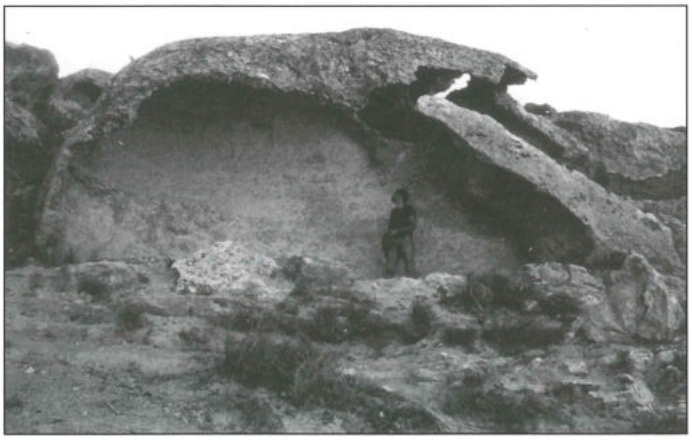
10. Major landslide on the canyon wall of the Wādī al-Lāhūn. This landslide involves an important volume of rock which blocked the course of the river bed. Such landslides may be trigged by earthquakes.



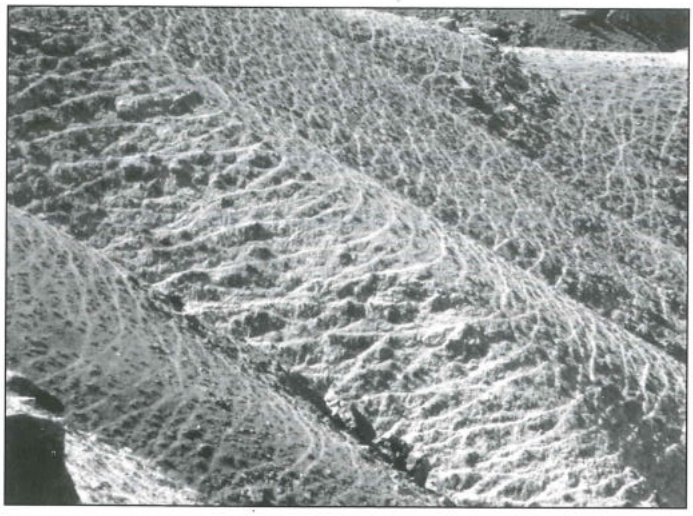
11. Formation of "abri sous roche" by differential erosion of alternating harder and softer rocks of the late Cretaceous substratum.



12. Chaotic stapling of huge blocks detached from the upper canyon wall after undermining of banks of massive limestone underlain by more erodible soft marls. After tumbling down the blocks came to rest at the foot of the canyon wall close to the river bed of the Wādī al-Mūjib. The spaces below the blocks are arranged by man to serve as shelter.



13. Formation of hollows called "taffoni" by dominantly chemical weathering. They may serve as shelters or granaries.



14. Dense network of "terracettes" on steep slopes. Those microsteps are due to the daily passage and trampling by sheep's and goats and are an important form of accelerated soil erosion.

izontal alternation of softer and harder layers of the almost tectonically undisturbed marine Cretaceous sediments which form the geological substratum of the al-Lāhūn area. Caves are excavated areas below massive limestone bedrock shelves which are originally the result of "abri sous roche" formation due to differential weathering and erosion or the formations of "taffoni" due to dominantly chemical honeycomb-weathering.

For the construction of cisterns – covered water storage areas, at al-Lāhūn usually underground chambers – massive limestone and chert layers may serve as "roofs", whereas the marly sediments are excavated to form the "bell" of the cisterns.

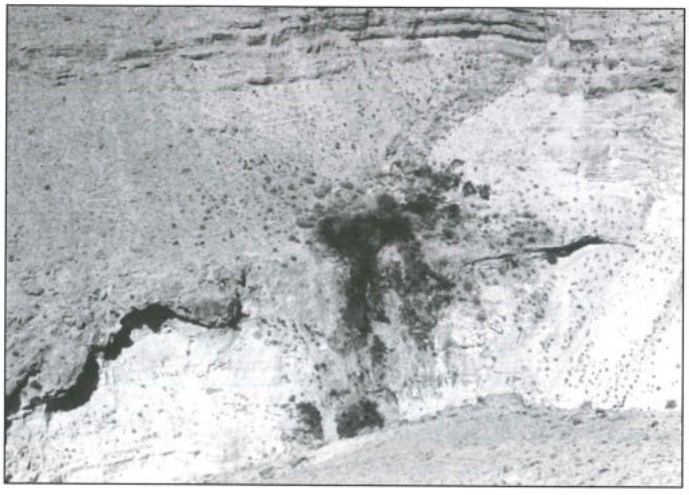
Waterpools – open reservoirs which rely on seasonal rain and run off collection – are in most cases located where natural closed terrain depressions occur. In some cases, the natural depressions are in fact well developed dolinas (FIG. 15). One occurs at the rim of the escarpment, east of the Iron Age fortress at al-Lāhūn, and is the result of a karstic solution of the carbonatic bedrock. The rainwater which infiltrates follows planes of weakness such as fissures and joints in the bedrock whereby the solution of the carbonates takes place. As a result an intricate network of small and large subterranean hollows is formed. Some of those hollows may become quite large and form natural caves (FIG. 16). In some cases the roof of large caves may collapse leading to the formation of closed depressions at the surface: these are the dolinas. In the escarpment just below the dolinas several karstic hollows developed along dominantly vertical fissures were observed. On the lower parts of those slopes important travertine accumulations are formed along seepage lines (FIG. 17). Those accumulations are due to precipitation of the calcium transported in solution in the groundwater. The travertine is still formed at present day, showing that the process of karstic solution and precipitation is still active. Those



16. Natural cave developed along a fissure in the limestone below the dolina shown on FIG. 15.



15. Dolina or closed karstic depression developed by solution of the underlying limestone on the rim of the Wādī al-Lāhūn east of the Iron Age Fortress. The dolina was arranged to serve as a pool.



17. Travertine formation due to seepage of calcium-rich groundwater on the slope below the dolina and cave shown in FIGS. 15 and 16. The travertine is still formed at present-day showing that the process of karstic solution and precipitation is still active.

travertines can be dated by radiometric methods. Moreover they contain fossil pollen which can help us for environmental evolution reconstruction.

Dams may be constructed where the wadi valley is narrow and the catchment area is large enough. Valleys are in most cases narrow where the bedrock is harder and more resistant to erosion. Those outcrops of harder rock offer at the same time a solid base for the wall of the dam. In most cases the walls have disappeared but part of the dam lake infill is still conserved (FIG. 18). Careful study of the infill stratigraphy and its sedimentological, mineralogical and microfaunal characteristics may help to reconstruct the dam history.

The al-Lāhūn GaIS Project

In order to link the geographical knowledge from al-Lāhūn and its surroundings with the archaeological information in an efficient way, a GIS (Geographical Information System) project was built up. The aim of this project is to establish more specifically a Geo-archaeological Information System (LEHUN-GaIS) for al-Lāhūn.

The GaIS comprises on one side a list of data which can be stored in a database (such as a list of observation points stating the artefacts found on that place plus typical characteristics such as the altitude, lithology, slope and aspect, era, etc.). On the other side, it comprises spatial data stored as digital maps (such as lithological maps, geomorphological maps, land-use maps, maps of the archaeological sites, etc.).

A GaIS is a tool based on computer technology, which makes it possible to link the database with the spatial data, and do as well a combination of database queries and spatial (vertical and horizontal) queries.

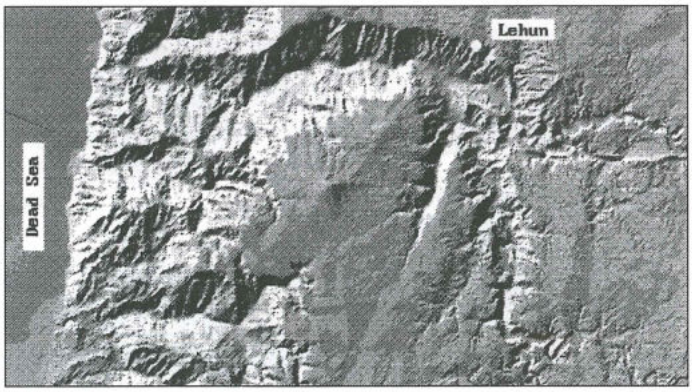


18. Remnants of dam lake infill in the upper reaches of Wādī al-Lāhūn.

To feed the GaIS with information, three main sources can be distinguished: (1) the collection of data via field observations, (2) the collection and digitizing of the existing cartographic data and (3) the derivation of information from remotely sensed imagery (aerial photos, satellite images...). In a second stage, a combination of these data can produce more advanced maps, and can be used to build and run models.

It stands to reason that the fundamental prerequisite to build a GaIS is the precise location of the observations in a fixed co-ordinate system. Such precise location can be done by using GPS (Global Positioning System) technology. The GPS technology is based on the NAVSTAR satellite system, which finished its experimental phase in 1994. 24 NAVSTAR satellites are broadcasting waves with a certain frequency from which some are received by the GPS device on the ground. The GPS calculates the time between the broadcasting and the reception of the signal. Knowing the exact position of the satellite and given the calculated distance from at least three satellites, the GPS device calculates the location on the Earth's surface in a chosen co-ordinate system. In the case of the al-Lāhūn survey the GPS location of the observation points is carried out with a compact and light weight hand-held device (The Ensign GPS of Trimble Navigation, USA) (FIG. 19). Since the al-Lāhūn area is almost entirely free of high vegetation, the reception of the satellite signals is almost never hindered. By taking the average of a set of measurements for the same point, the error can be reduced to about 30 m, which is, in general, sufficient to locate the observation points (30 m on a scale of 1/50.000 is the size of a pencil dot !).[5]

The building of LEHUN GaIS was started in December 1994. The digital treatment was performed on an ILWIS (Integrated Land and Watershed Management Information System, developed at the International Institute for Aerospace Survey and Earth Sciences at Enschede, The Netherlands) software package. Following



19. Shadow image of the al-Lāhūn- and Wādī Mūjib area derived from a Digital Elevation Model (DEM), based on the Jordan topographical map on scale 1/50,000.

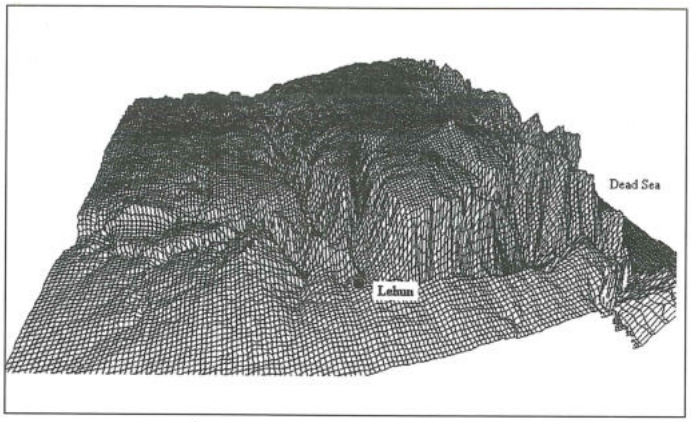
5 Brackman, P., De Dapper, M., Devreker, J. and Vermeulen, F. 1995. The Use of Geomorphology, Remote Sensing and GIS-Technics for Geoarchaeological Purposes in the Pessinus Area, Central Anatolia (Turkey). *Natuurwetenschappelijk Tijdschrift (Gent)* 75:3-34.

steps were taken during the indoor preparation:

1. The contour lines of the Jordan topographical map on scale 1/50,000 for the area were digitized and consequently rasterized. For steeply sloping parts only the 100 m contour interval was used; for plateau areas the 5 m contour interval was added.
2. From these files a DEM (Digital Elevation Model) was made. This DEM forms the base for the GaIS.
3. From the DEM derivated products were made: slope map, shadow image (FIG. 19), 3D-images (FIG. 20).

Conclusions

By the year 2,000 the al-Lāhūn Dighouse will become a museum. In order to make the richness of al-Lāhūn and its environment available for a larger public the establishment of a geo-archaeological park, wherein archeo-monuments as well as geo-monuments are displayed, is planned as a future project. Better understanding of the natural and cultural patrimony by the local people will lead to consciousness and sustainable use of their cultural and natural resources. In this way a contribution can be made to conserve this unique site and its environment for future generations.



20. 3D-image of the al-Lāhūn-viewed from NNW (vertical angle 30°, vertical exaggeration 10x) - and Wādī al-Mujib area derived from a Digital Elevation Model (DEM), based on the Jordan topographical map on scale 1/50,000.

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Natural Constraints, Space Organisation Models and Rhythm of Occupation at Abū Ḥāmid During the Seventh and the Sixth Millennium BP. A Geo-Archaeological Study

Introduction

This paper presents a geo-archaeological study in progress aimed at re-establishing the palaeogeographic and the palaeoethnographic framework of the settlement at Abū Ḥāmid. This settlement pertains to a period known by various sedentary, semi-sedentary and mobile ways of life. On an archaeological basis, we think that each of these ways reflects the need of human groups to define the appropriate strategies to survive or to improve their style of life. Environmental constraints, for example, climatic conditions, evolution of the landscape, availability of natural resources, are most probably the reason according to which human groups had to adapt themselves to a suitable way of life. Reconstructing the settlement patterns of this period and the strategy of subsistence, are among the most important questions raised by archaeologists working on the seventh - sixth millennium BP sites.

The best example in southern Levant are probably the sixth millennium BP sites in southern Palestine; it concerns different ways of life that are present in one cultural horizon and the scientific debate over their definition. Dothan (1959), based his arguments on well-built structures and on the assemblage at Horvat Beter, in the Beersheba region, to interpret the settlement as a permanent occupation of a high level of development where farming activity was more important than herding. Considering this situation, Dothan suggested a model of climate more humid than the present. Perrot (1984), suggesting climatic conditions similar to the present ones, defined the settlements at Bīr aṣ-Ṣafadī and Abū Maṭar, which offer very similar characteristics to those of Horvat Beter and are located in a very similar geographical context, as those of semi-nomadic societies practising mainly pastoralism and only marginally agriculture. However, more recent papers that deal with this question offer additional interpretations by considering various archaeological aspects and finds including constructions and the presence of the pig in the faunal assemblage as indicators of permanent occupations (e.g. Gilead 1992); in this paper, the aim is not to immerse into this debate but rather to present the angle from which we look at the problem of a site located in the Jordan Valley of the same period and of a close cultural context.

This study intends to examine, at a multiscalar perception from the region down to the microstratigraphic layer, the past environment at Abū Ḥāmid, to try to characterize the possible modifications induced within it and to estimate their impact on the inhabitants. Regarding the mode of occupation of the site, we contribute to its definition by using soil micromorphology complementary to the archaeological data.

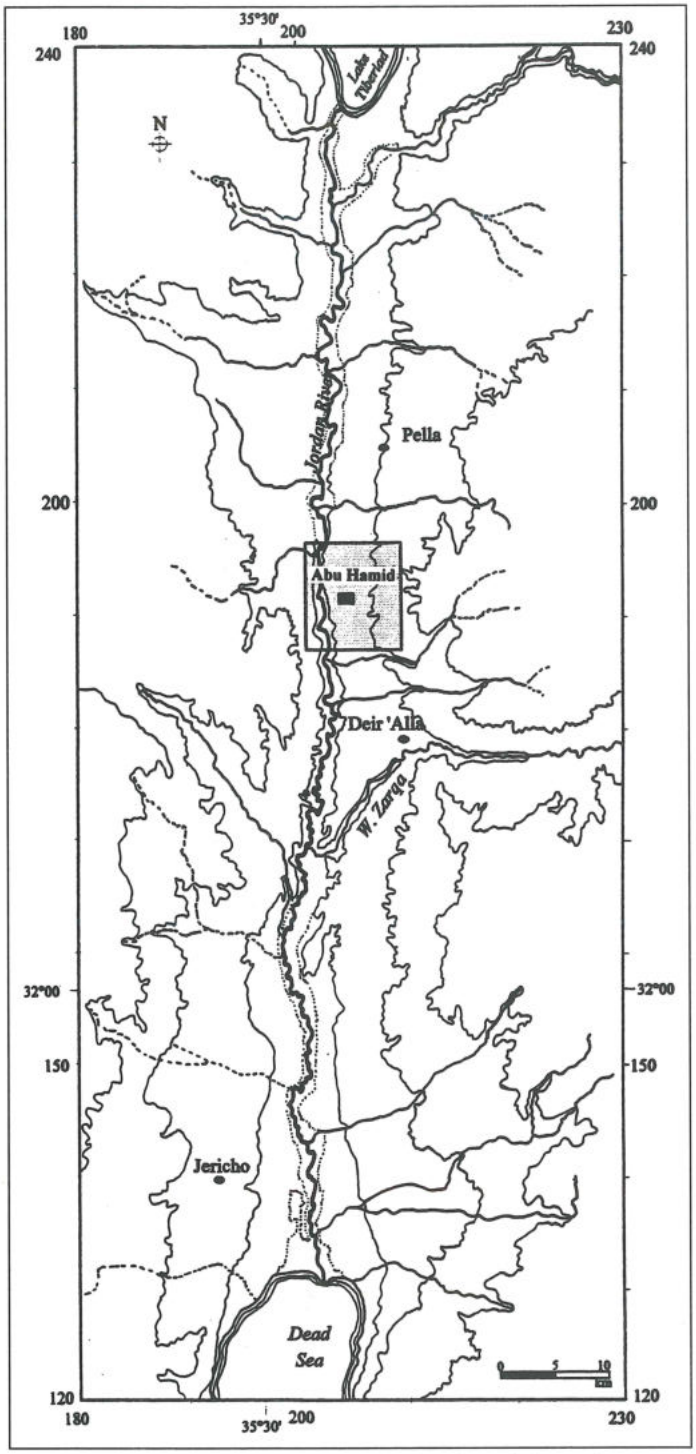
Site Setting and Stratigraphy

Located in the middle of the Jordan valley, at an equal distance between the Dead Sea and Lake Tiberias (FIGS. 1and 2), Abū Ḥāmid at -240m bsl was established close to the Jordan River on a red clayey colluvial soil that covers the marl deposits of the Late Pleistocene al-Lisān Lake. The region of Abū Ḥāmid is dominated to the east by the 'Ajlūn mountains which are in some places over 1000 m high. The physiographic and sedimentary evolution of the middle Jordan valley is strongly constrained by the highlands which consist of Cretaceous-Tertiary limestone and dolomite and are roughly covered by red Mediterranean soil type "Terra Rosa". Their escarpments towards the west are rocky, abrupt, deeply incised by several wadis and possess a number of scaling faults displaying parallel and sub-parallel orientation with respect to the Jordan valley. The Abū Ḥāmid region receives presently about 200 mm of rain per year; it is located in the Irano-Turanian vegetal zone.

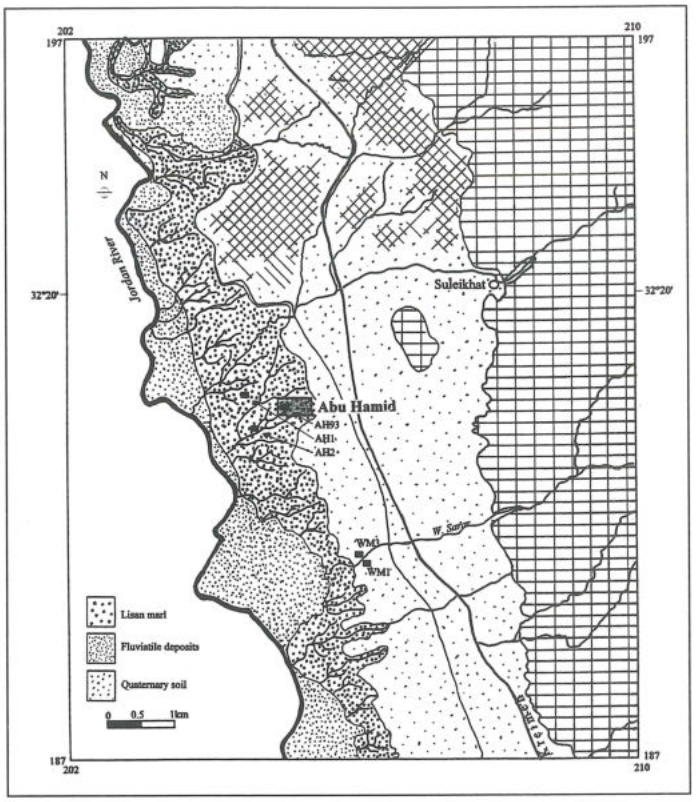
Five seasons of excavations took place at Abū Ḥāmid between 1986 and 1992 under the auspices of Yarmuk University - Institute of Archaeology and Anthropology- and CNRS and the Ministry of Foreign Affairs, France.

Excavations revealed three main phases of occupation (Dollfus and Kafafi 1993):

1 In the beginning of the Seventh millennium BP (?) the site seems to have been inhabited by temporarily setled human groups, whose shelters were partially dug into the soil; inside them accumulations of several occupation layers could be observed (FIG. 3);
2 By the end of the second half of the Seventh millennium BP, groups might have had a more sedentary way of life; among other things, their members were living in pluricellular brick houses (FIG. 4);



1. Map of the Jordan Valley showing the location of the study area.



2. Map of the Abū Ḥāmid area showing the badlands and location of the studied sections.

3 In the early Sixth millennium BP, most of the houses were at first monocellular and to some of them one or two rooms were later added. The site was completely abandoned by the middle of the sixth millennium BP.

The Archaeological Problem

Nowadays, the site and its boundaries consist of rounded to elongated hillocks gullied by a deep stream network. Today, most of the site and its micro region are in the zone of badlands and do not seem to be suitable for settlement and cultivation. Considering this situation, two questions arise: 1) What were the landscape and the environmental conditions during the initial phase of the occupation of the site? 2) Were there links between the changes of human behaviour that can be observed in the way the groups were living in the settlement and the modifications that could be observed in the conditions of their environment and of the landscape?

Methodology

Previous studies, mainly those relating to the Jordan Valley such as Mabry (1992), Macumber and Head (1991), Field (1991), Rewerski (in Dollfus *et al.*1988) and Goldberg and Bar Yosef (1982) have yielded important information and clarified various aspects regarding human occupations and their relationship with the environment during the Holocene. However, in this present study we are considering the question at a different scale. The results we try to obtain depend not only on the accuracy of chronological data, but also upon the method employed to decipher indications of the smallest geological events (Courty 1994). This method, based on the study of thin sections made from undisturbed soil samples, consists of the following principles:

The comprehensive study of soil landscapes, starting from analyses of the spatial distribution of geomorphic features, type of parent material and associated soils, down to a detailed characterisation of soil properties under the microscope, allow us to discriminate the processes of



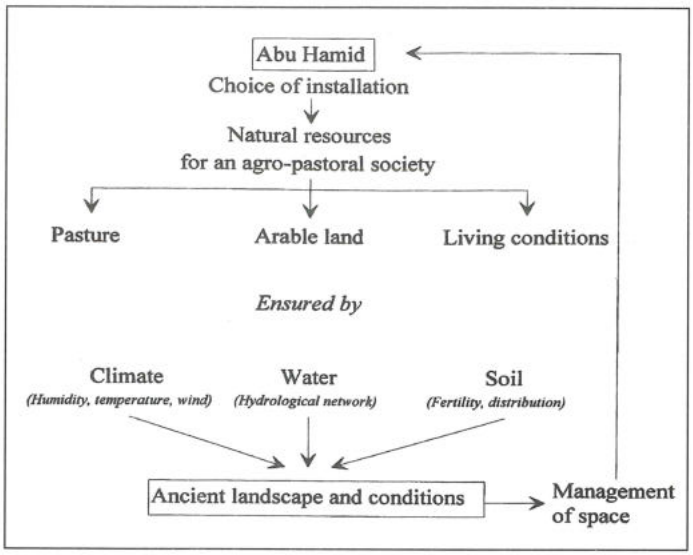
3. Alternate sequence and wall of the dwelling A2.

soil formation. These processes indicate the nature of the pedo-sedimentary events, that is the various natural and (or) human factors implied in the deposition and transformation of the sediment. Each one of these factors and sub-factors is represented in the soil by a set of sedimentary and (or) pedological characteristics. Regional correlations between the distinguished pedo-sedimentary units are deduced from petrographic, lithologic and pedographical resemblance. The recognition of changes in sedimentary or pedological dynamics permit a separation of successive palaeogeographic states. The succession is then restored in a chronostratigraphical framework with the available chronological data.

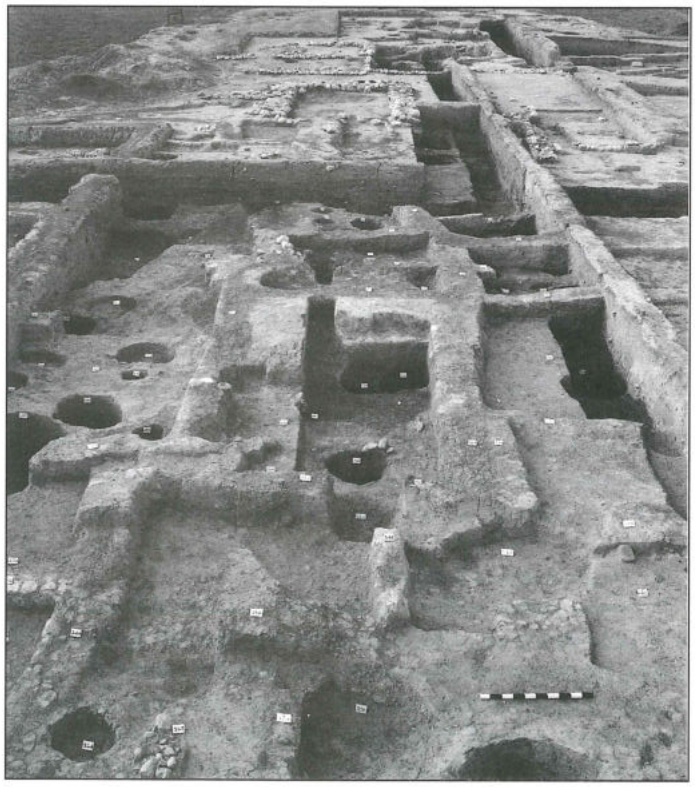
In respect of the archaeological questions specific to the site of Abū Ḥāmid, this study is geared towards two directions: first, the study of the surrounding formations in order to reconstruct the landscape evolution around the site and, second, the study of the archaeological deposits within the site in order to determine its mode of occupation. The hypothesis of a synchronic relationship between modifications recognised in these two analysis, will be examined. The study began with a procedure of field identification, then, some two hundred undisturbed soil samples have been systematically collected from various sections cut within the site and in its surrounding.

Reconstruction of the Palaeogeography of Abū Ḥāmid

Our understanding of the ancient palaeoenvironmental conditions of the site and its region can be summarised in the following scheme:



The excavations and the domesticated forms of the faunal and botanical remains have shown that Abū Ḥāmid was occupied since its foundation by agro-pastoral groups (Dollfus and Kafafi 1993; Desse and Neef, pers. comm.). Settled groups, contrary to hunting and gathering groups, are required to choose land suitable for pasture and agri/horticulture. Inhabitants of Abū Ḥāmid were interested, most probably, by favourable conditions for pasture, arable land and habitability. Theoretically, these conditions are determined by three factors: favourable climate, good hydrological regime as well as fertile and well-distributed soil cover. These factors determine the geographi- cal state of the site and its region. Re-establishing



4. Upper and middle levels at Abū Ḥāmid.

the palaeogeographical frame of the site requires examination of each one of these factors.

The Climate

Two ways to predict the palaeoclimate of the site are employed in this study: (1) published regional pollen diagrams and (2) climatic indices documented in the soil.

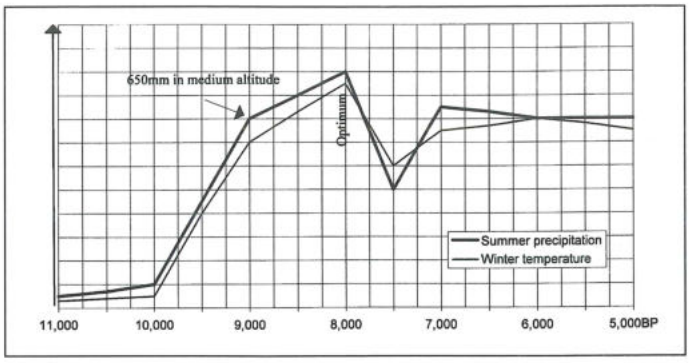
Recent work on the palaeoclimate of the eastern Mediterranean Basin (Van Zeist and Bottema 1982; Cheddadi *et al.* 1991; Rossignol-Strick 1993), based on marine and land records provided by palynology of long cores, proposes climatic information for the Late Quaternary. The recent Rossignol-Strick (1993) re-evaluation of these regional records and their comparison with those of neighbouring lands and seas excludes the possibility that any area of the Near East could have a completely opposite climatic history. Pollen diagrams (summarised in FIG. 5) show, from 11,000 to 10,000 BP, an arid and cold period (Younger Dryas). After 10,000 BP, the climate improved rapidly and reached its maximum between 9,000 and approximately 7,500 BP. After a few hundred years of decrease of summer precipitation and winter temperature, the climate factors became more favourable between 7,000 and 6,000 BP, summer precipitation increased and winters were warmer. Therefore, from a chronological point of view the occupation of Abū Ḥāmid falls within a period of the regaining of favourable conditions, that is the second climatic optimum of the Holocene.

Related to this last increase of precipitation registered in pollen diagrams, and conformable to them, micromorphological study of a well-conserved palaeosol buried under the occupation layers of Abū Ḥāmid reveals some palaeoclimatic indices of relatively humid conditions. Interpretation of these indices is deduced from the fact that soil is an open system, reacting to environmental changes of climate, vegetation and biological and human factors. Soil properties are thus gradually modified according to the specific kind of change induced (Courty *et al.* 1989). The climatic characteristics observed at Abū Ḥāmid are: massive micro structure with vesicular to vuggy voids (FIG. 6:a), carbonate dissolution from upper horizons to lower ones and iron oxide coating on voids (FIG. 6:b). These characteristics occur only under humid conditions over a certain time span.

Therefore, we can conclude that climatic conditions were more humid preceding and during the initial phase of the occupation at Abū Ḥāmid than those known today.

The Hydrological System

The main water source of the site was the Jordan River; not only did it provide a good water flow, as demonstrated by its abundant tributaries, but also the access to it was easier than it seems to be now. Today, the river is deeply embanked, a result of the gradual sinking of the Dead Sea. Abū Ḥāmid is bordered to the north by a deeply incised perennial stream which is fed by the source located at the



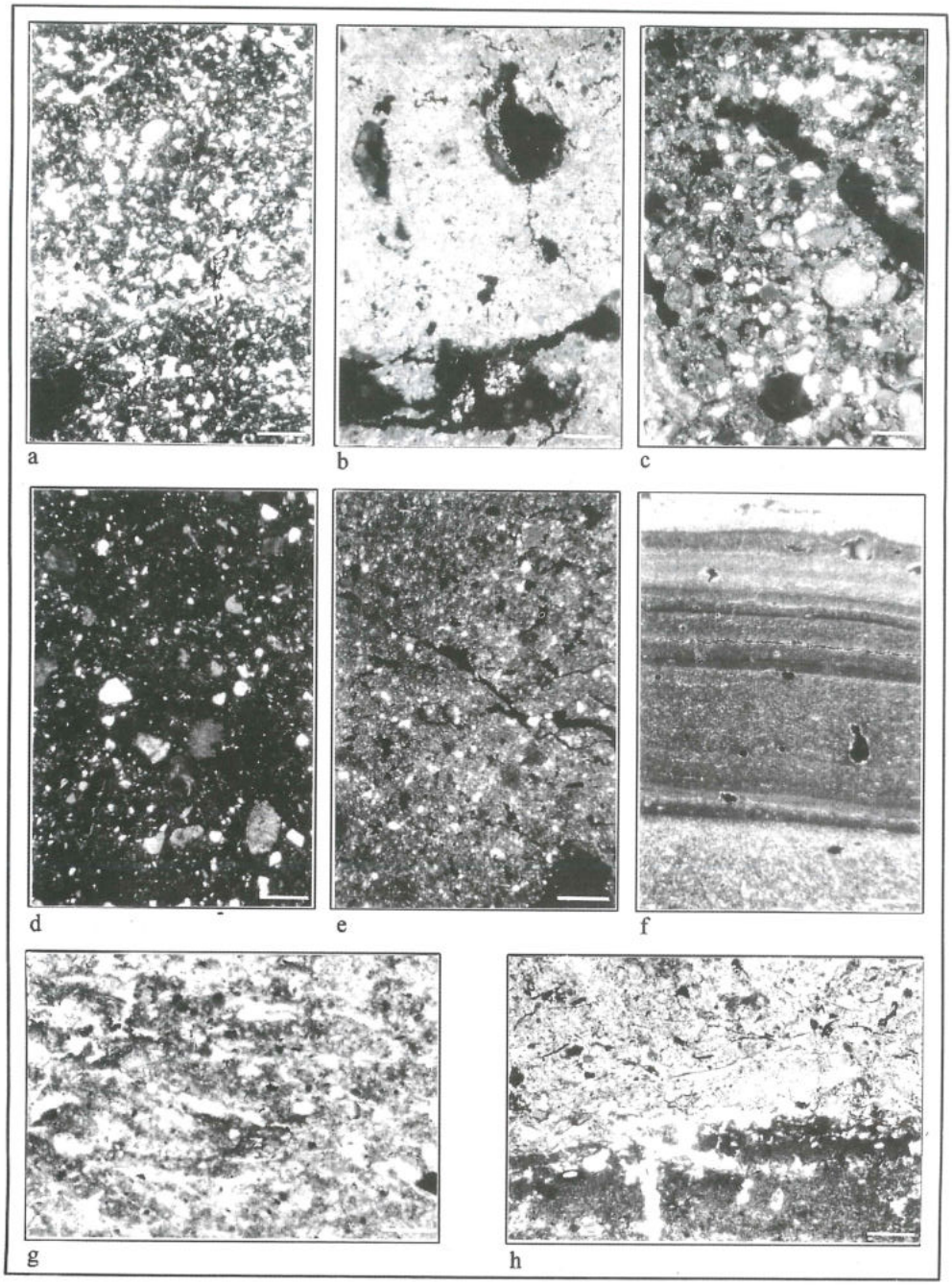
5. Synthetic curve of the Late Quaternary climatic evolution (after Rossignol- Strick correlations and re-evaluation, 1994).

north-eastern corner of what was the boundary of the site in 1975 as observed by Ibrahim *et al.* (1976). This stream constitutes also the extension of two intermittent Wadis descending from 'Ajlūn mountains. Along its northern cut one can observe the remains of three narrow steps of land (1-2m wide) with ten to fifteen meters interval between them. They might represent three levels of incision that follow the embankment of the river. The Abū Ḥāmid settlement could have made use of this stream while it was near the surface.

Specific to the Abū Ḥāmid region, some particular geomorphological characteristics have been observed. The glacis of erosion of the Jordan valley floor have been thought to be centralised to the actual place of the Jordan River; at Abū Ḥāmid, the evidence gathered presents a different scenario. The eastern zone of badlands is now in an anticlinal position; it possesses one steep slope toward the river to the west and a slight back slope toward the east. A transversal section of the erosion glacis on both sides of the Jordan River shows a west-east gradient instead of an expected east-west one (FIG. 7). However, the eastern al-Ghawr, from the pediment of the 'Ajlūn slopes down to the zone of badlands, always kept approximately to its gentle gradient (ca. 2%) towards the west. To explain this phenomenon, there are two possibilities: (1) the Jordan River, known by its frequent displacement, could have flowed one day before its deep embankment to the west of the site, somewhere further east. An ancient runoff system across the western al-Ghawr towards the river could have been at the origin of this event; (2) this could also be the result of a tectonic movement. As it has been shown by several earth scientists, the lateral shear along the Jordan-Dead Sea transformation resulted in the creation of various local depressions of different sizes. Regional and local uplifting is also evident along the whole transform (see Freund and Garfunkel 1981). However, some specialised investigations to clarify the situation are at hand now.

Soil Fertility and Distribution

The pedological cover in the region of Abū Ḥāmid consists of colluvial red clayey soil, originally of fersiallitic type.



6. Examples of some micromorphological features mentioned in the text.

(a) Photomicrograph of red brown clayey loam presenting an example of vesicular and vughy voids [in (e) they are associated with massive microstructure] characteristic of the water saturation of sediment. Dwelling A2, upper part of sample 5. PPL. (Bar=600um).

(b) Dark ferruginous coating around large void walls resulting from persistence of humid conditions over a certain time; some carbonate nodules can also be observed, they part of a burid palaeosol, sample 51.XPL.(Bar=600um).

(c) Different rock fragments transported by surface wash of strong energy, then, cemented by calcium carbonate in a marshland environment. Note the tuffa formation (lower left corner), and the palygorskan coating around the grains, feature of environments rich in cation exchange such as lakes and lagoons. WM1, sample 69. XPL.(Bar=600um).

(d) Colluvial clayey deposit with massive microstructure . Note the coarse and unsorted quartz grains and other rock fragments . WM2, sample 90.XPL.(Bar=600um).

(e) Massive microstructure of the clayey loam palaeosol buried under the site. Note the fine well-sorted quartz grains. AH93, sample 50.XPL.(Bar=600um).

(f) Finely interstratified micro-laminated layers of fine sand, silt and clay, characteristic of calm surface wash produced by torrential rain. WM1, sample 75. XPL. (Bar=600um).

(g) Trampled sediment in humid condition. Dwelling A1, sample 61. PPL. (Bar=600um).

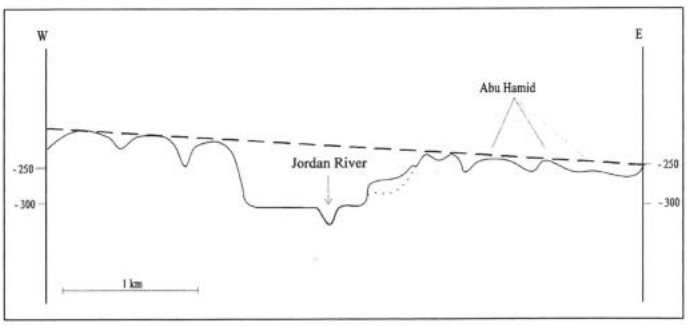
(h) Junction ashy domestic refuse and underlying well-kneaded marly floor. Note , at the uppermost part, the dark organic impregnation produced probably by the use of amat. Dwelling A1, sample 63. PPL.(Bar=600um).

This type of soil presents high potential for agricultural production, owing to its texture and wealth of nutrients.

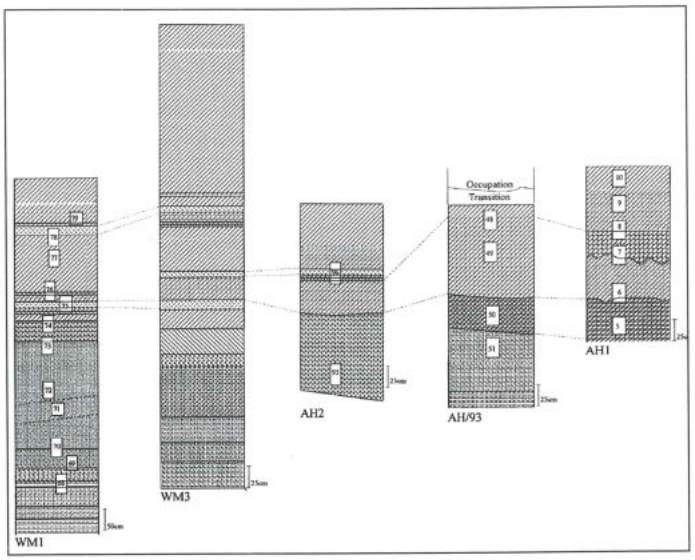
As for its distribution, at the present time the only remnants of this red soil are represented on summits of hillocks adjacent to the site. Its spatial distribution over time depends on the landscape's evolution. Correlation between sections opened in various locations of the Holocene formations in the Abū Ḥāmid area (FIGS. 2 and 8), show at least two colluvial phases covering the al-Lisān Formation. At ca. 2 km to the south of Abū Ḥāmid, Wādī Ṣarār (known locally as *Mukataleen*) shows more than five metres of Post-al-Lisān deposits. These accumulations provide a succession of various sedimentary units that help our understanding of the soil cover evolution of the region. The Mukataleen area (WM-1,WM-2 and WM-3) (FIG. 8) displays, from bottom to top: (1) a thick sandy dark organic unit of marshy land (FIG. 6: c) covering the al-Lisān Formation; (2) a transitional unit of grey-brown silt, (3) about three metres of successive layers of red soil separated by three thin units of fine interstratified sand which are characteristic of overland flow. Sections from within Abū Ḥāmid and adjacent to the north (FIG.8: AH93; AH-1) do not show the dark grey unit between the al-Lisān Marl and the red soil. This is due to the higher ground level of the Abū Ḥāmid area. Nevertheless, deposits to the west of the site (FIG.8: AH-2) include characteristics similar to those of low ground, that is dark grey clayey silt covering the marls.

These differences lead one to conclude that there was an undulating landscape preceding deposition of the colluvial red soil. Undulations were shallow enough to permit the widespread flow of colluvium. Thin sections from the colluvial deposits reveal more than two different types of constituents: first with a variety of different minerals and rock fragments (FIG.6: d), then a deposit of which the coarse fraction consists mostly of quartz grains (FIG. 6: e). Thin sections also show at least two surfaces smashed by torrential rain, as suggested by abundant sub-angular fragments of surface crusts. Macroscopic and microscopic comparisons between the sections of different areas suggest that these surfaces are subsequent to the palaeosol buried under the site. In the Wādī Mukataleen area they appear as units of surface wash (FIG. 6: f).

We can, therefore, conclude that the red soil of the Abū



7. Schematic section for the glacis of erosion at the Abū-Ḥāmid region.



8. Correlation between various sections opened around Abū Ḥāmid.

Ḥāmid region consisted of colluvial/alluvial deposits deriving, most probably, from the 'Ajlūn mountains. They were diffused, at least on the floor of the valley (al-Ghawr) by widely spread sheet flow, in several episodes and accompanied, each time, with torrential rains. The red soil was thus spread out over the floor of the valley, already undulated, creating a new plain, less irregular with a slight back slope towards the river. Such a regular extent of fertile soil produces the type of land habitable for settled groups. The first settlement on the site certainly made use of this situation.

Until we obtain dating for the colluvial accumulation, a number of questions arise: (1) chronologically, did this formation nearly precede the foundation of the site? (2) could we put it in relation with the last increase of precipitation registered in the regional or global published pollen diagrams, around the seventh millennium BP? (3) if not, why did populations of the preceding periods not make use of such favourable land?

RECONSTRUCTION OF THE SITE MODEL OF OCCUPATION IN ITS INITIAL PHASE

Field Characteristics

Lower levels at Abū Ḥāmid, as they are exposed in two large soundings, are comprised in a 30-80 cm thick red brown clayey/silty matrix, covering directly the Lisān marls. Their main characteristic are the two large pits (grid: A1 and A2) cut into the marls through a 30 cm thick layer of red brown sediment. The pit A2 (FIG. 9) is 5m in diameter and has a 1.20 m deep inclined wall; A1 (FIGS.9 and 10) is not fully excavated, its 60 cm deep wall is cut vertically straight. Those characteristics inspire excavators to interpret them as shelters partially dug into the soil. Deposits of each one of these pits show a succession of three ashy layers (10-20 cm thick) covered, each one, by a layer (20-30 cm thick) of red clayey sediment.

Nevertheless, inside them no mudbrick or stone structure or domestic installation was found. Difficulties, at the excavation, to understand their real function are mostly due to this fact. Furthermore, one cannot really define whether the rhythmical sequence originated from repeated seasonal or occasional use of the site or from human dumping activities during a single but continual occupation.

Reconstruction of Sedimentary Events

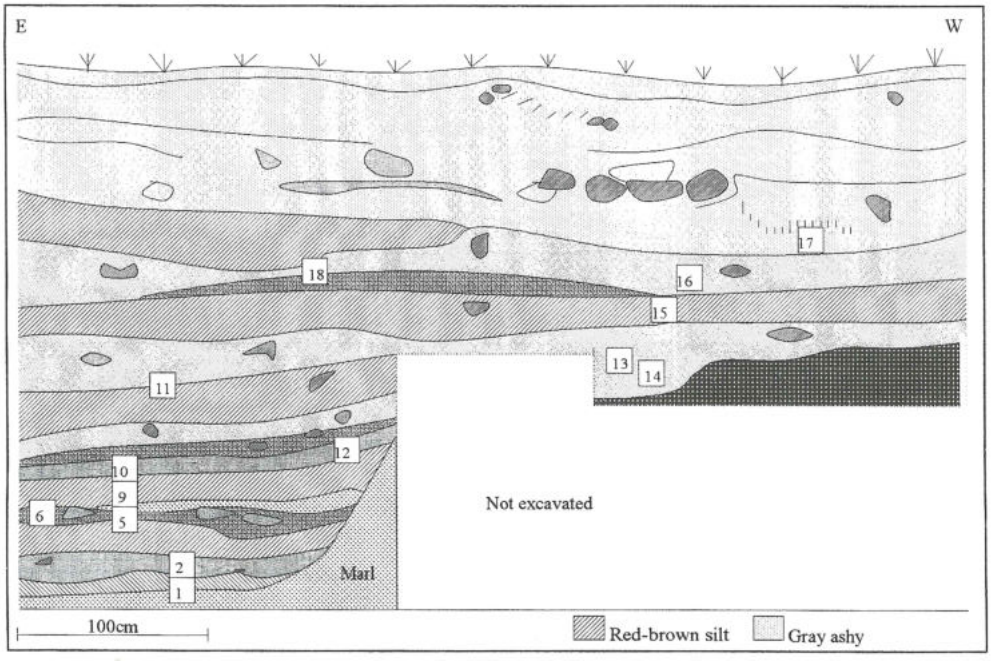
The study of thin sections made from undisturbed soil samples collected systematically from the pit deposits allow us to distinguish, for each pit, a succession of various sedimentary units of different characters. Characteristics of each sedimentary unit help to discriminate the sedimentary processes related to human activities from the ones related to natural phenomena. This discrimination allows us to separate the deposits' sequence into occupation / non-occupation surfaces. The interpretation can be made as follows* :

Occupation Surfaces

Occupations are distinguished, in addition to ash and other domestic refuse, by the nature of the underlying occupation surfaces:

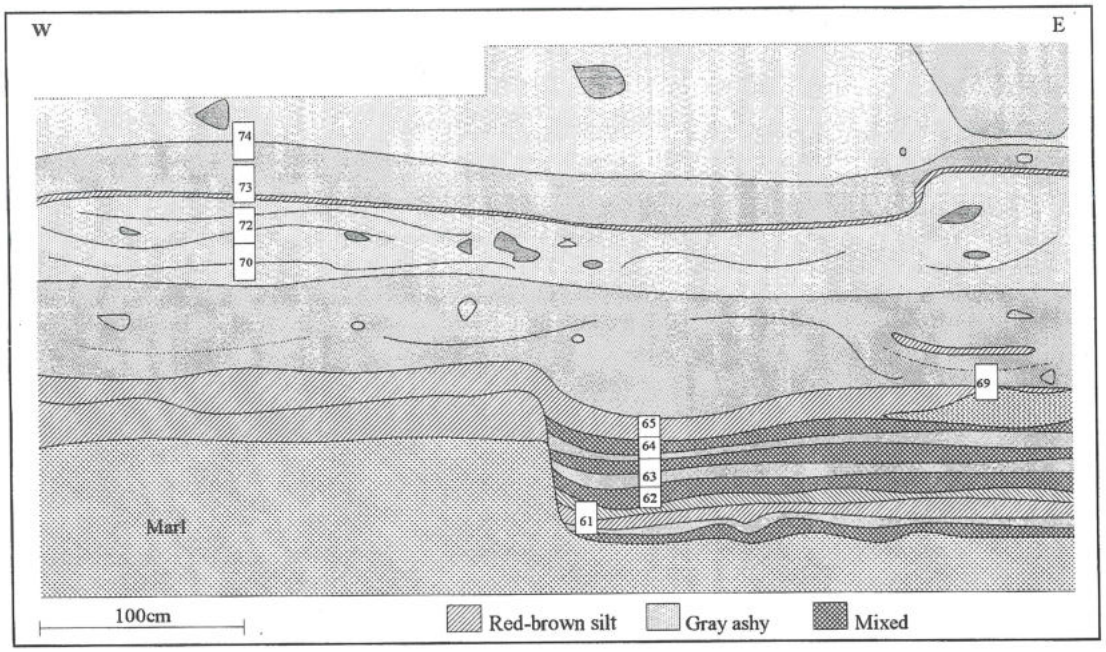
- surfaces where the sediment is homogenised by trampling. In the A2 pit, sample no. 2 (FIG. 9) includes the transition between a layer of red brown soil, covering the bottom of the pit, and an ashy occupational one. The uppermost part of the former displays well homogenised micro-aggregated fabrics with massive microstructure (compacted) in the lower part and less coherent in the uppermost one. These features result, by the action of trampling, from the desaggregation of the upper part of the underlying red-brown layer, it's homogenisation with material coming from the overlying human activities and then their compaction. Continuous trampling over a dry sediment induces the gradual attenuation of the voids between aggregates. On the contrary, the sample no. 61 in the dwelling A1 (FIG. 10) is a trampled humid surface. Here, the trampled sediments consist originally of free packing aggregate fabric which result from the desaggregation of the pit's wall and bottom and the incorporation of aggregates and anthropic material coming from the red brown outside surface. Evidence for void collapse suggests that the soil material was trampled on humid conditions. The free packing aggregates is then transformed on a spongy microstructure, then on a sub-horizontal vesicular one (FIG.6:g). In sample no. 61, trampling effects are also indicated by well-expressed four laminated centimetric layers with slightly different colour. Humidity of the sediment is also inferred by the presence of abundant orange-reddish organic and/or ferruginous impregnations. These characteristics suggest transformation under anaerobic conditions (covered surface or closed place) as well. The overlying unit consists of marly sediment, rich in plant pseudomorphs, most probably of reeds. Since reeds are not suitable for kneading with sediments assigned for preparing floors, they might belong to a fallen roof, or they could have been used as a thick mat.

The difference in the morphological characters



9. Dwelling pit A2 (lower left corner) and the location of samples.

* Because of the great amount of characteristics that belong to each one of the numerous sedimentary units, only some examples are given in this paper.



10. Dwelling pit Al cut into the marl.

between dwellings A2 and A1 is due probably to the different function of each one.

- surfaces with prepared floors: the sample no.6 of dwelling A2 comprises an irregular 3cm thick floor, made of coarse fragments of marl. Micromorphological observation of this floor shows an important quantity of centimetric sub-angular to sub-rounded marl aggregates integrated within a fine marly matrix. Their morphology and their size indicate either a poorly-kneaded sediment or a beaten flooor. An other type of constructed floors is seen in the dwelling A1 where, in sample no.63, a marly sediment is well-kneaded (FIG. 6:h).

Non-occupational Surfaces

The occurrence of red silty units covering each of the occupation layers could be explained, on the field, either by intentional human recovering action or by natural sedimentation. Observation of thin section samples taken from these deposits assigns their rhythmical occurrence to natural sedimentary and post-depositional processes. In the dwelling A2, sediments forming the layer from which sample no. 5 has been cut, consist of a uniform red-brown clayey/sandy silt matrix injected with hazardly distributed aggregates of red brown soil, few aggregates of construction material, some fine charcoal fragments and some sub-angular marl aggregates. The detrital character of the aggregates suggests a physical desaggregation of the local surrounding surface, of some adjacent constructions and of the pit marly wall. Occurrence of features relating to the mechanical effects of water such as clayey surface crust layering, the interconnected vughy microstructure and other textural features indicate that water actions have contributed to transport and to deposition of the material into the dwelling. At the base of the sample a destroyed clayey surface crust unit, is witness to water stagnation in the bottom of the pit. Its destruction is due to a subsequent desiccation that involves the development of fine cracks in the crust. The interconnected vuggy porosity of the overlying unit, described above, indicates a water saturation of the sediment during its deposition.

Thus, the red silty sediment was probably transported into the dwelling by runoff across the surrounding surface. The subsequent formation of some fissures and cracks seen throughout the whole sample is caused by repeated alternations of the swelling and shrinking mechanism. These phenomena generate also the alteration and the fragmentation of the soil constituents which explain the uniformity of the matrix.

Similar characteristics are also observed in sample no. 11 of dwelling A2 and in sample no. 65 of dwelling A1 with, in addition, the occurrence of fine channels related to earthworms' activities and roots and of some gypsum crystals. The layers from which these two samples were taken represent the last filling phase which conceal the dwellings and separate between the occupations of the lower levels and those of the middle ones. On the field, one can observe the extension of this last red clayey layer, ca. 30cm thick, overlying the red clayey surface associated to the dwellings and into which they have been cut. This observation and the scarcity of anthropic material integrated within the sediment suggest a new deposit deriving from relatively large scale redistribution of the already existing colluvial surface around the site. Also the incorporation of rounded surface crust fragments and their integration well within the sediment support this interpretation. The biological activities of earthworms and roots and

the occurrence of some gypsum crystals are examples of post-depositional processes which indicate the emergence of a new surface. Occupation of the middle levels has been founded over this surface.

Conclusion

From these macro and microscopic observations, we can confirm that the large pits found in the lower levels are dwelling structures. The alternations obscured in the stratigraphic sequence of each of them represent a rhythmical use; the ashy layers can be interpreted as representing in situ occupations and the red clayey ones as defining interruption of occupation. The weak thickness of the occupation units, in relation to those of the middle and upper ones, and the small amount of detrital construction material encountered across the overlying units of abandon, witness a model of occupation of non-permanent settlements during short periods which are characterised by a moderate anthropic sedimentation. This interpretation is supported by the absence of heavy vessels and groundstones in the archaeological register of the lower levels, by the absence of heavy constructions upon the outside surface associated with these dwellings (Dollfus and Kafafi 1993) and by the random character of the occupation deposits. We can, thus, suggest a semi-sedentary or seasonal use of the site during the time span of its lower levels. The first inhabitants cut their dwelling pits into an irregular substratum, taking advantage of some slight depressions probably made by erosion of the soil cover. This might explain the repeated occurrence of red silty fills covering each of the occupational ashy layers. The red fills appear to be the result of erosion of the gently sloped soil surface. Irregularity in the surface is also encountered in all areas where the excavation has reached this level.

In the first part of this study we concluded that the landscape around the site and climatic conditions were favourable. Nevertheless the first occupation appeared to have been seasonal, possibly related to a semi-sedentary type and not to a sedentary one. This leads us to ask about the reasons why the site was not at that moment permanently occupied and to see what happened a) around the second half of the seventh millennium BP, when a shift towards a sedentary form of life is more obvious in the archaeological record of the site, and b) by the middle of the sixth millennium BP when the site was completely abandoned. Those questions are now under study.

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Aerial Archaeology in Jordan: Air Photography and the Jordanian Southern Ḥawrān

Introduction

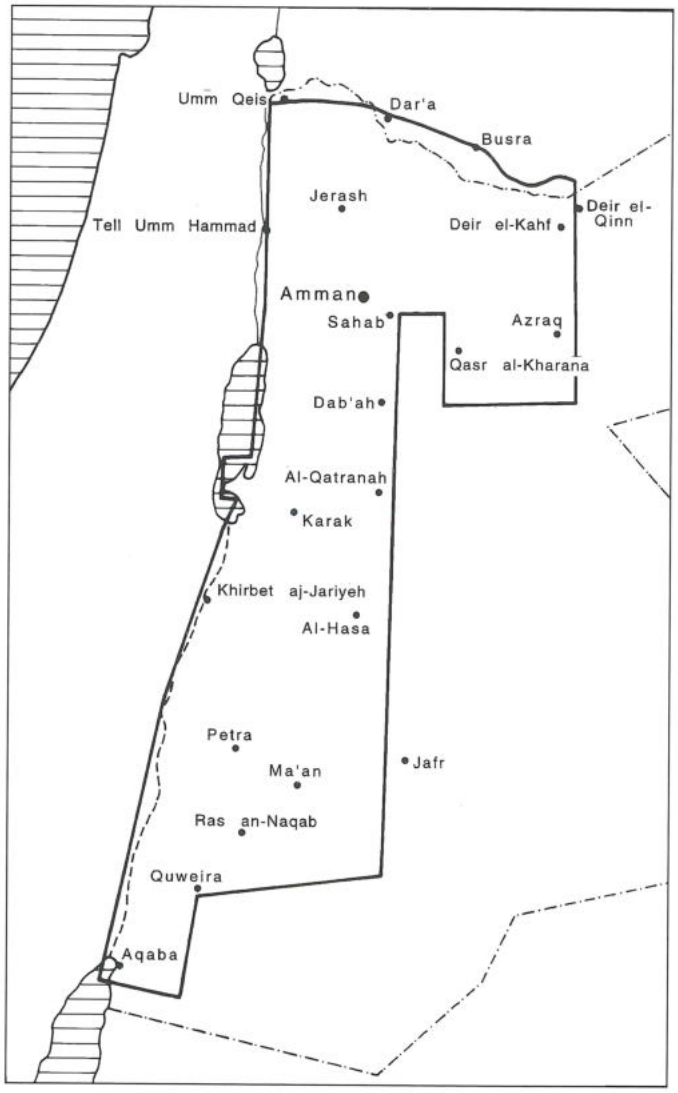
At Oxford in 1980, at the First Conference on the History and Archaeology of Jordan, the author presented a paper which was, in essence, a reminder of the potential of air photo- graphy in archaeology in general and a plea for its further use in Jordan in particular (Kennedy 1983; cf. 1982: 327-344). The motivation was simple: In the 1920s and 1930s, there were two significant areas of pioneering activity in what is often called "Aerial Archaeology". That, in Britain, continues still and the technique is well-established as the single most powerful tool for prospection and discovery available to archaeology, as well as offering wide scope for interpretation (see in general Riley 1987; Wilson 1982). The second area was in a part of the Midde East - in Syria, then it extended later into Iraq and Transjordan (Poidebard 1934; Mouterde and Poidebard 1945; Gregory and Kennedy 1985)[1] – but it largely came to an end in 1939 (see Kennedy and Riley 1990: Ch. 3). That has been a tragedy for the archaeology of the region.

The Aerial Photographic Archive for Archaeology in the Middle East

In 1980, the author had already established the Aerial Photographic Archive for Archaeology in the Middle East. Its objectives - essentially to identify and obtain access to existing caches of air photographs and to promote actively the value of the technique - were set out in a number of publications (Kennedy 1980; 1982: 341-342; 1987). With the patronage and support of HRH Crown Prince Hassan, and through the generous response of the Royal Jordanian Geographic Centre (RJGC) under its former Director-General Rifat Majali, the Archive developed rapidly in the later 1980s.[2]

Photographs and maps of the Middle East - but overwhelmingly of Jordan - were obtained from various sources, not least the holdings in Britain of the Royal Air Force. The principal acquisition, however, was from the RJGC itself of some 4000 frames of a vertical aerial survey of much of Jordan taken by Hunting Aerial Surveys in 1953 (FIG. 1).

Initial work on the material in the Archive was slow



1. Map of Jordan to illustrate the extent of coverage of the air photographs of the Hunting Aerial Survey of 1953.

for want of funds but there was a trickle of publications in which air photographs were a significant primary source (Gilbertson and Kennedy 1984; Gregory and Kennedy 1985; Kennedy 1982; Kennedy and Cowie 1984; Kennedy and Riley 1990; cf. Riley 1982). In 1991, how-

[1] We should not, of course, overlook the important work of Baradez published in 1949.

[2] It has continued to benefit still with, most recently, the friendly support of Dr Saliem M. Khalifa, the current Director– General.

ever, the Australian Research Council awarded a grant for the three years of 1992-1994 for a project, "Remote Sensing for Archaeology in the Middle East", the core of which was to be the systematic analysis of this air photographic evidence. That work continues still with a renewed grant for 1996 and has given rise to a number of publications (Kennedy 1992/93; 1994; 1995a; 1995b) with others pending (Kennedy 1995d; 1996a; 1996b; Kennedy forthcoming a; b; c). The entire research should be completed in 1997 and published in 1998 (Kennedy forthcoming d)

Remote Sensing for Archaeology in the Middle East Project: The Jordanian Air Photographs

For present purposes it is necessary only to describe briefly the procedures adopted for this air photography of Jordan; a fuller description is in press (Kennedy 1996a) and an overall interim survey of the project is in preparation (Kennedy forthcoming c).

The air photographs consist of diapositives (positive rather than negative images on film) each some 18-20 cm square (two different films were employed). The scale is 1:25,000 giving a coverage for each frame of about 20-25 sq km.

As is well-known, there are three steps in the analysis of air photographs in archaeology: air photographic interpretation, transcription/ recording (written description, plotting, drawing), and archaeological interpretation.

For the first of these, air photographic interpretation, various experiments have been carried out to identify an appropriate and cost-effective methodology. After several false starts, it was concluded that there was no alternative to the fundamental need for an *experienced* eye to be employed in scrutinizing each photograph in detail. With diapositives, that meant examining each frame under magnification on a light-table to identify actual or possible man-made intrusions which might pre-date 1919. The subsequent transcription/ recording involved plotting the colour-coded detail onto transparent overlays at the same scale. These overlays were derived by photographic enlargement of the 1:50,000 map series of Jordan onto acetate sheets. The third step in the procedure, archaeological interpretation, requires a familiarity with the landscape in question, with the existing archaeology, and, ideally, will involve a phase of ground verification. In practice, for so large an area and so many sites, existing funds will not permit full ground verification, only sampling of the whole and more detailed work for a selection of case study areas.

As far as air photographic interpretation is concerned, the intensity of scrutiny had to be set at a level to allow the project to proceed at a speed which would see its completion within three years. In doing so, it was recognized that a procedure which is already highly subjective, would be further compromised by placing limits on how much time could be devoted to any specific photograph or group of photographs. Nevertheless, it was judged that this level of scrutiny would reveal a detailed picture of the archaeological remains preserved on the photographs and a satisfactory overall impression of the patterns for sites in general and site types in particular. In short, it would reveal on a major scale the potential of the photographs as a source of evidence.

This general analysis of all the c. 4000 air photographs – hereafter called the First Interpretation–has progressed from a starting point in the north-east at Dayr al-Qinn, west to the Jordan Valley and then proceeded south (cf. FIG. 1). At the time of writing (November 1995),we were concerned with the photographs for the region south-east of the Dead Sea around Ma'ān. It was anticipated that all the remaining region down to the Red Sea will have been completed before the end of 1995. The number of sites recorded as visible on the air photographs from this First Interpretation stands at c. 12,500 and it is estimated that the final tally may be about 15,000. For reasons that will become apparent, it seems that this figure should be revised upwards quite considerably.

The photographs cover much of Jordan and, as such, record a wide variety of site types, forms, construction techniques and building materials. And, of course, the archaeological evidence is set within an ever-changing landscape and environment. For example, it was very likely that the site types and the character and degree of their survival in the arid conditions of the basalt desert would be very different from that in the extensively farmed and better watered Jordan Valley. In short, within the framework of general lessons which would be widely applicable across all of Jordan, it was likely that in detail we would have to identify and deal with several regions within which there were broadly similar conditions. Five regions have been provisionally identified. For the purposes of this paper, we are concerned with part of one of those regions, the basalt desert of north-east Jordan.

The Southern Ḥawrān

As is well-known, the basalt desert extends, in broad terms, eastwards from al-Mafraq; indeed, it extends far beyond the limits of the available air photographs. For practical purposes, therefore, the author is dealing in this instance with the region usually called the Ḥawrān, or, since much of it lies in Syria, the Jordanian Southern Ḥawrān.[3] There is of course great diversity even within this region from the mud-flats east of Qaṣr al-Ḥallabāt, through the unpopulated lava-strewn areas south of the Baghdad Highway, to the agricultural pockets quite common close to the frontier with Syria as at Dayr al-Kahf.

[3] The Princeton Expeditions to Syria at the beginning of this century differentiated between the sites they recorded in the Ḥawrān Plain and Jabal Ḥawrān on the one hand, and the Southern Ḥawrān on the other (PES). The sites visited in the latter included mainly ones now lying inside Syria (cf. Kennedy 1995c).

The basalt mantle and the generally low rainfall, however, provide a degree of unity which allows one to treat it as a single region for the purposes of the present exercise.

The question then was to devise a means of evaluating the extent to which the First Interpretation of all the air photographs of this region could be used as a guide to what might have been detected with a more detailed analysis and to what was *actually* there on the ground in 1953 as opposed to what we could see on the air photographs. The solution was to carry out now an intensive scrutiny of the air photographs of parts of this region - the Second Interpretation - and to pursue that by ground verification. It was hoped that the general lessons learned in this way would be applicable to the other regions or at least act as a guide in evaluating the results from the First Interpretation.

The selection of this region was not fortuitous. As noted above, analysis of the air photographs had begun with this area so that now, eighteen months after we completed work on the photographs for it, there has been time to absorb the lessons learnt there and subsequently developed as we moved southwards through changing landscapes and environments. More importantly, however, the region is one with which the author has greatest personal familiarity having been engaged on a field survey for some years.

The Southern Ḥawrān Survey, covering an area of some 600 sq km between Ṣabḥah in the west and Dayr al-Qinn in the east, and from the Syrian frontier south to the Baghdad Highway, has been in progress for a decade (Kennedy, MacAdam and Riley 1986; Kennedy 1993; 1995d; Kennedy and Freeman 1995; 1996). The area under investigation in this survey represents a manageable portion of the Jordanian Southern Ḥawrān. More of the Southern Ḥawrān lies to the west and is being treated by the Umm al-Jimāl Project and more lies further south beyond the Baghdad Highway. From the outset the survey methodology included the use of air photographs and the fieldwork explicitly aimed to evaluate those available. In practice that meant both endeavouring to locate and investigate on the ground those traces identified on specific frames, and seeking to explain how sites previously identified on the ground appeared on the photographs in the way they did – or why they did not appear at all (Kennedy, MacAdam and Riley 1986: 151-153; Kennedy and Freeman 1995: 39-61, *passim).*

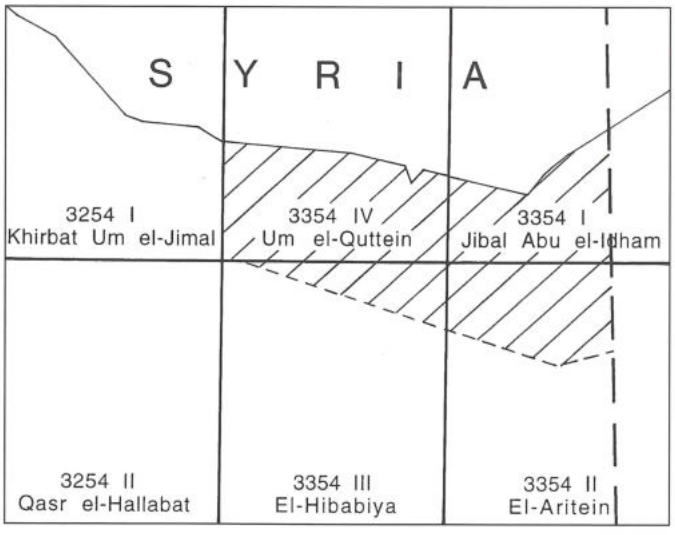
Air Photographs of the Southern Ḥawrān

For present purposes, the author has chosen to define the Southern Ḥawrān as the region encompassed by six sheets of the K737 series, 1:50,000 scale maps of Jordan provided by the Royal Jordanian Geographic Centre. The sheets in question are illustrated in (FIG. 2).[4] The area encompassed is, of course, also far more extensive than either the remit of the Southern Ḥawrān Survey or of the Southern Ḥawrān itself.

The air photographic coverage available in the Hunting Survey does not extend all the way across the "Jibāl Abū al-Idham" and "al-Aritein" sheets, but stops just before the longitude of Dayr al-Qinn. Moreover, for the three more northerly maps, many of the photographs of the Hunting Survey relate to Syria and are not included in this exercise which is limited to Jordan.

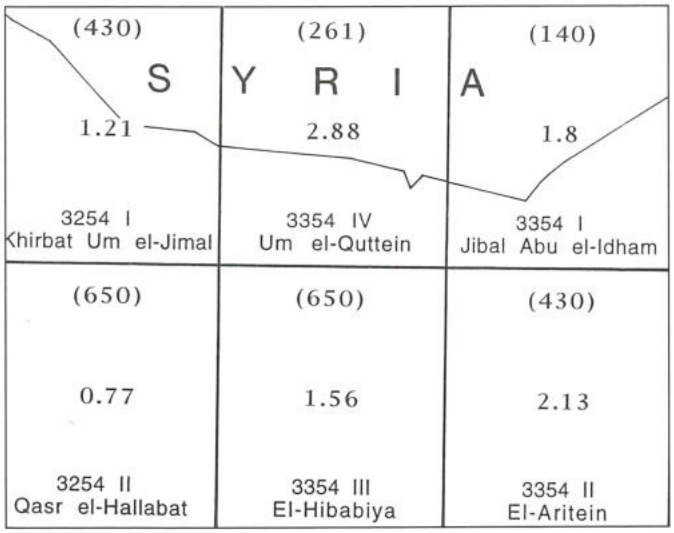
The area defined above is some 2,560 sq km. The three northern sheets covering c. 430, 260 and 140 sq km respectively; the southerly covering 650, 650, and 430 (cf. FIG. 3). The total number of photographs covering this area is 645 (about 16% of the c4000 in the Hunting Survey). All were taken flying north-south and south-north alternately and as part of much longer runs which extend from southern Syria deep into Jordan (FIG. 1). As the analysis of the photographs followed individual runs beyond the northern and southern limits of these maps, work on these particular sheets for the First Interpretation was spread over much of a year.

The number of sites identified on the First Interpretation was 3946 giving an average site density of just over 1.5 per sq km. The number of sites is very large; far in excess of what one might have gleaned from the maps themselves (cf. Kennedy 1996a) or what is known from previous ground recording by investigators over the last century. But to what extent are these findings a reliable guide to the number and range of sites which might be discovered on the photographs if a more intense analysis was carried out? Are they indeed archaeological sites and to what extent can they be traced on the ground today and dated? Finally, can such findings as these be employed as part of a full ground survey? Part of the answer to these questions can now be provided. Since the completion of the First Interpretation, the photographs covering two of



2. Diagram to illustrate the region encompassed by the present exercise, the limit of coverage towards the east, and its relationship to the area covered by the Southern Ḥawrān Survey.

[4] These map names are as they appear on the 1:50,000 map series. In the text itself, however, I have used a different spelling in more common use. The equation is usually self-evident.



3. Diagram to illustrate site density as seen after the First Interpretation. Area in sq km in brackets at top.

these sheets – al-Jimāl and al-Idham – have been the subject of a Second Interpretation. For this, no time limit was set. We may now compare the results.

The First Interpretation

The First Interpretation produced interesting comparative figures for the three most northerly sheets under discussion (TABLE 1). In many cases the numbers are too small to permit any meaningful comparison; for a few, however, they are more instructive (TABLE 2).

Generally there is a close co-relation between the percentages of site types in each of the three map areas. The exceptions are with agricultural features where the numbers rise proportionately by about half as much again as one goes further east. However, for cross-wadi walls the position is strikingly different for the Umm al-Jimāl area where they are 16-20 times more common than further east. This is best viewed not as a persistent oversight by the interpreter but a reflection of the reality: there are fewer instances of cross-wadi walls as one moves eastward in this broad area.[6] A desideratum will be to plot out the pattern of this site type and relate it to the landform and environment.

The implications of the figures in these tables are encouraging. The intepretation process is one which may be subject to variations from a number of factors; for example, fluctuating concentration, failing to recognize site-types initially, gradual and imperceptible changes in the criteria employed, changes in speed of scrutiny, the quality and timing of the air photographs, interruptions. Moreover, as noted above, these sheets were not examined in succession. Nevertheless, it would seem that broadly the same level of concentration and the same broad criteria for identification were maintained across

Table 1. Comparative figures of site types[5] recorded during the First Interpretation of three sheets of the Jordanian Southern Ḥawrān. 1. "Khirbat Umm al-Jimāl"; 2. "Umm al-Quṭṭayn"; 3. "Jibal Abū al-Idham". The bold figures in brackets are the approximate areas in each instance in sq km.

	1 (425)	**2 (260)**	**3 (140)**
Animal Enclosure /Corral	296	504	165
Rectilinear Enclosure	3	2	2
'Circular 'Enclosure	10	22	5
Kite	39	59	19
Water Associated Site (Reservoir, cistern , waterhole, channel)	37	84	30
Agricultural Feature , Field system	19	39	15
Road, Road Towers/Stations Bridge	2		1
Linear Feature	9	6	4
Village			5
Dam			1
cross Wadi Walls	42	4	1
Military Site (Fortress , fort, tower , defended site)	1	1	1
Cemetery/ Tumulus /Cairn	3	1	1
Cartwheel / hut (landscape and single)	3 ?	2 ?	
Farmstead	3		1 ?
Ring Settlements	1	6	1
Major structures	4	3	
Ancient settlement	12	13	
Modern feature?	6	4	
Foggara	3		
Areas of Discolouration	9		
Areas of Disturbance	2		
Pitting / Linear Landscape	5		
Rectilinear Structures	5		
Total	**514**	**750**	**252**

Table 2. Percentages of the total of site-types recorded in the First Interpretation of the air photographs for three sheets of the Jordanian Southern Ḥawrān. 1. "Khirbat Umm al-Jimāl"; 2. "Umm al-Quṭṭayn"; 3. "Jibāl Abū al-Idham". The bold figures in brackets are the approximate areas in each instance in sq km.

	1 (425)	**2 (260)**	**3 (140)**
Animal Enclosure /Corral	58	67	66
'Circular' Enclosure	02	02.9	02
Kite	07.6	07.8	07.5
Water Associated Site	13.9	11.2	11.9
Agricultural Feature , Field system	03.7	05.2	06
Cross Wadi Walls	08.2	00.5	00.4

[5] The site types were refined and reordered for the purposes of the Second Interpretation. For present purposes of general comparisons, the precise types are unimportant.

[6] The incidence of cross-wadi walls on the al- Jimāl sheet had already revealed a thinning in the pattern as one moved eastwards (Kennedy 1996a).

the sheets and over the course of the year which elapsed between work on the first and third sheets of this trio. Nevertheless, now, in the fourth year of the project the methodology is still constantly being evaluated and refined, new site types are still occasionally identified and the differing landscapes and environments give rise to new problems and opportunities.

The Second Interpretation

Great care was taken to look at the same areas on each photograph not just on any one single frame but on one or more others in the same overlapping sequence and one or more others in the parallel overlapping sequences. In some instances, up to nine frames could be examined with regard to a single location (Kennedy 1996a: FIG. 1a). The motivation was simply that it was apparent that sites clearly identifiable on three consecutive frames could show in very different ways and degrees; it was reasonable to assume, therefore, that other sites which were less distinct might show faintly on one frame but be invisible on another. The procedure is cumbersome even on a large light table and very time-consuming. For this Second Interpretation, therefore, no time limit was placed on the work. Second, in the light of ground verification and a generally greater familiarity with the region and its archaeology, the author was able to refine the view of how to isolate individual sites. The outcome was rather different as the tables below reveal. For both sheets, a number of sites from the First Interpretation were subdivided, others (principally isolated cairns) which had been deliberately excluded before were now included (as cairns/ burials), and a number of sites missed were now recorded (see, for example, the increase in the number of kites on the al-Jimāl sheet from 39 to 58). The outcome for the Umm al-Jimāl sheet was a doubling of the number of sites from 514 to 1070 (TABLE 3).

The "Jibāl Abū al-Idham" sheet covers an area of c. 140 sq km. Because it lies at some distance from the Umm al-Jimāl area a Second Interpretation of it permitted any glaring difference between the two to be more noticeable and offer lessons in advance for what one may detect on the intervening Umm al - Quṭṭayn map and to some extent the sheets to the south.

The Second Interpretation recorded 185 sites more than the First, an increase of 74%. The increase is less than the doubling for the Umm al- Jimāl area but gives a final site density of just over 3 per sq km compared with 2.5 on the Umm al- Jimāl sheet. There are notable differences and similarities.

Comparison of the Results of the Second Interpretations of the Sheets "Jibāl Abū al-Idham" and "Umm al-Jimāl".

First, the number of instances of cross wadi walls only changed from one to two. Even allowing for the differences in size of area, it is plain there are very few features of this kind in this easterly region in comparison with Umm al-Jimāl where, finally, 22 were isolated and many more examples were associated with settlements and the identified as components of farms.

Second, it is certainly possible to identify "farms"; including uncertain examples and others which might be small villlages, the total is 51 which compares quite favourably with the much larger area of al-Jimāl with 223. The farms in the east, however, are rather different from those around Umm al- Jimāl where they were often associated with cross wadi walls. Here they are often defined in terms of the extent and number of corrals and the presence of modern farming in the vicinity. Striking, however, is their near absence in the north of the area. There, modern farming and widespread and continuous traces of ancient field boundaries, implies earlier farming but vir-

Table 3. Comparison of the numbers and range of sites recorded on the First and Second Interpretations of the air photographs of the "Umm al-Jimāl" sheet (partly based on Kennedy 1996a: TABLE 2).

Major Settlements	12	13
Major Structure	4	1
Larger Enclosure	13	21
Farm (probable)	3	116
Cross-Wadi Walls (in isolation)	42	22
Fields (ancient)	19	5
Corrals (possible farm)		107
Corrals (multiple cells or scatter of single cells)	296	180
Corral (single isolated cell)		127
Discolouration (possible corral)		12
Reservoir/ Waterhole/ Cistern	37	37
Foggara/ Water Channel	3	9
Dams		2
Kites	39	58
Fortlet	1	2
Road (Roman)		5
Tower	2	11
Crain/Tiny Corral(possible Tower)		18
Cairns	3	178
Cairns (possible tiny corrals)		40
Discolouration (possible cairn)		27
Pitting (possible cemetery)	5	4
Earthwork		4
Wall		1
Areas of Disturbance	2	35
Areas of Discolouration	9	32
Miscellaneous	5 (rect.struct.) 6 (mod .feat) 1(ring settl.?) 3(cartwheels?) 9(linear feat.)	3
Total	**514**	**1070**

Table 4. Comparison of numbers of sites found on photographs covering the "Jibāl Abū al-Idham" sheet between the First Interpretation and the Second. For present purposes the site types employed have been redefined to suit those employed on the Second Interpretation.

	1st	2nd
Corral/ circular enclosure		100
Corrals	165	180
Irregular enclosures		7
Rectangular enclosure	2	4
Circular enclosure	5	1
Ring settlement	1	
Reservoir/ Reservoir?		13
Waterhole?	30	7
Cistern?		9
Water channel?		2
Dam	1	
Cross wadi walls	1	2
Kites	19	12
Village(?)/ farm(?)	5 ?	4
Farm?	1 ?	28
Corrals/ Farm?		19
Field(s)	15	14
Cairn?/ tower?/ burial?	1	20
Fort	1	1
Road	1	2
Miscellaneous		12
Total	**252**	**437**

tually no farms can be found. Unless they have been lost through recent land development, one must suppose people resided in the larger villages which existed further north in what is now Syria.

The number of kites is proportionately about that one would expect from the Umm al-Jimāl survey, but less than one might have predicted on the basis of the basalt landscape and the known chains of them only a little further east again (Helms 1981: 39-47).

The major increase in numbers has been with corrals, whether individual enclosures or multiple. While many are probably post-Ottoman and many of the total are individually unexciting, the category should not be neglected. Collectively their pattern points to the areas of human activity; individually, some of the more complex examples are worth closer examination. Sometimes around the clear corral circuits, traces of others appear as "phantoms". Around al-Jimāl, several examples of such corral sites were identified during the ground verification as ancient farms.

Several sites are individually worthy of closer investigation. Dayr al-Kahf has been examined by a number of scholars over several decades. More recently it has been the subject of air photographic interpretation (Kennedy 1995a). The very interesting collection of corrals, reservoirs and cisterns, and house foundations to the east of al-Kahf has been examined on the ground since the air photographic interpretation work (Kennedy 1995a). Notable too is Jubaiya. The site today is largely lost beneath modern structures but on the air photographs (FIG. 4) it appears in a fashion reminiscent of five such sites in the Umm al-Jimāl area (Kennedy 1996a: FIG. 17).

The Lessons of the Second Interpretation.

There seem to be two main lessons. First, we must be alert to notable differences; adjoining areas will not necessarily be at all similar in detail. Second, in broad terms, the results of the First Interpretation of the air photographs may be taken as a reliable guide to what would be achieved by a Second Interpretation when the overall numbers of sites will increase but will do so in reasonably predictable ways.

For the intervening map, the "Umm al-Quṭṭayn" sheet, one might now predict that the 750 sites of the First Interpretation would rise somewhere between the 100% increase for al-Jimāl and the 74% increase for Idham. The outcome might fall somewhere around 1400 sites. In detail, one might expect, for example, about 55-60 kites, several areas of cross wadi walls, and about 120 "farms".

Across the entire area of these three northern maps, a Second Interpretation may be expected to identify almost 3000 sites increasing the site density to 3.6 per sq km. If the three southern sheets were similarly treated, the total could rise steeply there too, giving perhaps an overall total of about 7500, and a site density of 2.85 per sq km (TABLE 5 and FIG. 4).

What is immediately apparent is that the lowest density is for the sheet on which one may see the most extensive modern settlement, namely "Qaṣr al-Ḥallābāt". Density rises as one moves north into the (at that time) less settled area around Umm al - Jimāl, and likewise east into the al- Hibabiya area. It rises steeply beyond each of those to the area around Umm al-Quṭṭayn which, in 1953, was very thinly occupied even in the village itself. Densities remain high to the east again but are starting to

Table 5. Comparing the actual and predicted numbers of sites for each of the six sheets of the Southern Ḥawrān on the basis of a First Interpretation and sample Second Interpretations.

	First	Second(Prediction*)
"Khirbat Umm al-Jimāl"	514	1070
"Qaṣr al-Ḥallābāt"	498	750*
"Umm al-Quṭṭayn"	750	1400*
"El-Hibabiya"	1015	2000*
"Jibāl Abū al-Idham"	252	437
"El-Aritein"	917	1700*
Total	**3946**	**7357***

fall away in the Dayr al-Kahf area where there was even then farming along the border but also the beginnings of the full basalt desert and declining scope for permanent settlement. In short, the photographs record most sites in the areas least developed.[7] That is the reverse of what one would have expected the *actual* pattern to have been and alerts us to the significant under-representation likely as one moves westwards into more densely settled.

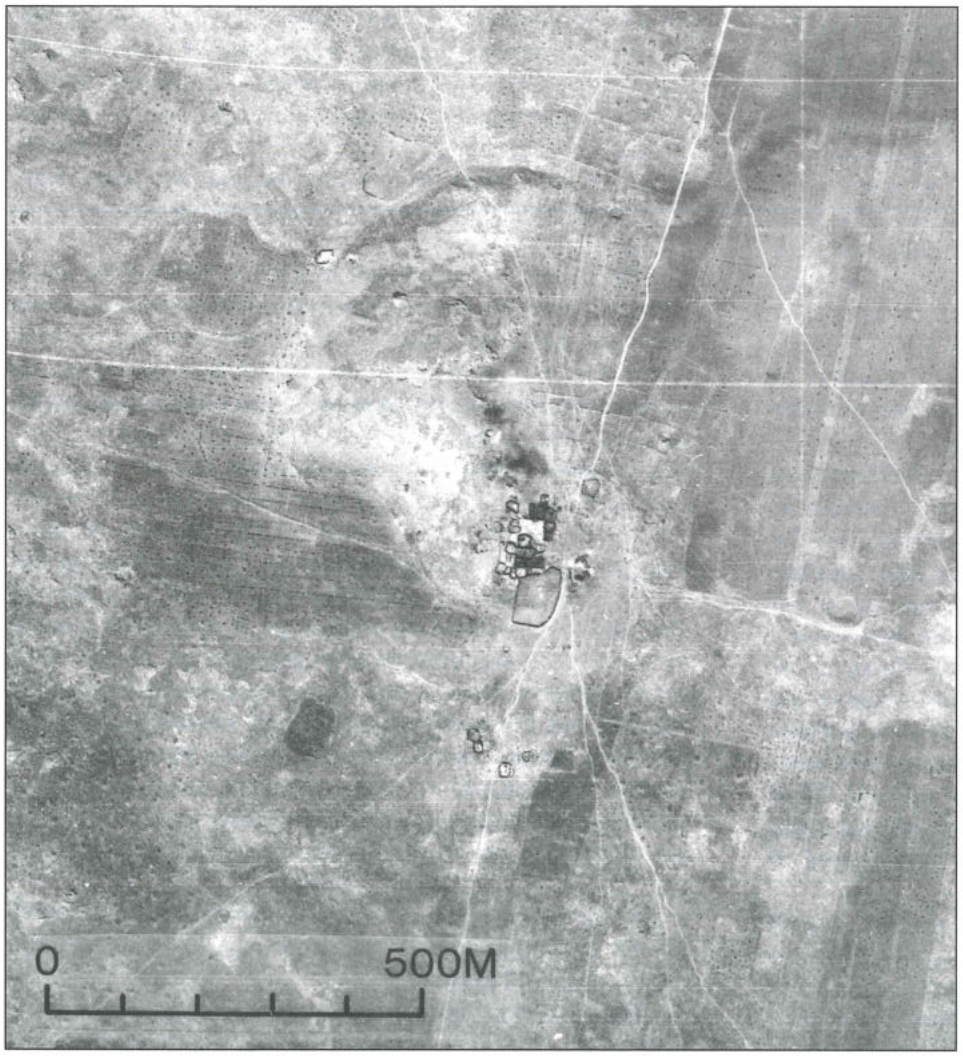
Overwhelmingly these sites are "corrals". Already from the First Interpretation, there were 2627 single or multiple corrals and they are the category which increased most in the Second Interpretation. That term implies animal pens; that is doubtless what most were and dating evidence from them may be slight. But the category deserves closer attention for that very reason and because some are plainly more than mere pens for the animals of migrating nomads.

As a result of field-work and closer scrutiny of some of these "corral" sites and their context on the air photographs, it is better to think of at least some as the traces of a building for human habitation surrounded by pens for stock and, perhaps, small gardens. The principle may be seen widely from prehistoric Britain to contemporary examples in Jordan. In the western part of the Southern Ḥawrān such "farms" often included some arable farming, marked by their location close to a wadi course and traces there of cross walls.

Two other site types are especially numerous: over the six sheets in question the First Interpretation recorded 490 kites. The densities are as follows (FIG. 5). It is striking that in the al-Ḥallābāt area, despite the intense agriculture, clear traces of so many kites can still be found. Kites, because of their size and usefulness as boundaries, are much more resilient to development, leaving tell-tale traces in the landscape even where least expected (cf. Kennedy 1996a: 23).

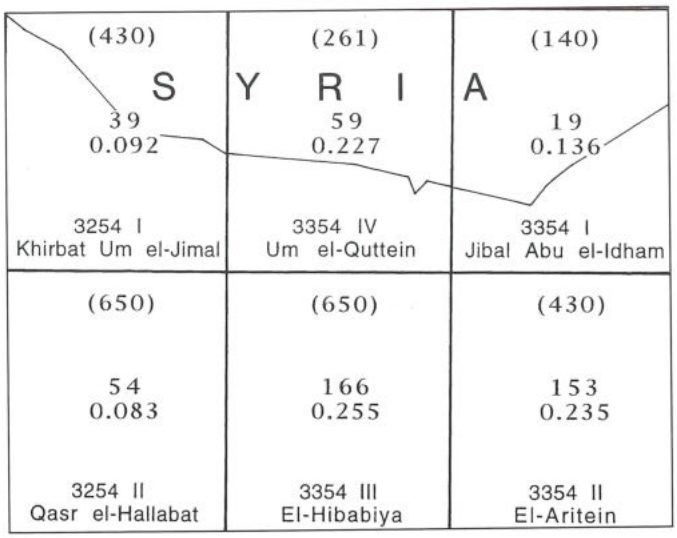
Sites and Ground Survey

Although the photographs are now over 40 years old and the landscape much changed, fieldwork in 1994 had relatively little trouble in tracing many of the sites; a more concentrated search in 1995 in the course of the final season of the Southern Ḥawrān Survey was even more suc-



4. Air photograph of Jubaiya (SHS Site 333) as preserved on an air photograph of 1953 (HAS 61.137).

[7] The same pattern was detectable further west where visible sites declined in number very considerably.



5. Diagram to illustrate numbers and densities per sq km of kites on the Southern Ḥawrān sheets after First Interpretation. Area in sq km in brackets at top.

cessful, finding over 90% of sites sought. In most cases it was apparent that the traces on the photograph were indeed those of an ancient structure. However, it is yet to be determined what sort of proportions survive. In specific areas it was immediately apparent that some sites had disappeared entirely under pressure of modern agriculture. Indeed, in the Umm al- Quṭṭayn area and around al-Ḥallābāt it was especially shocking to find some very large sites destroyed very recently by bulldozing for land clearance. Some large structures such as kites survived still embedded in the landscape; conversely, in one strking instance investigated in 1995, two large kites just south of ad-Dafyāna had been removed entirely (FIG. 6). In such instances, however, it is doubtful whether at ground level they would have been recognized as kites without the photograph to guide and explain.

In the light of the foregoing analysis, a few points may be made with regard to the potential of these interpretations for use in conjunction with ground survey. For the final season of the Southern Ḥawrān Survey just completed, the results of this work began by alerting us to the huge numbers and great variety of sites in the landscape - even a relatively inhospitable one as here. There is far more there than one might have guessed and without the air photographs many sites in low relief or incorporated into the modern landscape or lacking artifacts could easily be missed by even intensive ground survey. Then again, many may have been damaged or destroyed since 1953, the air photograph preserving the only record of what they were once like.

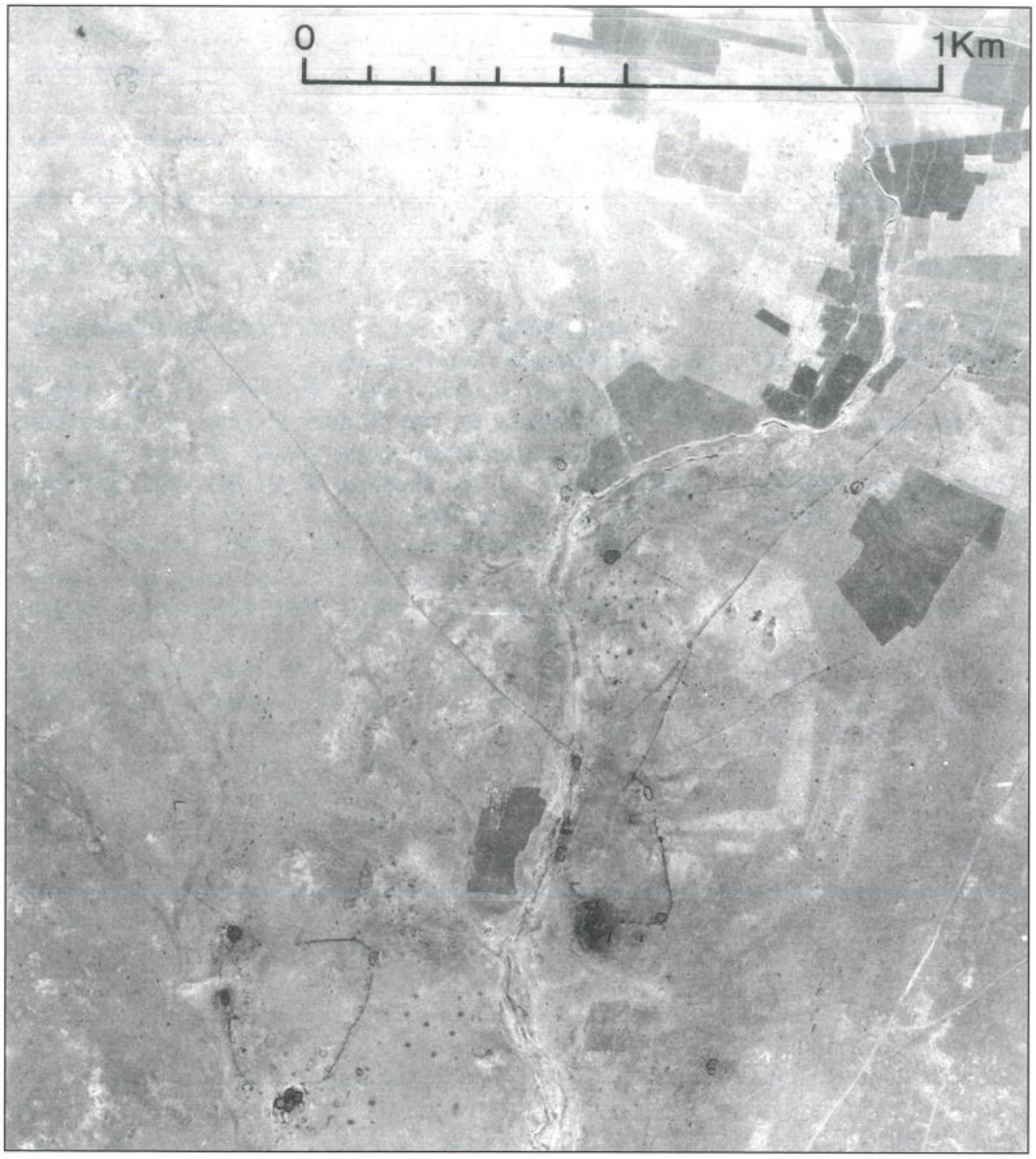
The fieldwork strategy for this last season was geared more specifically to locating and exploring specific sites found on the air photographs. Some because they were problematic; for others it was a case of seeking dating evidence from a representative of a type. In most cases a sketch plan at least is most easily prepared from the air photographs. A second strand to the strategy was to compare in a very direct way the results to be gained from ground survey with what was already known from the intensive Second Interpretation of the air photographs. It was fully expected that the air photographs would not show certain types of site. Our preliminary finding in August-September 1995 allowed us, at least provisionally, to quantify that belief - the air photographs recorded only about half the sites we were able to identify on the ground.

Air Photographic Research

Twenty years ago, aerial archaeology in north-western Europe created an "information explosion". Many thousands of new sites were recorded and an unexpectedly densely settled landscape emerged in many areas. The evidence offered opportunities of many kinds. Individual sites could be "explored" without resorting to expensive excavation, some sites could be understood better without excavation at all or excavation guided by air photographic evidence. The density of sites obliged archaeologists to reassess their views on land use and population - figures for which have been revised upwards significantly. The great quantities of new information arrived, too, at a point in the development of archaeology where the amassing of data was viewed as a means of permitting greater sophistication in interpretation. Finally, the technique was linked closely to the growing awareness of the need for planning: aerial surveys could help predict damage and alert planners to the consequences of intended actions before it was too late.

The results of our present project – even before completion – offer the same opportunities. It will be apparent from the foregoing discussion of just one region that Jordan too is littered with the traces of human activity. It is clear, too, that the exploration of individual sites can be pursued cheaply and easily through examination of existing air photographs even though taken for non-archaeological purposes. Likewise, future excavation or field survey should begin with a study of the relevant air photographs and they should be kept in hand throughout the work. With a view to assessing what might be achieved elsewhere in Jordan, case studies are in progress for areas in which there has already been a published survey. That for the Wādī al-Ḥasa is nearing completion while that for the al-Karak Plateau is planned. In the meantime, our project as a whole, based largely on these Hunting Aerial Survey photographs of 1953, covering much of Jordan and most of the areas within which there are active fieldwork projects, has produced a mass of data available for use. In the light of the above discussion, one would estimate that the number of sites which might be identified if *all* the photographs were to be re-examined intensively, would exceed 25,000.

The potential for such research in Jordan at this juncture where Cultural Resource Management (CRM) has become a critical issue, is self-evident. The JADIS project



6. Air photograph illustrating two large kites just south of Dafyāna visible in 1953 but destroyed by 1995 (HAS 55.056).

too may be transformed by systematic analysis of *all* the air photographs held by the Royal Jordanian Geographic Centre. A fuller picture of the archaeological heritage of Jordan may be obtained, an evaluation made of the pace and nature of the threat to sites, and plans made to preserve sites and record others before they are destroyed. The importance of doing so should not disguise the difficulties. The work is slow and painstaking, the skills required in separating the work of humankind from that of nature cannot be acquired swiftly, and adequate recording is not yet, in the author's opinion, a fully resolved problem.

Allied with that, one should seek to establish a programme of flying. Initially, that need be little more than some experimental flying to test the methodology in an environment and circumstances far different from those of north-western Europe or North America. In the longer term, however, it would be to the advantage of archaeology as a whole if a regular annual programme was to be established with a detailed research design and clearly defined gaols. As has been noted above, the Middle East was one of the two areas in which pioneering work in aerial archaeology took place – that in Syria by Père Poidebard in the 1920s and 30s is well-known, as is that by Sir Aurel Stein in Iraq and Transjordan in 1938-1939. Less well-known are the air photographs of archaeological sites in what is now Jordan being taken already in 1918 by the German air force attached to the Ottoman forces.[8] It would be fitting if Jordan were able to benefit from and to be at the forefront of such work once more. And, of course, it is a very cost-effective method of prospection.

[8] I owe this information to Professor Benjamin Isaac of the Dept of Classics, University of Tel Aviv. Cf. Lewis 1987: photographs *passim*; Kennedy and Riley 1990: 48-49.

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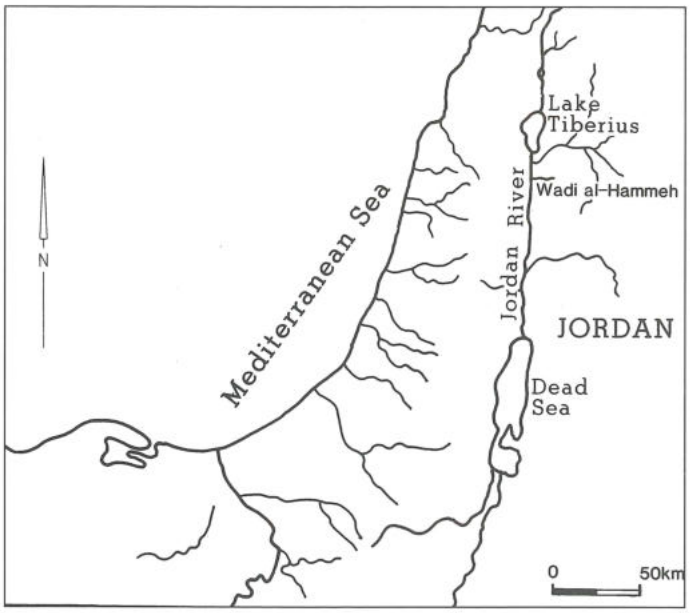
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Physical Environment and Occupation in the Ṭabaqat Faḥl Region, Jordan over the Last Half Million Years

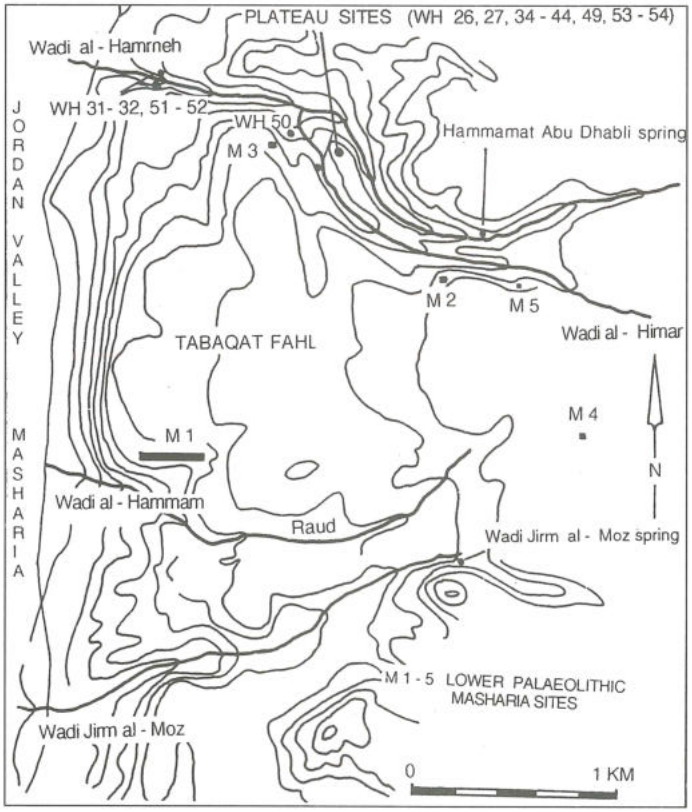
Introduction

The Ṭabaqat Faḥl region lies eastwards of the town of al-Mashāria' at the edge of the Jordan Rift Valley about 30 km south of the Sea of Galilee (FIG. 1). The region consists of a rectangular ten square kilometre buttress-like plateau (Ṭabaqah plateau - FIG. 2) rising steeply from the Rift Valley floor and lying at an elevation of approximately 125 m above the Jordan Valley (Macumber 1992). At the eastern margin of the plateau, the landsurface rises abruptly to the lower slopes of the 'Ajlūn Highlands. The Ṭabaqah plateau lies at an elevation of about ± 75 to ± 25 m, and appears to be the surface of an uplifted block – the Ṭabaqah Block – lying directly opposite the junction with the Jezreel Valley, itself part of the Rift Valley system.

The Ṭabaqah Block is bounded by deeply incised spring-fed wadis, the last phase of incision being in response to lowered base levels of erosion and sedimentation following the demise of Lake al-Lisān about 11,000 years ago (Macumber and Head 1991). These are the Wādī al-Ḥimma in the north and the Wādī Jirm al- Mawz the south; in addition there is the Wādī Khawaan in the centre. Very warm thermal springs feed Wādī al-Ḥimma, while the large springhead at Pella is situated at the head of Wādī al-Jirm (FIG. 3). The temperature of the Pella spring (s) is about 25° C which, while only marginally thermal, is still relatively warm, especially during the cold winter months. The spring outflow is about 1500 litre/second. Springs at Pella on Wādī al-Jirm and in Wādī al-Ḥimma, emerge at the far eastern edge of the block, suggesting groundwater flows up fracture zones associat-



1. Location plan of the Ṭabaqat Faḥl region. The Ṭabaqah Block lies immediately to the south of Wādī al-Ḥimma, about 30 km south of Lake Tiberias.



2. Ṭabaqat Faḥl region showing al-"Mashāria'" and "Wādī al-Ḥimma" series archaeological sites. The contour interval is 20 m, and the lowermost contour is -200 m amsl with the Ṭabaqah Plateau lying between -80 and -20 m.



3. Pella springhead from Pella tall with Roman/Byzantine civic complex to left.

ed with Rift Valley faulting.

The Ṭabaqah Block has been a focus for major spring outflow fed by regional groundwater systems developed in Cretaceous and Lower Tertiary marine limestones aquifers since Middle Pleistocene times. Chert bands are common in the limestone, and chert boulders and pebbles, an important source of stone material, are an integral part of the fluvial conglomerates derived from these older sequences. Recharge of the aquifers occurs to the east on the higher regions of the Western Jordan Mountains.

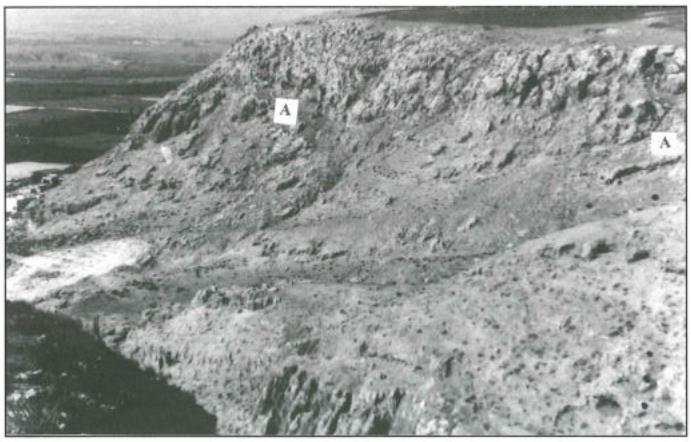
In situ archaeological sites span Lower, Middle, Upper and Epipalaeolithic periods and most of the Holocene. For instance, the Pella tall ranges in age from Chalcolithic up to Mamluke times, and the lower slopes are partially occupied by the village of Ṭabaqat Faḥl today (McNicoll, Smith *et al.* 1982; McNicoll, Hennessy *et al.* 1992)

Geology

The Pella tall deposits represent the most recent of three distinct cycles of sedimentation/occupation of the Ṭabaqah and its springs. The Ṭabaqat Faḥl Formation is the earliest sedimentary cycle forming the main part of the Ṭabaqah Block. The basal part of the Ṭabaqah Block is formed of fluvial chert and limestone conglomerate overlain by up to 100m of tufaceous limestone (Ṭabaqat Faḥl Formation), the latter deposited by groundwater which has since Middle Pleistocene times emerged in zones of regional outflow, along the edge of the Rift Valley. At the eastern edge of the block the conglomerates emerge from beneath the tufaceous limestone and rise onto the adjacent higher ground where they cap the hills. They outcrop on the Ramillah Ridge overlooking Wādī al-Ḥimma, where they contain Acheulian hand axes (Macumber1992). The tilt of the gravels and overlying limestone towards the Rift Valley is interrupted by a broad syncline visible in the southern side of the Wādī al-Ḥimār about 500m back from the rift edge and there followed by a tributary wadi.

The overall physical environment is that of a continental fluvial sequence (chert conglomerates) grading upwards into a groundwater-fed marshy plain (tufaceous limestone containing the freshwater snail *Melanopsis praemorsa*) bordering the Rift Valley. These sediments pass riftwards to merge with dense microcrystalline limestones, interpreted as lake or lake-margin deposits formed in an early pre al-Lisān Middle Pleistocene palaeolake. This lake was a precursor to Lake al-Lisān which occupied the Rift Valley from about 80,000-60,000 BP up to 11,000 BP (Neev and Emery 1967; Begin *et al.* 1974). On the Ṭabaqah Block, the earliest evidence of occupation appears in both the outcropping conglomerates and in the lowermost limestone sequences towards the base of the 125 m high Ṭabaqah plateau; it continues throughout the various sedimentary sequences up to the present. *In situ* sites containing Acheulian handaxes and bifaces occur within the limestone and perhaps in the conglomerate sequences (Macumber 1992). Although the Ṭabaqat Faḥl Formation is strongly tilted in places, the largest site – al-Mashārīa'1 (FIG. 4) – lies within horizontally bedded and variously cemented tufaceous limestone on a very steep slope (at times vertical cliff face) some 30 to 40m beneath the surface of the plateau, and 90m above the Rift Valley floor. The zone of *in situ* occupation is over 400 m long and large numbers of artifacts are contained in both calcareous silt/stone and in hard, very dense limestone boulders eroding from the cliff face. The source of material for the artifacts is the chert pebbles and boulders in the underlying conglomerates.

The present elevation of al-Mashārīa' 1 is believed to be due to post depositional uplift of the Ṭabaqah Block relative to the floor of the Rift Valley or perhaps lowering of the Rift Valley floor or a combination of both. As a consequence the Lower Palaeolithic al-Mashārīa' 1 site which extends horizontally for 400 m back from the Rift Valley edge and contained within the Ṭabaqat Faḥl Formation, is now about 90m above the floor of the Jordan Valley to which it would have previously been graded. A similar case has been previously made to explain the present elevation of later sedimentary



4. Cliff face within the Ṭabaqat Faḥl Formation containing the al-Mashārīa' 1 Acheulian site (A to A), 30 m from the top. Jordan Valley in the background.

sequences bordering the Rift Valley which contain Middle to Epipalaeolithic sites (Macumber and Head 1992). The implication is that during the Middle Pleistocene Period the region now represented by the Ṭabaqah, was a broad spring-fed fluvio-paludal embayment on the edge of an ancient lake. Subsequently there were phases of tectonism affecting the immediate region and eventually elevating the surface of the Ṭabaqah Block to its present height about 125 m above the Rift Valley.

During Middle Pleistocene times the Ṭabaqah Block and adjacent regions bordering the eastern Jordan Valley underwent a major phase of incision, perhaps in response to the phases of uplift which led to the formation of the Ṭabaqat plateau, and perhaps also to falls in base level following the drying of previously existing megalake systems. This event was followed by backfilling of the wadis in the Late Pleistocene in response to the gradual filling of Lake al-Lisān over the period from 60,000 BP (?80,000) up to 11,000 BP. In Wādī al-Ḥimma, a 60 m thick sequence of conglomerates, red and black clays and tufaceous limestone was deposited. This Wādī al-Ḥimma sequence (occurring beneath the plateau in FIG. 5) contains numerous bands of the freshwater snail *Melanopsis praemorsa,* which indicate fresh permanent stream flow. *The Melanopsis* bands are commonly associated with occupation sites.

A downvalley diachronous lateral facies change in the valley fill from pebbles and red clays into buff coloured calcareous silts, travertines and conglomerates represents a change from a typical wadi environment (represented by pebble/red clay sequences) to a zone of regional groundwater outflow (carbonate cemented conglomerate and buff calcareous silts and travertine) developed in the lower wadi region adjacent to the lake. At about 1 km from the Rift Valley, the top of the sequence is at about - 80 m but is tilted at 7° to 8° westwards, to dip down towards the Rift Valley. The presence at the rift edge of low energy calcareous silts containing layers of *Melanopsis praemorsa* shells dated between 15,000 and 19,000 BP, at levels some 20m to 40m above the highest levels of -



5. Tufaceous limestone at the Rift Valley edge which overlies the Wādī Khawaan 1 Natufian site.

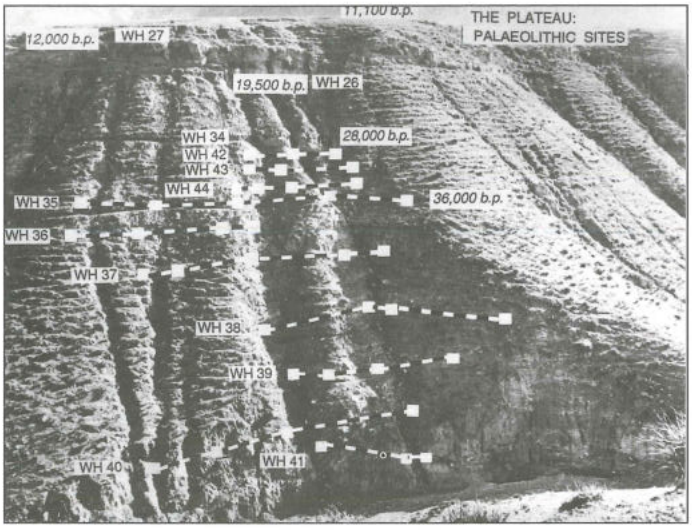
180m reached by Lake al- Lisān, is attributed to post-al-Lisān, tectonism (Macumber and Head 1991). *In situ* Kebaran sites (WH-51 at -156m, and WH-31 at -154m) and an Upper Palaeolithic site (WH-32) are contained within this sequence. A similar situation exists in nearby Wādī Khawaan, where spring tufas, Melanopsis bands and an *in situ* Natufian site (Wādī Khawaan 1) contained within well-bedded pisolitic gravels, overlain by a thick band of tufa (FIG.6) containing large roots and stalks - *Phragmites*?, are all found high in the landscape above the adjacent Rift Valley floor. A date from *Melanopsis* shells lying within and below a horizontal travertine/silt band on high ground close to the cliffed Rift edge at the nearby Wādī Khawwan 2 site gave an age of 11,620 +/- 240 BP (ANU-8470). While the conglomeratic and limestone sequences show folding and dip riftwards, the Ṭabaqah, as a whole, has maintained its overall integrity and appears to have moved essentially as a discrete block.

As is the case with thick travertine deposits described from the northern Hula Valley (Heimann and Sass 1989), there is abundant plant material (*Phragmites?*) scattered in beds throughout the limestone sequences, however, faunal remains of a non-archaeological nature consist almost exclusively of *Melanopsis* shells. In the case of the Hula Valley occurrence, it was noted that the travertines were probably formed by slow moving broad shallow sheets of water. The near absence of travertine formation today in the Hula region is linked to post-depositional uplift resulting in changed (steepened) gradients which may have caused a reduction in water residence time and a concomitant cessation of travertine formation. Today, travertine is only actively being deposited around vegetation and on pebbles in the bed of the perennial Wādī al-Jirm, and it is possible that similar processes and environments to those in the northern Hula Valley were present in the regional groundwater discharge zones of the Ṭabaqat Faḥl region since Middle Pleistocene times.

Throughout this period occupation continued unabated, being largely concentrated in or close to the zone of freshwater outflow extending about 1km down to the palaeolake shoreline. *In situ* archeological sites occur throughout the 60 m of sediment, ranging from Middle Palaeolithic, through Upper Palaeolithic and Epipalaeolithic (Kebaran and Natufian) periods (FIGS. 6 and 7). They include the Wādī al-Ḥimma sequences and sites on nearby Wādī Khawaan. This phase of sedimentation and the Late Pleistocene occupation record ceased at about 11,000 BP when the wadis were again deeply incised up to 60 m in response to the demise of Lake al-Lisān and a fall in base levels of erosion and sedimentation. This in turn led to a concomitant drastic fall in water tables, with spring flow now emerging at the lower levels presently seen at the Pella tall and Wādī al-Ḥimma bath house, and along the edges of the Rift Valley. No earlier fall in water tables, or interruption to sedimentation or occupation, or wadi incision is recorded in the Wādī al-Ḥimma sequences during



6. View across Wādī al-Ḥimma towards the Jordan Valley. The al-Mashārīa' 2 Acheulian site lies within the rocky area of the middle left background. The sediments beneath the (Wādī al-Ḥimma) Plateau in the middle ground contain the Wādī al-Ḥimma Middle, Upper and Epipalaeolithic sites (see FIG.7).



7. Wādī al-Ḥimma sequence showing excavated Palaeolithic sites and radiocarbon dates beneath the Plateau.

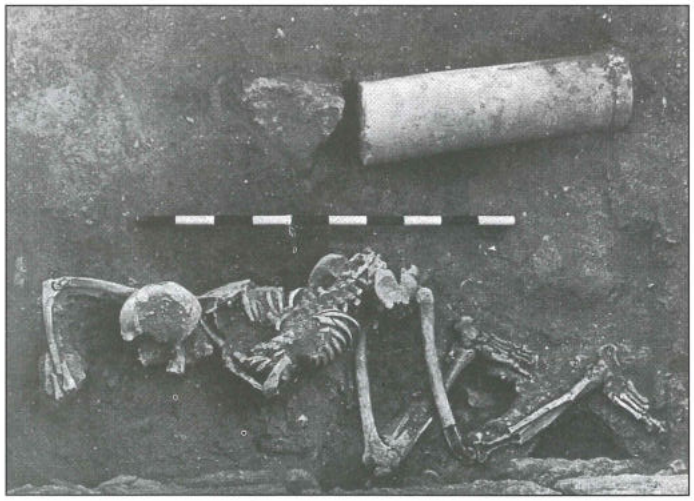
Late Pleistocene times over the period 18,000 up to 15,000 BP, despite the suggested very low Lake al-Lisān levels during the Late Glacial Maximum (Neev and Hall 1977).

Evidence for Late Pleistocene uplift of the Lower Palaeolithic sites in the Ṭabaqat Faḥl Formation (or depression of the valley floor) is supported by the high levels of dated sedimentary sequences containing Upper Palaeolithic and Kebaran sites in the lower regions of Wādī al-Ḥimma (Macumber and Head 1991) and a Natufian site in Wādī Khawaan (see below). These sites are situated well below ground surface, contained within horizontally bedded or slightly tilted carbonate sequences lying 30 m or more above the Rift Valley floor which, there, lies at much the same elevation as the uppermost levels of Lake al-Lisān (-180 m). It is to this level or perhaps even lower that the fluvial and spring-fed sedimentary sequences would have been graded. These sites now overlook the Rift Valley and the only explanation for their present position high above the Rift Valley floor, is neotectonics.

Support for ongoing Rift Valley activity is reflected in the numerous earthquake records of the region (for instance, Russell 1985; El-Isa and Mustafa 1986). Indeed, archaeological evidence indicates that the Pella tall which has a 7000 year old history has been repeatedly affected by earthquakes caused by movements along the Rift Valley faults. Examples of suggested earthquake impacts from Pella include the destruction of the Umayyad town in 747 AD (FIGS. 8 and 9) and the Abbasid Western Complex in 853/4 AD (Wamsley, in Walmsley *et al.* 1993), the (Byzantine) Church (McNicoll, in McNicoll *et al.* 1986) and the Byzantine Fortress in



8. Partially reconstructed Umayyad town of Pella destroyed in the 747 earthquake.



9. Human earthquake victim killed in 747 earthquake at Pella (North Building room no. 16, Area IV).

659/660 AD (Watson, in Walmsley *et al.* 1993)

Occupation

Clearly the single most important factor in the semi-continuous occupation of the Ṭabaqat Faḥl region throughout Middle to Late Quaternary times, was the presence of broad zones (spring-fed plains) of regional/local groundwater outflow emerging marginally to large lakes. The broad regional outflow zones of the Pleistocene Period were reduced to single springhead complexes in Holocene times (see FIG. 3), following the demise of the earlier megalakes, the concomitant fall in groundwater outflow and water tables, and the deep incision to give the present day landscape. The importance of the groundwater outflow zone to continuing occupation cannot be overstated. The springs are conduits for the naturally regulated release of regional groundwater systems that have been fed from a large recharge catchment refilled over millennia and extending over thousands of square kilometres, perhaps as far eastwards as the al-Azraq Basin. Flow times for water infiltrating within the highland catchments and discharging into the Rift are put at about 3,500 years (Salameh and Udluft 1985). Radiocarbon dates from *Melanopsis* shells at the present Pella spring-head give ages of about ca. 4,000 years, supporting these conclusions. Unlike the rivers and streams, the springs and their associated discharge zones are strongly buffered against seasonality and short term to long term periods of aridity that are known to have affected the region since Early Pleistocene times.

An indication of localized environment amelioration in the past is seen in the presence at the Kebaran site - WH 26 (see FIG. 7), radiocarbon dated at 19,500 +/- 600 BP of a localized remnant Mediterranean woodland association including trees and shrubs such as oak, almond, pistachio, buckthorn, hawthorn, and hackberry (Edwards *et al.* 1988). Notably, none of these species grow in the wadi today, and the Mediterranean zone does not appear until c. + 100m above sea level, some 200m higher than the altitude of the Kebaran sites. The faunal evidence at the site includes gazelle, sheep/goat, wild pig, fox, hare, wild cat, quail, song bird, tortoise and freshwater snail.

A similar, albeit larger, faunal assemblage occurs in the overlying Natufian WH 27 site (see FIG. 7) dated at ca.12,000 BP . The Kebaran to Natufian periods span the Late Glacial Maximum when there is a general recognition that conditions were significantly more arid and cooler than at present. No evidence for these harsher conditions exists in the geological or hydrological evidence from Wādī al-Ḥimma, despite the excellent geological, archaeological and chronological record. The low altitude of the Jordan Rift Valley provided as amenable a temperature regime as could be expected in the Levant during the Late Glacial Maximum, and it is not surprising that occupation continued in Wādī al-Ḥimma throughout that period. A combination of factors, such as reliable fresh warmish spring waters, a large supply of chert material for artifacts, the availability of game and plant resources, and moderate temperatures no doubt explains the attraction for human occupation at the time.

During early Holocene times, following incision, the significantly reduced (although still considerable) outflow represented by the Pella spring became established roughly in its present position at the top of Wādī Jirm al- Mawz. Occupation of the Pella site from Chalcolithic times through Bronze Age, Iron Age, Hellenistic, Roman, Byzantine, Mediaeval Islamic and Mamluk times indicates the importance of the stable Pella spring environment over this period. The present day situation within the Wādī Jirm al-Mawz of outflowing uncontaminated fresh springwater feeding pools containing *Melanopsis praemorsa* shells, visited by large numbers of people (especially on holidays), echoes an especially favourable physical environment that has existed in the Ṭabaqat Faḥl region for perhaps half a million years. In this sense the area has remained, since Middle Pleistocene times, an especially valuable piece of Rift Valley real estate, which provides a predictable, secure and well watered microenvironment, despite, and essentially immune to, the climatic vagaries existing regionally outside the valley.

Clearly, the spring systems of the Ṭabaqat Block provide an environment of stability and predictability, in which occupation has flourished over a very long period of time. However, the springs are linked to an active Rift Valley fault system, which has seen the accumulation of 10 km of sediment in the Rift Valley over a relatively short time period, perhaps since late Miocene times (Ginzberg and Kashai 1981). This gradual Rift Valley evolution has been witnessed by man who is known to have been in the region for at least 1.4 million years as shown by the 'Ubeidiya Early Pleistocene hominid site (Tchernov 1987), where the fluvial and lacustrine sequences containing human remains are overturned and steeply dipping.

It follows that there has been a duality of existence in this region, with long periods of stability and prosperity abruptly ending in catastrophic destruction as faulting is reactivated. In Pella, the periodicity of archaeologically ascribed earthquake destruction is in the order of a few hundred years at the most. Whether this periodicity is valid, and there is no reason to doubt certain of the events, it does underline an important feature affecting long term existence (and survival) of Rift Valley settlements, and is probably one of the most likely explanations for otherwise unexplained periods of abandonment, as was the case for Pella in the 17th and 18th centuries.

Perhaps the best documented case of this duality of existence comes from Genesis 13-19 set in the Rift Valley at the southern end of the Dead Sea, where Lot left Abraham to go down into the Jordan Valley where there was much water - *"like the Garden of the Lord or the Land of Egypt"*, but the cities of the valley and all the cit-

izens were destroyed by brimstone and fire, in an episode for which, whatever the absolute cause, the mechanism was almost certainly an earthquake.

Conclusion

The Ṭabaqat Faḥl region contains one of the longest documented records of semi-continuous occupation anywhere in the Middle East, going back at least 300,000 years. Over this time, plentiful supplies of fresh water from springs emerging along the edge of the Rift Valley provide a micro-climate conducive to stability and prosperity. Ironically, this cosy environment was periodically interrupted catastrophically by phases of tectonism, generated by the Rift Valley faults system, the same system directly and indirectly responsible for the groundwater outflow which enabled the favourable environment necessary for long term occupation.

Acknowledgements

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Aerial Photography and the Southern Ghors (al-Aghwār) and Northeast 'Arabah Archaeological Survey

Introduction

The Southern Ghors (al-Aghwār) and Northeast 'Arabah Archaeo-logical Survey (SGNAS) was in the field in 1985 (MacDonald and Koucky 1986; Koucky and MacDonald 1985) and 1986 (MacDonald, *et al.* 1992; 1987; MacDonald, Clark and Neeley 1988; MacDonald 1986) (FIG. 1). It used the Hunting Aerosurveys Limited 1977 aerial photographs, at a scale of 1:25,000, during the 1986 season. These photographs were obtained from the Royal Jordanian Geographical Society through the assistance of the Department of Antiquities.

The SGNAS team members had no special training relative to the use of these photographs. Their usage, on the part of the SGNAS, may, thus, be described as low-tech.

The SGNAS used the aerial photographs in stereoscopic pairs for four purposes: 1) to locate obtrusive sites, especially at the end of the season, in areas which had not been previously visited, due to lack of time; 2) to fill in gaps, left in part due to the nature of pedestrian transects; 3) to draw several sites, for publication purposes; and 4) to assess conditions of a site and/or area prior to modern development. In the process of carrying out these objectives, the SGNAS located additional sites. The present paper will expand on each of these purposes and indicate pertinent sites.

1) *To Locate Sites*

There was insufficient time to visit all the area which the survey wished to cover. Moreover, heavy rains in late November-early December 1986 washed out the routes which the SGNAS had previously taken from Qaṣr aṭ-Ṭilāḥ to Wādī Faydān. The survey team, therefore, turned to aerial photographs in search of sites in the unvisited and hard-to-get-to areas.

As a result of this examination, the SGNAS located nine sites. Two of these sites, namely Sites 239 and 240, are located in the northern segment of the survey territory, that is, north of the major east-west escarpment (FIG. 1). The remaining seven, namely Sites 232 228, 233, 236, 217, 216, and 215, are in the southern segment (or the area from the escarpment south to Wādī Faydān), especially along the Old Road between Wādī aṭ-Ṭilāh and Wādī al-Ghuweib (FIG. 1). SGNAS visited the sites in question, sherded and described them in the same manner as was done for the other sites of the survey.[1]

Only obtrusive sites could be detected from the examination of the aerial photographs available to SGNAS. Unobtrusive sites, for example, sherd scatters, cannot be detected using a low-tech methodology on 1:25,000 scale, aerial photographs. However, this latter type of site will be found frequently in the walk to and from an obtrusive site. Specifically, SGNAS discovered Site 226, a cemetery, in the walk to Site 228, and Site 235, a light sherd scatter, in the walk to Site 236. This brings the total number of sites discovered, either directly or indirectly as a result of the use of aerial photographs, to eleven.

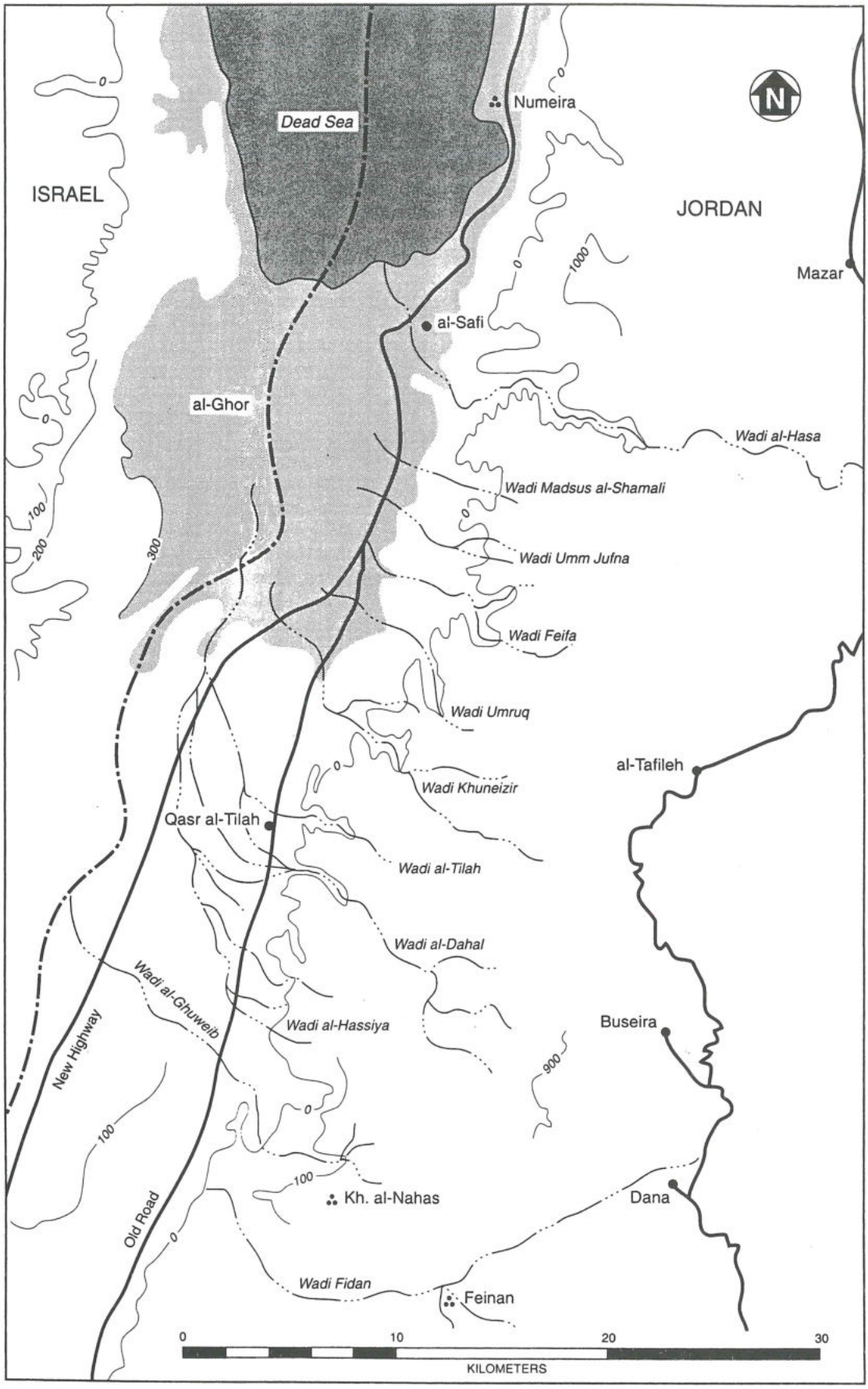
2) *To fill in gaps*

SGNAS employed pedestrian transects to a large extent in its survey of the territory between Wādī al-Ḥasa in the north and Wādī Faydān in the south (MacDonald, *et al.* 1992: 9-13) (FIG. 1). These pedestrian transects resulted in the lack of coverage of certain segments of the survey territory. SGNAS employed aerial photographs to fill in these gaps.

3) *To Draw Sites for Publication*

At the publication stage of the project, SGNAS blew up a number of aerial photographs 10 times to a scale of around 1:2,500. SGNAS' draughtsperson subsequently used these photos to draw 11 major architectural sites: Site 1 (Ṭawāḥīn as-Sukkar), Site 6 (Umm aṭ-Ṭawābīn), Site 75 (Ancient Feifa), Site 141 (Ab7 Irshareibeh/Khirbat al-Khunayzīr), Site 211 (Khirbat ad-Dahal), Site 155 (Qaṣr aṭ-Ṭilāḥ and adjoining fields), Site 229 (Khirbat al-Hassiya North), Site 232, Site 228, Site 216, and Site 159 (Khirbat an-Nuḥās). These sites appear as Figures 30, 17, 12, 13, 25, 19 and 20, 18, 26, 27, and 15 respectively in the final SGNAS report (MacDonald, *et al.* 1992).[2]

[1] It is unnecessary to describe these sites here. Their description can be found in MacDonald, *et al.* 1992, Appendix 1, "Description of SGNAS Site 1-240," pp. 249-274.



1. Southern Ghors (al-Aghwār) and Northeast 'Arabah Archaeological Survey territory.

The team of SGNAS wished to use aerial photographs to draw Site 46, Dayr 'Ayn 'Abāṭa, a monastery/church complex, located to the north west of aṣ-Ṣāfī (Politis 1993; MacDonald and Politis 1988). However, it was unable to locate convincingly the site on the available aerial photographs.

4) *To Assess Conditions of a Site and/or Area Prior to Recent Development*

The government of Jordan made a decision in 1977 to develop the southern half of the Jordan Rift Valley from the Dead Sea to 'Aqaba (Khouri 1981: 216). This decision resulted in the building of a new, two-lane, highway, the construction of the Arab Potash Company plant along the southeastern shore of the Dead Sea, and a drip irrigation system, especially in the Southern Ghors (al-Aghwār) for agricultural purposes. This development also includes quarries, dams, secondary roads, flood diversion devices, clearing land for agricultural purposes, and the building of houses for the increasing population. All this has resulted in the destruction of archaeological sites in the Southern Ghors (al-Aghwār) and Northeast 'Arabah. Because of this situation, aerial photographs can be helpful in assessing the condition of a site and/or an area prior to recent development. For example, aerial photographs show the condition of the mound at aṣ-Ṣāfī, SGNAS Site 2 (MacDonald, *et al.* 1992: 249), as it was before the building of the Jordan Valley Authority townsite at one of its highest points and the condition of Khirbat ash-Shaykh 'Isa, SGNAS Site 4 (MacDonald, *et al.* 1992: 249), before it was bulldozed for agricultural purposes. Such information is especially important when checking the reports of early visitors and/or explorers to the site and/or area in question.

Conclusion

The use of aerial photographs, even at a low-tech level, made the SGNAS a much more complete project. This is true relative to the coverage of the survey territory and the publication of the final report. These photographs could possibly have provided the SGNAS team, with further training and the employment of a more sophisticated technology, more information about the archaeological riches of the Southern Ghors (al-Aghwār) and Northeast 'Arabah of Jordan.

Peterman has subsequently used these same aerial photographs for his geographic information systems' work in southern Jordan (1992a and b). Moreover, Adams has employed them in his Wādī Faydān explorations (1991; Adams and Genz 1995). They are stored at the American Center of Oriental Research in 'Ammān.

Acknowledgements

SGNAS would like to thank the Royal Jordanian Geographical Society for permission to purchase and use the aerial photographs which are the subject of this article. We would also like to express our gratitude to the Department of Antiquities and especially to Dr Fawzi Zayadine who accompanied the project's director to the offices of the society to facilitate the purchase of the photographs.

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[2] It is not necessary to describe these sites in this publication. See the previous note as to where their description may be found.

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Optical Dating and Landscape Chronology at ad-Dīsa, Southern Jordan, and its Potential

Introduction and Acknowledgements

This paper reports on the use of Optically Stimulated Luminescence (OSL) dating (Huntley *et al.* 1985: 207) for establishing a chronology of soil landscapes in Jordan, and provides a time framework for the deposition of aeolian sand sheets in the ad-Dīsi area. The work was undertaken between 1989 and 1992 whilst R.N. Munro was working in the Department of Afforestation and Forests of the Ministry of Agriculture as part of the European Commission (EC) funded National Soil Map and Land Use Project (NSM and LUP), within the Ministry of Agriculture (EC Contract No SEM/03/628/005).

Following discussions with W.J. Jobling in March 1990, concerning the possible dating of soil features and sedimentary sequences in relation to the landscapes of Thamudic rock art period, a proposal was submitted by Jobling to the Australian Research Council through the University of Sydney. Field studies were conducted during 1990-92, and the OSL dating analysis was carried out in the UK and Canada during 1993 (Jobling 1993: 457).

Thanks are due to the Australian Research Council and the University of Sydney for funding; to Edward Rhodes of Royal Holloway and Bedford College, University of London, for carrying out the optical dating; and to Hunting Technical Services and the staff from the Ministry of Agriculture in 'Ammān for assistance and permission to use data from the NSM and LUP (Ministry of Agriculture 1993). Many other colleagues are profoundly thanked.

This work is dedicated to the memory of Dr Bill Jobling, friend to many in Jordan and a tireless, dedicated and original researcher of Thamudic art and its archaeology in Jordan.

Field and Laboratory Methods

The OSL technique (Aitken 1994: 175) involves sampling of sand samples under darkness to avoid exposure of samples to normal light giving rise to undesired bleaching of the electron trap and rapid reduction of the OSL signal. Laboratory treatment with HF acid removed surface layers and contamination of the quartz grains and samples were preheated to 220° C. Finally, exposure to argon laser green light gave rise to an OSL signal with detection in the blue/UV region as stored radiation was detrapped from the sample.

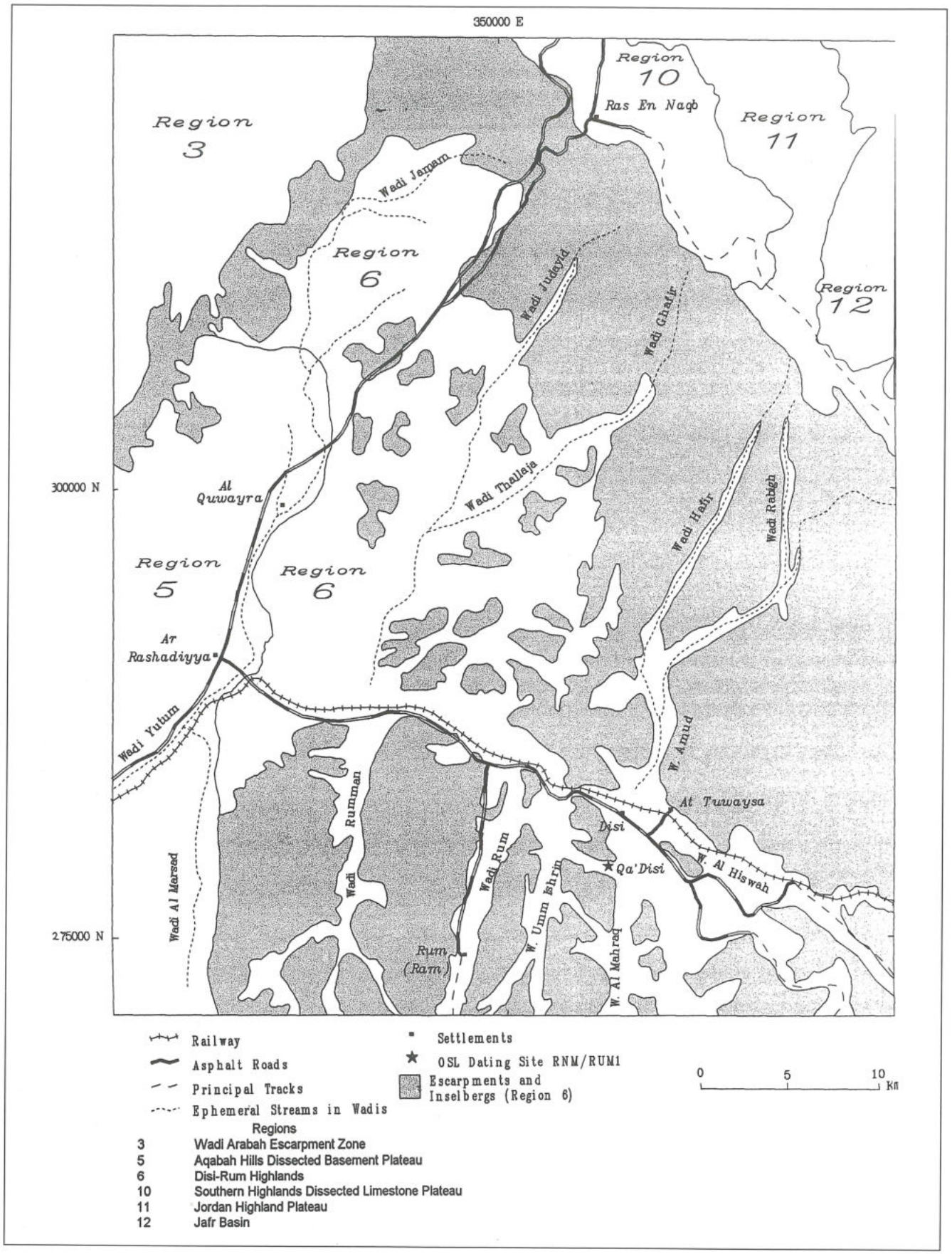
For the present research six sand samples were collected in June 1992, at 15, 35, 48, 60, 80 and 110 cm depth on the face of a section in a yellowish red sandy Typic Torripsamment soil of the Ishrin Formation (HTS 1993) located some 2500m south of the Post Office at qā' ad-Dīsa. The exact geographical co-ordinates of site RNM/RUM1 (site PW003 of the NSM and LUP) are 35.51020 degrees east / 29.62848 degrees north (JTM Grid Co-ordinates 355737 east / 279520 north) with an elevation of 795m asl, and about 0.5m above the level of the qā' ad-Dīsa playa (FIG.1).

Soil and Stratigraphic Background to the ad-Dīsa Area

The present studies have benefited from many works on prehistory, geomorphology and soils in Jordan, and in particular by Blake and Ionides (1939), Moorman (1959), Vita Finzi (1964: 19 and 1982: 23), Yaalon (1974: 91), Mitchell (1978), Garrard and and Gebel (1985), Byrd and Garrard (1990), Garrard *et al.* (1994), Macumber and Head (1991).

This study is centred in the Ḥisma, on the alluvial and aeolian units of the Wādī Ḥāfir, on the alluvium of qā' ad-Dīsa (also known as Dīsa), and on the sand sheets and dunes that lie beneath the sandstone inselbergs of Jabal Umm Nufus to the south of qā' ad-Dīsa. The lands surrounding ad-Dīsa comprise sandstone inselbergs (Osborn and Duford 1981: 113) with variable development of colluvial slope mantles (Bowman D. *et al.* 1986: 56). These pass downslope into a series of silt rich playas and salinas (*qā'*) that lie at the toeslope of alluvial fans degorging from wadis originating along the Edomite escarpment. Active sandsheets and dunes partly or completely mantle all older surfaces, whilst the thickness of the older fills in the ad-Dīsa area has been variously estimated up to 370m (Heimbach and Meiser 1971: 89; Lloyd 1969: 1).

On the fans and in the valleys upslope, gravelly and loamy alluvial sequences include a *Low Terrace*, at 1 to 1.5 above base level, with weakly developed cambic and calcic horizons and polygonal crack features, which is cut into a gravelly to loamy *High Terrace,* at ca +5 to +10m



1. Location of Optical Dating (OSL) Site at ad-Dīsa, Jordan .

with well-developed blocky structured horizons and CaCO3 concretions. The *High Terrace* merges laterally into aeolian-colluvial sandy to bouldery slope mantles that vary in composition according to their position relative to sand pathways. The ancient palaeo-sandsheets, which also have CaCO3 concretion layers and weak polygonal soil structural features, are widespread in the Rumm ad-Dīsa Wādī Ḥāfir areas.

Stratigraphy and Dating of ad-Dīsa Section RNM/ RUM-1.

The ad-Dīsa site lies on a flat surface of a stabilised palaeo-sandsheet. Active sand sheets and dunes cover the surface close by, and a short distance to the north the sands pass abruptly onto the flat playa surface of qā' ad-Dīsa. The site is partly surrounded by cliffs and talus slopes of Jabal Umm Nafus and other low ridges formed from the Umm Ishrin Sandstone and ad-Dīsa Sandstone Formations. The profile is described as follows:

cm

0-20 Yellowish red (5YR 5/6) gritty/slightly gravelly sand; platy topsoil; surface rain crust; loose sand on surface; no concretions; strongly calcareous; pH 7.2; clear smooth to:

20-63 Yellowish red (5YR5/6) fine sand; weak subangular blocky structure; 30% small (<5mm) CaCO3 concretions; strongly calcareous; pH 7.2; clear smooth to:

63-112 Yellowish red (5YR5/6) fine sand; subangular blocky structure; 10% small CaCO3 concretions; slightly calcareous; pH 7.4; clear smooth to:

112-142 Strong brown (7.5YR5/6) sandy loam; moderate to strong subangular blocky structure; 30% subrounded CaCO3 concretions; very strongly calcareous; pH 7.6; irregular to:

142-182 Yellowish red (5YR5/6) fine sand; structureless; no concretions; strongly calcareous; base not seen.

OSL dating was used to provide dates for the older aeolian sand sheets. The results are given in TABLE 1 and show a progressive increase in age with depth.

The validity of the optical dates for the ad-Dīsa samples is considered to be within the range of OSL dating (Rhodes, 1994). The rather large uncertainties of several samples is likely due to a high scatter in OSL signals, probably as a result of dominating individual bright grains reducing precision of the dose rate (DE) determination. This is thought due to the range of different quartz host rocks around ad-Dīsa from which individual grains were derived, rather than incomplete resetting of OSL signals at the time of deposition, or the accidental exposure to light during collection. Correlation with archaeological evidence would assist in calibrating the results against other chronologies in the area.

Table1. Optical (OSL) Dating at ad-Dīsa: Dose Rates (DE) and Calculated Ages.

Sample No	Depth (cm)	Lab code	Dose RAte (DE) Gy	Age Years BP
6	15	247	4.0+/- 2.7	6,100 +/- 4,100
5	35	243	17.4+/- 7.6	23,800 +/-10,400
4	48	246	51.7+/- 10.4	72,100 +/- 17,000
3	60	245	56.8+/- 11.9	74,000 +/- 15,900
2	80	244	55.0+/- 42.9	88,100 +/- 68,900
1	110	242	101 +/- 19.6	198,000 +/- 39,800

Results from Studies in Adjacent Areas

Parallel studies have been conducted by D. O. Henry (1982: 41, 1985: 67, 1994: 265) who has worked extensively on the Rās an-Naqab escarpment of the Edomite Plateau. In the Wādī Judayid a lithostratigraphic chronology was shown for the Judayid basin (1000-1200m asl) and a climatic reconstruction made from interpretation of pollen studies in this steppe zone. These showed environmental conditions changing from slightly humid to dry in the Upper Paleolithic (40,000 to 20,000 BP) and a similar pattern in the Epipaleolithic (20,000 to 14,000 BP). In the Chalcolithic also, conditions remained moist until about 11,000 BP, and then became progressively drier.

In the Wādī al-Ḥasa, Clark (1990: 89) extrapolated results from the Negev and showed that maximum aridity in the late Pleistocene occurred after a humid interval from 32,000 to 27,000 BP. Also in the Wādī al-Ḥasa, Schuldenrein and Clark (1994) presented a landscape chronology from the Middle Palaeolithic. From 200,000 to 90,00 BP springs and travertines were associated with several cycles of soil development. Around 70,000 BP a high lake bed was present in the Wādī al-Ḥasa and at 26,000 to 20,000 BP there were high lake stands with springs. This period was followed by lake regression and channel incision, and finally in the Natufian and Kebaran (17,000 - 9,000 BP) there were swampy conditions, with alluvial fan deposition.

Interpretation of ad-Dīsa Section (RNM-RUM1) and Landscape Chronology

The interpretation of the ad-Dīsa section RNM-RUM1 suggests the following sequence of events:

a. Initial deposition of aeolian sands (142-200 cm) under arid conditions. This conclusion is based on the structureless nature of the sands, lack of gravel and CaCO3 concretions and high sand content (>85%). This phase was earlier than 200,000 BP.

b. A fluvial interval when gravel free medium-texured sediments were accumulating in a playa or *qā'* mudflat (layer 112-142 cm). The slightly sandy nature of this layer suggests that sand may have been blowing across the playa, much as sand and dust does today

during the dry season. The presence of abundant large nebulous CaCO3 concretions, suggests that concretion formation took place due to fluctuations in a watertable in the playa. The structural morphology of the layer and the nature of the concretions do not suggest a soil forming process for the concretions. This ended earlier than 198,000 BP.

c. The succeeding layers (63-112 and 20-63 cm) are both weakly structured yellowish red sands, suggest aeolian deposition with later concretion formation by soil processes. From their position in the sands the concretions are considered to postdate aeolian deposition. There are no indications of any artifacts in these sands.

d. The surface layer (0-20 cm) is a weakly developed yellowish red soil formed on a stabilised sandsheet. It is slightly gravelly with a platy layer and rain crust at the top. Gravel content (2-5mm diameter) amounts to 30% and consists of ferruginous sandstone and quartz grains typical of materials that are weathering from the adjacent hills on ad-Dīsa and Umm Ishrin Sandstones. Various undiagnostic Neolithic or later flint artifacts are found on this stable surface, and small sherds of Chalcolithic pottery were also noted. The surface layer (0-10cm) is trampled by livestock and receives wind-blown sand. The age of this horizon, sampled below the surface of aeolian active and disturbed parts, was 6,100 BP(+/- 4,100 years). This appears to indicate the date at which the sand dunes ceased forming and soil formation commenced.

The progressive increase of the indicated ages with depth in the section appear to confirm that post depositional contamination (mixing) has not taken place. The lack of any original depositional features in the sands however was noted and may indicate that biotic activity has destroyed such features. This is seen to happen in modern sand dunes where roots, burrowing organisms and termites obliterate aeolian and other sedimentary laminations over a period of time. The profile was carefully examined after sampling to ensure that large burrows did not cross through these parts of the profile. These layers thus show aeolian deposition between 198,000 and at least as late as 24,000 BP. Given the errors shown in TABLE 1, and likely truncation by deflation, the latest deposition could be later than this.

The OSL dates appear to show that, in the ad-Dīsa area at least, a very long period of aeolian sand deposition took place during part of the Middle and much of the Late Quaternary (and Middle Palaeolithic) including the hyperarid period of the late glacial maximum at 18,000 BP. The dates may suggest four phases of deposition: at c. 200,000 BP (and possibly oxygen isotope stage 7); at 75,000 BP (possibly O.I. stage 5a); around the period 23,800+/- 10.4ka; and a Holocene event (Rhodes 1994).

What is not yet clear from this analysis is when and how CaCO3 concretion formation commenced, or indeed how it took place, whether in strongly seasonally arid/semi-arid conditions, or in more arid conditions than the present. There is no indication that large concretions are forming at present in these areas, but soft 1mm sized CaCO3 concretions were noted in recent sand sheets in the region during field work, and strongly calcareous dust or loess is deflated off playas (qa') and redeposited in significant amounts on other land surfaces during dry season dust storms.

Discounting groundwater effects, soil concretion formation in the old sand sheet would have occurred as far as the limits of rainfall penetration. Annual accretion of CaCO3 around nuclei might have been very slight with gradual build-up over many years. Ancient subsurface calcareous crusts are commonly observed in the ad-Dīsa-Rumm area and represent where calcareous leachates were redeposited at sand/rock interfaces. The latter were first described by Borzatti (1984: 71). Examination of profile morphology suggests that although some truncation of the original soil surface has occurred, this concretionary layer shows that it essentially marks the end of a major phase of aeolian deposition and commencement of concretion formation.

Discussion

The stratigraphic interpretation of the ad-Dīsa section, and its relation to many other sites examined in southern Jordan, suggests that soil and concretion formation is Upper Pleistocene, rather than terminal Pleistocene-Holocene. The principal reason for this assumption is that a number of profiles show repeated cycles of deposition, concretion formation, truncation, and additional fill deposition. The concretions are not thought to have formed during the moister phase that occurred between 15,000 - 11,500 BP, documented from the Hula lake by Schwarcz (1995: 21).

Studies in southern Jordan, by Jobling (1984, 1990) and others, suggested that there was widespread Bronze Age abandonment of sites from ca 4,500 BP to 2,800 BP when an intense regional drought affected the area. Sand dunes covering over earlier stablisied aeolian landforms may date from this phase. Subsequently, climatic amelioration prevailed through to the Roman period and Mediaeval times when drier conditions again ensued. Loss of topsoil from overgrazing of the vegetation cover and deflation of broken soil surfaces broken by livestock may have led to considerable erosion and degradation. Although their implications are far from clear the presence of large cattle in panels of rock art, datable to the Nabataean/Roman period, suggest a grazing regime in the adjacent Wādī Ḥāfir area that is different from today's pastoral ecology, where sheep and goats dominate.

Data from the Wādī al-Ḥasa (Clark 1990: 89) suggest that humid intervals occurred at around 20,000 and 50,000 BP respectively. Huckriede and Wiesemann (1968: 73) in the al-Jafr Basin reported a high lake level

in the later part of the Lower Paleolithic into the Levalloiso-Mousterian of the Middle Paleolithic, around 50,000 - 45,000 BP, with mudflat development and dessication occurring later, in the Upper Palaeolithic. Although it is strongly felt that correlation between these areas is at best very preliminary and sketchy they could relate to the formation of CaCO3 concretions in sands and fans in the ad-Dīsa-Rumm area, which the OSL dating shows was later than 23,800 BP. Polygenetic profiles in the Wādī Rumm area may relate to the earlier period.

A suggestion that also needs to be fully tested is whether wet conditions may have existed further north in Jordan on the highland (Edomite) plateau, whilst arid conditions remained in the sandstone areas of ad-Dīsa-Rumm. This is thought likely, and the OSL dates help to show that in general the landscape at ad-Dīsa at 200,000 BP was perhaps not unlike the present. The Edomite plateau lies in Mediterranean type soil moisture and climatic regimes, as exemplified around Rās an-Naqab and above Wādī Mūsā, with flood waters originating on the hills and draining into the arid interior basins or desert lowland fringes. Soils on the plateau are deep and do not in general indicate features characteristic of arid zone soils.

In the desert zones however, such as in the al-Jafr Basin and the ad-Dīsa-Rumm areas the climate is very different and soils show a range of features attributable to aridic processes (Dan 1983: 287; Ministry of Agriculture 1993). A model is suggested with sediment laden flood waters originating on the highlands depositing their loads as fans or lakes in deep graben in the ad-Dīsa and al-Jafr areas.

The ad-Dīsa OSL dates give a maximum age of 198,000 BP (+/-) down to a depth of only 1.1m. Given the apparent thickness of sediments in the qā' ad-Dīsa area it is difficult to surmise on the possible maximum age of the aeolian-alluvial fills in the ad-Dīsa-Rumm region. Conversely, if the ad-Dīsa basins were filled by lake and aeolian sediments during wet phases in the Pleistocene then sedimentation of these fills could have occurred over a relatively short time, simultaneously with dune formation under arid conditions: removal and deposition of aeolian and/ or fluvial sediments in arid regions is periodic but often on a massive scale.

Conclusions

The extent of the OSL sampling in 1992 was restricted to a stabilised paleo-sand sheet and its chronology appears to overlap only the oldest archaeological finds in the area. It remains important, therefore, to utilise the evidence from the archaeological record to attempt to complete the landscape chronology of southern Jordan during the late Pleistocene and Holocene. Based on the observations made during widespread field work throughout Jordan, various soil and depositional features are considered to lend themselves to OSL dating. Landscape, sedimentological and soil features where OSL dating could assist in establishing chronologies, include as examples the following:

- aeolian deposits;
- alluvial terraces;
- aeolian-colluvial slope mantles in desert areas;
- indirect dating of rock art surfaces buried by aeolian sands;
- lacustrine deposits (in the ad-Dīsa and Mudawwara areas);
- aeolian infills of polygonal gypsiferous crusts and basaltic terrain;
- calcreted aeolian sands;
- paleosol horizons on slopes and residual plateaux;
- loess sequences along the desert fringe;
- landslip deposits such as in al-Baqa'a Valley with sandy fills;
- sterile sandy infills at archaeological sites,
- sandy fills in man-made agricultural terraces and dams.

Fuller details of these applications were reported by Munro *et al.* (1995) and discussed at the Turin conference. It is not certain that OSL dating could be successfully carried out on field examples of all of these features, and in some cases (for example calcretes) the age of the material may exceed the maximum range of OSL range of around one million years.

The employment of the OSL dating techniques to the fieldwork of archaeologists is only beginning to be fully explored. It appears to be a particularly useful tool when examining geo-archaeological sites in conjunction with other dating methods. This research has provided a useful starting point and framework for the dating of sand accumulation at one site in southern Jordan during the Pleistocene and early Holocene. By extending the work to other landforms in the region, or all of Jordan, a more detailed chronology could be established. Data from the National Soil Map and Land Use Project of Jordan will be particularly useful in drawing up a list of land surfaces, key layers and soil horizons for which dating by OSL, or other methods could show promise.

The establishment of a chronology of landscapes furthermore could provide a measure for more detailed assessments of land use change in Jordan. In previous vegetation studies (Hunting Technical Services 1956; Long 1957; Poore and Robertson, 1964; and Ministry of Agriculture 1990) the degradation of the land cover and surface has been repeatedly noted as a trend that will reduce biodiversity and rangeland productivity. A much more comprehensive picture of land use history and chronology than exists at present has yet to be established in the Kingdom. Such a framework would also be of great benefit in assisting to define future land use policies in the region. It is considered that OSL dating could provide part of the means to provide important linkages that could bring together studies of landscape, soil and stratigraphic features, land degradation, erosion, and vegetation and climate change.

At present, a limitation in the use of optical dating for

archaeologists, requiring precise absolute dates, is the large uncertainties given in the OSL dates, although it is considered that these could well be reduced by refinement in the future (E. Rhodes, pers. comm.). In general this technique, if applied to age and chronology determinations of landscapes in Jordan, will provide a useful framework for archaeologists examining specific sites or undertaking regional surveys. It is by additional testing of the method in the context of soil and sedimentary features that its general usefulness will become apparent and proven.

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A GIS Application for the Analysis of Archaeological Survey Data: Natural Resources and Settlement History of the Upper az-Zarqā' Valley

The Wādī az-Zarqā'/ Wādī aḍ-Ḍulayil Project has the purpose of reconstructing human occupation in a very peculiar environmental zone of northern Jordan, a well-watered area at the edge of the desert, where different responses to environmental constraints are evident still today in the selection of settlement and of economic and subsistence strategies.

During the different phases of the project, all available aerial photographs were studied and the sites with visible architectural remains were marked on 1:10,000 and 1:25,000 maps. The photographs were scanned at a resolution of 1,200 dpi (dots per inch), and analyzed with image processing software (Adobe Photoshop). The use of this software allowed the identification of a number of sites with architectural remains which could not be identified during the first analysis of the photographs. This first phase of analysis brought to the identification of approximately 300 sites with the presence of architectural remains in an area of less than 100 km^2.

The application of image enhancement software is now being experimented. On the basis of the tests conducted so far, it is estimated that an extra 100-150 sites will be discovered through this analysis. All this of course does not tell us anything about the period of occupation of those sites. This is why an intensive survey program has been designed, in order to check all the sites found through the analysis of the aerial imagery, and to integrate that information with the information retrieved directly from the field. In the first year of survey we found 15 sites which were not visible on the aerial photographs. Application of image enhancement to the scanned photographs, revealed that 5 of these 15 sites could actually be seen. This, however, still left out 10 sites, that is 66% of what was found using traditional survey methods. This means that total coverage of the 144 km^2 of the survey area could potentially lead to the discovery of over 800 sites, a figure which should not come as a surprise, since intensive surveys conducted in Jordan so far have identified an average of 6 to 7 sites per km^2.

While a small project like this can afford total or almost total coverage of the area, if we translate this method to the whole of Jordan we would need a large amount of financial and human resources to cope with the size of such a project; on the other hand the exclusive analysis of aerial imagery will only add to our recorded sites with architectural remains, leaving out most of the subsurface sites and possibly all flint and sherd scatters, often the only evidence we have of prehistoric and early historic occupation.

For this reason we are also experimenting the application of a GIS method for the reconstruction of archaeological landscapes in the Upper az-Zarqā' Valley. If successful, this method could be applied to larger areas, and possibly to design a system of site location and monitoring for the entire country.

Before going into detail of this GIS, however, it is necessary to say a few words on the application of remote sensing to the analysis of archaeological landscapes. Present technology does not allow better resolutions than 5 m for available satellite imagery. Color Landsat imagery has a resolution of 20m per pixel; black and white Spot Image a resolution of 10 m per pixel. Even using image enhancement, it is very difficult to pick out even large sites with some kind of surface features well visible in traditional aerial photos. In the Upper az-Zarqā' Valley, half of the sites have a diameter of less than 20 m; another 30% a diameter comprised between 20 and 50 m; an extra 15% a diameter between 50 and 100m. This means that 95% or more of the sites in this area could not be seen with presently available satellite imagery.

The advantage of satellite imagery over traditional analog aerial photography is evident, not only for this imagery being in an electronic format, but also for the possibility of being recorded as multi-spectral data, that is in different and often very narrow wavelengths, including those invisible to the human eye and beyond the sensitivity range of film. Multi-spectral imagery can also be taken by instruments mounted on airplanes. The advantage of this approach is that the imagery obtained has resolutions of 1 m or less. The disadvantage, of course, is the high cost and the huge size of the resulting image files, which have to be broken down in segments or separate wavelength bands in order to be managed by a computer.

Another field of potential application is the imaging obtained through radar, like SIR or CAMS. Radar has an advantage over traditional satellite imagery: it is an active

system which records the energy reflected by the emitted laser beam, and it is not affected by cloud cover. There is still debate whether foliage can be penetrated by radar, while ground penetration is achieved only in extremely arid environments, where bedrock under the dry sand-cover easily returns a clear signal. The resolution of SIR is about 25 m in the horizontal, while CAMS and ATLAS have a resolution of 10 m and less. Unfortunately radar-sensed data does not have total world coverage, and it is not easily accessible to the public, even if airborne radar imaging is also obtainable.

In summary, satellite imagery still needs improvement in terms of ground resolution in order to be applied with some success to the problem of site location and settlement pattern analysis. Airborne (not satellite) multispectral and radar data, when available, are an ideal tool because both provide images from thermal and invisible light sources with a resolution between 50 cm and 2m. This is enough not only to recognize individual architectural features, either above or below ground, but also artificial "disturbances" of the ground cover, such as sherd or flint scatters.

Having said so, and recognizing the impossibility for 99% of the archaeological projects and 90% of the antiquities departments worldwide to afford finances, resources, and equipment for the analysis of high-resolution remotely-sensed data, one could go back to a lower-tech, but perhaps more effective method of spatial data analysis, that is the integration of aerial photography, map-derived geographic information, geo-referenced data, and GIS.

In the case of the upper az-Zarqā' basin, we have built a GIS using PC ARC/Info, available at the American Center for Oriental Research in 'Ammān. In the future, we will try to translate this GIS into G-Sys, a flexible GIS for archaeological applications developed by Dominic Powlesland, director of the Heslerton Parish Project in Yorkshire. G-Sys has recently been adopted by English Heritage to manage the English Sites and Monuments Record (the MONARCH system) and is used at the Getty Conservation Institute to experiment the feasibility of using satellite imagery to monitor change at World Heritage sites.

The GIS of the Upper az-Zarqā' Valley presently includes information on topography, drainage, water courses, geology, roads, modern villages and buildings, and archaeological sites. We are in the process of entering data on soils, vegetation, extent of agricultural fields, from both the 1978 and the 1991 aerial photos, and location of beduin camps, also from the 1978 and 1991 photos. Using these two sets of photographs we will also be able to map the expansion of inhabited areas, as well as the destruction of archaeological resources as a result of human intervention. This will allow us to project in the future the expansion of villages, agricultural, and industrial areas (especially if we can obtain demographic data for the villages in the area), and predict the impact of this expansion on archaeological sites. This will give us the possibility to draw a map of "sites at risk" which could suffer disturbance or destruction in the near future. But our use of a GIS will not stop at this level: while one of our objectives is certainly to demonstrate the usefulness of this tool for cultural resources management purposes, we have specific research questions in mind that could be answered by the use of a GIS, let alone the fact that a GIS is the best tool available today to manage and store the entire archaeological data set and its by-products: maps, photography, video, databases, and object records.

The first question we will try to answer is how much of the present surface was exposed throughout the prehistoric and early historic periods, and how much has been eroded since then. The geomorphologist and the pedologist will provide information on the evolution of the az-Zarqā' river bed and of some major lateral drainages. We hope to be able to identify some parameters (rate of erosion depending on slope aspect and percentage, depth and age of accumulated colluvial deposits, etc) that would allow the use of statistical analysis not only to reach conclusions on the aspect of prehistoric landscape, but also to reconstruct the relationship between site location and exploitation of natural resources.

The second question is what kind of relationship existed between different hierarchical levels of settlement from the beginning of urbanization to the spread of the Hellenistic culture in this area, and how these settlements exploited their natural resources. In this case we will need not only geological and soil data, but also botanical and faunal data from soundings already conducted or in the planning stage at various sites in the survey area.

Another question is concerned with the Roman, Byzantine, and Islamic occupations: did settlements depend primarily on "political" or "environmental" constraints"? In other words, was the selection of settlement location imposed by strategic, military, or otherwise "technical" considerations, or was it dictated by the presence of "natural" factors? In this case the GIS will help us to study the spatial distribution of settlements, linking observed function (villae, castra, etc.) to the physical environment, and comparing it diachronically in order to try to isolate the reason for change.

We also need to better explore the cairns, or towers, found on ridges and hilltops across the entire area. Using the data coming from soundings at some of those structures, we will use the GIS to match real and predicted cairn locations against soil types and settlement distribution during various periods, in the attempt both to date and explain the function of these structures.

Finally, an ethnographic study will be conducted in cooperation with the local beduin population, mainly to identify their preferred camp locations (this information will be derived from the 1978 and 1991 photos and from the present field checks). Interviews will be conducted in order

to understand the mechanics of site selection for the installation of a camp, evolution in time of the camp size and modification of functional areas through time, and so on. The availability of earlier photos is an important addition to our data, since it provides time-depth to an "ephemeral" occupation of space such a nomadic camp is often conceived by our uneducated eyes. In this final case, the use of the GIS will help us to compare present and past beduin land-use and settlement patterns, and hopefully will generate a model based on modern observations which can be experimented for the location of ancient nomadic camps.

In conclusion, while still in construction, we believe that the use of a GIS will help the Upper az-Zarqā' Valley Project in a number of ways: in managing the information which is being accumulated, in providing a map of the sites threatened by the expansion of agricultural areas and modern settlements, and in helping to analyze and answer the research questions emerging during our work. It is still too early to say whether or not some of these questions will ever be answered, but we believe that the integration of well-designed data collection strategies and processing tools will help to clarify most of the problems we still face in understanding the evolution of human activity and settlement in this critical area of north-eastern Jordan.

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The Restoration of the Propylaeum of the Sanctuary of Artemis in Jarash: Methodology and Perspectives *

The Propylaeum, at the crossing of the Sanctuary of Artemis' Via Sacra and the Main Colonnaded Street – giving access to the Intermediate Terrace of the sanctuary complex– has attracted the attention of the restorers since the earliest days of scientific research in the ancient city.

The monumental gates, framed on either side by two rooms which formed a part of the multistorey rows of shops as retainers of the artificial terracing higher up, were consolidated and partially restored, between 1928 and 1931.[1] Of the four pedimented gigantic columns ('Tetrastyle Gateway') corresponding to the propylaeum at the western side of the colonnaded street, only two of the pedestals and the *imoscapus* of the northern one were preserved *in situ*. This was a result of recurrent earthquakes which caused such destruction of the gateway. The collapsed elements of the pediment's *cyma* had already been lined up along the east side of the street by Horsfield in 1925 (technical adviser of the Department of Palestine and Transjordan at the time) who cleared most of the Main Colonnaded Street from the collapse of the buildings along its sides. Unfortunately, no record was taken of the dislocated architectural elements that could have represented a key for future study and restoration works.

It was not until the early 60's that the Department of Antiquities of Jordan resumed new restoration works. With the assistance of army engineers, more than 180 columns flanking the main streets were re-erected, among which are the columns of the 'Tetrastyle Gateway' The work was, however, left unfinished with only the four lower drums of the six originally forming the column shafts, re-erected.

A second resumption of the restoration work on the Propyaleum took place 20 years later, with the introduction of the Jarash Project for Excavation and Restoration, forming part of the Government's five-year plan. From 1976 on, H. Kalayan was entrusted by the Department of Antiquities with the follow-up of the aforementioned work in Jarash. His work at the Artemis Propylaeum consisted of the demolition of the service ramp that was built by the army for the erection of the four gigantic columns, and of the rebuilding of the four free-standing columns framing the three gates of the santuary's access west of the colonnaded street. Pretensed iron bars were inserted and cemented in the column cores with the intention of introducing an anti-seismic device, without considering the structural logic of the original architectural concept. Also noteworthy, upon careful observation, is the imperfect development of the columns' *enthasis* as well as the incompatibility of the four Corinthian capitals with the typical pattern that can be recognized throughout the sanctuary complex. In reality the style of the four capitals in question must be associated with the ones of the North Theatre to which, in all probability, they belong.

Having studied the architecture of the Sanctuary of Artemis since 1977, it was inevitable to focus particularly on the Propylaeum building whose architectural composition and articulation can be considered among the most remarkable in the Roman East. Restoration started in 1985 with the consolidation of the shops/retaining structures at the sides of the Propylaeum.[2] The question of restoration of the 'Tetrastyle Gateway', posed itself for a conspicuous number of architectural elements were available for *anastylosis*.

The study of each element pertaining to both the Propylaeum and the 'Tetrastyle Gateway' allowed a reconstruction on paper which in turn gave rise to problems (listed hereafter) to be solved before commencing restoration work (FIG. 1).

Propyleum

- no architectural element is available of the three-gated building attic nor of the entablature of the angular pillars framing the Propylaeum, which are of the same module as the 'Tetrastyle Gateway' columns;
- judging by: 1) the extent of cracks and fissures (especially in the bottom part of the building), some of which are of recent date, 2) by the exposure of the iron bars of the northernmost gate's reinforced concrete lintel built

* Posters exhibited in the hall of the auditorium of the "Centro Congressi della Cassa di Risparmio di Torino" as part of the Sixth Conference on the History and Archaeology of Jordan, June 5-10 1995.

1 C. H. Kraeling, 1938, *Gerasa: City of the Decapolis*, New Haven: 4-5.

2 R. Parapetti, 1983-84, 'Architectural and Urban Space in Roman Gerasa', *Mesopotamia:13-14*; 1986, The Italian activity within the Jarash Project 1982-83, *JAP I, 1981-1983*, Amman; 1989, Scavi e restauri italiani nel santuario di Artemide 1984-1987, *JAP II 1984-1988*, Paris.



1. JARASH, The Sanctuary of Artemis, *the Tetrastyle Gateway of the Propylaeum on the Main Colonnaded Street*; the missing architectural elements are indicated in black.

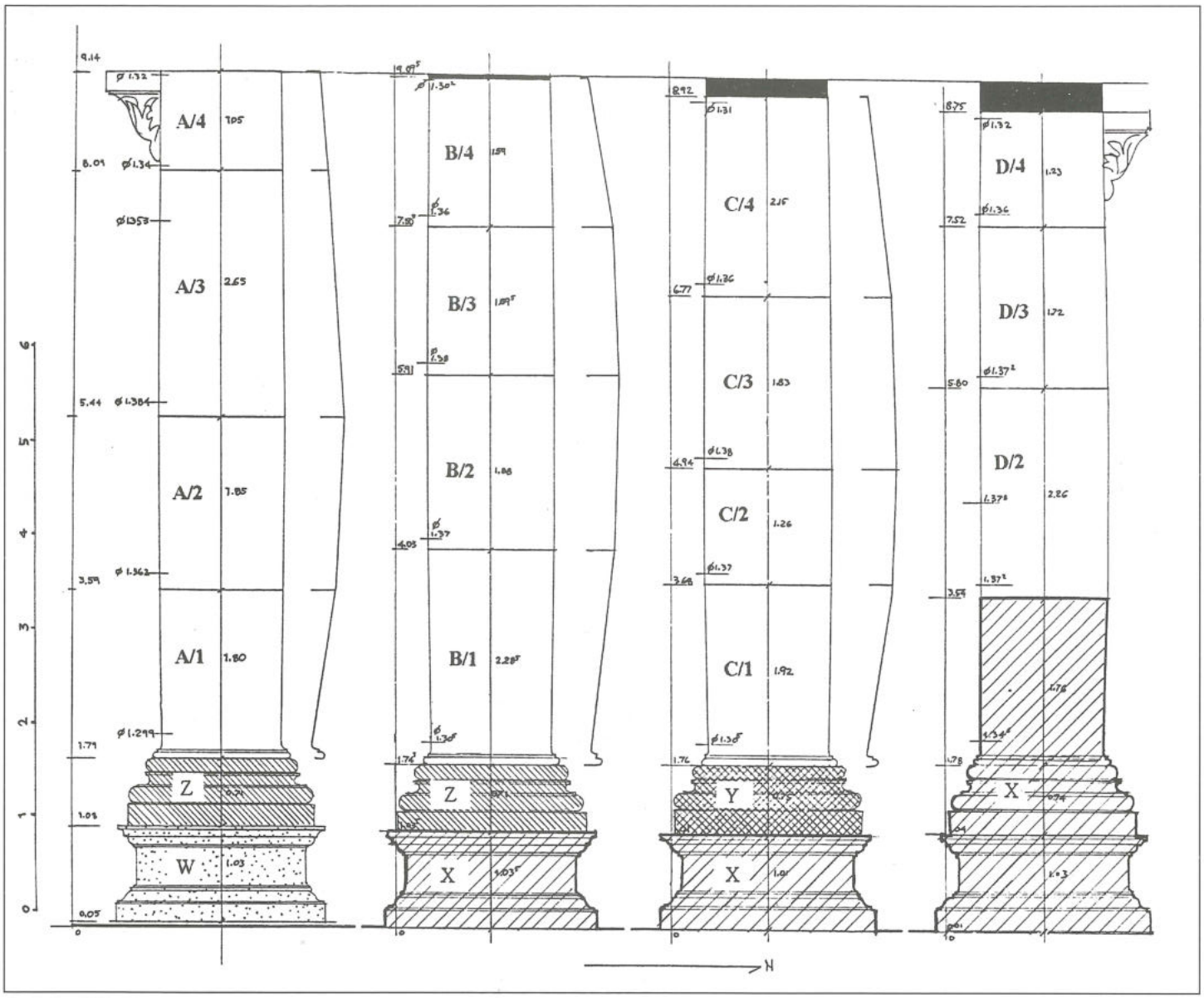
in the 30's and 3) by the fall of small stone particles, the progressively precarious static condition of the monument becomes clearly obvious.

Tetrastyle Gateway

- From the partial remounting work executed in the 60's the following observations can be made: 1) two of the column bases do not belong to the monument and come from the upper Temple of Zeus; 2) the sequence of the overlapping column drums, as they were then put, do not allow for any possible combination with the remaining drums and capitals on ground, to obtain the equal height for the four columns (FIG. 2).
- two column bases are missing;
- one of the 24 column drums is missing;
- no elements of the architrave are available;
- few elements of the frieze, the *geison* and the *tympanum* are missing.

Taking into consideration the high degree of seismic activity in the region, the anastylosis of the 'Tetrastyle Gateway', could only have been feasible by applying a non-conventional anti-seismic structural system that 'ties' the four columns to the Propylaeum. The complexity of the project that involves both the consolidation-restoration of the Propylaeum and the new structural system requires the employment of a highly specialized contractor for its realization. However, the limitations set within the terms of the present 'cooperation project', have led us to conclude that only a partial anastylosis could be achieved within this first stage of operation, that is the reassembly of only the four columns.

In accordance with the cooperation between Italy and

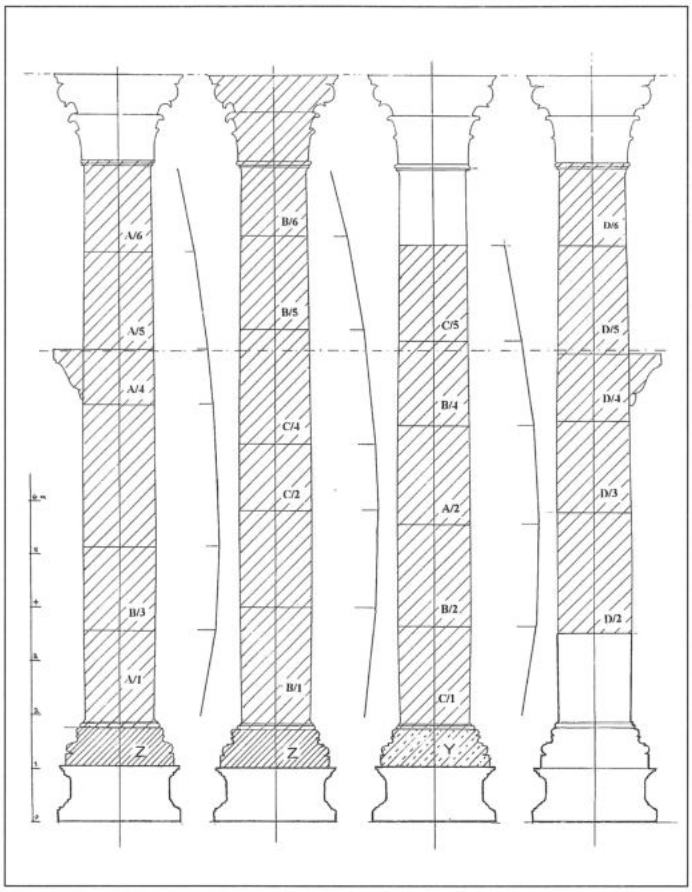


2. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway* , the four columns as restored in 1962: X *in situ*, Y reassembled, Z originated from the temple of Zeus, W rebuilt making use of stone blocks from the Northern Theatre *summa cavea.*

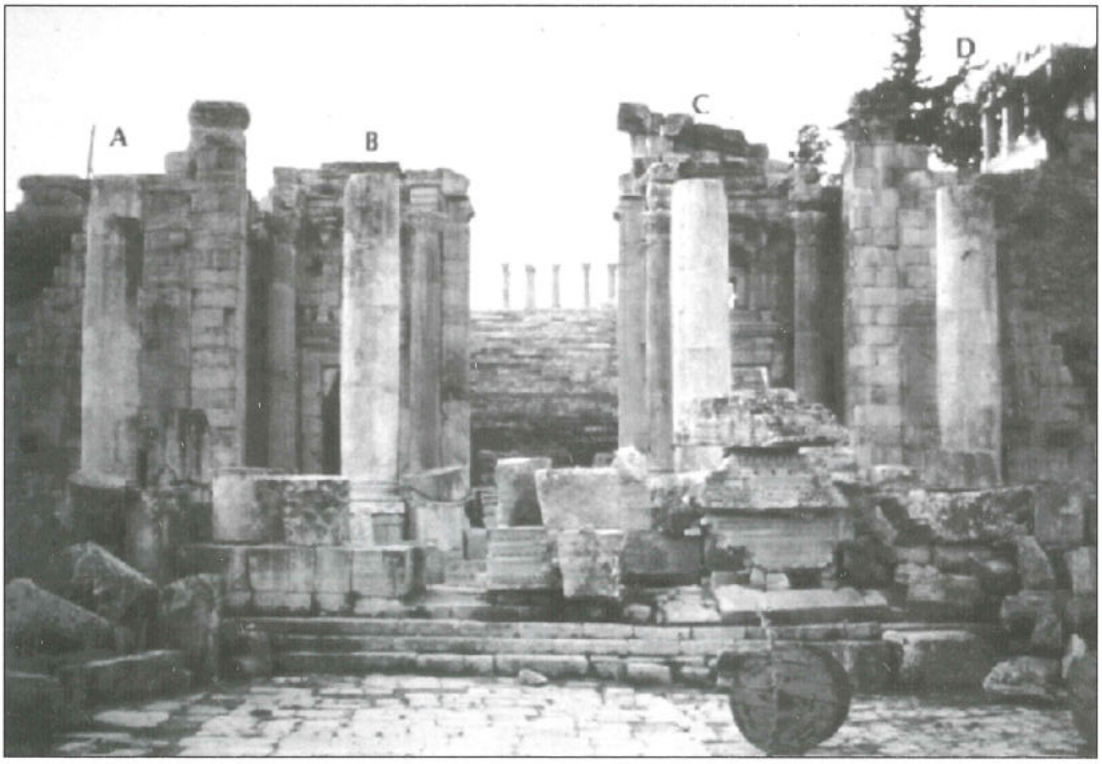
the Department of Antiquities of Jordan, the work from 1993 till the end of 1995, can be divided into three main operations: a) dismantling, b) reintegration of the single architectural elements, and c) reassembly.

a. The first operation, that of dismantling, was deemed necessary because of the incorrect sequencing of the overlapping column drums explained above (FIG. 3). It was also evident that there was an absence of mason marks, utilized to identify exact drum positioning, often recognizeable in Classical stone architecture. Only the presence of sockets for the lifting, except in one case, supplied at least the upright position of the drums. The identification of the original overlapping sequence was, therefore, only possible after a thorough geometric examination of each element. Only five of the 23 drums preserved, had a sure *'a priori'* location according to the design of the monument:
   - one element was preserved, *in situ,* at the northernmost of the four pedestals;
   - two elements with an incorporated bracket to hold the architraves of the colonnades, of a smaller module, had to be located at either sides of the gateway;
   - two elements, that were to be placed above the two aforementioned elements, are recognizeable by a groove for the insertion of the iron clamps that tie the architraves mentioned above;

   The careful measurement of the diameters of the top and bottom surfaces combined with the different heights of drums and capitals, allowed for the preparatory reconstruction on paper of the original sequence of the column drums (FIG. 4).



4. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway*, Reasssembly project.



3. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway*, view from east of the monument (from 1962 to 1993).

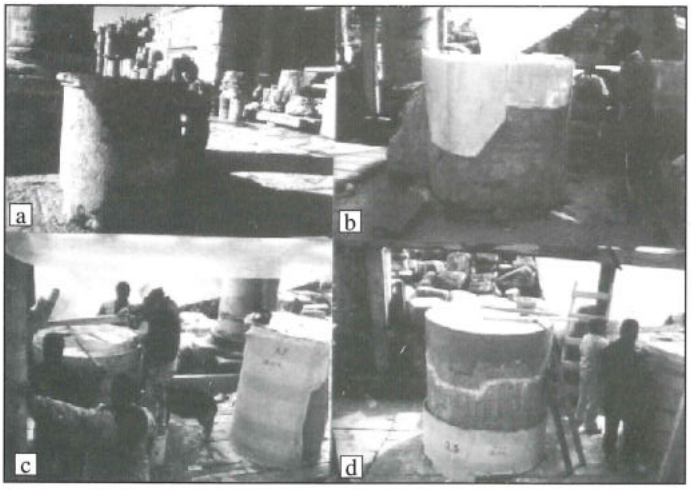
b. The second operation, that of reintegration, was planned to bring back the original static and volumetric characteristics to those column drums that were fragmented due to rocking, shaking and final falling due to recurrent earthquakes. In this operation the combined efforts of architect G. Rizzi, engineer D. D'Ayala and the restorers S. Volta and F. Beretti, led to the final solution for the artificial replacement of the missing parts of the columns. The building of an appropriate artificial stone out of reinforced concrete was found to be the most suitable solution to achieve the required objective. The insertion of iron bars in the column shaft as a strengthening measure was rejected as our aim was, in addition to the 'restoration of the elevation', the restoration of the original structural concept. The absence of connecting pivots in the column drums, as in most of the buildings in ancient Gerasa can, on the other hand, most likely be assumed as an empirical measure designed to minimize the devastating effects of earthquakes: Overlapping stone elements free to rock independently are relatively less affected by average seismic activity. The example of the pronaos' columns of the Temple of Artemis is an excellent proof of this theory. Left without the entablature and pediment, the columns have resisted collapse so far and the drums show only limited shifting from the axial alignment.

Eventually, the destructive and non-destructive analysis of the physical and mechanical characteristics of the original stone (a calcareous stone of 2900 Kg/m3, 5 % porosity, 45.5 N/mm2, E = 40,000/mm2) led to the use of a reinforced concrete, having the same parameters, that included an appropriate amount of stainless steel and an appropriate cement mixture (white cement with minimum content of soluble salts, five types of sand and two types of gravel were selected both for colour effect and for obtaining a better particle distribution. Finally, in order to reduce the bleeding effect as well as to slightly emeliorate the stress capacity, propylene fibres were added to the mixture).

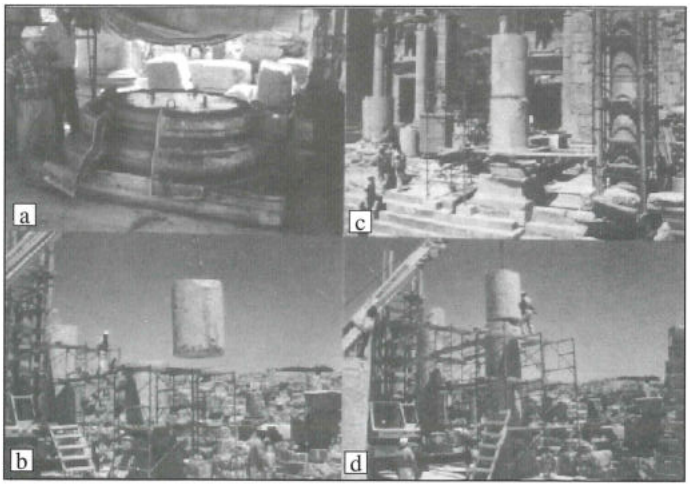
The following procedure was applied to replace the missing fragments,

- preliminary cleaning of the stone surfaces from microbiological aggression and consolidation of the fissures, cracks and slits;
- repair of the most conspicuous missing parts of each column drum by modelled clay (FIG. 5a);
- formation of a fiberglass mould on the clay matrix of the restored parts (FIG. 5b);
- removal of the fiberglass mould and of the clay;
- preparation of the stone surfaces for better adherence and for the insertion of threaded stainless steel bars for the anchoring and reinforcement of the artificial stone casting;
- repositioning of the fiberglass mould and casting of the cement mixture (FIG. 5c);
- removal of the mould after setting and reworking of the concrete to expose the aggregates (FIG. 5d).

c. The reassembly of the restored drums, in progress during the Sixth Conference on the History and Archaeology of Jordan, was eventually completed, at this point of the project, in December 1995 (FIGS. 6a-d, 7, 8).[3] Of the four co.lumns we expect to remount the uppermost drum of column C, because it is missing, as well as capitals A, C and D because they require particularly accurate consolidation and restoration. The missing bases of columns A and B have been completely reconstructed utilizing the artificial stone



5. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway on the Main Colonnaded Street*, a) the fragmented drum remodelled in clay, b) the formation of the fiberglass mould, c) the casting of the cement mixture, d) the repaired drum ready for reassembly.



6. a-d. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle on the Main Colonnaded Street*, reassembly in progress.

[3] Operations on the site and training of labour force have been followed up from the very beginning by F. Cardilli. P. Battino shared that task during the final phases of the work.



7. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway on the Main Colonnaded Street*, reassembled by December 1995, from the east.

described above (see FIG. 4).

Through future cooperation projects, the 'restoration of the elevation' of the four columns of the Tetrastyle Gateway is foreseen together with the remounting, on the ground, of the preserved parts of the entablature and pediment, according to their original design.



8. JARASH, The Propylaeum of the Sanctuary of Artemis, *the Tetrastyle Gateway on the Main Colonnaded Street*, reassembled by December 1995, from the south.

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The Settling Systems from Images: some Case Histories

Multispectral images offer a considerable quantity of information about the presence of man in a given region, through the analysis of the environment and natural resources that man was able to exploit and through the remains and artifacts, products of his activity, he left behind: we can find them in the most superficial levels of earth's surface in all areas where there has been man. All information is to be analysed and the first step of this operation consists in finding coherence within each set of information, in order to recognize the type of occupation or land-use by man, in the quest for survival. In fact, when we talk about occupied territory, we have to refer not only to the area chosen by man for dwelling, but also to the whole region surrounding this site, where man gets the fundamental resources for his life; therefore, the anthropised territory has to be seen as a set of used natural resources, always renewable, as a site where to place or deposit built artifacts or a place where to discard them, and at the same time, as the space where to carry out every activity or cultural performance.

The first element of this analysis can be ascertained and evaluated once we have carried out image georeference, that is information we acquired from images. In this, the concept of the settling system seems essential: it refers to an organic and, at the same time, complex unit of the human presence – the "settling needs". It combines the dwelling, which is simple or more or less articulated, with the resources linked to it. This is what we have to investigate, in order to achieve a complete historical record.

The identification of each settling system in the examined territory is the first part of the methodology: it enables us to provide interpretation by geophysic detections and undisturbed core drill sampling. At the same time, each settling system is the pattern on which we can safely lay the information, on a larger scale, through aerial and low altitude views (images) and by using information already available. That is, a heritage of information about the surveyed area already acquired in the past. Perhaps, it has its limitations inherent in traditional archaeological research: it requires many interpolations, sometimes quite arbitrary, to get to the organic historical reconstruction, and, in any case, it offers only partial data of a context, not its full retrieval. But the set of the previously acquired data is the fundamental support for the historical interpretation of satellite images to explain the acquired information about man's presence and activity in the investigated area which is done by using precise geometric and topographic references especially for built artifacts in which case the indication of the orientation is fundamental.

Geophysic detections of the most superficial levels of the earth crust, the ones which testify man's activity are a precious and fundamental checking-tool on what we have already acquired from images, adding further depth and essential specifications. Thanks to the improvements of different methodologies, detections allow us to quantify the ground anomalies linked to anthropic events and structures. The intrinsic limitation of these geophysic detections, aimed at inquiring only the superficial levels of our planet, is that of being substantially pinpointed they can not be used for regular enquiries over the whole region. This limitation can, however, be overcome by applying the geophysic detections to the areas of anthropic interest, individualized in a territory by the images: in this way the analysis provides only small margins of error for the examined area.

Starting from this sequence of images detections, the contribution of the geophysic detections becomes fundamental. We have, then, a direct comparison between low altitude images and geophysic maps, electronically processed by the most common methodologies for archaeological research.

A further methodology for checking information on the ground is the undisturbed core drill sampling. This method is well-known within the earth sciences: it can supply an extremely precise soil check with the advantage of offering exact stratigraphic sequences, fundamental for the chronological distribution of the located settling systems.

Of course, the ideal check is still represented by excavation of the site derived by above explained research process, which gives richer results complementing those gleaned from above methods.

All this demonstrates that we cannot expect to achieve the completion of the study of the chosen territory, too

quickly. The data quantity and the different interpretation and procedures require considerable research and processing and later, more checking on the ground. Thus, the examples presented here cannot supply final answers as yet. Most of all, they are supposed to present some procedures and propose new questions.

The first area where the methodology for examining the settling systems was applied by 'Centro Ricerche Archeologiche e Scavi di Torino' is Selinunte, the most western Greek colony in Sicily. The first use of orbital images dates back to the end of the seventies, interpreted, at that time, through photographic prints and not through computer analysis. This interpretation started a process of methodological studies and inquiries into the territory that led, on one hand, to the use of a more effective methodology and, on the other hand, to a more and more refined historical interpretation of the territory. This latter took the longest and required the cooperation of many people for the study of all previously recorded data and of what could be noticed on the surface through the direct recognitions of the area. The result was the retrieval of settling events of the territory, acquired during a long chronological sequence.[1]

Another example is the one offered by a region of North Africa, notably the territory of the ancient Carthage. It is an innovative contribution to an interdisciplinary research which involves many scholars and that Centro Scavi is carrying out within the activities of the 'Institut Tuniso-Italien des Sciences et Techniques du Patrimoine[2]'. The interpretation of Spot XS images of the territory allowed us to clearly distinguish the well-known urban lay-out which received the first fundamental definition during the Augustan age. It also allowed us to notice the considerable extension, even beyond what was known up to now, of the Carthage territory *centuriatio*, usually attributed to the failed colony of the Gracchi. The observation of this division, highlighted by a series of slight and discontinuous lineations with an orientation different from that of the city, made us notice, in fact, that this organization occupies a considerable portion of the territory located west of the new neighbourhoods of Tunis, which today, on images, hide in part the continuity of the lay-out.

The Palmyra area in Syria was suggested by the Syrian Authorities as a priority one for the realization of an archaeological cartography of Syria and Jordan, entrusted to Centro Scavi by UNESCO.[3] The work, started in 1995 in cooperation with the 'Direction Générale des Antiquités et des Musées (D.G.A.M.)', was carried out, in a preliminary phase, on a 30 x 30 km area, with the town at the centre.

The oasis of Palmyra, mentioned in sources of the second millennium BC by the name of Tadmor, rose to an important centre of trade and cultural exchange between the Roman and the Parthian worlds in the first centuries AD and is one of the most studied sites of Syria. More than sixty years of archaeological researches, following the studies of the great expert of the antiquities of Palmyra H. Seyrig, brightly enlightened the history of this large caravan city and rest-place in the Syrian desert on the axis which connects Homs with Abu Kamal, half-way between Damascus and the Euphrates (FIG. 1).

Processing and interpretation of Landsat and Spot images of this region showed us, on one hand, all evidence of an interesting geomorphology, and, on the other hand, the evidence of settling systems sequences; these systems encourage us, indeed, to explore each context in order to historically interpret an area with natural springs which explain the sequence from the Tadmor to the Roman, Byzantine and Islamic Palmyra.

This is an area where archaeological identification on the ground ascertained a long series of presences that now, with orbital images and the increase of information due to multispectrality, will be better and better linked to a very interesting framework, to which the reconstruction of the caravan route (across the area within the more direct connections between Mesopotamia and Mediterranean) will provide solid evidence of a series of specific settling problems.

A complete georeference on the ground, carried out by the GPS receiver and a total station, allowed us to realise a significant direct control of the results of the images interpretation, with remarkable land controls. The reconnaissance on the ground and the collection of material from the surface will be integrated into the information



1. Palmyra. Panoramic view of the monumental area.

[1] The research about the architecture and the settling systems of Selinunte is a great task of the Centro Scavi di Torino. The team of scholars led by G. Gullini includes F. Colosi, M. C. Conti, C. Zoppi, and, for the image interpretation, P. Baggio and C. Zamboni.

[2] The team, led by G. Gullini and co-ordinated by M. Casini, is composed of C. A. Birocco, S. Bullo, A. Leone, C. Rossignoli, D. Sangiorgio, C. Schiavon and C. Zamboni.

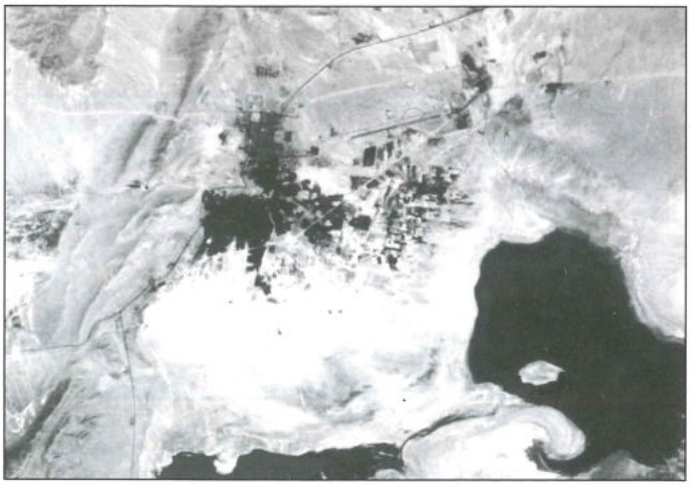
[3] The team on the field, led by G. Gullini, was composed of C. A. Birocco, P. Rossi, D. Sangiorgio and the author on the Italian side, and by N. Darrous, B. Habib, M. Rukieh, O. Sayasne, A. Sirrieh on the Syrian side.

system which is being built by data already known through archival and bibliographic documents. The interface of GIS with the georeferenced and interpreted images will enable a profounder historical reconstruction and indicate the areas to be covered by shots from low altitude. They will allow us to get detailed analytical information about the areas with more evidence and will guide eventual subsequent excavations.

A general picture of the territorial occupation in an historical age seems already well pointed out; it seems to prefer the quadrants south of Palmyra, as the ones north of Palmyra, which are hilly, give back most of all prehistoric lithic material and that often not in primary contest.

The southern sector extends around an ancient lake which at present is eutrophic (sabka) (FIG. 2); it has settlements which seem to be generally over low hills or talls emerging from the steppe. Their constant characteristic seems to be a remarkably large occupation, in the diachronic sense, often characterised by a prehistoric phase (from Middle Palaeolithic inwards) up until the Islamic period.

Some of these sites, as the mighty Umayyad fortress of al-Bakhra, situated about 18 km south of Palmyra, present building techniques and clay materials which certify also a phase dating back to the Roman period (Bounni; Al-As'ad 1989: 122). The aforementioned case concerns a walled-in citadel with a regular plan, of about 300 x 250 m, which lies over a settlement of the Roman Imperial age and reuses the remains of it (FIG. 3). The fortification, made of limestone blocks, presents two opposite entrances, the whole north-east side consisting of a doubled wall, and fourteen semicircular towers which stress the structure of the walls. Inside, it is possible to make out the remains of constructions, even if the rooms, with entrances indicated by large monolithic thresholds, are not clearly definable. Outside the fortified area, the traces of dwelling and service quarters are impressive with regard to their extension; furthermore, on the west side, there is an Islamic cemetry area, also situated on a hill. A large reservoir, fed by the natural water-table, represented one of the attractions of this inhabited area.

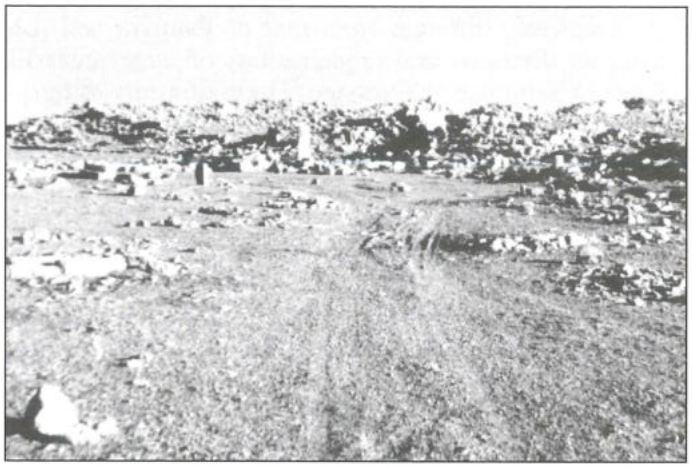


2. SPOT Pancromatic Image, 29.05.1993. Palmyra area, Syria.

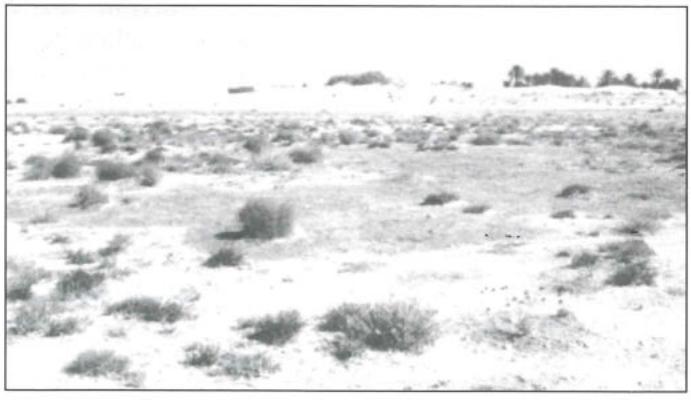
The fortified aspect and the spatial relations, which seem to connect most of these settlements, make us suppose a logic settling system planned with full knowledge of the ancient crossroads, like those towards Damascus and the Mediterranean, in the investigated south-west sector, and those towards the Euphrates, in the south-east sector.

Tall Schéjara also appears interesting: it is situated 12 km south-east of Palmyra and, at present, it is still exploited for crops, with orchards and palmgroves (FIG. 4). It does not present visible ancient structures, but it yields prehistoric lithic tools and Islamic clay materials, while, on the satellite images, the presence of four road-axes is clearly legible: they branch off as rays of a structure which encloses the perimeter of the hill (FIG. 5).

At the moment, we only provide a few explicative hints of an extremely variegated situation, in which every element can find its exact historical setting only in a more advanced phase of the research. An example can be



3. Al-Bakhra. A general view from south-east angle.



4. Tall Schéjara. A general view from south angle.

[4] The team on the fields, leaded by G. Gullini, was composed by C. A. Birocco, L. Ferraresi, M. Musso, D. Sangiorgio and the author.



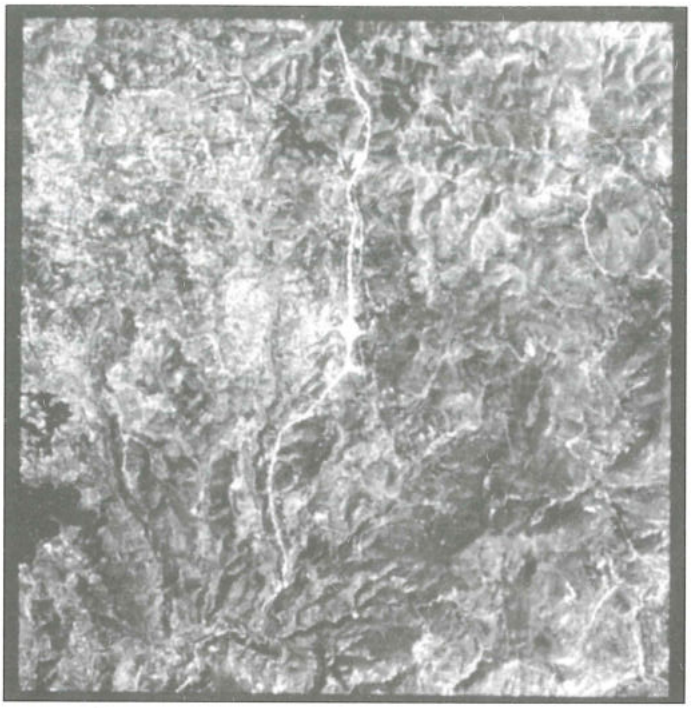
5. SPOT Pancromatic Image, 29.05.1993. Area south-east of Palmyra (Tall Schéjara).

offered by the possibility to reconstruct the whole lay-out of the *Strata Diocletiana,* suggested by the images and controlled on the ground through the more evident structures and the numerous blocks and columns, likely to be interpreted as shrines and milestones.

The Jarash territory, in Jordan, is the first site of study east of the Jordan river, chosen, here too, as priority by the Jordan Authorities.[4] In this case the natural morphology is completely different from that of Palmyra and there exist no divisions and organizations of large areas like those of Selinunte or Carthage. The conformity of territory offers easy use, thanks to the flat valleys that open out into others and are protected by hills. The presence of a territorial occupation becomes clear which we may define as "leopard patch" with several small agricultural settlements that probably survived over long periods. The first series of checking "truth-ground" and the more and more advanced details offered by integrating the interpretation of Landsat and Spot images (FIG. 6) and aerial photographs made it possible to find confirmation of all information read on the images and to reveal the extreme exposure of these 'marks' of territorial use due to the realization of new infrastructures and land reforms.

One example is the site of Khirbat Katla (FIG. 7), situated about 5 km north-east of Jarash, where we arrived through a series of patterns shown on the satellite image, corresponding on the ground to a 'natural amphitheatre' with many natural occupied caves on its edges. Still *in situ* there are structures (FIGS. 8-9) that, according to the ceramics collected in the survey, date from Late Antiquity to the Mamluk period.

As we said, we propose questions which require a number of specific studies that have to be carried out in two directions. On one side, the exact transcription on a topographic map on a large scale of all data acquired, both through intentional recording and through the systematic organization of casual or emergency finds, as already done by JADIS. On the other side, the exact georeference and plotting of the images, in order to superimpose with absolute certainty the information of the latter with the



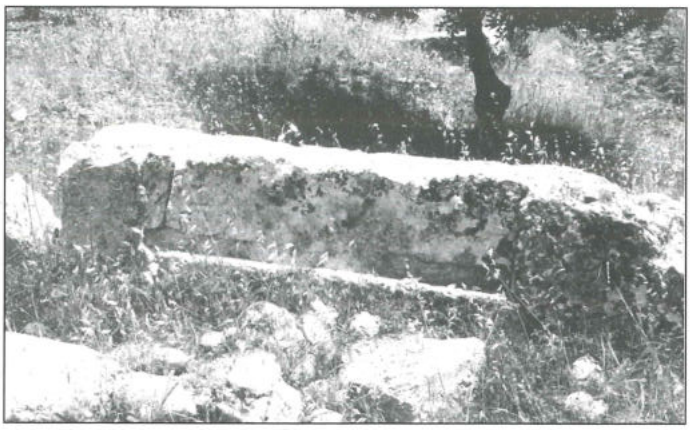
6. Landsat 5 TM Image, 4.04.1994. Jarash area, Jordan.



7. Khirbat Katla. A general view.



8. Khirbat Katla. A column base.



9. Khirbat Katla. Threshold block.

direct recognition and the previously acquired data.

We still need to work for a long time to complete our project; this will be possible with aerial shots at a very low altitude so as to obtain the highest resolution in the most specifically researched areas. In this way it will really be possible to record those settling systems in the various occupation periods and, as a consequence, to acquire a solid and systematic knowledge of this area of Jordan, one of the most interesting for the history of the civilization.

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The Changing Landscape of the Clay Deposits at 'Ayn aṭ-Ṭīnah, Wādī Mūsā

Introduction

In his study of industrial rocks and minerals in Jordan, Khoury (1989: 92ff) showed the main industrial clay minerals to be present at the Māḥiṣ to Ghawr Kabid area, al-Azraq and Baṭn al-Ghūl (with other less important occurrences at ar-Rashādiyya and al-Fujaij). By 1993, another major industrial source of clay was added, at the "Wādī Mūsā - Petra area" (Abu Dayyeh 1993). The clay source was found to be applicable for the industrial manufacture of pottery by modern geological standards (Abu Dayyeh 1993: 141, 143). More surprising was a study indicating its possible application for the treatment of polluted water resulting from modern industrial waste (Baker 1993).

The clay source concerned comprises Jabal aṭ-Ṭīnah (the mountain of clay), located between the town of Wādī Mūsā and Petra (FIG. 1). The section of the site next to a spring ('Ayn aṭ-Ṭīnah, UTM coordinates 737610E-3357730N) was first recognised as an important source of clay by archaeologists in 1981 during a search for possible clays used at the Zurrāba pottery workshop ('Amr 1987: especially 43; first reported by Zayadine 1982: 380), and was brought to the attention of the scientific community in Jordan through personal communications (Khairieh 'Amr with Maha Tutunji and Hani Khoury in 1992), thus being a case of the field archaeologist recognising a geological discovery more than a decade earlier than the field geologist. Of course the local people were aware of the clay in the area and of its use for pottery production much earlier than both the archaeologists and scientists ('Amr 1987: 43; Mason and 'Amr 1990: 288).



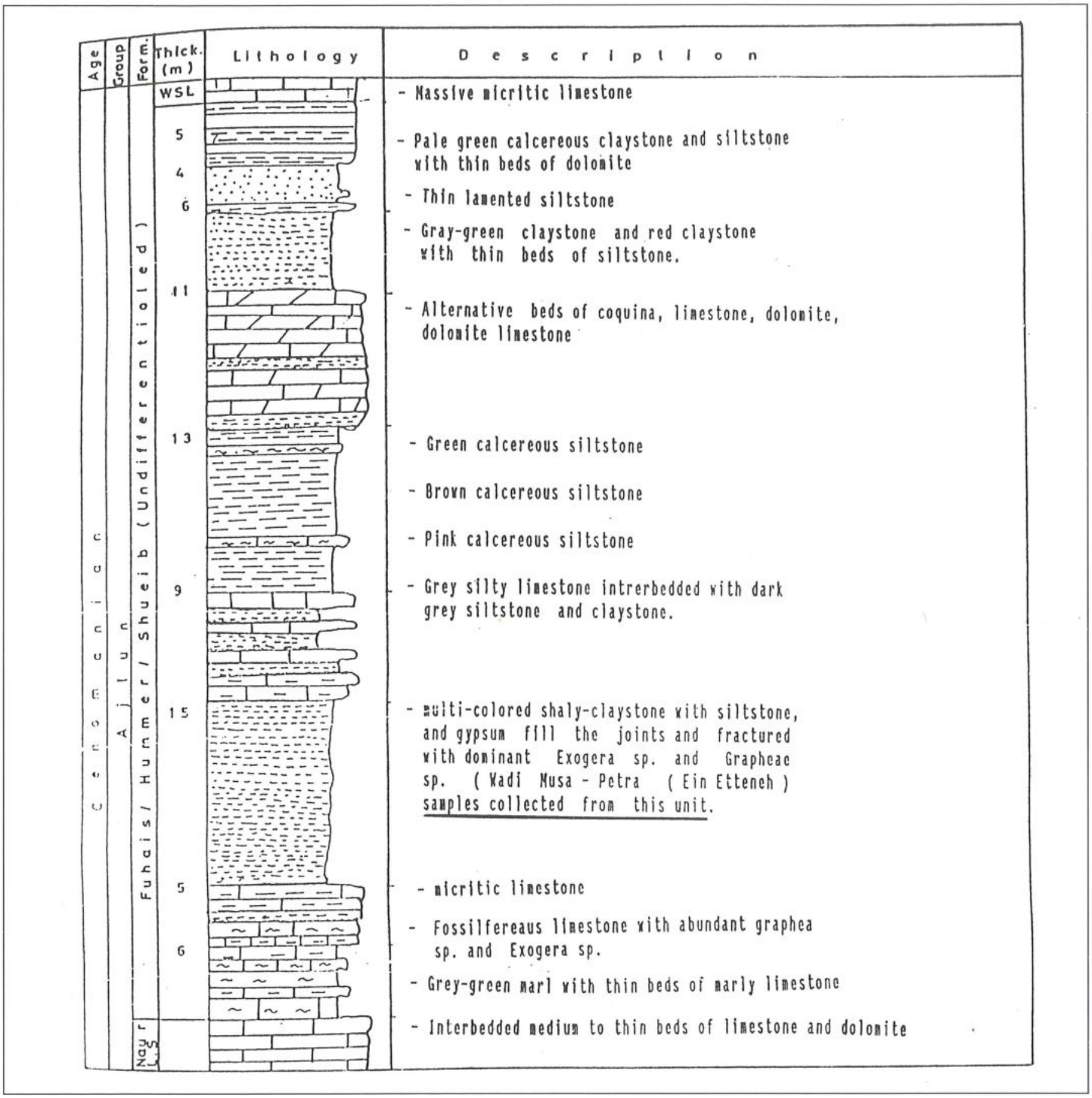
1. Aerial photograph of the Jabal aṭ-Ṭīnah area (IGN-PARIS and Dept. of Antiquities - Amman 1977).

The geology of the area is discussed in Abu Dayyeh 1993 (14-23, after Barjous; FIG. 2). It suffices here to say that the clays under discussion come from a 15m thick band in the lower part the "Fuhais-Hummer-Shueib" (undifferentiated) Formation (as compared to the 4.2m thickness of the Māḥiṣ clay layer and 2.8m thickness of the Ghawr Kabid clay layer, Bender 1974: 168). The clay at 'Ayn aṭ-Ṭīnah directly overlies outcropping limestone of the same formation.

The claystone at Jabal/'Ayn aṭ-Ṭīnah is intensely fractured by the "Wādī Mūsā Fault" and is characterised by massive landslides due to the nature of the deposits, and notably due to the deposition of secondary gypsum in the fractures (Abu Dayyeh 1993: esp. 128, 142). This threat to buildings there has been brought to the attention of the Wādī Mūsā municipality and currently no building permits are issued in the area (personal communication with the former mayor of Wādī Mūsā in 1993, who also said that owners of land there are offered alternative municipal land for building). Unfortunately, some houses were built, without permission, at the southwestern edge of this dangerous zone. The residents report difficulty in getting home during the rainy season and one fortunate house was abandoned due to substantial cracking during the initial building stage. It is gravely feared now — due to the recent building boom in Wādī Mūsā — that this municipal decision will be overruled and lives will be endangered.

The Raw Material for the Nabataean Ceramic Industry

The accidental discovery of the Zurrāba pottery workshop in the outskirts of Petra in 1979 opened a whole new horizon for the study of the most common archaeological artifact of the Nabataean culture, which chronologically went even beyond the limits of the Nabataean Kingdom as defined by history. This workshop, which is much humbled by the nearby magnificent capital of Nabataea, manu-



2. Columnar section for the "Fuhais-Hummer-Shueib" Formation at Wādī Mūsā (after Abu Dayyeh 1993: FIG. 2.5).

factured Nabataean products from the first up to the sixth century AD, making it the longest operating industrial area known in Jordan ('Amr 1991).

The Petra area — with its major pottery production centre at Zurrāba — was proven to be the main producer of fine Nabataean ceramics through two Neutron Activation Analysis studies ('Amr 1987; Gunneweg *et al.* 1988). The results of the first study indicated that the same clay source in the Petra area was utilised from around the beginning of the second century BC up to the sixth century AD for manufacturing a wide variety of wares ('Amr 1987: 199); while the second study arrived at two closely related composition groups, of chronological significance, dated from circa 50 BC to the end of the second century AD (Gunneweg *et al.* 1988: 342-343). The Neutron Activation Analysis studies failed to pin-point the clay source(s) in the Petra area, but the composition of clay samples from 'Ayn aṭ-Ṭīnah (presented in 'Amr

1987) came closer to the composition of the "local Petra Group" (in the same study) than any other clay samples from the Wādī Mūsā area (TABLE 1, based on 'Amr 1987; also compare to Gunneweg *et al.* 1988: 324 Table 4). This failure to relate the pottery to its clay source is thought to be mainly due to the processing of clay prior to manufacturing the pots, especially the extensive levigation needed for the production of fine wares which results in the removal of the heavier particles.

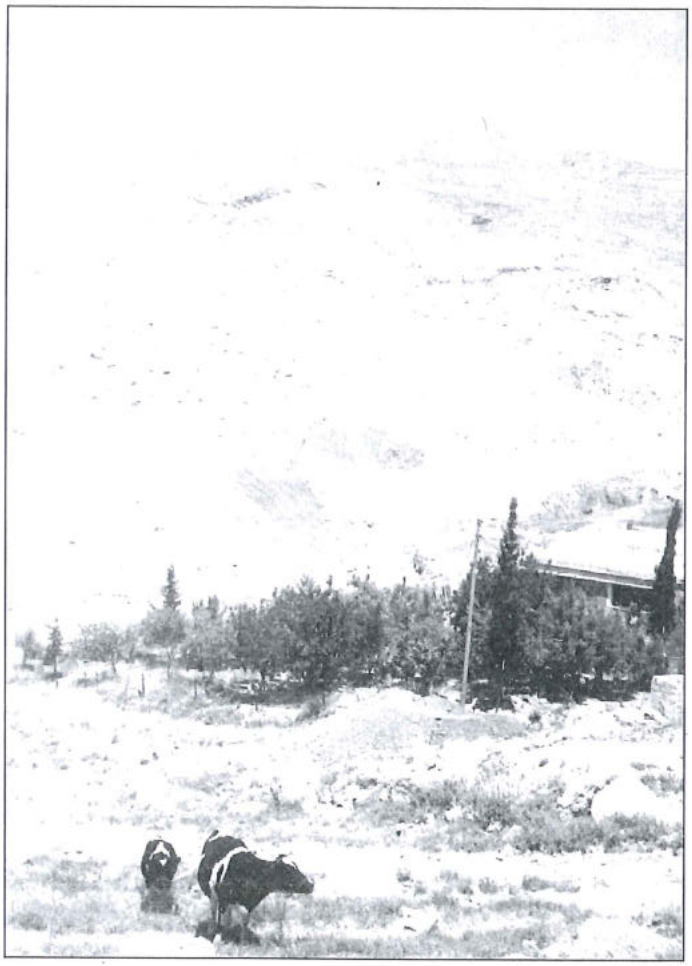
In their search for clays used in ancient ceramic industries, several researchers have concentrated their efforts on wadi beds, this being a natural choice as the secondary transported clays found there are usually well sorted due to the action of water, thus reducing the effort needed in processing. For example, an experimental firing of a dried sample of 'flood clay' deposited in Petra after the floods of March 1991 — with no post-field treatment — resulted in an appearance which is very similar to the finest of the Classical Nabataean fine wares (Mason and 'Amr 1993: 207), although all the primary clay deposits in the area would necessarily require much levigation before they can even get close to the finesse of the Nabataean wares.

Unless dealing with alluvial flood plains or deltas, it is difficult to conceive that the small amounts of clays usually found in the wadi beds of Jordan could support anything larger than a small-scale household industry. Mining of dependable clay deposits, despite the extra effort needed in the processing, would be the answer for a commercial pottery industry. An extreme (modern) example can be seen at the Tunisian island of Jarba, where the clay has to be quarried underground "a practice which is dangerous and has claimed many lives" (Peacock 1982: 42).

Failure to find evidence for the extraction of clay, other than the occasional relatively small clay pits in the immediate vicinities of kilns, has been assumed to be due to very little material being required for making a pot "and the extraction of raw materials can have a relatively slight impact on the landscape" (Peacock 1982: 52). In the case of the Nabataean ceramic industry, it is difficult to conceive that a material which was probably extracted for almost eight centuries would not have impacted the landscape. The area of 'Ayn aṭ-Ṭīnah presents evidence for exactly this sort of impact, where part of the eastern edge of Jabal aṭ-Ṭīnah seems to be gouged in the form of a huge, open edged, ovoid "pit". The orientation of the long axis of this "pit" is at around 20° west of North, and it measures just under 80m in length by 45m in width with a maximum depth of around 15m (the full thickness of the natural clay deposit layer; FIGS. 3, 4). The "pit" is cut on the northeastern side by Wādī Qrāra (Ghrāra), a tributary of Wādī Ḥamāṭat Ḥammād. The overall form of this "pit", evident in the centre of FIG. 1, is a prime candidate for the location of an ancient mine, although the dimensions may not be exact due to landslides which are especially evident

Table 1. Compositions of "local Petra group" compared to green clay samples from 'Ayn aṭ-Ṭīnah. Concentrations in ppm except for K and Fe, which are in % (based on 'Amr 1987).[1]

	Petra pottery (211 spls)		'Ayn aṭ-Ṭīnah Clay (4 spls)	
	Mean	σ	Mean	σ
K	002.34	00.35	001.96	00.17
Fe	004.71	00.59	005.54	00.71
Cs	003.32	00.48	003.56	00.28
Sc	021.1	02.4	022.1	04.7
La	027.9	03.0	025.8	03.6
Ce	067.8	12.3	049.6	07.2
Lu	000.414	00.056	000.355	00.026
Th	009.03	01.07	008.67	00.78
Cr	128.	20.	113.	11.
Co	019.8	03.0	025.7	10.
Sm	005.70	00.68	004.40	01.17



3. General view of the clay deposits at 'Ayn aṭ-Ṭīnah (view from the south-east).

[1] Only the green coloured clay samples from 'Ayn aṭ-Ṭīnah are considered in this table as the green clay forms the bulk of the deposit in the area, with the other clays being present in only small amounts.



4. The northwestern edge of the ovoid "pit" at 'Ayn aṭ-Ṭīnah where the concave form is evident (view from the south).

at the southern end of the western slope (FIG. 5). However, this pit form cannot be caused by landsliding.

Further indications for the clays at 'Ayn aṭ-Ṭīnah having been used by the Zurrāba potters are given in Mason and 'Amr 1990; 1995. The strongest evidence is presented by the suitability of the clay for manufacturing fine wares very similar to those produced at Zurrāba due to its special mineralogical composition, more specifically its high illite/smectite content (see Baker 1993 for comparisons between the mineralogical contents of various clay sources in Jordan).

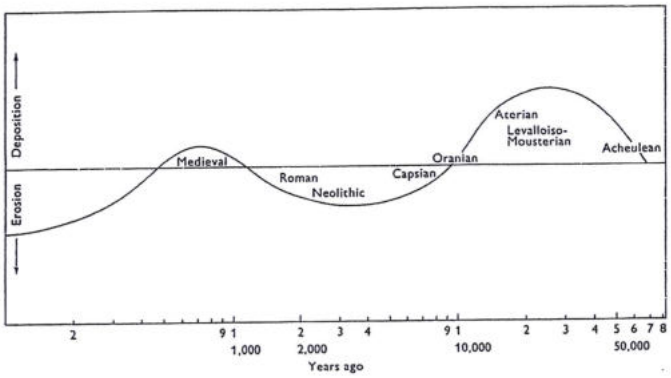
The Historical Wadi Terrace at 'Ayn aṭ-Ṭīnah

The phenomenon of a "historical wadi terrace" — notably where ancient remains that had been buried are re-exposed in wadi cuts — is not uncommon, although this useful indicator seems to be utilised more by "pre-historic" archaeologists (and geologists) than by archaeologists dealing with the later "historic" periods (a random survey of *ADAJ* volumes produced the following examples: Edwards 1984: 56; 1993; Petocz and Villiers 1984: 78-80; Macumber 1984: 83-86; 1993; Besançon *et al.* 1984; Byrd and Rollefson 1984: 143; Gilbertson and Kennedy 1984: 156; Mabry and Palumbo 1988: esp. 277, 296; Palumbo *et al.* 1993: 316).

Vita-Finzi (1969) has beautifully and simply illustrated and explained the formation of the present configurations of valleys in the Mediterranean area, including Jordan. The noted "historical" terraces are due to cycles of erosion and deposition (FIG. 6). Quite simply, soils accumulated *in the valleys* between around 60,000-10,000 years ago, then were eroded away or cut down up until just over a thousand years ago, during which time the floor level (and the cultural material deposited on it) got lower, then again deposition of soils occurred (covering the cultural material) in a process that lasted up till around 500 years ago. Finally, erosion set in again, currently even undercutting the lowest of the previously deposited material and exposing the Capsian-through to-Roman remains that were deposited in the previous erosional cycle.



5. Landslide at the southern edge of the "pit" at 'Ayn aṭ-Ṭīnah (view from the north west). The spring can be seen just below the house on the upper terrace of Wādī Qrāra.



6. Chronology of erosion and deposition in the Mediterranean area (after Vita-Finzi 1969: 92, FIG. 42).

This other form of changing landscape is evident in Wādī Qrāra beneath and just to the northwest of the spring of 'Ayn aṭ-Ṭīnah, opposite the "clay mine", where walls can be seen along the wadi cut (FIG. 7). The walls form a structure of several rooms and are built with mostly unhewn limestone chunks and a few dressed blocks (FIG. 8; it

should be noted that the limestone underlying the clay in the area tends to fracture at right angles). The section below the walls is of wadi cobbles with little silt, from which two probable Neolithic sherds and one flint arrow head were recovered, while the fill at the level of the walls is composed mostly of silt with less cobbles (FIG. 8). One Classical Nabataean body sherd was recovered (by Henry Cleare) from one of the walls and a second century AD cooking pot sherd was found in the fill nearby. These findings are another illustration of Vita-Finzi's study.

The two sides of Wādī Qrāra differ markedly from each other, with the opposite southwestern cut showing the lower (natural) strata of the "Fuhais-Hummer-Shueib" (undifferentiated) Formation. However, around 50m further up the wadi, one wall could be seen next to the northern edge of the "mine pit". This wall could be traced with difficulty for approximately 5m on the surface in the only area with an abundance of Nabataean sherds. Still further up the wadi, more walls preserved to higher heights corresponding with the deeper cut were found. However, none on the side of Jabal aṭ-Ṭīnah .



7. Stone walls in the northeastern cut of the lower terrace of Wādī Qrāra (view from the south-east, below the spring of 'Ayn aṭ-



8. Section of a wall in the northeastern cut of Wādī Qrāra.

Currently it is difficult to say what the function of the structures near 'Ayn aṭ-Ṭīnah may have been. A purpose related to clay processing is a possibility due to their position next to a "clay mine" and running water. The pottery workshop at Zurrāba is on a slope with several wadis but no dependable water source in the immediate vicinity. Although the Zurrāba cistern and the channel carrying water from 'Ayn Mūsā to fill it are near the pottery workshop, this water would have been too precious to use for clay processing, like the juniper trees on the surrounding hills would have been too precious for kiln fuel. Clay processing installations at 'Ayn aṭ-Ṭīnah would save hauling both water and heavy, unprocessed clay. To date, no levigation set-up was confirmed at the Zurrāba workshop (see Mason and 'Amr 1990: 298). However, only a small part of the Zurrāba site is excavated and much of it has been lost forever due to modern building at the site.

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The Southeastern Dead Sea Plain: Changing Shorelines and their Impact on Settlement Patterns through Historical Periods

Introduction.

Among the many possibilities for GIS mapping of the southeastern Dead Sea area one of the most interesting and feasible to present in a brief study is the impact on the settlement patterns by rising and falling Dead Sea levels through historical periods. Data for the study has been drawn from surveys, excavations and field studies of the Expedition to the south east Dead Sea Plain, low and high level aerial photos and electromagnetic radiation data from the Landsat Thematic Mapper (TM).

Sources and Methods

The sources used for this study include results from surveys and excavations collected by the Dead Sea expedition since 1973. An accurate and comprehensive locational data base listing all of the known archaeological sites for the southeastern Dead Sea region has been recently updated incorporating information from the most recent surveys and excavations, including some unpublished data. Information in the data base (TABLE I) includes exact site locations, utilizing the Palestine grid, elevations, size, type and extensive textual descriptions of the nature of the sites. Geological field studies have documented the natural stratification in the region and recreated the basic changes in wadi profiles through historical times.

Aerial photographs accessible for the study include low level plane and helicopter shots from 1975, 1979 and 1990. We are grateful for the support of the Royal Jordanian Air Force which made it possible for our staff photographers to take these photos. Stereo pairs taken at 10,000 feet for the northern part of the region were made available to us by the Jordanian National Geographic Society.

The Landsat 4 Thematic mapper images for this region were recorded on 9/6/84, a day with 0% cloud cover. The satellite records surface reflectance intensities from visible to thermal infra-red in seven wave length regions (Band 1 = 0.45-0.52 microns, Band 2 = 0.52-0.60, Band 3 = 0.63-0.69, Band 4 = 0.76-0.90, Band 5 = 1.55-1.75, Band 6 = 10.4-12.5, Band 7 = 2.08-2.35). Seven bands, each with different wave length and color, were recorded. The two standard types of images used in this study and presentation are 'Achromatic Greyscale' and 'Four Component RGB' (Red-Green-Blue). The greyscale makes it easier to see linear and high frequency features than on a color image. In the Four Component RGB bands are combined to emphasize various minerals. The different colors can sometimes be related to different lithologies.

For the studies of site settlement pattern a program was developed to convert site locations and site codes from the database to vector overlay on the image. The Landsat image data was georeferenced to a Universal Transverse Mercator (UTM) projection using real world coordinates (Lat. Long.) of natural and man-made landmarks. Features such as stream tributaries and road intersections are easily identifiable with the 30 m resolution of the image even though the features themselves may have a dimension smaller than 30 m Contours of the 1969 shoreline, -380 m (not shown in FIG. 1) and -300 m were digitized for two 1:50,000 scale maps and converted to UTM coordinates. A program was then written to overlay the contours on the image.

Dead Sea Levels

A. *Recent changes*

A number of important features may be seen in recent satellite images. The 1984 TM image (FIG. 1) clearly illustrates the fall in the Dead Sea level over the last 20 or more years caused by the removal of fresh water from the Jordan River and numerous wadis on the east and west side of the Dead Sea for use in agricultural irrigation. The straight line features in the South Basin are dikes used to create small evaporating pans for extraction of potash by both the Jordanians and Israelis. The drop in Dead Sea water levels is especially obvious around the al-Lisān Peninsula shoreline. The white interior of the peninsula denotes the 1960's through 1970's higher levels for the Dead Sea while the darker area, especially between the al-Lisān Peninsula and the Israeli coast marks a dry land area separating the North and South basins.

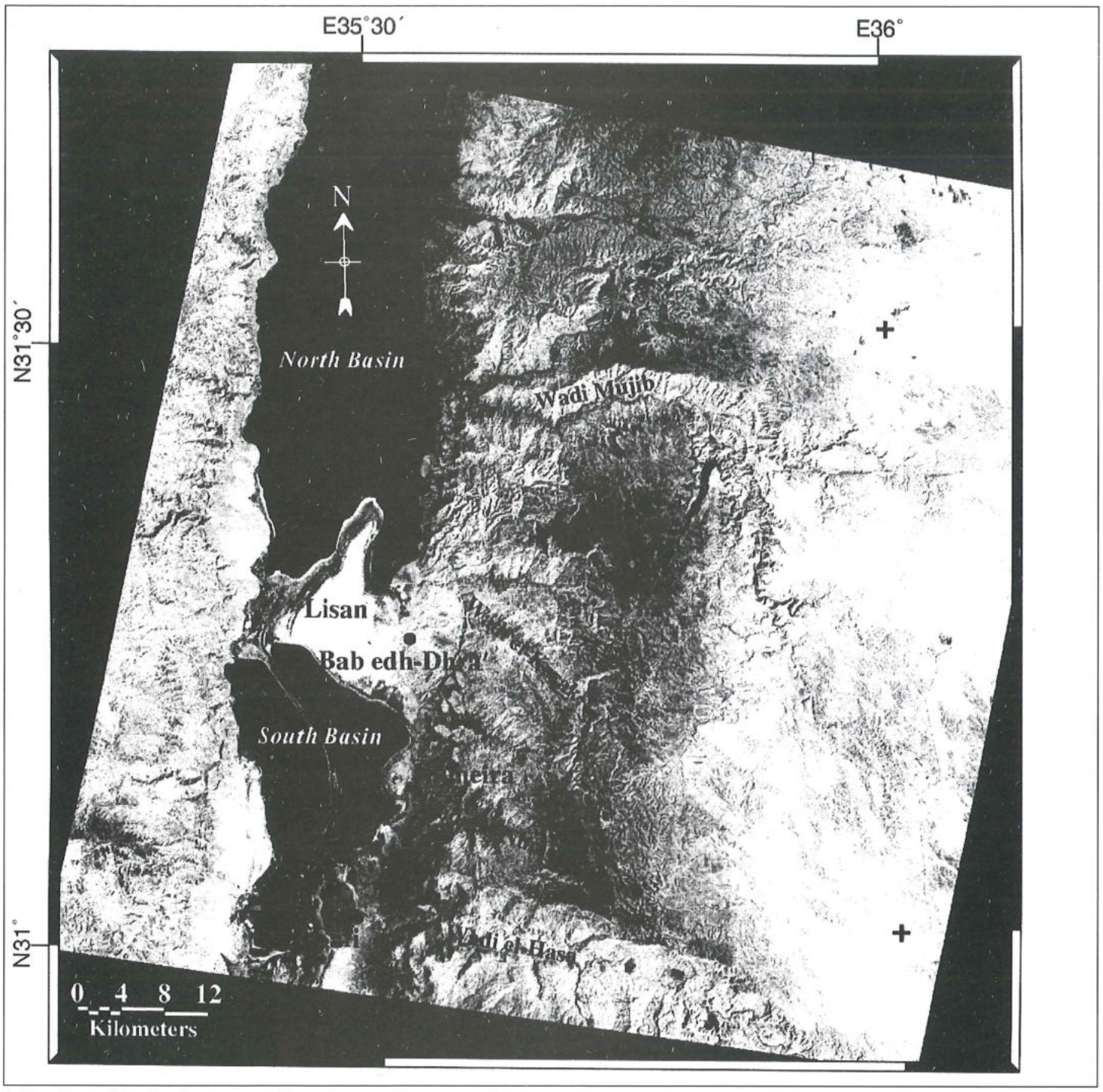
Also indicated on the image is the location of three significant Early Bronze Age sites, Bāb adh-Dhrā' an-Numayra and aṣ-Ṣāfī and four major east to west flowing wadis, al-Mūjib, north of the al-Lisān Peninsula, al-Karak

Table. 1

NAME	PGE	PGN	ELV	SZ	TP	OCC	OTHER
BILAYDAII	204.4	076.6	-60	SM	CM	EB	MANY DIAGNOSTIC, PROBABLY BECAUSE TOMBS
ER-RISHI 1	205.9	075.4	-140	ME	WA	EB	80 X 60 M. DESTRUCTION LEVELS, EBI-III
NWAK-37.1	203.6	078.9	-165	SM	BG	EB1	LATE CHALCO/EBI- HOUSE FOUNDATIONS
KHAN CEM.	191.8	032.6	-175	LG	CM	EB4	LARGE EBIV CEMETERY WITH RECT. BLDGS.
BDSUR77-11	203.1	070.6	-200	SM	CS	EB	ALSO PAL. HAND AXE 50 M. AWAY
NUMSUR24	201.4	061.4	-200	SM	CS	EB	NATURAL CLEARING NEAR ROCK SHELTER
NWAK 43	203.2	076.5	-200	SM	CS	EB	NO WALL REMAINS
NUMSUR13	201.4	062.0	-220	SM	RG	EB	RING STRUC., 23 M. IN DIAM.
NUMSUR28	201.7	066.8	-220	SM	RG	EB	NAB/LR/BYZ/MAM 18 M. DIAM. RECT PLATFORM
BABEDHDHRA	200.6	073.4	-245	LG	WA	EB	EBI-IV, LG SETTLEMENT 330 X 110 M.
BDSUR77-5	200.7	074.1	-250	SM	FM	EB	FARMSTEAD, UPPER FAN, 3 X 7 M. HUT FOUNDATION
BDCEM	200.3	073.0	-260	LG	CM	EB	EBI-IV, CEMETERY USED THROUGHOUT TOWN OCCUPATION
NWAK.-37.2	202.5	079.8	-260	SM	CV	EB	CAVE WITH TERRACE COVERED WITH LARGE STONES
NUMSUR12	201.0	062.0	-270	SM	RG	EB	RING ENCLOSURE, 13 M. DIAM. LOCATION UNCERTAIN
NUMSUR11	201.0	062.0	-270	SM	RG	EB	TWO STONE CIRCLES, JOINED 38 M. X 19 M.
NUMSUR10	201.0	062.0	-270	SM	RG	EB	STONE CIRCLE, 30 M. DIAM., STONES ON EDGE
SGNAS3	195.9	047.3	-280	SM	TO	EB	ROBBED TOMB, EB1, IR1A, MAM, OTT
NUMSUR22	200.8	060.3	-280	ME	BG	EB	LARGE ENCLOSURE, WALLS ON N. AND S.; ASH
NUMEIRATWN	200.4	060.1	-280	ME	WA	EB	WALLED TOWN SITE
FEIFACEM	193.8	038.9	-280	LG	CM	EB	LARGE CIST TOMB CEM CHAL\EB
SGNAS78	194.5	038.1	-280	SM	CS	EB	BYZ, OTT, UD, SHERD SCATTER
SGNAS2	195.0	047.4	-285	LG	CM	EB1	EBIB, EBII-III (?), MAM,
SGNAS79A-H	197.2	049.9	-300	LG	CM	EB	TOMB AREAS, EB4, IR2, NAB, ROM, BYZ, MAM
SGNAS67	195.2	040.8	-300	SM	CS	EB	POTBUST, 7 X 5 M. AREA
NUMSUR17	200.7	057.0	-300	SM	RG	EB	SEMI CIRCULAR RING, 12 X 7 M.
NUMSUR21	199.3	054.9	-300	SM	RG	EB	2 RING STRUCT. ONE 22 M., OTHER 3 X 8 M.
BDSUR77-4	200.3	074.9	-305	SM	FM	EB	FARMSTEAD ON UPPER FAN
NUMSUR16	201.4	057.2	-310	SM	RG	EB	2 RINGS, ABOUT 10 M. IN DIAM EACH
BDSUR77-19	198.9	072.9	-330	SM	CM	EB	EBI SHERDS - TOMBS?
BDSUR77-17	199.0	073.4	-335	SM	FM	EB	FARMSTEAD ON LOWER FAN
BDSUR77-20	198.9	072.7	-335	SM	CM	EB	EBI SHERDS-TOMBS?
BDSUR77-18	198.3	073.4	-360	SM	CS	EB	FARMSTEAD LOWER FAN
NUMSUR2	200.9	059.8	-200	ME	VI	CHA	POSSIBLE VILLAGE CHALCO-EBIB
NUMSUR7	201.3	062.5	-225	LG	VI	CHA	FOUNDATIONS, SQ. RECT. DOLMENS
BDTWNSHIP	200.5	072.5	-255	LG	CM	CHA	STONE CIRCLE TOMBS OVER LARGE AREA
SGNAS80	197.3	049.1	-275	SM	CS	CHA	CAMPSITE, 22 X 6 M. AREA
NUMSUR8	201.2	061.8	-290	ME	VI	CHA	ASH PITS, SOME WALL REMAINS
AINSIKKIN2	200.7	075.4	-310	MD	VI	CHA	CHAL/EB- 50 M. SOUTH OF SPRING
BDTWNSHIP3	199.6	072.6	-310	SM	BG	CHA	BUILDING, CHALCO\EB
DHIRA-NEOL	204.9	072.5	-30	ME	CS	NEO	1979-POTTERY NEO A
FEIFAEAST	193.9	038.9	-270	LG	VI	NEO	APPEARS TO BE LARGE NEOLITHIC VILLAGE
AINSIKKIN1	200.8	075.5	-300	SM	CS	NEO	CLOSE TO SPRING
BDSUR77-3	201.7	074.4	-200	SM	CS	LPA	PAL. SITE BUT PROBABLY SECONDARY
BDSUR77-21	201.7	069.4	-280	SM	CS	MPA	2 LEVALLOIS POINTS - ON BEACH LINES
BDSUR77-10	202.2	070.1	-220	SM	BG	PAL	2 CIRC. AND 1 RECT. STRUCT., UD.
BDSUR77-2	201.5	074.6	-225	SM	CS	PAL	COBBLES, FLINTS
BDSUR77-9	202.1	070.3	-230	SM	CS	PAL	
BDSUR77-1	201.5	074.5	-235	SM	BG	PAL	CIRCULAR HUT- ONLY FLINT TOOLS
BDSUR77-15	201.4	072.8	-240	SM	CS	PAL	
BDSUR77-8	202.1	070.6	-240	SM	CS	PAL	
BDSUR77-16	201.3	073.0	-240	SM	CS	PAL	ALSO BYZ.
BDSUR77-6	199.0	072.4	-260	SM	CS	PAL	
BDSUR77-7	201.7	070.1	-260	SM	CS	PAL	
BDTWNSHIP2	199.5	072.1	-330	SM	CS	PAL	LARGE COLLECTION(92) FLINTS
NUMSUR19	201.0	056.5	-150	SM	RG	UD	SMALL, 9M. DIAM CIRCLE
NUMSUR29	202.1	066.5	-200	SM	RG	UD	13 M. DIAM. RING ENCLOSURE
NUMSUR14	201.4	062.1	-220	SM	RG	UD	COMPLETE RING STRUC. OUTER, INNER, ROOF
SGNAS17	196.8	044.9	-240	SM	CM	UD	UD, CAIRNS, CAMPSITE
NUMSUR31	201.8	066.3	-250	LG	CS	UD	RINGS, CRUDE WALLS, MANY LITHIC, NEOLITHIC?
SGNAS19	196.4	043.8	-270	SM	CS	UD	MIDDEN, NO OBJECTS
SGNAS22	196.3	044.4	-285	SM	CS	UD	UD, SMALL CLEARING, NO OBJECTS
SGNAS68A-C	195.7	040.3	-290	SM	TO	UD	SERIES OF GRAVES, SOME CAIRNS
SGNAS64	196.7	047.8	-290	SM	CS	UD	CAMPSITE
SGNAS81	196.7	048.6	-310	SM	AQ	UD	CONDUIT REMNANTS, 100 M. AREA
SGNAS63	196.6	047.9	-310	SM	TO	UD	ROCK PILES, GRAVES, 20 X 10 M.
SGNAS26	196.0	044.9	-320	SM	TO	UD	EB? A TOMB, FIVE OTHER TOMBS LOCATED NEARBY
SGNAS25	195.9	044.6	-320	SM	CS	UD	GRAVES, OVEN, HOUSE, SHERD SCATTER
SGNAS8	195.2	043.2	-330	ME	CM	UD	UD, GRAVES OVER LARGE AREA, NO OBJECTS
BIRKETL2	199.6	070.2	-380	LG	BI	UD	MAN MADE WATER TANK, ANCIENT BUT REFUBISHED

Table 1. cont.

NAME	PGE	PGN	ELV	SZ	TP	OCC	OTHER
SGNAS5	196.5	047.1	-270	SM	CS	MOD	BEDOUIN, IR1A, NAB, MAM
SGNAS70	195.7	040.5	-270	SM	CS	MOD	
SGNAS59	194.8	048.5	-355	SM	FM	MOD	3 ROOM FARM HOUSE, 25 X 6 M.
NUMSUR20	201.5	065.2	-290	SM	BG	OTT	ENCLOSURE WALL, VAT, STONE HOUSE, MAM ALSO
EL-QASR	200.1	077.3	-350	SM	TR	OTT	SHERDS FROM LOWER SLOPES-IRON, ROM, OTT
ISALF3-3	201.5	066.5	-290	ME	MD	MAM	90 X 30M. MOUND, MOD TOMBS ON TOP, LROM-BYZ, IRII SHERDS
T.SUKKAR2	200.1	073.6	-300	LG	VI	MAM	SOME EB, LARGEST MAMLUK, BYZ
QAL'AT HAD	201.2	078.0	-309	ME	BG	MAM	TO EAST OF POLICE POST, BYZ, OTT ALSO
T.SUKKARI	195.3	047.9	-330	ME	SM	MAM	
BDSUR77-12	198.8	073.6	-340	SM	CS	MAM	
SGNAS1	195.3	047.6	-340	SM	SM	MAM	EB2-3(?), NAB, BYZ, LBYZ-UM, LABB/FAT, MOD
el-HADITHA	201.1	077.8	-340	LG	VI	MAM	SOME BRONZE, MORE BYZ, OTTOMAN
QASRFAYFA	192.3	039.1	-350	LG	MD	MAM	SOME BYZ, MOSTLY OTT TO MAM. MILL STONE
SHEIKH'ISA	195.1	048.0	-350	LG	VI	MAM	EB, NAB, ROM/NAB, LATE BYZ, FATIMID
NUMSUR5	199.8	060.3	-360	LG	MD	MAM	WEST OF RUJM, SOME NAB, BYZ, UMM, ASH, STONE
SGNAS77	194.9	038.4	-270	SM	AQ	ISL	EB, UD, 2 SQ. BLDS, AQUEDUCT
SGNAS58	194.9	048.8	-355	SM	CS	ISL	UD., SHERD SCATTER
BIRKET,L1	197.1	073.9	-360	LG	BI	ISL	WATER TANK FOR ISLAMIC PILGRIMAGE
AL-RUJOUM	194.9	049.9	-370	LG	MD	ISL	MOUND + CEM., 100 X 200 M. ROM? ABB, FAT, AYY, MAM
ALTHIAHEM	196.2	051.3	-375	SM	BG	ISL	FARM BLDG. 21 X 6 M., UD, PROB. ISL.
SGNAS74	197.3	039.4	-200	SM	FM	BYZ	SOME ROCK ALIGNMENTS
SGNAS18	196.8	044.4	-260	SM	CS	BYZ	HEARTH, STONELINES
ISALF3-2	201.6	066.8	-275	SM	TR	BYZ	IRON II, LATE ROM -16 M.SQ
NUMSUR27	201.5	066.8	-280	SM	MD	BYZ	STONE BLDG. 15 X 8 M., NAB, LR, MAM REBUILT
AIN-ABATA	197.9	052.8	-290	LG	CH	BYZ	MON. CH. HAB, ROM, UMM?, ABB, OTT, UD
SGNAS7	196.9	047.4	-300	SM	CV	BYZ	BYZ HERMITAGE, ROCK-CUT CHAMBERS, CISTERN
ISALF3-1	201.6	067.0	-300	SM	BI	BYZ	35 X 35 M. WALLS, 3 M. HIGH, 2.5 M. THICK, STYLE BYZ
ISALF3-4	201.5	066.4	-300	SM	TR	BYZ	EARLY ROM TO LATE BYZ. TOWER 22 X 12 M.
FEIFA WEST	193.3	038.8	-310	ME	CS	BYZ	ALSO EB/IRON--PLOWED FIELD, MASONRY, SHERD
NUMSUR4	200.2	059.7	-320	MD	VI	BYZ	BETWEEN TOWN AND RUJM BYZ, UMM, MAM REBUILT
QASRETTUBA	195.3	047.9	-320	ME	TR	BYZ	SHERDS NO LATER THAN POST-UMMAYYAD
BDSUR77-14	199.2	073.2	-330	SM	CS	BYZ	ALSO ROMAN, SOME EB?
BDSUR77-13	199.3	073.4	-330	SM	CS	BYZ	
SGNAS61	197.2	049.9	-335	SM	BG	BYZ	ISL, UD, 2 STRUCTURES, GRAVES NEARBY
AINSIKKIN3	200.6	075.8	-340	LG	BG	BYZ	MUTRABA EAST AND WEST, NAB, ROM, ARABIC
DYKE,LISAN	195.5	073.5	-340	LG	DM	BYZ	100 M. LONG RAISED CAUSEWAY OR DYKE
SGNAS65	194.9	048.4	-350	SM	CS	BYZ	ISL, UD SHERD SCATTER, 15 X 10 M. AREA
SGNAS66	195.0	047.5	-355	SM	CS	BYZ	NAB, ROM, UM, ABB, ISL, MOD. SHERD SCATTER
DEIR,LISAN	196.1	075.2	-360	SM	BG	BYZ	RUINS OF MONSTERY/HERMITAGE
BIRKETSAFI	194.9	049.5	-360	ME	BI	BYZ	FEW SHERDS BYZ, MAM, 60 M. SQ., CUT STONE
ISALKINGII	201.2	066.1	-370	SM	MD	BYZ	SOME MAM, 2 UMM, 1 FAT, SOME IRON I
ISALKINGI	201.0	066.1	-380	SM	TR	BYZ	SOME LATE ISLAMIC, FALLEN MASS SANDSTONE
BILAYDA I	204.5	076.5	-60	ME	BG	ROM	ROM/NAB, BYZ, ISL, MANY GRAVES
NUMSUR30	202.1	066.1	-180	SM	RD	ROM	LROM/BYZ/ ISL/ ROMAN ROAD
SGNAS24	196.3	043.0	-255	SM	CS	ROM	POTBUST
SGNAS23	196.3	043.9	-290	SM	CS	ROM	CAMP, GRAVE, STONE LINES
FEIFATELW	193.6	038.9	-306	SM	TR	ROM	ROM/NAB/BYZ/ OTTOMAN TO MAMLUK
T.SUKKAR2W	199.6	073.6	-320	ME	VI	ROM	ROM/BYZ, LOW MOUND, SOME NAB, ISL, EB
KH.el QUNE	201.9	082.3	-385	SM	BG	ROM	21 X 50 M. BUILDING, ER, LR
ER-RISHI 2	206.0	075.4	-140	SM	BG	NAB	BLDG. 30 X 25 M., ALSO TOWER ER/LR/BYZ
NUMSUR23	202.0	062.3	-150	SM	RG	NAB	RING 5 M. IN DIAM. LATER SHERDS ALSO
ET TAWABIN	196.9	046.7	-165	LG	WA	NAB	ROM/NAB (MOST), BYZ, POST UMM, MAM. TOWERS
NUMSUR9	201.0	062.1	-270	SM	CS	NAB	WATCH STATION? SMALL PILE OF STONES
RUJMNUMEIR	199.9	059.8	-355	SM	TR	NAB	NABATEAN WATCH TOWER, DAMS TO N. AND W.
NUMSUR26	200.9	066.6	-355	ME	MD	NAB	ER/BYZ/ UMM TO MAM, ASH, BLDG. FOUDATIONS
NUMSUR25	200.8	066.6	-360	SM	TR	NAB	EARLY ROM. LOW MOUND, BLDG., 5 COURSE
NUMSUR15	200.2	058.6	-390	LG	CS	NAB	HELLENISTIC? ASH, SHERDS
SGNAS60	196.6	039.5	-200	SM	CS	IR	BYZ, UD SHERD SCATTER, 20 X 20 M. AREA
SGNAS62	196.5	048.9	-315	SM	CM	IR	6 ROCK BUILT TOMBS, 50 X 20 M. AREA, OTT
SGNAS71	196.6	039.5	-210	SM	CS	IR1	EB, UD, SHERD SCATT., POTBUST?, 10 X 6 M. AREA
UMJUFNA	198.5	039.4	-180	SM	TR	IR2	HELL. TOWER 15 M. IN DIAM
SGNAS72	196.8	039.4	-190	SM	CS	IR2	NAB, TOMB, SHERD SCAT.
SGNAS69	195.6	040.5	-270	SM	TO	IR2	2 GRAVES, TOWER, 20X10 M.
KH.KHANAZI	191.5	033.8	-270	ME	WA	IR2	ALSO EB? NAB/ROM, BYZ
FEIFA-TELE	193.6	038.9	-300	ME	WA	IR2	WALLED AREA IRON
QASR UMRUQ	194.3	035.8	-320	SM	TR	IR2	POSSIBLE, ALSO ROM/BYZ, BYZ, MANY POST-UM
NUMSUR6	200.3	059.5	-345	SM	BG	IR?	DATE UNCERTAIN, ALSO HAS STONE CIRCLES
DHRAWAIDHA	205.2	072.3	-30	ME	CU	EB	HIGH PLACE WITH LONG WALL OR STAIRCASE

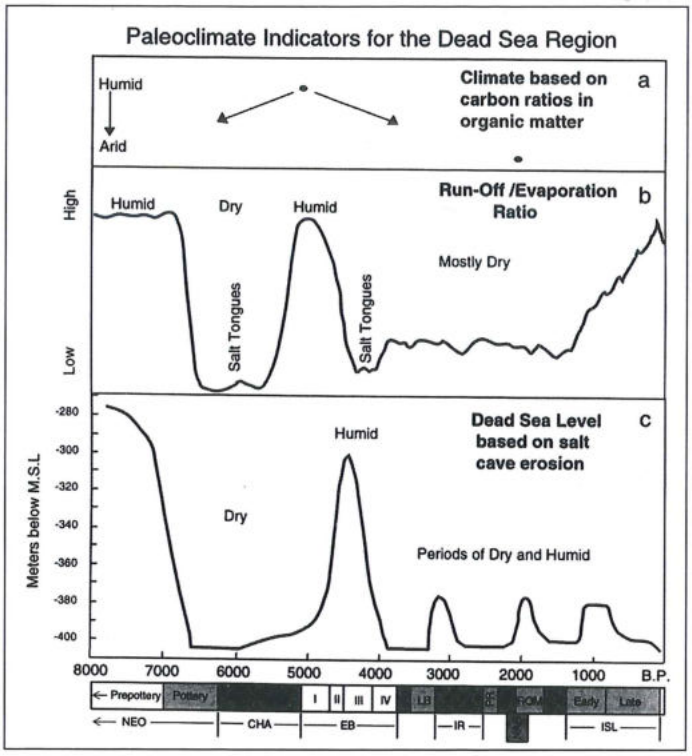


1. Georeferenced Landsat Quarterscene (1984) of the Dead Sea region. Achromatic Greyscale image was produced using bands 2,3,4, and 5.

located immediately north of Bāb adh-Dhrā', an-Numayra situated just north of an-Numayra and al-Ḥasa which occurs adjacent to aṣ-Ṣāfī.

B. *Estimates of Past Dead Sea Levels.*
Three different estimates of changes in the Dead Sea climate are presented in FIG. 2. Both BP and the cultural sequence are shown along the bottom horizontal axis with the calendrical time scale for the latter reflecting calibrated Radio Carbon dates.

FIG. 2a (Margaritz *et al.*1991) is based on carbon ratios in organic matter with only four rather widely spaced data points. This suggests the most humid conditions during Early Bronze I. More arid conditions occur during the Early Chalcolithic and Middle Bronze periods while the most arid conditions happen during the Hellenistic/Nabatean periods. Only four data points are used in this proposal making it too generalized to provid-



2. a) Cilate aridity based on 12C/13C rations in organic matter collected from cores in alluvial sediments of the western shore of the Dead Sea (adapted from Margaritz *et. al.* 1991). b) Cilamte aridity based on run-off of clastic versus precipitated (salt) material found in the south basin of the Dead Sea (adapted from Neev and Emery 1967). c) Dead Sea level based on salt cave development in the diapir of Mount Sedom, Israel(adapted from Frumkin *et. al.* 1991).

ed good estimates.

FIG. 2b (Neev and Emery 1967) is based on a run-off evaporation ratio estimate derived in part on dated sediments and sedimentary rock units during their study of the Dead Sea. The figure presents their estimates of humidity in the Dead Sea valley over the last 8000 years. They suggest humid conditions during Neolithic, Early Bronze and Islamic Ages, with relatively arid conditions during the other cultural periods.

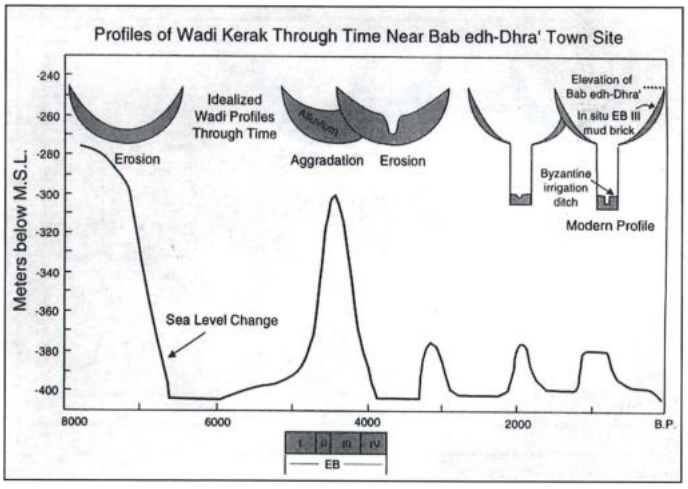
In FIG. 2c (Frumkin *et. al.* 1991) the Dead Sea level curve is based on the morphology of well-dated salt caves located in the subsurface of Jabal Usdum on the south west shore of the Dead Sea. Thirty two Carbon 14 dates, with treering calibration, were used in the study including eight for the Early Bronze Age. This is a quantitative curve with the highest sea level stand (-280 m bsl) during the Neolithic period. The next highest stand (-300 m bsl) occurs in the first half of the Early Bronze Age. The BP dates range from 4580 +90 to 4050 +75 and the corresponding adjusted calendrical dates are 3350 (+450,-150) BCE to 2590 (+390, -270) BCE. The widest cave width is dated by a wood sample to 2930 +180,-160, ranging from 3110 to 2730 BCE. It is important to note that both the rise and fall of the Dead Sea to and from -300 mm was quite rapid. Three lower high stands (-380 bsl) occur in Iron I, Nabataean/ Roman and Early Islamic periods. The Frumkin hypothesis estimates rather rapid changes in the Dead Sea level in all cases.

C. *Geomorphological Studies at Bāb adh-Dhrā' and an-Numayra.*

Extensive and detailed field work at the Early Bronze Age sites of Bāb adh-Dhrā' and an-Numayra and their adjacent wadis demonstrates a consistent pattern of erosion, deposition and then rapid erosion at both the sites and wadis. Additional field studies at two additional Early Bronze sites, Feifeh and al-Khanazīr, further south in the al-Ghawr, document the same sequence of events.

The wadi profiles in FIG. 3 illustrate the proposed relationship between the development of Wādī al-Karak and the changes in the Dead Sea level proposed by Frumkin, *et al.* (1991; see also Frumkin 1994). During the Neolithic period, a stable high stand of the Dead Sea and resultant slow erosion caused the gentle bowl-shaped profile for the upper half of the Wādī al-Karak. The low stand during Chalcolithic and EBI undoubtedly caused some rapid downcutting in the Wādī al-Karak and at Bāb adh-Dhrā' but no record of that is preserved.

The middle profile corresponds to Early Bronze II-III, during which there is a rising Dead Sea level and a corresponding rise in the base level for the Wādī al-Karak and even more so, its tributaries. Aggradation or deposition of sediments occurred during this period. This is quite obvious within the interior of the site of Bāb adh-Dhrā' where active sedimentation caused development of cultural feature sequence up to more than three meters in thickness. Finally the rapid drop in the Dead Sea level during EB IV caused extensive erosion, particularly within the two tributaries of Wādī al-Karak which breach the interior of Bāb adh-Dhrā'. This erosion also removed most of the northern portion of the stone and mudbrick wall line which originally encircled the site. The subse-



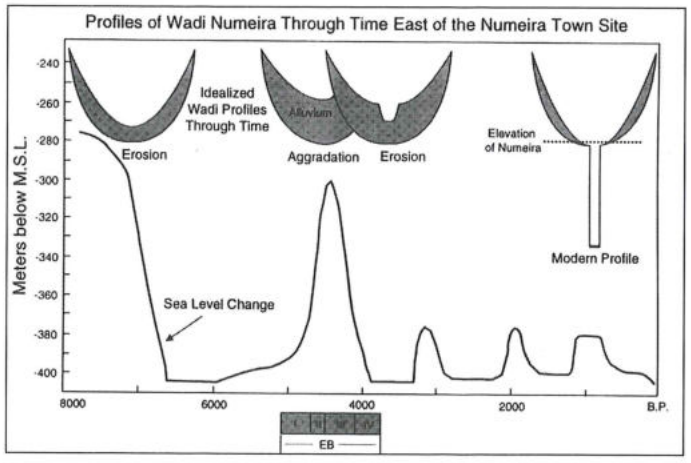
3. Realtionship of idealized profiles of Wādī al-Karak through time (adapted from Donhaue 1985) and the changes in the Dead Sea level (adapted from Frumkin *et. al.* 1991). Extrapolation of profiles back through time was determined from cultural material found within the wadis, and erosional and depositional features found at Bāb adh-Dhrā'.

quent downcutting of the Wādī al-Karak, is reflected in the steep sides (diagrammatic) of the lower, narrow, vertically sided "stem" on the third profile.

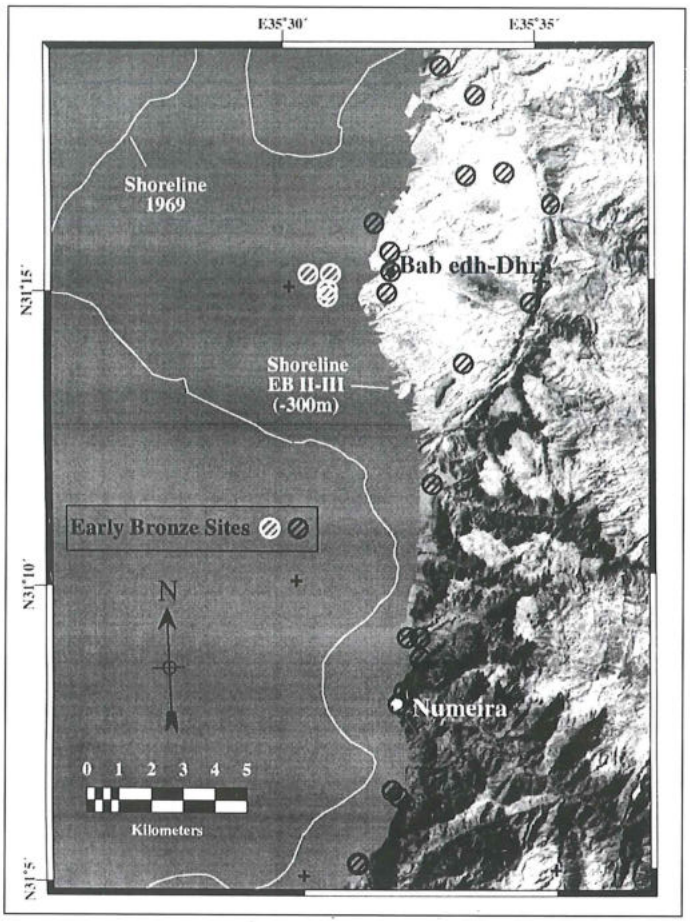
FIG. 4 compares the Wādī an-Numayra profile with the Frumkin (1991) Dead Sea level curve. The periods of erosion at an-Numayra were more extensive than at Bāb adh-Dhrā'. Both the upper bowl-shaped profile and the lower "stem" are narrower and deeper than within the Wādī al-Karak profile at Bāb adh-Dhrā'. The Early Bronze site an-Numayra is quite small while the stream emerging from the narrow, deeply entrenched Wādī an-Numayra has apparently eroded a large volume of sediment from a previously more extensive alluvial fan terrace. There is a distinct possibility that the Early Bronze III site of an-Numayra was far larger than the erosional remnant which remains preserved today. In contrast to Bāb adh-Dhrā', there is no indication of sediment deposition at the preserved remnant of an-Numayra during EB III. The differences between Bāb adh-Dhrā' and an-Numayra may have been caused by less fault movement in the area of the al-Lisān Peninsula where Bāb adh-Dhrā', is located and more movement along the South basin of the Dead Sea where an-Numayra is located. Additional field work and data analysis will be necessary to confirm or deny this hypothesis.

D. *Reconstructed EB II-III Shoreline*

FIG. 5 shows the proposed location of the Dead Sea shore line during EB II-III, assuming that Frumkin's (1991) interpretation of salt cave data from Jabal Usdum is correct. The 100 m rise in the Dead Sea level would place the shore much closer to Bāb adh-Dhrā' and an-Numayra. Both sites have a steep slope on their western edge which strongly resembles a wave-cut bluff generated during an Early Bronze III high Dead Sea level stand. The 1969 shore line for the Dead Sea which outlines the al-Lisān Peninsula is also given in the figure. The Early Bronze sites located in the area of the submerged al-Lisān Peninsula just west of Bāb adh-Dhrā' documented during a 1977 survey (BDSUR77-17,18,19,20 in TABLE 1), appear to challenge this hypothesis. A check of the field notes, however, reveals that two of the sites had only EB I tomb pottery (before the high stand of the Dead Sea) and all four were located on the western edge of the alluvial fan in recent erosional cuts and not on top of the alluvial fan.



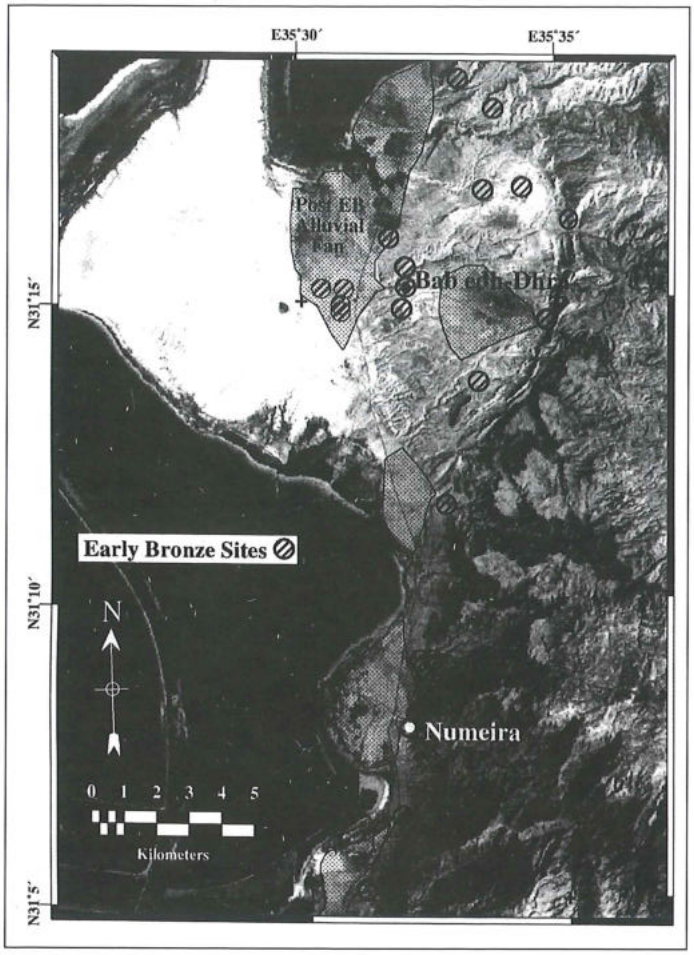
4. Realtionship of idealized profiles of Wādī an-Numayra through time (adapted from Donhaue 1985) and the changes in the Dead Sea level (adapted from Frumkin *et. al.* 1991). Extrapolation of the profiles back through time was determined from cultural material found within the wadis, and erosional and depositional features found at an-Numayra.



5. Reconstruction of the Dead Sea highstand during late EB II and EB III . EB sites represented by light grey circles are EBI sites which would have been occupied before the highstand.

Post EB III.

The dotted areas on the satellite image (FIG. 6) show positions where post-Early Bronze III alluvial fan deposition occurred. All of these fans are distinctly different in appearance (color and texture) from the older fans on which Bāb adh-Dhrā' and an-Numayra are situated. The fans immediately west of Bāb adh-Dhrā' and an-Numayra may be interpreted as post EB II-III alluvial fans caused by the down gradient deposition of sediments derived from the down-cutting of the wadis and some erosion of the two sites. If the interpretation is correct, the sediments should contain transported and redeposited cultural materials.



6. Location of post EB alluvial fans and EB sites. EB I sites emphasized in FIG. 5 are beneath the post-EB Alluvial fan.

Settlement Patterns and Changing Shorelines.

A comparative study of the basic settlement patterns along the south-east shore of the Dead Sea during the major historical periods reveals no major inconsistencies with the hypothesis of Frumkin. In fact, when the corrected calendrical BCE dates are used, the settlement patterns of occupational sites correlate well with the proposed changing shorelines.

Since 1973, a series of intensive and extensive surveys have built up an impressive data base of sites for the south-east Dead Sea area (see TABLE 1). Rast and Schaub (1974) highlighted the Early Bronze Age and King (1987) the Byzantine and later periods over the entire area. Raikes (1980) concentrated on earlier sites. Others have focused on sub-regions, McCreery (1978-79, 1979), Clark (1978), McConaughy (1981) on the Sahl adh-Dhrā' region, Mittmann (1982) and Jacobs (1983) the Wādī Isal, Koucky (1983) the Ghawr an-Numayra, Worschech (1985a,b;1986) the Ard-al Karak and MacDonald (1992) the Southern Ghors, south of aṣ-Ṣāfī.

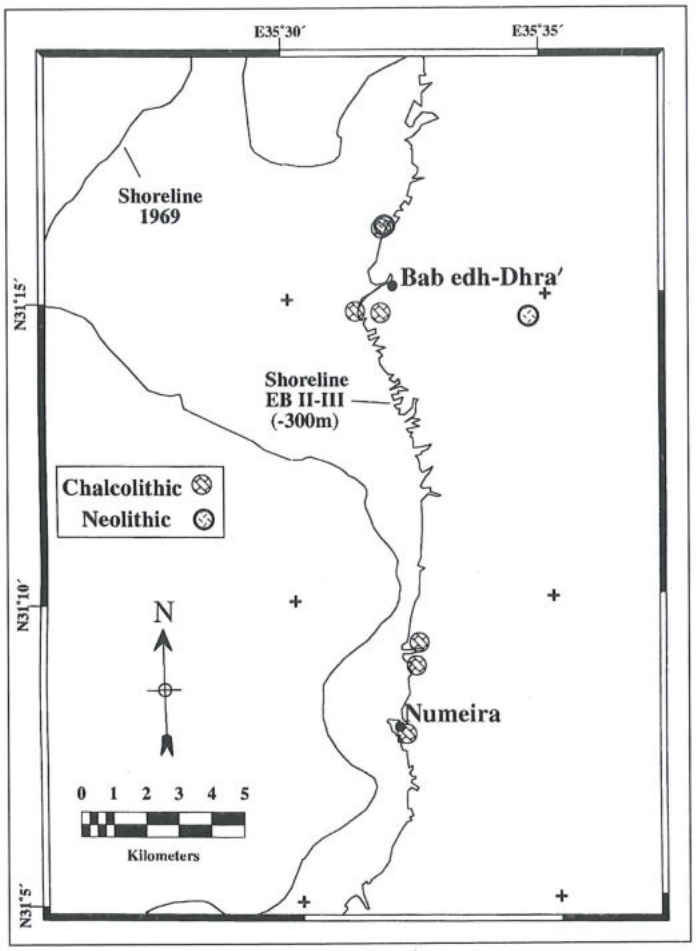
Excavated sites include Bāb adh-Dhrā' (Lapp 1966, 1968; Schaub and Rast 1989), Bāb adh-Dhrā' and an-Numayra (Rast and Schaub, 1981; Schaub and Rast, 1984; Schaub 1993), Feifa and al-Khanāzīr by the "Expedition to the South-east Dead Sea Plain" (EDSP) in 1989-90, Waidha, near adh-Dhrā' (Korber 1993), Bāb adh-Dhrā' Chalcolithic cemetery (Clark 1979), adh Dhrā Neolithic (Bennett 1980) and 'Ain 'Abata (Politis 1989, 1990, 1992.

The sites in TABLE 1 are listed in sequence by major occupational period (MOD, OTT, MAM etc.) and within each period by decreasing elevation. Only those sites below sea level in this area are included in the Table. Site size is indicated in the table by the terms LG, ME, or SM. Apart from the excavated sites most of the size designations are relative estimates lacking quantitative precision but they do offer some relative sense of the extent of observed ruins. There are actually few "large" sites in the south-east al-Ghawr Bāb adh-Dhrā' with a walled town area of 12 acres and a large cemetery area of over 120 acres is the largest for the earlier periods.

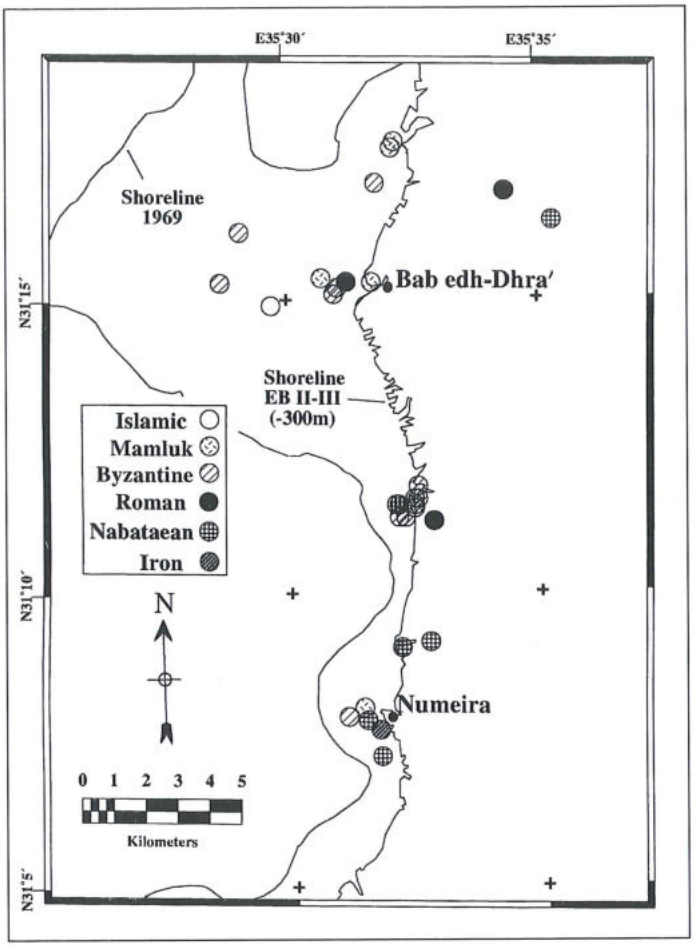
The Palestine Grid coordinates and elevation data listed in TABLE 1 are based, for the most part, on published data from the surveys and excavations listed above. Some unpublished sites from surveys (Koucky 1983 and McCreery 1979) are also included. Most of these surveys used 1:50,000 and 1:10,000 scale topographic maps (see the data in MacDonald 1992: 9). In some instances we have corrected the published data using 1:2500 scale maps provided by the Jordan Valley Authority. In these cases the information varies from that listed in the Jordan Antiquities Database and Information System (JADIS) (Palumbo 1994). Some sites listed in JADIS for the different chronological periods have not been included in this data base because the evidence recorded by the surveys appears inconsequential (a "potbust" or a few body sherds).

The settlement pattern maps (FIGS. 5,7,8) are based on the available satellite data north of the aṣ-Ṣāfī region and are intended to show the impact of changing shorelines on the settlement patterns along the southeastern coast. In general, sites for the earlier periods, the Early Bronze Age, (with the exceptions of the BDSUR 17-20 sites, discussed above), and the Neolithic and Chalcolithic are above the -300 m while the majority of sites for the Byzantine, Mamluk and Islamic periods are below -300m bsl (See also TABLE 1).

The easternmost Neolithic site in FIG. 7 is a flint factory site in the Sahl adh-Dhrā' dated to Pottery Neolithic A. Similar levels were also exposed by the EDSP in the plateau area east of Tall Feifa in the south, also at higher elevations, which could reflect the high stand for the Dead Sea in Frumkins's hypothesis. For the Chalcolithic period both cemeteries (excavated) and settlements (unexcavated) are attested. In the Sahl adh-Dhrā' 17 tombs, constructed of concentric stone circles with monolithic stones in the center, were assigned to the early Chalcolithic period. Similar sites occur all along the slopes and plateaus of the hills from Bāb adh-Dhrā' to aṣ-Ṣāfī. Surveys describe a possible habitation site near the



7. Location of Neolithic (pottery stage) and Chalcolithic sites.



7. Location of Iron through Islamic Age sites.

'Ayn Sikkin spring above Mazra'a, three in the an-Numayra area, and several south of the Wādi Feifa. All of these sites are near or to the east of the -300 m. bsl contour. In Frumkin's hypothesis the Chalcolithic period was dry and the level of the Dead Sea was around -400 m bsl If the hypothesis is correct there could be Chalcolithic sites buried below the later alluvial fans at Bāb adh-Dhrā' and an-Numayra.

The Early Bronze Age represents the first extensive occupation in the southern Ghawr with 32 sites reported although many of these are small (FIG. 5 and TABLE 1). The major occupational sites during EB II-III, the projected high stand of the Dead Sea, are above the -300 m bsl contour and concentrated in the north, including the excavated walled towns of Bāb adh-Dhrā', an-Numayra and a third site, ar-Rīshi, situated on the northern bank of the Wādī al-Karak as it exits from the mountains. Both Feifa and aṣ-Ṣafī have large EB I cemeteries and the southernmost site al-Khanāzīr is a cemetery from the EB IV period.

The one Iron Age site in FIG. 8, near an-Numayra, represents the remnants of a building found during a survey (NUMSUR6) with a question mark on the dating evidence. Two possible Iron II tower sites not on the map, nor listed in TABLE 1, have been noted in the Wādī Isal (Palumbo, JADIS, 2006.099, 2006.104) and at al-Qaṣr above al-Mazra'a (Palumbo, JADIS, 2007.104). All of the Iron Age sites are above the -370 m. bsl high stand level for this period in Frumkin's hypothesis (see FIG. 2c).

Evidence for Middle and Late Bronze age occupation has been rarely recorded in the Southeast ghors. Nine cairn tombs with MB/LB pottery near the Byzantine site of 'Ayn 'Abāṭa were observed recently by Politis (1993).

The location of Nabataean through Islamic sites are also indicated on FIG. 8. Small Nabataean towers guarded the Wādī al-Karak (ar-Rīshi 2) and the Wādī an-Numayra (Rujm an-Numayra). The an-Numayra region has several additional sites including a medium-sized settlement mound with Nabataean and later remains and a possible large camp area (Hellenistic?) at a level below the high stand of -375 m bsl. for this period in Frumkin's hypothesis. The largest Nabataean site in the area is Umm aṭ-Ṭawābīn, located in the south and not indicated in FIG. 8. It is a walled site (2.5 km in circumference) built on a high ledge on the south bank of the Wādī al-Ḥasa. There is a large tower at the south-east corner and many structures, large and small, visible within the enclosure wall.

The Byzantine period has the largest number of sites from after the Early Bronze Age. Several seasons of sur-

vey and excavations at the Byzantine site of Dayr 'Ayn 'Abāṭa, north of aṣ-Ṣafi, have revealed an impressive reservoir with water catchment and distribution system, and a religious building with mosaic pavement. Surveys have recorded other Byzantine cultural remains throughout the area. In the aṣ-Ṣafi area, a large pottery scatter south-west of Ṭawāhīn as-Sukkar, the shrinking mudbrick ruins of the nearby Qaṣr aṭ-Ṭuba, and a large reservoir or *birka*, 60 sq. m, further north, have been interpreted as Byzantine by King.

In the north a large Byzantine complex with several buildings is located near the 'Ayn as-Sikkin spring. Two kilometers to the west Buleida has tombs and a settlement. Both of these sites also have Nabataean and Roman remains. Other Byzantine sites include two on the al-Lisān, a dike and a mud-brick hermitage, Qaṣr aṭ-Ṭūba, and several in the Wādī Isal, including a large *birka*, 35 x 35 m, several towers and a possible settlement mound. Many of the Byzantine sites, especially those on the al-Lisān are located at lower levels which corresponds to a low level of the Dead Sea according to Frumkin's hypothesis.

Arab geographers generally describe the southern al-Ghawr as flourishing during the Mamluk period (Le Strange 1965). Although only ten archaeological sites are listed as primarily Mamluk, seven of these are large or medium (TABLE 1, FIG.8). The major Mamluk sites are al-Ḥaditha and Ṭawāhīn as-Sukkar 2 in the Ghawr al-Mazra'a, a mound west of Rujm an-Numayra (NUM-SUR5)in the Ghawr an-Numayra, Al-Rujūm, Shaykh'Isa and Ṭawāhīn as-Sukkar 1 in the aṣ-Sāfi region and Qaṣr Feifa. According to Frumkin's theory there is a high stage of the Dead sea in the early part of the second Millennium followed by a low stage. All of the Mamluk sites, dated from the mid-12th to the 16th century are located at lower levels.

Summary

The hypothesis of Frumkin on changing Dead Sea levels of the past that we have examined holds its own in the light of the evidence examined from survey, excavation, geomorphological fields studies and comparison of settlement patterns. The geomorphological studies of the wadi profiles coordinated with excavation of the sites of Bāb adh-Dhrā' and an-Numayra certainly correlate well with the theory. A survey of the settlement patterns of the various cultural periods does not yield any major obstacles to the hypothesis. The study of the satellite images did not reveal traces of ancient shore lines but the outlines of recent alluvial fans show up clearly on these images.

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Intrasite Spatial Analysis and the Settlement History of Mādabā

In the modern Middle East, with its long history of urbanism, the consequences of urban continuity present a daunting challenge to archaeological research. Since the priorities that usually guide settlement, such as defensibility, access to routes of communication, and proximity to water and other resources, have changed little over the millennia, the settlement landscape is dominated by sites with long occupational sequences, that sustain—more often than not—modern living communities still today. The stratigraphic succession created by such prolonged settlement activity, of course, is exceedingly complex; a reality compounded by the destructive forces presumed to be an inescapable part of modern development, and all too often sufficient motivation to send prospective projects looking elsewhere for research opportunities. Yet, contrary to this general perception, research conducted in dense urban contexts has consistently found that urban settings are in fact surprisingly good preservers of the archaeological record (Staski 1982: 117-19; see also Salwen 1973; 1978; and Staski 1987). It would seem then, that the ancient urban cores that typically anchor modern Middle Eastern towns and cities deserve a closer look, particularly in those cases where it is clear that the existing city preserves a history central to understanding patterns of sociocultural and economic development for a broader region.

The modern city of Mādabā , located 30 km southwest of 'Ammān amidst fertile rolling plains on the Central Jordanian Plateau, provides just such an opportunity. Continuing an urban tradition of some 4,500 years, the modern town engulfs the ancient settlement that still forms a visible rise in the town center. A growing realization, in the wake of extensive clearing efforts in the 1970s and 1980s, that many of Mādabā's beautiful mosaic treasures faced critical preservation needs finally led, in 1991, to the creation of a program to train skilled local mosaic conservators (Piccirillo 1991). Largely as a result of this impetus, a long-term joint project was conceived between the Ministry of Tourism of Jordan and the United States Agency for International Development (USAID) to preserve the rich cultural heritage of Mādabā (see reports in Bikai forthcoming). Towards this end, in 1993, the author was invited to conduct an intensive and systematic survey of the town in order to assess and document the current state of its existing cultural resources (Harrison, forthcoming b). An important component of this effort involved the systematic collection of surface sherds for the purpose of reconstructing a broad outline of the town's settlement history; an objective that the present paper seeks to accomplish.

Survey Methodology

For an understanding of the archaeological remains to be successful, the survey and sampling methods used in obtaining such a record must be appropriate for an urban context. Archaeologists have long assumed, whether implicitly or explicitly, that some relationship exists between the cultural debris found lying on the surface of a site and that which remains buried below (Redman and Watson 1970: 279). Attempts have been made to determine the sub-surface spatial dimensions of sites by documenting their above ground sherd density distributions, and then excavating to compare results,[1] including two studies conducted in the Mādabā region at the sites of Tall Jalūl (Ibach 1978) and Tall al-'Umayrī (Herr 1989). Among other things, these studies have found, upon excavation, that even in cases where surface patterns had been disturbed by erosion, gravity and modern activity, a general isomorphism still existed between sub-surface artifact distributions and what remained on the surface. Also, because of these disturbances, the probability that sophisticated sampling techniques would produce better results than a simple, systematic survey was not considered very high (Flannery 1976: 62; see also discussion in Lewarch and O'Brien 1981: 328-30).

Thus, in spite of the limitations caused by the presence of the modern town, there was good reason to believe that by intensively and systematically sherding the entire urban core of Mādabā, some sense of the sub-surface spatial dimensions of the site would be possible. Although the presence of the modern town would prevent unrestricted access to the ancient settlement, and preclude the use of random sampling methods, it was nevertheless clear from preliminary study, that a significant percentage

[1] In particular, see Binford, *et al.* 1970; Tolstoy and Fish 1975; Flannery 1976 Whallon 1980; Portugali 1982; and Cowgil, *et al.* 1984.

of the pre-modern town was accessible, and would repay an intensive and systematic sherd collection effort, with the constraints imposed by the layout of the modern town creating a randomness of its own.

Consequently, a simple grid system set at 50 m intervals [2] was devised utilizing a topographic relief map (1:1250 scale) to facilitate systematic collection over the entire survey universe, an area of approximately 40 ha (or 400,000 sq. m) encompassing the town's ancient urban core. The survey universe was determined through a careful study of nineteenth century traveler's descriptions, turn of the century aerial photographs and previous archaeological research. The survey was conducted over a 12-day period by a three-man team, with each 50 m square being searched for an average of one man hour.[3]

In all, 166 squares were surveyed, resulting in coverage of an area totaling 415,000 sq. m, or approximately 42 ha, with open and uninhabited space accounting for about 25% of this total.

Survey Results

A total of 8,524 sherds were collected in the course of the survey. After processing and a preliminary reading, 913 diagnostic sherds (or roughly 10% of the entire assemblage) were kept for further analysis, and the remaining material returned to the site. This preliminary reading of the pottery identified material from the Early Bronze Age, Iron Age, Persian/Hellenistic, Nabataean, Early Roman, Late Roman, Byzantine, Umayyad, Abbasid (?), Fatimid (?), Ayyubid/Mamluk, Ottoman and Modern periods. Subsequent analysis of the diagnostic collection largely confirmed the infield preliminary readings, and has resulted in an index of the site's occupational history. The pottery readings of each 50 m square grid unit were then entered into a database created for a computer-digitized map of the city of Mādabā,[4] making it possible to view graphically the spatial dimensions of each period of settlement, and to trace settlement pattern shifts as they occurred from period to period.

Before proceeding, a number of important clarifications must be made regarding the survey results. First, the spatial dimensions portrayed by the distribution maps should be viewed as a reflection of the presence or absence of ceramic remains from a period, and not that of density. Uneven collection due to the nature of the survey universe dictated that density, or frequency, distributions were tilted heavily toward exposed areas, and therefore inherently unreliable. Secondly, it should be kept in mind that uneven temporal divisions, for example the thousand years or more encompassed by the Early Bronze Age as compared to the few centuries covered by the Early Islamic period, tend to skew the settlement picture in favor of the longer periods represented, although the lengthier time spans of earlier periods are compensated for to some extent by the visibility they lose to the later periods that cover and conceal them. Thirdly, the settlement patterns presented here are tied to current understandings of the regional ceramic typological sequence, which continues to undergo refinement,[5] rendering spatial distinctions based on the ceramic record an ongoing affair.

Finally, the surface survey did not attempt to sherd areas that were currently under excavation, as access was difficult, and it was felt that the survey would not be able to add appreciably to what these excavations were uncovering. This means that almost the entire exposed stretch of the Roman cardo was left out of the survey, and full settlement information for this important area must await the final completion of excavations.

Broadly then, the distribution maps created for each period reveal, not surprisingly, that the town was confined to the area of the tall and acropolis during the Bronze and Iron Ages. Settlement then began to expand to the north during the Nabataean and Early Roman periods, reaching its greatest extent during the Late Roman and Byzantine periods, when the town sprawled over most of the survey area. Mādabā began to shrink in size during the Early Islamic period, reaching a low point (and possibly even becoming abandoned) some time in the mid-ninth or tenth century, with what remained of the town concentrated along the Roman cardo. There was little apparent settlement activity over the ensuing centuries, although the limited presence of Ayyubid/Mamluk and Ottoman period pottery indicates that some human activity did occur before the arrival of Christian refugees from al-Karak launched the modern resettlement of the town in 1881.

Documentary Sources

In order to place this broad settlement picture into better perspective, a review of the existing documentary sources is needed.[6] The earliest reference to Mādabā occurs in *Numbers* 21:30 as part of a lament describing the conquest of a series of Moabite cities, of which Mādabā (then known as *Medeba*) was one, by the Amorite King Sihon of Heshbon. Shortly thereafter, the tribes of Israel are credited with defeating Sihon and gaining control over his domain, so that in *Joshua* 13:9 and 16 we find *Medeba*,

2 By way of comparison, the mean area of the provenience units used in the mapping project of the huge prehistoric site of Teotihuacan (over 2000 ha in size) located in the central highlands of Mexico averaged 3600m^2 (Cowgill, *et al.* 1984: 156), while the area of the units used in our survey was 2500 m^2.

3 The results of the survey would not have been possible without the dedicated efforts of team members Adeeb Abu Shmeis of the Department of Antiquities and Usama Twal of the Mādabā Society. Thanks are also due to the Roman Road excavation team in Mādabā for the use of their facilities, to Dr Pierre Bikai and Branwen Denton of ACOR for their support, and to Dr Safwan Tell, former Director–General of the Department of Antiquities, for his help in obtaining a survey permit and facilitating the work of the survey. Funding for the survey was made possible by a grant from USAID.

4 A debt of gratitude is owed to Dr Patricia M. Bikai and Glen Peterman of ACOR for their work creating the computergenerated maps, and for seeing to it that I received copies which could be used in this study.

5 Some periods are in greater flux than others, as is the case with the latter part of the Early Islamic period, where considerable revision is currently underway. See in particular, Walmsley 1992 and Whitcomb 1992.

6 More thorough accounts of the documentary evidence concerning Mādabā can be found in Piccirillo 1989a: 316-22 and Harrison (forthcoming a).

and the surrounding tableland (or *Mishor),* being allotted to the tribe of Reuben. This strategically located tableland, with its agriculturally rich fields, would become a highly contested region over the ensuing centuries.

Sometime in the tenth century BC, the Israelite King David is said to have fought and won a pitched battle against a coalition of Aramaeans and Ammonites in the vicinity of Medeba, seizing control of the entire region as a result (*I Chronicles* 19:7ff; cf. *II Samuel* 10). According to the Moabite King Mesha, *Medeba* remained under Israelite control ("the house of Omri") until he took (lines 7-8 of the Mesha Inscription) and rebuilt it (line 30) along with a series of other cities on the tableland sometime during the mid-ninth century BC (either during or shortly after the reign of Ahab, the son of Omri). The region probably remained in Moabite hands until the end of the Iron Age. *Medeba* is listed with other Moabite cities in an oracle by *Isaiah* (15:2) forecasting the future devastation of Moab.

Medeba continued to play a role in regional conflicts during the Hellenistic period. The "sons of Jambri," apparently members of a Nabataean tribe (the Beni 'Amirat?) from *Medeba* (by then known as *Medaba*),[7] were accused of ambushing a passing Jewish caravan and killing John the brother of Judas Maccabeus (*I Maccabees* 9:35-42; cf. Josephus' *Antiquities of the Jews* 13.1.2 and 4) (ca. 160 BC). *Medaba* came into conflict again with the Maccabaeans (or Hasmonaeans), when in 129/28 BC, John Hyrcanus captured the town after a six-month siege in an effort to gain a foothold along the commercially important "King's Highway" (*Antiquities of the Jews* 13.9.1). *Medaba* remained under Hasmonaean control down through the reign of Alexander Jannaeus (103-76 BC) (*Antiquities of the Jews* 13.15.4). His successor, Hyrcanus II, then offered the town, along with eleven other Hasmonaean-held Transjordanian towns, to the Nabataean King Aretas III in return for his help in the civil war between Hyrcanus and his brother Aristobulus II (*Antiquities of the Jews*. 14.1.4).

Inscriptional evidence suggests that Mādabā remained within the Nabataean sphere of political influence until the region was incorporated into the Roman Province of Arabia *(Provincia Arabia)* in AD 106, following Trajan's defeat of the Nabataeans at Petra. By the second or third century AD the town was minting its own coins (Spijkerman 1978: 180-85). The recent discovery of an imperial inscription indicates that Mādabā also underwent physical expansion during this period (Piccirillo 1989b: 105-8). The inscription commemorates the erection of a city gate by the imperial legate Flavius Julianus in year 114, or AD 219/20, during the reign of Elagabalus.

Christianity gained an early foothold in the Mādabā region, and by the mid-fifth century, the Christian community had grown large enough to warrant the services of a bishop, a development revealed in the Acts of the Council of Chalcedon (AD 451). Although the town goes unmentioned in the literary sources for the remainder of the period, as the seat of a diocese, the town clearly continued to prosper, and over the succeeding two centuries (ca. sixth- seventh centuries AD) witnessed the construction of numerous churches and other public structures. It was during this period that the many mosaic pavements Mādabā is renowned for were laid, including the famous Map of Palestine.

Following the Islamic conquest and the establishment of the Umayyad Caliphate in the mid-seventh century, Mādabā continued to flourish. Renovations were carried out on a number of Byzantine churches, and the town remained the seat of a bishopric. In AD 719/20, a church was dedicated on the acropolis of the town of Mā'in, southwest of Mādabā (de Vaux 1938: 238-40). During the Early Abbasid period, mosaic dedicatory inscriptions from the Church of St. Stephen at Umm ar-Raṣaṣ mention the names of two bishops from the diocese of Mādabā Bishop Job in AD 756, and Bishop Sergius II in AD 785, when the church was completed (Piccirillo 1987: 180-86). Interestingly, however, in an episode also dating to the Early Abbasid period involving the pursuit of rebellious Umayyad partisans through the Mādabā Plain region, the town of Mādabā fails to receive any mention, in spite of specific references to the nearby towns of Ḥisbān, Masuh, Zīzyā' 'Ammān and Fudayn (?) (Grabar 1964).[8] References to Mādabā including inscriptions, cease entirely by the end of the eighth century, and the town is not referred to again until the early nineteenth century, when western explorers began traveling through the region. Mādabā escaped the attention of the medieval Arab geographers,[9] and does not appear in the tax records (*dafāter*) of the Early Ottoman period (Hütteroth and Abdulfattah 1977).

The Settlement History of Mādabā

When the survey results and documentary sources are combined, a complementary, more complete picture of Mādabā's settlement history emerges. As indicated by the survey, the earliest settlement at Mādabā seems to have occurred during the Early Bronze Age. This was followed apparently by a lengthy occupational gap corresponding to the Middle and Late Bronze Ages, although it is quite feasible that a small settlement existed which the survey simply missed.

7 Bowersock (1983:20) has questioned this Nabataean association, since they were reputed to be on good terms with Jonathan Maccabeus, and it would make little sense for them to attack their own allies. He suggests instead that the Jambri/ Amrai were but one of many nomadic Arab tribes moving in and out of Nabataean controlled territory during this perod. While he may well be right, the Jambri/ Amirat/ Amrai were nevertheless an undeniable presence in the Mādabā region for close to three centuries, receiving mention in a number of inscriptions up until the beginning of the second century AD, or roughly the period of Nabataean hegemony in the region. For more on the Beni 'Amirat, see Milik 1980.

8 D. Whitcomb deserves credit for drawing this reference to my attention.

9 It is particularly telling that Muqaddasi, who is known to have passed through the area in the tenth century (de Goeje, 1967: 54, 155, 173, 178-80, 186, 192 and 252), does not mention any town or site at all.

With the transition from the Late Bronze Age to the Iron Age, both the archaeological and documentary record come into play. Textual sources are unequivocal about the strategic importance of Mādabā and the surrounding tableland, which becomes the scene of a succession of power struggles for control of the region. The survey results, while not definitive, are supplemented by an excavated tomb that bridges the Late Bronze-Iron I transition (Harding and Isserlin 1953), and by the dramatic increase in settlement that occurs in the Mādabā region during this period (Ibach 1987: 160-63). In spite of periodic conflict and alternating political control, Mādabā clearly flourished over the course of the ensuing Iron II period. The surface sherd distribution indicates a site size approaching 13 ha or more, easily making Mādabā one of the largest Iron Age sites in all of highland Transjordan. A tomb dating to Iron I-Early Iron II meanwhile, represents the extent of excavated evidence so far uncovered at Mādabā from this period (Piccirillo 1275; Thompson 1984; 1986). By the end of the Iron Age, settlement intensification and political consolidation in central Transjordan had reached a peak (LaBianca 1990: 154-56; Herr 1992: 176-77; McGovern 1992: 181), and was configured into regionally defined cultural spheres centered around distinct political entities (LaBianca and Younker 1995), with Mādabā probably within the Moabite political realm.

As the textual sources indicate, Mādabā continued to play a prominent role in regional events during the Hellenistic period; a reality substantiated by inscriptional remains, but only limited evidence from the survey. Following an end to the political stability enforced by the Neo-Assyrians in the seventh century BC, and the collapse of the various Transjordanian nation-states in the sixth century BC, Mādabā went into an extended period of decline along with the rest of the region. The trend finally began to reverse itself during the latter part of the Hellenistic period, when powerful groups such as the Nabataeans and Hasmonaeans began reasserting political hegemony over large portions of the southern Levant, and vying for strategic control of vital commercial corridors. The Mādabā survey data reflects the renewed settlement activity generated by these developments, although subsequent expansion during the Roman and Byzantine periods probably obscures its full extent.

With the transfer of political power to Rome, and the administrative realignment of Transjordan into the Roman Province of Arabia in AD 106, Mādabā entered a period of even greater growth, as both the documentary sources and survey results attest, expanding to its largest extent ever. Spurred on by the political stability afforded under the "Pax Romana," the town experienced a prolonged period of economic prosperity, marked by the construction of public structures and the minting of its own currency. This prosperity continued under Byzantine rule, reaching its peak in the sixth and seventh centuries AD, when Mādabā was serviced by no less than eight churches.

Settlement patterns for the broader region mirror the developments in Mādabā. Regional site surveys reveal a widespread return to sedentism at the end of the Hellenistic period, a trend that continued into the Early Roman period (Ibach 1987: 168-74; LaBianca 1990: 168-73; see also Hart 1986: 54-55; Mattingly 1990: 317-24; and Graf 1992: 254-56). By the time of Roman annexation in AD 106, settlement density in much of the region had returned to levels comparable with those reached at the end of the Iron Age. The introduction of Roman military power, and formal integration into the Roman imperial realm, only intensified this ongoing sedentarization process, accelerating the region's transformation into a highly urbanized landscape. At the center of this resurgence were numerous newly founded or revitalized cities bearing distinctly classical, orthogonal layouts (Barghouti 1982; Will 1985), of which Mādabā seems to have been one, with its central cardo and flanking public structures. Settlement intensity persisted through the Late Roman and Byzantine periods, with extensive agricultural activity and rural development fueling productivity (LaBianca 1990: 184-87).

Towards the end of the sixth century however, a variety of factors, including persistent Sassanid attacks from the east, natural disasters and plagues, and a deteriorating imperial administrative system, converged to threaten the stability and economic prosperity the region had enjoyed for so long. Their cumulative effect is evident in the gradual onset of urban decline witnessed at many of the great urban centers in the east (Kennedy1985a; Liebeschuetz 1992). Yet all was not lost. Some areas continued to thrive, even as others fell into decline. Indeed, central Transjordan seems to have flourished in particular, including Mādabā and its surrounding hinterland. Thus, a more accurate depiction of developments during this transitional period might be one of urban change (Kennedy 1985b; 1989), rather than of decline, as one era came to an end and another began.

The arrival of Islam, and the establishment of the Umayyad Caliphate in Damascus, brought both change and continuity to the region, resulting in a hybrid culture that incorporated pre-existing institutions and new ones to form a remarkably heterogeneous society. However, the tranquillity of this "new age" was short-lived, and by the mid-eighth century political intrigue had successfully undermined the Umayyad regime and shifted the balance of power to the east. This precipitated a lengthy period of declining and contracting settlement throughout the Levant, which eventually stabilized into a rural settlement configuration that persisted until the Ayyubid/Mamluk period (Kennedy 1991; Walmsley 1992: 382).[10] In the

[10] This view of a decline in settlement should be distinguished from that of an outright occupational gap; a widespread assumpiton that has been rightfully challenged in recent years. As earlier, see Walmsley 1992 and Whitcomb 1992.

case of Mādabā this decline apparently was never fully reversed until the late nineteenth century arrival of the Christian settlers from al-Karak, as both the survey data and documentary sources attest.

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Ressources Naturelles et Occupation du Site de Pétra

Depuis 1978, nous avons conduit différentes recherches à Pétra et dans ses environs sur les ressources en eau et à caractère agricole, indispensables à l'établissement puis à l'expansion de la capitale du royaume nabatéen, telle qu'elle nous apparaît au travers du témoignage de Strabon et surtout de celui de ses vestiges matériels. C'est une partie des données obtenues à partir de nos travaux, que nous exposerons ici.[1]

Du point de vue de sa localisation géographique, le site de Pétra se situe dans une zone semi-aride où la moyenne annuelle des précipitations est d'environ 250 mm, avec quelques variations selon les secteurs envisagés. A cet égard on remarque que la région située au pied du Jibāl ash-Sharā, où les chutes de neige sont fréquentes en hiver, bénéficie de conditions plus favorables comme en témoigne son exploitation actuelle par les paysans venus des villages de Wādī Mūsā et de ash-Shawbak. Toutefois ces données climatiques doivent être interprétées en fonction de la topographie particulière du site. Celui-ci présente en effet un relief extrêmement accidenté, comprenant des hauteurs profondément entaillées par des wadis qui constituent à la fois un facteur de morcellement de l'espace en isolant les différents secteurs et un facteur d'organisation de ce même espace en servant de voies d'accès et de communication reliant notamment le centre du site aux divers faubourgs situés à la périphérie du site.

L'étendue de cet espace ainsi que sa division explique que le mode d'organisation de cet espace soit difficile à percevoir, notamment au niveau de l'habitat, ce qui a conduit certains chercheurs à privilégier l'étude de quelques secteurs sans relier ces recherches à une problématique plus vaste et à une vision d'ensemble du site. C'est pourquoi, puisque la disponibilité de ressources en eau constitue un facteur déterminant pour l'occupation d'un site, le recensement et l'étude des vestiges liés à l'alimentation en eau ainsi qu'à la conservation de celle-ci et à sa distribution constituent probablement la meilleure base de travail. Nous avons pu ainsi reconstituer le réseau de cet approvisionnement (FIG. 1) et déterminer la répartition des principales zones d'occupation du site en comparant notamment la concentration des installations à caractère hydrauliques avec la présence de salles rupestres ou de vestiges de constructions ma'onnées.[2] Le report des informations obtenues a été facilité grâce à l'utilisation de photos aériennes et de cartes provenant du relevé photogrammétrique effectué en 1975 par l'Institut Géographique National Français (IGN).[3]

Les hauteurs qui bordent le pourtour du site se situent à une altitude d'environ 1200 m. D'un accès souvent malaisé, leur occupation a nécessité l'aménagement d'un réseau d'escaliers rupestres permettant d'atteindre les différents replats et terrasses ainsi que le plateau sommital. Ces hauteurs constituées d'un grès extrêmement sensible aux phénomènes d'érosion, sont profondément ravinées par les précipitations qui ruissellent en hiver et au printemps le long des parois et des failles. Ce processus a permis d'y effectuer la collecte et la conservation des eaux pluviales ainsi que d'établir de petites communautés selon le modèle reconnu à Umm al-Biyāra où l'on a relevé les premières traces d'occupation qui datent de l'époque édomite.[4] Cette collecte était effectuée au moyen de rigoles ou de fines canalisations creusées dans un plateau incliné dirigeant les eaux vers des citernes rupestres en forme de bouteilles. De telles citernes associées à des réservoirs de forme rectangulaire taillés dans le roc ont également été relevées sur le plateau du ad-Dayr où l'importance de la collecte pluviale que l'on pouvait effectuer dans ce secteur explique que l'on y reconnaisse une forte concentration de vestiges d'habitat rupestre ou maçonné.[5] Le sommet de al-Khubtha présente un dispositif de collecte particulièrement élaboré destiné à alimenter les secteurs habités du plateau et les installations domestiques aménagées en contrebas. En effet après une première phase, consistant en l'occupation des sommets probablement dans un souci de sécurité, en raison des risques que représentaient le ruissellement des eaux

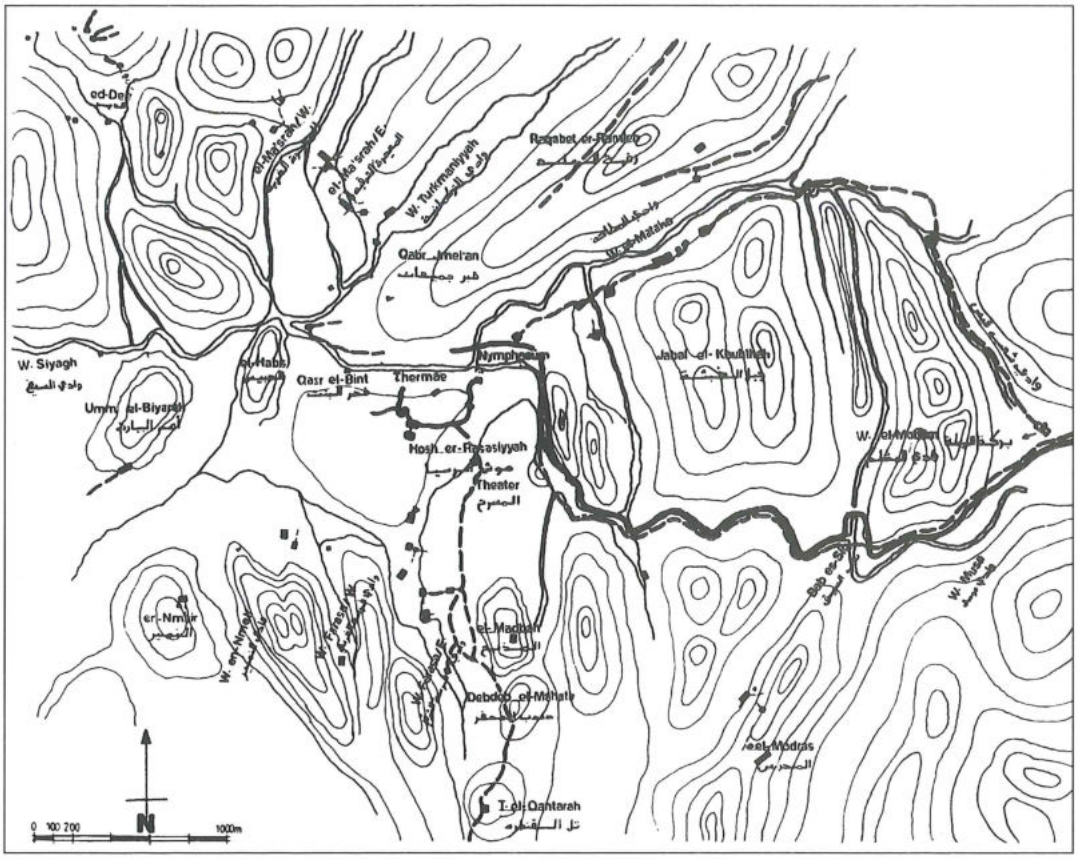
[1] Ces travaux ont été notamment consignées dans les thèses de Doctorat suivantes :Z. al-Muheisen, *Techniques hydrauliques dans le sud de la Jordanie, en particulier à l'époque nabatéenne*. Paris I-Sorbonne, 1986, et Dominique Tarrier, *Les triclinia nabatéens dans la perspective des installaions de banquet du Proche-Orient*. Paris-Sorbonne, 1988.

[2] Voir Z. al-Muheisen *op. cit.*, carte p. 238.

[3] M. Gory, 'La photogrammétrie à Pétra.' *Le Monde de la Bible* 14 (1980): 43-45.

[4] C.M. Bennett, 'Fouilles d'Umm el Biyarah-Rapport préliminaire.' *RB* 73 (1966): 372-403.

[5] Z. al-Muheisen, *op. cit.*: 85-90.



1. Carte des principaux aménagements hydrauliques relevés a Pétra.

pluviales le long des failles et des wadis, l'aménagement de barrages servant autant à l'approvisionnement en eau qu'à la protection des installations domestiques, a permis l'occupation des différents niveaux des hauteurs. Ceci est particulièrement évident pour le secteur de al-Mesara, où le relief moins accidenté présente de nombreuses terrasses au long desquels on reconnaît des tombeaux mais aussi de nombreuses salles rupestres à proximité de dispositifs de collecte pluviale. Précisons ici que ce secteur a été réoccupé jusqu'à une époque récente par des familles de bédouins qui avaient réaménagé certaines salles en fonction de leurs nécessités domestiques et devaient acheminer par portage l'eau que le réseau de collecte pluviale hors d'usage ne pouvait plus fournir. On a remarqué cependant quelques exemples de remises en état récentes de certains de ces dispositifs .[6]

La région de al-Madras de par sa localisation au sud-est du site est rattachée à Pétra mais sa topographie contribue à lui conférer un caractère isolé, le rendant plus proche d'un faubourg que d'un secteur intégré à l'espace urbain. Une inscription retrouvée dans un triclinium, et qui démontre par ailleurs que le toponyme antique s'est conserve jusqu'à nos jours, mentionne la principale divinité nabatéenne Dushara sous l'épithète de "dieu de Madrasa", ce qui prouve le particularisme de ce secteur .[7] On accède à ce dernier par un chemin, situé à une centaine de mètres au sud-ouest du Tombeau aux Obélisques et que prolonge une série d'escaliers conduisant à une grande vallée qui suit un axe nord-ouest. L'importance de cette région se définit par la présence de nombreux aménagements rupestres à caractère cultuel et privé tels que bétyles, salles rupestres (triclinia et installations de banquet appartenant à des thiases) associés à plusieurs dispositifs de collecte pluviale alimentant des réservoirs et citernes répartis sur l'ensemble du secteur.[8] Ce dernier présente également différentes zones, constituées essentiellement par des fonds de wadis, favorables à des activités agricoles et l'on remarque à proximité de ces zones de grands réservoirs aménagés selon un modèle moins élaboré que ceux mentionnés plus haut (absence de couverture et de système de filtrage notamment), destinés à l'irrigation des terres agricoles, notamment celles situées en bordure du Wādī al-Hremiyé.[9]

Sur l'habitat de type rupestre déjà mentionné nous apporterons ici quelques précisions. Nous devons à Horsfield différents plans de maisons ce qui a constitué une étape importante dans l'étude de cette question.[10] Cependant ces travaux n'ayant pas été poursuivis, certains

6 Z. al-Muheisen, *op. cit.*: 117.

7 CIS II: 443.

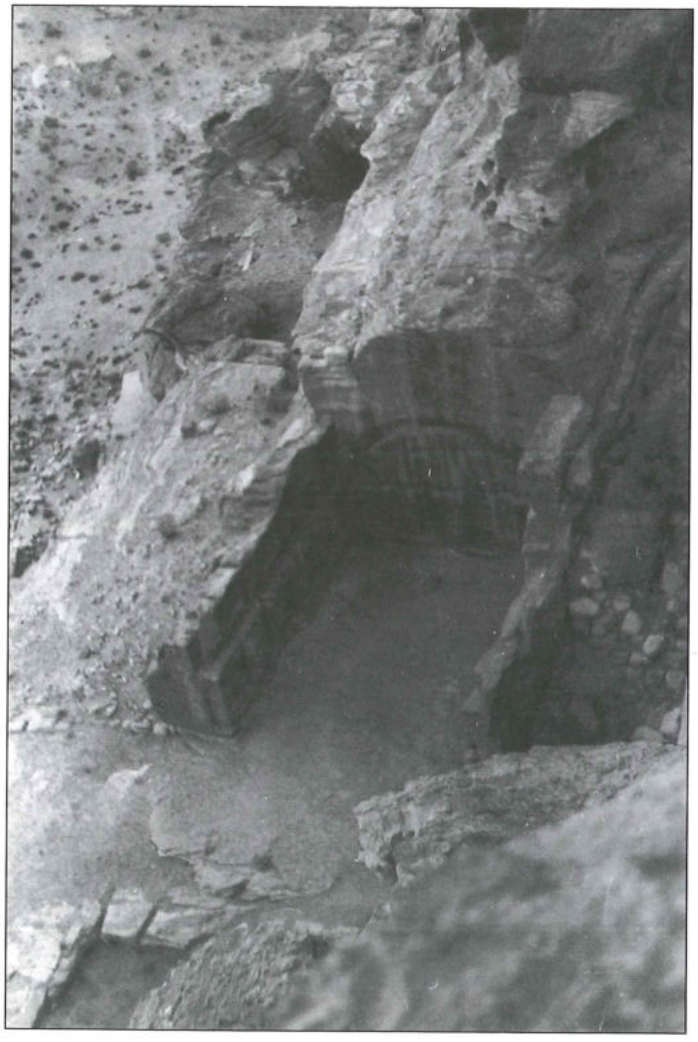
8 Z. al-Muheisen, *op. cit.*: 73-78 et D.Tarrier, *op.cit.*: 175-183.

9 Z. al-Muheisen, *op. cit.*: 78.

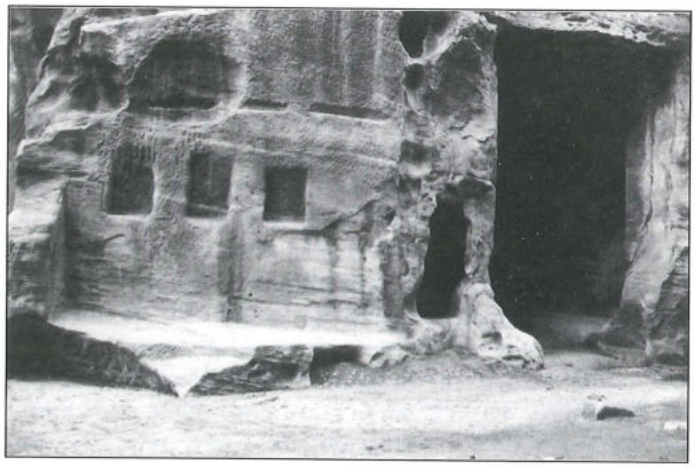
10 G. Horsfield, Sela-Petra, the Rock of Edom and Nabatene. *QDAP* 7 (1938):15-42.

chercheurs ont pu croire que l'habitat à Pétra, se limitait aux seuls exemples publiés.[11] En réalité, comme nous avons pu le constater au fil de ces recherches, ce mode d'habitat est bien attesté sur l'ensemble du site, le problème principal consistant en sa définition. Les plans d'Horsfield concernent des ensembles relativement vastes et présentant une certaine cohérence dans leur organisation, tandis que de nombreuses salles rupestres présentent un aspect dispersé qui rend leur identification parfois difficile. Ce problème provient en partie d'une conception en partie erronée de cet habitat et l'exemple du mode d'utilisation de ces salles par les familles bédouines mentionnées ci-dessus se révèle éclairant à cet égard. Il apparaît, d'après l'étude des secteurs choisis pour l'implantation de ces maisons, que l'espace extérieur pouvait servir aux activités domestiques (cuisine notamment), et qu'ainsi une ou deux pièces pouvaient suffire à abriter une famille. En outre différents vestiges témoignent de l'existence d'un mode d'habitat semi-rupestre où des piéces en partie maonnées complétent l'ensemble domestique. Une ou plusieurs parois ainsi que tout ou partie des assises des arcs et des dalles de couverture étaient alors ménagées dans le rocher. Des exemples d'emploi de ce mode de construction se reconnaissent dans le triclinium D. 248 (Wādī Farasa FIG. 2), ainsi que dans le Sīq al- Bārid dans la région de Bayḍa au nord de Pétra (FIG. 3). On soulignera également ici le caractère clément du climat de Pétra, qui diffère nettement de celui des régions immédiatement voisines, où les hivers sont doux et la chaleur de l'été tempérée par l'air qui souffle sur les hauteurs, notamment le soir. D'autre part il convient de remarquer que les salles rupestres assuraient une isolation thermique efficace. Bien que l'intérieur de ces pièces présente aujourd'hui un aspect très dégradé, on a pu néanmoins relever des traces de peintures murales et de stucs simulant un décor de type architectural appliqués à l'intérieur et à l'extérieur de ces salles. La présence de ce décor pourrait d'ailleurs expliquer la remarque rapportée par Strabon selon laquelle les Nabatéens avaient de somptueuses maisons de pierre.[12] Il est vrai que notre connaissance des maisons édifiées à Pétra demeure encore trés fragmentaire. Le caractère dispersé de cet habitat s'explique pour des raisons d'ordre topographique et pratiques, concernant notamment les questions d'approvisionement en eau, qui impliquait la nécessité de rester à proximité des réseaux de collecte pluviale. Il est également possible d'y voir la trace d'un mode d'organisation de l'espace de type familial ou clanique correspondant à la répartition des hauts-lieux.

A une époque, probablement non antérieure au début du premier siècle avant notre ère, bien qu'il soit difficile en l'état de nos connaissances d'en préciser la date, correspondent à la fois l'occupation du centre de la ville et l'adduction des sources provenant de la périphérie de Pétra. L'espace limité qu'offrait les hauteurs présentées plus haut, concevable pour des petites communautés, ne pouvait suffire à l'accroissement de la population et à la transformation de l'ancien refuge édomite en une capitale ouverte aux influences hellénistiques. L'utilisation de cet



2. Triclinium D 248 (Wādī Farasa).



3. Sīq al-Bārid (Bayḍa).

[11] A. Negev, *Nabatean Archaeology Today*. 1986: 35-36.

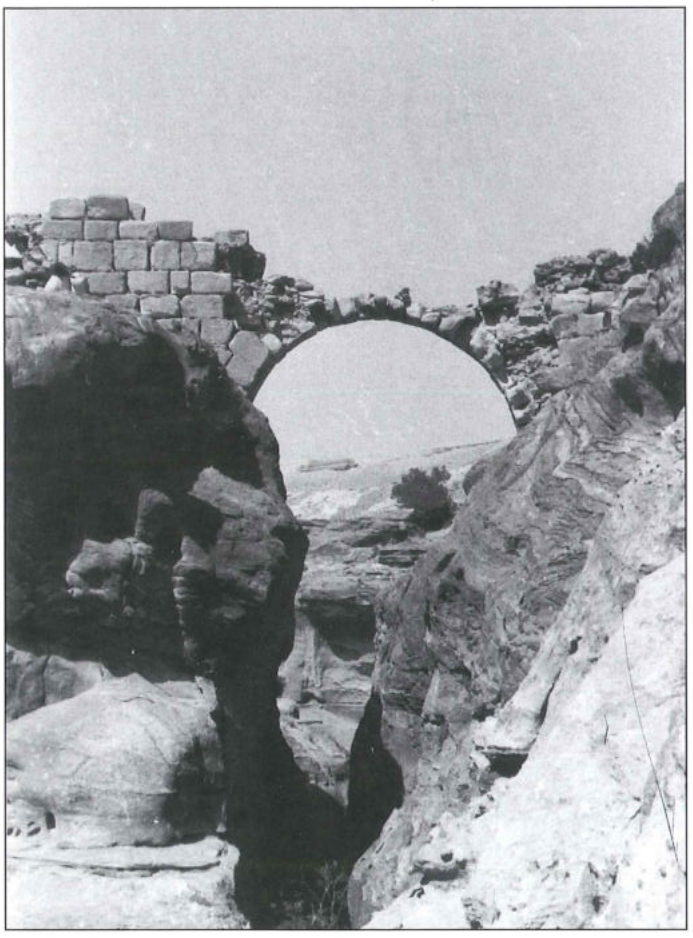
[12] Strabon, *Géographie* 16, 4:26.

espace qui a profondément transformé le caractère de la ville a notamment nécessité la mise en oeuvre d'importants travaux concernant de la protection du site.[13] Le centre de Pétra situé à une altitude de 900 m est en effet un vaste bassin par où s'écoulent selon une direction est-ouest les eaux du Wādī Mūsā vers la dépression du Wādī 'Arabah. La cohérence et l'ampleur de l'aménagement de ce secteur témoigne de l'existence d'un plan directeur mis en oeuvre par une autorité centrale. Ces travaux concernent tout d'abord la fermeture de wadis s'écoulant vers le bassin central et donc en premier lieu la canalisation du cours du Wādī Mūsā. Les vestiges du barrage qui fermait l'entrée du Sīq ne semblent pas antérieurs dans leur état actuel à la seconde moitié du premier siècle de notre ère, mais il semble certain que ce dispositif très élaboré a remplacé un système de fermeture moins complexe.[14] Un tunnel aménagé un peu plus au Nord forçait les eaux du Wādī Mūsā à contourner la hauteur de al-Khubtha, pour emprunter ensuite la route du Wādī al-Maṭāḥa et regagner le centre ville où les eaux reprenaient leur cours naturel mais de façon contrôlée vers le Wādī aṣ-Ṣiyyagh.

Comme on ne reconnaît sur le site même aucune source pérenne, à l'exception de celle du Wādī aṣ-Ṣiyyagh, susceptible de fournir une alimentation en eau permanente indispensable au développement d'un centre urbain, l'occupation du bassin de Pétra est donc corrélatif au réseau d'adduction des sources situées à la périphérie du site. Ces sources, au nombre de trois jaillissent à une altitude d'environ 1400m, ce qui facilite leur acheminement vers le centre de la ville dont l'altitude est bien inférieure. Cependant leur relatif éloignement, qui est d'environ 5 km, a nécessité d'importants travaux qui, outre des canalisations de type rupestre, mais aussi maçonnées ou formées de tuyaux de poterie, comprend de nombreux ouvrages d'art permettant de franchir les dépressions ou les wadis qui ferment l'accès de la ville .[15]

La première canalisation rassemblait les eaux de plusieurs sources de la région du village actuel de Wādī Mūsā, dont la plus importante est celle dite 'Ayn Mūsā. Elle parvenait dans une première phase dans le secteur de Ramleh où elle se déversait dans un vaste réservoir qui servait à la fois de château d'eau et de centre de répartition puisque deux canaux partaient de ce réservoir, l'un suivant le cours du Wādī Mūsā puis le as-Sīq en direction du centre de la ville, le second empruntant la route du Shub Quais pour rejoindre le Wādī al-Maṭāḥa. Le premier canal se divisait en deux branches dans la région du as-Sīq, ce qui permettait ainsi d'alimenter les installations situées sur leur parcours jusqu'au centre ville où elles se déversaient dans différentes citernes.Le second canal, après avoir franchi un aqueduc voûté, encore visible de nos jours (FIG. 4), longeait la paroi nord-ouest de la hauteur de al-Khubtha , à une altitude d'une quinzaine de mètres environ. Cette canalisation passait donc au dessus des nombreuses installations rupestres aménagées dans cette paroi, parmi lesquels on reconnaît plusieurs triclinia dont celui dit de Dorotheos, qui appartenait à un ensemble rupestre à caractère privé. Parvenu au centre-ville ce canal alimentait plusieurs citernes dont la plus importante se trouve à proximité de la Palace-Tomb.

Une seconde canalisation provenait de la source de Brak au sud de Pétra. Bien que mentionnée par les premiers chercheurs, cette canalisation n'avait été relevée que de façon fragmentaire jusqu'à nos récentes recherches qui ont permis de retracer son parcours jusqu'au centre ville. Après avoir desservi le secteur qui s'étend entre Brak et le Jabal al-Madhbaḥ, elle se divisait en deux branches pour alimenter le secteur du Wādī Farasa, en contrebas du al-Madhbaḥ. Entre autres installations, était aménagéé dans une vaste paroi rocheuse une grande fontaine haute de trois mètres dite Fontaine du Lion, d'après l'image du félin qu'elle représente, ainsi qu'un vaste réservoir long de 28 m, recouvert à l'origine par des arcs. Un des branchements de ce réseau suivait ensuite une direction nord et rejoignait la région qui s'étend au



4. Aqueduc du Shub Quais.

[13] Z. Al-Muheisen et D. Tarrier, 'La protection du site de Pétra à l'époque nabatéenne.' A paraître dans *Syria* 1-2 (1996).

[14] P. Parr, 'La date du barrage du Siq à Pétra.' *RB* 64 (1967):45-49.

[15] Z. Al-Muheisen, *op. cit.*

sud du Cardo où il alimentait une série de citernes échelonnées d'est en ouest, tout en desservant les Thermes et, comme le suggèrent certains vestiges, le Nymphée.

Le troisième réseau d'adduction provenait de la hauteur de ad-Dubduba, située à l'est de Bayḍa, à une distance de 6 km du centre de Pétra. De même que pour les canali- sations précédentes, l'aménagement de ce réseau a nécessité la mise en place de nombreux murets et aqueducs ainsi que par endroits l'emploi de canaux de poterie dans les secteurs où le rocher faisait défaut. Ce réseau était principalement destiné à alimenter le centre ville mais quelques branchements secondaires desservaient des secteurs comme celui de Mughur al-Maṭāḥa, où l'on relève une importante concentration de salles rupestres. En raison de travaux de construction récents le parcours de la canalisation n'a pu être reconnu dans son intégralité, mais on en relève les vestiges au nord du Cardo, à la hauteur du Qaṣr al-Bint.

La constitution de ce réseau fait appel à un ensemble de techniques largement répandues sur tous les sites nabatéens, ce qui ôte tous les doutes concernant la mise en oeuvre de ce réseau d'adduction, qui est un fait proprement nabatéen, bien que des modifications aient pu y être apportées à des époques ultérieures. Son existence prouve surtout l'existence d'un schéma d'aménagement du centre ville progressivement mis en place au cours du premier siècle avant notre ère, date de l'édification des premiers grands monuments de Pétra.

La canalisation de ad-Dubduba suivait partiellement à une faible distance l'itinéraire d'un sentier partant du secteur de Ramleh au sud-est de l'entrée de Pétra. Il est aujourd'hui remplacé par une route asphaltée, dont la construction a d'ailleurs endommagé plusieurs sections de la canalisation. Ce parcours qui longe à mi-pente la hauteur de Umm Ṣayḥūn, est encore emprunté de nos jours par les habitants du village de Wādī Mūsā car il permet d'accéder à une vaste zone s'étendant entre Pétra et la région de Bayḍa et qui comprend cette zone comprend de nombreux vallons et secteurs d'accumulation au pied des massifs de grès dont les sols permettent le développement d'activités agricoles de nos jours comme dans l'antiquité.

Les secteurs les plus importants sont ceux de al Bequ'ah, Etnub, Umm Qussa, Sīq al-Ghrab et du Wādī Aqlat. Outre les traces de champs et de terrasses délimités par des murettes de pierres sèches, nous y avons reconnu de nombreux vestiges d'aménagements hydrauliques dont le report sur les photos aériennes et les cartes établies d'après celles-ci ont permis de reconnaître le schéma d'organisation et de mettre en évidence les divers réseaux de collecte pluviale.[16] Ces derniers étaient alimentées par les eaux qui ruissellaient des hauteurs et s'écoulaient dans les wadis en contrebas où des barrages étaient aménagés afin d'alimenter des citernes tout en protégeant les champs et les cultures. Nous avons également reconnu dans ces différents secteurs plusieurs exemples de ferme et d'habitat à proximité de citernes destinées à la conservation de l'eau potable, bien que l'on puisse se demander s'il n'existait pas parallélement à cet endroit un habitat de type temporaire utilisé seulement, comme cela se voit encore de nos jours, lors des principales périodes d'activité agricole. Ainsi la présence de nombreux fragments de céramique a été relevée à proximité de pressoirs à vin, dans des secteurs ne présentant aucune trace d'habitat identifiable. Le grand nombre de ces pressoirs rupestres prouve l'importance dans l'antiquité de la culture de la vigne à cet endroit, remplacée aujourd'hui par celle de l'olivier, pratiquée conjointement avec celle des céréales .[17]

Plus loin vers le nord, on rejoint la région de Bayḍa qui jouait un rôle essentiel dans la vie économique de la capitale nabatéenne puisqu'il s'agissait d'un vaste centre de stationnement pour les caravanes venant du Wādī 'Arabah mais aussi d'une importante zone d'exploitation agricole. Le Sīq al-Bārid qui s'ouvre à l'est de Bayḍa, présente un important réseau de collecte pluviale alimentant un ensemble de citernes au nombre de cinq, ainsi que plusieurs bassins secondaires desservant les maisons rupestres et les six triclinia aménagés dans les parois du as-Sīq. Plusieurs barrages fermaient le débouché de wadis secondaires assurant ainsi la protection de ce secteur contre les risques de ruissellement tout en assurant l'approvisionnement en eau. Le mieux conservé de ces barrages, auquel on accéde par un escalier taillé dans le rocher, se trouve au fond du defile au dessus d'un petit biclinium hypethre. L'élaboration du décor intérieur (vestiges de peintures murales) et extérieur (colonnes et pilastres) des salles rupestres ne laissent aucun doute sur le caractère aristocratique de ce faubourg, où la fraîcheur qui y règne en permanence en rendait le séjour particulièrement agréable durant l'été.[18]

L'exploration de la région au nord de Bayḍa a permis de reconnaître à une distance de 5 km, dans le prolongement du Wādī Umm al-Alda, l'existence d'un vaste terroir agricole exploité de nos jours par les habitants de la région de Bayḍa et de Wādī Mūsā. L'alimentation en eau du village aménagé à cet endroit par les Nabatéens, ainsi que l'irrigation des champs et terrasses étaient assurées grâce à un barrage fermant le débouché du Sīq al-Bārid, à la hauteur duquel partaient deux canalisations.[19]

La source du Wādī aṣ-Ṣiyyagh, mentionnée plus haut, se situe à un niveau inférieur à celui du bassin de Pétra, et n'est en fait que le principal point d'affleurement d'une nappe d'eau s'étendant sous le fond de cette vallée par où s'écoulent les eaux du Wādī Mūsā. Cette source qui pouvait

16 Z. al-Muheisen, *op. cit.*

17 Voir notamment Z. al-Muheisen, Installations agricoles nabatéennes dans la région de Petra et le Wadi Arabah. Pp.215-219,dans *SHAJ* IV, 1992.

18 D. Tarrier, les triclinia nabatéens, 55-57 et 89-93 (voir n.1).

19 Z.al-Muheisen, Exemples d'installations hydrauliques et de techniques d'irrigation dans le domaine nabatéen. Pp. 507-513 dans B. Geyer (ed.) *Techniques et pratiques hydro-agricoles traditionnelles en domaine irrigué. Approches pluri-disciplinaires des modes de culture avant la motorisation en Syrie*, Paris 1990.

être aussi utilisée pour le puisage, était canalisée et dirigée vers un secteur dit Qaṣr Umm Rattam, situé ā une dizaine de kilomètres, où se trouve un réservoir maçonné mesurant 12 x 10 m, aménagé dans le sol. Outre un petit fortin, on reconnaît sur le site des vestiges de construction ainsi qu'une vaste zone agricole de plusieurs hectares comprenant des champs délimités par des murets. Ces champs étaient irrigués au moyen de canalisations rupestres et de rigoles selon un modèle comparable à celui identifié à Ba'ja.[20]

Dans la région qui s'étend au sud de Pétra, le faubourg de Ṣabrā, aménagé sur un axe de communication sud-ouest en direction du Wādī 'Arabah, a fait l'objet depuis sa découverte au XIXe siècle de nombreuses recherches car il semblait être le seul secteur d'importance de cette région sud.

Au printemps de 1984, nous avons reconnu avec Maurice Gory, responsable du projet de cartographie aérienne de la région de Pétra effectué par l'IGN, le site de as-Sadah, qui se trouve, à une distance d'environ 16 km au sud de Pétra.[21] On y accède en suivant le Wādī Ṣabrā puis le Wādī Rasharis en direction de al-Mureibed où l'on emprunte vers l'est le Wādī Abū Uruk puis en direction du nord-est, le Wādī as-Sadah. Le toponyme de ce site, dont l'accès est plutôt difficile, est un diminutif du mot saad car le fond du wadi est fermé par une gorge très resserrée. Sur le côté est de ce wadi on reconnaît des vestiges de construction au nord desquels se trouve une citerne mesurant 17 m x 8 m. Cette citerne était alimentée par une source, dite 'Ayn as-Sadah, située sur le sommet nord du Jabal as-Sadah. L'eau provenant de cette source forme une cascade qui ruisselle dans le lit très étroit du wadi avant d'être canalisée au moyen d'un aqueduc long de 300 m. Cet aqueduc présente la particularité rare dans les techniques employées par les Nabatéens d'être supporté sur une partie de son parcours par des arches hautes de 5,80 m par rapport au niveau actuel du sol. Outre les traces d'habitat associés à de nombreux tessons de céramique nabatéenne, nous avons également relevé des vestiges de terrasses dans les Wādī as-Sadah et Wādī Abū Uruk, ainsi que des champs de vignes et de figuiers poussant à l'état sauvage avec la seule eau des précipitations. A l'époque de notre reconnaissance de ce site, les bédouins de Pétra se rendaient encore à cet endroit pour y prélever des plants qu'ils mettaient ensuite en place dans les jardins aménagés dans les Wādī Turkmaniyé et Wādī aṣ-Ṣiyyagh.

Bien que le relief particulier de Pétra et surtout la présence de nombreux tombeaux et aménagements cultuels aient constitué un obstacle pour de nombreux chercheurs dans leur appréciation de la nature de l'espace de Pétra, les travaux et relevés que nous avons effectués sur l'ensemble du site permettent de mieux en comprendre l'organisation interne. Car, plus que pour n'importe quelle autre site classique, où les rues et les places disposées à intervalles réguliers distribuent l'espace de façon aisément identifiable, l'aménagement du site de Pétra dépend étroitement des contraintes de la topographie pour l'implantation de ses aménagements comme celui de sa subsistance dépendait essentiellement de son alimentation en eau. L'aspect dispersé de l'occupation du site, que l'on ne retrouve d'ailleurs pas sur les autres centres nabatéens, est donc consécutif à ces contraintes bien que l'on puisse supposer qu'il convenait, surtout aux débuts de leur implantation à Pétra, à la nature de l'organisation sociale des Nabatéens. Celle-ci ne présentait pas un caractère tribal, comme en témoignent les inscriptions qui ne précisent que le nom et le patronyme et qui démontrent, sous l'emploi du seul vocable de Nabatu, l'existence d'une conscience d'appartenance à un même groupe ; on verra plutôt dans cette organisation de l'habitat l'expression d'un caractère clanique ou familial de type traditionnel, dont il subsiste quelques traces dans certains villages actuels, sans doute peu différent de celui que présentait récemment les groupes d'origine bédouine qui y résidait de façon discontinue selon un mode de répartition familial. Il est évident que l'urbanisation du bassin de Pétra a profondément affecté l'occupation du site en lui conférant une relative unité grâce à la création d'un espace d'où l'on pouvait rejoindre les différents quartiers ainsi que les issues de la ville et où se tenaient les différentes activités à caractére religieux ou social. L'existence des faubourgs reconnus à la périphérie de Pétra conduit à s'interroger sur leur fonction ainsi que sur leurs liens et degrés de dépendance envers la ville proprement dite. Le secteur de as-Sadah et probablement aussi celui de Ṣabrā, bien que plus proche, présentent un caractère autonome évident, qu'expliquent suffisamment leur éloignement et leur accès difficile, et devaient donc abriter de petites communautés vivant en autarcie et servant d'étapes aux caravanes qui transitaient par cette région. Pour les faubourgs situés au nord de Pétra et aisément accessibles, l'importance de leur fonction économique, qu'il s'agisse des activités caravanières ou agricoles, laisse supposer que l'ensemble de ce secteur quoiqu'autonome du point de vue de ses ressources, demeurait sous le contrôle direct de l'autorité centrale, d'autant que le nombre des aménagements agricoles permet de penser qu'une partie de la production était acheminée vers l'intérieur de la ville. Bien que de nombreuses questions demeurent encore concernant le processus d'urbanisation de Pétra, nous pouvons cependant en discerner les phases décisives correspondant moins au seul processus de sédentarisation, comme on veut trop souvent le voir en référence aux descriptions de Diodore de Sicile, qu'à la conquête progressive, puis à la maîtrise d'un espace dont les conditions naturelles représentaient un véritable défi.

[20] Z. al-Muheisen, '*Techniques hydrauliques*,' pp. 125-126 (voir n.1).

[21] Les résultats de cette exploration ont été premièrement présentés par Z. al-Muheisen, *op.cit.*: 130-132.

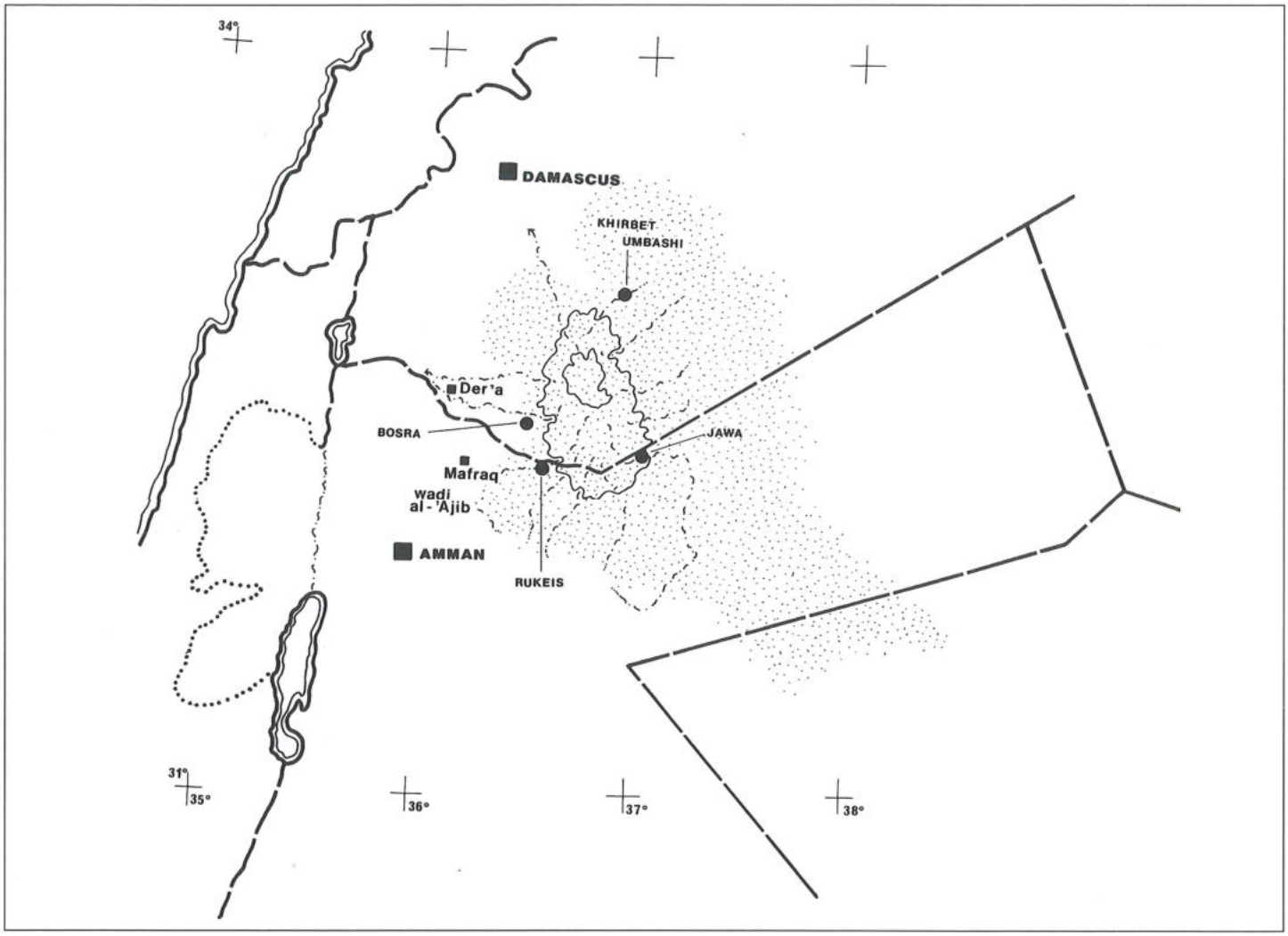
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Australia

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A Middle Bronze Age Landscape: Occupation and Resource Management in the Wādī al-'Ājib, al-Mafraq

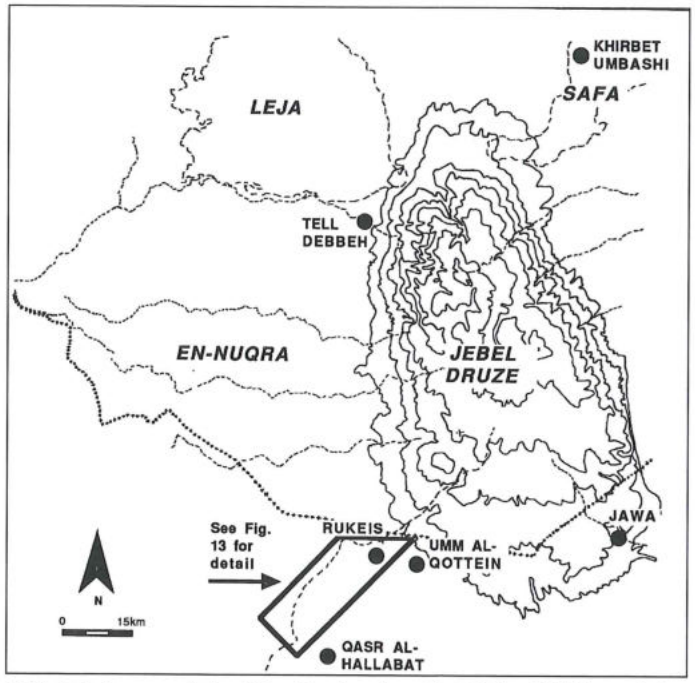
The large district of plain and mountain generically known today as the Ḥawrān stretches from south of Damascus to northern Jordan and encompasses three geographically distinct regions: the Leja, the Nuqrah and the Jabal Ḥawrān, Jabal al-'Arab or Jabal ad-Drūz (FIG. 1). The Ḥawrān is situated within the transitional zone between well-watered valleys to the west and the semi-desert or steppe region (*bādiyah*) to the east. Average rainfall within the transitional zone is between 200 mm and 350 mm a year and the major type of agricultural activity in the region is dry farming. The range of crops that can be grown in this manner is greater in the west, where rainfall is about 350 mm a year. As rainfall decreases towards the east, little can be grown without irrigation except for wheat and barley, which are the predominant crops. The grazing of animals, particularly sheep and goat, is also widely practised throughout the region.

The Wādī al-'Ājib cuts down the south-western slopes



1. Map of Syria and Jordan showing the geographical location of the Ḥawrān.

of the Jabal ad-Drūz and crosses the border between Syria and Jordan west of Umm al-Quṭṭayn. From here it runs in a south-west direction, eventually draining into the mud-flats near Qaṣr al-Hallābāt (FIG. 2). In 1992 and 1993 preliminary studies undertaken by a University of Sydney team under the direction of Alison Betts involved an area survey of the upper Wādī al-'Ājib in the al-Mafraq district, just south of the Syrian border (Betts *et al.* 1995, 1996). During the 1993 season the fortified Bronze Age site of Rukeis was chosen for further investigation and a small sounding was made. This was followed up in 1994 by an eight-weeks excavation season at Rukeis and further area survey of the upper wadi system (Betts *et al.* 1995,1996). The aim of the project is to investigate the nature of settlement and land use in this region, particularly during the Middle Bronze Age.



2. Detailed map of the Ḥawrān showing the Wādī al-'Ājib and the location of Rukeis.

Rukeis Excavation Results

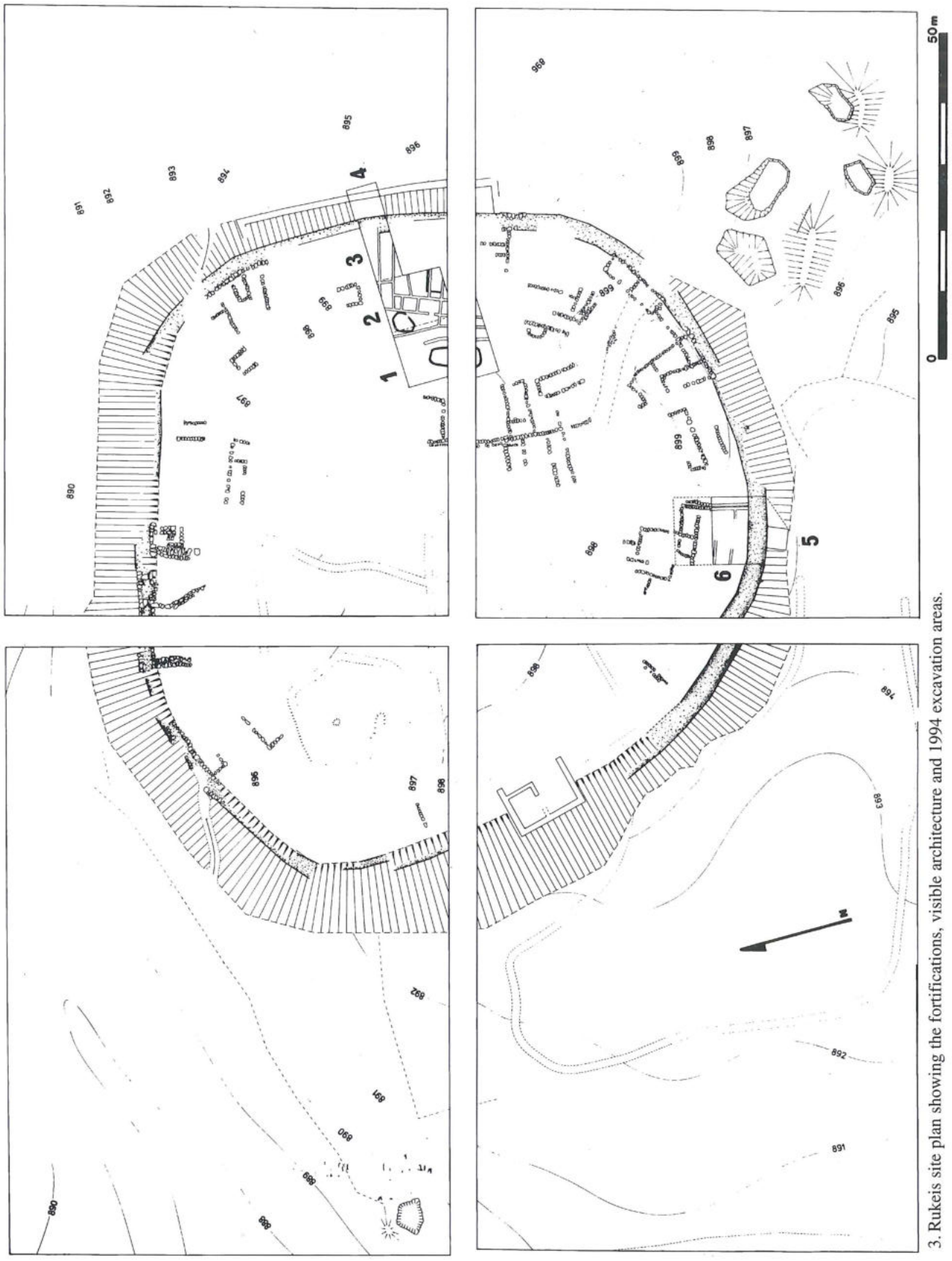
Rukeis is situated on the upper Wādī al-'Ājib, north of the village of ad-Dafiyānah. The site consists of a large walled citadel, with traces of a lower town on the south-western side (FIG. 3). Initial investigation of the site suggested that much of the occupation consists of relatively undisturbed Middle Bronze Age deposits and includes massive, well-preserved fortification walls and traces of stone architecture visible on the surface. A later structure, a square building of cut basalt masonry, overlies the fortification wall at the western end of the citadel and may have been a small watch-tower dating to the Roman/Byzantine period. Evidence of canals and ancient field systems in the wadi may relate to occupation at the site, though to which period is uncertain.

During the 1994 excavation season five trenches were opened. Trenches 1, 2 and 3, which were situated on the east side of the top of the tall, combined to make up a total area of approximately 210 m² (FIGS. 4 and 5). The excavation area extended from the inner face of the main fortification wall westward towards the centre of the mound. Trench 1 consists of an open area with a number of circular stone-lined pits. One of these had partially been excavated as a sounding during the 1993 season (Silo 1). The pit, which may have been a silo or storage bin, is approximately 2.5 m in diameter and is stone lined to a depth of 2.2 m, where the walls were abutted by a layer of flat stones. It is unknown whether this represents the bottom or not as the layer of stones were not removed. While the majority of the ceramics from the silo date to the Middle Bronze Age, several finds suggest the silo was used and possibly filled in during the Iron Age or later. Other circular stone walls in this area may represent similar features. One of these was partially excavated to a depth of 0.5 m, revealing several courses of stone (Silo 2). Lying north-south along this area are a number of isolated walls, the function of which is not clear. These walls, which lay very close to the modern surface and had no reliably associated occupation deposits, may represent a later phase of construction as most are out of alignment with underlying walls.

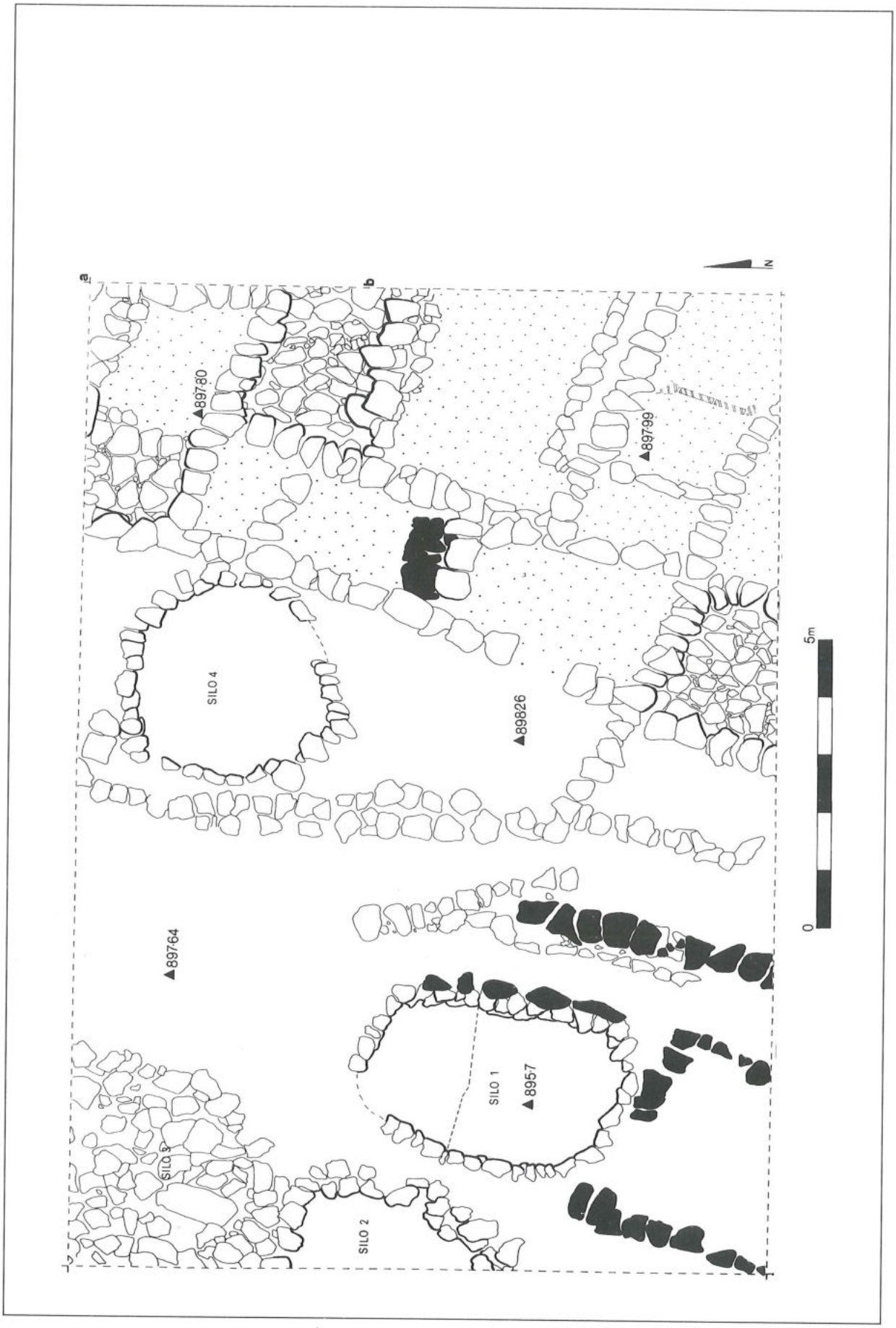
In Trench 2 part of a large complex with stone-built walls and small rooms was uncovered. At least one of the walls ran up to the inner face of the main fortification wall. Several phases of rebuilding could be identified within this complex, not all of which have been clearly defined. There is evidence for later subdivision as in most rooms the lowest occupation deposits abut only one, two or three of the walls, while the remaining walls are at a higher level. Some of the rooms have stone-paved floors. These have not yet been lifted so it is not clear if they belong to the first use of the structure, or represent later phases. Some rooms also have blocked doorways, and one has a thin mudbrick division across it. Several large rectangular-shaped stones may represent the remains of collapsed corbelled roofing. Broadly, this sector contains a large multicelled structure of uncertain function which was in use over a period of time, during which it was reshaped several times.

An extension of this area was opened in Trench 3 up to the inner face of the fortification wall (FIG. 5). A small sounding in this area uncovered a stone-paved floor also abutting the inner face of the main fortification wall and the bottom of the wall of the main structure, which was preserved to 5 courses. Below this construction phase was an ashy deposit, and several layers of fill, excavated to a depth of almost three metres.

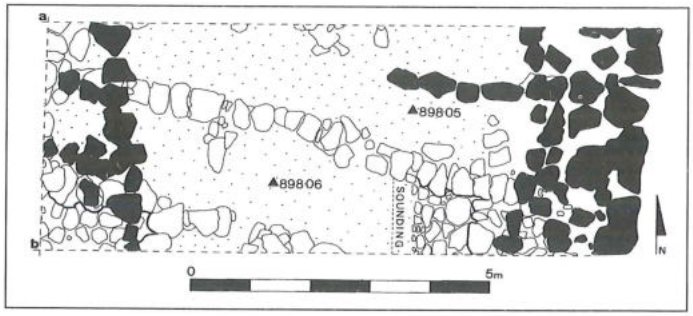
Trench 4 was opened up as an area of clearance against the outer face of the main fortification wall to the east of trenches 1, 2 and 3. Clearance of fallen rubble revealed an outer, well-built stone wall running parallel to the main fortification wall. A complete doorway was uncovered



3. Rukeis site plan showing the fortifications, visible architecture and 1994 excavation areas.



4. Plan showing the combined area of Trenches 1 and 2 with several silos to the west of the main complex.



5. Plan of Trench 3 showing the extension from the main complex to the inner face of the fortification wall.

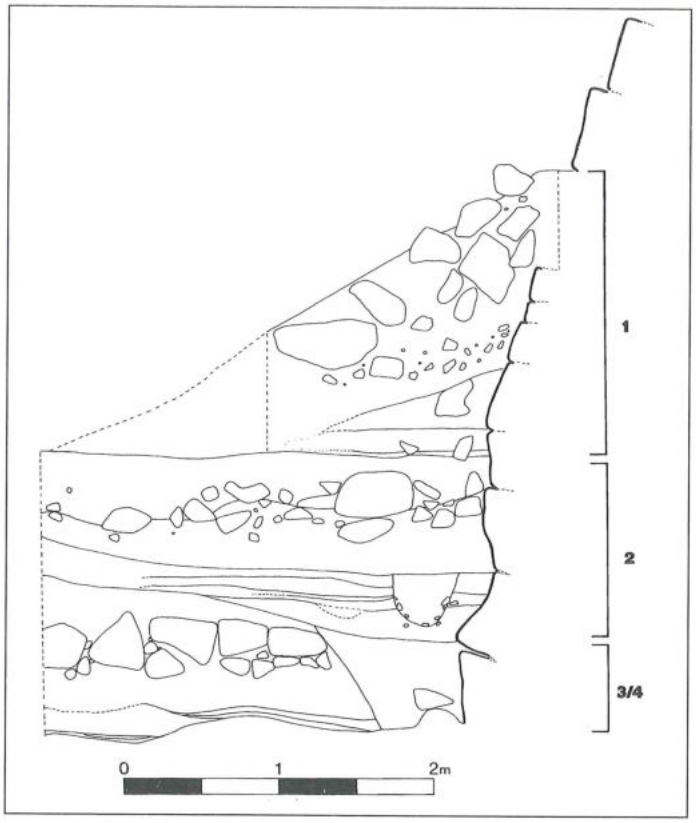
which had two stone lintels preserved *in situ*. Excavation between the two walls revealed traces of collapsed corbelling which may have formed part of the roof covering the rooms between the walls. This area was only partially excavated and a date for the structure cannot yet be established.

Trenches 5 and 6 were opened up on the southern side of the tall. Excavation of Trench 6 began by the removal of topsoil over an area of about 300 m² extending from the inner face of the main wall towards the centre of the mound. Clearance of this area revealed a series of rectangular rooms. Two of these, which were adjacent to the main wall, had stone-paved floors. One had a stone lined *ṭābūn* against the outer wall, within which sat a partially complete coarse ware vessel. This area was only partially excavated.

Trench 5 was situated against the outer face of the main fortification wall. It consisted of collapse from the main wall interspersed with wind blown silt. This overlays a layer of ashy soil with deposits abutting the wall, below which is an earlier stage of collapse again lying on windblown silt above layers of cultural deposit. Below this is a cut against the main fortifications which appears to be a foundation trench (FIG. 6). The trench is cut into earlier occupation levels represented by a rounded stone structure with pisé packing against the outer face of the walls. On the basis of ceramic evidence, these levels are dated to the EB IB period.

Preliminary analysis of the results of the 1994 excavations at Rukeis indicate that the site was settled by the Early Bronze Age, but that the main period of occupation was during the Middle Bronze Age. The site appears to have been abandoned in the late Middle or early Late Bronze Age. It was then apparently reused during the Iron Age, sometime in the eighth to tenth century, although the extent and nature of the Iron Age occupation is unclear. The site was also used during the Late Roman/Byzantine period to which the fort on the western side of the tall belongs.

There are few excavated Middle Bronze Age sites in Jordan from which comparisons with Rukeis can be drawn, but several similarities can be seen at the site of Abū Snaslah (Lehman *et al.* 1991; Kerner *et al.* 1992). Like Rukeis, Abū Snaslah, which is located east of



6. Section of Trench 5 on the outer face of the fortification wall showing the successive deposits and foundation trench.

ʿAmmān at the confluence of the Wādī Irmidān and Wādī al-Qaṭṭār, is situated in a marginal region where agriculture reliant on rainfall is limited to areas along wadi tributaries, and where annual rainfall is sufficient only for simple agricultural systems. This region is also similar to the Ḥawrān in that almost no excavations have taken place here, except for salvage work at Saḥāb (Ibrahim *et al.* in press).

During excavations carried out in 1990 at the site of Abū Snaslah, substantial Middle Bronze Age architectural remains were revealed, including a rectangular building thought to be a house (Lehmann *et al.* 1991; Kerner *et al.* 1992). The house (house 1), which is constructed of large limestone blocks, shows evidence of internal partitioning, as seen by the existence of a subdividing wall and at least one phase of restoration or rebuilding with the existence of a number of small, possibly later additional walls to the south. Two stones found in the centre of the building may have acted as pillars that held wooden posts to support a roof, while there is evidence of at least one blocked doorway. The remains of several other walls similar to those of house 1 may be part of other houses, while to the north wider and more heavily constructed walls appear to have had a different purpose and are provisionally considered to be terracing walls. The preliminary interpretation of the Middle Bronze Age remains at Abū Snaslah is that they appear to be largely domestic in nature. Due to a general lack of painted Middle Bronze Age pottery, Lehmann *et*

al. (1991: 59) see the site as a "provincial" settlement. While Abū Snaslah appears to have been slightly different in nature to Rukeis it is one of the few recently excavated Middle Bronze Age sites in Jordan that has revealed similar architectural remains.

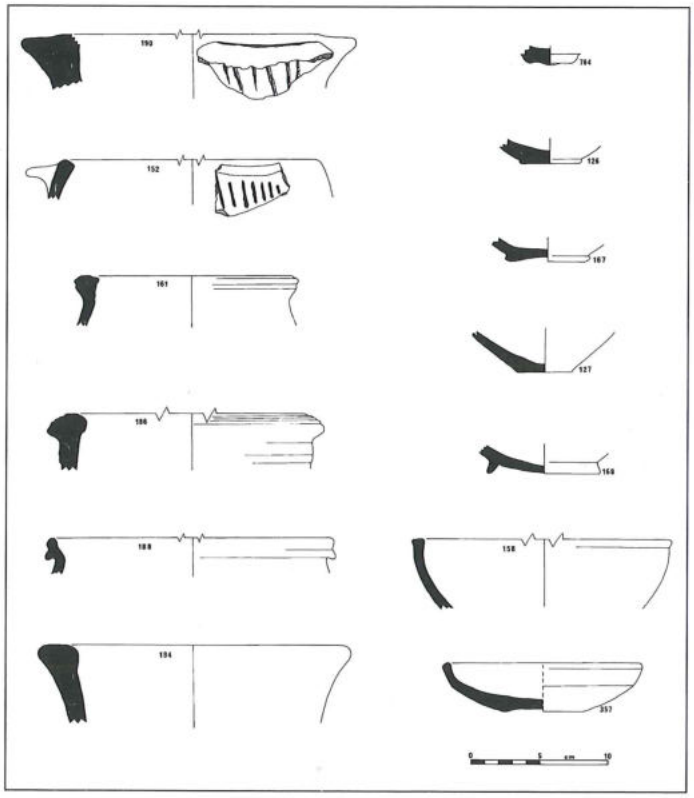
Ceramics, Small Finds and Ground Stone

The 1993 and 1994 excavation and survey seasons at Rukeis produced a substantial amount of ceramic remains. An analysis of these ceramic finds has resulted in the beginnings of a Rukeis ceramic type series or shape typology. Thus far, a total of 975 diagnostic and 6671 body sherds from Rukeis and 49 diagnostics from the survey of the Wādī al-'Ājib has been recovered and processed.

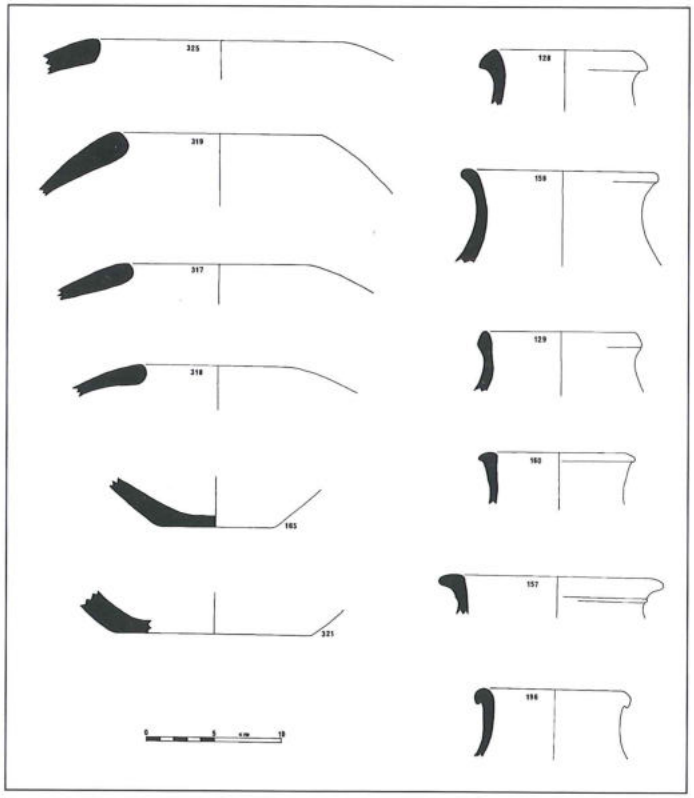
The excavation of the five areas recovered diagnostic sherds of all forms of ceramic vessels (FIGS. 7-9). Over half of the ceramic fragments are from storage vessels such as bowls, jars, short-necked and tall narrow-necked jars, while fragments of fine and domestic types are few with Cooking Pot ware in use for the making of storage jars, as well as cooking pots (see below FIG.11). Preliminary analysis of these diagnostics has shown that with relatively few exceptions, the majority of the ceramic material from Rukeis dates to the Middle Bronze Age, in particular the later Middle Bronze period - the MBIIC. Ceramics from the Late Bronze, Iron, Byzantine and Roman periods are also represented at Rukeis. (FIG.10) The Iron Age ceramic material awaits further analysis. A large portion of the ceramic material excavated comes from Area 1 and the excavation of Silo 1, yet the total amount of material from the structures in Areas 2 and 3 combined, is slightly greater.

The majority of forms were undecorated, with most of the decorated wares having a reddish brown slip on the exterior of the vessel. Few vessels were burnished, or elaborately painted. Brown ware was the most common ware in use at Rukeis (see FIG. 12), while both Cooking Pot ware and Red ware also occur frequently. Brown ware is a medium fired brown coloured fabric with no distinct variation in the colour of the core, (although occasionally with a very faint light grey core), with up to 10% inclusions of very fine chert, basalt and lime. Brown ware is most commonly used on storage vessels, along with other wares such as Cooking Pot ware. Red ware is a medium fired red coloured ware with no distinct variation in core colour and up to 7-10% inclusions of very fine lime and basalt. Variants of Cooking Pot ware are relatively frequent, whilst fine and decorated wares are comparatively infrequent. In general, the variety of wares is not great, and the use of both ground basalt and lime as an inclusion is a common characteristic of many of the wares. Nearly half of the ceramic sherds recovered were medium fired, whilst more than another quarter were low fired.

In Area 5, the ceramic material recovered from the lowest levels, up against the city wall, may be dated to the Early Bronze Age. Early Bronze Age forms recovered



7. 190, 152 - Incised ledge handle fragments;161, 186, 184 - Storage jars; 188 - Cooking pot; 764, 126, 167, 127, 168 - Bases; 158, 357 - Bowls.



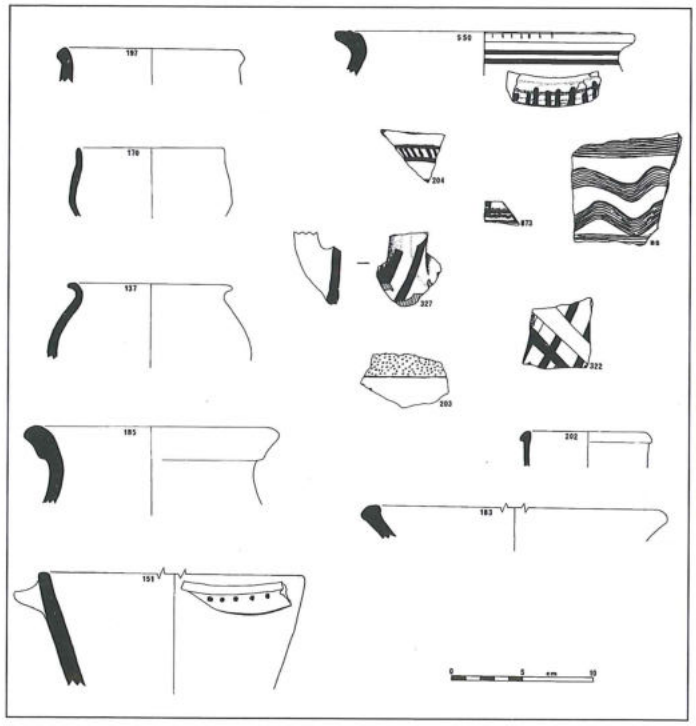
8. 325, 319, 317, 318 - Holemouth jars; 165, 321- Flat bases; 128, 159, 129, 160, 157, 196 - Tall narrow-necked jars.

include holemouth jars (FIG. 8:325, 319, 317 and 318), and body sherds with band-slipped patterning (FIG. 9:322, 327). Other significant ceramic finds include two rim sherds and one body sherd of "Chocolate-on-White" ware (FIG. 9:550, 873 and 204), one "Tell el-Yehudiyeh" body sherd (FIG. 9:203) and several body sherds with bands of horizontal and wavy combed incised decoration, all of which are datable to the Middle Bronze Age (FIG. 9:BS).

Preliminary examination of the ceramic material from Braemer's survey and excavation in the Ḥawrān suggests that the common wares found at Rukeis are not found in significant numbers at sites such as Khirbat al-Umbachi in the north-east Ḥawrān.[1] There is also much more variety in wares at Khirbat al-Umbachi. By contrast, in the ceramic material from Braemer's survey to the west of Jabal ad-Drūz, there are many parallels with the material from Rukeis in terms of form/function of the vessels found, and the wares used in their production.

The majority of ground stone finds from the 1994 excavation season at Rukeis are fragments of basalt grinders. Other ground stone artefacts, all of basalt, include several fragments of bowls, footed bases from larger storage vessels, pounders, mortars, pestles, saddle querns and rubbing stones. A complete basalt mortar was found *in situ* in Area 2.

Most of the special finds from the 1994 excavation season at Rukeis have come from Silo 1. These include fragments of two ceramic spindle whorls, a broken painted clay figurine showing the head of a woman, a section of a marble bowl, a pierced clay disc, two shell beads, an ostracon with an Aramaic inscription, a bone spatula and a burnt fragment of decorative bone inlay. A second pierced clay disc was recovered from Area 3, together with a piece of pierced basalt. Preliminary analysis of the letter forms and text of the ostracon suggests a ninth century date (Mendenhall, pers. comm.). According to Mendenhall the inscription translates to "grain belonging to s[" and is one of the earliest Aramaic inscriptions known thus far. The date of the inscription is confirmed by Lenzen who identifies the sherd as coming from a ninth century storage jar of medium size (Lenzen, pers. comm.). The figurine fragment, the head of a woman in Egyptian/Phoenician style, may represent the goddess Astarte, and could date to the same period as the ostracon (cf. Vance 1994: 118; Yadin 1975: 180). While the majority of the ceramics found in Silo 1 date to the Middle Bronze Age, the ostracon and figurine fragment suggest the silo was in use and probably filled in no earlier than the Iron Age and possibly later.



9. 197, 183-Storage bowls; 170, 137, 202-Fine Jars; 185-Storage jar; 151-Storage bowl with incised handle; 550, 204, 873 - "Chocolate-on-White" ware; 327, 322 - Band-slipped patterning; BS - Combed incised decoration.

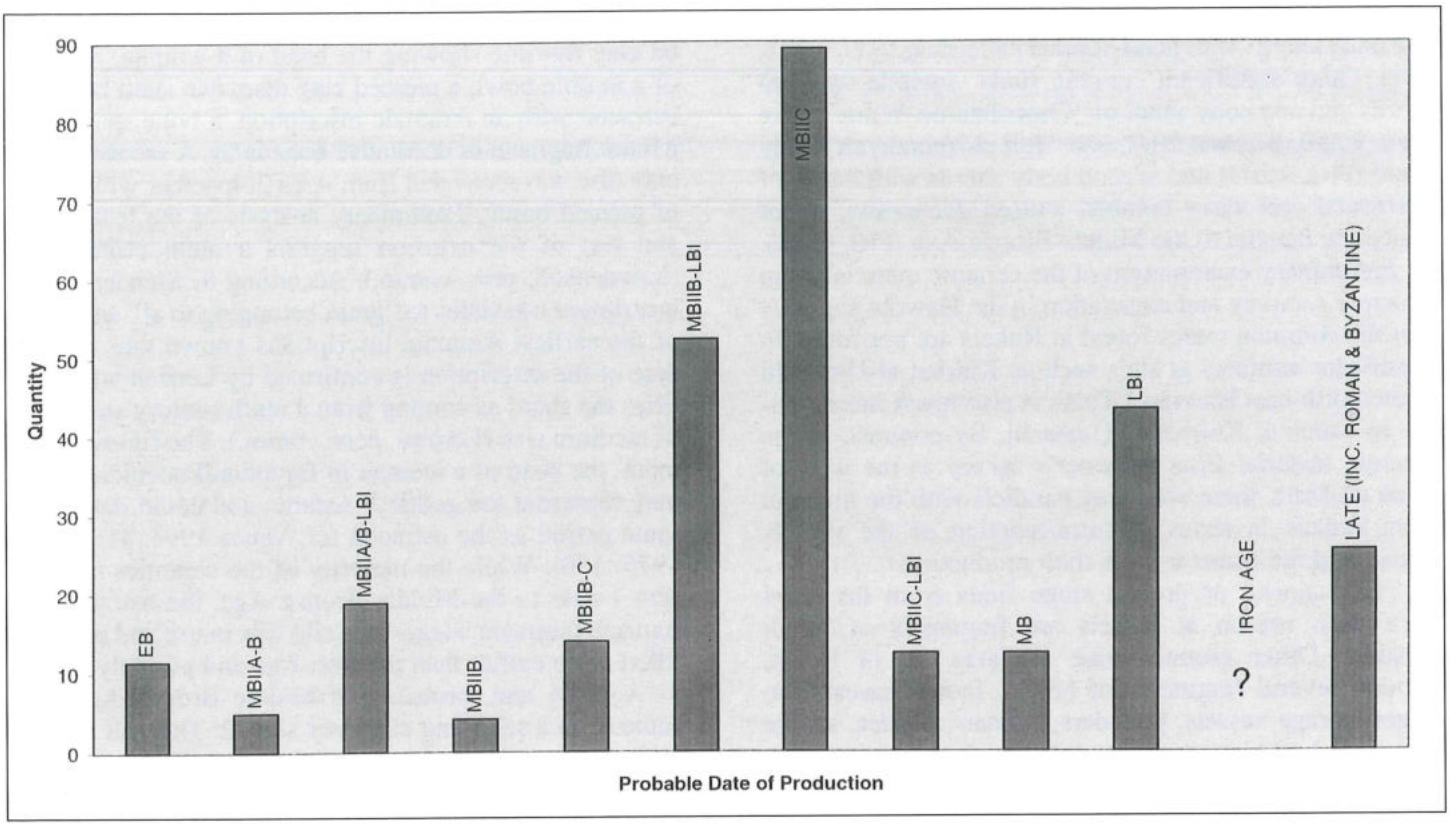
A stone seal, probably of Middle Bronze Age date, came from a sounding at survey site 42. The seal features a crescent enclosing four dots. Above this is a design resembling a quarter rosette. Middle Bronze Age stamp seals, mostly of faience, have been found at a number of sites in the Levant and Anatolia (cf. Keel *et al.* 1989: 47, Nos 12 [Alisharhüyük], 13 [Acemhüyük], 15 [Gordion]; 53, No 28 [Beth Shemesh]). The same designs occur on scarabs, and a motif with crescent and rosette similar to that of the Wādī al-'Ājib seal appears fairly frequently (cf. Keel *et al.* 1989: 51, No. 22 [Gezer]; 23 [unknown provenance, purchased in Jerusalem]). Keel *et al.* suggest that the motif represents the sun and the sickle moon, a motif which occurs on Akkadian, Old Babylonian and Anatolian seals (1989: 78-80).

Middle Bronze Age Settlements in the Wādī al-'Ājib

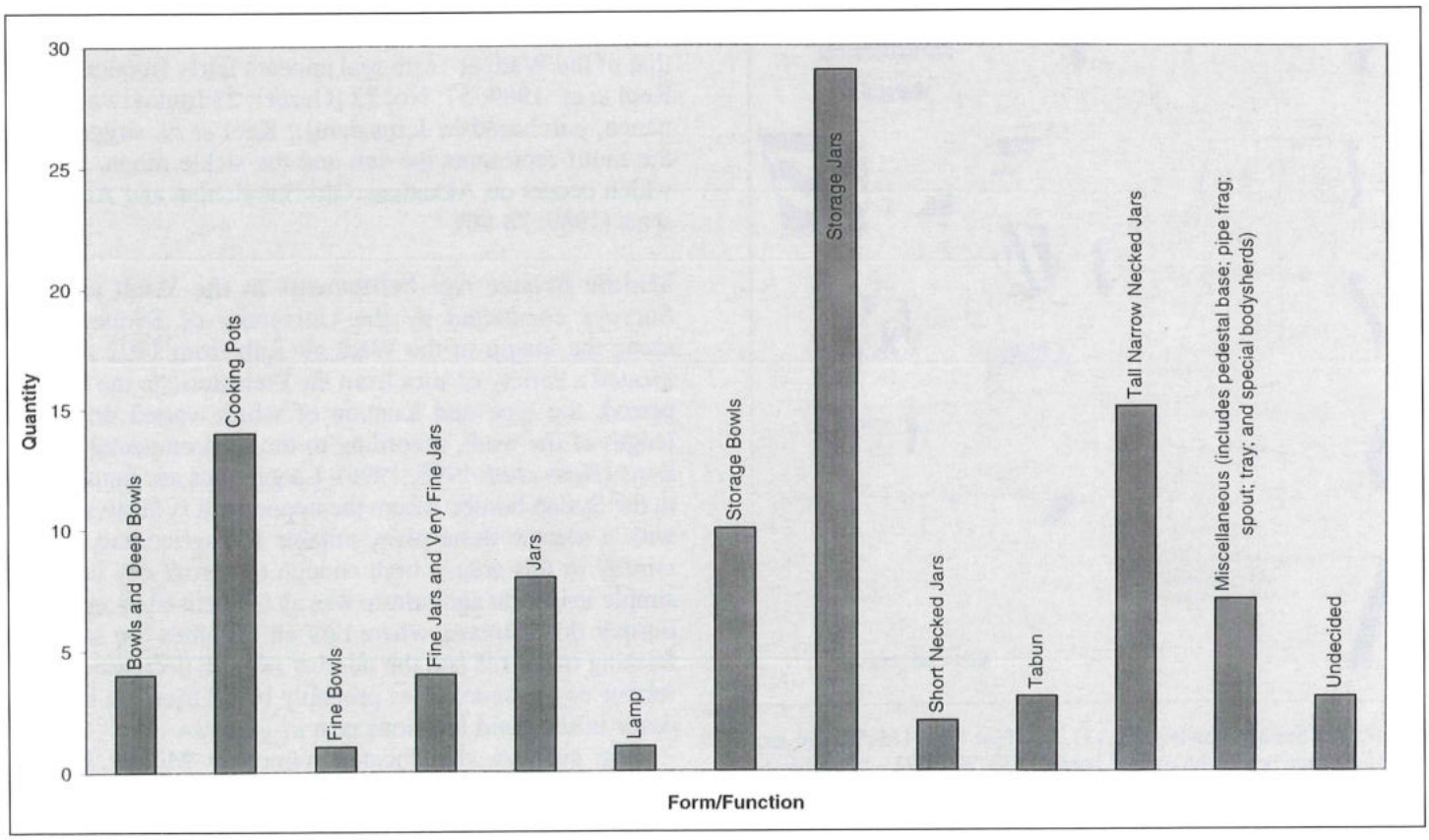
Surveys conducted by the University of Sydney team along the length of the Wādī al-'Ājib from 1992 to 1994 located a variety of sites from the Prehistoric to the Islamic period, the type and location of which varied down the length of the wadi, according to the environmental conditions (Betts *et al.* 1995, 1996). Larger sites are found close to the Syrian border, where the upper wadi is fairly shallow with a narrow flood plain suitable for agriculture. While rainfall in this area is high enough to permit dry farming, simple irrigation agriculture was also practised in antiquity. Further downstream, where rainfall becomes too low, dry farming drops off and the number of sites decreases. Even further downstream, sites probably based more on herding occur in sheltered locations near *al-ghudrān*.

The surveys also located numerous Middle Bronze Age sites along the banks of the Wādī al-'Ājib stretching from south of the Syrian border north-east of Rukeis to

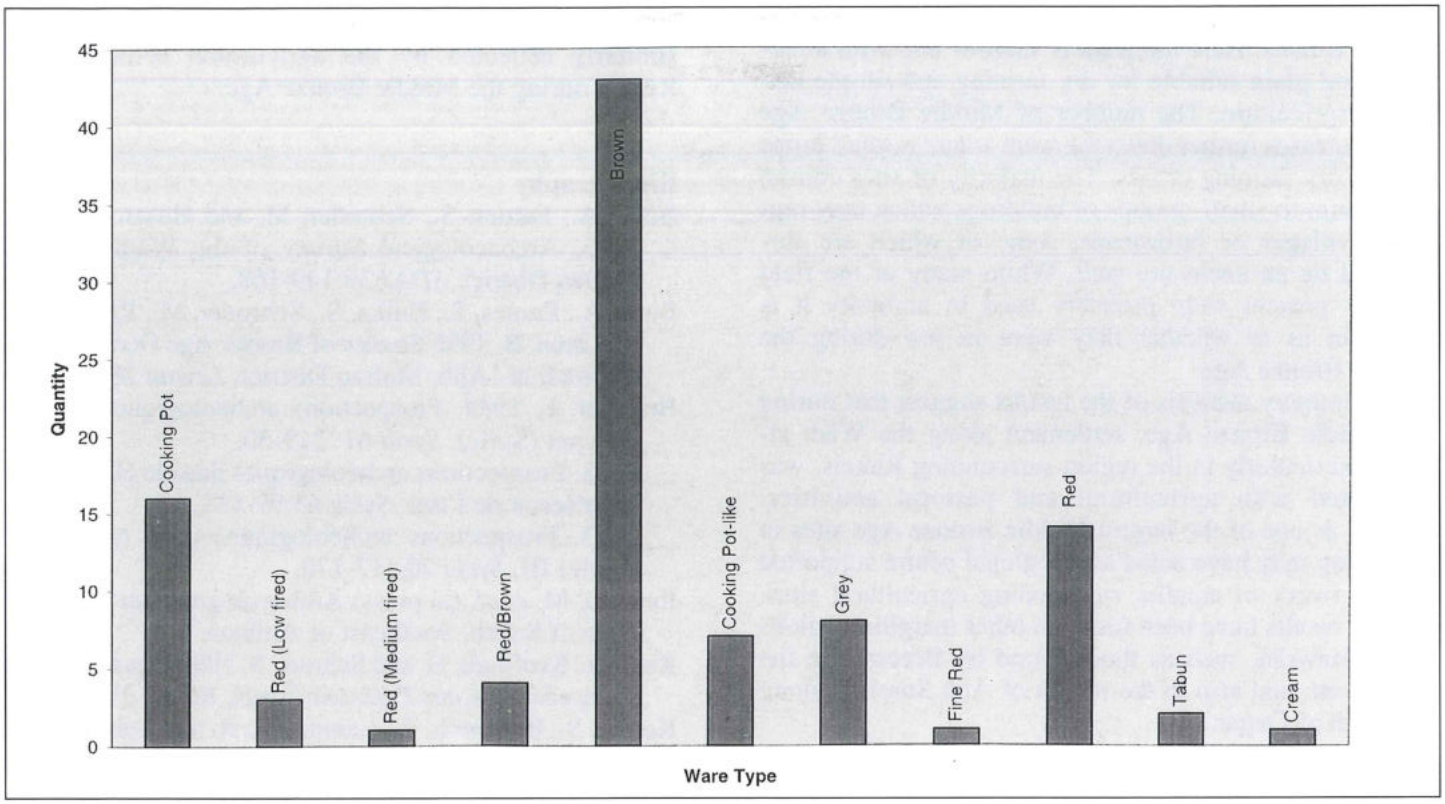
[1] M. Schroder would like to thank Frank Braemer and Cristoph Nicolle for kindly allowing her to examine their Ḥawrān survey material housed in the as-Suwaydā' Museum.



10. Quantity of diagnostics according to probable date of production, Rukeis, (excluding those yet to be dated).



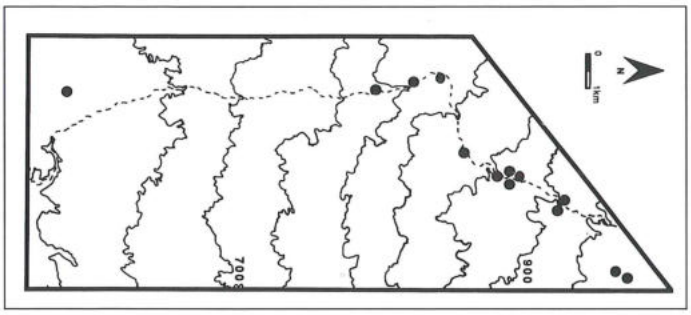
11. Quantity of diagnostics according to form/function, Rukeis (excluding the non-applicable).



12. Quantity of diagnostics according to ware type, Rukeis (excluding the non-applicable).

beyond Ṣabḥa in the south-west (FIG.13). The majority of Middle Bronze Age sites are concentrated along the upper wadi, particularly around the site of Rukeis. They consist mainly of small villages and hamlets as well as some larger villages and small tall sites, some of which are surrounded by an enclosure wall. Further south are a number of smaller Middle Bronze Age walled farmsteads with field systems probably sustained by canal irrigation.

Preliminary analysis of Middle Bronze Age settlements along the Wādī al-'Ājib indicates a pattern similar to that observed by Braemer around the site of Tall Debbeh in the north-west region of the Jabal ad-Drūz (Braemer 1984, 1988 and 1993). In this region Braemer has identified a centralised organisation of villages and peripheral sites of an agricultural nature connected by canals which surround and support the fortified capital of Tall Debbeh (Braemer 1993: 160). Similarly, the pattern of settlement so far identified along the Wādī al-'Ājib indicates that the site of Rukeis may have acted as a local centre surrounded and supported by a series of small agricultural sites.



13. Detailed map of the Wādī al-'Ājib showing the location of Middle Bronze Age sites identified during the 1992 and 1993 surveys.

A survey carried out during the excavation season at Abū Snaslah along the Wādī al-Qaṭṭār produced similar results to those along the Wādī al-'Ājib. The region in which the Wādī al-Qaṭṭār is situated is similar to that of the Ḥawrān, in that it is a marginal zone where the nature of agricultural activities is determined by limited rainfall. While the Wādī al-Qaṭṭār survey located over 200 sites of varying types from the Palaeolithic to Islamic periods the period most represented was, along with the late Chalcolithic, the Middle Bronze Age (Lehmann *et al.* 1991: 59).

The results of excavations at Rukeis indicate that the main period of occupation at the site was during the Middle Bronze Age. While the extent of the Middle Bronze Age remains and the function of the site during this period are unclear, the evidence suggests that Rukeis was at this time enclosed by a simple yet massive stone wall within which existed a settlement of long rectangular basalt-built constructions with small internal rooms and divisions.

The survey of the Wādī al-'Ājib suggests that, prior to the Roman/Byzantine period, the Middle Bronze Age was the most significant period of activity in this region of the Hawrān. The majority of Middle Bronze Age sites were

located along the upper wadi and in the immediate environs of Rukeis. Here the wadi is shallow and with a narrow flood plain suitable for dry farming and simple irrigation agriculture. The number of Middle Bronze Age sites decreases further down the wadi where rainfall drops off and dry farming ceases. The majority of sites consist of medium to small groups of buildings which may represent villages or farmsteads, some of which are surrounded by an enclosure wall. While many of the field systems present were probably used in antiquity it is uncertain as to whether they were in use during the Middle Bronze Age.

Preliminary analysis of the results suggest that during the Middle Bronze Age, settlement along the Wādī al-'Ājib, particularly in the region surrounding Rukeis, was associated with agricultural and pastoral activities. Rukeis, as one of the largest Middle Bronze Age sites in the region may have acted as a regional centre supported by a network of smaller surrounding agricultural sites. Similar results have been found in other marginal regions of the Ḥawrān, such as those found by Braemer in the north-west, and also in the region of Abū Snaslah, along the Wādī al-Qaṭṭār.

The hypothesis that during the Middle Bronze Age Rukeis was the centre of a region participating in agricultural activities is partially confirmed by the ostracon found in Silo 1. The Aramaic inscription suggests that the vessel, identified as a storage jar, held grain and that the stone-lined silo in which it was found may have been a grain storage facility. While no occupational evidence has been found as yet, the ninth century date of both the sherd and the inscription indicates that during the Iron Age Rukeis was an important agricultural settlement and may have acted as the region's central storehouse of local agricultural products. The discovery of the ostracon at Rukeis also suggests that during the Iron Age the southern Ḥawrān was a significant region of agricultural activity, similarly reflected by the agricultural settlement of Rukeis during the Middle Bronze Age.

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Tall Abū al-Kharaz: Occupation Throughout the Ages. The Faunal and Botanical Evidence

Introduction

Tall Abū al-Kharaz, "The Hill of the Father of the Beads", was occupied from the Chalcolithic period until Islamic times except for a break of ca. 1000 years which lasted from the beginning of the Early Bronze Age III until the end of the Middle Bronze Age period (state of excavation November 1994). Major occupations occur during Early Bronze Age II, Late Bronze Age I and II, and Iron Age I and II . However, in this study the higher order of chronological division, namely Early Bronze Age, Late Bronze Age and Iron Age, has been employed, since many shorter and more accurately defined chronological periods did not yield enough bone or charred plant remains samples of adequate size. The annual excavations of *The Swedish Jordan Expedition,* directed since 1989 by the author, have given quite reliable evidence that the city of the Early Bronze Age was the largest settlement, the Late Bronze Age town being the next in size, and the Iron Age citadel the smallest (see Fischer 1991, 1993-96).

The Site

Tall Abū al-Kharaz lies in the central part of the Jordan Valley, north of Wādī al-Yābis. The co-ordinates of its summit, 116 m below msl, are N 200623.07 and E 206196.54 using the Palestine co-ordinate system.

The position of the tall and its surroundings should briefly be discussed. Tall Abū al-Kharaz is located at a strategic point just 4 km east of the River Jordan and above the eastern border of the Jordan Valley north of the point where the perennial stream of Wādī al-Yābis emerges from the eastern hills into the Jordan Valley. Irrigation systems ancient as well as modern can be seen everywhere in the fertile surrounding land. Approximately 4 km to the north is Pella of the Decapolis, and Bayt Shān is approximately 20 km to the north-west. The isolated, huge mound of Tall Abū al-Kharaz lies about 300 m east-south-east of the smaller hillock of Tall al-Maqbarah. It rises about 60 m above its surroundings. The elevation of the valley floor, where the main road runs north/south, is approximately -200 m. A splendid view and an excellent military control over large areas are obtainable from the summit of Tall Abū al-Kharaz (summit elevation -116 m). These areas include Nazareth, Mount Tabor, Bayt Shān, Mount Gilboa, the Samarian mountains and a large part of the northern Jordan Valley.

The area occupied by the tall is approximately 300 m (north-south) x 400 m (east-west). The tall is quite easily defended: steep slopes to the west, north and east are natural obstacles to presumptive invaders. On the gently sloping lower part of the south side of the tall, the most vulnerable side, a number of defensive walls are still visible. The relatively flat summit of the hill is oriented approximately east-west. The "plateau" on the summit measures about 120 m in the east-west and about 90 m in the north-south direction. The upper part of the tall is surrounded by defensive walls of complicated pattern from all the periods found at the site.

The Occupational Pattern

General Reflections

The climatic situation is of great importance to human society. Roberts and Wright (1993:199) stated that the early Holocene in the Mediterranean region was marked by the expansion of trees into areas previously dominated by steppe. The first evidence of a Mediterranean-type of climate, with winter rains and summer draught, appeared about 11,000 years ago. Indicators of Mediterranean-type climates were olive, pistachio and evergreen oak, expanding westwards during the course of the Holocene (Huntley and Birks 1983). Several important pollen sites reveal essential information about the vegetational and climatic sequence. The most important pollen site in the Levant is in the Ghab depression, a long narrow marsh at the northern end of the Dead Sea–Jordan Rift Valley in north-west Syria (Roberts *et al.* 1993:201). By 6,000 BP the proportion of deciduous oak pollen decreased to 20% as the total tree-cover diminished steadily from its early Holocene maxima. It is likely that the climate was drier 6,000 than 9,000 years ago. Another well-dated pollen diagram from the Huleh marsh in the same Rift Valley in Israel shows that oak was reduced between 9,000 and 6,000 years ago about to its present level (Botema and van Zeist 1981).

The decrease in the dimensions of the different cities of Tall Abū al-Kharaz and the major break in occupation are unlikely to be due to one single factor, and there are a

number of plausible hypotheses. One is the increasing difficulty of exploiting available natural resources: the surrounding agricultural land may have been impoverished by overexploitation and lack of knowledge of fertilisers, water may have become scarcer and the amount of game declined.

Another possibility may be that there were an increasing number of smaller centres during the later periods compared with fewer, but larger, ones during the Early Bronze Age. Political circumstances must be considered, too. The important strategic position of the rich site must surely have aroused envy throughout the ages. Substantial ash layers at the end of each major period of occupation, and also within these periods, may be due to enemy attacks. Natural or other man-induced causes for conflagrations must of course also be considered. Epidemic diseases, often not traceable in the skeletal remains, cannot be ruled out as a factor contributing to a major break in occupation. All these and other factors not mentioned in this exposition would certainly have had a crucial influence on the diachronic occupational pattern of Tall Abū al-Kharaz. In this presentation, besides an evaluation of the remains of human activities unearthed by traditional excavation, an effort is made to understand the human occupation of Tall Abū al-Kharaz by diachronic consideration of the faunal and charred plant findings from the habitation area of the different cities.

The Faunal Remains (TABLES 1-4)

The osteological examination of the faunal remains from the 1991-93 excavations was performed by Paul Croft (final report forthcoming). The résumé of the examination presented below is provisional, however, "...the great majority of the identified mammalian specimens have been attributed to taxon with a high degree of confidence, whilst a small proportion of the identifications (chiefly of the rarer taxa) remain tentative at the present time, and require checking. Since the final determination of this very small proportion of the assemblage cannot make much difference to the overall picture, unconfirmed identifications have been taken as correct for the purposes of the present preliminary statement" (pers.com. P. Croft).

The three seasons of excavation yielded a total of 85.5 kg of non-human mammalian bone. The bone was generally well-preserved although rather brittle, no doubt due to the low collagen content reported by the Oxford Radiocarbon Accelerator Unit (Fischer 1995:93-119).

Some 54% by weight of the total bone sample proved identifiable, this fraction comprising 3255 individual identified fragments of non-human mammalian bone. The representation of the various animals in terms both of counts of identified fragments and of bone weights is presented in TABLE 1. Although a relatively broad range of mammals is represented, it is clear that the great majority of animal remains from Tall Abū al-Kharaz whether based on fragment counts or on bone weights represent caprines and cattle. The imbalance in fragment counts between these two main taxa reflects the numerical predominance of the much smaller caprines including significant proportions of both sheep and goats, whilst the slightly greater weight of cattle than of caprine bone emphasises the very great economic significance of cattle in the long-term economic history of the site.

The quantity of the remains of other food animals in the Tall Abū al-Kharaz assemblage is comparatively small, although pig, fallow deer and gazelle were clearly of some significance. Equid, dog, cat and fox remains attest the presence of animals whose importance to the human community may have lain in other attributes than their ability to provide meat. Bear may have been hunted for meat and furs. Hippopotamus may also have been hunted locally, although the few items attributable to this animal, pieces of ivory, may equally well have been acquired by trade. The few rodent remains probably include house mouse (*Mus musculus*) and mole rat (*Spalax leucodon*), and these may also be intrusive.

Table 1. Overall representation of mammalian taxa at Tall Abū al-Kharaz based on total numbers of identified fragments and on bone weights.

	Total ident. frags.	%	Weight (g)	%
Caprines	2250	69.1	18647	40.5
Cattle	679	20.9	21057	45.8
Pig	108	3.3	1444	3.1
Fallow deer	90	2.8	2625	5.7
Gazelle	67	2.1	547	1.2
Dog	18	0.6	588	1.3
Equid	15	0.5	901	2.0
Rodent	11	0.3	2	-
Cat	9	0.3	22	-
Fox	4	0.1	10	-
Brown Bear	2	0.1	148	0.3
Hippo	2	-	14	-
Total identified	3255	100.1	46005	99.9

Small quantities of human remains were also recovered from the habitation area of Tall Abū al-Kharaz and non-mammalian taxa were represented by small amounts of bird bone, and very small amounts of fish, (freshwater?) crab, frog and tortoise/terrapin.

Early Bronze, Late Bronze and Iron Age: A Diachronic View

Counts and percentages of identified fragments of the three most abundant animal taxa at Tall Abū al-Kharaz (namely caprines, cattle and pig) for each of the three major periods represented are shown in TABLE 2. There is a high degree of similarity between the figures for the Early and Late Bronze Age samples, but those for the Iron Age sample suggest that caprines (although still numerically overwhelmingly predominant) were significantly less important and cattle much more important than formerly. In the two Bronze Age periods identified, caprine remains outnumber those of cattle by almost 5:1, whilst in

Table 2. Numbers and percentages of identified bone fragments of caprines, cattle and pig in the Early and Late Bronze Ages and the Iron Age.

	Early Bronze Age		Late Bronze Age		Iron Age	
	n=	%	n=	%	n=	%
Caprines	854	80.1	254	81.2	719	65.8
Cattle	180	16.9	53	16.9	318	29.1
Pig	34	3.0	6	1.9	56	5.1
Total	1068	100.0	313	100.0	1093	100.0

the Iron Age this ratio has fallen to not quite 2:1.

Consideration of weights of identified bone fragments for the three animal taxa for the Early and Late Bronze Ages and for the Iron Age yields a comparable result (TABLE 3). For the Bronze Age periods caprine remains somewhat outweigh those of cattle, whereas in the Iron Age, by contrast, those of cattle considerably outweigh those of caprines.

A further contrast between the Bronze and Iron Ages seems evident from the data on reliable findings of the

Table 3. Weights and percentages of identified bone fragments of caprines, cattle and pig in the Early and Late Bronze Ages and the Iron Age.

	Early Bronze Age		Late Bronze Age		Iron Age	
	g=	%	g=	%	g=	%
Caprines	6493	52.2	1809	55.0	6522	38.1
Cattle	5515	44.3	1396	42.5	9923	57.9
Pig	431	3.5	83	2.5	695	4.1
Total	12439	100.0	3288	100.0	17140	100.1

remains of fallow deer. Deer are considerably more abundant in the Iron Age sub-sample, and this development may probably run concurrently with a decrease in the relative abundance of gazelle (TABLE 4). The reality of this latter trend remains to be properly established, as a number of uncertain identifications of gazelle bones have still to be checked against adequate reference material.

Few of the bird remains have yet been identified, but it is clear that they derive from a wide diversity of species.

Table 4. Relative abundance of fallow deer and gazelle remains relative to those of the three most abundant taxa. Abundance of identified fragments and weights of identified fallow deer and gazelle are expressed as a percentage of the combined total of identified fragments/combined weights of caprines, cattle and pig for each period sub-sample.

	Fallow deer		Gazelle	
	Fragments	Weight	Fragments	Weight
Early Bronze Age	1.2	1.6	2.4	1.8
Late Bronze Age	2.2	3.0	4.2	3.0
Iron Age	5.4	11.0	1.2	0.7

Apart from deer and gazelle, bird is the only minor taxon to be represented by sufficiently numerous specimens for comparison of their relative abundance in the various periods to be potentially interpretable.

In the case of birds, where there is a wide diversity of species, no trend through time is discernible. The small number of bird and fish remains suggests that the hunting of birds and fishing persisted throughout as a minor economic activity.

The Charred Plant Remains (FIGS. 1-13)

The charred plant remains from Tall Abū al-Kharaz have been recovered by bulk flotation of approximately 770 litres of soil from 22 soil samples (approximately 35 litres each), and were analysed by Tim Holden, *AOC (Scotland) Ltd.* The following presentation is a synopsis of the final report (forthcoming).

The 22 samples derive from Early and Late Bronze Age, and Iron Age contexts. They comprise approximately 10.5 litres floated volume. The samples were sorted using a low-powered binocular microscope and carbonised plant remains of economic or environmental relevance were removed. In some cases, where the volume of charred material was great, a fraction of the total was sorted following separation using a standard geological sample splitter. All identifications were made using the reference collections of *AOC (Scotland) Ltd* and the Department of Archaeology and Prehistory, University of Sheffield. Botanical nomenclature for non-cereal species generally follows the Flora Europaea (Tutin *et al.* 1964-80).

Early Bronze Age

The species present are dominated by the grains of einkorn/emmer wheat with the majority of the grain being morphologically similar to two-grained einkorn. Some of the grains were, however, more closely identified with emmer. In contrast, the chaff was clearly dominated by emmer although einkorn was also present in small amounts. These chaff elements are more reliable in distinguishing between emmer and einkorn than are the grains themselves. In view of this many of the grains put into an emmer/einkorn category (above) were probably also emmer. Lesser quantities of two-rowed hulled barley were present. Rare twisted grains and apparently naked ones give the impression that rare six-rowed hulled barley and naked barley could also have been present but in very low numbers.

In all cases the chaff remains were much fewer in number than the grains themselves. This together with the absence of many of the small-seeded weed species could be taken to indicate that the crop had been well-cleaned of all but the larger contaminants represented by spikelet forks and seeds such as those of *Lolium* sp (rye grass). Following the scheme of crop processing presented by Hillman (1984) this would be consistent with a prime

grain fraction during the final stages of crop cleaning. Such an assemblage could have been burnt while in storage or during food preparation. It is, however, also possible that the grain and chaff represent a mixing of different cereal fractions, one consisting of clean grain and a second consisting of a waste fraction containing the more dense cereal chaff elements and larger weed seeds. If this mixing had occurred then this could, to some extent, explain the differing ratios of einkorn/emmer-like features in the chaff and grain.

Other cultivated species recovered in much smaller numbers include broad bean *(Vicia faba)* and lentil (*Lens culinaris*) which would have been important protein-rich food resources. Flax *(Linum usitatissimum)* and olive *(Olea europaea)* were recovered from different samples and might have been cultivated as a source of oil or for their fibre or edible fruits respectively. The remains of fig are present. Finally, evidence for grape *(Vitis vinifera)* in the form of the whole dried fruits and the pips was recovered from three samples. The pips could have derived from eating either the fresh fruits or from wine making but it would seem most likely that fruits, which must have been burnt while in a dry condition, represent the remains of a dried grape product such as raisins. The presence of these non-cereal cultivars, particularly grape pips and olive stones which could have been disposed of into the fire once the fruits had been consumed, might suggest that some of the carbonised debris derived from domestic waste. It would, however, seem more likely that the larger quantities of cereal grain were the product of the burning of grain while being bulk-processed or while in storage.

Non-crop species were dominated by members of the grass family but, with the exception of the grains of *Lolium* sp (rye grass) and *Bromus* sp., are not abundant. This genus contains a number of species which are common components of the weed flora of cultivated fields, such as *Chenopodium* sp, *Amaranthus* sp. and *Malva* sp. They are all typical weeds of cultivation which were probably brought to the site with the crops. It is therefore likely to represent a contaminant of the cereal crops. One further identification of note is that of small-fruited (4-5 mm) species of *Pistacia* sp. which could have been used economically for its oil, or its flavouring or as a food (Hedrick 1972; Rivera and de Castro 1991).

The legume *Scorpiurus muricatus* L. is present in large numbers. This species is a common component of agricultural fields (Townsend 1974) and is common in the Jordan Valley (Zohary 1972). One explanation for its presence could be that the crop with which it probably arrived, originated from a different area from the others. It is, for example, interesting to note that this species was very common in Bronze Age contexts from the site of Tall ash-Shūna located only few a kilometres to the north of Tall Abū al-Kharaz but in an area where there is more alluvial valley bottom suitable for cultivation.

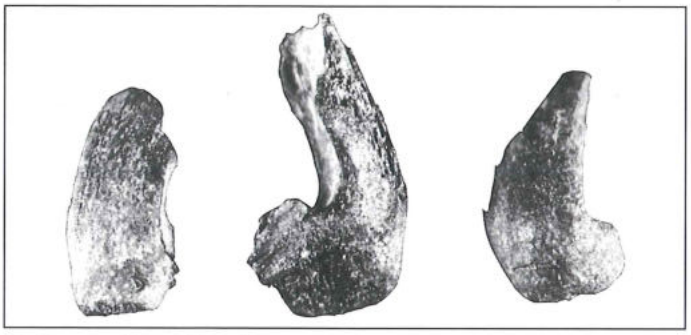
Late Bronze Age

The dominant cereal remains are the grains of hulled two-rowed barley although there are also large numbers of grains of emmer/einkorn grain accompanied by a much smaller quantity of emmer chaff and caryopses of *Lolium* sp. This assemblage indicates the charring of a cleaned prime crop. The number of grains present suggests the destruction of stored contexts rather than a casual build-up of debris. The presence of both barley and wheat indicates that different stored products which were possibly being stored side by side have become intermixed during the burning of the store room.

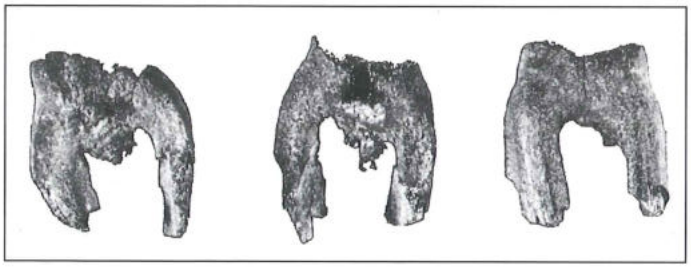
Iron Age

The charred plant assemblage is dominated by hulled two-rowed barley with only minor amounts of wheat.

The non-crop seed element from this last sample would be consistent with the common weeds of cultivation although in view of the small quantities of grain recovered they may have been brought to the site by some other means. Most are readily adapted to high levels of soil disturbance and so could have been growing over many of the less intensively used parts of the site.



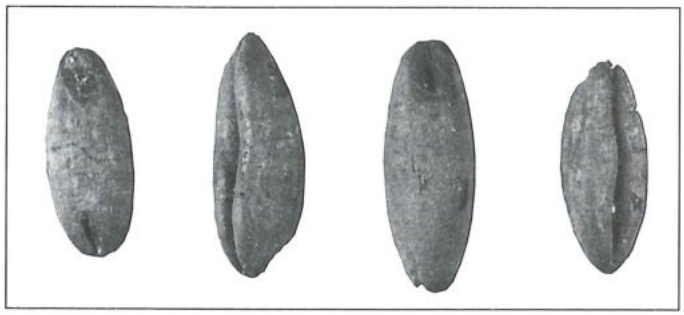
1. Emmer wheat, glume base.



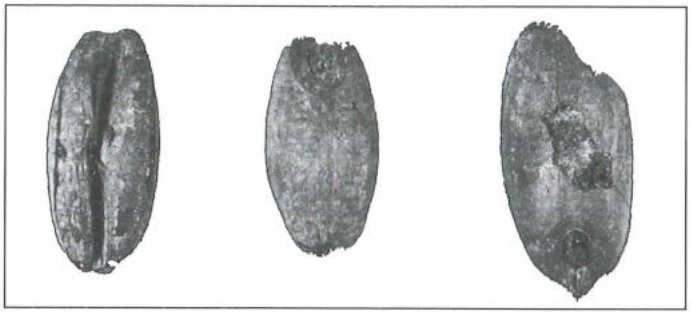
2. Emmer wheat, spikelet fork.



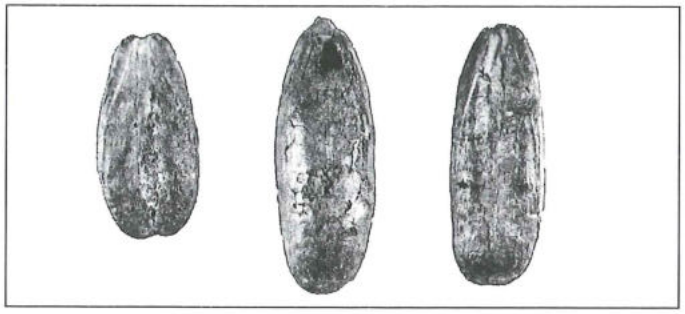
3. Emmer wheat, caryopsis.



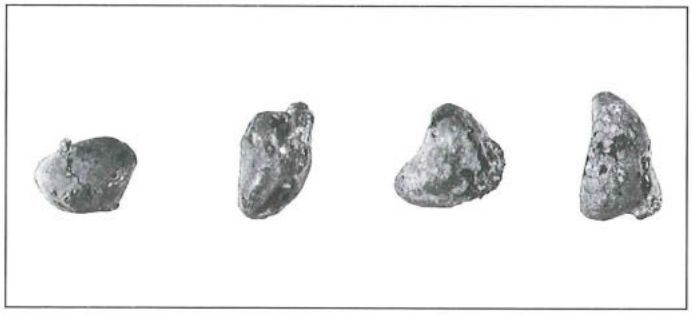
4. Einkorn wheat, caryopsis.



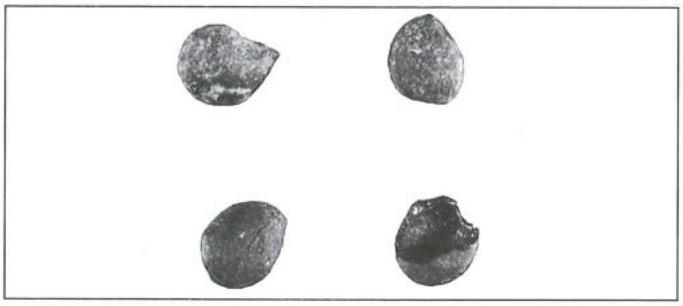
5. Hulled barley, two-row,cary opsis.



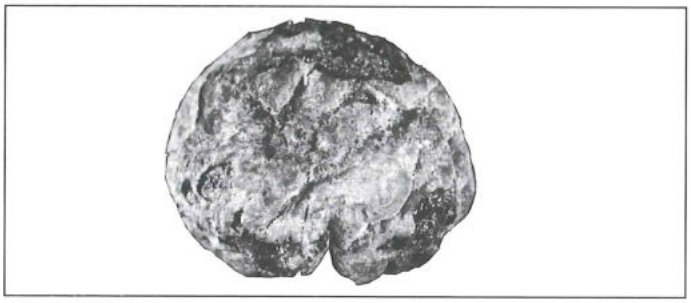
6. Rye-grass, caryopsis.



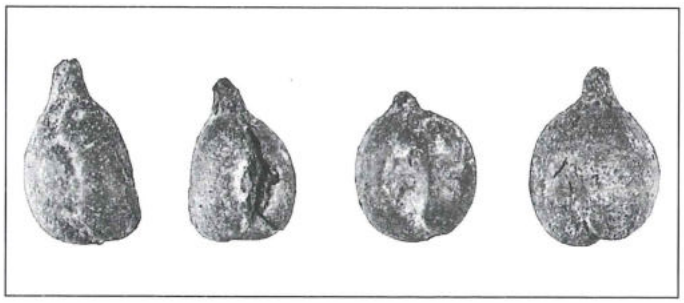
7. Seed, Scorpiurus muricatus L.



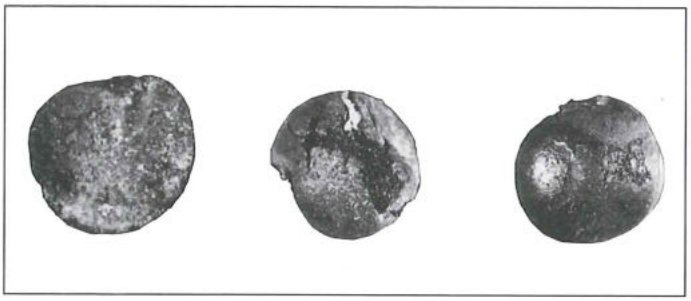
8. Fig, pip.



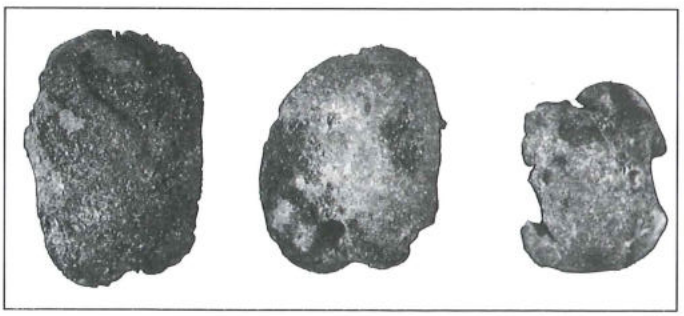
9. Grape, fruit.



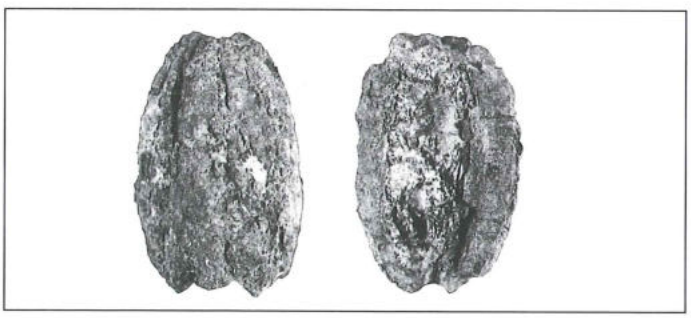
10. Grape, seed.



11. Lentil, seed.



12. Broad bean, seed.



13. Olive, stone.

Discussion

During the five seasons of excavation it was generally observed that the great majority of findings of stored cereals, both in number and in amount were in the Early Bronze Age strata; findings in the Late Bronze Age strata were much less frequent and those in the Iron Age strata were sparse. Cereals from the Early Bronze Age were usually stored in large jars, but wooden containers were also used (Fischer 1993: 285) together with circular stone silos (report forthcoming). In Area 2, for example, several cubic metres of grain were found in such containers during the 1989, 91 and 93 excavations.

The considerable amount of stored grain from the Early Bronze Age suggests that the area from which it derives was a centrally administrated grain storage area: the excavated amount of grain is far too much to be used by a single household. The grain was no doubt distributed by a central administration within the city, but was certainly also of economic significance as a medium of exchange for coveted goods, for example copper. Grain accumulations from Late Bronze Age strata were found in storage jars, in one case close to a plastered room forming a sort of basin which was used as a silo. The amount of grain found in this room might possibly belong to a single household. Large containers for grain have not yet been found in Iron Age strata.

The charred plant remains analysed are dominated by the cereals, primarily the grains but also lesser quantities of the more resistant chaff fragments. In many of the samples a high proportion of the total carbonised material is made up of grains, giving rise to the supposition that it was the result of the burning of storage contexts. In some cases the charred debris would appear to have accumulated *in situ,* but in others it is possible that it represents secondary deposits of dumped charred grain. The actual composition of most of the samples supports the suggestion that they were from storage contexts. They consist of clean grain with few chaff or seed contaminants and therefore represent the prime grain product in the final stages of processing. The crop was probably stored in this condition and any further cleaning would have been undertaken piecemeal, possibly by hand picking, for example as a prelude to food production or packing. The dominant components recovered from these burnt storage deposits are either two-rowed hulled barley or einkorn/emmer wheat (see above) with some samples showing high numbers of both wheat and barley. These cereals were clearly being stored in considerable quantities, sometimes separately and sometimes side by side.

Legumes such as lentil and broad bean are also present in some samples but they are never recovered in such high concentrations as the cereals. This can be interpreted in a number of ways. Perhaps, the legumes were being stored but not, as it happens, in any of the contexts that have been excavated, or perhaps they were not stored in the same way or the same places as the cereals. Possibly the most likely explanation is that they were only a minor part of the site economy. At present we are not in a position to answer these questions but it is perplexing that when legumes are recovered they appear to be in those loci which also contain other non-cereal cultivars such as olive and grape. If, as seems likely, these deposits represent accumulations of domestic waste rather than burnt storage deposits, it shows that legumes were being used but not, apparently, stored in large quantities.

In addition to the legumes other cultivated plants include flax, fig, olive and grape (including dried fruits). There is no reason why these could not have been growing in the vicinity of the site since all have been demonstrated for earlier periods. The wood of olive and grape from, for example, the Early Bronze Age II period at Jericho (Hopf 1983) adds weight to the evidence of their being cultivated locally, probably using irrigation, rather than being imports from elsewhere. There is little evidence to suggest that these resources were being stored on the site and they seem to be more common in the putative domestic refuse deposits.

The element of weed seed is small compared to the quantity of grain recovered. In those samples dominated by barley the non-cereal element is particularly sparse. The results also seem to show that taxa such as rye grass (*Lolium* sp) are more closely associated with wheat than barley at this site. One explanation for this might lie in the sieve sizes used in the cleaning of the different crops. The sieves used for barley might well tend to remove the grains of rye grass whereas the wheat ones would not. Alternatively the rye grass might be a reflection of the field ecology of the two cereals or the value that the population placed upon them. Is it possible that the rye grass was more prevalent in irrigated fields or on richer alluvial soils and that it does not grow on poorer saline soils where barley might be expected to compete preferentially?

Summarizing the analyses of the charred plant remains it can be stated that a clear diachronic pattern cannot be observed. However, a preliminary conclusion is that cereals were of much greater importance to the site economy during the Early Bronze Age than during the Iron Age. It is clear that a better knowledge of the field ecology would help our interpretation and that if these suppositions are correct it could have important implications for our understanding of the site economy.

A clear diachronic pattern can be discerned in the results of the osteological investigation. It has already been pointed out that the figures in TABLES 2 and 3 imply a high degree of similarity between the Early and Late Bronze Age samples, but suggest a different situation during the Iron Age: the still predominant caprines were significantly less important and cattle much more important than formerly. No clear contrast can be seen in the case of pigs. They are at their most abundant during the Iron Age, but they never exceed 5.1% by numbers, and 4.1% by weight. They were obviously of subordinate economic value.

A further contrast emerges from the data on relative abundance of fallow deer (TABLE 4): deer are more abundant in the Iron Age sub-sample and this may run concurrently with the decrease in the relative abundance of gazelle. If the two trends (the increase in deer and the decrease in gazelle) do prove to be concurrent this could indicate either an environmental shift from more steppe-like, open conditions to a somewhat more vegetated landscape affording increased cover for deer. Alternatively it may simply indicate a shift away from the exploitation of the resources of the steppe biotope towards a greater emphasis upon hunting in less arid areas. Another possibility might be that deer became a (semi-domestic?) animal and was therefore of greater economic importance than gazelle.

In conclusion, it may be stated that there is evidence that einkorn/emmer wheat together with sheep and goats, was the backbone of the Bronze Age economy of Tall Abū al-Kharaz, whereas during the Iron Age, cattle were of greater and cereal products of lesser economic importance than in the earlier periods.

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A History of Occupational Changes at the Site of the Hippodrome of Gerasa*

INTRODUCTION

In the first century AD Gerasa was a city in the making. By the end of that century its nucleus had already been architecturally formed but it hardly presaged the changes in the urban landscape which, starting from the nucleus, was to develop in the following century. By the early decades of the third century the architectural development of Gerasa was accomplished (see e.g. Seigne 1992: 331 passim). The main cultic and secular complexes were in place and the occupational nature of the particular quarters of the city was defined. Since then and until the sixth century there were few changes in the occupational pattern within the urban complex, surrounded by a city wall at the turn of the third century (Seigne 1986:55,59; 1992:341 and Fig.9).

The history of the site of the hippodrome was different. Here the type of occupation changed frequently. The area entered the history of the city as a cemetery site possibly after the quarrying for stones had already begun.[1] Some scholars assume that the area had been earmarked for eventual urban expansion southward from the nucleus. In reality it became a place for chariot racing only to be turned shortly after into an industrial suburb, left well outside the city wall of Gerasa and clustered within and around the building of the hippodrome. It is the latter occupation that lasted longest and meant the final use of the building and its vicinity as an organised space. After the abandonment of the area the hippodrome was used once more but this time, due to its isolation from the population at large, as a place of mass burials for the victims of the mid-seventh century plague (Hendrix 1995).

FROM THE FIRST TO THE THIRD CENTURY AD

As in most ancient cities, the cemetery developed along the suburban section of the road connecting Gerasa with Philadelphia. The cemetery stretched for a length of about 800m southward from the nucleus of Gerasa at a width of 60-100m. The tombs were of the hypogean type some of which had been surmounted by superstructures (see Seigne and Morin 1995; Abu Dalu 1995). However, little is known about the cemetery and even less of the tombs as only a few have been properly excavated and even fewer have been published (Ma'ayah 1960:115; Zayadine 1986:12-16). The cemetery area closest to the Hadrianic Arch and the hippodrome is better known, including the eleven tombs found there.

Tombs 1, 2 and 3 were excavated in the 60's without leaving a record behind. Tombs 4 and 5 were discovered when greater parts of their burial chambers were bulldozed during the construction of the now older Amman-Irbid road; there is no publication either. Tombs 7 and 8 were excavated in 1993 (Abu Dalu 1995) and the plans mapped by an IFAPO team of architects then working at Jarash.[2] Dromos 9 belongs to a tomb the construction of which was never finished. Tomb 10 and Grave 11 were found in 1985 and 1992 during excavation between the foundation walls of chambers E45 (Ostrasz 1989:55,72; Figs.2 and 7b) and E28 of the hippodrome. All these tombs are closely associated with the road linking Gerasa and Philadelphia.

The course of the road in this area is attested by wheel ruts in the 'floor' (top of the foundation wall) of the east archway of the Hadrianic Arch and by cuts in the rock north of it. The cuts mark the east and west sides of the road, being 2.6m wide at this point. The terminal north section of the road passed through the South Gate which is again attested by wheel ruts in the thresholds of the central and west archways of the gate (Seigne 1986: Figs.10-12).

Between these two gateways, about 450m apart, the course of the road can be redrawn for a length of about 100m northward from the Hadrianic Arch, passing west

* For plans of the hippodrome, see esp. Ostrasz 1991 and 1995a.

1 See below. Foundation deposits of the hippodrome contained a good number of misfired ceramics of the first century BC/AD and two matrixes for lamp moulds of the first and early second century AD were found mixed with discarded ceramics in Late Roman kiln dumps in the chambers of the hippodrome. One may safely suggest that the former belonged to potters' kilns within the compound of what was then the cemetery. That potters established themselves within cemetery grounds is well attested as in the case of, e.g. the Kerameikos, Athens, which was then the potters' quarter at the necropolis in the Geometric period. The products of these potteries were primarily meant for the burials which is evidenced in the rich tomb deposits there as well as here in Gerasa.

2 What was thought to be Tomb 6 at the north-west corner of the church of Bishop Marianos turned out to be a cavity in the bedrock cut by the quarrymen.

of Tombs 1-3 and 7-9 and east of the outer wall of the future hippodrome. Such supposition is warranted by the alignment and orientation of these tombs. The road did not follow a straight line; it ran askew in relation to the Hadrianic Arch and the line of the outer wall of the hippodrome, following the least slope of the rock. Further north the course of the road is not retraceable. It probably followed as before the contour of the terrain which is not known there apart from that it sloped considerably down northward and then upward towards the South Gate.

The road was not built but at some points the rocky surface may have been roughly levelled and at others cavities in the rock filled to form an approximately even surface, as was the case of the short section north of the east archway of the Hadrianic Arch. In fact, the road was not much more than a track and was never paved. The wheel ruts in the archways of the Hadrianic Arch and the South Gate show the course of the road from about 130 AD, the approximate date of construction of the arch and the supposed date of construction of the gate (Seigne and Wagner 1992).[3]

The road followed, then, this course from the second half of the first century AD on but it is probable that the route was established much earlier, from the earliest period of urban development of Gerasa. Whether the pre-hippodrome area crossed by this road was used for burials at that early period is not known. Seigne seems to suppose so (1992: Fig.2) but this supposition is yet to be confirmed. The earliest burial deposits (in Tombs 7 and 8) date to the first centuries BC/AD (Abu Dalu 1995), but this is a rather broad date as its *terminus post quem* is ca 50 BC whilst the *post quem* non is ca 75 AD (Braemer 1986:63 and n.49). All the finds prove is that the tombs were built not later than in the last quarter of the first centuryAD.

Damage inflicted by quarrymen on parts of a hypogean chamber of a tomb (Tomb 10) suggests ignorance of its existence in the quarried area. This also means the quarry was in operation even during the use of the area as a cemetery and possibly after – during (and for) the construction of the Hadrianic Arch – but not by the time the hippodrome was built. Whilst the urban planning of this area and thus the building of the Hadrianic Arch (first stage) may have spelt the end of the cemetery, the construction of the hippodrome (second stage) provides the ceiling date for both the cemetery and the quarry.[4]

The building of the Hadrianic Arch marks the beginning of the next phase in the history of occupation of the site. Detweiler (1938:81), Kraeling (1938:50-51) and recently Seigne (1992:337 and Fig.6) interpret the location of the arch there as the indication of a planned extension of the city southward, conceived at the time or shortly after Hadrian's visit in Gerasa. This hypothesis seems to imply that the site was intended to become an additional built-up area of the city. It is open to questioning.

Apart from the Hadrianic Arch itself (and later the hippodrome), the only secular building known to have been erected south of the nucleus of the city is represented by the remains of two (?) modest rooms south-west of the South Gate and dated to a period between AD130 and 200 (Seigne 1986: Figs. 10 and 11-grids 10333/Z through AA). Only 50m south from that place is a hypogean tomb surmounted by a tower, situated west and very close to the line of the Gerasa-Philadelphia road. This tomb seems to be one of many in the cemetery shown in the plan published by Schumacher in 1902. According to Schumacher, this part of the south cemetery stretched from there to the very apex of the semi-circular end of the hippodrome and for about 120m westward from the line of the road (Schumacher 1902: Taf.6). It is true that Schumacher's accounts must be viewed with utmost caution which one is forced to when examining his reconstruction of the architecture of the hippodrome and his surprisingly wrong recording of the position of the Hadrianic Arch in relation to the hippodrome (Schumacher 1902:155ff., Abb.33,34; Taf. 6,7). However, notwithstanding Schumacher's fantasizing on the subject, it hard to suppose that he had invented the existence and territorial extent of the cemetery in this area.

Since Schumacher's time sedimentary dirt covered the whole area and in the recent decades a large earth platform and a restaurant were built over a larger part of it which make checking his account practically impossible. Nevertheless, several tombs are still recognizable in the westernmost part of the cemetery and one tomb seems to exist ca 10m north of the hippodrome which gives some credibility to Schumacher's account of the extent of the cemetery. Almost all tombs in this cemetery would have had to have been disused had the extension of the city southward begun to take place. It never did but had it ever been planned? The hypothesis, that it had been planned, rests on the evidence of the location of the Hadrianic Arch and of a constructional feature of the east face of the arch (Detweiler 1938: 81 and Plan II) interpreted as the provision for future construction of the city wall which supposedly would abutt against the building. The interpretation is debatable. The location of the Hadrianic Arch may have been meant to mark the point of entry into the area of the city. The North Gate, about two decades earlier (Detweiler 1938:117; Welles 1938: inscr. 56/57) seems to have been built for just such a purpose. It is not impossible that the city wall was planned to include this southern area of Gerasa within its circuit, but this does not rule out the possibility that the area was planned just for what it

[3] The course of the road was almost the same at the site of the South Gate in the second half of the first century AD, cf. Seigne 1986:45.The same is true for the pre-hippodrome area, suggested by the alignment and orientation of the tombs built prior to the construction of the Hadrianic Arch. Two of the tombs belong to the last decades of the first century AD, see below.

[4] Ornate architectural blocks of a first century mausoleum in the area were found in the dromoi of Tombs 7 and 8, cf. Abu Dalu 1995, and some of the blocks were used to build the core of the arch, cf. Seigne and Morin 1995. The latest burial deposits in the tombs date to the earlier part of the second century AD, a date which fits the disuse of the tomb and the building of the arch.

eventually became: the site of the hippodrome. In this case the hippodrome would have been seen as the architectural extension of the urban complex. Marking the entrance into this complex by a monumental gate would have been a reasonable solution. Another city of the Decapolis, Gadara, offers an example of an almost identical association of the hippodrome-road-monumental gate (Kerner and Hoffmann 1993:Fig.5), conceived about a century later (Hoffmann 1990:330; Kerner and Hoffmann 1993:366). Gerasa may well have been the model.

Once the construction of the Hadrianic Arch was accomplished, this part of the cemetery may have ceased to be used but the site was not immediately occupied otherwise. The change in the nature of occupation ensued only when the construction of the hippodrome was undertaken and achieved, that is to say between the mid-second century and 209-212 AD (Kehrberg 1989:85-87; Ostrasz 1989:71). From that time on the area was transformed by becoming a place for chariot racing – however, not for long! Due to exceptionally poor founding of the structure and poor building technique, the masonry of the hippodrome deteriorated very soon after the construction to the point where racing could no longer be held (for reasons of safety). Not later than by the end of the third century the hippodrome ceased to serve its primary function (Ostrasz 1995b: 189).

FROM THE LATE THIRD TO THE EARLY SEVENTH CENTURY

When the charioteers abandoned the hippodrome, potters and other craftsmen took over the building and its site. From the end of the third century right through the beginning of the seventh century the area developed into a large industrial centre, notable mainly for its ceramic production. For over three centuries the chambers of the building housed pottery kilns, installations for blunging clay and calcium carbonate substances (also produced on the site) and basins for water storage. Some chambers were adapted for dwelling but most were used for dumping discarded waste products of the kilns. As the waste spread gradually outside the confines of the building, so did the building of kilns which, by the later sixth century, occupied the outer periphery of the hippodrome. By that time the building and the whole site of the former hippodrome had become a substantial industrial suburb of Byzantine Gerasa. In 570 AD a small church was built there (Gawlikowski and Musa 1986) apparently for, and perhaps by, the community living and working there.

Evidence of Architecture

Architectural evidence for the reuse of the building of the hippodrome is presented by the remains of intrusive structures revealed in almost all excavated chambers. The chambers (9.6 x 3.6m in the straight and 9.6 x 3.0/4.2m large in the semi-circular parts of the hippodrome) formed the constructional system supporting the seating tiers set over their stepped vaulting. They were entered through doorways (1.5m wide and 2.4m high) built in the outer wall of the hippodrome. At the podium wall (facing the arena) the chambers were about 3m and at the outer wall about 10m high. Such as they were, they did not suit the requirements of the new users and they had to be adapted the fit their needs.

The architectural repertoire of these adaptations appears to have been limited to a few simple solutions, one of which was building a wall across the chamber to make a smaller room. If such a room was put in the chamber at the podium wall end, the room was entered from the arena through a doorway cut in the podium wall. Whenever the smaller room was put close to the outer wall of the chamber, the original large doorway was blocked with a wall in which a narrower new entrance (0.7 - 0.8m wide) was built. From there a flight of several steps led into the room from the threshold of the new door down to the 'floor level' of the occupied room. The steps were necessary because of the difference in level (0.8 -1.0m) between the top of the original constructional earth fill of the chambers ('floor level' of the new room) and the walking level of the outer periphery of the hippodrome, that is the level of the original thresholds of the outer doorways.

The primary structure of the hippodrome included also small closed rooms (3.6 x 3.0m) between the podium wall and the substructure of the vomitoria type B (Ostrasz 1989: Fig.3; 1991: Fig.1), not accessible from anywhere outside them. Cutting doorways in the podium or the transverse walls (separating the neighbouring chambers) was all that the new occupants of the building had to do to use these rooms without any further adjustments.

The original chambers were from 8 - 10m high at the outer wall. To reduce the height, many of the installed rooms close to this wall were provided with roofing put at about 3m above the 'floor level'. That there was a new ceiling is attested by a series of slots, apparently for wooden beams, cut at uniform height in the face of the opposite transverse walls of the chambers. The beams probably bore mats and/or reeds daubed with mud.

Only some rooms were floored with stone slabs and/or terracotta tiles but in most cases the new rooms kept the dirt floor made up of the original earth fill (foundation fill) in the chambers.

Stones of the masonry of the hippodrome were recycled for the intrusive structures – it is most likely that the 'quarrying' source was the masonry of the south-west part of the hippodrome which had collapsed earliest(on the destruction phases of the building see Ostrasz 1995b:188-191).

The quality of the masonry of the intrusive structures was extremely poor. The stones were laid on earth, rubble and stone chips (as in the primary structure) but no principle of building in constructional uniformly horizontal

courses was followed and the width of a particular wall varied from one section to another. This building 'technique' bears witness to an amateurish manner – no professional masons were employed here.

The excavation of the chambers revealed four distinct types of installations associated with the industrial productions there: 1) large pottery vats aligned in rows stretching along the transverse and podium walls and placed on the 'floor' of the chambers. All vessels were found more or less half-filled with a dried-up solution of the calcium carbonate substance. This installation was usually covered by a thick layer of dirt mixed with large amounts of discarded misfired ceramics, that is the former had by then ceased its production; 2) small basins built of stone and plastered or tiled on the inside. The basins are also placed along the transverse and podium walls and rest on the floor level. In some cases the basins alternated in a particular row with the pottery vats. Some basins were found with the dried chalky solution while others contained only dirt and again large quantities of pottery sherds; 3) in three chambers were found large basins about 2m wide and stretching across the whole width of the chambers, along the inner face of the podium wall. The basins were dug in the original earth fill ('dirt floor') of the chambers to a depth of 2.0 - 2.5m. The foundations of the podium and transverse walls made up the three 'walls' of the basins while the fourth one, across the chamber, was built against the dug-out section of the earth fill. Fragments of hard plaster which once covered the walls of the basins have survived in all three, the evidence of which points to the use as water storage. About the top three-quarters of the basins were filled with stone tumble of the walls and vaulting of the chambers while the bottom layer inside them consisted again of earth mixed with large amounts of misfired ceramics. 4) Among the various installations, the pride of finds needs go to the fourth type: the kilns. Remains or traces, in most cases the latter, of pottery kilns and two lime kilns have been found in the building and on its outer periphery. Unfortunately, the kilns built inside the chambers were almost completely demolished in ancient times. In chambers E32 and E40 only traces of their fire boxes have survived on the thresholds of the doorways leading into the chambers, in chamber E29 is left but a roughly round cut in the stones of the lower steps there and a burnt fragment of the round inner face of the kiln. Other examples consist of building material for kilns (also made at the hippodrome), like the round 'bricks' for the internal pilasters, deep layers of concentrated burnt patches on the floor and abutting walls, and on and so on. The burns bear witness to high temperatures which must have affected the stonework for a long time, which can best be explained by the existence of kilns built against the walls of the chambers.

Among other fragmentary evidence, more substantial remains of a complex of three kilns were found outside, east of the outer wall of the hippodrome, in front of chambers E36 - E38 (Abu Dalu 1993).

The raw material for the production of lime in the lime kilns at the site was the actual stones of the hippodrome - stones distinctly belonging to particular parts of the building were found half-burnt inside the kilns, the final remains of the cycle before the production closed down.

What has been presented so far illustrates cumulatively the nature of reuse of the chambers and the environs of the building over three centuries. However, particular chambers did not serve permanently the same use for the whole period. Most chambers display evidence for a superposition of different kinds of use in chronological sequence. Some chambers initially adapted for dwellings were subsequently converted into pottery workshops. There were chambers which from the start of reuse of the building housed the industrial installations but which subsequently were used just for dumping discarded ceramics. Some other chambers were used for dwelling or industrial purposes after they had ceases to be waste dumps. In the latest phase of reuse of the building most chambers and areas outside them, especially the areas north-west of the hippodrome, were used for dumping misfired ceramics.

Some chambers of the hippodrome may have been used intermittently already in the time when chariot racing was still going on. In many chambers there are small patches (ca 0.2-0.3 sq.m) superficially burnt on the face of the walls, in all cases just above the 'floor level';no structures whatsoever that could be associated with these burns have been found. The size and nature of the burns suggest small fireplaces as one would use for cooking and heating the closest surrounding space, a squatter's type transient accommodation. These were found mainly in the southern part of the building, while the earliest 'permanent' dwellings described above were concentrated mainly in the northern part of the hippodrome. The permanent tennants established themselves in the chambers as early as in the Late Roman period and the occupation lasted right through the fourth century and some through later periods. The earliest industrial installations (vats, basins, kilns) date to the same period.

Finally, it is interesting to note that there is a distinct pattern in the distribution of the particular kinds of chambers, the arena and the area around the building. Almost all permanent dwellings were centred on the arena, that is to say, they were entered from this part of the hippodrome. In the period in question, the north part of the arena became a huge 'courtyard' for the common use of the dwellers living in that part of the building. Never at any time in the over 300 years of secondary occupation was the arena littered with industrial waste or built on.

Evidence of Ceramics

The value of the enormous waste dumps of the Late Roman and Byzantine kilns cannot be exaggerated. Vast amounts of misfired, broken and unfired pottery, lamps

and other ceramic products (pipes, tiles, terracottas) were discarded by the potteries in untidy heaps within and outside the chambers of the hippodrome (supra). The dumps of Late Roman kilns were often superseded by waste of Byzantine kilns, although quite a number of chambers were filled to the 'brim' with dump from a one-period production.[5]

A little after the abandonment of the hippodrome by the end of the Late Byzantine period (early seventh century), the contents of the chambers were sealed by the collapsed masonry of the cavea of the hippodrome (on earthquakes,see Ostrasz 1989 and 1991; Kehrberg and Ostrasz 1994), which left intact material evidence of vast proportions of two clearly defined historical periods.

The sheer size of the 'waste products' is convincing proof of large-scale productions over a long period of time and represents most probably the largest industrial complex at Gerasa in antiquity. Most of our knowledge of Roman and Byzantine ceramics (as indeed all others) is based on finds in settlement and other domestic deposits of human occupation where the typological range of objects is limited to the function within the find context. In contrast, a site of manufacture can offer a complete range of, as in this case, ceramic merchandise albeit as industrial waste deposits.

These spoilt products are then the source material for establishing a tightly knit typology of wares and forms. The waste provides a unique opportunity to study the gradual succession of types, of fashion overlaps, regional and workshop variations and, so important for historical studies, all within a secure chronological frame. In addition, there is technical information with regard to the various stages of ceramic manufacture up to the point of how much and with what types of objects a kiln is stacked for one firing. It also provides a glimpse into the organization of trade in ceramics. The investigation and evaluation of the hippodrome deposits is the subject of many years of study, some preliminary results of which are presented here.

Catalogue of Forms and Wares

In general, the ceramics found in the hippodrome are not an unknown quantity of Roman and Byzantine pottery. What the hippodrome dumps offer lies rather in the specific: in the completeness of specific forms, in the closing of gaps in a flawed typological series, in filling the missing links between a variety of forms and in tightening and correcting the dating of certain types. In addition, one gains a microscopic insight of the minute (and often unintentional !) variations of a shape. This in itself may not be of great importance but it will undoubtedly lead to a better understanding of the norms of production as they were then. It should, ultimately, help point to where research, based on previous lack of data, has led to wrong assumptions. There are variations of forms - bowls, jars or lamps- the new classification of types and variants thereof do no longer fit the established typology which was devised over decades and used so far as a parallel for the study of other assemblages.

The hippodrome evidence allows one to reconsider the question of continuity of by us culturally determined and 'frozen' types with new regard to continuity of the producer, that is the workshop. There is clear evidence (Kehrberg, forthcoming) that a Late Roman pottery workshop (in chamber E8, supra), begun in the late third century, crossed historical barriers or rather ignored the cultural norms as we apply them today by continuing to produce 'classical' Late Roman lamps throughout the fourth (and possibly early fifth) century, together with 'classical' Early Byzantine lamps and pottery! The potter used Late Roman lamps as a matrix for new moulds, sometimes with 'fashionable' adjustments, for his Byzantine customers. The adjustments were a hybrid between the Roman and Byzantine lamp types which seems to be the archetype for the development of the later fifth century lamp and the Late Byzantine tongue handle form (Kehrberg 1986, 1989 and forthcoming; Rasson 1989; Lapp 1995). The workshop was still operative in the fifth century and there were made Byzantine lamps which can now close the gap between the fourth century types and the later sixth century Jerash lamps. There is no better case with which to illustrate the importance of the hippodrome finds. It leads also to the next major topic of investigation, that of technical procedures of the manufacture of ceramics.

Organization and Technical Aspects of the Potteries

A major discovery has been that of unfired ceramics found mixed in the dumps with misfired products of the same workshop and date. The stone tumble of the cavea, the skeletal remains (see above, introduction) and the misfired pottery protected the fragile unfired ware by insulating it from the natural elements (apart from worms which left minute tunnels in the unfired fragments). The thousand or so unfired fragments belong to ceramic types of the late sixth to early seventh century, as does the rest of the dump and the preliminary study has shown that the unfired lot had been made for one firing (Kehrberg and Ostrasz 1994). The range of vessels include all known types of the Late Byzantine period: the finer wares as the Jarash Bowls with their distinctive painted decoration clearly showing, through the normal range of other bowls, jars, jugs, cassrols and lids and down to the coarser tiles and pipes. As is to be expected, there are also the Jarash lamps with their zoomorphic handles. In fact, the unfired fragments mirror perfectly the typological range of the

[5] For example: in chamber E1 Late Roman; in E29 Late Roman; in E8 Late Roman and Early Byzantine of the fourth century; in chamber W6 Late Byzantine with a gypsum 'factory' (supra) of the fourth century below the sixth century dump and many dumps of the Late Byzantine period in the S-E chambers of the hippodrome.

misfired types among which they survived for so long. This unique find was in a densely concentrated spot, which speaks for an accident which destroyed one load designed for one firing. One may therefore reasonably conclude, seeing the mixture of types, that specialization of forms and wares was not part of the ceramic production at the hippodrome, and one may doubt if anywhere else in Gerasa. It appears instead that it was the quality of production which varied between workshops at the hippodrome and even more so between workshops at other sites in Gerasa.

The material from the hippodrome provides enough data to chart a conclusive stylisitic evolution of ceramics which allows for idiosyncrasies of individual workshops as well as for chronological and regional manifestations. Technically speaking, one can also differentiate between workshops that use different clay. This evidence is based on unfired fragments from various kilns of the hippodrome and the differences in the clay as it appears to the eye is not determined by difference in time.

Historical and Cultural Evaluation

Finally, one has to reassess the mass of information to fit into an historical and cultural frame. And here, too, the hippodrome excavations have proved to be useful. Among some of the major culturally homogeneous dumps referred to earlier in the text, there have been coin hoards: one hoard dates an entire deposit to the first decade of the fourth century(chamber E2); another hoard in chamber E8 dates the dump to the second half of the fourth and early fifth century and yet another of over 100 coins albeit mostly integrated dates the deposit to the late sixth and early seventh century (chamber W2 with the unfired fragments). In the latter chamber and above the ceramic dump there was one gold coin of the mid-seventh century belonging to the mass burial of the plague victims there (Kehrberg and Ostrasz 1994) which sealed the ceramic deposit as the stone tumble did shortly after that for the interred.

In all, this has put the typologically known but often vaguely associated pottery into firm chronological brackets. In some cases, it has led to a longer lifespan of a type than was previously known. As with the above mentioned fourth century lamps but here in reverse, some pottery types thought to be Early Byzantine can now be recognized as having begun in the Late Roman period. It is the thresholds of new chronological periods which are the most difficult to define in material assemblages and the hippodrome deposits hold much information with regard to the cultural transitions from one historical environment to the next.

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Landscape and Cityscape in the Ḥisma: The Resources of Ancient Al-Ḥumayma

The site of al-Ḥumayma, ancient Hawar or Auara, was the major Nabataean, Roman, Byzantine, and early Islamic centre in the Ḥisma, Jordan's southern desert.[1] The ruins of the settlement, approximately 10 ha in area, are at an elevation of 955 m on the east slope of some rugged sandstone hills between the Jabal al-Qalkha and Jabal al-Ḥumayma 3 km east of the Wādī 'Arabah. The site dominates the west edge of a rolling plane framed on the east and north by white sandstone hills. Precipitation in the region averages only 80 mm/year, but the lowland plain is watered as well by the winter rains that run off the ash-Sharā escarpment, which forms the dramatic north boundary of the roughly triangular catchment basin, 240 km^2 in area. The Wādī al-Qalkha carries run-off water past the site.

Despite the very arid environment, this site flourished for 800 years, relying as much on local resources as on the profits of trade and passing caravans. The loessal soil in the plains is sandy and light, but suitable for grain production. The precipitation, although meager in local terms, could be concentrated by directing the run-off from the surrounding sandstone hills into fields, or by storing it up in cisterns and reservoirs. Many wild species of plants were available for food, medicine, fodder, and fuel, and a prolific stock of wild species of mammals, birds, and reptiles was subject to exploitation. The environment also supported a remarkable variety of domesticated animals. We will consider these four natural resources of the environment of al-Ḥumayma in turn, and their interaction with the human history of the site: the manipulation of the water resources by the population of Hawar, the potential fertility of the soil, and the patterns of exploitation of wild and domesticated species of plants and of animals. This approach will allow an estimate of the bearing capacity of the catchment area in antiquity and the effect of human occupation on the natural environment.

History of Hawar

According to Ouranios's *Arabika* (*FGrH* 675 frag. A.1.b) Auara (the Greek transliteration of Nabataean Hawar) was founded by the Nabataean king Aretas III (87-62 BC) in response to an oracle.[2] Nothing is known of the early history of the settlement, but an extensive water-supply system was built in the early years, probably to attract settlers, caravans, and a market. Early and Middle Nabataean ceramics are found at the site. Trajan's *Via Nova*, built along the course of a pre-existing Nabataean north/south road, passed through or very close to the settlement, and archaeological and literary evidence indicate that Hawar flourished in the Late Roman, Byzantine, Umayyad, and early Abbasid periods. Ptolemy includes Ἄυαρα in his list of towns in Arabia Petraea (*Geography* 5.16.4), and Stephanus Byzantinus provides the alternate name Ἄυαθα. The site was included in the source for the Peutinger Table, perhaps Agrippa's map of the empire in Rome, and the *Notitia Dignitatum* (*Or.* 34.25) records the presence of a unit of *equites sagittarii indigenae* at Hauare (Hauanae, Havarra). A fort was built at the north edge of the site in the second century AC. According to the contemporary Beersheba Edict, the governor of Palestina Tertia assessed Hawar the highest sum of any settlement in Transjordan, just after the Roman fort at present-day Udhruḥ. Hawar continued to flourish in the early Islamic period under the name al-Ḥumayma, and soon after 687/8, 'Ali ibn 'Abd

[1] The Project Director is J. P. Oleson, University of Victoria. Co-Directors are K. 'Amr, Department of Antiquities of Jordan, R. Schick, Albright Institute, and R. Foote, Harvard University. The project has been funded by the Social Sciences and Humanities Research Council of Canada, Taggart Foundation, Van Berchem Foundation, and the American Schools of Oriental Research. For recent reports and full bibliography, see J. P. Oleson, 'The Water-Supply System of Ancient Auara: Preliminary Results of the Humeima Hydraulic Survey'. Pp.269-275 in *SHAJ* IV. Amman: Department of Antiquities, 1992; J. P. Oleson, K. 'Amr, and R. Schick, 'The Humeima Excavation Project, Jordan: Preliminary Report of the 1991-1992 Seasons'. *ADAJ* 37 (1993) 461-502; J. P. Oleson, K. 'Amr, R. Foote, and R. Schick, 'The Humeima Excavation Project, Jordan: Preliminary Report of the 1993 Season', *Classical Views/Echos du monde classique* 13 (1994) 141-79; J. P. Oleson, K. 'Amr, and R. Schick,' Preliminary Report of the Humeima Excavation Project, 1993,'*ADAJ* 39 (1995) 317-354. For the ancient name of Humeima, see now D. Graf, 'The 'God' of Humayma.' Pp. 67-76 in Z.J. Kapera, ed., *Intertestamental Studies in Honour of Józef Tadeusz Milik* Kraków: Enigma Press, 1992. The text of this presentation was adapted in part from technical reports by M.J. Goldstein on soil, C. Thomas Shay, M. Kapinga and C. Jorgenson on botanical remains, K. Riley on the 1987-89 faunal remains, L. Quintero on the 1991 faunal remains, and M. Finnegan and R. Lane on the 1995 faunal remains. Those authors are not responsible for any errors I may have introduced while editing their text and tables and interpreting their reports for this publication.

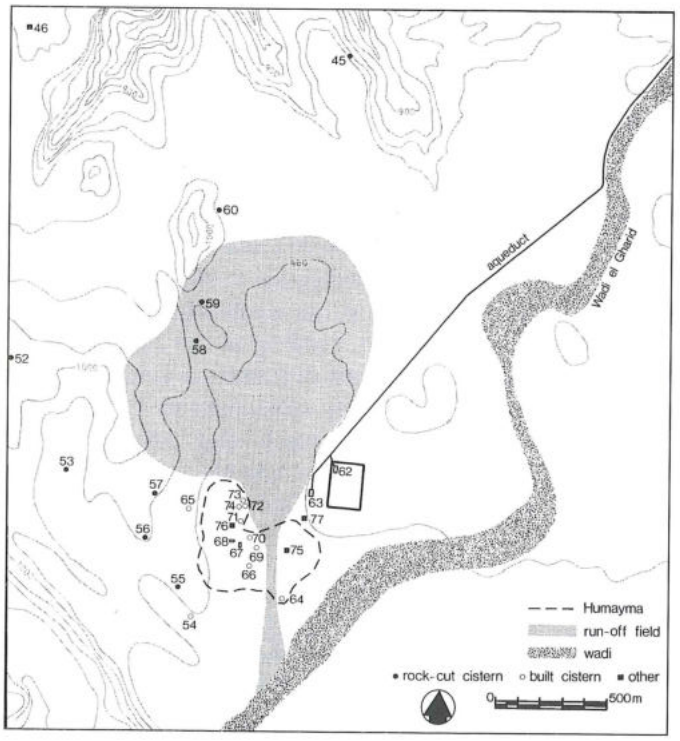
[2] For the history of the site, see especially J.P. Oleson, and J. Eadie, 'The Water-Supply Systems of Nabataean and Roman Humayma,' *BASOR* 262 (1986) 49-76.

Allah ibn al-'Abbās purchased the town, which became a centre for the Abbasid family's revolt against the Umayyad dynasty. The family built a fortified house at the site which has been identified by our excavation. Ceramic evidence shows the virtual cessation of habitation after the mid-eighth century, but there are traces of light, intermittent occupation through the Ottoman period.

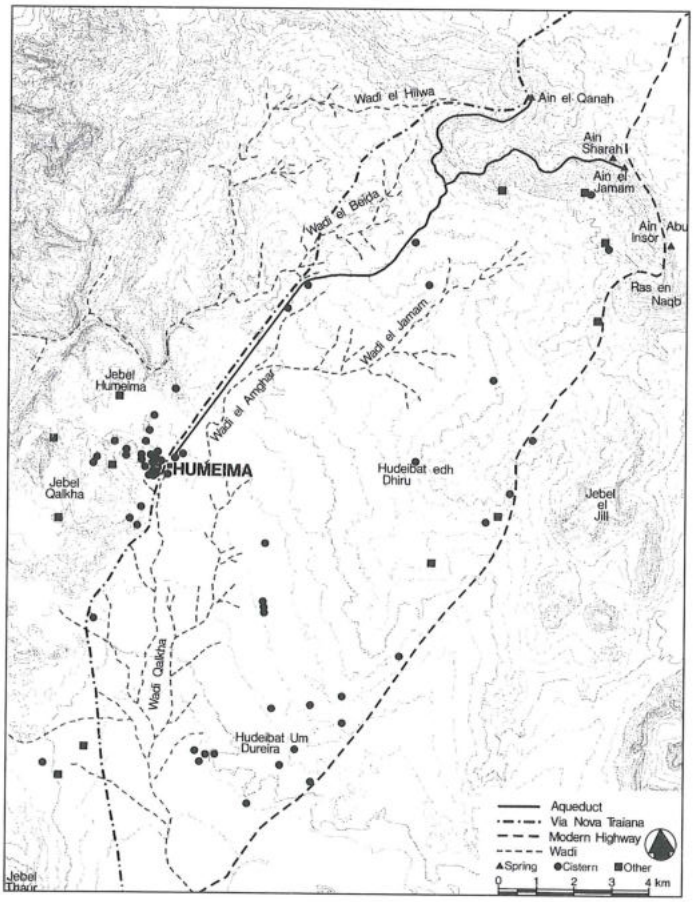
Water Resources

Since the water-supply system of Hawar is presented in detail elsewhere, its characteristics will only be summarized here.[3] Soon after the foundation of Hawar, an aqueduct of traditional Nabataean design (a ground-level, roofed conduit of stone gutter blocks) was built to carry water 26.5 km from 'Ayn Ghāna, 'Ayn Jammām, and 'Ayn ash-Sharā to an open reservoir with a capacity of 633.4 m at the north end of the site. The flow was approximately 6.192 m³/hour. A reservoir with a capacity of 1273.3 m³, also served by the aqueduct, was later built inside the Roman fort. The habitation centre was served as well by a pair of large, rectangular, roofed reservoirs with a total capacity of 933.1 m³, fed by run-off water from a catchment to the north of the settlement area. There were also at least 13 smaller cisterns associated with nearby houses, fed by the same run-off field, and with a collective total capacity of 1444.5 m³. Dots on FIG.1 indicate the location of these structures. Finally, there were at least 41 rock-cut and built cisterns, with a total capacity of 3766 m³, in the rocky foothills around the plain of Hawar, and a dam which created a pool of approximately 1000 m³. The system also included several wadi barriers and carefully modified run-off fields which were intended to harvest water for storage in the soil rather than in basins. Dots on FIG. 2 indicate the location of these structures.

Although only a few of the cisterns have been dated through excavation – to the first two centuries of Hawar's existence – the technique of stone-working and construction, and the chronology of the site's development, suggest that all but one of the cisterns (which seems to be Umayyad in date) belong to the Nabataean/Roman period. Furthermore, the importance of stored water to survival in such an arid environment suggests that cisterns must have been built early on, and that – once built – they would have been maintained and used until the abandonment of the site. In fact, most of the ancient cisterns in the region are still in use today. Assuming, then, that all of these facilities were in use at once and were filled to capacity, the total supply of stored water in the habitation centre would have been 4284.3 m³. To this can be added the 6.2 m³/hour supplied by the aqueduct. In addition, the cisterns and dammed pool farther off in the countryside



1. Al-Ḥumayma: Schematic plan of ancient remains, with indication of water-supply structures.



2. Map: Catchment area of ancient al-Ḥumayma, with indication of water-supply structures.

[3] The water-supply system is discussed in J.P. Oleson, 'Aqueducts, Cisterns, and the Strategy of Water Supply at Nabataean and Roman Auara (Jordan). Pp. 45-62 in A. Trevor Hodge, ed., *Future Currents in Aqueduct Studies.* Leeds: Francis Cairns, 1991 and *idem*, 'The Origins and Design of Nabataean Water-Supply Systems.' Pp. 707-19 in *SHAJ* V Amman: Department of Antiquities, 1995.

had a capacity of 4766 m³. The total regional amount of water that could be stored once all the cisterns and reservoirs had been built was 9050.3 m³.

A reasonable figure for the minimum daily personal water requirement for drinking, cooking, and washing at ancient Hawar is 8.0 lt.[4] If we assume that the run-off water in the cisterns in the habitation centre was intended entirely for human consumption, and that the system was designed with a safety margin of 100% (i.e. that the inhabitants counted on the cisterns being filled only every second year), the 4284.3 m³ stored there could have supported a population of approximately 734 souls. If we assume that up to half the water in the two central, public cisterns was used to water animals, the population figure would be 654. As for livestock, camels require approximately 5.0 lt/day when eating dry fodder, goats or sheep 3.0 lt/day.[5] If we assume that the herds were composed of 10% camels and 90% goats and sheep, we get the figures of 20 camels and 180 ovicaprids supported by a 50% share of the water in the two public cisterns.[6] If we assume that 80% of the water in the cisterns and pool outside the settlement centre was intended for livestock — since the human population was undoubtedly more thinly scattered in the countryside — that there was a safety margin of 100% (although in fact many animals most likely were slaughtered in times of drought because of the problem of finding fodder), and that the proportion of camels, sheep and goats was the same as in the settlement centre, we get the following figures: 163 persons, 163 camels, 1469 ovicaprids. The combined regional total is 817 persons, 183 camels, and 1649 ovicaprids. The combined regional population density reconstructed above is 3.4 persons/km², the urban density 146.8 persons/km², the suburban density 1.4 persons/km². All of these figures, of course, are highly hypothetical, but they give an idea of the very significant carrying capacity of this arid landscape with regard to water supply. In fact, it is likely that many families moved from the rural sandstone hills to the settlement and back again many times in the course of a year.

Soil Resources

The basin east of al-Ḥumayma stretching for 25 km to north and south, is filled with light, very sandy, loessal soil, for the most part apparently carried in by wind in the Pleistocene period and deposited in a fossil lake bottom.[7] Today the bedouin plant wheat and barley in fields that have been watered by the run-off from the winter rains. The location and extent of the run-off determines the location of the cultivated areas. Four samples of soil from fields in the centre of al-Ḥumayma and in the immediate vicinity were analyzed.[8]

Sample 1: Surface of field, 50 m west of the Roman bath (site E077).

Sample 2: Surface of field between Lower Church (C101) and site no. 054.

Sample 3: Surface of field at very north edge of settlement centre catchment, at approach to site no. 045.

Sample 4: Surface of field 1 km east of watch-tower just east of al-Ḥumayma.

The chemical properties of the four soil samples were very similar (see TABLE 1). The analysis indicated that the general agricultural potential of the soil is surprisingly high for a desert area. The pH is slightly alkaline (soils with pHs over 8.5 are said to be "alkali"). Most grain plants would perform sufficiently well at a pH of 8. Electrical conductivity (EC) is a measure of the soluble salts in the soil. In many desert regions salt is the major impediment to agriculture. While an EC of 1 mS/cm³ in Sample 3 is slightly high, salts are not a major problem below an EC of 4. Soils are said to be "saline" at an EC of over 4. The EC would in any case be lowered by the localized soaking which preceded sowing, according to the agricultural method practiced in this region.

In addition to total salts, excess sodium (Na) is a problem in many desert areas. Exchangeable sodium is less than 1 milli-equivalents per 100 grams (meg/100gm) in all the al-Ḥumayma samples. This figure represents less than a 1/10 of the cation exchange capacity, resulting in an exchangeable sodium percentage (ESP) of less than 2%. This level is good for agriculture. Soil with ESPs exceeding 15% are termed "sodic" and cause major problems for agricultural production.

With regard to plant nutrients, available calcium and magnesium in all four samples are high, but in balance. Available potassium is also high. Nitrogen and phosphorus, however, are both low. Phosphorus is especially low, reaching a maximum of only 7 ppm, a level which would result in low grain yields for the ancient farmer.

Since most virgin, arid soils would be substantially higher in phosphorus (possibly 20 times higher), it is possible that the available phosphorus at al-Ḥumayma has

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4 Estimates of human water needs vary significantly, but this figure seems a useful middle-of-the-road estimate. For further discussion, see S.E. Helms, 'Paleo-Beduin and Transmigrant Urbanism.' Pp. 97-113 in *SHAJ* I Amman: Department of Antiquities; 1982 *idem*, *Jawa* London: Methuen, 1981. 188-89; B. de Vries, 'The el-Lejjun Water System.' Pp. 399-428 in S. Thomas Parker ed., *The Roman Frontier in Central Jordan* , I. Oxford: BAR, Intl. Ser. 340, 1987.

5 See works cited in n. 4.

6 All of these figures, of course, are hypothetical, but at least they give a possible picture of the human and animal occupation of the site. It is interesting to note that the 1273 m³ of water stored in the reservoir in the Roman fort would have been sufficient to support 436 men for one year, approximately equal to the size of the auxiliary detachment likely to have been stationed there; see S.T. Parker, *Romans and Saracens: A History of the Arabian Frontier.* Winona Lake: Eisenbrauns, 1986, 105. This figure does not, of course, allow for the watering of any military livestock. Since this reservoir was filled by the aqueduct, it was not necessary to allow for a safety margin against atypical rainfall patterns.

7 There is an excellent review of topography and soil in D.O.Henry, 'Topographic Influences on Epipaleolithic Land-use Patterns in Southern Jordan.' Pp. 21-27 in *SHAJ* III. Amman: Department. of Antiquities, 1987. The evolution of the landscape is discussed in G. Osborne and J.M. Duford, 'Geomorphological Processes in the Inselberg Region of South-Western Jordan.' *PEQ* 113 (1981) 1-17; see also F. Bender, *Geology of Jordan* Berlin: Borntraeger, 1974, 20-1, 188-93.

8 The analysis was carried out by Soilcon Laboratories of Richmond B.C.

been depleted by agricultural activity in antiquity. The normal cure for low phosphorus and nitrogen is the addition of organic matter, manure in particular. The present-day farmers at the site do not seem to make intentional use of manure as part of their agricultural regimen, and the situation was probably similar in antiquity. Because of the sparse vegetation, the livestock is grazed over a wide area, resulting in scattering of the manure thinly over a region for the most part unsuitable for agricultural production. Furthermore, the aridity of the climate does not foster the decay of manure or vegetation and the formation of humus. Dung and dead vegetation simply dehydrate, are reduced to a powder, and blow away. Even if manure were carried from corrals or campsites to a field likely to be watered by rain and run-off, it would not enrich the soil before the rain arrived.

Cation exchange capacity (CEC) is a measure of the ability of soils to store available nutrients such as potassium, calcium, and magnesium. The CECs of all the al-Ḥumayma samples are fairly high for the texture and age of soil and would be adequate for agriculture.

The physical properties of the soil samples are more variable. Sample 1 is loam in texture and has excellent physical properties, including an available water storage capacity (AWSC) of 13%. Sample 2 is a sandy loam, with an AWSC of only 1.8%. This soil would be very droughty for grain production based on water storage in the soil before sowing. Sample 3 falls between samples 1 and 2 in water storage capacity. Since soil physical properties are longer lived than chemical properties, the ancient farmers probably faced the same limited water storage capacities the soils now possess.

Wild and Cultivated Plant Resources

The al-Ḥumayma area embraces at least four major vegetation units belonging to several geobotanical regions. These units include desert, desert savanna steppe (grassland) and steppe-maquis (Mediterranean-type shrub).[9] Although the desert vegetation includes mostly annuals, it is characterized by several types of shrubs (e.g., *Anabasis articulata, Hammada salicorica*). Groves of trees, such as *Acacia tortilis*, can be found in areas where there is sufficient soil moisture for tree growth. The steppe vegetation is characterized by the shrub *Artemisia herba-alba*. These vegetation units all have floral affinities to the east and south in the Arabian Peninsula and beyond. The Mediterranean steppe-maquis is a mixture of grassland and shrub that contains species more typical of the Mediterranean basin.

Flotation samples from 40 loci have been analyzed so far (another 100 are still undergoing processing). They came from four locations: the Late Roman bath building (E077); the Byzantine Lower Church (C101); an Umayyad/Early Abbasid house or market complex built on top of a Byzantine church (B100); and an Umayyad house built on top of a Byzantine church and a Nabataean or Roman structure adjacent to a Nabataean-type cistern (F102) (TABLES 2-4). The samples derive from various contexts including occupation level, fire pit, dump, midden, destruction level, collapse and fill. They were associated with such materials as iron, copper, glass, ceramics, plaster, stone, bone and ash. The estimated dates for the samples range from the fifth to eighth century AC with the majority spanning the seventh century.

The samples contained 633 seeds; 611.5 were charred and 21.5 were uncharred. The uncharred seeds (TABLE 3) are considered recent intrusions. Of the charred seeds (TABLE 2), 10.2% or 61.5 belonged to domesticated plants such as cereals, tree crops, vines and other fruits. These were, in order of abundance, six-rowed barley (*Hordeum vulgare*), fig (*Ficus* sp.), unidentified grass family species (*Gramineae*), date (*Phoenix dactylifera*), bread wheat (*Triticum aestivum*), olive (*Olea europaea*), grape (*Vitis vinifera*), chick pea (*Cicer arietinum*), fig (cf. *Ficus* sp.) and unidentified wheat (*Triticum* sp.). Most of the domesticates were found in relatively few samples. The more frequent domesticates were barley, found in 12.5% of the samples, fig in 12.5%, unidentified grass family species in 7.5%, and date in 7.5%. Each of the remaining domesticates was found in only 2.5% of the samples (TABLE 2).

Over 30 types of wild plant seeds were identified (TABLE 2). The nine with percentages of more than 1% were white broom (*Retama raetam*), plantain (*Plantago* sp.), chickweed (*Cerastium* sp.) sea-blite (*Suaeda* sp.), common peganum (*Peganum harmala*), medick (*Medicago scutellata*) and unidentified members of the pink (Caryophyllaceae), legume (Leguminosae) and goosefoot (Chenopodiaceae) families. These wild seed types were more frequent in the samples (2.5 to 22.5%) than most of the domesticates.

The interpretation of past plant uses depends upon factors such as the preserving conditions, which part of the plant was used and how it was prepared. Some reconstructions of uses of the species identified at al-Ḥumayma are summarized in TABLE 4. There is a good mix of grain foods, vegetables, herbs, and oil seeds.

The only way that plant remains can be preserved for any length of time in soils which are subject to alternating wet and dry cycles is through charring or mineralization. The probability of a plant food becoming charred is dictated by its structure and the way in which it is processed. Few plant foods are likely to become charred during preparation other than cereal grains that are parched or roasted over a fire. With this qualification in mind it is possible to offer some insights into the ancient vegetation, agricultural economy, and uses of wild plants of the Hawar area, particularly during Byzantine times.

[9] See M. Zohary, *Plant Life of Palestine, Israel and Jordan*. New York: Ronald Press, 1962.

Archaeological, geological, and botanical evidence all suggest that the local climate and vegetation of this arid area in Byzantine times were similar to those.[10] A number of the seed types from the site today can be referred to the communities within deserts and grasslands, although many could also be found in disturbed ground.

Although the desert vegetation includes mostly annual plants such as those belonging to the pink and legume families, it is characterized by several types of shrubs. In sandy areas, these would have included white broom, the seeds of which were numerous in the al-Ḥumayma flotation samples and perhaps shrubby species of milk-vetch. Saline depressions would have supported salt-tolerant species of sea-blite. The Mesopotamian grassland steppe is represented among the seeds by grasses such as rye grass and Bermuda grass. This type of plant community would also have included annuals and scattered shrubs.

Many of the seed types belong to plants characteristic of disturbed ground, such as that found along roadsides and trails, fields and pastures, and areas within the settlement. Considering the fact that Hawar was located on a caravan route and that both travelers and the local pastoral inhabitants probably established temporary tent camps in the area, it is not surprising that many of the seed types belong to plants of disturbed ground. These plants include chickweed, plantain, common peganum, medick, trigonel, poppy, scorpion vetch, goosefoot, bedstraw, pigweed and fumitory.

The domesticates found at al-Ḥumayma include the traditional crops of cereals, legumes, olives, grapes, figs and dates. These have been part of the Near Eastern crop complex since at least the Bronze Age. It is not known, however, whether all these crops were grown locally or brought in by caravan. Arabic sources mention a grove of 500 olive trees at the site around AD 700,[11] and olive, fig, and apple trees are successfully cultivated by one of the landowners at the site today. The wild watermelon seed found may have come from a plant that was cultivated locally.

The wild seeds found at al-Ḥumayma may have come from several sources. They could be from plants that grew in the settlement area itself, or they could have been brought to it with such things as fodder, fuel or manure. The seeds of white broom, for example, could have been carried in on shrubs used as fuel. Fuel was certainly an important application of local plants. The Romans even heated the hot bath with a local shrub (*Haloxylon articulatum*, also called *Hammada salicorica*) still used by the bedouin today to boil their tea water.[12]

Some of the wild plants found undoubtedly were brought to the site intentionally by the ancient inhabitants of Hawar for use as food or medicine or both (TABLE 4). Trigonel, coronilla, poppy and lolium are today used for fodder. White broom, common peganum, milk-vetch, watermelon, plantain, bedstraw, pigweed, poppy, chickweed, medick, goosefoot, and coronilla are eaten or are useful in medicine.

Archaeological research in the region of Ḥumayma has shown that over the long span of its existence, the people settled at Hawar depended on a mixed regime of grain-growing and pastoralism, supplemented by trade and military activities. Analysis of the botanical remains indicate that the inhabitants made excellent use of local soil for growing domesticated grains and fruits, and that they harvested wild species as well. The main crops grown in the fields around the town were barley, wheat, and chick-peas, possibly supplemented by figs, dates, and grapes. We cannot yet tell, however, if the seeds of the last three domesticates were produced locally or imported. Barley, fig, and date predominate in the samples. In antiquity as today, there was probably significant production of wheat and barley in the fields around Ḥumayma. During the winter, while the grain crops were growing, the livestock would be grazed in the rocky highlands surrounding the Ḥumayma basin, where the rains had refreshed the landscape. During the summer, after the grain had been harvested, the flocks would be grazed on any stubble left in the fields, or fed on the whole, uprooted grasses left after threshing. Both procedures are followed today. It is clear from analysis of flotation samples from the habitation area that there was also great reliance on wild species used for food or medicine (white broom, common paganum, milk-vetch, watermelon, plantain, bedstraw, pigweed, poppy, chickweed, medick, goosefoot, and coronilla), or for fodder (trigonel, coronilla, poppy, lolium).

Wild and Domesticated Animal Resources

The landscape around Hawar was heavily used for grazing as well as for drought farming. Analysis of the bones found in the 1989, 1991-93 and 1995 seasons is nearly complete, but the overall summary of the statistics was not available at the time this paper had to go to press. As might be expected, sheep and goat predominate among the remains of domesticated mammals, along with camel, equid, pig, cow, and dog. Among birds, chicken, dove, and raven are found, along with numerous ostrich eggs. Wild mammals include gazelle, mountain lion, hare, rodents (probably gerbils and jerboas), and possibly boar.

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[10] D.O.Henry, 'An Investigation of the Prehistory of Southern Jordan.' *PEQ* 115 (1983) 1-24; N. Shehadeh, 'The Climate of Jordan in the Past and Present.'Pp. 25-37 in *SHAJ* II. Amman: Department of Antiquities, 1985; R. Rehav, 'The Debate over Climatic Changes in the Negev, Fourth-Seventh Centuries C.E.' *PEQ* 121 (1989) 71-78.

[11] Upon purchasing al-Ḥumayma, Ali ibn Abd Allah built a *qaṣr* with a garden there; in'Abd al Aziz al-Duri, 'Abd al-Jabbar al-Mutallabi, eds., *Akhbar ad-Dawla al-Abasiyya.* Beirut: 1971,107, 108, 149, 154; Abu 'Ubayd al-Bakri, *Mu'jam ma Ista'jama min Asma' al-Buldan wa al-Mawadi'*. Cairo: 1945-51, 130. Balâdhurî tells us that 'Ali was noted for his piety and that he prayed two rak'as each day in front of each of his 500 olive trees and 500 rak'as each day in his mosque; Abu al-Hasan Ahmad ibn Yahya al-Balâdhurî, ed., *Ansâb al-Ashrâf*, 3: *'Abd al-'Azîz al-Dûrî*. Wiesbaden: 1978 iii, 75.

[12] J.P. Oleson, 'Humeima Hydraulic Survey, 1989:Preliminary Field Report.' *ADAJ* 34 (1990) 305.

It was interesting to discover that large quantities of fish were imported: mullet and sea bream from the Red Sea, and Nile perch, probably from lagoons in the 'Aqaba area. Fresh oysters and conch were imported from 'Aqaba as well, in the shell. The results presented here are still tentative, particularly with regard to changes in use of animals over time, since the chronological information has not yet been entered. The tables do not go beyond genus identification for many of the categories, and the identification of fish species remains to be verified. The statistics below are based for the most part on material recovered in the 1995 season, summarized on TABLE 7, but with reference to the data from the 1987-1991 seasons that still has to be incorporated (TABLES 5-6).

Excavation of five areas at al-Ḥumayma in 1995 resulted in the recovery of 7851 animal bones and bone fragments. The bones were dry-brushed, washed when necessary, and separated into generalized categories such as large, medium, or small mammals, fish, and birds, etc. Bones possessing diagnostic morphologic features were further identified, when possible, to family, genus, and species.[13] All bones were examined for butcher marks, spalls, rodent or carnivore gnawing, and evidence of burning. Worked bone or bone tools, separated from the assemblage, were washed, repaired, and registered.

Predominantly, the recovered bone was in a good to excellent state of preservation, but due to breakage and fragmentation, it was often in a poor condition with respect to identification. Of the recovered bones, 2.80% were so badly broken that they could not be classified, and are listed as undetermined bone (TABLE 7). Bones of a certain size and thickness, but lacking specific morphologic features, could only be classified in general categories: large, medium, and small mammals (these categories were responsible for 73.66% of all recovered bone). Bones belonging to the large mammal category (3.40% of the total assemblage) probably represent the cow (*Bos*) and the horse or donkey (*Equus*). Bones belonging to the medium mammal category (69.19% of the total assemblage) undoubtedly represent non-diagnostic fragments of sheep (*Ovis*) and goats (*Capra*), although the bones of wild ungulates may be represented as well. Bones within the non-diagnostic small mammal category (1.07% of the total assemblage) belong to rabbits, cats and the smaller rodents. These percentages are in line with the identified mammal categories, where domesticated sheep and goats form the largest percentage of identified remains (30.57%), followed by domestic chicken (*Gallus*) (22.84%) and domestic pig (*Sus*) (19.89%)(TABLE 7). These trends correspond well with the initial, rough analysis data recovered from the 1992 and 1993 field seasons at Ḥumayma. The corresponding statistics for 1987-1991 are somewhat different: ovicaprids 35.05% of the identified species, bird (probably mostly domestic chicken) 4.47%, and domestic pig only 0.69%.

Many of the diagnostic sheep/goat, pig and cattle bones from the 1993-1995 seasons showed evidence of spalls, or green bone fractures. These fracture types generally occur during the butchering process of the animal, when heavy blows are delivered against the shafts of long bones of the axial skeleton with a sharp tool not unlike a cleaver. The majority of sheep/goat, pig and cattle bone fragments and spalls recovered from the site were autopodia, metapodials, phalanges, and hoof cores – bones associated with the lower, non-meat bearing portions of the legs. Very likely, one of the first steps in the process of butchering sheep and goats, pigs and cattle involved removing the lower legs in the region of the articulation between radius and tibia and their associated autopodia. These disarticulated leg bones were undoubtedly discarded as the meat bearing portions of the carcass were further processed.

In the 1995 collection, identified sheep outnumber identified goat by a slight but significant margin: 5.45% to 4.09% (13.60% and 10.20% of the sheep, goat, and ovicaprids taken together) — a ratio which can be seen at some earlier sites in Jordan.[14] The slightly larger proportion of sheep over the hardier goats might be taken to suggest that a more lush grazing environment was available for these animals at Ḥumayma during the occupation layers that produced these remains. It should be noted, however, that the preliminary statistics from the earlier seasons give a very different result (TABLE 6), the goats constituting 2.56% of all identified species, and sheep only 0.73% (6.67% and 1.90% of the sheep, goat and ovicaprids taken together). Discrepancies such as this can be the accidental result of the sampling or analysis, or may indicate chronological differences in herding practices, or even reflect the location of butchering areas.

The 1995 excavations indicate that the chicken (*Gallus gallus*) also formed an important part of the diet at the Ḥumayma site (22.84%) (TABLES 6-7), particularly as compared with earlier sites in Jordan.[15] Chicken accounts for more of the faunal remains than do pig (19.89%) and either sheep or goats singularly (but not combined) and must be counted with the population's meat preference along with sheep, goats, pigs and cattle. The domesticated horse and donkey, beasts of burden and at the same time a secondary meat source, were recovered in moderate numbers (4.32% combined) during the 1995 field sea-

[13] Without the aid of a comparative collection in the field laboratory, the following sources were useful in the identification process: J. Boessneck, 'Osteological Differences Between Sheep (*Ovis aries* Linne') and Goat (*Capra hircus* Linne').' Pp. 331-58 in D.R. Brothwell and E. Higgs, eds., *Science in Archaeology*. New York: Praeger, 1969; E. Schmid, *Atlas of Animal Bones for Prehistorians, Archaeologists and Quaternary Geologists.* Amsterdam: Elsevier, 1972.

[14] M. Finnegan, 'Faunal Remains from Bab edh-Dhra, 1975.'Pp. 51-54 in *AASOR*, 1978, 51-54; *Idem*, 'Preliminary report of animal remains recovered from the 1993 excavations at Tell Nimrin, Jordan.' Unpublished Report to the Directors; D.L. West, 'Preliminary report of animal bones recovered from the 1990 excavations at Tell Nimrin, Jordan.' Unpublished Report to the Directors.'

[15] *Op. cit.*

son. Fish bones represented 2.11% of the overall faunal inventory in 1995 (TABLE 7), and 30.46% in the earlier seasons (TABLE 6), with representation of the families *Mugilidae* (mullet), *Sparidae* (sea bream), *Mochokidae* (perch), and possibly *Cyprinidae* (carp) and *Bagridae* (armored catfish). Given that they had to be imported fresh from 'Aqaba, marine shells represent an a very impressive 6.93% of the 1995 faunal remains, 7.92% of the 1991 sample, including the families *Trochidae* (top-shells), *Strombidae* (conch), *Ostreidae* (oysters), and *Tridacnidae* (clams).

Remains of the pig were found in 1995 in a greater proportion (19.89%) than at a number of other Jordanian sites, suggesting that it had a prominent place in the diet along with chicken, sheep and goat. Since in the 1991 and earlier excavations pigs constitute only 0.50% of the sample, the increase for the 1995 material may derive from the Roman fort, where excavation began only in 1993. Spatial and chronological analysis of the material is not yet complete. No measurements were taken to determine if the pigs associated with al-Ḥumayma were wild or domesticated using the criteria of Flannery.[16] Pigs recovered from the Middle Bronze Age levels of nearby Jericho, because of small size and immaturity, have been called domesticated when compared to the bones of the hunted wild pigs excavated from earlier Pre-Pottery Neolithic levels of the same site.[17] Nevertheless, it is possible that some of the fragments of pig recovered from al-Ḥumayma may belong to the wild boar which today can still be found in the thickets of the well-watered larger wadis and in the Jordan Valley. The wild boar would have been easi-ly accessible, although a formidable quarry for the hunters of al-Ḥumayma.

Overall, the 1995 faunal data are in general agreement with the faunal data from the earlier field seasons which indicate that throughout time sheep and goat were favored in the diet of the inhabitants at al-Ḥumayma. To a lesser extent, cattle were utilized for their milk, meat and skin. Cattle yield approximately six times the edible meat as sheep or goats, making them a close second for meat production. While inhabitants at al-Ḥumayma overwhelmingly followed a subsistence pattern based on animal husbandry and agriculture, they occasionally varied their diets by means of the chase – hunting the wild hare (*Lepus*) and deer (*Cervus*) (one each) in addition to the boar. Deer, represented by one bone fragment in the 1995 assemblage, may have been somewhat rare to this region of Jordan in the later time periods, preferring the more forested areas of the earlier time periods in the region. The smaller gazelle (*Gazella* sp.) appears in the 1987-91 material (0.20%). Although it was not identified in 1995, some of the medium mammal bones may represent this animal. Inhabiting drier climates than the red deer, the gazelle would have browsed in dry grass steppe and desert region near al-Ḥumayma and could have been captured by nets or snares.[18] Ostriches may have been captured for their meat, but so far only fragments of egg-shells have been recovered. The rodents identified in the faunal remains of every season might derive in part from burrowing by these animals into cultural deposits laid down long before. Some, however, may represent individuals caught for consumption; even today the local bedouin catch and cook the jerboa that populate the site. The single fox (*Vulpes* sp.) that appeared in the 1991 sample, and the 4 unidentified carnivore bones (probably lynx or mountain lion) in the 1995 sample probably represent preditors whose corpses were brought back to the site to allow recovery of the pelts.

Since the chronological information has not yet been entered into the faunal database, only gross generalizations can be made concerning trends in the use of various species at al-Ḥumayma over time. With the assignment of dates to loci, trends in percentages of bones of sheep and goats, pigs, chickens, and cattle may emerge. As well, placement of wild animals within a time framework may throw light on changing hunting patterns over time.

In any case, it is likely that – except for pigs, equids, and dogs – the domestic animals and birds were raised for more than just their meat. Mature animals could produce a wide variety of valuable secondary products: from sheep/goat, wool, hair and milk; from cattle, milk and work potential (e.g. pulling a plough); from camels, milk, hair, and work potential (transport); from chickens, eggs.

In conclusion, it is likely that a mixed animal farming policy was employed, involving the use of both primary and secondary products, with no single product of paramount importance. The meat demand was met almost exclusively by domestic animals, and sheep/goat in particular. It is possible that some feral species which live in the vicinity today, for example, chukar partridge and quail, may have been hunted in antiquity as they are today, but simply have not been recovered or recognized yet. The dove (probably rock or stock dove) is one species which may have either been hunted or a domesticate. Our understanding of the use of wild and domesticated animals in ancient Hawar will be elucidated further by analysis of the rest of the bone collection.

Conclusions

To the eyes of a modern Canadian scholar who lives in the rain forest of British Columbia, the desert landscape around al-Ḥumayma looks like a desolate — but beautiful —wasteland. Nevertheless, survey and excavation at the site, and analysis of the ecofacts recovered have shown

16 K. Flannery, 'Early Pig Domestication in the Fertile Crescent: A Retrospective Look.' Pp. 163-187 in *Hilly Flanks: Essays on the Prehistory of Southwest Asia. Studies in Ancient Oriental Civilization* No.36. Chicago: Oriental Institute, 1982.

17 J. Clutton-Brock, 'The Primary Food Animals of the Jericho Tell from the Proto-Neolthic to the Byzantine Period.' *Levant* 3 (1971) 41-55.

18 G. Cansdale, *Animals of the Bible Lands.* London: Paternoster Press, 1970.

that the ancient inhabitants of the site were able to live quite comfortably by paying close attention to the resources of the landscape and respecting the shape and limitations of the ecosystem. Locally produced food could easily have supported the maximum regional population of 817 suggested by the capacity of the water-supply system. The figure of 654 persons for the settlement centre — although admittedly hypothetical — also corresponds well with the number of separate structures — approximately 40, mostly houses — identifiable on the surface of the site. These date for the most part to the early Islamic period, but the population may have hovered around this figure from the very foundation of the city.

Table 1. Analysis of soil samples from al-Ḥumayma.

		Sample 1	Sample 2	Sample 3	Sample 4
CHEMICAL ANALYSES:					
pH		7.95	8.0	8.0	8.0
EC	mS/cm^3	0.62	0.70	1	0.70
Total Carbon*	%	3.31	1.68	2.61	2.09
Total Nitrogen	%	0.07	0.04	0.02	0.03
Avail. Phosphorus	ppm	2	7	<2	<2
Avail. Potassium	ppm	650	465	160	160
Avail. Calcium	ppm	2600	2000	2450	2050
Avail. Magnesium	ppm	295	120	195	165
CEC (NaOAc)	meg/100g	17.3	8.8	12.5	8
Exc Ca (NH_4OAc)	meg/100g	13.8	10.3	12.6	10.7
Exc Mg (NH_4OAc)	meg/100g	2.7	1.1	1.8	1.6
Exc Na (NH_4OAc)	meg/100g	0.3	0.2	0.1	0.1
Exc K (NH_4OAc)	meg/100g	1.8	1.3	0.4	0.5
ESP	%	1.7	1.9	0.8	0.6
* Organic C and carbonate C.					
PARTICLE SIZE ANALYSIS:					
gravel	% by wt	0.9	6.8	0.8	3.2
sand	% by wt	45.8	71.6	64.1	n/a
silt	% by wt	33.1	19.0	25.4	n/a
clay	% by wt	21.2	9.4	10.4	n/a
Textural class		loam	sandy loam	sandy loam	
WATER RETENTION:					
1/10 bar	% by vol	32.6	27.9	28.1	
1/3 bar	% by vol	29.6	17.3	19.7	
15 bar	% by vol	15.7	15.4	12.9	
AWSC	% by vol	13.9	1.8	6.7	
Bulk Density	kg/m^3	1530	1827	1666	
Particle Density	kg/m^3	2561	2582	2618	
Total Porosity	% by vol	40.3	29.3	36.3	

Table 2. Abundance and frequency of charred seeds from al-Ḥumayma.

Common Name	Family Name	Scientific Name	Abundance		Frequency (n=40)	
			# seeds	%	# samples	%
DOMESTICATES						
Cereals						
Six-rowed Barley	Gramineae	*Hordeum vulgare*	24.0	3.9	5.0	12.5
Grass family	Gramineae	Unident. Gramineae	12.0	2.0	3.0	7.5
Bread Wheat	Gramineae	*Triticum aestivum*	2.5	0.4	1.0	2.5
Wheat	Gramineae	*Triticum sp.*	0.5	0.0	1.0	2.5
Legumes						
Chick-pea	Leguminosae	*Cicer arietinum*	1.0	0.2	1.0	2.5
Tree Crops and Vines						
Fig	Moraceae	*Ficus sp.*	14.5	2.4	5.0	12.5
Date	Palmae	*Phoenix dactylifera*	3.0	0.5	3.0	7.5
Olive	Oleaceae	*Olea europaea*	2.0	0.3	1.0	2.5
cf. Fig	Moraceae	*cf. Ficus*	1.0	0.2	1.0	2.5
Grape	Vitaceae	*Vitis vinifera*	1.0	0.2	1.0	2.5
WILD PLANTS						
White broom	Leguminosae	*Retama raetam*	86.0	14.1	5.0	12.5
Goosefoot family	Chenopodiaceae	Unident. Chenopodiaceae	26.0	4.3	9.0	22.5
Mouse-ear chickweed	Caryophyllaceae	*Cerastium sp.*	22.5	3.7	5.0	12.5
Plantain	Plantaginaceae	*Plantago sp.*	21.0	3.4	7.0	17.5
Common peganum	Zygophyllaceae	*Peganum harmala*	17.5	2.9	1.0	2.5
Medick	Leguminosae	*Medicago scutellata*	17.5	2.9	5.0	12.5
Sea-Blite	Chenopodiaceae	*Suaeda sp.*	13.0	2.1	5.0	12.5
Legume family	Leguminosae	Unident. Leguminosae	8.0	1.3	6.0	15.0
Pink family	Caryophyllaceae	Unident. Caryophyllaceae	7.5	1.2	5.0	12.5
Trigonel	Leguminosae	*Trigonella sp.*	5.5	0.9	1.0	2.5
Mallow family	Malvaceae	Unident. Malvaceae	5.0	0.8	6.0	15.0
Poppy	Papaveraceae	*Papaver sp.*	5.0	0.8	4.0	10.0
Sedge family	Cyperaceae	Unident. Cyperaceae	4.0	0.7	2.0	5.0
Grass family	Gramineae	Unident. Gramineae	4.0	0.7	3.0	7.5
cf. Pink family	cf. Caryophyllaceae	cf. Caryophyllaceae	4.0	0.7	4.0	10.0
Scorpion vetch	Leguminosae	*Coronilla sp.*	3.5	0.6	1.0	2.5
Goosefoot	Chenopodiaceae	*Chenopodium sp.*	3.5	0.6	1.0	2.5
cf. Trigonel	Leguminosae	*cf. Trigonella sp.*	3.5	0.6	2.0	5.0
Oval-leaved Androsace	Primulaceae	*Androsace maxima*	3.0	0.5	2.0	5.0
Mustard family	Cruciferae	Unident. Cruciferae	3.0	0.5	3.0	7.5
Bedstraw	Rubiaceae	*Galium sp.*	2.0	0.3	2.0	5.0
Rye grass	Gramineae	*Lolium sp.*	2.0	0.3	2.0	5.0
Alkanna	Boraginaceae	*Alkanna sp.*	2.0	0.3	1.0	2.5
cf. Star-of-Bethlehem	Liliaceae	*cf. Ornithogalum*	1.5	0.2	1.0	2.5
Daisy family	Compositae	Unident. Compositae	1.0	0.2	1.0	2.5
Wild Watermelon	Cucurbitaceae	*Citrullus colocynthis*	1.0	0.2	1.0	2.5
Parsley family	Umbelliferae	Unident. Umbelliferae	1.0	0.2	1.0	2.5
Bermuda grass	Gramineae	*Cynodon dactylon*	1.0	0.2	1.0	2.5
Pigweed	Amaranthaceae	*Amaranthus sp.*	1.0	0.2	1.0	2.5
Nightshade family	Solanaceae	*Solanaceae*	1.0	0.2	1.0	2.5
Fumitory	Fumariaceae	*Fumaria sp.*	1.0	0.2	1.0	2.5
Milk-Vetch	Leguminosae	*Astragalus sp.*	1.0	0.2	1.0	2.5
cf. Goosefoot family	cf. Chenopodiaceae	cf. Chenopodiaceae	1.0	0.2	1.0	2.5
cf. Medick	Leguminosae	*cf. Medicago*	1.0	0.2	1.0	2.5
cf. Scorpion vetch	cf. Leguminosae	*cf. Coronilla*	1.0	0.2	1.0	2.5
cf. Grass family	cf. Gramineae	cf. Gramineae	0.5	0.0	1.0	2.5
cf. Pigweed	cf. Amaranthaceae	*cf. Amaranthus sp.*	0.5	0.0	1.0	2.5
Unidentified seeds			267.5	43.7	25.0	62.5
TOTAL =			611.5		100.0	

Table 3. Abundance and frequency of uncharred seeds from al-Ḥumayma.

Common Name	Family Name	Scientific Name	Abundance		Frequency (n=40)	
			# seeds	%	# samples	%
Mallow Family	Malvaceae	Unident. Malvaceae	3.0	14.0	4.0	10.0
Puccoon	Boraginaceae	*Lithospermum sp.*	2.0	9.3	2.0	5.0
Poppy	Papaveraceae	*Papaver sp.*	2.0	9.3	3.0	7.5
Pink Family	Caryophyllaceae	Unident. Caryophyllaceae	1.5	7.0	2.0	5.0
Sow Thistle	Compositae	*Sonchus oleraceus*	1.0	4.7	1.0	2.5
Sedge Family	Cyperaceae	Unident. Cyperaceae	1.0	4.7	1.0	2.5
Borage Family	Boraginaceae	Unident. Boraginaceae	1.0	4.7	1.0	2.5
cf. Pink Family	cf. Caryophyllaceae	cf. Caryophyllaceae	1.0	4.7	1.0	2.5
Storksbill	Geraniaceae	*Erodium sp.*	0.5	2.3	1.0	2.5
	Compositae	*Hedypnois rhagdioloides*	0.5	2.3	1.0	2.5
unidentified seeds			8.0	37.2	7.0	17.5
TOTAL =			21.5	100.0		

Table 4. Domesticated and wild plant uses at al-Ḥumayma.

Common name	Scientific name	Description	Cultivated fields	Waysides, wasteland	Other locations	Use(s)
DOMESTICATES						
Six-rowed Barley	*Hordeum vulgare*	Annual grass	Yes	Yes		One of the most important grain crops
Bread Wheat	*Triticum aestivum*	Grass	Yes			Wheat normally used for making bread, etc.
Chick-pea	*Cicer arietinum*	Erect or sprawling annual herb	Yes	Yes		Seeds eaten, also made into flour, fodder
Date	*Phoenix dactylifera*	Perennial tree	Yes			Staple food and dessert
Olive	*Olea europaea*	Evergreen bush or tree	Yes	Yes	Hillsides in garigue or maquis	Fruit pickled, source of olive oil. Also used in decoration, fuel, craft, medicine and fodder
Fig	*Ficus (F. carica)*	Trees, shrubs and climbers	Yes			Edible fruit, also used forfodder, craft, medicine, food and poison
Grape	*Vitis vinifera*	Deciduous climber or trailer	Yes	Yes	In thickets and wooded ravines	Fruit eaten fresh or dried, seeds used to make oil, used in medicine, fodder, crafts and beverages

Common name	Scientific name	Description	Cultivated fields	Waysides, wasteland	Other locations	Use(s)
WILD PLANTS						
Oval-leaved Androsace	*Androsace maxima*	Herbaceous annual	Yes	Yes		
Common peganum	*Peganum harmala*	Herbaceous perennial		Yes	Roadsides	Often a relic of cultivation, used in medicine and as a condiment
Trigonel	*Trigonella (T. sprunerana, T. strangulata, T. spinosa, T. spiculata)*	Annual herb, rarely a perennial	Yes	Yes	Dry rocky hillsides, garrigue	A fodder plant
Scorpion vetch	*Coronilla (C. securidaca, C. scorpioides)*	Annual or perennial herbs or shrubs	Yes	Yes		*C. scorpioides* purgative used for fodder
Mouse-eared chickweed	*Cerastium (C. dubium, C. dichotomum C. brachypetalum, C. semidecandrum, C. illyricum, C. glomeratum)*				Some are widely distributed; mountain slopes, river banks cultivated fields, damp ground	Consumed as a potherb
Sea blite	*Suaeda (S. aegyptiaca)*	Annual or perennial herbs or shrubs			Cosmopol-itan, near salt marshes/lakes	Eaten cooked or raw
Milk-Vetch	*Astragalus (A. asterias, A. hamosus, A. boeticus, A. lusitanicus, A. caprinus, A. echinus)*	Annual, biennial and perennial herbs and subshrubs	Yes	Yes	Cosmopol-itan	*A. hamosus and A. boeticus* used for food, *A. hamosus* also used medicinally
White broom	*Retama raetam*	shrub		Yes	Dominates large sand and gravelly areas	Medicinal, used as fuel
Fumitory	*Fumaria (F. gaillardotii, F. judaica, F. macrocarpa, F. petteri, F. officinalis, F. densiflora, F. bracteosa)*	Annual	Yes	Yes	Europe, Mediterranean and Western Asia	
Medick	*Medicago scutellata*	Annual	Yes	Yes	Mediterranean Cultivated and fallow fields and waste ground	

Common name	Scientific name	Description	Cultivated fields	Waysides, wasteland	Other locations	Use(s)
Alkanna	*Alkanna (A. tinctoria, A. galilaea, A. hirsutissima, A. strigosa)*	Perennial herbs			Dry hillsides in garrigue, sandy and rocky places	*A. tinctoria* eaten as a vegetable; dye derived from roots
Wild Watermelon	*Citrullus colocynthis*	Prostrate trailing perennial herb		Yes	Dry sandy and rocky places	Seeds are eaten, also used medicinally
Plantain	*Plantago (P. major, P. coronopus, P. lanceolata, P. lagopus, P. amplexicaulis, P. notata, P. ovata, P. loeflingii, P. cretica, P. bellardi, P. afra)*	Annual or perennial herbs or sometimes woody subshrubs	Yes	Yes	Rocky slopes	Food source *P. cretica and P. afra* used medicinally
Goosefoot	*Chenopodium (C. botrys, C. foliosum, C. vulvaria, C. murale, C. opulifolium, C. album)*	Annual or rarely perenial herbs	Yes	Yes		Food source
Bedstraw	*Galium (G. canum, G. humifusum, G. setaceum, G. peplidifolium, G. aparine, G. pisiferum, G. tricornutum)*	Annual or perennial herbs or subshrubs	Yes	Yes	Rocky ground, crevices	*G. aparine* eaten and used medicinally
Pigweed	*Amaranthus (A. hybridus, A. retroflexus, A. albus, A. viridis, A, graezicans)*	Annual or rarely a perennial herb	Yes	Yes		Food source, *A. lividus & A. retroflexus* used medicinally
Poppy	*Papaver (P. rhoeas, P. minus, P. hybridum)*	Annual or perennial herbs	Yes	Yes		*P. rhoeas* used as spice, also used in craft, fodder and medicine
Rye grass	*Lolium (L. multiflorum, L. rigidum, L. perenne, L. loliaceum)*	Annual or perennial grasses	Yes	Yes		*L. rigidum* used for fodder
Bermuda grass	*Cynodon dactylon*	Perennial grass	Yes	Yes	Sandy areas	Cool drink is made from the root

Table 5. Al-Ḥumayma 1987 -1991. Number and percentage of all animal bones.

	1987-1989	% of Total	1991	% of Total	1987-1991	% of Total
Camel	1	0.54	6	0.22	7	0.24
Cattle	11	5.91	31	1.12	42	1.42
Chicken	13	6.99	97	3.45	110	3.71
Dog	4	2.15	1	0.04	5	0.17
Dove	2	1.08	—		2	0.07
Equid	2	1.08	52	1.87	54	1.82
Fish	25	13.44	848	30.51	873	29.44
Fox	—		1	0.04	1	0.03
Gazelle	—		5	0.18	5	0.17
Goat	6	3.22	57	2.05	63	2.12
Hare	—		2	0.07	2	0.07
Large Mammal	—		17		17	0.57
Marine Shell	—		220	7.92	220	7.42
Medium Mammal	—		19		19	0.64
Ostrich (egg)	1	0.54	397	14.28	398	13.42
Pig	13	6.99	4	0.14	17	0.57
Raven	2	1.08	—		2	0.07
Rodent	—		42	1.51	42	1.42
Sheep	5	2.69	13	0.47	18	0.61
Sheep/Goat	101	54.30	762	27.42	863	29.11
Small Egg Shell	—		56	2.02	56	1.89
Small Mammal	—		41	1.48	41	1.38
Small Ruminant	—		108	3.89	108	3.64
Total	186		2779		2965	
Unidentified	169	47.88 (of 355)	8652	75.69 (of 11431)	8821	74.84 (of 11786)

Table 6. Al- Ḥumayma 1978 -1991. Al-Number and percentage of identified species.

	1987-1989	% of ID	1991	% of ID	1987-1991	% of ID
Camel	1	0.54	6	0.26	7	0.28
Cattle	11	5.91	31	1.36	42	1.71
Chicken	13	6.99	97	4.26	110	4.47
Dog	4	2.15	1	0.04	5	0.20
Dove	2	1.08	—		2	0.08
Equid	2	1.08	52	2.28	54	2.19
Fish	25	13.44	848	37.26	873	35.46
Fox	—		1	0.04	1	0.04
Gazelle	—		5	0.22	5	0.20
Goat	6	3.22	57	2.50	63	2.56
Hare	—		2	0.08	2	0.08
Ostrich (egg)	1	0.54	397	17.44	398	16.17
Pig	13	6.99	4	0.18	17	0.69
Raven	2	1.08	—		2	0.08
Sheep	5	2.69	13	0.57	18	0.73
Sheep/Goat	101	54.30	762	33.48	863	35.05
Total	186		2276		2462	

Table 7. Al-Ḥumayma 1995. Number and percentage of all animal bones .

	No. of Pages	No. of Pieces	No. of Total	% of ID Species Only
Archamedes	10	12	0.15	1.36
Bird	2	8	0.10	
Camel	5	5	0.06	0.57
Carnivore	3	4	0.05	
Cattle	4	4	0.05	0.45
Chicken	135	201	2.56	22.84
Clam	1	3	0.04	0.34
Clam/Oyster	6	12	0.15	1.36
Conch	1	1	0.01	
Deer	1	1	0.01	0.11
Dog	1	2	0.03	0.23
Egg Shell	2	34	0.43	
Equids	12	38	0.48	4.32
Fish	56	166	2.11	
Goat	33	36	0.46	4.09
Hare	1	1	0.01	0.11
Large Bird	1	1	0.01	
Large Mammal	75	267	3.40	
Medium Bird	62	90	1.15	
Medium Mammal	1188	5432	69.19	
Ostreidae	3	3	0.04	0.34
Ostrich Shell	6	10	0.13	1.14
Pig	80	175	2.23	19.89
Rodent	1	1	0.01	
Sea Urchin	1	3	0.04	0.34
Sheep	43	48	0.61	5.45
Sheep/Goat	195	269	3.43	30.57
Small Bird	6	6	0.08	
Small Mammal	47	84	1.07	
Small Rodent	5	26	0.33	
Snail	13	39	0.50	
Trochus	13	17	0.22	1.93
Un-ID Marine Shell	17	45	0.57	
Undetermined	43	221	2.80	
Undetermined Mammal	71	586	7.46	
Total	2143	7851	100.00	
Total of Identified Species:	565	880	11.21 (of 7851)	

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Human Settlement at the Northern Head of the Gulf of al-'Aqaba:Evidence of Site Migration

Introduction

Recent archaeological research around the northern head of the Gulf of Aqaba suggests considerable migration of human settlement since late prehistoric times. The available evidence, based on excavation and survey of local sites ranging from the Chalcolithic to the Late Islamic periods, suggests that this migration has generally trended from north to south. This paper reviews the evidence specifically from the Chalcolithic to the beginning of the Islamic period. The paper will conclude by suggesting a possible explanation for this migration.

The Prehistoric Periods

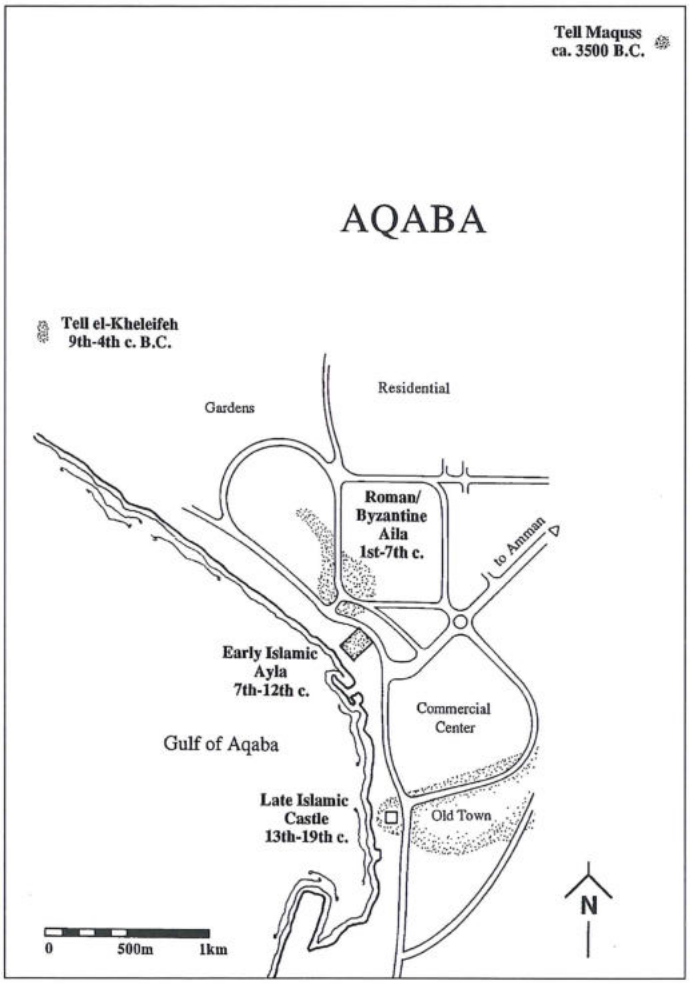
The earliest evidence of human presence in the Aqaba region was obtained in 1994 by the Southeast Wadi Araba Survey (SWAS), a unit of the Roman Aqaba Project (RAP). The SWAS recovered chipped stone artifacts at several sites in the southern Araba dating to the Middle Paleolithic period, perhaps as early as 200,000 BC. The same survey also recovered evidence of the Upper Paleolithic, Epipaleolithic, and Neolithic periods in the same region (Smith, Niemi and Stevens forthcoming).

The earliest evidence of sedentary occupation reported thus far in the immediate region of Aqaba is at Tall Maquṣṣ, ca. 4 km north of the present shoreline near the Aqaba airport (FIG. 1). Excavated by Lufti Khalil in 1985, Tall al-Maqaṣṣ is a single period site of the mid-fourth millennium BC, that is the late Chalcolithic Period. Tell al-Maqaṣṣ was interpreted by the excavator as an industrial site for processing copper, presumably mined farther north in the Araba (Khalil 1987; 1992; 1995). Ḥujayrāt al-Ghuzlān, a contemporary site just 1.5 km to the east, was interpreted as the residential site for these inhabitants (Khouri 1988: 130-31). It is notable that occupation of both sites appears confined to the late Chalcolithic period.

The Iron Age

The history of the Aqaba region between the Chalcolithic period and the Iron Age is problematic. There is clear evidence for Egyptian exploitation of the copper mines at Timna, just north of Aqaba, during the transition from the Late Bronze Age to the Iron Age (Rothenberg 1988; 1993).

Evidence of later Iron Age occupation is attested at Tall al-Kheleifeh, now 500 m north of the present shoreline just inside the modern Jordanian border (FIG. 1). The site was surveyed in 1933 by Fritz Frank, who identified it with the Ezion-geber of biblical tradition (Frank 1934: 243-45). According to 1 Kings 9:26-28, Solomon built a fleet at Ezion-geber whence a merchant fleet sailed to Ophir and returned with 420 talents of gold (cf. 2 Chron 8:17-18). The passage, also asserts that Ezion-geber was located "besides Elath, on the shore of the Red Sea, in the land of Edom."



1. Map of archaeological sites in the region of Aqaba.

The tradition also asserts that a later king of Judah, Jehoshaphat, constructed another fleet to sail to Ophir, but these ships were wrecked at Ezion-geber (1 Kings 22:48; cf. 2 Chron. 20:36-37). Judah later lost Elath to the Edomites during the reign of King Ahaz in the late eighth century BC (2 Kings 16:2).

Inspired by these traditions, Nelson Glueck surveyed Tall al-Kheleifeh in 1937 and directed extensive excavations in 1938-1940. Glueck initially accepted Frank's identification of Kheleifeh with Ezion-geber and dated the earliest phase of occupation to the tenth century BC, associating the site with King Solomon's Ezion-geber (Glueck 1935:48;1937:12). However, Glueck later acknowledged that the bulk of the pottery from both surface survey and excavation was in fact no earlier than the eighth century and thus the identification of Kheleifeh with Solomon's port was tenuous (Glueck 1938: 3-5). In his last published statement on the site, Glueck backtracked further from his initial identification, but continued to insist that Kheleifeh was at least a satellite of Ezion-geber/Elath, serving as a fortified caravanserai and granary (Glueck 1965). Unfortunately, Glueck never published the results of his excavations in final form.

Gary Pratico, in a thorough re-examination of Glueck's work, concluded that the site was not founded prior to the eighth century BC. This in turn suggests that Kheleifeh is more likely to have been established by the Edomites. Again, there is clear evidence at this site for processing copper, presumably from the mines in Wādī 'Arabah. Occupation clearly continued well into the Persian Period (539-332 BC), certainly into the fourth century BC. A single Rhodian stamped amphora handle, a surface find dated ca. 200 BC, is the only Hellenistic evidence yet attested from the site (Pratico 1985; 1993). The near total absence of Nabataean pottery from Kheleifeh, so ubiquitous elsewhere in the region, strongly suggests abandonment before the early first century BC.

The Roman and Byzantine Periods

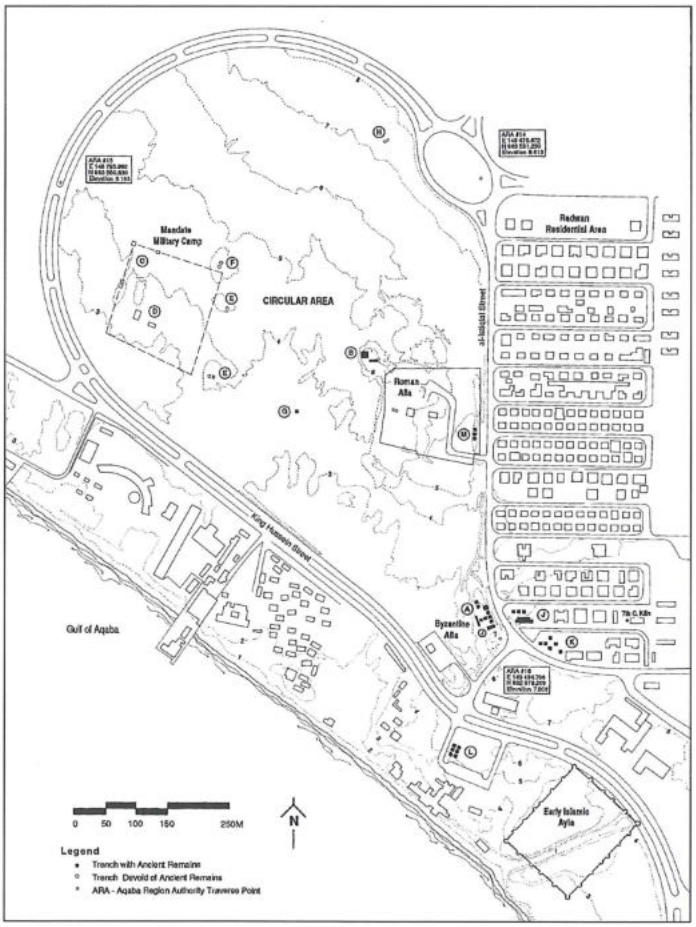
Excavations in 1994 by the Roman Aqaba Project, directed by the author, have now definitively located the apparent successor settlement to Tall al-Kheleifeh, the city of Aila. The classical Aila is located just over 2 km south-east of Kheleifeh (FIG. 1). Excavating several widely scattered areas (FIG. 2), the project recovered a complete stratigraphic sequence extending from the first century BC (Early Roman/Nabataean period), through the Late Roman, Early Byzantine, Late Byzantine, and well into the Early Islamic period, to perhaps the tenth century AD (Parker 1994;1996).

Although evidence of the first season is still at a preliminary stage of analysis, a number of important facts about the classical Aila have already emerged. These include the types and location of structural remains and analysis of some categories of artifacts.

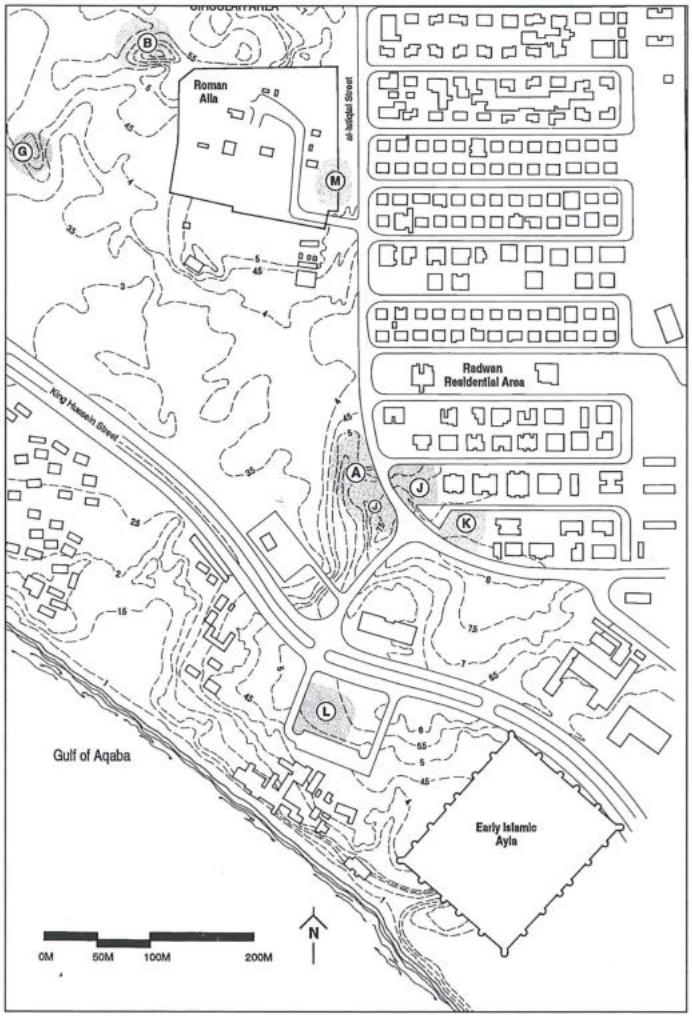
Interestingly, the earliest evidence of occupation (first centuries BC/AD) was located farthest north (ca. 500 m) from the present shoreline, while the latest occupation (eighth/ninth centuries AD) was closest to the present coast. Mostly Early Roman/Nabataean material (first centuries BC/AD) was recovered from Area M, a group of three 5 x 5 m trenches just west of al-Istiqlal Street (FIGS. 2 and 3). This included Nabataean painted and unpainted fine ware, imported terra sigillata (mostly Eastern Sigillata A), and two Nabataean coins from stratified contexts.

Just over 200 m to the north-west, atop a mound heavily disturbed by modern military trenching, Area B yielded stratified material from a mudbrick domestic complex dated from the Early Roman through Early Byzantine periods, that is to at least the fourth century AD (FIGS. 2 and 3). A significant quantity of terra sigillata pottery and a few sherds of African Red Slip (ARS) ware attest to continued importation of fine ceramics through Aila in this period. The area yielded three Late Roman and two Early Byzantine coins, the latter both of the mid-fourth century. Two Late Byzantine coins (one unstratified) suggest that Area B witnessed some human activity in the sixth century.

Excavation in Area J, ca. 300 m south of Areas B and



2. Map showing all excavation areas of the Roman Aqaba Project in 1994.



3. Map with location of all excavation areas of the Roman Aqaba Project in 1994 that encountered ancient remains.

M on the east side of al-Istiqlal Street (FIGS. 2 and 3), revealed a massive vaulted mudbrick structure erected in the fourth century AD. Some of the surviving mudbrick walls were built atop stone walls, from which good dating evidence was obtained. Most coins from the structure date to the Early Byzantine period, that is fourth or early fifth century. But little clear occupational evidence has yet been recovered from the building. The fragmentary plan thus far available suggests the possibility of a public building, perhaps even a Christian basilica. A bishop of Aila is attested as early as 325, but the identification of the structure as a basilica remains nothing more than a suggestion at this stage.

A cemetery of mudbrick tombs, also apparently dating to the fourth century, was discovered in Area A (FIGS. 2 and 3) just west of the mudbrick structure. Three tombs were excavated in 1994. Each contained a single articulated skeleton with minimal grave goods. Associated artifacts included two coins of the mid-fourth century AD. The cemetery is seemingly contemporary with the mudbrick structure in Area J and may be associated with it.

Whatever its intended function, the mudbrick structure in Area J was soon abandoned. It was then partly demolished and partly built over by construction of a stone curtain wall and projecting interval tower (FIG. 4). Two mid-fourth century coins, one from the rubble core of the curtain wall and another from a constructional fill within the tower, provide a terminus post quem for the curtain wall's construction. Associated pottery from the wall's foundations also support a construction date in the late fourth or early fifth century. The exposed segment of the curtain wall was 1.6 m thick nearly 30 m long, and still preserved to a maximum height of 1.8 m.

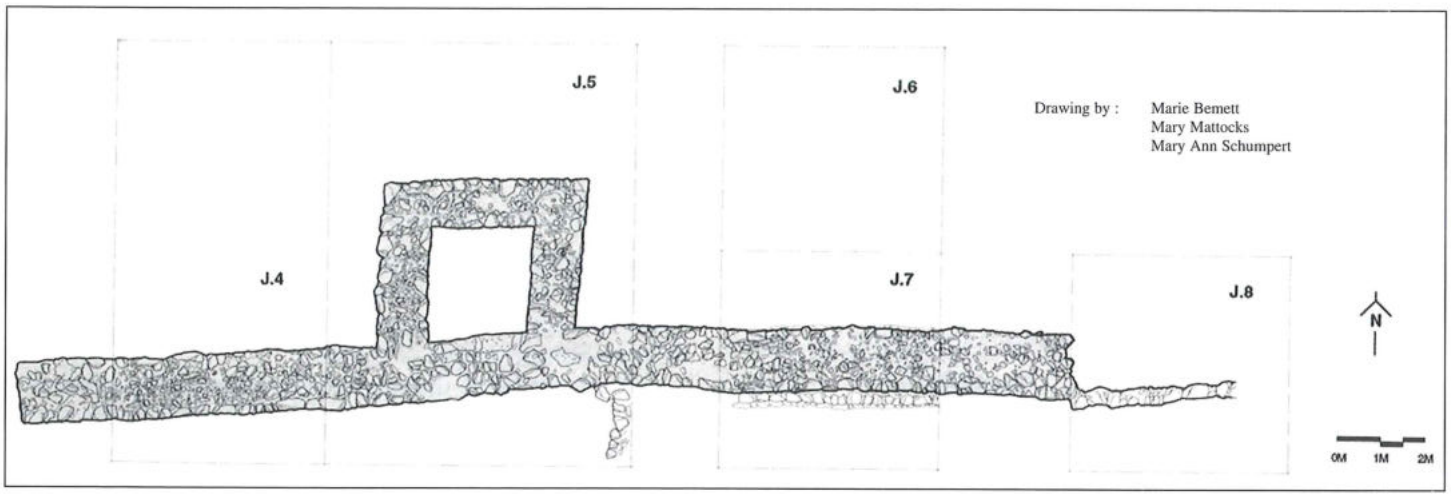
The location of the projecting tower on the north face of the curtain wall clearly suggests that this was the northern limit of a defended enclosure. This curtain wall must represent either the city wall of Early Byzantine Aila or the curtain wall of the fortress of *legio X Fretensis*. This famous legion was transferred from Jerusalem to Aila by the turn of the fourth century (Eusebius, *Onomasticon* 6.17) and was still in the garrison at Aila a century later (*Notitia Dignitatum Or.* 34.30). Roman army units garrisoned in cities typically walled off part of the urban area as a separate fortified military quarter, as at Dura Europos and Palmyra. Thus it may be supposed that *X Fretensis* was based in a similar manner. It must be stressed, however, that the numismatic evidence from the wall itself suggests that it was not constructed before the mid-fourth century and thus could not have been part of the original legionary base.

Because of this, it seems perhaps more likely that the curtain wall is in fact the city wall of Early Byzantine Aila. This in itself is worthy of note, because the excavated evidence of Early Roman, Late Roman, and Early Byzantine occupation (in Areas B and M) lie 300-500 m beyond and north of the Byzantine wall line.

Stratified Late Byzantine occupation and a sixth century coin were recovered from stone structures just west of al-Istiqlal street in Trenches J.9 and J.10 (FIG. 3). These structures may have been built over an earlier westward extension of the curtain wall.

In other words, the focus of human settlement at Aila seems to have moved significantly southwards by the fourth century AD by which time the Early Roman domestic complex in Area M had long since been abandoned. The domestic complex in Area B, however, seems to have continued in occupation as a surburb after construction of the curtain wall in Area J, although it was also apparently abandoned by the fifth or sixth century.

It appears that the Byzantine curtain wall fell out of use by the seventh century, when extensive robbing of its building stones and dumping of debris within the tower occurred. Some of the debris dumped into the tower included kiln wasters and ceramic slag, possibly from the seventh century pottery kilns recently excavated only ca. 100 m to the east (Melkawi, 'Amr and Whitcomb 1994). It is tempting to associate this robbing and dumping activity with the contemporary construction of the Early Islamic town ca. 650.



4. Plan of the Early Byzantine curtain wall with a projecting rectangular tower.

The Early Islamic Period

Excavation of three areas, one north and two south of the Byzantine curtain wall, revealed substantial occupation in the Early Islamic period.

Just north of Byzantine curtain wall and west of al-Istiqlal Street, a mudbrick domestic complex was excavated in Area A (FIG. 3). The latest phase of occupation dates to the mid-eighth century, that is Late Umayyad or Early 'Abbasid, as suggested by the presence of so-called "Mahesh Ware" (Whitcomb 1989) and an Umayyad coin dated ca. 735-742. The absence of typical Abbasid glazed wares from the mudbrick complex suggested it was abandoned by the turn of the ninth century (Whitcomb 1990-91). Stratigraphic and artifactual evidence suggested that the mudbrick complex was founded in the Late Byzantine period (sixth/early seventh centuries). If the complex was in fact founded this early, it might suggest that the Early Byzantine curtain wall had gone out of use prior to the Muslim conquest.

Area K, located south of the Byzantine curtain wall and just south-east of Area J, consisted of six 5 x 5 m trenches (FIGS. 2 and 3). A complex of stone walls, mudbrick walls, and associated floors appeared, partly covered by extensive dumps. Rich artifactual remains were recovered from these dump layers, including pottery, glass, coins, animal bones, and carbonized plant remains. The latest pottery from these dump layers was Abbasid. One of the uppermost dump layers also yielded an Abbasid coin of the early to mid-tenth century AD. Removal of these dump layers exposed more architecture, including several phases of mudbrick and stone walls. The layers under the dumps yielded an Umayyad coin of the early eighth century. The pottery of the latest architectural phase was 'Abbasid, that of the earlier phases was Umayyad (ca. 650-750). All this suggests that Area K served as a suburb to the adjacent Early Islamic town in the Abbasid and Umayyad periods. Subsequently it was abandoned and used as a dump by the tenth century . Given the proximity of Area K to the Byzantine city wall and the fact that the deepest excavation in this area reached only about 1 m below the modern ground surface, its seems likely that Byzantine remains underlie the Early Islamic strata.

Area L was opened nearly 250 m farther south-west of the Byzantine city wall, 150 m west of the walled Early Islamic town, and less than 100 m from the present shoreline (FIGS. 2 and 3). Excavation revealed a complex of mudbrick and stone structures with associated floors and domestic installations. The complex clearly experienced several phases of occupation within the Abbasid period. Therefore it appears that Area L, like Area K, was a suburb of the walled Early Islamic settlement to the east.

Although this paper focuses primarily on the pre-Islamic period, it is notable that the process of site migration continued in the Medieval period. Recent excavations by Whitcomb have located the walled Early Islamic town, founded in the mid-seventh century, ca. 250 m south-east of the Byzantine city wall (FIGS. 1 and 3), directly on the modern beach (Whitcomb 1988; 1993; 1995). Its abandonment in the twelfth or early thirteenth century was followed by the establishment of the Late Islamic settlement ca. 1 km farther down the coast to the south, around the present Hashemite castle.

Conclusion

In short, it seems clear that human settlement in the Aqaba region has migrated persistently southwards over the past five millennia. Why? One possible explanation may be a change in the shoreline. Tina Niemi, staff geologist of the Roman Aqaba Project, suggests that the sea might have extended farther north in antiquity. She bases this suggestion on examination of aerial photographs combined with the results of regional archaeological surveys and excavations. Niemi suggests that the shoreline in the classical period possibly extended farther north into the so-called 'Circular Area', just west of Area B. Indeed she reports the deposition of halite (sea salt) on mudbrick walls in Area B that might have resulted from sea water

sprayed from waves.

This suggestion is further supported by results from several other areas excavated farther north and west in the 'Circular Area' by the Roman Aqaba Project (FIG. 1). Excavation of these areas (designated C, D, E, and F), yielded no stratified ancient remains, only some modern mudbrick structures overlying deep deposits of apparent beach sand. Several trenches excavated by mechanical equipment to a depth of 3.5 m in these areas within the 'Circular Area' did not reveal significant ancient occupation.

What could have caused the advance of the shoreline southwards over the centuries? It would appear that fluvial deposits washed down from Wādi 'Arabah and Wādi Yutm during the torrential winter rains may be responsible. Therefore, in order to remain a viable port for shipping, human settlement has been compelled to follow the receding shoreline. It must be stressed that, although migration of human settlement southwards is now well documented by recent archaeological research, the explanation of an advancing coastline at the head of the Gulf of Aqaba proposed in this paper remains only a working hypothesis. More research is needed to test this hypothesis. And, even if valid, it is entirely possible that other factors may have figured in the process of site migration. Nevertheless, current evidence does suggest that this hypothesis is worthy of further consideration.

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Vernacular Architecture and the Assessment of Demographic Patterns within the Recent Environment in Relation to the Evidence from Tall Iktanū

Introduction

Throughout the periods of work at Iktanū and al-Ḥammām in the south Jordan Valley, from 1965 to 1992, the patterns of land use and demography have been the subject of at first interest and observation, and finally more focussed recording and analysis. It has been evident that the local people had much information to provide on subsistence survival in the landscape, in traditional and other ways that reflected both directly and indirectly on the information being retrieved by our excavation and survey work.

The modern ethnographic data was relevant to the ways in which our archaeological evidence should be perceived, but more than that, provided models which challenged traditional interpretations of archaeological evidence. The processes of observation and recording have been pursued steadily, and have led to assessments of transhumant elements in the ancient and modern populations (Prag 1985 and 1991a); and to the assessment of the balance in the environment between settled and pastoralist communities (Prag 1992 and 1995). Increasingly also the processes of sedentarization and flexible settlement patterns have been observed. Latterly studies of local traditions in architecture have contributed to understanding the limitations imposed on ancient and modern building by the use of locally available materials in the region, and to assessing the speed from abandonment to collapse of buildings in local conditions.

The observation of multiple traditions in construction techniques, and of changes in function during the life span of a building, have also provided relevant data. It has been observed that the demographic patterns and dynamics within the largely post-1948 refugee settlements in the vicinity of Iktanū also challenge the archaeological record with a large number of similar parameters. These are particularly apposite when patterns in the sudden appearance of the town at Iktanū in the later third millennium and the recent appearance and rapid development of nearby modern ar-Rawḍa are juxtaposed, with the rapid demographic growth reflected in expansion of housing and housing infill at both sites.

The general architectural styles can also be compared within the local landscape. Obviously we are not talking of identical circumstances and patterns, nor attempting to produce absolute explanations which might lead from recent history to a much more ancient period. The recording of data in all periods however, leads to challenging models of interpretation for the past.

The following data is derived from diaries and records beginning in 1965 when the writer first conducted archaeological surveys in the area (see Prag 1974, 1989, 1990, 1991b); from figures provided by the Department of Statistics of Jordan, and from the copies of the Community General plans of ar-Rawḍa and of an-Nahda provided by the Jordan Valley Authority.

The Township of ar-Rawḍa (FIG.1)

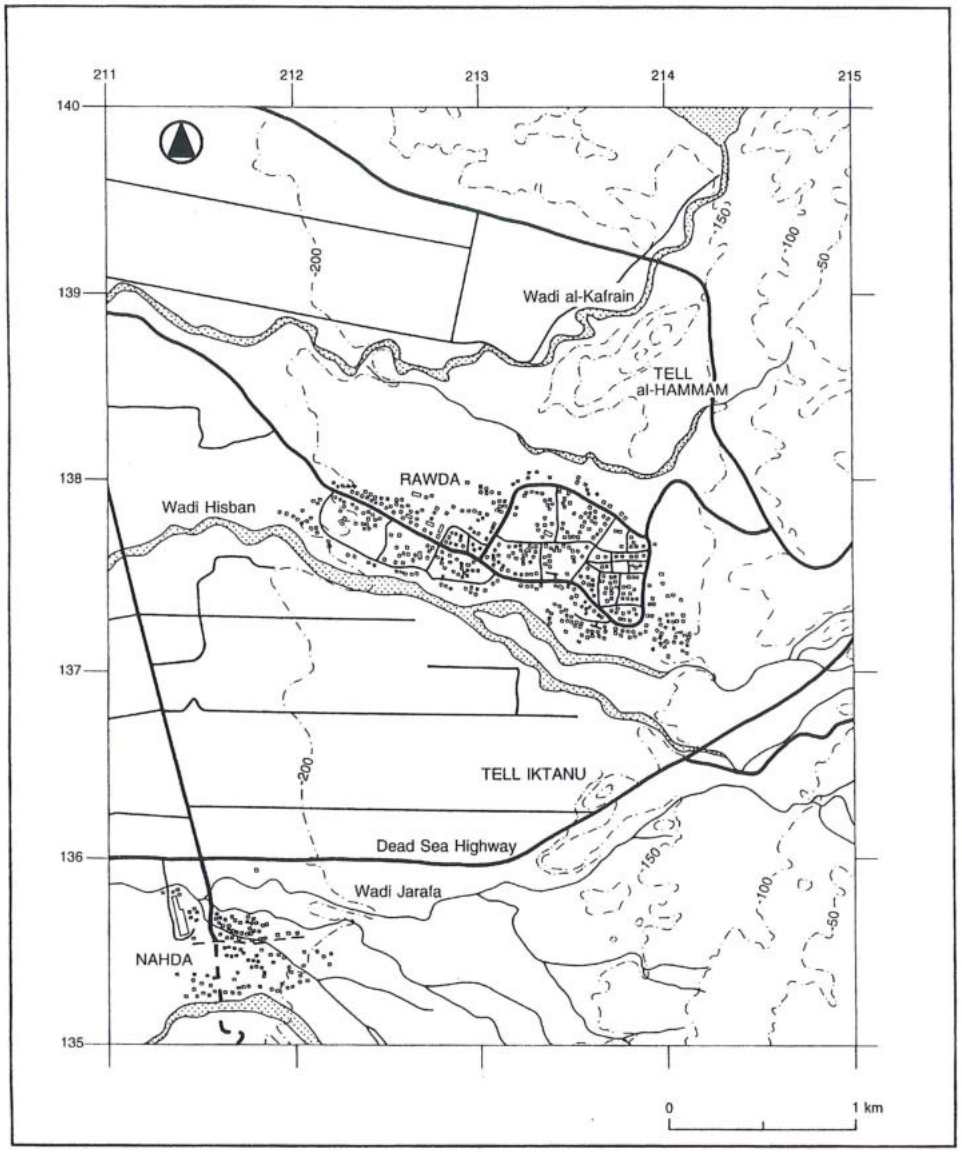
History and Statistics

Ar-Rawḍa lies in the al- Balqā' Governorate, in the sub-district of ash-Shūna aj-Janūbiyya. Present residents say the township of ar-Rawḍa (Arabic = the garden) was first settled in 1957 though it may have been earlier. When the writer first visited the village in 1965/6 it consisted of a ribbon strip of mudbrick houses built by Palestinian refugees along a dirt road; there was a small school house.

In 1992 ar-Rawḍa was reaching the status of a municipality, with a population of between 5000 and 6000. Most of the roads within the town are now laid out in accordance with the community plan and are surfaced. The main east/west road is partly lined with shops. The rapid population growth is reflected in the number and size of schools both operational and planned (TABLE 1). An open plot of land in 1992 was occupied by another large new school building in 1994.

It can be seen that the population growth in ar-Rawḍa was very fast; between 1975 and 1979 it grew by over one third, roughly at a rate of 276 per annum; between 1979 and 1992 it had almost doubled, approximately at an average growth rate of 225 per annum.

The population is mainly descended from a number of tribes from both the east and west banks of Palestine. The population of the ash-Shūna sub-district as a whole is composed mainly of the local land-owning tribe, the 'Adwān; of the Ghawārni (tribes inhabiting the al-Ghawr before 1948); and of refugees coming mainly from the northern an-Naqab after 1948, including the 'Azāzma, the



1. Map of the localities of ar-Rawḍa and Tall Iktanū, indicating the proximity and similar environments of the ancient and modern sites.

Table 1. Population Statistics

Year	ar-Rawḍa	ash-Shūna aj-Janūbiyya sub-district
1961[1]	not recorded	1078
1974/5[2]	1961	?
1979[3]	3068	18093
1992[4]	c. 5000/6000	?

[1] Source: 18 November 1961, first census of population and housing; Department of Statistics, Jordan. In the 1961 census ar-Rawḍa is not listed.

[2] Source: 1974/5 census; " Roda ", Department of Statistics, Jordan.

[3] Source: 1979 census; Department of Statistics, Jordan. The municipality building in ar-Rawḍa was constructed in this year (local informant).

[4] Source: 1992 ; according to the Municipality in South ash-Shūna, the present population is between 5000 and 6000 people .

Amarin, the Beshash and the Jabarat tribes (Prag 1992; Oppenheim 1943: 81-90).There are also immigrant workers from Egypt and from Syria. The population within ar-Rawḍa itself has a generally higher proportion of people of Bi'r as-Saba' origins.

The Environment of the Town

Ar-Rawḍa lies between contours -150 and -200 m. below Mediterranean Sea Level (grid.ref. 213138), on a flat strip of land bounded on the north by a minor wadi, and on the south by the Wādī al-Quṣayb and Wādī Ḥisbān: the two wadis unite south of the centre of the town. The Ḥisbān is perennial, the al-Quṣayb, though deep, is not. To the east the houses extend almost to the line of faulted cliffs which mark the edge of the Rift; and to the west the houses end at the edge of irrigated fields and orchards. The area receives an average annual rainfall of 164 mm but this varies drastically from one season to another. Rainfall is

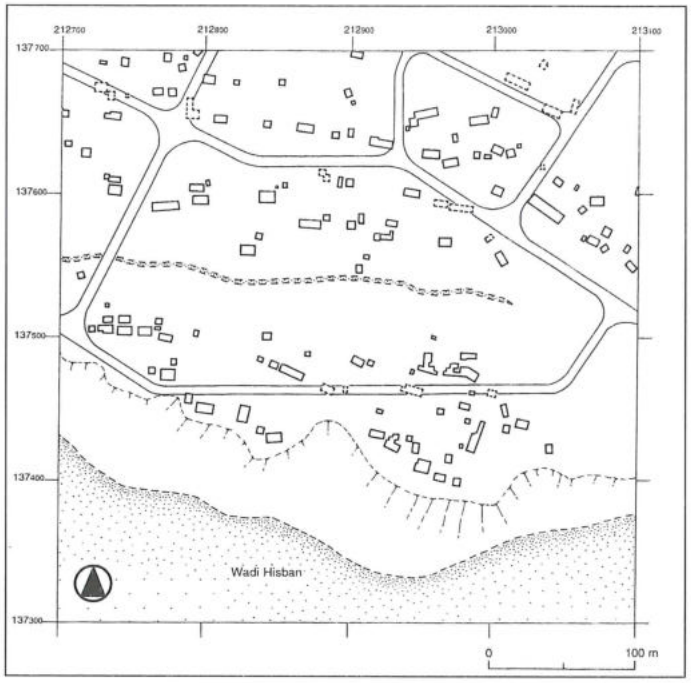
restricted to the winter and spring months; occasional torrential rain turns the alluvium into deep mud, puts the wadis into impassable spate, and for an hour or two creates impressive waterfalls on the cliffs to the east of the town. When this happens it is easy to understand the problems of erosion in the area, attested by the deeply eroded wadi beds, and the rapid collapse of any mudbrick houses which are not annually and carefully maintained.The land around in summer and autumn is bare and very arid; after good rain in winter and spring it turns green and blossoms with flowers. Crops of cereals can be dry-farmed on the alluvial soils thanks to this rainfall and to seepage from the high ground to the east. Nearly all vegetation is burnt up and dies away by late April (when cereal harvest normally takes place), and from May onwards only the irrigated zones of alluvial soil remain green.

A number of the inhabitants leave the town during the very hot summer months; some migrate to the cooler temperatures of the plateau; some take a tent and go only a short distance to slightly higher ground, away from the houses to obtain the relief of any breezes. Many of the inhabitants have animals; a donkey, small flocks of goats, a few cows or sheep being the most common; these are often kept in pens or stables in a yard around the house and taken out to graze. Hens and pigeons are also kept in these circumstances. Around some houses are yards with trees, such as figs and olives, and fruit or vegetables such as prickly pear and onions.

The Layout of ar-Rawḍa (FIG. 2)

The first houses in the 1950s and 1960s were laid out along the line of the north banks of the Wādī Ḥisbān and Wādī al-Quṣayb. The wadis provided the only source of water for the inhabitants in the 1950s, which was carried to the houses by people, sometimes with donkeys. The distribution of the houses in the older settlement shows this functional relationship. The houses also indicate a loose social structure, with little other evidence for planning. The houses were laid out in an almost tent-like pattern, not too close to each other, in more or less regular rows, with backs to the south-east which is the direction of the fierce easterly gales (the *sharqiya*) which are an unpleasant and not infrequent feature of the area, and probably a factor to be considered in damage and collapse patterns for housing. The house doorways usually face the north, on the cooler side of the house, and the normal north-western breezes. There are relatively few windows, and many are blocked up. There is no evidence for an earlier village on the site that might influence the modern layout.

The houses are simple in plan, normally made of locally available materials. They are rectangular, have one or two rooms, occasionally three. They are built of rectangular sun-dried mudbrick, set on a single row of wadi stones laid directly on the ground surface. They usually have slightly sloping roofs, of poles, reed-canes, thatch and



2. Central-south area of ar- Rawḍa, showing original layout of row housing parallel to the Wādī Ḥisbān, overlaid by the modern road system. Based on the ar-Rawḍa Community General Plan, Sheet 2, 1976.

clay. There are indications of more than one building tradition. Many of the houses now are enclosed within yards, often with gardens; but there seem to have been very few yards around houses in the early years of the settlement.

It is clear from the municipality map of this section of ar-Rawḍa drawn in 1976 that the modern road system, municipal amenities and a civic plan have been overlaid on the simpler earlier system, and there are clear indications of recent attempts to rationalize property boundaries in a systematic way in relation to these civic plans. Some houses have been demolished to accommodate the roads now required in the developing town. Others are scheduled for demolition to make way for future development as areas have been designated for schools, commercial or industrial use. This recent development does not form part of our study.

There is, particularly on the northern and eastern sides of the town, a proportion of winterhomes for citizens of as-Salṭ and people from elsewhere on the plateau, some of whom come on Friday or for holidays during the winter to escape the cold wetness of the highlands. Nearly all these buildings are modern, in both plan or materials. In this part of the town a number of buildings are either empty or only occasionally occupied. This area has little to offer a study of traditional demographic patterns, apart from noting the continuing practice of using al-Ghawr as a favoured winter living zone.

A group of empty houses in the old centre of the town, scheduled for demolition, was the subject of a survey in 1992 to be described by A. McQuitty; the plans, construc-

tion materials, building traditions and collapse patterns were recorded, along with some ethnographic data.

These houses were built in the 1950s, planned in 1976 and had been demolished by 1994. At the same time, a second survey, concerned with changing patterns of occupation, was begun in the south-east corner of the town. It is this survey which is outlined below.

The South-East Corner of ar-Rawḍa (FIG. 3)

A survey of the houses in the south-east corner of ar-Rawḍa has provided catalogue of structures and records changes through time. This is based on four sucessive levels of recording. Level I is provided by the municipality map drawn up for this area in 1987. Level II is based on a series of air photographs taken March, 1990. This information has been supplemented by two further levels (Levels III and IV) of informal interviews and ground-checking on 22nd April, 1992 and on the 18th February, 1994. Levels III and IV are not comprehensive. The type of information recorded is illustrated below.

House 1 at south-east corner of Block 1

I : pre 1987. Mudbrick structure, lean-to roof; no yard.

II : 1990. Roof intact, no yard.

III : 1992. Two rooms, two doors facing north. The east room has an internal buttress in east wall, two small windows on either side of the door in the north wall, both of which are blocked with mudbricks; there are two small ventilation holes above the windows; this room has fallen in. The west room is still intact, has windows on the south and west sides, which are blocked. House stands in an unfenced waste ground. Probably abandoned?

IV : 1994. Completely collapsed in unfenced waste ground, brick debris max. 0.50m high. According to the Jabarat family living opposite, this house was built by a Jabarat family in 1956. The Jabarat who owned this building were living in it (the west end?) until three months ago, but they have now built a house in the hills and are not coming back to ar-Rawḍa.

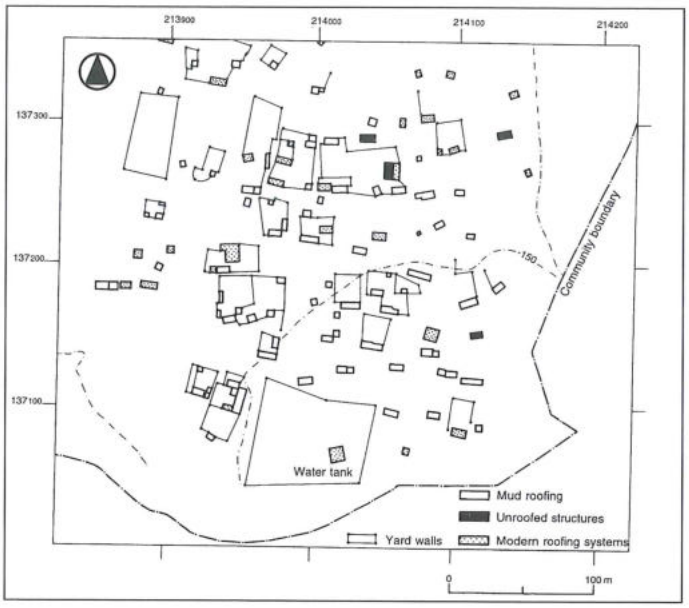
*Summary:*traditional mudbrick two room lean-to, built by Jabarat in 1956, east end abandoned between 1987 and 1992; west end abandoned in 1993 when the owners moved away; completely collapsed by February 1994.

House/complex 7 at east end of ar-Rawḍa in centre east of Block II

I :pre 1987. Mudbrick structure with yard wall on west side only.

II :1990. Two-room, lean-to, mudbrick house in the south side of a fenced yard, converted to use as stable; new concrete house to north with second fenced concrete yard on north side. No plants.

III:1992. A neat and well-maintained house at the extreme east end of the village. Near the centre of the yard is a new L-shaped concrete house (three years old, built c.1989), with attached concrete lean-to on the east side. Against the south perimeter of the yard is a mudbrick two-room lean-to, with two north-facing entrances. This was built around 20+ years ago (c.1972 or earlier). There is a low open-fronted shed with stone pillar at the east side. The new concrete house is the family dwelling; the old house is used as stabling for cows and calves, goats and sheep. There are pigeon houses made from tin cans on the north wall above the door.



3. The survey in the south-east area of ar-Rawḍa. Traditional mud-roofed houses/storage buildings are left blank; houses with modern roofing systems are stippled; unroofed structures are indicated in solid black. Based on the ar-Rawḍa Community General Plan, Sheet 5, 1987.

There is a new concrete breeze-block wall around the south yard; the single entrance to the yard is on the east side, and is blocked by sheets of tin, and tin barrels. The south yard is used by the animals and is dark with dung. The front yard is a garden with fig and prickly pear well-established on the central west side. The fence is used for drying washing and airing bedding. Most of the dung from the stables is carried out in sacks, put in a heap against the minefield fence about 50m to the east, and subsequently taken out to the fields and placed around fruit trees. Outside the house on the south-east were six feeding troughs for flocks.

The inhabitants are Palestinians; they go up to the plateau for two months every year.

Analysis

As can be seen in FIG. 2, the dominant pattern in the original layout of ar- Rawḍa consists of rows of rectangular dwellings and small storehouses in alignments roughly parallel to the wadi on the south. Near the top right is the small block of houses surveyed in 1992, all of which were constructed of mudbrick with pole/reed /thatch/clay roofs.

None have yards.

In FIG. 3 (also based on the plan of the Municipality) in the plan of the south-east area, the basic pattern is similar, with a loose alignment of rectangular dwellings and smaller storehouses. The plan is however more complex, even without the overlay of the modern road system, and this reflects more complex developments in recent years. In this area of ar-Rawḍa, there are about 45 dwellings, approximately 56 store/stable buildings, and 22 yards. Of the c. 111 structures, 76 have a traditional mud roof, 31 are roofed with other materials, and 4 are unroofed.The great majority of structures in 1987 were still mudbrick houses, and the larger number appear to be in use as stores or stables.

In the more detailed survey of two blocks of this area higher figures for dwellings as opposed to stores are offset by the number of dwellings which are being abandoned.

The processes observed in Levels III and IV of the project are i) abandonment and collapse of some dwellings and storehouses; ii) a simultaneous process of infill with mudbrick houses being replaced by one or more concrete dwellings, on the same site or on a site adjacent to the original house, which is often then used as a stable; iii) increase in the number of paved roads in accordance with the civic plan, which involves some demolition of traditional style houses; iv) increase in the number of walled yards, also laid out (sometimes rebuilt) in accordance with the civic plan and defined property boundaries.

Both processes – of abandonment, and of growth, are linked with a high degree of population mobility, both long and short term. People move to the plateau for as little as two months in the summer, or permanently, abandoning houses in the town. Economic and demographic growth is indicated by housing infill; and by the increased numbers of animals kept. Permanent occupation is reflected in the increase in gardens. The pattern of enclosed units laid out in accordance with the civic plan, in which the land is generally planted with fruit trees and flowers, dominates the north side of the town.

Conclusions

When the morphological patterns of modern ar-Rawḍa and late third millennium Iktanū are compared, both contrasts and parallels are very marked.

1. Iktanū was a planned settlement from the outset; its courtyard houses enclosed by walls, and its clear street layout, were in place from the beginning of construction of the settlement (Prag 1974: 97; 1993: 267-270). By contrast, ar-Rawḍa initially had a loose, functional layout, with walled yards and civic organization only developing later. The historical, economic and ethnographic background of the modern inhabitants accords with this pattern. The contrast suggests that the late third millennium inhabitants of Iktanū arrived on the site bringing with them more urban traditions.
2. On both sites the materials used were the products of the local environment and in use in similar conditions. Rectangular structures of mudbrick walls set on stone bases, with poles, reeds, thatch and clay used for roofing materials. These structures can be built quickly, but must be maintained regularly. Such houses in ar-Rawḍa collapse very swiftly as soon as winter rainwater penetrates the roof; and in some cases walls fall even before the roof, perhaps due to the ferocity of the local gales, or to seismic activity or simply the poor construction methods. The collapse of such houses can follow within months, rather than years, of abandonment. The assessment of the occupation interval between Phase 1 and 2 at Iktanū may be even shorter than the 5 to 50 years originally proposed (Prag 1974: 81), especially when the length of many stretches of the Iktanū walls is considered. With the latter factor in mind, it may also be necessary to consider many of the walls on Iktanū as low yard walls, rather than higher structures.
3. Storage and stabling play a large part in the town at ar-Rawḍa, as does storage in other villages in modern Jordan (Köhler-Rollefson 1987:536, 538) and in Palestinian villages in the past. It is clear that the houses at Iktanū had significant storage capacity (Prag 1993: 270), and it seems likely that the large courtyards were originally linked to animal ownership (Prag 1974: 98). This pattern may have changed through time, as infill of new rooms in the courtyards displaced animal pens. The quantities of pottery in the rooms suggest they were used as dwellings and/or stores, not as stables.
4. Both ar- Rawḍa and Iktanū appear on fresh sites, and grow very rapidly to considerable size. The population of ar-Rawḍa has grown from zero to 6000 in less than forty years. Although ar-Rawḍa covers a larger area, the layout is much less dense than that at Iktanū. The estimated minimum population of Iktanū in Phase 2 is 2000-2500; but the minimum area occupied even in Phase 1 was 18 hectares. Even if many of the houses were used principally for storage, the production and storage facilities indicate a sizeable community. Ar-Rawḍa and other villages in the vicinity illustrate the patterns of rapid demographic growth in a locality affected by adverse environmental factors. Factors in the establishment of these modern villages were more political than environmental or demographic, and suggest that we should not necessarily restrict our interpretion of the past to economic and environmental factors.
5. The population of ar-Rawḍa has mixed origins, which may be reflected in varied traditions in the modern vernaclular architecture. This will require careful assessment of the vernacular architecture and the ethnographic data. The material from excavation should be equally carefully assessed for intrasite variation.
6. On both sites, demographic growth appears to be indicated by patterns of housing infill.

This aspect of the work in the vicinity of Iktanū and al-Ḥammām is part of an on-going project of regional archaeology in the Shu'ayb-Ḥisbān region.

Acknowledgements
The project is indebted to the Department of Statistics of the Hashemite Kingdom of Jordan; to the Jordan Valley Authority through the kind co-operation of the Department of Antiquities, who provided the copies of plans of the communities of ar-Rawḍa and of an-Nahda. Between the 18th and 22nd April, 1992 Alison McQuitty made a detailed record of a small group of buildings in the centre of ar-Rawḍa, to be published in due course. We are indebted to Sa'ad Hadidi of the Department of Antiquities; and to the Mayor of South ash-Shūna in 1992, Mahmoud al-'Adwan.Within ar-Rawḍa, we are indebted to the Secretary of the al-Baladiyya for his assistance.

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Spatial Patterns and Middle Paleolithic Behavioral Organization within the Ṭor Faraj Rockshelter

Introduction

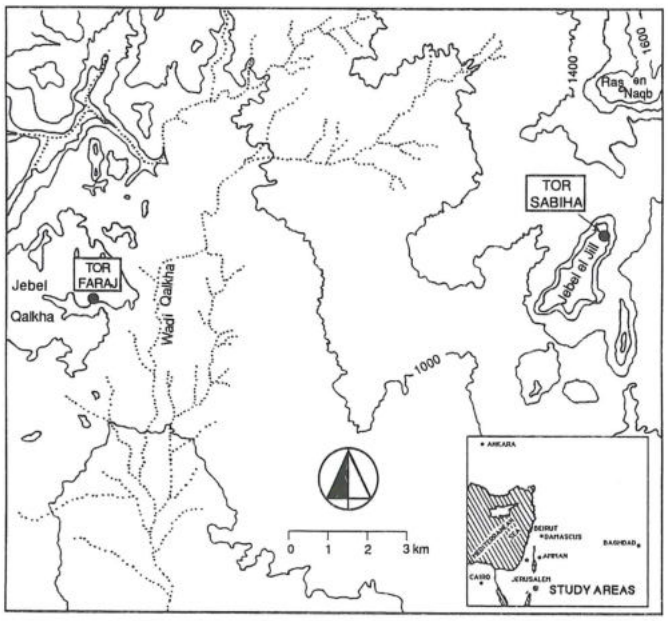
Previous results of field research at the Late Levantine Mousterian Rockshelter sites of Ṭor Faraj and Ṭor Ṣabīḥa in the mountains of southern Jordan have yielded evidence indicating the sites were inhabited during an annual cycle of transhumance (Henry 1994, 1995; FIG.1). Intersite data comparisons suggest that the occupants of these Middle Paleolithic sites adjusted their summer and winter behavior through differential opportunistic and logistical provisioning strategies. The summer camps, such as Ṭor Ṣabīḥa were at higher elevations, were associated with ephemeral occupations, and were provisioned *opportunistically* from resources within their catchment areas. In strong contrast, long-term winter camp occupations, such as Ṭor Faraj, were at lower elevations and were *logistically* maintained through acquisition of critical resources from outside their catchment areas. Thus, not only did the site occupants seasonally vary their adaptive strategies, but, in addition, they were fully capable of anticipating their resource needs. Since planning depth and behavioral flexibility are thought to characterize modern hunter-gatherers, this points to the existence of modern adaptive strategies approximately 70,000 years ago.

Both Ṭor Faraj and Ṭor Ṣabīḥa have amino acid racemization dates, on ostrich eggshell samples, of ca. 69,000 +/- 6,000 bp (Henry and Miller, 1992). The natural settings of the two sites, based on elevation and exposure, points toward differential seasonal occupations. Ṭor Ṣabīḥa is at a comfortable summer elevation of 1,300 m while Ṭor Faraj is significantly lower at 1,000 m. Also, Ṭor Ṣabīḥa has an eastern exposure and, therefore, would have made a poor winter camp while Ṭor Faraj, with its southwestern exposure, provides for a more comfortable winter setting. The results of phytolith analysis of sediment samples collected from Ṭor Faraj are also consistent with a winter occupation of the shelter.

Typologically, the artifacts from both sites resemble *Ṭābūn* B-type assemblages, especially as reflected in the presence of numerous broad based Levallois points. While this is compatible with the dating of other B-type assemblages (e.g., Kebara), the high blade and point frequencies of the Jordanian assemblages are more similar to *Ṭābūn* D-type configurations. This disparity may be tied to inherently higher blade and point representation in arid-zone Levantine Moustrian assemblages regardless of their temporal placement.

The tool-kits of the two sites display roughly similar configurations when classes are compared even though there are slightly higher relative frequencies of burins at Ṭor Faraj with a larger percentage of notches and denticulates at Ṭor Ṣabīḥa. Although all stages of lithic reduction are present at both sites, there seems to have been a greater emphasis on core shaping and blank production at Ṭor Faraj, consistent with occupations of longer duration. In addition, tool maintenance and rejuvenation seems to be more frequent at Ṭor Ṣabīḥa, a likely expression of ephemeral occupations. Detailed attribute studies also suggest longer occupations at Ṭor Faraj, relative to Ṭor Ṣabīḥa (Henry 1995)

In addition, micro-wear studies have identified Levallois points as the most utilized artifact category. Shea's (1991) analysis of a Ṭor Faraj sample suggests that butchery, light-duty woodworking and hunting were inferred activities with medium-resistant materials, such



1. Map of the western end of the Wādī Ḥisma showing the locations of the Levantine Mousterian sites of Ṭor Faraj and Ṭor Ṣabīḥa.

as wood, producing extensive wear. A wide range of functions, dominated by cutting activities but followed by scraping and piercing, were represented. Some hide-working and soft-plant processing were also noted. In contrast, Lee's (1987) comparative study , on Levallois points from both sites, found the wear patterns at Ṭor Ṣabīḥa to be more represented by work on soft materials, such as animal, while Ṭor Faraj, was more represented by woodworking. Cutting activities were more frequent at Ṭor Faraj. Altogether, a more complex picture of activities seems to emerge for Ṭor Faraj; consistent with complex long-term seasonal occupations.

Spatial Patterning

While differences in inferred occupational modes between Ṭor Faraj and Ṭor Ṣabīḥa are based on comparisons of the inventories and contexts of the artifacts recovered from the two sites (Henry 1992, 1995), the transhumancy model should be tested through comparisons of intrasite structure.

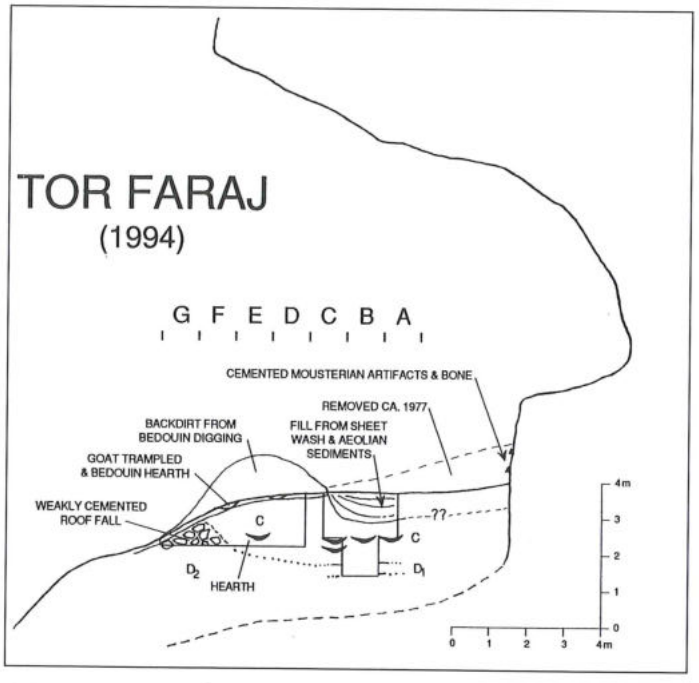
Studies of modern hunter-gatherers have demonstrated that long-term campsites exhibit more complex patterning, with discrete activity areas, resulting from a greater emphasis on the spatial separation or segregation of activities (Binford 1983:191; O'Connell 1987:104). A similar variation in site structure has previously been recognized in Levantine Paleolithic studies. Basecamps, sites with long-term occupations, associated with "radiating" settlement patterns seem to possess "specialized" or segregated activity areas, while ephemeral occupations associated with "circulating" settlement patterns seem to possess activity areas which are "generalized" (Marks and Freidel 1977). Specialized activity areas have been reported for early Levantine Mousterian sites, such as Rosh Ein Mor (Hietala 1977), as well as Late Levantine Mousterian, such as Far'ah II (Gilead and Grigson 1984) and Quneitra (Goren-Inbar 1990). Kebara (Bar-Yosef *et al.* 1992) certainly seems to possess specialized activity areas. The Middle to Upper Paleolithic transition site of Boker Tachtit seems to possess evidence of "specialized" and "generalized" activity areas, although in different levels (Hietala and Marks 1981; Hietala 1984). Interestingly, Kent (1991) has noted that anticipated length of residence is a stronger predictor of site size than is actual camp population. In general, though, the consensus is that long-term sites generally exhibit more complex structural patterns.

If the occupants of Ṭor Faraj organized their behavior in a manner similar to those of modern humans, then Ṭor Faraj would be expected to exhibit a more complex site structure than exhibited by the material remains of the occupants of Ṭor Ṣabīḥa. In fact, Ṭor Ṣabīḥa does show a relatively simple site structure with a lack of features and no evidence for activity segregation (Henry 1995). Thus, Ṭor Faraj is fully expected to exhibit complex site structure with definitive evidence for the spatial segregation of activities. A carefully designed two-year excavation program at Ṭor Faraj was initiated in 1993, in order to address questions about the behavioral organization of it's inhabitants.

Excavation Plans and Rockshelter Deposits

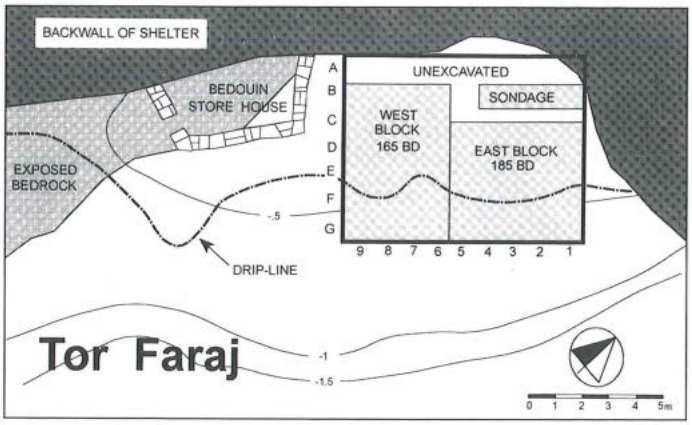
Information retrieved from an initial exploratory sondage in 1983 suggested relatively level-bedded Late Levantine Mousterian deposits over 1.5 m in thickness, suitable for intensive spatial analyses (Henry 1986). The first excavation season called for systematic removal of Bedouin backdirt piles associated with their construction of a stone-walled store house (*"ghurfa"*), the initiation of a large block excavation on the terrace of the rockshelter, and an extension of the 1983-1984 sondage (Henry *et al* . 1996). Sediments, below the Bedouin deposits, accumulated from aeolian silts primarily introduced from the plain forming the western end of the Wādī Ḥisma. Sand and sandstone rubble were also introduced from exfoliation of the shelter's ceiling and backwall, sometimes accompanied by massive roof-collapse of the shelter's brow. Major differences in the color and texture of the sandstone beds served as an excellent vehicle for tracing the depositional history of the shelter's formation.

The interior shelter's deposit is primarily composed of a thick 75 cm stratum (Layer C) consisting of a fine reddish yellow silty sand. This unit includes numerous hearths and ash lenses (FIG. 2). It is underlain by a more compact light red silty sand with a moderate amount of sandstone detritus (Layer D). This layer has a heavy component of rooffall in the southwestern corner of the block excavation. Artifacts associated with the layer D sediments frequently evidenced post depositional surface modification. The depositional history of the deposits is



2. Schematic plan of the stratrigraphy for the Ṭor Faraj deposits.

detailed in Henry *et al.* (1996). Preliminary results from the first season (summarized below) suggested an expansion of the of the initial block excavation to include the area between the block and the backwall of the rockshelter (FIG. 3). This was undertaken in the second season.



3.Topographic map and excavation plan of Ṭor Faraj.

CURRENT RESEARCH

Data Collection and Analytical Methodologies

Spatial analyses of artifacts and related evidence, from any rockshelter, requires an accurate and precise collection of all information in three dimensions. To accomplish this by traditional archaeological field methods requires collection in thin, as well as small, excavation units and mapping in place, by hand, for all artifacts, features, and ancillary materials. This is not only exceptionally time consuming but, in general, does not have sufficient built-in redundancy, or self-referential capacity, for correction if recording errors occur at the site or in the field laboratory. Fortunately, modern technology, with the development of the total station, assists in this regard. All artifacts, exceeding 30 mm in maximum diameter, bone, ostrich eggshell fragments, hammerstones, and features were plotted in a referential three-dimensional coordinate system using a Set-6 Sokkia laser theodolyte with an electronic data collection unit (SDR). It was easy, using a benchmark datum established in the backwall of the shelter, to reestablish an identical three-dimensional coordinate system in the second season. Artifact type, unit and quadrant, layer and specimen number (labeled on the artifact in the field) were also recorded on the SDR, in addition to the three dimensional coordinate pin-pointing the location of the artifact. In addition, any unusual field observations were recorded into the SDR, as notes. Screening the excavated material through 2 mm sieves allowed the recovery of artifacts smaller than 30 mm in maximum dimension which were identified by one quarter meter units within 5 cm levels. All data recorded by the laser theodolyte were, in addition, sketched onto unit record forms, giving a backup, in case damage occurred to the electronic equipment. Since individual artifacts were numbered sequentially in each meter square unit, an artifact or sequence of artifacts that either lost their numbers through over-zealous washing in the laboratory or labeled incorrectly in the field had both the computerized data and the sketch forms to unravel the error(s). In addition, features and rock accumulations were also sketched onto the unit record forms. This not only gave tight control over the feature information, but allowed for the later develoment of visual templates incorporating other artifactual and contextual information.

The data recorded by the laser theodolyte into the SDR were downloaded daily to a PC; two PC 's were available although only one was ever required. These data were first checked for internal integrity. For example, any artifact within a given unit, specified by a known given 5 cm level, is constrained by definition to have only a specific set of possibilities for recorded three dimensional coordinates. Any discrepancy was immediately noted with subsequent rectification of the recording error. In a few cases the operator of the theodolyte made a small error in "setting up", but these too were capable of correction. The data on the computer were then cross-checked with the artifacts in the laboratory to ensure that all pin-pointed artifacts could be "tracked" when they were later processed or analyzed by other members of the scientific team. The data were then downloaded, in "ascii" format, as files for input into other quantitative software packages, such as *Surfer* and *SPSS*. This procedure allows for a rapid check of provenience data against the sketch plans and they are then ready for spatial descriptions. Hard copies of the spatial data, in site plan, can be produced to assist in tracking overall field impressions and in ensuring effectiveness of the excavations as they are proceeding. This is particularly useful in the complex three-dimensional environment of a rockshelter excavation.

As a final step, in the oftentimes rarefied environment of computer systems terminology, the data are incorporated into a data management system which allows the development of a powerful "relational" data base. Specifically, the initial SDR spatial data, are meshed with over 50 other observations made on each artifact specimen. These observations not only involve conventional typological and technological measurements, but raw material varieties, refit constellations, blood residue analyses, wear pattern analyses, etc. These all then form part of one data base that becomes relational through the tracking of artifacts by sequence number, within unit, and within level. The successor to *D-base IV*, in the computer field, is the Borland software product known as *Paradox* (there is a windows based system). This is the package used in the construction of the Ṭor Faraj "relational" data base. When data are entered into *Paradox*, it can be queried to retrieve almost any imaginable subset of the data. For example, it might be desirable to construct the distribution of all hafted Levallois points. Or the distribution of all Levallois points with evidence of wood-

working. Or, it might simply be of interest to document wear pattern variability for all utilized artifacts within two meters of a hearth, or the backwall of the shelter. The variations are endless but the relational data base system allows these kinds of queries to be posed. Of course, any spatial data base can be related to contextual information gained from standard stratigraphic sampling of sediments for micromorphologic, palynologic and phytolith studies.

Sampling for phytolith analysis were collected from hearths and ash lenses and samples for phosphorous analysis were collected from the centers of one meter square units across the excavation block (Henry *et al.* 1996). In addition, a high proportion of artifacts from one floor were systematically analyzed for wear patterns.

Paleosurfaces

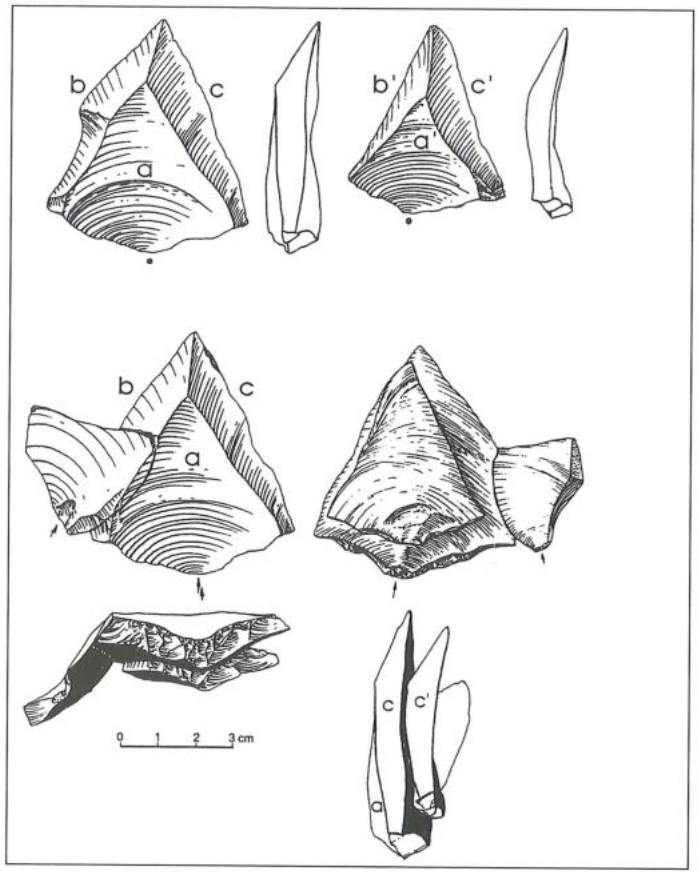
Meaningful interpretations of spatial data are only possible if prehistoric living floors (paleosurfaces), associated with material culture, can be realistically identified. Initial efforts toward identifying living floors involved the tracing of sedimentary bedding planes, assessing the degree of post-depositional disturbance, and examining the associated spatial distributions of artifacts, artifact 'refits', artifactual wear patterns and hearths (covered in the next section). The sedimentary information from the first season have been examined in detail (Henry *et al.* 1996) where the bedding planes are realistically concluded to be near-level.

Little post-depositional disturbance follows from several lines of evidence. The presence of shallow hearths and thin ash lenses suggests rapid burial. Many thermally fractured artifacts were found in place, with their pieces still articulated. Artifact refits within the Mousterian deposits were generally close and separated by no more than 10 cm vertically. Refits refer to artifacts that are fitted together and describe, minimally, a part of a core reduction sequence. One interesting refit sequence from the first field season shows the refitting of two Levallois points and a lateral flake (FIG. 4). The sequence assists in tracing the initial steps of core shaping: A central plane is first formed followed by the removal of lateral convergent elements to form a Y-arrete pattern that, in turn, guided the removal of the Levallois point. It is important to note here that the core was significantly reduced in volume to produce the second Levallois point. One reconstructed core, from the second field season, involved 9 pieces. For this core, 7 of the 9 pieces were in a single 50 cm by 50 cm unit, quadrant D5a, with a maximum vertical separation of 10 cm.

Finally, outside of artifacts from the D layer, the preservation of the flint surfaces is exceptional, more than sufficient for wear pattern studies (Laura Longo, pers. comm.). This excellent preservation suggests rapid burial of the artifactual material.

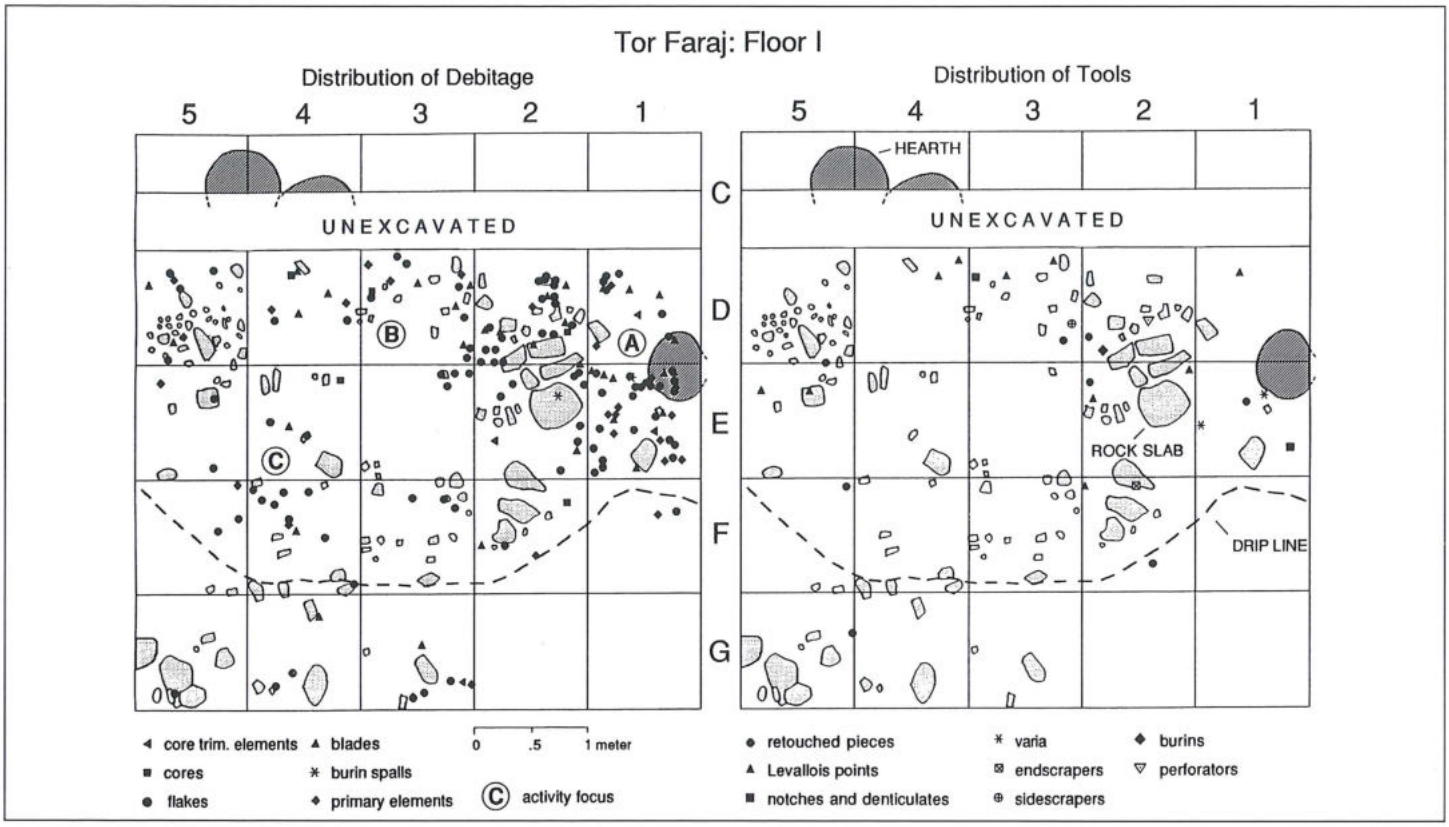
Intrasite Spatial Patterns

The distributions of artifacts and hearths suggest the existence of, at least, two living floors, tentatively designated as Floor I (160-170 cm below datum) and Floor II (180-185 cm below datum). Hearths are level bedded (FIG. 2), and exist in two horizons within Layer C. These two horizons are, not surprisingly, synonymous with the initial definitions of Floors I and II. In addition, the hearths are remarkably consistent in their horizontal positioning (FIGS. 5-8). The hearths are generally positioned about 2-3 m from the backwall of the shelter. This is a common pattern that is known for occupants of sheltered sites (Thomas 1983: 432-433); Binford 1983:160-163). This pattern has been interpreted as providing warmth between the hearth line and the backwall for specific activities, including sleep. The location of the hearths at Ṭor Faraj are predominantly consistent with a winter occupation since they are mostly adjacent to the NE backwall which absorbs the greatest intensity of sunlight in the afternoon. During the winter months this would be a favorable situation since the backwall would continue to radiate heat in the evening. In addition, the distances between hearths is fairly regular, suggesting single, rather than repeated occupations. This has been noted elsewhere in the Levant (Hietala 1984). But, there must be artifactual corollaries for these presumed interpretations.

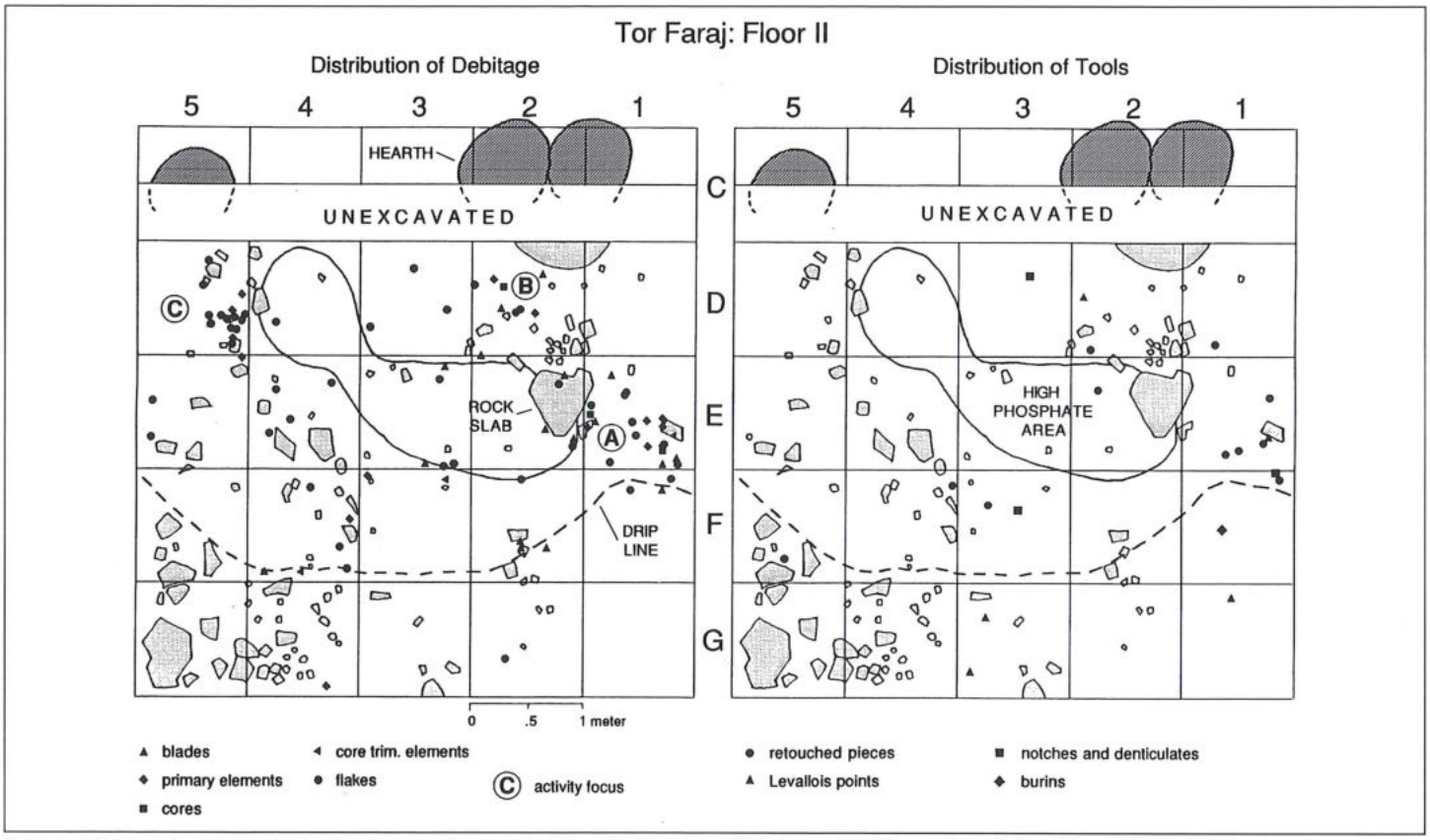


4. Illustration of refitted Levallois points from Ṭor Faraj. Note the ca. 40% reduction in the size of the second point.

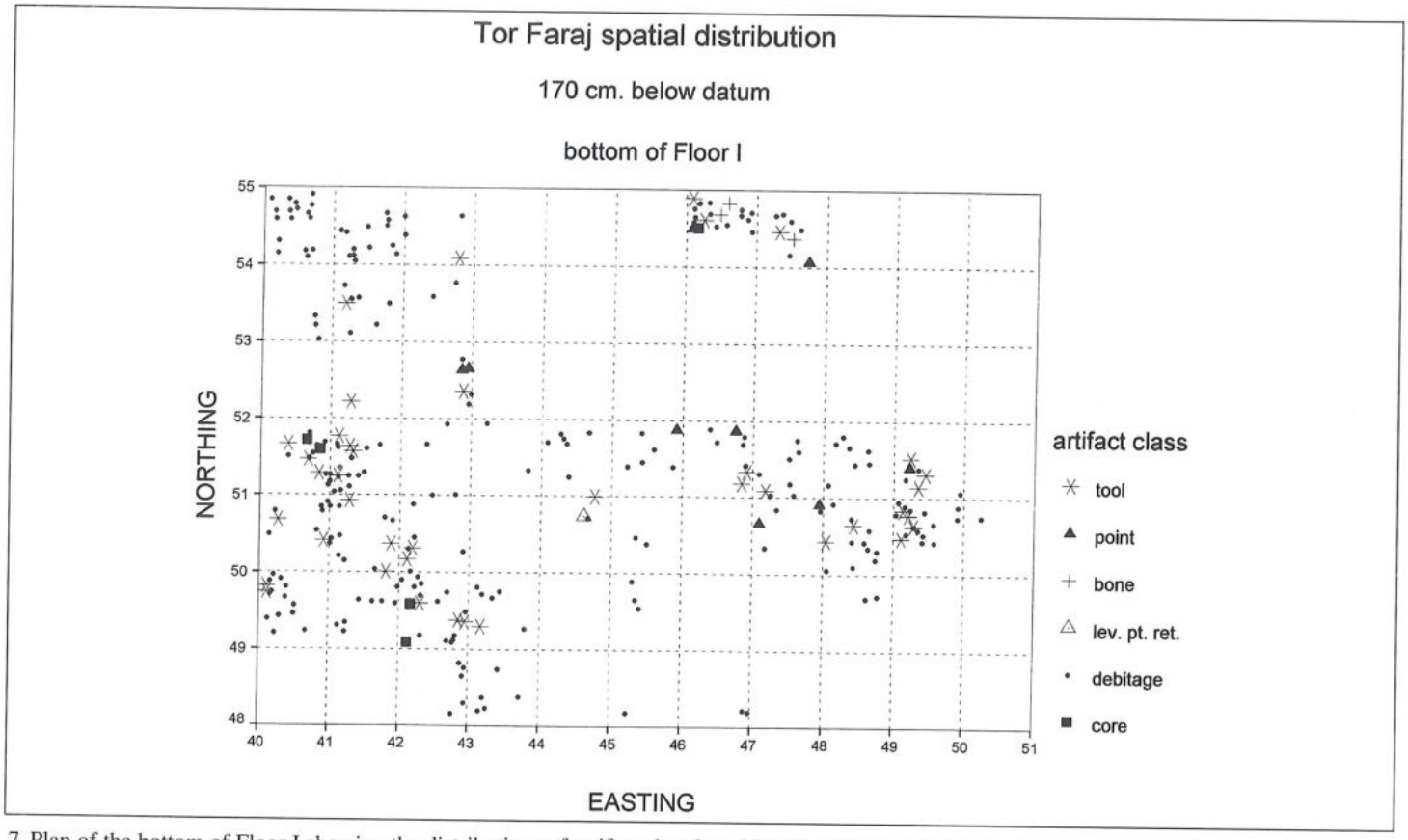
Floor I (FIG. 5) and Floor II (FIG. 6) show similar, but presumably distinct, patterns in the eastern block. The



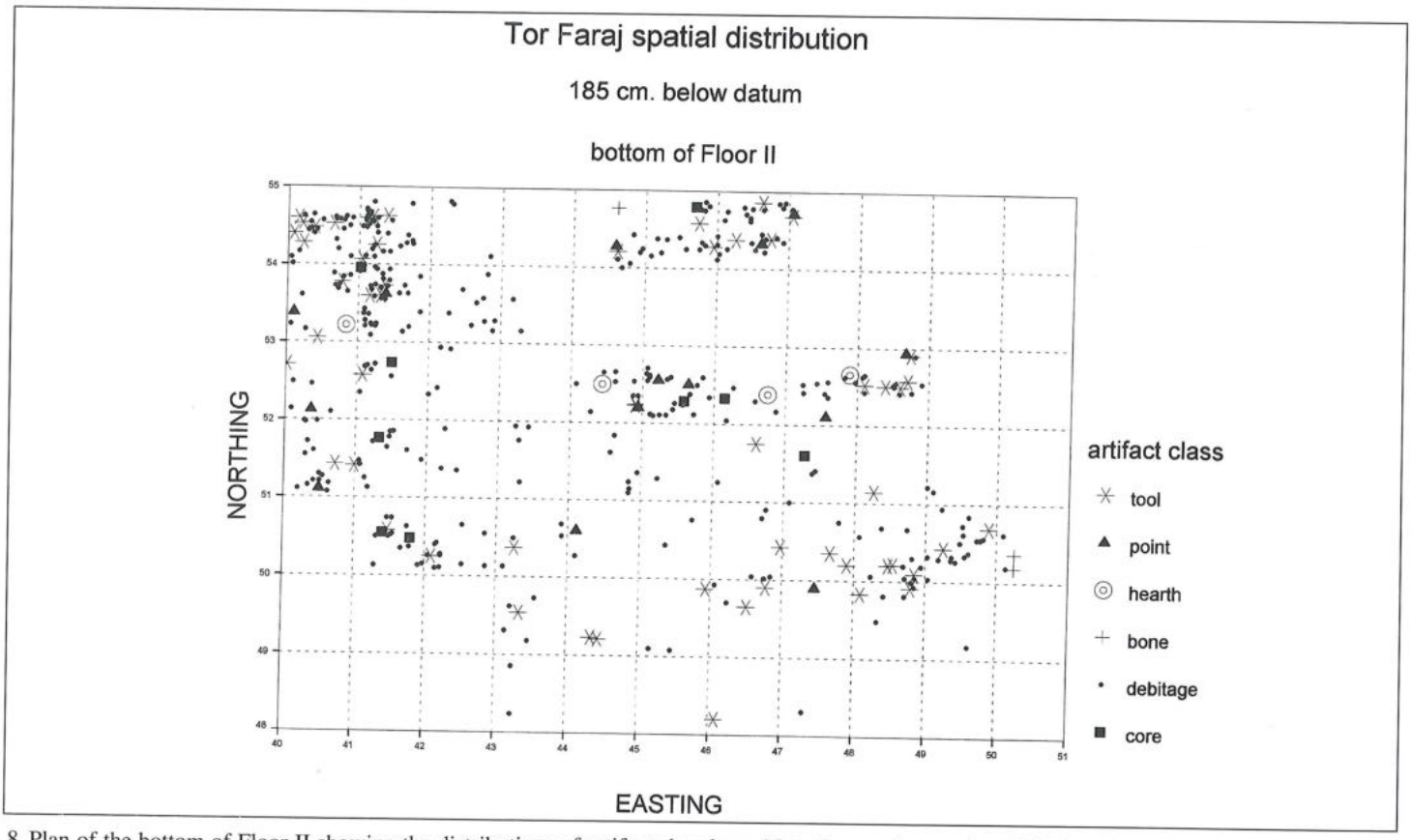
5. Plan of Floor I, as exposed in the east block, showing the distributions of debitage (left) tools (right), hearths and rocks. Note the three artifact clusters (A,B,C) and the marked decline in artifact density beyond the drip line.



6. Plan of Floor II, as exposed in the east block, showing the distributions of debitage (left) tools (right), hearths, rocks and high phosphate values. Note the three artifact clusters (A,B,C) and the marked decline in artifact density beyond the drip line.



7. Plan of the bottom of Floor I showing the distributions of artifacts by class. Note the multiple clusters and the segregation of cores and points.



8. Plan of the bottom of Floor II showing the distributions of artifacts by class. Note the regular spacing of the hearths and the occurrence of artifact clusters associated with and without hearths.

principal patterns are as follows: (1) Both floors show a much higher density of artifacts behind the dripline of the shelter and (2) both floors show specific concentrations (A and B) of artifacts tethered to hearths and rock slabs. In Floor I , cluster A is positioned between a firepit and a cluster of tools, adjoined by sandstone slabs. Clusters A and B contain significantly higher frequencies of cores and primary elements than found in Cluster C. This implies that initial lithic processing activities were emphasized to a greater extent in the areas of Clusters A and B than C.

Floor II shows similar patterning, although the position of Cluster C is located closer to the backwall of the shelter, centered in Unit D5. Another source of patterning for Floor II is the distribution of phosphate concentrations identified from sediment samples. As an indicator of organic remains, the high phosphate values recorded for the area resting between the three artifact concentrations indicate that it was used for butchery, food preparation, or refuse (Henry *et al.* 1996).

Conclusions and Summary

The patterns observed for hearths, artifact distributions, and phosphorus concentrations indicate a site structure at Ṭor Faraj that differs little from the structures observed for modern foragers inhabiting rockshelters. The spacing of the hearths relative to other hearths and to the natural features of the shelter is statistically indistinguishable from that recorded for modern foragers.

Artifact distributions reveal concentrations indicative of intensive activity areas around hearths resembling the drop zones recognized for modern foragers. Beyond the dripline artifacts as a whole decline in frequency, but fine residue is virtually absent. This again resembles that aspect of the site structure of modern foragers inhabiting shelters as reflected in a drop zone inside the dripline and a toss zone outside the shelter.

The site structure of the Ṭor Faraj living floors, as revealed by the contextual relationships of artifacts, hearths, and phosphate concentrations, is both complex and diverse.

This is consistent with the structure of a long-term encampment of modern foragers, but contrasts with the redundant, homogeneous structure thought to be associated with the occupations of archaic foragers and "proto-cultural" behaviors.

Acknowledgements

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The Upper Paleolithic in Jordan : Evidence from the Wādī al - Ḥasa and South Jordan

Introduction

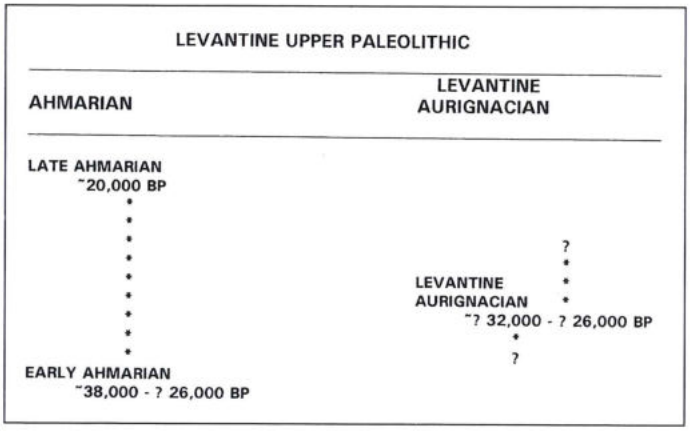
Since the 1980's we have been in a position to begin discussing the Upper Paleolithic of Jordan. What was known of the Levantine Upper Paleolithic stemmed almost exclusively from the coastal Mediterranean areas of the Levant or from the deserts of the Negev and Sinai. As a result, little has been said about hunter-gatherer adaptations in the inland deserts and steppe of Jordan during the distant time ranges between ca. 40-20,000 BP. Nor did we know how these Paleolithic sites fit into the larger archaeological picture of the greater Levant. Because of systematic surveys and excavations since 1980 in the Wādī al- Ḥasa (MacDonald 1988; MacDonald, Banning *et al.* 1980; MacDonald, Rollefson *et al.* 1982, 1983), South Jordan (Henry 1979, 1982, 1986, 1995), the al-Azraq Basin (Garrard 1991; Garrard and Price 1977; Garrard, Betts *et al.* 1987, 1988; Garrard, Byrd *et al.* 1986), and the Black Desert of eastern Jordan (Betts 1983, 1984, 1985, 1986), we are now able to begin evaluating the Upper Paleolithic of Jordan and develop models appropriate to the landscapes and ecology of Late Pleistocene Jordan.

Upper Paleolithic sites in the Wādī al-Ḥasa, west central Jordan and the Jabal al-Qalkha of South Jordan occur in a variety of ecological settings and represent occupations that span approximately 20,000 years. The lithic assemblages represent both earlier and later Upper Paleolithic technologies, and some vary significantly from the current assemblage types for the Levantine Upper Paleolithic. Extensive new data on the Upper Paleolithic from Jordan and elsewhere in the Levant have suggested variability significant enough to warrant reassessment of the general Levantine models and assemblage types for the Upper Paleolithic. This new evidence from Jordan provides an initial opportunity to reassess our views of hunter-gatherer adaptations in the Late Pleistocene. This article reviews the current interpretive framework for the Levantine Upper Paleolithic and evaluates it in light of the more recent evidence from Jordan.

Upper Paleolithic Cultural Units

Research on the Paleolithic of the Levant during the last 20 years has resulted in a number of major revisions to interpreting and explaining the Upper Paleolithic in this region. The earlier explanations by Neuville (1934, 1951) and Garrod (1954), which proposed a pan-Levantine unilinear developmental sequence for the Upper Paleolithic, have since been replaced with a multilinear model that focuses on two cultural traditions (TABLE 1). These assemblage types are now formally recognized as the Levantine Aurignacian and the Ahmarian (Ronen 1976, Gilead 1981, 1991; Marks 1981). Research in the Negev, Sinai, and most recently in Jordan has been critical in establishing the multilinear nature of cultural evolution in the Levant during the Late Pleistocene. Currently, however, there is a lack of agreement on the nature of these assemblage types as they occur across the greater Levant, especially the southern and eastern regions that include Jordan. While there is a growing consensus on the identification, description, and distribution of the more recently identified Ahmarian, our knowledge and understanding of the Levantine Aurignacian cultural unit is less clear as extensive data accumulate from outside the core Mediterranean zone. The Levantine Aurignacian now encompasses significantly greater technological and typological variability than when it was initially defined on the basis of cave and rockshelter sites in Lebanon, Syria, and northern Israel. Exhibiting strong similiarities to the European Aurignacian, the earlier descriptions of the Levantine Aurignacian featured typical Upper Paleolithic tools,

Table 1. Explanatory model of the Levantine Upper Paleolithic showing the Levantine Aurignacian and Ahmarian techno-complexes.

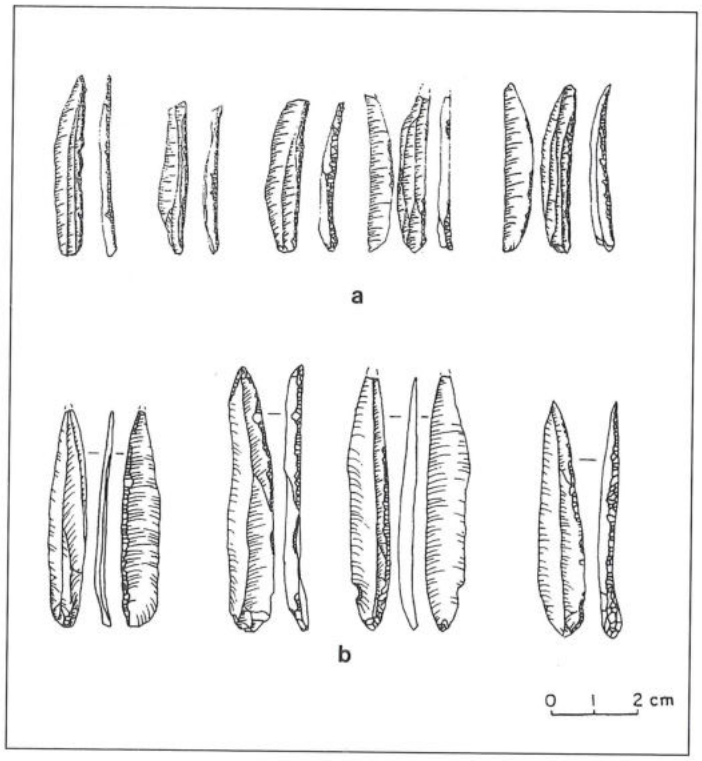


such as endscrapers and burins, especially "Aurignacian," carinated, and nosed varieties (Neuville 1934; Garrod 1954; Belfer-Cohen and Bar-Yosef 1981:39; Bar-Yosef and Belfer- Cohen 1988: 28,35-36). Core reduction focused on the production of flake debitage and tool blanks with low proportions of blades and bladelets (Neuville 1951; Garrod 1954; Hours 1974; Copeland 1975; Gilead 1991). More recently, however, lithic assemblages from the Negev that varied from the Ahmarian have been identified as Levantine Aurignacian and have been described as having some Aurignacian elements, although they exhibited a relatively inferior *blade* technology characterized by large, thick blades but lacked a true bladelet technology (Marks 1976; Marks and Ferring 1988:46; Gilead 1991:128).

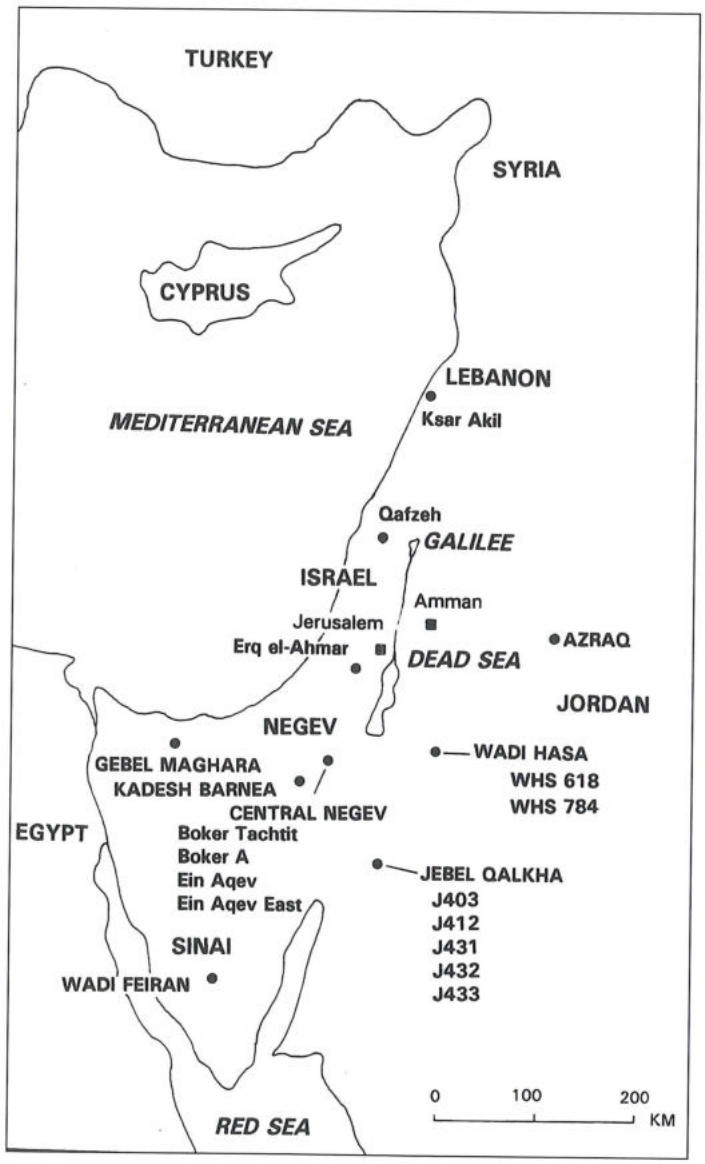
Unlike the Levantine Aurignacian, the Ahmarian has achieved a greater amount of consensus and is currently recognized as a well-developed blade technology, dominated by the production of blades and small bladelet tools, many of which are retouched, backed, or pointed (Ronen 1976; Gilead 1981, 1989, 1991; Marks 1981; Marks and Ferring 1988).

Traditional Upper Paleolithic tools, such as endscrapers and burins, occur but are suggested to be less frequent than in Levantine Aurignacian assemblages.

The Early Ahmarian, ca. 30-38,000 BP, is generally distinguished by various proportions of pointed blades and bladelets, namely el-Wad points, whereas Late Ahmarian assemblages between ca. 17-23,000 BP lack the larger el-Wad points but are characterized by equally distinctive Ouchtata bladelets with extremely fine, graded retouch (Marks and Ferring 1988:46; Coinman 1990, 1993) (FIG.1). Although archaeological sites with Ahmarian assemblages have been identified in the northern and central Levant (e.g., Qaṣr Akil and al-Qafzeh), the Ahmarian is most extensively documented in open-air sites in the Negev (Ferring 1977; Marks 1977; Jones *et al.* 1983), in the Sinai (Bar-Yosef and Belfer 1977; Gisis and Gilead 1977; Gilead 1977, 1983, 1989, 1991; Phillips 1988), and most recently in the Wādī al-Ḥasa of west central Jordan (Coinman 1990, 1993; Olszewski *et al.* 1990, 1994) and south Jordan (Coinman and Henry 1995) (FIG. 2).The Lagaman industry from the Sinai is considered an important representative of the Early Ahmarian (Gilead 1983, 1991; Gilead and Bar-Yosef 1993).



1. Early and Late Ahmarian pointed tools: (a) Late Ahmarian Ouchtata bladelets from 'Ayn al-Buḥayra (WHS 618) in the eastern Wādī al-Ḥasa, (b) Early Ahmarian el-Wad points from Boker A in the Central Negev (after Jones *et al.* 1983:fig. 9-9).



2. Map of the Levant showing archaeological sites with Upper Paleolithic assemblages mentioned in this paper.

UPPER PALEOLITHIC LANDSCAPES

Wādī al-Ḥasa and South Jordan - The Local Environments

During the last 15 years, surveys and excavations in the eastern portions of the Wādī al-Ḥasa have provided a wealth of data on Paleolithic occupations spanning the Lower Paleolithic through the Epipaleolithic. MacDonald's initial survey of the south bank of the Wādī al-Ḥasa (WHS) identified 30 Upper Paleolithic sites, with an additional 46 sites representing multi-component Middle-Upper (28) and Upper-Epipaleolithic (18) sites (MacDonald 1988; MacDonald *et al.* 1980, 1982, 1983; Coinman *et al.* 1986).

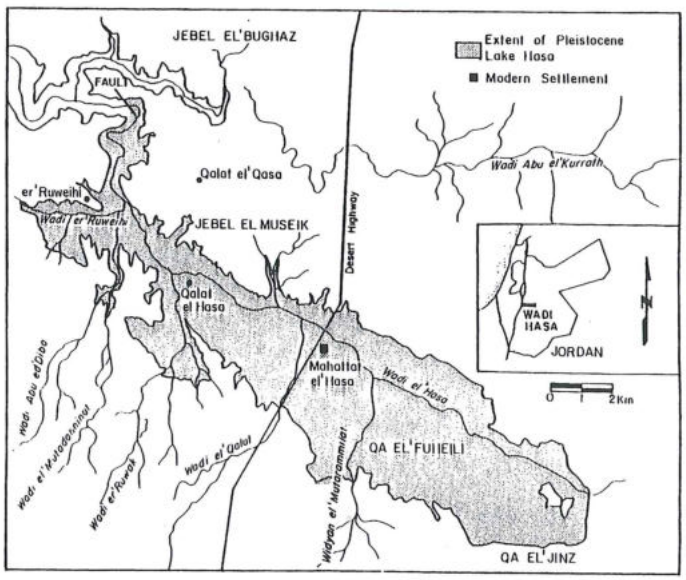
Clark's survey of the north bank of the al-Ḥasa (WHNBS) in 1992 and 1993 located an additional 19 Upper Paleolithic sites (Clark *et al.* 1992, 1993). The landscape of the eastern al-Ḥasa is typical of the Jordanian plateau east of the Rift, but the paleolandscape and archaeological successions included more mesic bi-omes during the Late Quaternary.

The major environmental feature of the eastern Wādī al-Ḥasa is Pleistocene Lake al-Ḥasa, which formed in the eastern basin of the al-Ḥasa drainage and may have reached its highest levels during a climatic optimum between 42,000 and 35,000 BP (Vita-Finzi 1964, 1966; Copeland and Vita-Finzi 1978; Schuldenrein and Clark 1994) (FIG. 3).

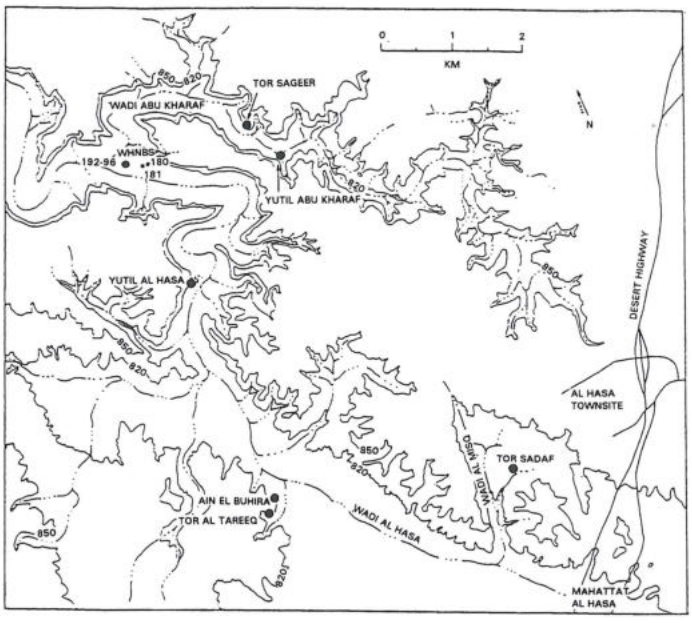
Geoarchaeological investigations indicate that, in general, Upper and Epipaleolithic sites are relatively better preserved than earlier Paleolithic occurrences (Schuldenrein and Clark 1994:49). Between 25,000 and 14,000 BP many of these sites occur adjacent to the lake margins and in the lower tributary drainages at elevations around 815 masl. 'Ayn al- Buḥayra (WHS 618), a large open-air site, and the rockshelter site of Yutil al-Ḥasa (WHS 784) appear to have taken advantage of the optimal lacustrine and marsh habitats around the lake (Coinman 1990, 1993; Olszewski *et al.* 1990, 1994) (FIG. 4). Equally attractive may have been marshy microhabitats where long, narrow arms of Lake al-Ḥasa extended into the lower portions of tributary drainages, as well as where freshwater spring flows formed ponds, and in areas where seasonal marshes were present as lake levels decreased. Sites in these types of environments include rockshelters such as Ṭor Ṣadaf (WHNBS 8) in the tributary Wādī al-Misk, Yutil Abū al-Khirāf (WHNBS 135) and Ṭor Ṣageer (WHNBS 242) in the Wādī Abū al-Khirāf, as well as a series of Upper Paleolithic sites (WHNBS 192-96, 180-181), which are located in lacustrine marls at the confluence of the Wādī Abū al-Khirāf and the Wādī al-Ḥasa. After 20,000 BP, the predominant lake environment was being displaced by ponds and stream-fed marshes, evidenced by the multi-phase Kebaran and post-Kebaran site of Ṭor aṭ-Ṭarīq (WHS 1065) (Schuldenrein and Clark 1994:47; Neeley *et al.* in this volume).

The lakeshore site of 'Ayn al- Buḥayra (WHS 618) (FIG. 5) exhibits multiple occupation loci in a complex sequence of spring and lake margin environments between 25,000 and 20,000 BP tied directly to lake level stands during this time period (Schuldenrein and Clark 1994:39-40). Earlier occupations ca. 25,000 - 23,000 BP in the central part of the site are associated with both colluvial and alluvial sediments, resulting from episodic flooding of a nearby drainage and the development of a marsh sub-basin during spring flow.

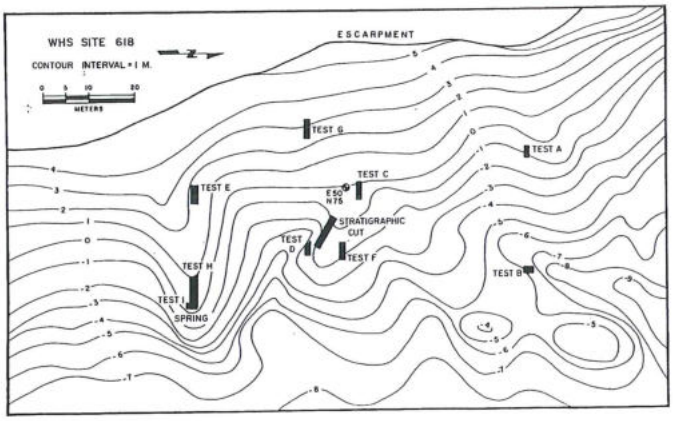
In the southern portion of the site, a Late Ahmarian occupation is associated with remnant tufa mounds dated



3. Map of the eastern Wādī al-Ḥasa in west central Jordan illustrating the extent of the Pleistocene lake.



4. Map of the eastern Wādī al-Ḥasa showing the locations of the Upper Paleolithic sites of 'Ayn al- Buḥayra (WHS 618) and Yutil al-Ḥasa (WHS 784) and other contemporaneous sites.

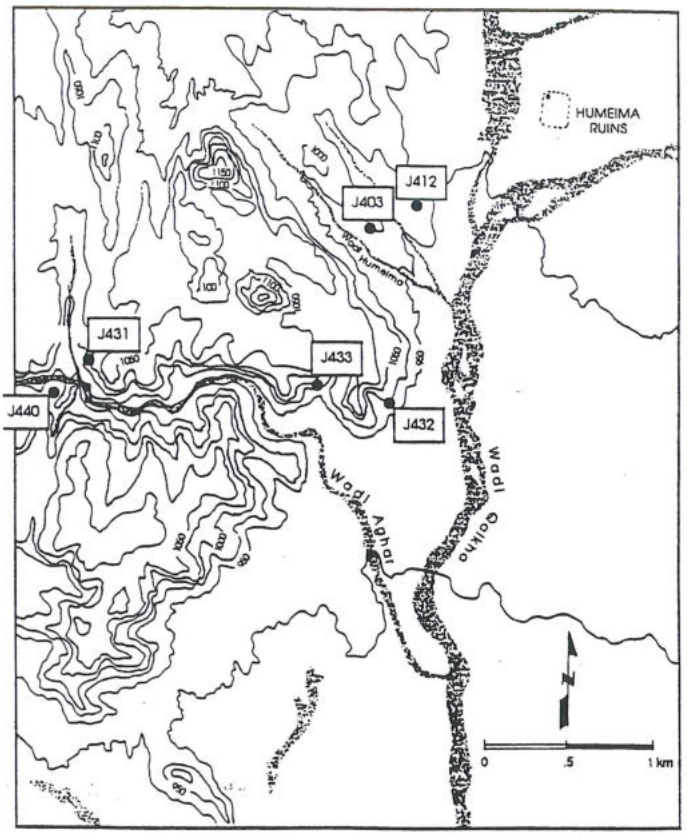


5. Site map of 'Ayn al-Buḥayra (WHS 618).

to 20,300 600 BP (UA-4395) signifiying spring flow and the discharge of fresh waters into the lake (Schuldenrein and Clark 1994:39). Reconstruction of the plant community at 'Ayn al- Buḥayra is hindered by a paucity of pollen from the cultural deposits. Preserved pollen of sedges (*Cyperaceae*) in the laminar lacustrine marls directly underlying the tufa deposits are indicative of marsh and/or lake margins while the presence of Chenopodiaceae and *Artemisia* pollen from other parts of the site suggest an open steppic environment. Faunal remains are equally scarce and predominantly equids (70%) with approximately 26% *Bos* sp. indet.

Yutil al-Ḥasa (WHS 784) is a collapsed rockshelter located approximately 3 km north of ' Ayn al-Buḥayra and situated about 10 m above the drainage channel along an east-facing cliff where the main al-Ḥasa drainage narrows (Olszewski *et al.* 1990, 1994) (see FIG. 4). The generally well-preserved faunal assemblages demonstrate the procurement of gazelle, equid, *Bos*, and tortoise during both Upper and Epipaleolithic times. Geoarchaeological studies of the environment in and around Yutil al-Ḥasa has identified preserved marls in the narrow wadi below the rockshelter that document a lacustrine setting at approximately 20,000 BP since the marls are probably associated with peak lake levels identified at 'Ayn al-Buḥayra. Pollen evidence suggests a change during the Ahmarian from drier conditions dominated by chenopods of the amaranth type to the more mesic conditions of a marshy microenvironment with the appearance of willow (Salix) and cattail (*Typha*). The high percentage of oak (*Quercus*) pollen, occurring in clumps in the upper Ahmarian levels is thought to document the presence of an oak tree at the site as well.

In contrast, the South Jordan Upper Paleolithic occurrences on the Ma'ān plateau are restricted to south or south-west facing rockshelter locales in the Wādī al-Qalkha and its tributaries, the Wādī al-Ḥumayma and the Wādī Aghar (Coinman and Henry 1995) (FIG. 6). The rockshelters are located between 940 and 980 m asl, in the steep sandstone cliffs and canyons, near the interface of the piedmont and the lowlands of the Wādī al-Ḥisma. All



6. Map of the Jabal al-Qalkha area in South Jordan showing the locations of rockshelter sites with Upper Paleolithic assemblages.

of the rockshelters display shallow overhangs of 2-5 m that extend some 15-20 m along the cliffs.

Prehistoric resource catchments for these sites are very similar given their close proximities to each other. The catchment area would have included the steep-walled canyons and flat-topped jabals of the area west of the Wādī al-Qalkha, as well as the plain and shallow drainages that form the western end of the broad valley of the Wādī Ḥisma.

Surface water was probably available in the wadis as runoff during the winter wet season and in bedrock pools in the canyons until late spring. Ṭor Ḥamar (J431) is located at the confluence of several side drainages where a series of large pools provided water during the winter and well into the spring. Evidence of an ancient seep or spring was discovered on the south wall of the canyon across from Site J403. Chert was available locally from a limestone remnant near Jabal al- Ḥumayma, approximately 3-10 km walking distance from the sites. Small stream cobbles were also available along the Wādī al-Qalkha, while other sources are located some 16-20 km beyond the local catchment area.

The Upper Paleolithic occupations in South Jordan appear to be long-term winter encampments because of their generally southern orientations, elevation, and the configuration of features and artifact densities. Stratigraphically, these Upper Paleolithic sites are dated to

deposits that occurred during a relatively warm, dry interval between earlier and later cold periods from ca. 70,000 to 38,000 BP and from 30,000 to 13,000 BP (Henry 1994:339-340). Henry has suggested a model of seasonal transhumance between long-term, wet-season, winter camps at the lower elevations and more ephemeral sites at higher elevations during summer months – a contrast that reflects adaptive responses to seasonal fluctuations in moisture and the abundance of critical resources in different elevational zones. However, smaller summer camps in such a transhumant settlement pattern for the Upper Paleolithic have yet to be located at the predicted higher elevations.

TEMPORAL AND TECHNOLOGICAL VARIABILITY

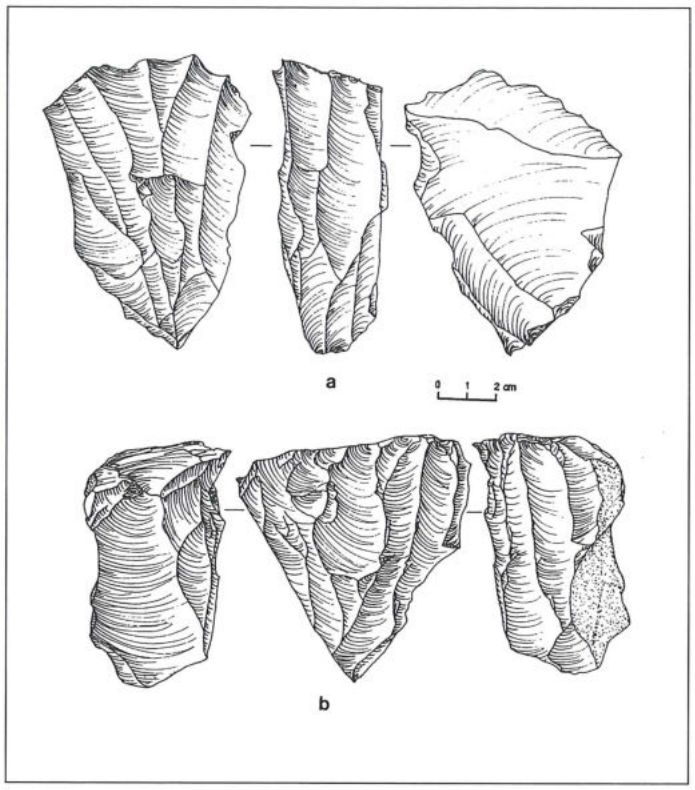
Upper Paleolithic occupations in South Jordan are temporally earlier than those in the Wādī al-Ḥasa. The Early Ahmarian, which dates from ca. 38,000 to 26,000 BP, is represented by the rockshelter sites of Ṭor Ḥamar (J431, F-G) and Ṭor ʻĀyid (J431). Undated Upper Paleolithic assemblages from the rockshelters of Jabal al-Ḥumayma (J412) and Ṭor Fawāz (J403) appear to be technologically later than the Early Ahmarian and precede the Late Ahmarian that occurs in the Wādī al- Ḥasa at ca. 20,000 BP at ʻAyn al-Buḥayra (WHS 618) and Yutil al- Ḥasa (WHS 784).

Wādī Aghar (J433)

The earliest evidence for the Upper Paleolithic in Jordan appears to be a transitional assemblage with similarities to Boker Tachtit in the Negev and Qaṣr Akil in Lebanon (Coinman and Henry 1995:182-191). A transition from the local Mousterian to the Early Ahmarian in southern Jordan is documented at J433 in the Wādī Aghar, exhibiting transitional characteristics similar to early Upper Paleolithic technological attributes found in Level 4 at Boker Tachtit (Marks 1983) and in Levels XXII-XII at Qaṣr Akil (Ohnuma and Bergman 1990). Particularly striking are the similarities in single-platform core morphologies between cores from Boker Tachtit and Wādī Aghar, where the lack of platform regularization results in characteristic scalloping of the margins of the platform, as well as the associated platform morphology of the distinctly elongated blade products (FIG. 7).The Wādī Aghar debitage is significantly more elongated than debitage in the subsequent Early Ahmarian assemblages. Locally, the core technology and debitage production appears to represent an *in situ* technological evolution and reflects an intermediate stage between the Levantine Mousterian at Ṭor Ṣabīḥa (J8) and Ṭor Faraj (J430) (Henry 1995) and the Early Ahmarian at Ṭor Ḥamar (J431) and Ṭor ʻĀyid (J432).

Ṭor Ḥamar (J431) and Ṭor ʻĀyid (J432)

Upper Paleolithic levels at Ṭor Ḥamar (J431, F-G) and Ṭor ʻĀyid (J432) represent Early Ahmarian occupations

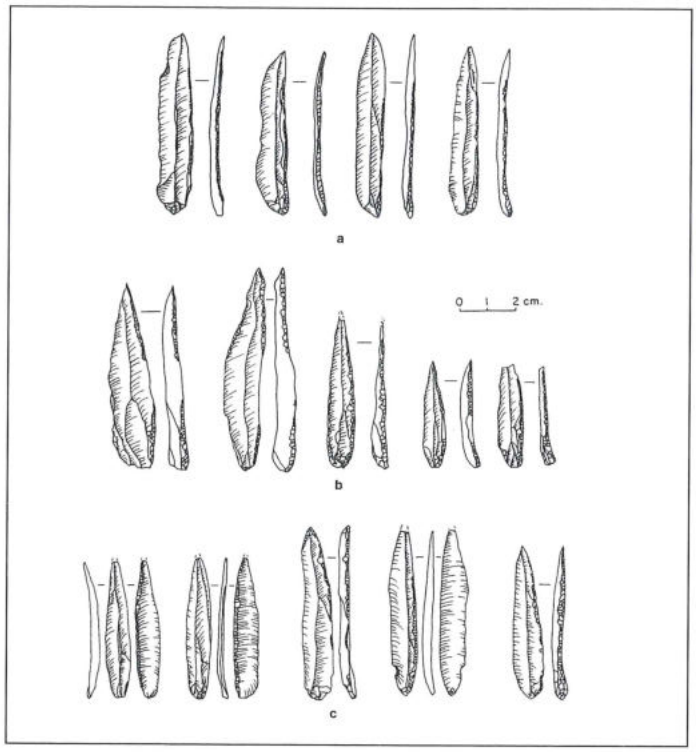


7. Blade cores from transitional Upper Paleolithic assemblages: (a) Wādī Aghar (J433) in the Jabal al-Qalkha, South Jordan, (b) Boker Tachtit (Level 4) in the Central Negev (after Marks and Kaufman 1983:fig. 5-25) .

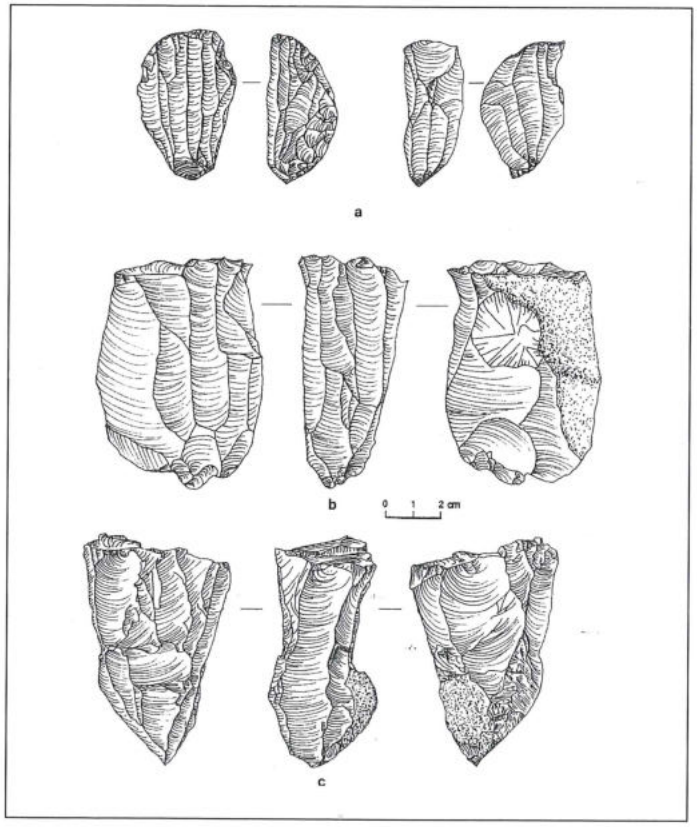
(Coinman and Henry 1995:160-179). Although radiometric dates are lacking for the Upper Paleolithic assemblages, all of the Upper Paleolithic cultural material is associated with a common depositional unit that occurred between the red sandy silts of the Mousterian levels and the red sands associated with the later Epipaleolithic. The lithic assemblages illustrate a serial blade technology directed at elongated debitage from which endscrapers and burins were made, while smaller blades and bladelets were selected for specialized el-Wad points. These assemblages are similar to other Early Ahmarian assemblages in the Negev and Sinai, dated between 38,000 and 30,000 BP, although some stylistic differences in the el-Wad points are reflected in size and retouch (FIG. 8).

Jabal al- Ḥumayma (J412) and Ṭor Fawāz (J403)

Later Upper Paleolithic assemblages have been identified at the South Jordan sites of Jabal al- Ḥumayma (J412) and Ṭor Fawāz (J403) (Henry 1982; Coinman and Henry 1995:144-160). These two sites illustrate the problem of assemblage variation that fits neither the current descriptions for the Ahmarian nor that of the Levantine Aurignacian. The lithics at Jabal al- Ḥumayma and Ṭor Fawāz represent a blade technology that produced larger, thicker, and bulkier debitage and tools than is documented for either the earlier or later Ahmarian blade/bladelet technologies (FIG. 9). The majority of tools in the later South



8. El-Wad points from Early Ahmarian sites: (a) Qadesh Barnea (QB 9, QB 601), northeastern Sinai (after Gilead and Bar-Yosef 1993:fig. 10), (b) Jabal al-Qalkha (J432, J431), South Jordan, and (c) Boker A, Central Negev (after Jones *et al.* 1983:fig. 9-9).

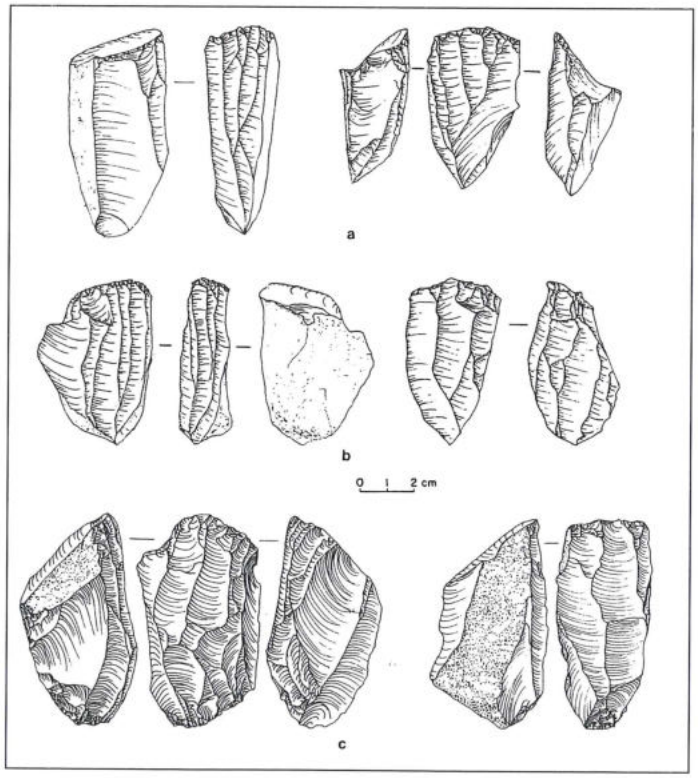


9. Representative blade and bladelet cores from the Jabal al-Qalkha in South Jordan: (a) and (b) Ṭor Fawāz (J403) and (c) Jabal al-Ḥumayma (J412).

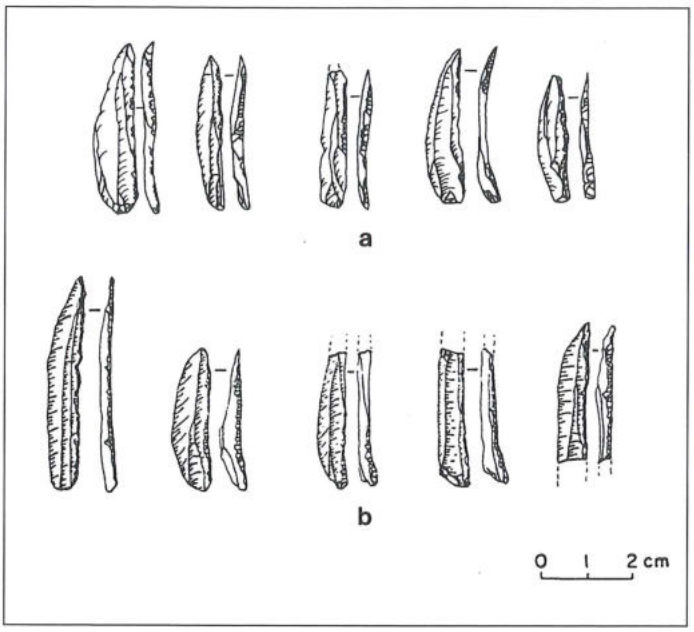
Jordan assemblages were made on blades, while the pointed tools of the Early Ahmarian are absent, and smaller retouched bladelets are rather infrequent. Therefore, these assemblages appear to be technologically later than the Early Ahmarian but clearly not Late Ahmarian. Significantly, they are also not typical of the *traditional* Levantine Aurignacian descriptions since the emphasis is on blade production.

'Ayn al-Buḥayra (WHS 618) and Yutil al-Ḥasa (WHS 784)

In comparison, the Upper Paleolithic assemblages from the large open-air lakeshore site of 'Ayn al-Buḥayra (WHS 618) and the rockshelter site of Yutil al-Ḥasa (WHS 784) in the Wādī al-Ḥasa of west central Jordan are clearly Ahmarian and radiometrically dated to ca. 20,000 BP (Coinman 1990, 1993; Olszewski *et al.* 1990, 1994). The technology of the lithic production at these sites emphasized sophisticated small bladelet tools, especially the precisely retouched and pointed Ouchtata bladelets, while typical Upper Paleolithic endscrapers and burins were made on large blades or core-like blanks. In some cases, flake blanks were frequently selected for endscrapers, as at Yutil al-Ḥasa. The single platform core technology that emphasized blade and bladelet production at 'Ayn al-Buḥayra is identical to that found at 'Ayn Aqev East in the central highlands of the Negev (Ferring 1977; Marks and Ferring 1988; Coinman 1990, 1993) (FIGS. 10 and 11), while that at Yutil al-Ḥasa varies with somewhat



10. Late Ahmarian blade and bladelet cores: (a) and (b) 'Ayn al-Buḥayra (WHS 618), Wādī al- Ḥasa, and (c) 'Ayn Aqev East (D34) in the Central Negev (after Ferring 1977:fig. 4-9).



11. Late Ahmarian Ouchtata bladelets: (a) 'Ayn Aqev East (D34) in the Central Negev (after Ferring 1977:fig. 4-15), (b)'Ayn al-Buḥayra (WHS 618), Wādī al-Ḥasa .

less emphasis on the production of Ouchtata bladelets. Detailed comparisons with Upper Paleolithic assemblages from South Jordan, the Negev, and Sinai suggest little variability in the underlying blade technology among the assemblages, while differences are present in tool types and stylistic variability between early and late assemblages.

Discussion

The Levantine Aurignacian /Ahmarian explanatory model for the Upper Paleolithic has been subjected to increasing scrutiny in recent years. Some have questioned the relevance of redefining the Levantine Aurignacian to accommodate new variability within the traditional assemblage descriptions while others have questioned the validity and accuracy of a model for the entire Levant (e.g., Bergman and Goring-Morris 1987; Bergman 1988a,b; Coinman 1990, 1993; Coinman and Henry 1995). Increasing variability may be due to a number of factors as the data base for the Upper Paleolithic becomes more extensive and geographically more diverse. The geographic variation represented in these assemblages indicates that the Levantine Aurignacian, as traditionally defined, may not be relevant to Upper Paleolithic occupations outside the core Mediterranean zone.

Patterned geographic distributions associated with the Levantine Aurignacian and the Ahmarian are far from clearcut. Environmental associations among the Levantine Aurignacian, northern cave and rockshelter sites, and more mesic Mediterranean coastal conditions contrast with more open-air Ahmarian sites in the arid, steppe and desert environments of the eastern and southern regions. There are, however, numerous contradictions to these generalized distinctions and associations. Surveys in South Jordan (Henry 1979, Henry *et al.* 1983), the Wādī al-Ḥasa (MacDonald 1988), and the al-Azraq Basin (Garrard and Price 1977) have identified predominantly blade assemblages that can be identified for the most part as Ahmarian. These occur in a variety of ecological settings and site types, including both rockshelters and open-air sites in lacustrine, marsh, desert, steppe, and piedmont environmental settings. Assemblages that vary from the well-defined Ahmarian blade-bladelet technology are rare and inconsistently identified to date (e.g., Henry 1982, Coinman 1990, 1993; Coinman and Henry 1995). Evidence that the Levantine Aurignacian is relevant and present in the eastern regions of the Levant appears to be limited.

The evidence from Jordan suggests there is an important overlap in technology between the Ahmarian and assemblages that have been identified as Levantine Aurignacian that occur outside the Mediterranean area. The most important overlap is represented by various kinds of blade technologies, ranging from large, bulky, sometimes poorly-developed blades to fine blade and bladelet dominated assemblages. Comparative analyses of the South Jordan Upper Paleolithic assemblages suggest that some of the variability identified in blade-oriented technologies, which previously has been attributed to the Levantine Aurignacian, does not represent a significantly different underlying technology from a more generalized Ahmarian blade technology since so many of the technological parameters appear to be similar, varying, however, in quality and quantity rather than kind. Typological differences are limited with the most important tool differences represented by pointed blades and bladelets - typological differences that exist *within* the Ahmarian itself and represent temporal changes between the early and late Ahmarian. The non-Ahmarian assemblages referred to here as "Levantine Aurignacian" vary significantly from "Aurignacian" assemblages first identified in the northern Levant. Their distinctiveness and separation from northern Levantine Aurignacian assemblages needs to be emphasized and their general technological similarities to the Ahmarian should be investigated more thoroughly. The key to understanding the variability in the Upper Paleolithic assemblages in the southern and eastern Levant requires reassessing all aspects of the underlying technology and defining the technological parameters that distinguish different cultural adaptations, and thus, different taxonomic units.

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WHS 1065 (Ṭor aṭ-Ṭarīq): An Epipaleolithic Site in its Regional Context

Introduction

Wādī al-Ḥasa Survey Site 1065 (Ṭor aṭ-Ṭarīq) was discovered in 1982 by Burton MacDonald during a survey of the south bank of the al-Ḥasa (MacDonald 1988). Situated on the north-west shore of a former Pleistocene lake at an elevation of 815 m asl, the site covers an area of about 812 m^2 along a slope below a collapsed rockshelter and fossil spring (FIG.1). Artifacts cover the entire slope, although much of the downslope material appears to be derived from above due to erosion and colluviation. Disturbance is less evident upslope where deposits are relatively intact and the slope of the landsurface is less pronounced. Initial assessments of the nature of site occupation suggest a series of camps moving up and down the slope following the fluctuations in the level of the lake.

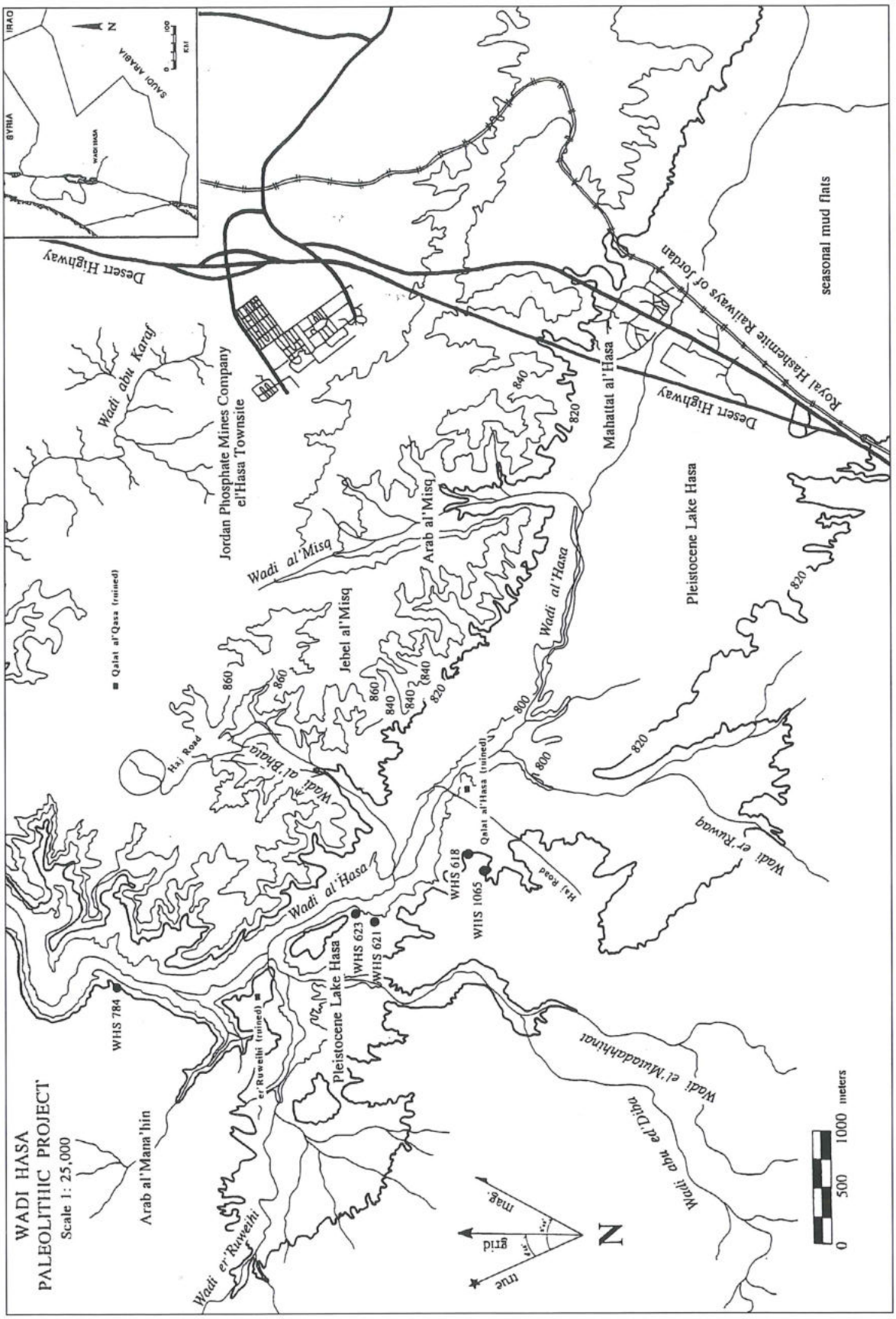
Fieldwork was initiated in 1984 under the auspices of the Wādī al-Ḥasa Paleolithic Project with the aim of recording information pertaining to the paleoenvironmental, geomorphological and cultural history of the eastern al-Ḥasa basin. At Ṭor aṭ-Ṭarīq, this included an extensive surface collection (95%) followed by excavation of a 44 m long step-trench that bisected the site and extended down into the lake marls below (Coinman *et al.* 1989; Clark *et al.* 1987). This resulted in the collection of faunal and pollen samples, and more than 160,000 pieces of chipped stone. The high density of lithic material in distinct strata indicates that the locality around the spring was occupied repeatedly and intensively over a long interval of time. The major part of the occupation appears to represent the Kebaran phase of the Levantine Epipaleolithic based on typological indicators (high incidence of narrow backed bladelets) and radiocarbon dates that range between 16,900 and 15,600 BP. Changes in typology, and an increase in geometrics in the upper levels in some parts of the site suggest a later Epipaleolithic component corresponding to the Geometric Kebaran or perhaps to the Natufian (Clark *et al.* 1987).

Excavations were resumed in 1992 in an effort to refine the definition of the various occupational episodes and to expose horizontal areas adjacent to the main trench. Two 4 m^2 units were opened up adjacent to the trench in Steps B and C in order to identify additional site features and/or architecture associated with the occupations (FIG. 2). This resulted in the collection of an additional 40,000 lithic artifacts along with fauna, shell and ground stone (Clark *et al.* 1992).

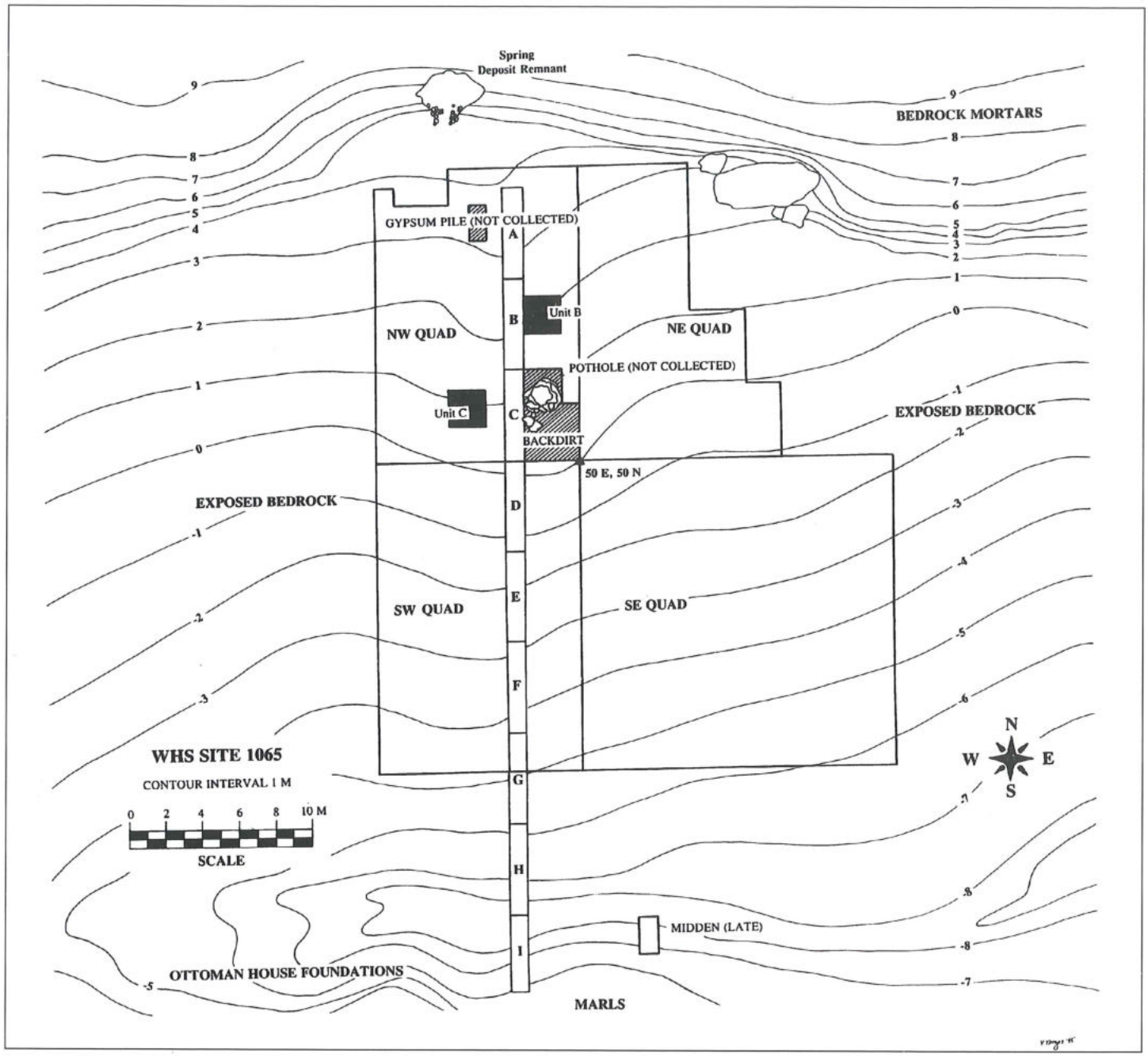
Eight radiocarbon samples have been processed so far. Six of the eight determinations cluster in the 16.9-15.6 kyr BP interval – dates compatible with other radiocarbon dated Kebaran industries elsewhere in the southern Levant (Bar-Yosef and Vogel 1987). Typologically, the paucity of geometric microliths and a high proportion of backed bladelets in the radiometrically dated levels correspond to a generalizable Kebaran pattern described by Bar-Yosef (1981) and Henry (1983). These radiocarbon dates come from the lowest levels in Steps A, B and C. Although they provide an internally consistent cluster of dates for the Kebaran, the Ṭor aṭ-Ṭarīq dates do not shed much light on the question of subsequent occupations, as the upper layers did not yield datable remains.The later material, containing higher proportions of geometric microliths, is confined to Step C and rests well above the dated levels from that unit. Typologically, this material appears to be similar to the Geometric Kebaran levels at al-Kharrāna IV in eastern Jordan (Byrd 1994:211; Muheisen 1985:156-158;1988:362-365; Olszewski *et al.* 1994:137). Two other dates were obtained from bulk sediment samples of a heavily calcreted, consolidated layer in Unit B. At 11,280 and 9,010 BP these dates are much younger than the others and are considered problematic with regard to site chronology because of potential problems inherent in the bulk sampling technique, and the possibility of contamination (Neeley *et al.* n.d.).

The Local Context

Ṭor aṭ-Ṭarīq is only one of dozens of Upper and Epipaleolithic sites recorded in the eastern basin of the al-Ḥasa drainage. The high incidence of Pleistocene archaeological sites along the wadi is due in part to its function as the only perennial watercourse draining the central Jordanian Plateau between the Dead Sea and the Gulf of ʻAqaba. More mesic biomes flanked the al- Ḥasa intermittently during the late Quaternary, although rainfall is now sparse and the project area is mostly contained within the 100-200 mm isohyets. Significantly, most Levantine regions associated with open air late Paleolithic assem-



1. Map of the eastern end of the Wādi al-Ḥasa indicating the extent of the Pleistocene lake and the location of Ṭor aṭ-Ṭariq (WHS 1065) along with other nearby Upper– and Epipaleolithic sites .



2. Site map of Ṭor aṭ-Ṭarīq indicating the 1984 step trench (A-I) and the 1992 excavation unites (B and C).

blages are found within the same precipitation belt and today sustain similar Irano-Turanian steppic vegetation.

The site lies atop a 10-20 m high bedrock spur that overlooks the dissected basin of the former lake, above a third order al-Ḥasa tributary (the Wādī ar-Ruwāq) that has incised the site landform to a depth of 10-12 m. The uppermost site surface slopes at 16 degrees from the mouth of the rockshelter to the wadi floor. The substrate is characterized by complex interdigitations of cultural sediments and calcareous wadi and marl deposits that are laterally discontinuous. At depths ranging from 0.3 m to greater than 1.3 m, cultural sediments rest on a base of fluviolimnic sands, silts and clays that in turn overlie lacustrine marls. The marls have accumulated over bedrock that was exposed only along the eastern edge of the rockshelter. The sediment complex is typical of lake edge depositional environments, where poorly sorted alluvium and mud flows were laid down intermittently over a period of several millennia. Structural and textural variability within these sediments suggests that they represent deposition under paludal (ponded) conditions (Schuldenrein and Clark 1994:38).

Stratigraphic separation between the cultural and the uppermost palustrine deposits is obscured by lenses and

pockets of colluvial detritus. Human occupation of the slope, combined with wave cutting and shoreline movements along the lake margins stripped away lake edge deposits in the immediate vicinity (although they are preserved at nearby WHS 618), and transported anthropogenic residue downslope. Portions of the stratified marls are preserved atop eroded bedrock and are most extensive midway down the slope. The palustrine sediments incorporate extensive, silicified root casts, indicating a sustained vegetal community over the course of the occupation. The faunal inventory contains high proportions of *Testudo* (38.6% of the bone count), *Gazella* (34.8%), *Bos* (10.9%) and equids (7.6%). Pollen profiles include cattail (*Typha*), riparian willow (*Salix*), pine (*Pinus*) and oak (*Quercus*). There is also a substantial chenpodiaceae component (> 40% in most samples). Collectively, these elements suggest a mosaic of relatively mesic Mediterranean open woodland-steppe environments.

The Regional Context

Integration of the late Quaternary al-Ḥasa sequence is best modeled after reconstructions for the western an-Naqab highlands (the drainage of the Nahal Zin) and the Jordan Rift-'Arabah Valley. The former is similar in topography and is located 100 km to the west on the same latitude (30 degrees 50'). Hydrogeographically, the Nahal Zin is the al-Ḥasa's drainage equivalent west of the Rift and, like the al-Ḥasa, it preserves a more or less continuous geoarchaeological record. The Rift-'Arabah is the regional catchment for both the Zin and the al-Ḥasa, and is one of the most thoroughly researched late Quaternary arid zones.

Although geoarchaeological data on al-Ḥasa hydrology and paleolandscapes extends back nearly to the Middle-Upper Pleistocene boundary, at 130 kyr BP (Schuldenrein and Clark 1994), it is only the ten millennium interval between 25,000 and 15,000 years ago that is of interest in the context of this paper. The first five millennia of this period are characterized by relatively mesic environments, and recharging of aquifers documented in the eastern al-Ḥasa drainage at the lakeshore Ahmarian site of 'Ayn al-Buḥayra (WHS 618), located a scant 200 m north-east of Ṭor aṭ-Tarīq (Coinman 1993). The an-Naqab equivalent of these occupations is the site of Boker with dates between 25.5 and 23.6 kyr BP (Marks and Ferring 1988). Although the an-Naqab does not contain lake basins, its higher energy fluvial environment corresponds with the moist peak of ca. 22 kyr BP in the Rift and the al-Ḥasa.

By around 20 kyr BP, initiation of a drying trend is marked by erosion of the Lower Terrace at Boker and incision of the al-Ḥasa marls. More generally, high lake levels throughout the eastern Mediterranean had begun to decline after about 19 kyr BP. Across the southern Levant, widespread valley erosion is inferred from a total absence of dated fluvial deposits between 22 and 17 kyr BP. Only Macumber and Head (1991) argue for no significant retreat of lake levels at this time, based on silting of the lower reaches of the Wādī al- Ḥammah, an eastern tributary of the Jordan.

Evidence for renewed humidity after ca. 17 kyr BP comes from the most recent Rift Valley pollen records. The Hula core (Golan Heights) shows that, after the pleniglacial maximum, ratios of tree pollen to steppe plants increased steadily from a low of 20%, at ca. 22 kyr BP, to a high of 75% at about 11.5 kyr BP, followed by a precipitous decline (to 30%) during the following millennium (Baruch and Bottema 1991). Kebaran pollen records at Ṣalibiya-Fazael in the lower Jordan Valley show earlier climatic amelioration (Schuldenrein and Goldberg 1981). Progressively mesic environments were marked by renewed alluviation, creation of fan-deltas at the junctures of major tributaries and local palustrine basins in the al-Ḥasa and in the lower Jordan Rift. Prevailing climatic conditions at this time are inferred from a 13 kyr BP an-Naqab paleosol, the formation of which required 500 mm of annual precipitation (2.5 time greater than present) (Goodfriend and Magaritz 1988). Rainfall gradients were depressed 150 km southward in the an-Naqab and, by extension, in the al-Ḥasa, which is on the same latitude.

Most reconstructions of lake environments in the al-Lisān basin suggest that high lake level stillstands culminated there at about 14.6 kyr BP (Begin *et al.* 1985). Transferring this chronology to the al-Ḥasa basin might account for the densest lake margin occupation at Ṭor aṭ-Ṭarīq during the Kebaran. The rising lake levels in the Rift Valley, which persisted into Natufian times, may have promoted backfilling in the vicinity of the site, as evidenced by variability in marl composition. Inundations of the wadi mouth would have resulted in the periodic relocations of the site's inhabitants that seem to be documented archaeologically. Although there is reasonable overall agreement between the al-Lisān and al-Ḥasa sequences, the smaller size of the al-Ḥasa basin would have tended to produce a different series of microenvironments in the immediate site vicinity, regulated by geomorphic and hydrographic processes that were strictly local.

The clustering of radiocarbon dates from the eastern end of the drainage indicate that optimal human occupation of the al-Ḥasa lake plain was essentially confined to the late Ahmarian, between 25 and 20 kyr BP, and to the Kebaran, between 17 and 15.5 kyr BP. These periods coincide with high lake level stillstands, moist climatic cycles, and transitions to paludal environments (Schuldenrein and Clark 1994:52). Seasonal, lakeshore marshes in the vicinity of strong freshwater springs seem to have acted as a powerful attractor for intensive human settlement in the eastern al-Ḥasa, as was generally the case across the southern Levant (Clark 1992).

Deconstructing Base Camps

Previous reports have suggested that Ṭor aṭ-Ṭarīq was a

residential base camp, or a series of superimposed base camps, based in large part upon the areal extent of the site, the potential for architectural remains, and the high density of lithic and bone debris (Clark *et al.* 1987). This interpretation should be reassessed in light of the 1992 data. The long span of human use of the locality, and the likelihood that continuing processes of erosion (esp. colluviation) have artificially inflated the surface area of the site making the "base camp" interpretation less straightforward than it appeared to be in 1986 (cf. Clark *et al.* 1987; Neeley *et al.* n.d.).

The use of the term "base camp" is somewhat ambiguous since what is implied by a base camp will depend almost exclusively upon perceptions of the mobility strategies of the prehistoric foragers involved. In the Levantine context, mobility strategies have been dichotomized conceptually by Marks and Freidel (1977) as "circulating" versus "radiating". The Kebaran and its regional variants, as well as most of the Upper Paleolithic, are usually thought to be characterized by a circulating strategy. With a circulating strategy, extractive localities and other kinds of limited activity sites are apt to be small, perhaps archaeologically invisible loci, whereas base camps, which vary in the length of occupation, are not expected to be formally structured in terms of their use of space, since the anticipated duration of occupation is likely to have been short. The result is typically little intrasite patterning with regard to the use of space, and because of repeated, non-continuous occupation over time, a tendency for patterns originally present to become "blurred".

Under a radiating strategy, believed to characterize the latter part of the Middle Paleolithic and the Natufian, base camps are organized logistically and may be highly visible because of protracted occupation and the accumulation of midden deposits. They can contain greater intrasite patterning with regard to structures, features and trash disposal areas. Extractive sites are expected to be more numerous, and perhaps better defined in terms of their residues, but still potentially invisible archaeologically because of the limited range of activities occurring there. Relatively convincing examples of logistically-organized base camps include Ein Gev I (with architecture), Ohalo II (flora and fauna indicate long-term occupation), al-Kharāna IV and Jilāt 6 (both with human remains and structures) (Nadel and Hershkovitz 1991; Garrard *et al.* 1994). Thus, the term "base camp" might best be prefaced by reference to the organizational properties of a settlement system, for the archaeological "signature" varies accordingly.

For the most part, Kebaran sites appear to represent a strategy of circulating mobility characterized by small site size (15-400 m^2) and a limited range of artifacts (Bar-Yosef 1990: 65-67). Extensive scatters of material and/or associated evidence of architecture are rare. Settlement pattern models pertaining to seasonal movement like that suggested in regions of high relief have not been developed for the Kebaran itself, due in large part to the paucity of Kebaran-like sites from different environmental contexts (Henry 1994). While Ṭor aṭ- Ṭarīq is not a sedentary site in any absolute sense of the term, it does not appear to be a limited activity station either, given the high density and diversity of remains and features. Whether it represents a long-term, semi-sedentary locality like Ohalo II, or is the result of repeated, short-term occupation over a span of several millennia is the question of interest here.

The location of the site on the lakeshore in association with a strong spring at the confluence of a tributary wadi and the evidence for paludal conditions indicates a rather diverse mosaic of local microenvironments that probably attracted a variety of potentially exploitable plant and animal resources to the area. These would include open woodland, steppe and aquatic species, all concentrated around the lake in the swamps and ponds found along its shores. The presence of "site furniture" in the form of bedrock mortars and heavy, non-portable ground stone tools reinforces the notion that plant resources in the site vicinity might have played a significant role in repeated visits to the area (Peterson 1994). Given the mildly alkaline lake, fresh water from the spring would have been a powerful attraction. In addition to its southern exposure, potentially important for winter occupations, the bedrock promontory above the site would have provided a vista for observing most of the eastern lake basin (an area of >75 km^2), and been useful for tracking the movements of game.

Conclusions

Taken in aggregate, most of the evidence does not suggest long-term, continuous occupation at Ṭor aṭ-Ṭarīq. The high density of artifactual debris evidently accumulated over several millennia.The different ages and placement of the hearths and the relatively informal nature of their construction would also seem to militate against permanency, since it is more likely that long-term occupants would have invested greater time and effort in constructing site features had they planned to occupy the area for an extended period of time. The lone architectural feature is tenuous in its association with the Kebaran levels. Other evidence for long-term occupation such as living surfaces, houses or burials were not identified. The heavily microlithic assemblage can also be argued to be a response to the demands of mobility in which lightweight, portable and interchangeable, multifunctional tool elements would be highly desirable (Neeley and Barton 1994; Kuhn 1994). The informal, expedient quality of many of the ground stone tools lends additional support to a higher degree of group mobility. The only category of evidence that might support a more permanent occupation is the formation of dark organic levels, probable midden deposits given the absence of any features. These areas are characterized by high densities of bone and lithic debris, but the rate at which this material accumulated is not known and it is

entirely possible that they resulted from relatively intensive, short-term or seasonal occupations.

Finally, these conclusions concerning the place of Ṭor aṭ-Ṭarīq within the regional settlement system are derived from a single site. Clearly, a single site will not encompass the full range of structural poses that characterize forager behavior over the course of an annual round. Only through the continuation of survey, excavation, and geomorphological studies in the al-Ḥasa basin can we enhance our understanding of the prehistoric settlement-subsistence strategies of this region.

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A PPNB Settlement at aṣ-Ṣifiyya in Wādī al-Mūjib

Introduction

In the spring of 1994 the presence of a large Pre-Pottery Neolithic settlement at Wādī al-Mūjib, adjacent to the bridge of the King's Highway (FIG.1), was brought to the attention of the Department of Archaeology at Mu'tah University following ploughing and bulldozing activities by the owner of the land .

The site was , and indeed is still further endangered by seepage of a water pool dug in the upper slopes of the site as well as a net of several water pipes scattering all over the site surface.

A series of damage to the site took place : rock debris from scooping the surface of the upper slopes of the site partly covering and cutting the cultural layers, dirt roads were erected at the site through bulldozer works. These bulldozer activities left behind tracks running in different directions, exposing cultural layers by sections up two meters high in some areas.

In March 1994, preliminary investigations lasting twenty days, were initiated in order to estimate the extent of the site, the thickness and the state of preservation of the archaeological layers, the nature of the damage incurred, and the potential for more extensive excavations.

The initial investigations revealed a predominantly Neolithic settlement that can provisionally be dated (on the basis of the technotypological criteria of the chipped stone tool assemblage and the style of architectural constructions) to the late Pre-Pottery Neolithic B period which spans the years from ca. 6500 BC - 6000 BC.

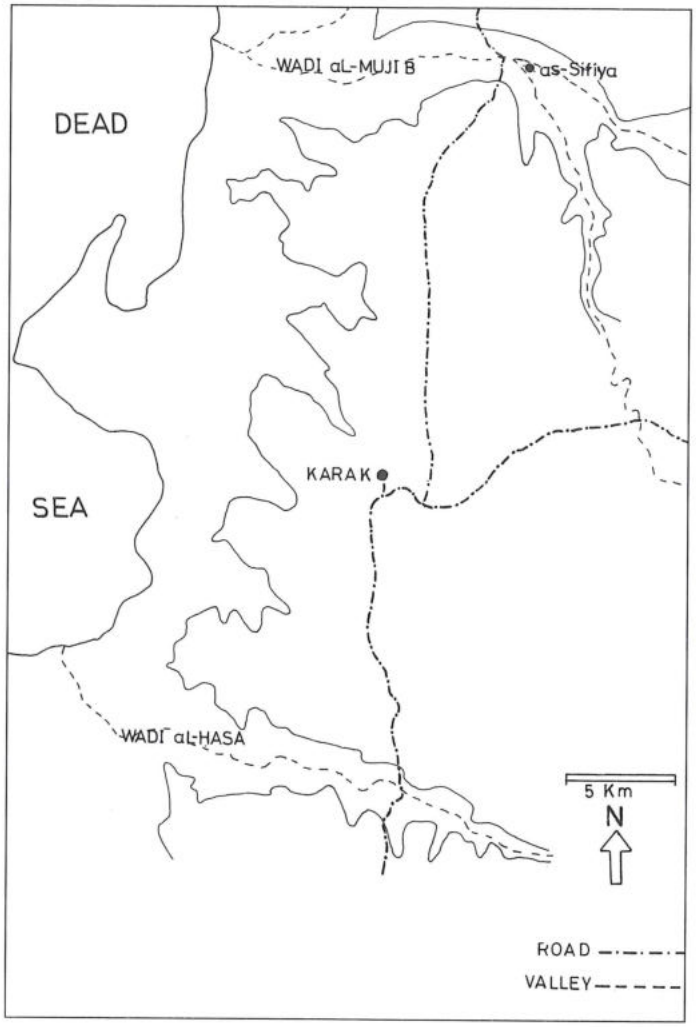
Despite the importance of the site, it was never mentioned earlier by any surveyor or archaeologist who passed through the area during the last decades.

A full investigation has become imperative as the expansion of the agricultural activities on the site were advanced and caused more damage to its cultural layers.

Site Setting

Aṣ-Ṣifiyya is situated high on the eastern slopes where Wādī al-Mūjib and its tributary Wādī as-Salāyṭa meet at an elevation of ca. 210m asl Wādī al-Mūjib is located in a quite wide and rising sharply slope on all sides.

The entire area of the site has recently been disturbed



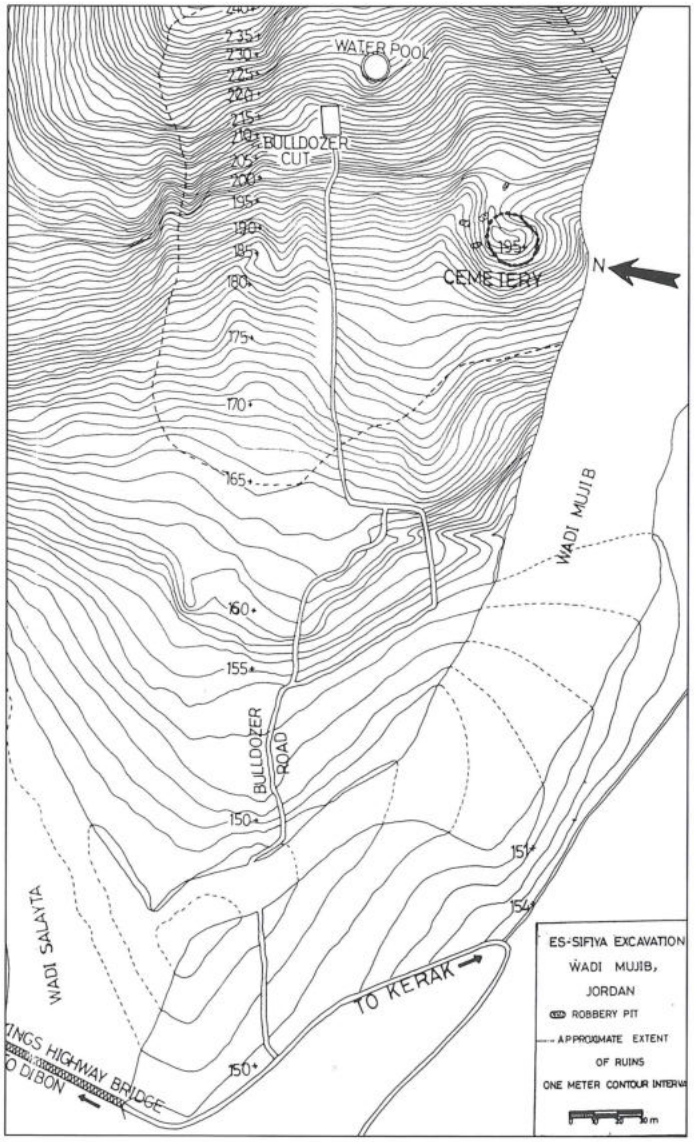
1. Map showing the location of aṣ-Ṣifiyya.

by current agricultural terracing, ploughing, burials and irrigation systems. These activities make it difficult to assess the real size of the aṣ-Ṣifiyya settlement. However, the distribution of the surface artefacts and cultural material extends over approximately 118 dunams, although it is likely that the architectural remains cover about 20 dunams (FIG. 2). The recent bulldozer damage has shown that the settlement of aṣ-Ṣifiyya has extensive architecture, which is in good condition with walls standing to a

height of two meters in some areas.

The immense area of the aṣ-Ṣifiyya settlement makes it ranking in size with the main Neolithic sites such as Mureybet (Van Loon 1966:215), Tall Abū-Hurayra (Moore 1975:56 and 1978:164), Tall Aswad and Tall Ramad in Syria (Mellaart 1975:59; Mahasneh 1989:229), Beisamo, Munhatta (Singh 1974:55) and Jericho in Palestine (Kenyon 1979:29), Wādī Shu'ayb (Simmons *et al.* 1989:29), 'Ayn Ghazāl (Kafafi 1990:134; Rollefson 1983a and 1983b; Rollefson and Simmons 1985a and 1985b), al-Bayḍa (Kirkbride 1960:141), al-Baṣṭa (Gebel *et al.* 1988:107), Ba'ja (Gebel 1988:85) and 'Ayn Jammām (Bisheh *et al.* 1993:121) in Jordan.

The environment of aṣ-Ṣifiyya presents an excellent record for determining the subsistence economy and demography of a stable settlement that lasted for at least about half a millennium. The present ecological setting in Wādī al-Mūjib which could be considered as one of the largest drainage passages in Jordan, provides perennial sources of water. The natural habitat of this wadi explains its importance for the understanding of the early village/ herding economy in less severe early Holocene environment. Therefore, the site of aṣ-Ṣifiyya is of extreme importance for understanding the later development during the Neolithic period.



2. The Contour Map of aṣ-Ṣifiyya.

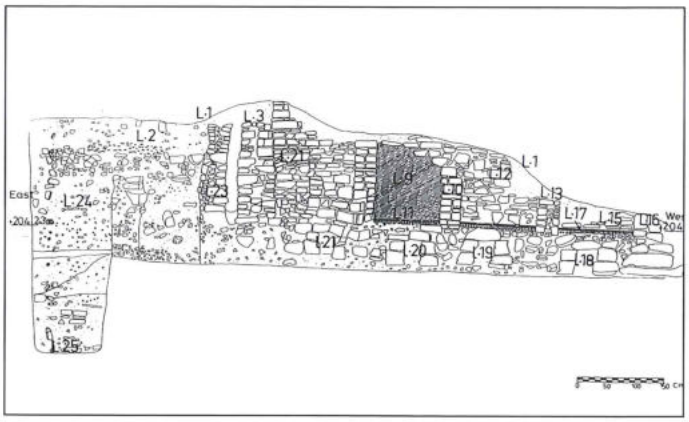
The Excavation Goals

Prior to our arrival to the site, an area approximately 160 sq.m was cut and cleared by a bulldozer for irrigation purposes, exposing the occupational layers of a Neolithic culture.

The initial objectives for the 1994 season had two goals: The first one was to carry out a preliminary survey in order to assess the extent of the Neolithic occupation. This was achieved through an intensive survey of the prospective area of the old settlement and through investigations of modern cuts at various locations at the site. Although it was nevertheless possible to conduct an intensive surface survey, as it was intended, the density of tomato plantation which covered each square meter in the southern part of the site made our tast in this part of the site more than a difficult one. The second goal was mainly to conduct a preliminary small salvage excavation in the bulldozer-cut area where cultural layers were exposed. Despite the fact that we were neither prepared nor fully equipped for a full-scale excavation, we trimmed and cleared the longest bulldozer-cut section (about3 11 m) where rectangular structures and plaster floors were attested. This trimming provided us with information about the archaeological stratigraphy of aṣ-Ṣifiyya.

The Architectural Remains

The small-scale excavation which was carried out in March 1994 focused mainly on trimming and clearing the longest part of the bulldozer cut section. This bulldozer - cut section is oriented approximately east-west and revealed a thick PPNB occupational level along the entire length of the section. Red-stained floors, stone walls and sub-floor structures are exposed clearly for a length of 8 m and vary in thickness from about 80 cm at the west side of the section to about 2.3m at the east side (FIG. 3).



3. The Section of the bulldozer-cut area.

We started to remove the top soil (Locus 1) and below that a sedimental layer (Locus 2) was exposed. This sediment contained large quantities of burnt limestone chunks, fragments of plaster , loamy matrix , ashes, animal bones, lithic tools, and artefacts washed in from the upper slope . At the top of the section the sediment has been damaged by recent agricultural activities and truncated by the present topography of the site.

The exposed architectural remains consist of plaster floors and stone walls which are the remains of a building unit. The bulldozer's work was responsible for wiping out most of the features of this building unit and, unfortunately, very few structures were left behind.

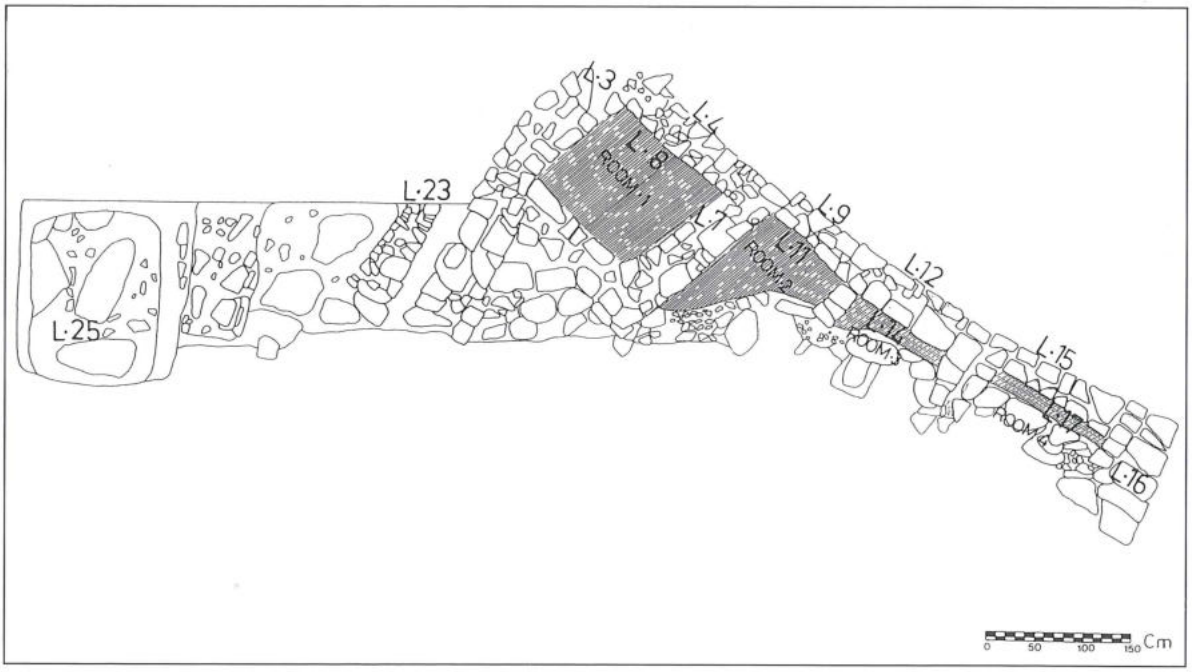
The remains of four small rectangular rooms which vary in size can be recognized easily (FIG. 4). The walls (Loci 3-6) represent the first room which has a structure of comparatively good condition where the remains of four walls are still preserved at different leights. In the west wall Locus 6 of this room is a narrow passage (Locus 7) completely preserved including the entire door frame with some additional structures above the lintel. This doorway measures 50 cm high x 40 cm wide and connects room 1 with the neighbouring room 2.

Room 2 is formed of walls Loci 6, 9 and 10 and is located to the east of room 1. Room 3 is framed by walls Loci 10, 12 and 13, while room 4 is located in the west edge of the section and consist of walls Loci 13, 15 and 16 (see FIG. 4). The northern walls of rooms 2-4 are destroyed and have disappeared through recent bulldozer activities. The remaining walls of rooms 3 and 4 are preserved only to a height that has left no traces for the doorway passages.

The walls of these four small rooms have the same building technique. The occupants of aṣ-Ṣifiyya took advantage of the fact that the soft limestone flaked off in pieces of comparatively equal thickness, thus providing them with building material. These stone slabs have rectangular shapes. All the walls are built of two facing rows of rectangular stone slabs laid horizontally and providing the exterior façades of the walls. Wedge stones were used between the rows of these rectangular stones, creating walls still preserved to a considerable height of 1.5 m (Locus 4).

The walls which are exposed in the bulldozer cut section are associated with plaster floors (Loci 8,11,14 and 17). The plaster floor of room 1 (Locus 8) is the only one which escaped the bulldozer destruction, while the floors of the other three rooms are destroyed and only little remains are still *in situ* and can be seen vividly in the section. The preliminary result of analysis indicates a considerable variability with regard to the relative composition of the lime plaster and crushed chalk/limestone. Lumps of what seems to be sun-dried or perhaps even fired reddish clay were noticed in some quantity in the excavated area.

These plaster floors were built of a hard matrix 'bale' with gravel and small pebbles, laid down and then coated by a thin plaster, The floors were then burnished and given a coat of red paint. The entire stone walls also received an interior coating of mud plaster and were finished by a thin sheet of white plaster. Only some patches of plaster are still adhering to the stone walls. However, the south wall of room 2 (Locus 9) (see FIG. 3) is still completely coated with white plaster. The plaster of the walls received the same finishing treatment as the plaster floors and is covered with red paint. There is an accumulation of several re-plasterings which were attested very well on the walls as well as, on the floors of these four rooms. The walls and the plaster floors of aṣ-Ṣifiyya are



4. The Top-plan of the bulldozer-cut area .

identical in form and building technology to those found at 'Ayn Jammām (Gebel 1992:3-6), al-Baṣṭa (Gebel *et al.* 1988: Fig. 6; Nissen *et al.* 1987:88 and Nissen *et al.*, 1991:15), al-Bayḍa (Kirkbride 1966:14) and 'Ayn Ghazāl (Banning and Byrd 1984:15; Rollefson 1983:12; Rollefson and Suleiman 1983:471-478) in Jordan, and Yiftahel (Garfinkel 1985) in Palestine.

Below the plaster floors there is a layer of rows of large stone boulders and rubble in between , among these boulders sub-floor structures (Loci 18-21) are exposed underneath the floors of the four rooms and running in a north-south direction (see FIG.3). All the sub-floor structures or the channel-like sub-structures are entirely filled with very fine soil.

Each sub-floor structure consists of two parallel rows of large slabs and in each row two courses of limestone were constructed. These sub-floor structures are sealed with flat stone slabs. The average measure of these channel-like sub-structures is about 30 cm wide and 50 cm high. The floors of these structures were built of finely dressed stones. No evidence for mortar or plaster has been uncovered on the interior faces of these sub-floor structures.

Since these four sub-floor structures are located beneath the floors of the four rooms and running in north-south directions, we were unable to excavate them. However, a two metre rod was inserted inside one of these structures and the end was not reached . The channel-like sub-structures of aṣ-Ṣifiyya have counterparts at the two sites of al-Baṣṭa (Gebel *et al.* 1988:116; Nissen *et al.* 1987:89 and Nissen *et al.* 1991:14) and 'Ayn Jammān (Gebel 1992 : 3). This type of structures which is unparalleled elsewhere in the Levant outside these three sites, was probably used as a water-channel system for drainage since it is filled with a soft silt.

To the east of room 1, the remains of a stone wall can be clearly seen. Both walls Locus 3 of room 1 and the free standing wall Locus 23 are separated from each other by a small space of 20 cm wide and 80 cm high (see FIG. 3). This narrow area is filled with cobbles, pebbles and with a large quantity of silt. This discovery might indicate that there was a surface drainage system at aṣ-Ṣifiyya beside the sub-floor one.

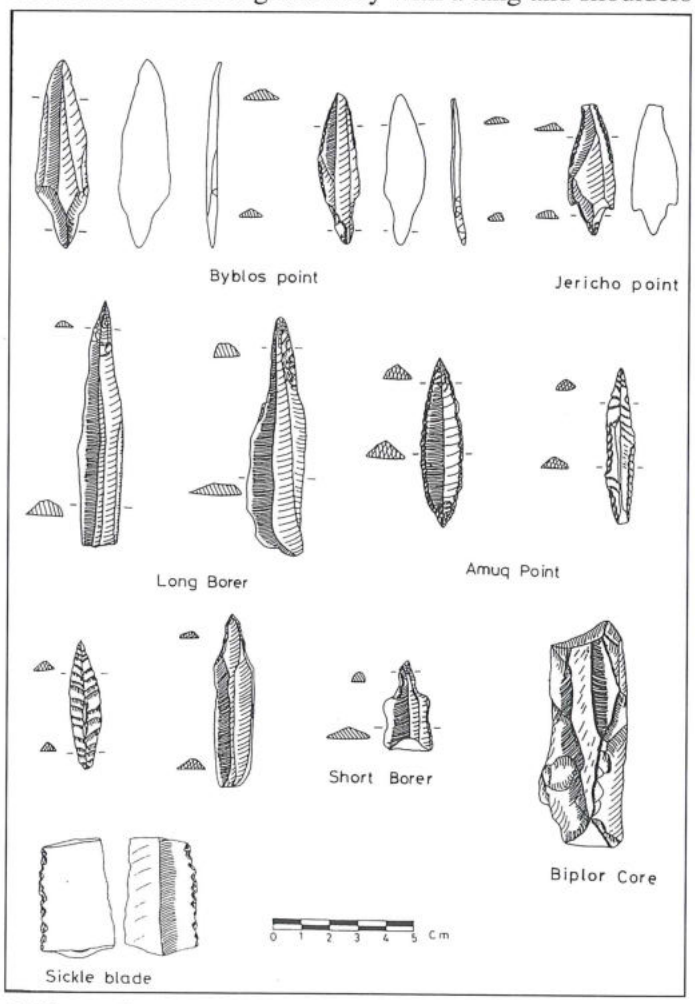
In the easternmost corner of the bulldozer-cut section , a small trial trench was opened in order to obtain more information about the stratigraphical sequence of the site. The trial trench resulted in uncovering a dumping pit . After removing the top soil, the first sign of human activity was uncovered: a greyish layer (Locus 24) with quite densely packed fire-cracked stones, heavy admixture of ashes, pieces of mortar material, chunks of plaster, building debris, flint artefacts, fragments of stone tools and massive chipping debitage. This large amount of finds suggests that stone tools and artefacts were manufactured at the site.

The bedrock (Locus 25) was reached at a level around 4m deep (see FIG. 3) This indicates that the upper architectural remains appear 2.30m above bedrock. No material culture in this dumping pit could be dated before the middle of the seventh millennium BC was found. Therefore, one initially could conclude that the uncovered structures in the bulldozer-cut section belong to a single period which can be dated to the late PPNB.

The Lithic Industry

The collection of the chipped stone artefacts from the excavated section appears to indicate a homogeneous assemblage which reflects the distinctive elements of the chipped stone industry of this period (Mahasneh 1989 : 203). It is dominated by the use of the bipolar technique. The retouched blades show distinct patterns of edge retouch. Amongst the artefacts the use of heat-treated pink /purple flint is to be noticed as practised at the site. However, the diagnostic tools of the aṣ-Ṣifiyya flint industry are the arrowheads.

Three types of arrowheads or projectile points (FIG. 5) were attested : The Jericho large point , and which has a tang and wings, which is common during the early PPNB period, is very rare in the late PPNB (Burian and Friedman 1978:58 ; Crowfoot-Payne 1983:679; Rollefson 1983a: 4). The Byblos point represents the second type of arrowheads. It has an elongated body with a tang and shoulders



5. Flint artefacts.

between the body and the tang. The Amuq point is the third type which has an elongated leaf-shaped body and is pointed at both sides. Byblos and Amuq points are common at aṣ-Ṣifiyya during the late PPNB, unlike the Jericho point which , as stated above, was only common during the early PPNB, but rare to absent in the late PPNB (Baryosef 1981 : 599 ; Gopher 1985 : 56 - 59; Mortensen 1970: 17-26).

Flint borers of both squat and elongated forms were attested at aṣ-Ṣifiyya (FIG.5). The sickle blades of aṣ-Ṣifiyya belong to the common type of the PPNB, with fine denticulation done by semi-abrupt retouch, usually on the ventral face (Burian and Friedman 1979 : 13).

The chipped stone industry of aṣ-Ṣifiyya bears a strong resemblance in forms and technology with those recorded at the PPNB sites of al-Baṣṭa (Gebel *et al.* 1988 : Figs. 9-11), Ba'ja (Gebel 1988: Figs 9-10), 'Ayn Ghazāl (Rollefson and Abu Ghaneima 1983 : 46 - 469) and Jericho (Crowfoot - Payne 1983 : Figs. 292-327).

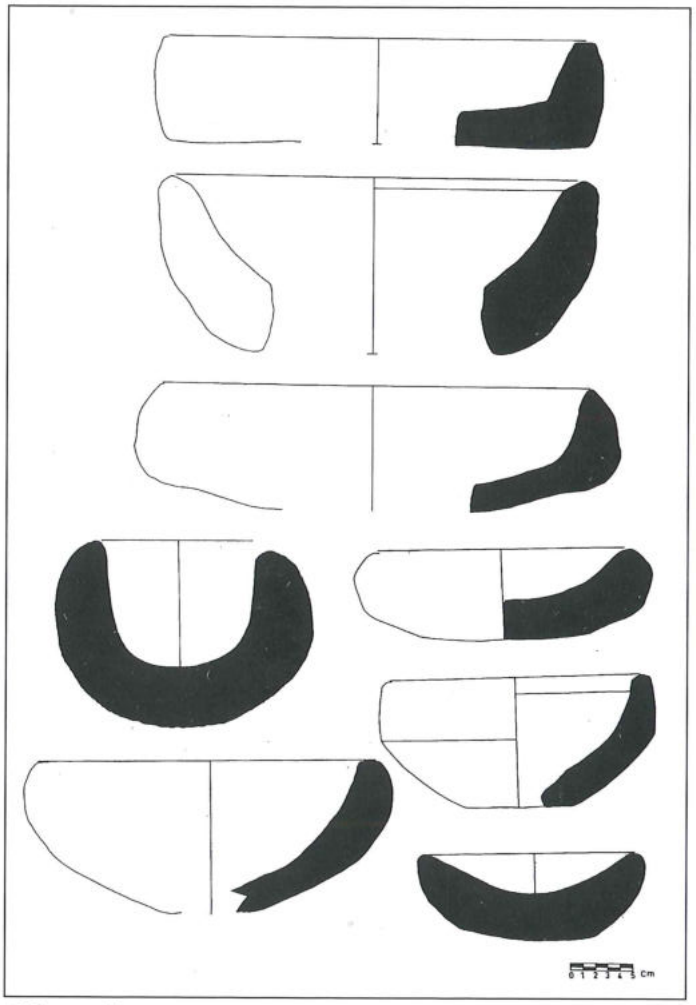
Heavy duty ground stone objects such as querns were found scattered throughout the site. They are chiefly of limestone and basalt boulders and give evidence of hard and prolongated use. These querns are minimally modified and left unshaped on their exterior surfaces which have been hollowed out (FIG.6). The rarity of such objects may point to the general preference of wood rather than stone for the making of these vessels.

Grinding stones of various hardness, such as pestles, rubbing stones, stone hammers and grinding slabs (FIG. 7) are recorded. Chiselling, pecking, grinding or polishing and flaking were used in forming these tools. One complete stone weight was found. It is made of basalt and perforated off-centre at the narrowest point. The perforation is biconical in section. The shape tends to be trapezoid with rounded edges. Only few small finds are recorded. Six fragments of sandstone bracelets were found. They range in diameter from 4 cm to 7 cm A small fragment of sandstone palette was also uncovered (FIG. 8).

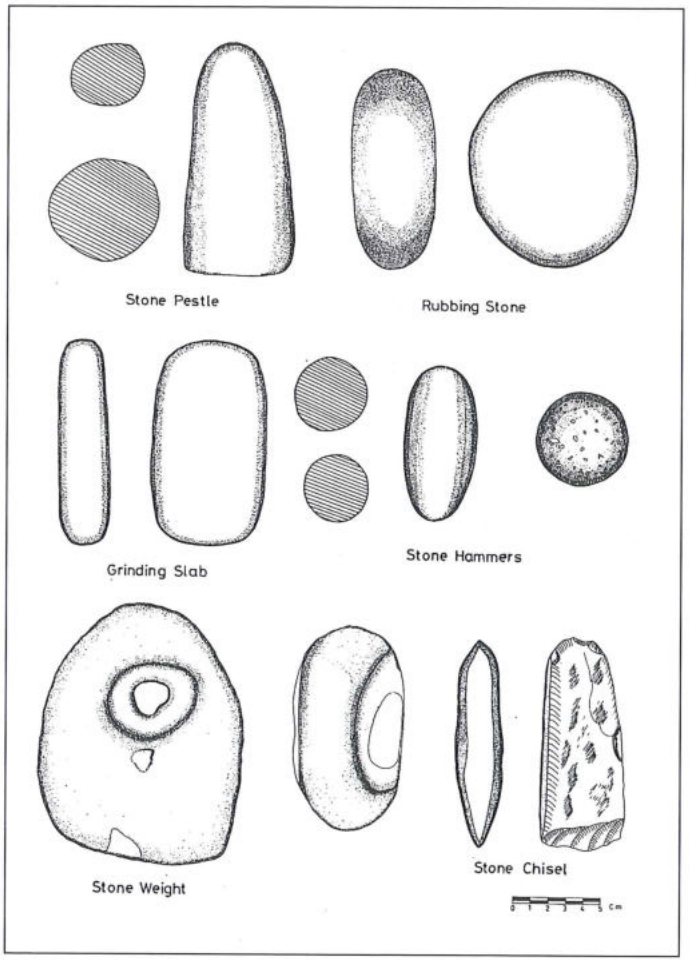
The ground stone industry of aṣ-Ṣifiyya has parallels at many PPNB sites,for example Jericho (Dorrell 1983 : Figs. 224 -226 and 228), al-Bayḍa (Kirkbride 1966 : Fig. 7) and al-Baṣṭa (Nissen *et al.* 1991 : pl. 111 ; Nissen *et al.* 1987: Figs 13 and 15 ; Gebel *et al.* 1988: Fig. 13).

The Economy

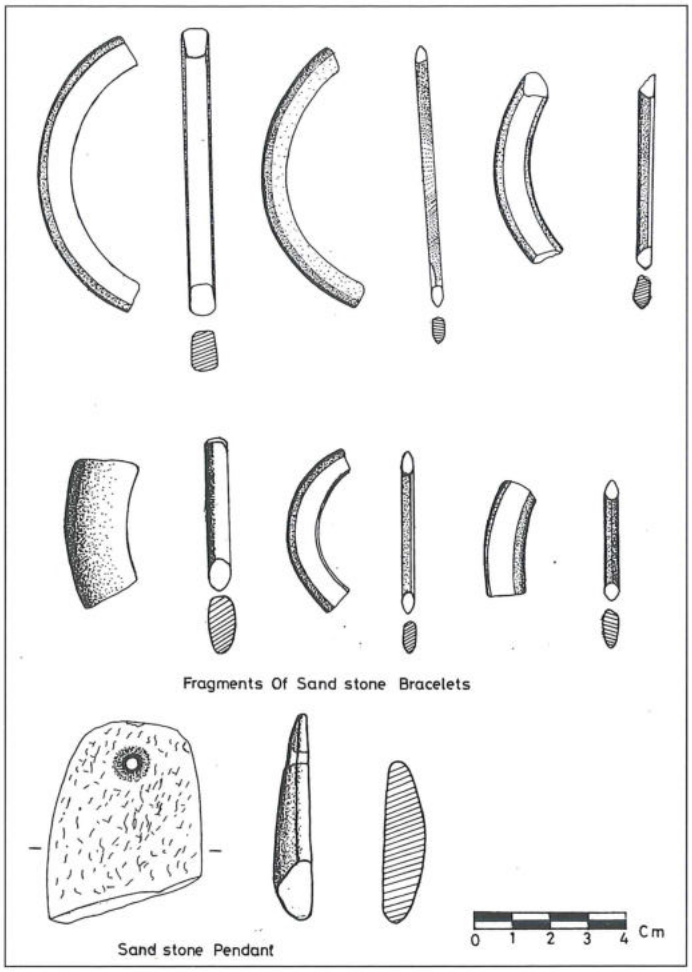
The situation of aṣ-Ṣifiyya presents an excellent record for determining the subsistence economy of a stable settlement that lasted for, and as long as, half a thousand years. The present day ecological setting shows a small wooded



6. Stone objects.



7. Stone tools.



8. Small finds.

area dominated by wild trees as well as cultivated cereals and vegetation. Lavish perennial water sources, flow from the nearby springs, scattering throughout the valley bed of Wādī al- Mūjib, the flood plains adjacent to the site led to the cultivation of einkorn wheat (Triticum Monococcum), and two-row barley (Hordeum Distichum) are attested here. The cereal cultivation made aṣ-Ṣifiyya identical to al-Bayḍa (Helbaek 1966:64), 'Ayn Ghazāl (Rollefson and Simmons 1985 : 17) and al-Basṭa (Gebel *et al.* 1988 : 132).

The small but well preserved remains of fauna uncovered from the excavation include goats, sheep, capra sp., gazelle, Bos sp., sus scrofa as well as smaller elements such as red fox, hare and birds. The faunal analysis have shown that sheep and goats were domesticated while the rest of the species were hunted.

The overall composition of the admittedly small assemblages compares well with those of al-Basṭa (Nissen *et al.* 1991:29), al-Bayḍa (Perkings 1966:66) , 'Ayn Ghazāl (Köhler - Rollefson 1988:89), Beisamon (Davis 1982:10) and Jericho (Clutton - Brock 1979:115). However, the specific proportions of the species differ, which may reflect differences in animal exploitation patterns.

The floral and faunal analysis have shown that the occupants of aṣ-Ṣifiyya were responsible for erecting the earliest village farming community in Wādī al-Mūjib area. The local economy of aṣ-Ṣifiyya, which was mainly based on food production, contributed to a certain degree in constructing large building units in order to fulfill the domestic needs of the aṣ-Ṣifiyya settlers at that time. The fertile habitat gives rise to the early village mixed farming economy and aṣ-Ṣifiyya provides important information for the understanding of the development of this type of settlement.

The paleoeconomic data which were obtained from the bulldozer excavation have shown a typical Neolithic economy, consisting of self-sufficient farmers, with sheep and goats being herded, but still obtaining part of their food by hunting and gathering.

Conclusion

Aṣ-Ṣifiyya is one of the early village settlements situated next to a chain of strong springs flowing lavishly along the Wādī al-Mūjib valley bed. This perennial source of water certainly was the reason for the site location. From the first reconnaissance at the site, aṣ-Ṣifiyya is considered to be, together with al-Basṭa, Ba'ja, 'Ayn Jammām, Wādī Shu'ayb and the later levels of al-Bayḍa and 'Ayn Ghazāl, among the largest late Pre-Pottery Neolithic B (6500 - 6000 BC) settlements encountered so far in Jordan.

The distribution of the surface artefacts and tools extends over approximately 118 dunams, although it is likely that the architectural remains are confined to the upper slopes of the site and cover about 20 dunams. The recent bulldozer damage has shown that the settlement obtains an extensive and substantial architecture, with walls standing to a height of 1.75m. The slope-setting of the site is most likely responsible for the excellent conditions of architectural preservation. The sediments of the site reveal a fair amount of chipped and ground stone artefacts, animal bones and ashy deposits.

The most interesting discovery exposed in the bulldozer-cut section at aṣ-Ṣifiyya were the architectural structures. Part of the building unit is restored and consists of four small rectangular rooms. Three were destroyed and one almost remained in good condition which measures 1.10m x 1.20m. These small rooms might be used for storage purposes. The main large room which represents the major architectural element in this building unit was probably destroyed by and disappeared through the recent bulldozer activities.

The building techniques observed in aṣ-Ṣifiyya are the same as reported from late PPNB al-Basṭa and 'Ayn Jammām in Southern Jordan. The dressing of stone faces and the use of wedge stones between the rows of carefully placed stones are characteristic. The plaster floors, the sub-floor structures, and the channel-like sub-structures uncovered at aṣ-Ṣifiyya are identical in plan and building techniques with those found at al-Basṭa.

The chipped lithic industry fully reflects al-Basṭa, Ba'ja and 'Ayn Jammām with the primary production and

tool kit. The ground stone industry including querns, stone bowls, pestles, pounders and grinding slabs shows close affinity with that of al-Bayḍa, Basta, Ba'ja and 'Ayn Jammān.

The test investigations which were conducted at aṣ-Ṣifiyya in 1994 have clearly indicated the potential of the site for further excavations and investigations into late PPNB ways of life in the region of Wādī al -Mūjib. The data presented above indicate that this site was formerly a large settlement which was occupied for a long period covering the second half of the seventh millennium BC.

Acknowledgement

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Excavations at Neolithic 'Ayn Ghazāl, 1993-1994

Introduction

After a four year hiatus since the close of the 1989 season, excavations were resumed at 'Ayn Ghazāl during 1993 and 1994 under the auspices of Institute of Archaeology and Anthropology, Yarmouk University, and the Department of Antiquities of Jordan. Efforts focused on continued investigation of changes in architecture, economy, and technology during the Yarmoukian, Pre-Pottery Neolithic C (PPNC), and Late Pre-Pottery Neolithic B (LPPNB) periods. A brief summary of the evidence for resource utilization and of the architecture from the two seasons is provided below (cf. Kafafi and Rollefson 1995; Rollefson and Kafafi 1994).

Synopsis of Resource Utilization at Neolithic 'Ayn Ghazāl

'Ayn Ghazāl was founded as an agricultural village at about 8,300 BC (calibrated) at a time when farming was supplemented with hunting and a growing control over herds of goats (Rollefson, Simmons and Kafafi 1992; Köhler-Rollefson and Rollefson 1990). Charcoal from fires and burned houses show that the area near 'Ayn Ghazāl was rich in terms of oak, pine, poplar and tamarisk trees, and charred seeds indicate a broad menu of domesticated and wild grains, pulses, and other plants (Rollefson *et al.* 1985; Rollefson and Simmons 1988). Goats were a major focus for the earliest residents of 'Ayn Ghazāl, probably domesticated in the seventh millennium (Köhler-Rollefson 1989), although other animals were probably domesticated during and just after the late seventh millennium, including cattle, pigs (Köhler-Rollefson *et al.* 1993; Rollefson and Köhler-Rollefson 1993) and especially sheep after 6,000 BC (Wasse n.d.). A dramatic decline in the variety of wild animal species among the faunal remains in the latter half of the seventh and throughout the sixth millennium testify to a marked alteration of the local vegetation cover, which has been ascribed to overgrazing of plant cover by goats and overutilization of woodland resources for fuel and construction purposes (Rollefson and Köhler-Rollefson 1992).

Inorganic resources used by the Neolithic 'Ayn Ghazāl residents principally came from local resources. Limestone (both of soft and very hard quality) for house construction and other uses was abundantly available from exposures in the eroded az-Zarqā' River canyon sides immediately adjacent to the settlement. The excellent quality "pink-purple" flint that characterizes the PPNB lithics industry at 'Ayn Ghazāl (and many other contemporaneous settlements in the southern Levant) was traced to a broad outcrop in the Wādī Ḥuwayjir, about 2 km to the north of 'Ayn Ghazāl, during the 1993 season, and a probable seventh millennium flint quarry was located (Quintero, pers. comm.); in the sixth millennium, poorer quality flint outcrops in the cliffs around 'Ayn Ghazāl were resorted to with increasing dependence.

Clay used for animal and human figurines and a temporary experiment in pottery production (Rollefson and Simmons 1986) during the Pre-Pottery Neolithic phases was apparently obtained from the iron-rich colluvial deposits on the site itself, and to a lesser extent from a fine whitish clay band just above bedrock. Later, during the Yarmoukian phase of the Pottery Neolithic, a source of yellow clay at the northern edge of the site, at the junction of Wādī az-Zarqā' with Wādī al-Fakhit, appears to have been one of the principal sources. Lime plaster manufacture relied once again on the easily obtained soft limestone around the site; in the sixth millennium, lime plaster was replaced with *ḥuwwār*, a mixture of mud with crushed chalk that existed in both the Wādī az-Zarqā' and Wādī al-Fakhit at the northern edge of 'Ayn Ghazāl.

Not surprisingly, all of the essential requirements for a permanent (and large) farming population at 'Ayn Ghazāl were available within a short walk from the center of the settlement (see below for fields, hunting, and pastoralism). But 'Ayn Ghazāl residents also acquired exotic resources, either directly or indirectly. Bitumen, used for ritual (Tubb 1985) and profane purposes was probably obtained from the northeastern shores of the Dead Sea, a trek that could easily have been undertaken by one or more members of the 'Ayn Ghazāl population at any time. Some elements of jewelry reflect long-distance networks for Mediterranean and Red Sea shells, although many beads and pendants were made of locally available

animal bone and limestone. In the seventh millennium there was a strong reliance on copper ore for beads from the Wādī Ḍānā, although there was a gradual shift to the use of greenish "Dhabba marble" from nearby Wādī Jilāt at the end of the seventh millennium (Rollefson, Kafafi and Simmons 1990). Carnelian probably came from the sandstone outcrops west of 'Ammān. The most distant contacts of the 'Ayn Ghazāl residents are shown by obsidian fragments, whose color and opacity suggest a minimum of two sources in Anatolia.

The Late PPNB (6,500-6,000 b.c.)

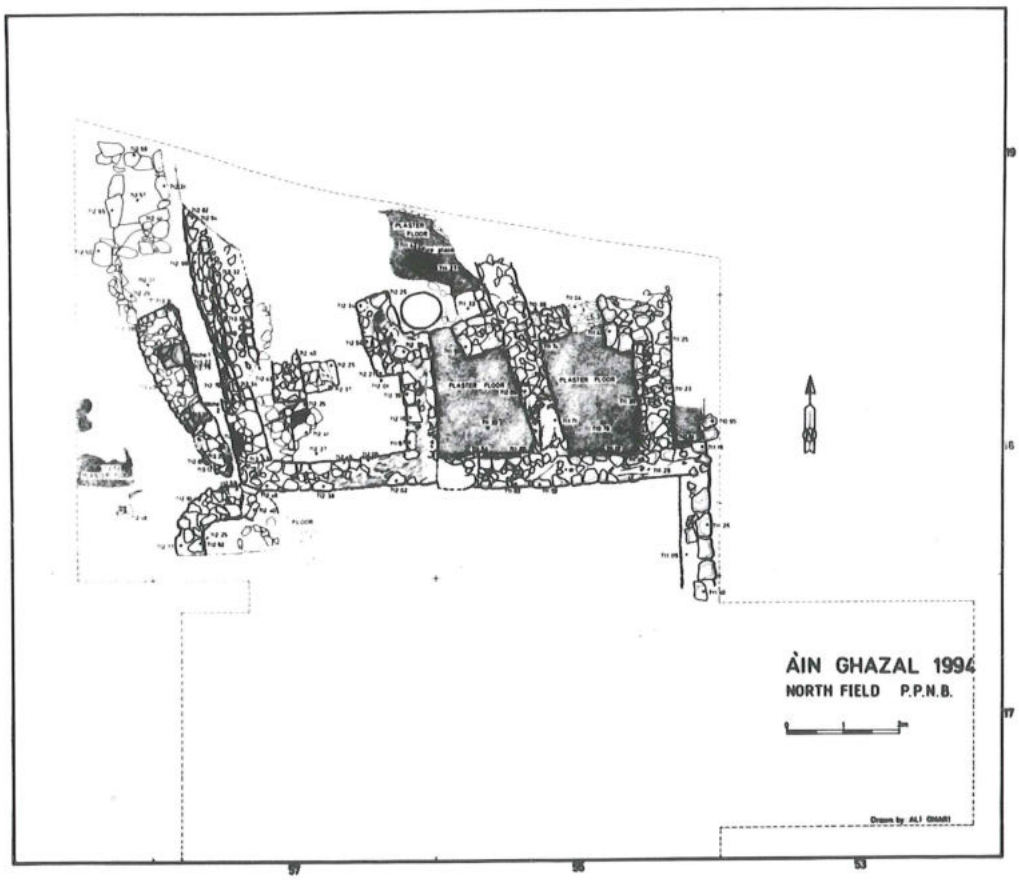
At the end of the sixth excavation season in 1989, the 500-year long LPPNB period had been sampled over a combined area of only 60 m^2 in the South and Central Fields of 'Ayn Ghazāl. This under-representation of the LPPNB was mainly due to the extensive damage and destruction of late seventh millennium layers by later PPNC and Yarmoukian inhabitants of the village. Because this half-millennium is among the least-known periods of the Neolithic in Jordan, it was necessary to increase the exposure as much as possible. In 1989, a trench in Sq. 5518 in the North Field revealed remains of a substantial LPPNB structure (Rollefson, Kafafi and Simmons 1993: 114-115; Figs. 6-8) relatively unaffected by later occupations, so it was selected as a major focal point of the 1993 and 1994 seasons. Approximately 100 m^2 were exposed in several adjacent trenches centered on Sq. 5518 (FIG. 1).

The Two-Storied House (FIG. 1)

The building first exposed in 1989 proved to be one of the largest structures encountered so far at 'Ayn Ghazāl. Much of the building was destroyed by recent highway construction and by erosion in prehistoric times, but parts of at least seven rooms climbed the hillside for at least 10 m in an E-W direction. The southern row of four rooms (numbered 1- 4 from west to east) were of moderate size, with dimensions of roughly 2 x 2 m, and each room opened to the north onto one or more other badly damaged rooms. Doorways also permitted access at least from Room 2 to Room 3, although this passage was later blocked; it is still unclear if another doorway connected Rooms 3 and 4.

The N-S dimensions of the building are unknown. Nevertheless, the western area of the house was at least 6 m wide, and minimally the building must have covered at least 60 m^2, and if symmetry played any role in the original construction, the house was perhaps about twice this size, placing it in the class of large buildings exposed at LPPNB Basta (Nissen *et al.* 1991: FIG. 1).

The LPPNB building suffered a severe fire, which was fortunate in several respects for our interpretations. First,



1. Plan of the two-story LPPNB house in the North Field. (Drawing: A. Omari).

it is now clear that the house consisted of two stories as a consequence of the ensuing collapse of the upper story into the rooms below. This is demonstrated in Room 1 (and to a lesser extent in Room 2) by the presence of burned-clay molds of ceiling beams that supported a thick, burnished, red-painted plaster floor. The room above Room 1 (and perhaps above Room 2) was evidently a storage chamber for peas, vetch, and lentils, numerous liters of which were recovered as charred remains through flotation.

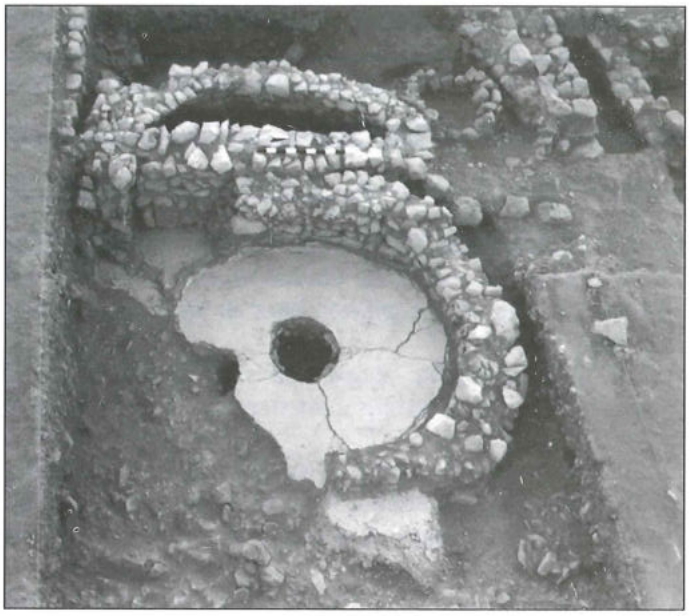
A sun-dried storage "pot" exposed in 1989 near the northern doorway of Room 2 of this building (Rollefson, Kafafi and Simmons 1993: 115 and Fig. 8). proved to be a "tubular silo" of clay using the plaster floor as its base; that is, it was not a vessel in the normal sense, since it had no clay bottom. A low plastered platform occurred nearby to the east, separated from the silo by an arc of small stone slabs, and a small (ca 35 cm diameter) hearth built into the floor was situated about 40 cm to the NE of the silo. With this combination of storage feature, platform, and hearth, the complex may represent a "kitchen area" of the building.

Based on a radiocarbon date of 6,050±80 b.c. (uncalibrated) from charred pulses from the fill in Room 2 (Rollefson, Simmons and Kafafi 1992: Table 1), this building was destroyed by fire near the end of the LPPNB period. But a new structure was soon erected, using many of the earlier walls as foundations for the new building and construction techniques similar to those of the lower LPPNB house. Unfortunately, much of this more recent architecture was destroyed in the sixth millennium by PPNC residents, but it is clear that the most recent LPPNB building incorporated a narrow entrance passage at the west end. The westernmost wall formed a shallow arc with a preserved chord length of ca 2.2 m and stood about 1.2 m high. On the interior (east) side of the wall were two niches, each about 40 x 40 x 25 cm. The northern end of the wall appears to have ended at a broad doorway leading to the exterior (west), while the southern end led to an entrance into the former Room 4 area. (This doorway was later blocked by PPNC remodelers). Future excavations in the area will help in reconstructing the terminal LPPNB construction.

The LPPNB Cult Building (FIG. 2)

In 1993 the remnants of the walls of a unique LPPNB structure came to light just a few centimeters below the eroded and bulldozed surface of Sq. 5517, just south of the LPPNB house described above. The structure proved to have four phases of use.

The first phase of construction is represented by a small, straight southern wall stub and adjacent red-colored plaster floor that curves up along it. A period of abandonment of unknown duration is represented by several centimeters of sediments that contain stony debris, although this layer is surmounted by another red-painted plaster floor coving up a southern straight



2. The LPPNB cult building in the North Field. (Photo: Y. Zoubi).

stone wall that joins a curved western wall arcing to another straight wall at the northern edge of the structure.

This second phase of the building's history appears to be short-lived, possibly due to the soft texture of the angular and chalky limestone used in the apsidal section to the west: the SW corner area began to collapse inward. The building was salvaged in Phase 3 by erecting a wall at right angles to the northern and southern walls (a chord across the Phase 2 apse and directly atop the Phase 2 floor), changing the shape of the building in the process.

Phase 4 entailed a totally new design: a circular wall was built directly on top of the Phase 2/3 floor, creating a room approximately 2 m in diameter. A doorway at the eastern perimeter of the Phase 4 circular room led to another room whose dimensions and shape are unknown due to erosional destruction, probably in prehistoric times. In addition to the striking geometry of the Phase 4 room, the floor was relaid at least six (and possibly more) times, with no evidence of deposits between the episodes; it seems probable that each new flooring episode included the application of red pigment, although this cannot be confirmed.

Perhaps the most striking feature of the circular room in Phase 4 is a relatively large central hole in the floor, 65 cm across and almost 40 cm deep (its bottom reached beneath the lowermost Phase 1 floor). At almost one-third of the diameter of the room (ca 2 m), it is clear this was not a massive post hole, a conclusion reinforced by the subfloor features that exist in the sides of the hole. Four small stone-lined channels lead pair-wise (N-S and NE-SW) from the central hole towards the exterior walls, although we have not yet determined if they actually led to the exterior of the building. Since the flat, hand-sized slabs lining the channels occur only along the vertical sides and across the top of the passageways, it is clear

that they were not intended to conduct fluids into or out of the hole; instead, it is probable that they were air ducts, perhaps to draw air into the central shaft for a hearth, perhaps an altar. All of the exposed surfaces of the floors of this structure, from Phase 1 through Phase 4, were coated with a dense layer of calcretion, so no evidence of possible burning is available at the present time. It is clear, however, that at one time an installation of some kind existed in the central hole as shown by an upward curving of the plaster floor at the edges of the opening.

The uncharacteristic shape and size of the room of Phase 4, at least, is strong evidence that this was not a common domestic area. The repeated reflooring efforts conform to ritual reflooring of MPPNB houses following subfloor burials, and although we have not destroyed the floor to seek interments, it is likely that there is a ritual association with the replastering of the room's interior.

The radiating subfloor channels are also unparalleled in LPPNB architecture, although we wish to emphasize that LPPNB architecture is poorly known outside of al-Baṣṭa.

The presence of the calcareous encrustation on the Phase 2/3 and Phase 4 floors is frustrating, since it inhibits the detection of any possible painted designs on the surface. But the calcified deposits also are clear evidence that the floors were kept scrupulously clean until and even after the abandonment of the structure: any domestic trash would have been cemented to floors, but no such evidence was found. Altogether, the constellation of features indicates that the remodeled building served some non-domestic and probably cultic role for the LPPNB people living in this part of 'Ayn Ghazāl, at least during Phases 2-4.

The PPNC (6,000-5,500 b.c.)

Most of the PPNC architectural information from 1993 and 1994 came from the North Field. After the final abandonment of the LPPNB two-storied house, at least some of the standing walls were used by PPNC residents, who cut through at least one of the latest floors of the Room 4 area. The deposits in this sector were dark and ashy, reflecting heavy use of several firepits in the area bounded by the walls. This appears to have been an enclosed inner courtyard that served some industrial purpose. To the south of this small courtyard was a rectangular room approximately 2 x 3.5 m in size. In view of the elevations of the floor, it must have been semisubterranean, with a dirt floor and walls about a meter thick that reflect two phases of construction. The features of this structure stand out in stark contrast to the PPNC "corridor buildings" excavated in the South Field in 1984-1989 (cf. Rollefson, Simmons and Kafafi 1992: Fig. 5), which we have interpreted as storage bunkers (Rollefson and Köhler-Rollefson 1993: 36-37). The North Field PPNC building appears to have been a normal domestic building with an associated courtyard and compound wall.

PPNC layers were encountered only on a small scale in the South Field in 1993 and 1994, and it is clear that Yarmoukian disturbance to the latest PPNC occupations here was extensive.

The Yarmoukian (5,500-?4,500 b.c.)

Almost 400 m^2 of Yarmoukian deposits were investigated in the South Field in 1993 and 1994. One aspect of village layout in the latter half of the sixth millennium became clear: housing density had decreased substantially. Yarmoukian houses were widely dispersed, with immense open courtyards dominating the village area. In comparison with the almost townhouse arrangement of buildings during the MPPNB period, it appears that 'Ayn Ghazāl's population had decreased acutely by the latter half of the sixth millennium.

The Yarmoukian House (FIG. 3)

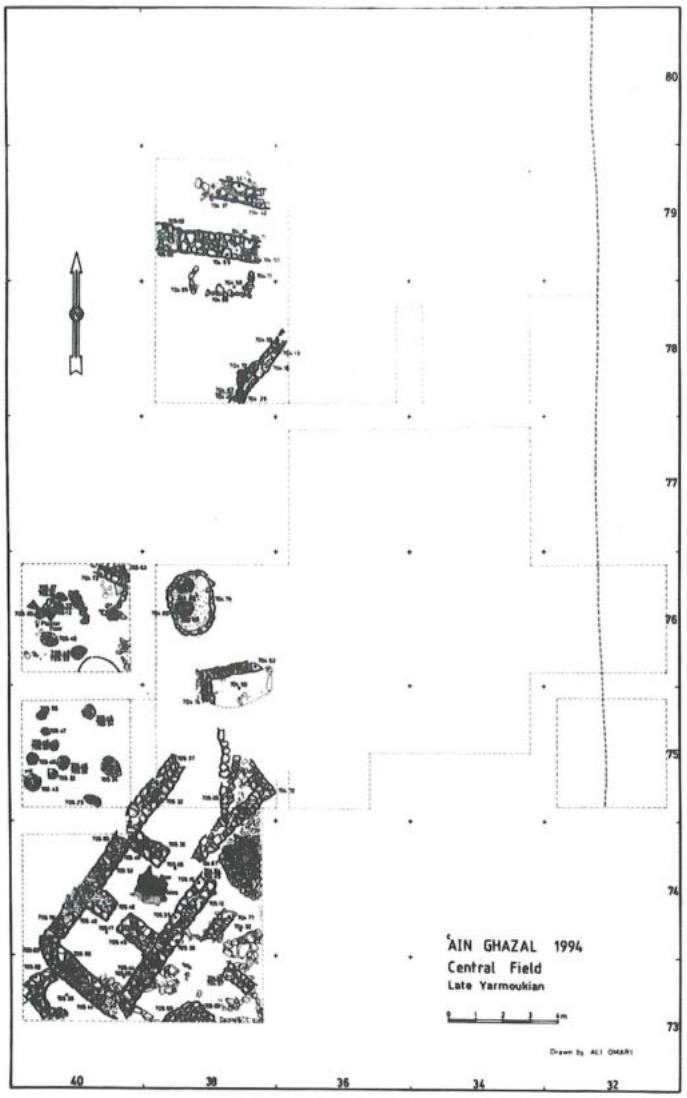
A nearly complete house plan was exposed in 1994. Oriented SW-NE, the length was preserved for about 9 m (although the NE end was destroyed some time after abandonment), while the minor axis (NW-SE) was almost 4.5 m wide. The house consisted of at least three rooms and possibly a fourth, although the area at the northeastern end may have simply been an open porch structure. Although the exterior walls defined an area of approximately 40 m^2 or more, the thickness of the walls (including interior partition walls) greatly reduced the interior room areas. Attached to the "back end" (SW) of the house was a small semicircular utility room with no apparent direct access to the interior of the house. To the NW of the house were several superimposed courtyard surfaces with fireplaces and postholes that suggest a ramada- or *'arīsha*-like shade structure, a feature noted in several other courtyard areas in 1993.



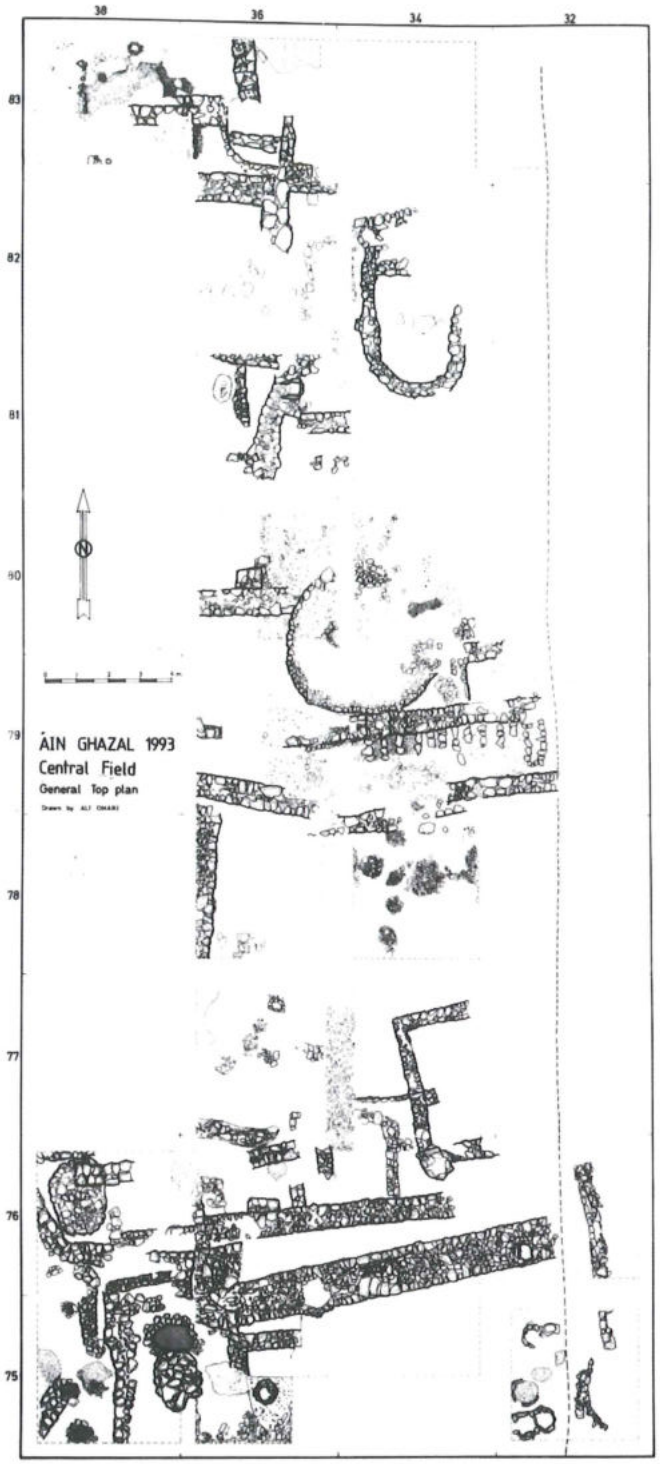
3. Yarmoukian house in the Central Field of 'Ayn Ghazāl. (Photo: Y. Zoubi).

The Yarmoukian "Kitchen" (FIG. 4)

At least three circular or elliptical stone platforms were uncovered during the two seasons. Measuring from 3 - 4



4. Plan of the Yarmoukian house (lower left) and the "kitchen" outbuilding (left center). (Drawing: A. Omari).



5. The circular Yarmoukian tent foundation lies adjacent to the walled street in the Central Field of 'Ayn Ghazāl. (Drawing: A. Omari).

m^2, there was a general association with grinding slabs, which suggested that they were work areas in the courtyards. The largest platform was excavated in 1994. Stone slabs (including numerous grinding stones) had been set on edge to form an oval area of ca 1.5 x 2.5 m. Partially buried in the earth, the single course of stones probably anchored a flimsy superstructure of brush or skins to protect the interior. In the northern end of the enclosure was a large (ca 50 cm diameter) storage jar partially set beneath the surface. Just to the south, two large grinding slabs were set on edge, separating the storage section from the rest of the interior, whose surface was very ashy due to a small fireplace in the southern end. The small structure appears to have served as an outdoor kitchen, where grain or pulses were taken from the storage jar, ground to meal, then cooked or baked over the hearth.

The Yarmoukian Tent (FIG. 5)

The latest occupation phase at 'Ayn Ghazāl is represented by a large circular structure that was found just below the modern surface of the South Field. Approximately 4.5 m in diameter, the structure consisted of a narrow, low wall of small stones one to two courses high, with a broad entrance facing the NE. Flanking each side of the interior of the doorway were low stone platforms, and the floor had been prepared using *ḥuwwār* plaster. Near the center of the building was a shallow pit about 50 cm in diameter, although it is not clear if this was a posthole or a hearth.

The small size of the stones and the narrowness of the walls indicates that this was a temporary structure that could represent the Yarmoukian version of Bedouin tents of much later times.

The sixth Millennium Street (FIG. 5)

The 1993 season produced one of the most impressive features uncovered anywhere in the Levant. Two stone walls in the South Field ran in an E-W direction, parallel to and about 15 m north of the Great Wall (Rollefson, Kafafi and Simmons 1993: Fig. 3); the Great Wall was built originally during the PPNC period but used well into the Yarmoukian as well. Between the two walls was a series of at least 13 steps 2.5 m wide that climbed the hill at intervals of 35-65 cm. The southern boundary of this walled street was repaired badly at one time and eventually destroyed during the Yarmoukian period, but the northern wall preserved two 75 cm wide gateways that opened from the street into courtyards. A single course of small stones acted as a "curb" at the gateways. The eastern end of the street was destroyed by bulldozers, but the street could be traced uphill for more than 9 m toward the west, where it was also destroyed by later Yarmoukian construction.

The street was certainly in use during the Yarmoukian period, as is shown by potsherds mixed into *ḥuwwār* surfacing of the steps. But it remains unclear when the street was originally constructed: at the eastern end of the street, the dirt between the stone steps produced no pottery, suggesting that it may have been constructed in the PPNC at about the same time as the Great Wall. But this small area barren of ceramic evidence is insufficient in sampling terms to be conclusive, and the only way to make a convincing determination would be to excavate (and in the process destroy) the feature, which we do not wish to do. It is safe to conclude, on the other hand, that the walled street represents one of the earliest efforts at community planning, dating to around the middle of the sixth millennium.

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Neolithic 'Ayn Ghazāl in its Landscape

Introduction

'Ayn Ghazāl was a permanent farming settlement for more than 2,000 years, a dynamic and vital center that witnessed one of the largest populations of its time anywhere in the world. Nine seasons of archaeological excavations conducted from 1982 through 1995 have sampled only about one per cent of the surface area of this town that had grown to more than 15 ha before its eventual decline and ultimate abandonment, research that has provided a considerable amount of detail concerning the changes in technology, architecture, subsistence economy, and social organization.

One of the principal aims of prehistoric archaeology is to understand social systems in terms of their interaction with the near and distant reaches of its surrounding environment, including assessments of how the environment constrained certain options for human development, as well as how society affected its surroundings. Put in other terms, what resources were available to human groups, how were these resources extracted and utilized, and how did these systems of procurement and use influence the viability of future social systems in a particular settlement, locality, or region?

Direct archaeological evidence can provide major insights to these questions, and much has been learned already about the 'Ayn Ghazāl area through analyses of faunal and botanical remains, geological processes, and changes in the patterns of recovered evidence. Even so, eventually all of the site-specific information must finally be placed in the context of the landscape around 'Ayn Ghazāl in order to understand why 'Ayn Ghazāl flourished so well for so long, but then declined in its fortunes to the point that it became a virtual ghost town, visited only seasonally by pastoral nomads for a couple of months of the annual round.

But it has been perhaps 8,000 years or more in calibrated radiocarbon time since 'Ayn Ghazāl went through its death throes, and in the past 80 centuries continued overexploitation and unconcern for the countryside has devastated whatever regional evidence could have been recovered for a detailed reconstruction of 'Ayn Ghazāl's surroundings. This problem has been particularly exacerbated within the past three decades as a result of urban expansion between 'Ammān and az-Zarqā', resulting in wholesale replacement of hilltops, slopes, and valleys with new constructions and modifications.

But one can approach a general estimate of ancient land-use patterns, even in the urban sprawl around 'Ayn Ghazāl, by comparing archaeological evidence with references that reflect differences between modern conditions and those that pertained in the past. Two aspects of this avenue of investigation include detailed topographical maps and aerial photographs.

Occupational Stability versus Abandonment

'Ayn Ghazāl is only one of a number of sites on the Jordanian Plateau that demonstrates such extensive continuity through time, including Wādī Shu'ayb and– to a lesser temporal extent– Baṣṭa, which until now has produced the only well-documented sequence for the elusive Late PPNB period (ca. 8,500-8,000 bp, uncalibrated). In contrast, Neolithic settlements in the Jordan Rift (including Bayḍa) and westwards show either a much shorter span of occupation (e.g. Beisamoun) or contain sequences that reveal substantial interruptions in their settlement history (e.g., Jericho and Abou Gosh). In short, west of the Jordanian Plateau, every known farming village was abandoned by the middle of the ninth millennium bp, while those in the Jordanian highlands were either newly founded (Baṣṭa) or grew substantially in size after this time ('Ayn Ghazāl, Wādī Shu'ayb, aṣ-Ṣifiyya).

It remains a major problem to account for this contrast of site abandonment on the one hand and continuity of settlement on the other; associated with the latter aspect, the phenomenon of "site giganticism" also requires an assessment of the mechanisms underlying the apparent relocation of populations to the Jordanian Plateau. Information for most of the Jordanian sites remains unpublished or at an early stage of analysis, but a possible explanation is suggested by a general examination of the landscape surrounding the settlement at 'Ayn Ghazāl.

The disruption of many PPNB sites and the rapid growth or founding of others coincide with a dramatic decline in variability in the 'Ayn Ghazāl faunal record (Köhler-Rollefson *et al.* 1988). It is an inescapable conclusion that this decrease in the species inventory is asso-

ciated with a severe alteration in the local environmental and ecological conditions around 'Ayn Ghazāl, a situation that is clearly supported by the disappearance of forest or woodland associated species and the decline of small carnivores, birds, and microfaunal evidence (cf. Köhler-Rollefson *et al.* 1993).

The faunal situation at 'Ayn Ghazāl in the mid-ninth millennium bp might be taken to reflect the consequence of decreased rainfall, an interpretation that was popular from the 1950s to the early 1980s. But it is now clear that the "Climatic Hypothesis" to explain the fate of Neolithic settlements west of the Jordanian Plateau is no longer tenable (Köhler-Rollefson and Rollefson 1990). Instead, our research at 'Ayn Ghazāl indicates that the environmental degradation around mid-ninth millennium farming villages was the result of cultural overexploitation and mismanagement of resources over a number of centuries in an area that is notoriously delicate and marginal. Briefly, the effects on the local countryside of intensive browsing/grazing by ovicaprines in addition to local deforestation for construction, lime plaster manufacture, and domestic fuel needs –and the consequent exposure of otherwise protected agricultural soils to water and rain erosion– had the same effect on the viability of Jericho or Beisamoun as a decrease of 50 - 100 mm of annual rainfall.

It can be suggested, therefore, that the opposing fates of the sites on and off the Jordanian Plateau are related to the contrasting local landscapes; to the ecotonal variety surrounding farming settlements in terms of inherent adaptability potentials in case of environmental degradation. In this regard, the rich ecotone at 'Ayn Ghazāl (including Mediterranean woodland and *maqūis,* river galleria, steppe, and desert) offered considerable flexibility to generations of 'Ayn Ghazāl residents that may not have been available to the more environmentally circumscribed villages to the west.

Neolithic Land Use at 'Ayn Ghazāl

The general pattern of resource utilization mentioned above ignores the fundamental question of how the Neolithic people of 'Ayn Ghazāl lived off the land. Where, exactly, did they live, where did they plant their crops, and where did they take their flocks? The plethora of multi-story dwellings, highways, and military reservations established in the past few decades make it difficult to resolve these problems by undertaking surveys in the area around 'Ayn Ghazāl (Simmons and Kafafi 1992). Even an attempt to reconstruct the original area of the Neolithic site boundaries of 'Ayn Ghazāl has proved difficult in view of the radical changes affected by public and commercial destruction/construction since the 1970s.

Former Size of Neolithic 'Ayn Ghazāl

The 'Amman area was sparsely populated, in a relative sense, until the surge of refugees into Jordan after 1948. At some 14 km to the north-east of the center of 'Amman, the 'Ayn Ghazāl area was little affected by the immediate events of the war, as can be seen from the aerial photograph taken in 1953. The photo (originally 1:25,000 scale, but enlarged to 1:10,000) reflects the general landscape dissected by the Wādī az-Zarqā' and it tributaries, the presence of small black rectangles indicating Bedouin tents, and faint traces that represent dirt paths and roads, as well as the Ḥijāz railway in the eastern edge of the photo (FIG.1). The illustration also dimly shows the active zone of the az-Zarqā' river in addition to an area of perhaps seasonal or semi-periodic inundation of the lower terraces. The distribution of plantations indicates limits of expected river-fed irrigation of agricultural plots.



1. Aerial photo of the 'Ayn Ghazāl area taken in 1953.

FIG. 2, an aerial photo taken in 1990 (1:10,000 scale), shows the effects of population growth since 1953. The az-Zarqā' River Valley has been completely altered, and former floodbank plantations no longer exist. Much of the river valley has been reformed to reduce the earlier dramatic sinusoidal flow of the az-Zarqā' River to a lazier S-shaped plan. The high and broad terrace to the east above the Wādī az-Zarqā' is covered with recent residential developments.

Despite the contrasts in the two photos, one aspect remains little changed. The area between the west bank and the Ḥijāz railway on the east bank is constant, and one can estimate how much of the Neolithic settlement at 'Ayn Ghazāl was destroyed by recent twentieth century construction activity. A strip 40-50 m wide along the present course of the highway was bulldozed (ca.2.6 ha in total), and at the northern end of the site an area of perhaps a hectare was removed for the highway interchange. At its greatest extent, then, 'Ayn Ghazāl probably extended well over 15 ha (cf. earlier size estimate of 12 ha in Rollefson and Köhler-Rollefson 1989).



2. Aerial photo of the 'Ayn Ghazāl area taken in 1990.

Neolithic Farm and Pasture Land

The 1953 aerial photo is not of much help in locating potential acreage available to the Neolithic farmers of 'Ayn Ghazāl, but maps of varying scales show the most likely areas. The topography to the west of the settlement is wildly undulating and relatively deeply scored by wadis, and from the general steepness of the terrain it is unlikely that much of this area contributed greatly to cereal and pulse production; on the other hand, one should not overlook the potential of garden plots in the wadi bottoms that may have provided root crops for nutritional and seasonal variety. It is more probable that the hillsides and hilltops were used for hunting and herding. In the former case differences in elevation and plant cover would have provided the most diverse selection of prey, and in the latter case, the animals would have been kept well away from the fields during the growing season.

To the east of 'Ayn Ghazāl, there is a broad and gently falling plateau with a slope of approximately 4% or less, from the area just south of the Mārka Airport to the cliffs beyond the northern end of 'Ayn Ghazāl. Where the terrain becomes broken in the northern reaches of this sector, there are still sizable terraces that would have been suitable for extensive agriculture, including one shelf just above and east of the East Field and another about a kilometer to the north-east of the site. Within a 2 km radius of the center of 'Ayn Ghazāl, we calculate that there would have been more than 500 ha of available farmland, well within reasonable limits of travel time and transport distance to and from the fields, as well as the food requirements of the large population inhabiting 'Ayn Ghazāl at its peak (Köhler-Rollefson and Rollefson 1990: 7-9).

Within the river valley, the 1953 photograph shows broad flood plain plantations that were undoubtedly also important in Neolithic times. Better watered than the plateaus, fields of legumes and grain on these low terraces (10-15 ha in area just along the Neolithic village itself) would have provided some measure of food security during occasional short-term droughts in the 'Ayn Ghazāl vicinity.

Degradation of the Neolithic Landscape

The desert-like appearance conveyed by FIG. 1, a view repeatedly portrayed in 19th and early 20th century photographs from the southern Levant (e.g. Ramadan 1981), is certainly the consequence of persistent overexploitation of the landscape. We have detailed elsewhere (Köhler-Rollefson and Rollefson 1990) that this human devastation of the environment began with the founding of the Neolithic settlement at 'Ayn Ghazāl, a process of overgrazing, devegetation, and prolonged cultivation of fields that began to reduce the sustainable population level at 'Ayn Ghazāl by the beginning of the sixth millennium and eventually led to the abandonment of the settlement as a permanent farming community (Rollefson and Köhler-Rollefson 1993; Kafafi and Rollefson 1995).

Although a luxuriant ecotone at the beginning, the rapid population growth of the village came at the expense of increasing demands of food, fuel, and architecture. Land was cleared for new fields of wheat, barley, and legumes, opening the way to eventual erosion of the arable soil by wind and water. Depletion of wood stands for buildings and fires destroyed the natural habitats of wild animals that the earlier inhabitants hunted with such great success; hunting became less and less productive in the near reaches of 'Ayn Ghazāl, and in compensation more numbers and varieties of animals were domesticated and herded to make up for the shortfall of meat in the diet. The growing number of animals browsing and grazing in the vicinity of 'Ayn Ghazāl accelerated devegetation of the landscape, including the post-harvest stubble that otherwise would have protected the field soils from deflation and sheet wash. Water remained sufficient in the river and at the spring of 'Ayn Ghazāl (witness the small but short-lived Early Bronze site a half-kilometer south of the Neolithic settlement [Petocz 1986] and the Byzantine farmstead at 'Ayn Ghazāl itself [Rollefson, Kafafi and Simmons 1993]), but by the fifth millennium the landscape around the spring and river could support only small Neolithic shepherd groups on a temporary basis.

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Landscape Archaeology and the Exploitation of Natural Resources in the Eastern Levant: A Neolithic Case Study

Introduction

Although much of the landscape of the eastern Levant, including Jordan, now appears to be a harsh marginal environment, it has supported substantial human populations for over a million years. Given the rich cultural developments of the area, much of this barrenness is deceptive. Even if humans have adapted to harsh arid conditions, however, we know that the environment also has changed throughout the millennia, and during certain times it was more favorable than at present. A major question for researchers to ask is, how much of the modern barrenness of the environment has been humanly induced and how much is due to climatic change? This paper examines this issue from an interdisciplinary perspective.

For the vast majority of the huge time span that humans have occupied the region, it appears that they existed harmoniously on the landscape. While hunters and gatherers may have had impacts on the environment, these generally had short-term effects, with disruption of the ecological balance rarely having been severe or long-lasting.

This changed dramatically with the Neolithic period. During this critical time of cultural development, the exploitation of Jordan's natural resources by people began to have an irreversible environmental impact (cf. Simmons *et al.* 1988). Beginning about 10,000 years ago, in conjunction with the domestication of plants and animals, human settlement on the landscape changed profoundly. It was during this time that the first settled, permanent villages and exploitation strategies based on agriculture, herding, and the use of wild resources appeared.

Previously, I (1995) outlined a tentative model examining the environmental impact of Neolithic settlements in Jordan. This model is based on an interdisciplinary study of recently excavated Neolithic settlements in Jordan, and draws heavily on the research of colleagues such as Gary Rollefson, Ilse Köhler-Rollefson, Zeidan Kafafi, Rolfe Mandel, and the late Jonathan Davis. The model is briefly summarized below.

We now know that these Neolithic developments were substantially different than those closer to the Mediterranean coast, and proposed that huge settlements such as 'Ayn Ghazāl (Rollefson *et al.* 1992; Simmons *et al.* 1988; Simmons and Rollefson 1988) and Wādī Shu'ayb (Simmons *et al.* 1989), located in central Jordan, represented unique desert-edge adaptations. Other recently investigated sites in southern Jordan, such as al-Baṣṭa (Nissen 1990) or as-Sifyia (Mahasneh, this volume), appear to follow the same pattern. These settlements were initially founded during mid-Neolithic, with earlier developments (such as PPNA) apparently occurring further to the west. The author suggested that natural population increase in the west associated with sedentary Neolithic economies there ultimately depleted local environments and that an adaptive strategy was to expand eastward, towards the desert margins. Large sites such as 'Ayn Ghazāl perhaps served as population "magnets," with the consequence of dramatic population increase centered into a few, nearly urban centers (Simmons 1995).

This constellation of activities had substantial ecological consequences, ultimately straining the landscape. This was particularly acute on the large Jordanian sites, since these were situated in ecologically precarious zones to begin with. While this pattern of population aggradation and pooling of scarce resources was initially adaptive, it, too, began to deplete the environment. This resulted in critical resource shortages that first required an economic split between farmers and pastoralists, and ultimately resulted in the abandonment of the large villages and an increase in pastoral activity at the end of the Neolithic. This cultural response may, in fact, be the beginning of the classic Near Eastern dichotomy between the "desert" and the "sown" (cf. Köhler-Rollefson 1992). All of these cultural developments were occurring, we believe, against a backdrop of steadily deteriorating climatic conditions (cf. Davis *et al.* 1990).

We know, from the archaeological evidence, that Neolithic peoples had a severe impact on the natural landscape (Rollefson and Köhler-Rollefson 1989; Simmons *et al.* 1988). At issue, however, is how to systematically document this. Using modern technologies, as well as traditional methods, how do we convincingly demonstrate human versus natural impacts on the environment? That is what needs to be addressed. In order to do this, a brief summary of some contemporary technologies may be of

assistance, to be followed by the use of a geoarchaeological example from our studies at 'Ayin Ghazāl and Wādī Shu'ayb.

Remote Sensing

Certainly one of the most promising advances in archaeological interpretation on a regional scale is the application of Geographic Information Systems (GIS), a sophisticated application of remote sensing technology. There are now numerous examples of the applicability of this technique to archaeology, and Jordan is well poised to take advantage of this powerful tool with the development of the JADIS site data base. While applications of GIS may be tailored to address specific archaeological questions, a major use may be in assessing the impact of human activities on the landscape, both through time and for particular periods.

While "settlement" archaeology has always attempted to analyze the distribution of humans on the landscape, GIS offers a powerful enhancement. As one example, it is now possible to examine the geographic distribution of sites belonging to particular cultural periods, and see how these vary through time. This will allow researchers to determine the landscape preferences, and presumed resource availability, of specific cultures. Even within the same cultural groups, such analyses can allow an examination of the diversity of landscape practices exhibited by the distribution of sites. The often misused concept of site catchment analysis may now be more rigorously and objectively applied.

Another application of GIS is in modelling the impacts of environmental change (either humanly induced or climatic). GIS technology allows visible simulations of numerous dependent or independent variables. For example, how would an increase in rainfall effect the percentage of available arable land within a particular area? If we applied this sort of modelling to the 'Ayn Ghazāl and Wādī Shu'ayb examples, coupled with reliable paleoenvironmental data, we could perhaps determine if these settlements were indeed located at deserts' edge when occupied. We could also determine whether patterns observed at these sites are repeated at contemporary settlements located in markedly different ecological setting, such as in the Wādī Faynān (Najjar 1994) in the al-Ghawr.

Another aspect of remote sensing to interpreting the past is simply in locating buried sites. Of considerable potential is satellite imagery, employing Landsat technology (Sharer and Ashmore 1993:213-215). Surface, and even buried, features, both cultural and natural, can be observed from space. These areas can then be visited on the ground, and systematic survey can be undertaken in the hopes of locating exposures or paleosols that might contain cultural remains.

Thus, it is clear that remote sensing and GIS technology have tremendous advantages to addressing precisely and realistically how past humans used the landscape. But they are not without limitations. We must remember that the information obtained by remote sensing is only as good as the data upon which it is based. This requires careful and judicious application of archaeological data in the construction of GIS and other data bases. It also requires ground verification to ensure that what is being entered is an accurate reflection of what is really on the ground. Archaeologists, who are notoriously borrowers of technologies from other fields, must be careful in their use of these methods, and must not fall prey to being in awe of what seem like precise scientific techniques that really have but trivial applications to real archaeological issues.

Geoarchaeology

While recent technological advances have enhanced archaeological interpretation, there are more traditional methods that also supply us with tremendous environmental information. Certainly one data set that is absolutely critical in understanding past human interaction with the landscape is paleoenvironmental reconstruction. There are, of course, countless ways in which to do this, some more robust and compelling than others. But it should be intuitively obvious that before we can understand how people interacted with their environments, we must first understand what those environments were like. Perhaps one of the most powerful tools here is the use of geoarchaeology.

It has become apparent over the years that archaeological sites are subjected to numerous transformations during both their formation and after they are abandoned. Often these are subtle, and documenting them requires the expertise of geological specialists. Again, a mistake can be made by assuming that any geologist will be able to provide answers to archaeological questions. All too often geological consultants without a proper understanding of archaeology are used on projects. It is, however, no longer imaginable doing a project without some geological input. It simply is too important to ignore, and often geoarchaeologists will be able to provide insight that might have been overlooked, misinterpreted, or simply not understood by the archaeologists. The final portion of this paper demonstrates this.

A Geoarchaeological Case Study from the Neolithic

This study is to present an example of the application of interdisciplinary research oriented towards understanding Neolithic interactions with the landscape. At sites such as 'Ayn Ghazāl (Mandel and Simmons 1988) and Wādī Shu'ayb (Simmons *et al.* 1989), which contain both Pre-Pottery Neolithic and Pottery Neolithic components, as well as sites containing only Pottery Neolithic components, such as Abū Thawwāb (Kafafi 1988), we have observed enigmatic thick layers of cobbles in the deposits. Such deposits also may be present at al-Baṣta and other Neolithic sites. The interpretation of these layers has been

difficult and unsatisfactory.

One plausible interpretation, however, has come as a result of geoarchaeological analysis during which we proposed the following hypothesis. Based on archaeological, climatic, and geological data, we believe that the combination of renewed summer drought in the Levant, the impacts of expanded human population, agriculture, the intense herding of sheep and goats, and deforestation for fuel, together caused an environmental crisis that has dominated human adaptation in the region ever since (Davis *et al.* 1990).

Modern climates in the Levant rarely if ever include summer precipitation. However, paleoenvironmental research employing General Circulation Models of the atmosphere (GCM's) consistently shows that a major aspect of climate from between 11,000 to 7,000 years ago was the enhancement of summer monsoons. These are driven by summer heating over the continents; stronger heating about 9,000 years ago drew significantly more precipitation from the subtropical oceans into continental interiors as summer thunderstorm rains.This both increased summer precipitation amounts and expanded the area of summer precipitation. The Levant appears to have been on the edge of the expanded areas of summer precipitation.

We hypothesize that increased summer precipitation indeed affected the Levant at precisely the time that the Neolithic began in earnest. This issue, of course, is an immensely complex one. For example, McCorriston and Hole (1991) and Moore and Hillman (1992) offer alternate climatic scenarios for stimulating agricultural origins, suggesting increased dryness. What is at issue here is that a variety of paleoenvironmental data often present conflicting interpretations. It also is important to realize that **increased** precipitation, as proposed here, does not necessary translate into increased **effective** moisture. It is thus possible to have short-term and intense seasonal precipitation in conjunction with overall increasing aridity.

As proposed here, this increased precipitation initially helped propel the Neolithic. By about 9,000 years ago, however, summer precipitation had declined and ceased altogether by about 7,000 years ago. This corresponds with increased humanly induced environmental degradation, brought about by intense farming and herding, and eventual abandonment of major Jordanian centers at the end of the Neolithic.

Precise evidence for this monsoonal incursion into the Levant is scant but tantalizing. Loss of agricultural productivity may have begun with erosion by summer torrential rains of land previously forested but now cleared for fields, pastures, and settlements. Evidence for this is in the form of slope instability at several Jordanian Neolithic sites. This appears as fine-grained colluvium and slopewash interlayered with cultural debris, and as layers of the aforementioned comparatively well-sorted cobbles at sites such as 'Ayn Ghazāl, Wādī Shu'ayb, and Abū Thawwāb. The cobble layers may be attributed to debris flow that was caused by torrential summer thunderstorms — the physical manifestation of the increased monsoonal pattern. Erosion could have been accelerated via debris flows that mobilized the cobbly sediment, especially if surrounding vegetation had been substantially reduced by human activity. Thus we suggest that the cobbly layers observed at these sites indicate increased incidence of torrential precipitation. Because torrential precipitation is much more common during the summer than the winter, this constitutes plausible evidence of an early Holocene monsoonal incursion into the Levant.

While there may be alternate explanations for the presence of the massive layers of cobbles at sites such as 'Ayn Ghazāl, Abū Thawwāb, and Wādī Shu'ayb, we are convinced that they represent concrete examples of a constellation of both humanly induced environmental degradation in conjunction with heavy summer precipitation. In their zeal to increase arable land and obtain fuel, Neolithic peoples cut down the very vegetation that previously had served as a retardant to erosion. Without the vegetation, there was no resistance to increased slope wash, accelerated by torrential summer rains, with the result that the settlements were subjected to annual "floods" of cobbles. These activities influenced Neolithic settlement landscape activity, ultimately contributing to the forced abandonment of major villages.

This is but one example of the types of interdisciplinary approaches that may be of considerable benefit to our understanding of how ancient peoples affected their environment. By applying both traditional methods, such as geoarchaeology, and modern technologies, such as GIS, coupled with ground verification, to other major Neolithic sites, this model could be refined, verified, or refuted. This is a major direction to which researchers should direct future investigations.

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The Urbanisation Process in the South Jordan Valley: Renewed Excavations at Tulaylāt al- Ghassūl 1994/1995

Preamble

The southern Levant, and the Jordan Valley in particular, has long been identified as a region crucial to urbanisation/state formation studies.[1] Chalcolithic urbanisation research began with the first excavations at Tulaylāt al-Ghassūl (1929-38), as it was here that the first pre-Bronze Age archaeological horizons were isolated by Mallon, and the first round of a long running debate over the degree of relatedness of Chalcolithic and EBA assemblages occurred.[2] Whilst most parties came to accept the essentially separate existences of Late Chalcolithic and EBA assemblages,[3] accounting for the apparent disjunction between sequential assemblages has been a constant issue since the 1930's, and many senior commentators still claim a significant alien component for the Ghassulian.[4]

Extensive multiperiod tall excavations during the interwar period at Bayt Shān (1921-32), Megiddo (1923-38) and Jericho (1932-36) began the exploration of Neolithic occupational horizons, and by dint of revealing discrete Neolithic, Chalcolithic and Early Bronze Age strata, facilitated the first tentative diachronic comparative analyses. However, as Neolithic and Chalcolithic period exposures at these large sites were not extensive, and generally excavated in difficult circumstances, results tended to cloud the picture rather than illuminate it, especially as recovery methods were unavoidably crude.[5]

In the postwar period, research based on restricted or single-phase Neolithic and Chalcolithic occupation in the Beersheba region (1952-58) and at Munhata (1960-66) dominated over multi-phase tall research at Tall al-Fār'ah(1948-60), Jericho (1952-58), Shechem (1954-68) and Gezer (1964-74), as large exposures could be readily achieved in the single period sites, allowing for a more satisfactory documentation of the material cultural assemblage.The much improved excavation methodology employed on the large tall sites resulted in an even more restricted exposure of early deposits than in pre-war excavations.[6] This skewing of the database led to the dominance of ever more detailed typological descriptions over diachronic analysis.[7]

Over the last twenty years the tendency to excavate short duration or single period exposures has become more marked, and when coupled with the results of greatly increased small-scale soundings and rescue projects swamping results from the increasingly rare multi-period tall excavations carried on today, particularly as ever intensifying sampling strategies and rising costs, result in ever smaller areas excavated in the more complex tall excavations.[8]

Consequently, debate over state formation processes is dominated by evidence from short-lived discontinuous archaeological 'snapshots' of what still seems likely to be a long-term progression from one mosaic of adaptations to another. The nature of this evidence encourages the over-periodisation of the archaeological record, which in turn lends unavoidable weight to studies that seek to characterise processes such as urbanisation and state formation as progressing through discrete developmental stages. It is only through the detailed consideration of comprehensive, quantitative data sets taken from long unbroken developmental sequences that we can overcome the stacatto testimony of much recent evidence. Analysis of data drawn from the long essentially unbroken sequence at Tulaylāt al-Ghassūl provides such an opportunity. Sydney University teams have been involved in the excavation and analysis of material from the site for over twenty years. By concentrating on data from a long-lived continuously-occupied site, we aim to evaluate the main factors held to be important in urbanisation/state formation from the unmatched spatial and chronological perspective afforded by the unique circumstances present al-Ghassūl.

The Tulaylāt al-Ghassūl Sequence: Summary of Excavations (1929-95)

The PBI Mission (1929-38, 1959-60)

The first PBI expedition, under A. Mallon and R.

1 Stager 1992; Garfinkel 1993, passim; Joffe 1993: 23-37.

2 Lee 1973: 19-26.

3 Engberg and Shipton 1934; Fitzgerald 1935; Wright 1937; Shipton 1939.

4 Perrot 1984 for the strongest statement of these views, Lee 1973 and Elliot 1978 for literature surveys.

5 Moorey 1991: 50-78.

6 Moorey 1991: 94-111.

7 For an elaborate typology divorced from any diachronic concerns see, par excellence, Lee 1973 on Ghassūl, and Commenge-Pellerin 1987 and 1990 on Beersheban sites.

8 Moorey 1991: 174; Dever 1989: 146-150; Shiqmim might seem to be the exception to this (Levy *et al.* 1990), but Gilead's recent analyses 1994 have raised significant questions as to the overall length of occupation at the site.

Koeppel, excavated two large fields over seven seasons at the site (1929-1938).[9] The south field (Tulayl I) was excavated between 1929-31, and the north field (Tulayl III) between 1932-38. The four phase delineation of Ghassūl (IV-I) pertains only to the south field excavations, which were taken down to sterile in one small area. In the more extensively explored north field, only the upper two phases (IV-III) were excavated.[10] A short continuance under R. North (1959-60) opened a series of small probes (Fields A-E) between the main northern and southern exposures, seeking to establish stratigraphic equivalences between the two original fields, whilst further exploring the lower levels in the north field.[11]

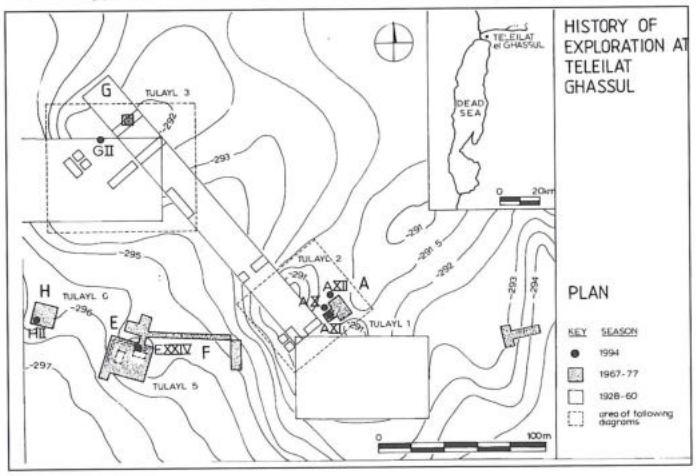
Mallon and Koeppel's work documented an extensive architecturally impressive horizon of occupation across the site, later characterised as the Classic Ghassulian phase (Ghassūl IV). As well, their work suggested that significant deposits of earlier material existed below the upper phases (Ghassūl IV-III) in the region of Tulayl I. North established a similar depth of deposit within (Area A) and beside (Area B) the area of Tulayl III, and noted a significant depth of deposit between the two PBI exposures (Areas C-D), whilst recovering further impressive architecture and wall paintings along the north-west slopes of Tulayl I (Area E). However North was not able to establish convincing equivalences between the Tulayl I and III exposures, and as he concluded that there was no possibility of differentiating assemblages in the absence of direct stratigraphic connection, no comparative stratigraphic relationships for the various PBI exposures across the site could be proposed.

The BSAJ/University of Sydney Mission (1967, 1975-77)
The BSAJ/University of Sydney excavations under J.B. Hennessy (1967-77), were of crucial importance to a full recognition of the significance of the site for urbanism studies. The first season in 1967 concentrated on that small part of the central area of the site between Tulayl I and II not excavated by the PBI or contaminated by their extensive dumps (Area A). The initial aim was to explore the significant depth of deposit noted in both PBI exposures. Results documented the long essentially unbroken sequence of at least ten major building phases in Area A, and demonstrated significant continuity from Late Neolithic origins, apparently settling any issue surrounding the origin of the Ghassulian culture in favour of *in situ* development.[12]

In the return to the site in 1975 Hennessy further explored the lowest levels in two of the original Area A probes, and opened a number of new areas across the site (Areas E-H), seeking to explore horizontal variation and identify special function zones. Work resulted in the identification of the main sanctuary area of the site (Area E), an industrial complex (Area F) and a flint knapping floor (Area A).

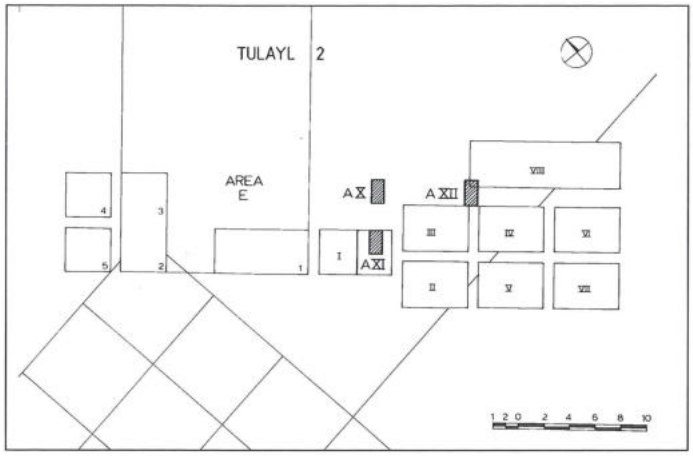
Two further seasons in 1977 expanded Area F to the west, linking it and the sanctuary area and isolating another (painter's?) workshop in the process. As well, work within sanctuary Area E was intensified and expanded to north and west, identifying what are likely to be storage facilities to the north of the temenos wall. Work in Area A concentrated on further exploration of the lowest (Neolithic) levels and the conservation of a unique cultic wall painting. By the end of the field program, Hennessy's excavations had revolutionised understanding of both the vertical and horizontal occupation at the site.[13] The site is now generally acknowledged as uniquely important for our understanding of the Late Neolithic /Chalcolithic period in the southern Levant.[14]

Current University of Sydney Excavations (1994-95)
Changing research priorities and refined sampling strategies (and increasing emphasis on intensively sampled palaeoenvironmental data not attempted by Hennessy) prompted renewed excavations at Tulaylāt al-Ghassūl. The Sydney University excavations were resumed in 1994 (FIG.1), mainly concentrating on the excavation of detailed palaeobotanical and palaeozoological samples from each of Hennessy's main areas of excavation (A and E), whilst beginning a number of new probes in the western (H), and northwestern (G) reaches of the site. In the first season excavation units were mainly small (2 x 1 m) soundings, designed to maximise vertical stratigraphic sampling. Two (A X and A XI) were placed within (A XI) and immediately to the north (A X) of Hennessy Area AI (FIG. 2), another two (E XXIII locus 50 and E XXIV) were placed to the north of Hennessy Area E Sanctuary B (FIGS. 3 and 4), one in the southwestern corner of Hennessy Area



1. Tulaylāt al-Ghassūl. Excavated areas mentioned in text.

9 Mallon *et al.* 1934; Koeppel 1940; Lee 1973: 19-26 for a convenient summary.
10 Lee 1973: 25-26.
11 North 1961: 3-4.
12 Hennessy 1969: 1-24, for the detailed report on the first season of excavations.
13 Hennessy 1977, 1978, 1982 and 1989 for description of Sydney seasons and evaluation of results.
14 Stager 1992: 27; Levy 1993: 511.



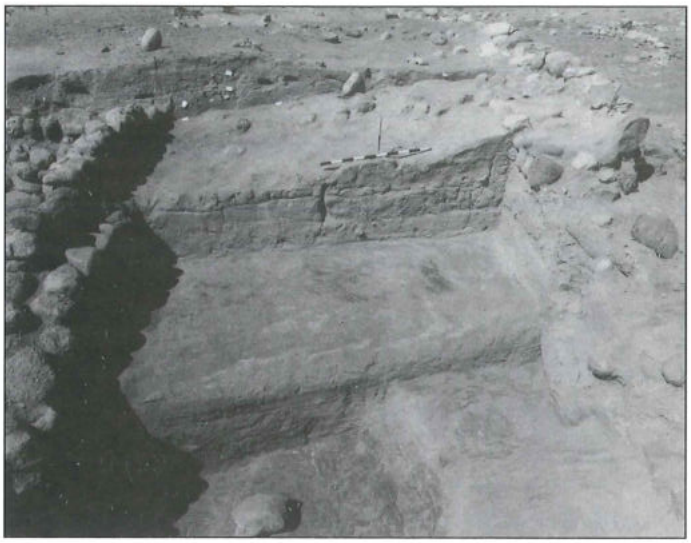
2. Area A trenches in relation to Hennessy's trenches.



3. Area E. Sanctuary B. Looking south. Note two-phase construction and EXXIII locus 50 sondage.

H (H II) and two more (G II locus 1-3, and G II locus 20 (FIGS. 5 and 6) slightly southwest of Hennessy Area G, in the northern face of PBI Field III.[15]

In 1995 the small sondages were continued in Area A, although where feasible (AXI) the excavation unit was expanded. Two complete stratigraphic profiles were obtained from Area A (A X (FIG. 7) and A XI (FIGS. 8 and 9), one from Area E (EXXIII locus 50 (FIGS. 10 and 11), one from Area H (HII locus 2-3 (FIGS.12 and 13)) and another from newly opened northeastern Area P (PI locus 2). Investigations in Area G sampled over 3.5 m of the PBI Field III sequence (GII locus 1-3, 20, 58-64 (FIG.14), but are still over a metre off sterile. Two seven metre deep pits (GII locus 51 and 55 [FIG. 15]) were excavated in Area G. Ceramic material from these pits would seem to be the latest excavated from the area, and possibly the site. A further new area (Area N) was opened approximately one hundred metres north-east of Area A. A 2.5



4. EXXIII and EXXIV. sondages between Sanctuary B and Temenos Wall 1994/95. Looking west .

metre square probe (NI locus 4-5) sampled some three metres of deposit. As well, excavations in the sanctuary (E), western (H) and northern (G) areas were expanded to better investigate architectural and functional variation.[16]

Renewed excavations have only served to underline previous judgements on the importance of the site to any understanding of the urbanisation and state formation process in the southern Levant.[17]

Research Concerns

Analysis centres on the high quality archaeological (ceramics and lithics) and palaeoenvironmental data (botanical, faunal and C14 samples), with the former providing the chronological and cultural keys necessary for appropriate cross-cultural analysis, and the latter providing an environmental perspective against which we may view anticipated chrono-cultural alterations. Our major aim is to determine if observed/anticipated change is best characterised as episodic or gradual. As well, we hope to examine any significant alterations against factors commonly held to be prime movers (i.e. inter-regional interaction, craft specialisation, specialised modes of production and distribution, centralisation of authority, social stratification, variant environmental zoning, to name but a few). Finally, a number of specific issues relating to the sequences al-Ghassūl will be examined over the course of the next few years, as successful characterisation of the al-Ghassūl assemblages is a necessary preliminary to a more wide-ranging enquiry. These are:

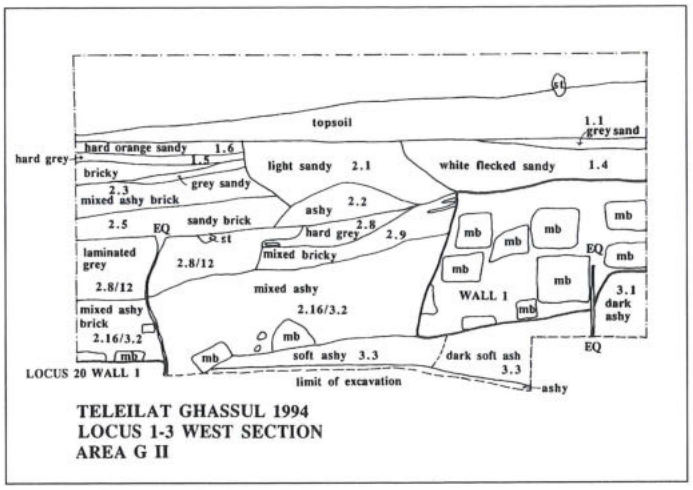
1. The status of the 'pre-Ghassulian' levels at al-Ghassūl, and the degree of continuity between Hennessy's 'Neolithic' and 'Chalcolithic' phases. It has been suggested that the Neolithic levels be considered 'Qatifian', and part of a larger Negevite Neolithic entity.[18] Such a

15 Bourke 1995; Bourke *et al.*, the 1994 field season.*ADAJ* 39: passim.

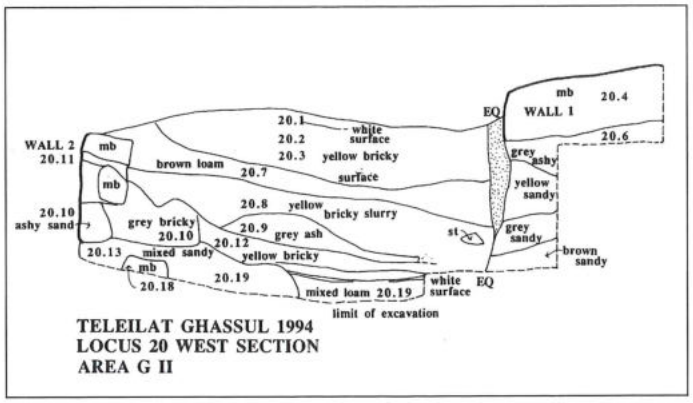
16 Bourke in press, Bourke *et al.* forthcoming, for the 1995 field season.

17 Garfinkel 1993: 812-813; Joffe 1993: 31-32.

18 Goren 1990: 110-113, for the Early Ghassūl-Qatifian equation, Gopher 1995, for a more cautious approach to interregional equations.



5. Area G II. Sondage Locus 1-3 West Section 1994.



6. Area G II. Sondage Locus 20 West Section 1994.

suggestion bears heavily on the origin of the Ghassulian culture, a crucial starting point for any diachronic analysis.

2. The relationship of the four to five stratigraphic phases al-Ghassūl I-IVB) of the PBI investigations to Hennessy's ten phase Area A sequence (A^{+}-I), and the relationship of 'pre-Classic' Ghassulian levels (D-G) to contemporary assemblages in the Jordan Valley and adjacent regions.[19]
3. The full description of Classic Ghassulian levels (PBI al-Ghassūl IV, Hennessy Phase A-C), and an evaluation of the significance of observed change from pre-existing (PBI al-Ghassūl II-III and Hennessy Phase D-G) norms.
4. The nature and date of the terminal occupation horizons al-Ghassūl. Most explanatory scenarios currently employed propose cumulative environmental degradation.[20] as the primary cause for the collapse of Chalcolithic settlement, although one notes the failure to provide anything like adequate archaeological support for such notions. Through detailed microfaunal and palaeobotanical sampling the current expedition hopes to address this issue in particular, as it bears heavily on the question of the nature of the transition between the Chalcolithic and the EBA.

Observations

1. *Subsistence*

(a) Archaeozoological analysis has been divided by area of excavation (A, E, G, H, N and P) to consider variation across the site, and into five phased assemblages (Neolithic, Early, Middle, Late and Terminal Chalcolithic), to consider change through time.

The Neolithic sample is small (239 large mammal NISP), but comparable in size to other published material.[21] Ovicaprines dominate the large mammal assemblage (76%), followed by gazelle (10%), cattle (7%) and pig (4%). Ovicaprines remain important (72%) in the Early Chalcolithic, with the only major change a drop in the importance of gazelle (to 3%), and an increase in cattle (13%) and pig (10%) utilisation. These relative percentages stay much the same throughout the Middle and Late Chalcolithic phases, with the noteworthy fact that equids appear (1%) for the first time in the Middle Chalcolithic.

The very last phase of occupation, recovered from deposits in deep pits (wells?) in Area G, is probably contemporary with the Terminal Chalcolithic [22] of the Negev and would appear to suggest a major alteration in subsistence regime. Although ovicaprines are still most important (68%), gazelle reappear in the assemblage in considerable numbers (19%), and are three times as numerous as either pig (6%) or cattle (6%). It is tempting to associate the shift away from cattle and pig towards a greater reliance on gazelle with a major deterioration in the climatic regime. The scarce and scrappy nature of much of the latest Chalcolithic occupation at al-Ghassūl might suggest a semi-permanent or much reduced permanent occupation in latest Chalcolithic levels, perhaps with an increasing specialist pastoral element.

(b) Archaeobotanical analysis is considered by area of excavation and relative chronological period. General comments only are offered here, with no detailed quantitative analysis at this time.[23]

All samples from Early, Middle and Late Chalcolithic levels record the preponderance of hulled barley, and

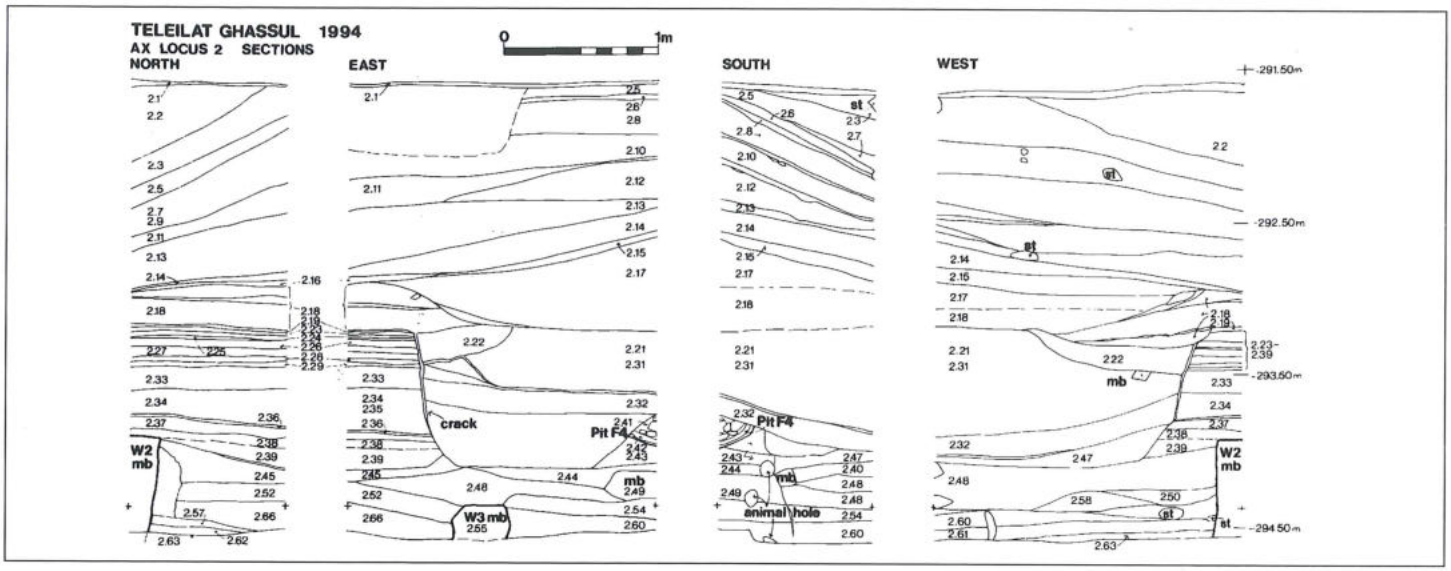
19 Comparison will be limited to Jordan Valley sites initially, beginning with Ghrubba (Mellart 1956), Tell Tsaf (Gophna and Sadeh 1988/89), Katerat es Samra (Leonard 1989), Abū Ḥāmid (Dollfus and Kafafi 1993) and Pella (Bourke *et al.* 1994).

20 Joffe 1993: 36-37.

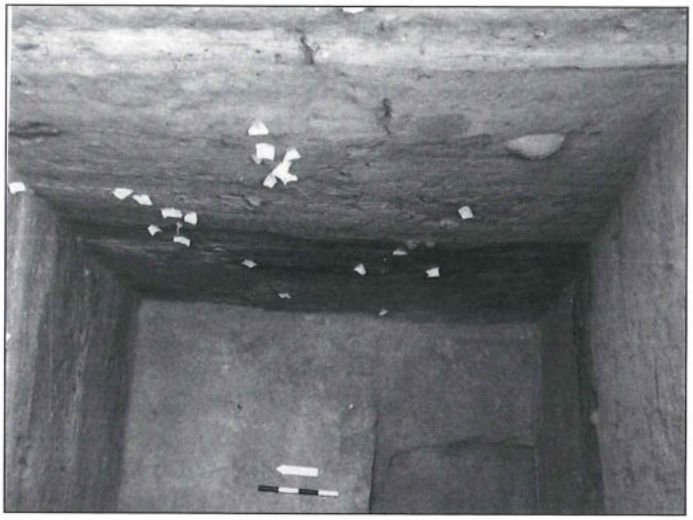
21 Grigson 1995: for a superb synthesis, but note the figures on al-Ghassūl, derived from Lee 1973, are selective, and totally superseded by current analyses; Mairs, in: Bourke *et al.* in press; Bourke *et al.* forthcoming, for a more detailed (and accurate) analysis of al-Ghassūl fauna. I thank L.D. Mairs (Australian Museum, Sydney), for discussing the al-Ghassūl faunal material with me.

22 Joffe and Dessel 1995: for the terminology and radiometric rationale for a 'Terminal Chalcolithic' phase.

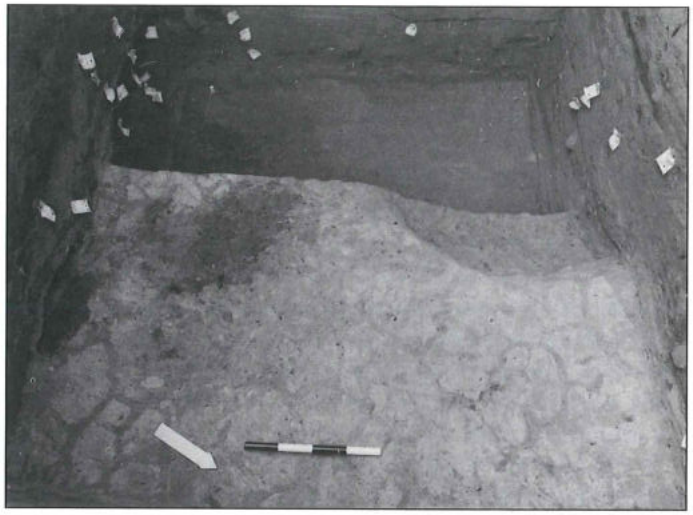
23 Kislev, in T.Levy ed. 1987 for Chalcolithic archaeobotanical survey, although her species listing for al-Ghassūl (272, Table 9.3) is woefully inadequate, and wholly superseded by present work, for which see Hoppé, in Bourke *et al.* forthcoming. I thank C. Hoppé for discussing the al-Ghassūl archaeobotanical material with me.



7. AX. All sections 1994.



8. A XI. 1994/95. Sterile below Neolithic.



9. A XI. Extension 1995. Neolithic plaster floor.

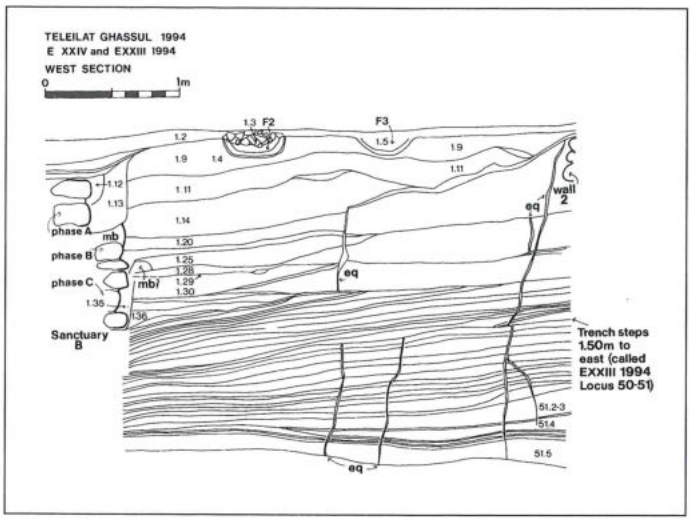
the restricted presence of waste products from wheat processing. Legumes and olive are important supplementary presences from early in the Chalcolithic. There is a gradual increase (but overall small incidence) in more productive forms of wheat (Durum) and barley (six-row hulled) over time. The consistent presence of a restricted range of weeds, glume bases and the low incidence of basal nodes suggests considerable crop processing off-site, and the large quantity of culm nodes and grasses suggests collection of fodder crops (although use as bedding is another possibility). A noticeable increase in legume diversity (particularly vetches) in the later Chalcolithic samples may suggest widespread fodder crop production, although the use of vetch as 'famine food' may suggest a grimmer alternative. Overall, the botanical evidence suggests a diversified crop production from earliest Chalcolithic times, with barley, wheat, legumes and olive the most important food crops. Over time, olive is of increasing importance, [24] along with a growing emphasis on fodder-crop production.

2. *Architecture*

One aim of renewed excavation is the exploration of architectural diversity, with particular focus on the identification of specific-function architecture. A second is to recover further evidence for overall settlement plans, to supplement the original PBI findings, and to further investigate urban design through time.

The main area deemed suitable for large scale architectural analysis was the relatively undisturbed western area of the site, Hennessy Area H, where exceptionally well preserved architectural remains were discovered immediately below the surface, during initial cleaning in

24 Neef, in Dollfus *et al.* 1988: 597-598 for early Jordan Valley; Galili and Sharvit 1994/95 for early olive oil production in the Carmel region, Carmi and Segal 1994/95, for the Neo/Chalco date; Kislev 1994/95, for the suggestion that the olives employed were harvested wild.



10. E XXIII/XXIV. Composite west section showing multiple-phase construction of Sanctuary B.

1994. After a deep probe (HII, locus 2-3 see FIG.12) had determined that at least four major phases of architecture (the earliest Middle Chalcolithic, the top three Late Chalcolithic) existed in the area, detailed planning commenced in an 11 x 11 m area after loose surface material had been removed (see FIG.11). Planning this area revealed two phases of architecture intermixed. The uppermost (Phase A) consisted of a number of contiguous multi-cellular structures, rectilinear rooms and groups of small roughly square stone-lined storage bins, built around a series of squarish courtyards, each with a centrally placed hearth or fire pit. This was built on top of and where possible against the remains of two splendidly constructed longhouses (Phase B), the northern one approximately 18 x 7m in extent.[25] Initial scraping in 1995 revealed that the multicellular phase stone architecture was more or less confined to the area of our initial clearance in 1994, and that further to the north an earlier longhouse phase (B) remained effectively undisturbed. The further north one advanced, the more complete became the preservation. With this in mind, the scraped area was expanded some 17m to the north in 1995, making the total coverage a 28 x 11m area.[26] Two 5 x 5m squares (HII locus 50 and H II locus 100) so placed to straddle the northeastern and southwestern regions of the northern longhouse, were excavated in 1995. H II locus 100 uncovered a beaten earth pathway along the north face of the north wall of this well-preserved longhouse, and a series of floors within the northern end of the building, recovering a collection of stone tools (large axes, scrapers, and a series of beautifully ground chisels) and a complete ceramic vessel from the uppermost of a series of floors. To the south, H II locus 50 recovered essentially the same stratigraphic sequence as in the 1994 sondage H II locus 2-3. H II locus 50 sampled the southwestern entrance into this longhouse. An elaborately constructed entrance, consisting of a section of beaten earth exterior pathway (similar to that along the north wall), two flanking door posts and a small section of mudbrick wall, and a small area of interior plastered floor were preserved below the upper phase multicellular stone structures. The uppermost deposits were disturbed, with at least one floor level completely eroded, and some root damage to the central courtyard installation. Even so, a double-walled central firepit was preserved within a multisurfaced courtyard, along with a series of small storage rooms on the south side of the courtyard. Further expansion of Area H to the north and east is planned in future seasons.

Area H was initially seen as the main focus of our architectural analyses. At the beginning of the 1995 season, initial cleaning in the southernmost 5 x 5m plot (GII locus 50) of the original 15 x 5m trench GII revealed well preserved multicellular mudbrick architecture immediately below the present surface (see FIG .15), which is at the limit of excavations reached in 1938 by the PBI mission.[27] Excavation in GII locus 50 revealed parts of six small (2 x 1 m) rooms, set in two lines. Each appears to have been entered from above, and in the one room fully excavated (see FIG.14), [28] a collection of bone antlers and stone borers hinted at a special purpose work (?) or more likely storage room. As this architectural phase exists at least 2.5m below the present Tulayl III surface, it is certainly not of latest Chalcolithic date, and PBI determinations would favour al-Ghassūl III or Middle Chalcolithic (Sydney) date for the complex.[29]

Dollfus has noted that multicellular room arrangement becomes general in the latest Chalcolithic levels at Abū Ḥāmid,[30] which are sometimes suggested to be 'post-Ghassulian' in date. Until now, well stratified architecture at al-Ghassūl was dominated by stand-alone long-room units. However, our initial results suggest that multicellular and/or special purpose architectural units have a long history at al-Ghassūl, whatever the sequences at other sites.

Whether or not there are chronologically or culturally significant shifts in overall architectural patterning remains to be determined, but the evidence from al-Ghassūl does not support Dollfus' suggestion that the apparently sudden change from 'simple' longhouse to 'complex' multicellular town plans at 'Latest Chalcolithic Abū

25 The southern longhouse, at least as wide, extends south from an alleyway between the two.

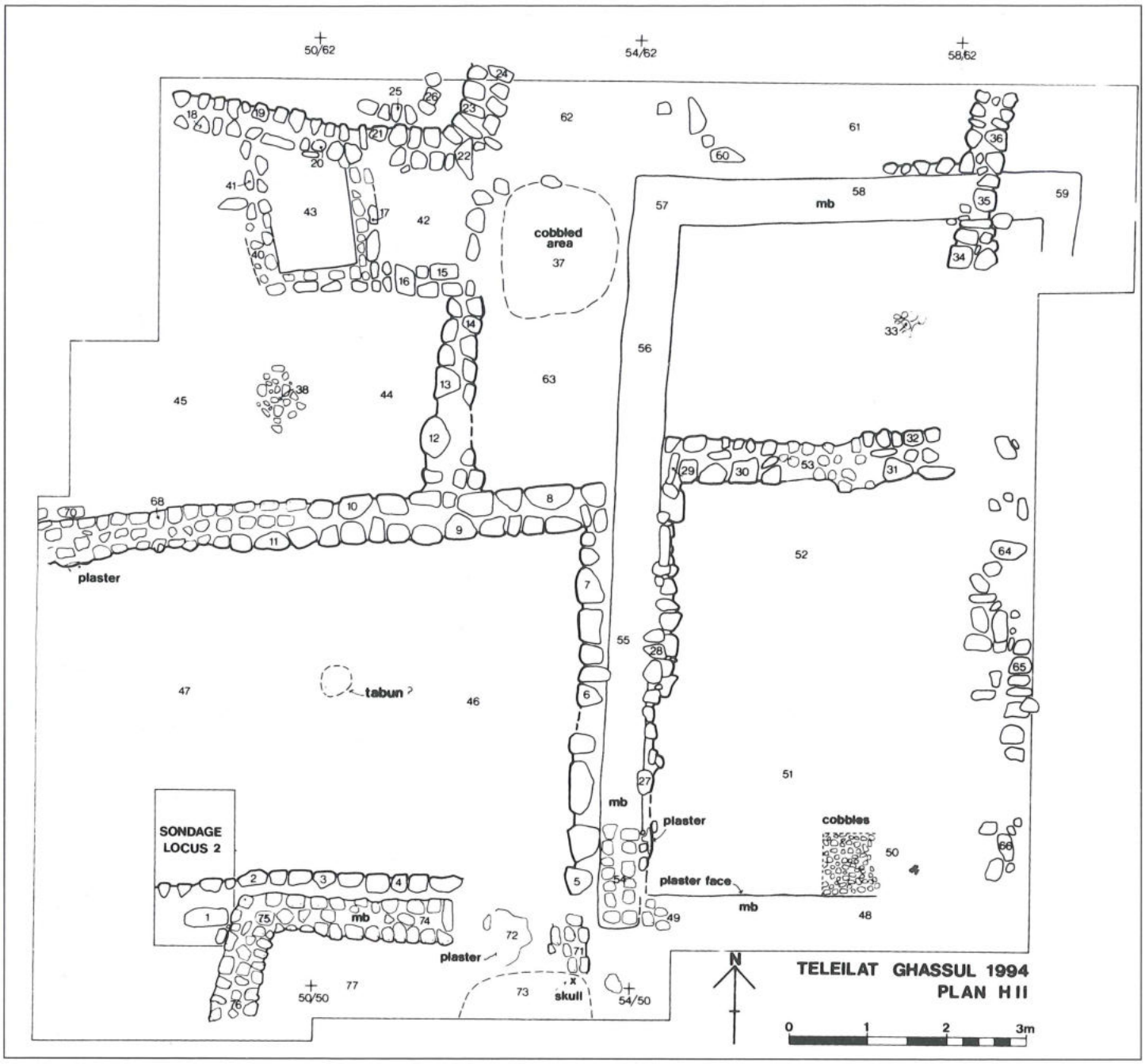
26 Ten 5 x 5m squares were laid out across the 25 x 11m area to the north of the original stratification probe (locus 2-3), and two excavated in 1995 to sort out the intermingled uppermost phases.

27 Lee 1973: 25 and 339-340; each architectural phase isolated in the PBI excavations, whether in Tulayl I or III, seem to consist of groups of long-room structures (with the main building sometimes subdivided), although Lee's presentation of PBI 'stratum-plans', which probably contain multiple subphases rendered together, are to be used with caution.

28 The opportunity to explore the G II locus 50 complex more fully overrode the original aim of column sampling. Column sampling did take place during the second half of the season, although the 1.5m sondage was very badly affected by subsidence splitting (see FIG 14).

29 Lee 1973: 25, probably al-Ghassūl III (Lower) in his terms.

30 Dollfus and Kafafi 1993: 242-245; Dollfus and Kafafi 1988.



11. Area H, showing surface architecture and position of Sondage H II.

Ḥāmid' might be symptomatic of a more general tendency.[31]

3. *Ceramics*

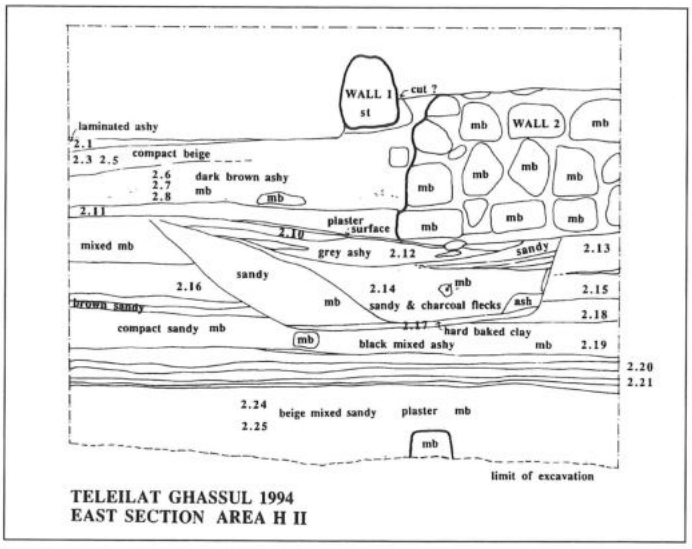
Hennessy proposed three broad periods of development in the ceramic sequence from his Area A sequence. The first encompasses the Neolithic (Area A: Phases H-I) and earliest Chalcolithic (Phases F-G), the second the Middle Chalcolithic (Phases C-E), and the third the Late Chalcolithic or 'Classic' Ghassulian levels (Phases A-B). Whilst Hennessy was able to isolate distinct characteristics for each phase, he concluded that all variation occurred within a single ceramic tradition, and came down firmly on the side of *in situ* development for the ceramic tradition and the Ghassulian culture in general.[32] Most of our preliminary findings support Hennessy's general conclusion, although we prefer a five-fold division of ceramic assemblages, separating the Neolithic

31 Hennessy found a curvilinear multicellular structure in 1967, in a Late Chalcolithic phase of trench A I (Hennessy 1969:Pl. IVb). Current excavations uncovered a similar structure in the uppermost phase of Trench N I. Here, the curvilinear structure was linked by a series of floors to a 'classic' longhouse, underlining the contemporaneity of the two architectural forms.

32 Hennessy 1969 and 1982: Elliot 1978.



12. H II. Sondage 1994. Looking north.



13. H II. Sondage east section, showing relationship of multicellular [Wall 1] and Longhouse [Wall 2] phases.



14. Area G II, 1995. Locus 58-64 sondage. Note extensive earthquake/subsidence splitting of plaster floor within small room.



15. Area G II, 1995. Multiple small room structure with very late pits (loci 51 and 55) cut through them. Looking south.

from Early Chalcolithic and Terminal Chalcolithic from Hennessy's Late Chalcolithic or Classic Ghassulian assemblage. Only a few preliminary remarks are warranted as much of the material still remains to be processed.[33]

The pottery from the two very shallow 'Neolithic' pit phases display characteristics not shared with later material. Whilst the clay is a fine lacustrine type, the absence of any filler larger than silt suggests an unmixed fabric with little pre-treatment. Fabric types are coarse and 'biscuity', and generally fired from yellowish buff through to greenish buff, often quite crumbly. Shape range is very restricted, consisting overwhelmingly of simple rim bowls and squat narrow-necked jars. Surface decoration is very rare.

The pottery from the Early Chalcolithic levels differs from the Neolithic, in that small amounts of subangular calcite, limestone and shell filler are consistently added to the clay body, which is more commonly a marl, although the Neolithic silt fabric continues at a low incidence for a short time. Fabrics appear less 'biscuity', which, along with the calcite filler, might suggest some limited pre-treatment of the clay. Firing colour varies from the Neolithic norms consistently, with grey-cored pale brown through dark brown fabrics common, although a small amount of reduced sooty black-cored material occurs from this time. As well, a reduced coarse variant of the normal fabric with added quartzite filler occurs from this time, although too rarely to associate with a particular

[33] I thank J. Lovell, Ceramic Registrar for the al-Ghassūl Project, for discussing the al-Ghassūl corpora with me.

shape class. Shape repertoire is still restricted, dominated by holemouth jars, simple bowls and short-necked jars. Stump-based cornet cups appear during this phase, as do the first simple fenestrated stands.

In the Middle Chalcolithic levels the Early Chalcolithic traits outlined above continue, but at a gradually reducing level. However, many of the features of the succeeding Classic Ghassulian assemblage appear for the first time in Middle Chalcolithic phases.

In fabric, the marl type common in the Early Chalcolithic layers continues to dominate the Middle Chalcolithic assemblage, although a second ferruginous clay appears, and is increasingly employed on many of the smaller vessel forms. Firing colour varies greatly, as does the firing temperature. In these levels the later dominant 'hard red' fabrics become a significant (10-15%) part of the assemblage. These latter fabrics are fired brick red throughout, and are often (20%) over-fired to the point of vitrification. Firing temperature appears to be considerably higher on average, which, when coupled with the consistently high degree of firing variability, might suggest the development of kiln, or what has been termed 'proto-kiln' technology.[34] Shape classes are more varied and rim forms more elaborate, with the appearance of churn and miniature churn forms, a number of bevelled-edge fenestrated stand variants, and elongated or 'full' cornet cups a feature. However, the assemblage is still dominated by flat-based fine and coarse holemouth jars, simple bowls, and necked jars.

The Late Chalcolithic 'Classic Ghassulian' assemblage has been well documented in all previous studies.[35] Oxidised ('hard red') and reduced ('hard grey') variants of the iron-rich clay now dominate the fabric assemblage (75-85%), with perhaps 20-30% fired to the point of vitrification. Hard red fabrics are commonly employed in small shape manufacture, and hard grey fabrics in storage jar and bowl production, although some crossover does occur. Shape repertoire increases, with spouted bowls, fine cornets and rough-fluted goblets, elaborate rimmed holemouth and short-necked jars, large storage jars and bowls, and figurine attachments all featuring in a generally more varied assemblage. Self-slips or variants of Hennessy's 'Streaky Wash' (a thin white slip carelessly applied) dominate small vessel treatments, although a 'streaky red' wash occurs on larger vessels occasionally. Painted decoration is generally restricted to careless red painted bands or neatly executed chevrons and pendant latticework triangles over a white slip, although rare 'freefield' red painted cornets occur in the latest levels. Overall, there is the impression of increased standardisation in fabric preparation and firing, and increasing variability in small shape repertoire, whilst storage shapes increase in overall size, and seem to be more commonly highly fired.

General Conclusions

The Tulaylāt al-Ghassūl excavations, past and present, have produced a wealth of palaeoenvironmental and material cultural data of crucial significance to a more comprehensive understanding of this early phase in the urbanisation process. Other projects have produced high-quality data bearing on specific aspects or specific phases of Chalcolithic settlement history, but none can match the al-Ghassūl assemblages for chronological range and typological variety.

Our architectural, material cultural, zoological and botanical analyses all suggest the same main point, that is while there is clear functional variability across the site in the later periods (the only ones thoroughly investigated to date), both environmental and subsistence data suggest only slow change through time. If there is any major environmental change, it occurs at the very end of the occupation sequence, probably contemporary with the Terminal Chalcolithic phase of the Beersheban culture.[36] Here there is some faunal evidence for changed husbandry patterns, an impression that may be accommodated to the archaeobotanical evidence.[37] Excavations are planned to continue for a number of years. Whilst many of the major issues at al-Ghassūl itself will necessitate at least three further years of work, thereafter, we hope to expand our investigations into the Ghassulian countryside, to begin studying the interaction between this large and complex central settlement and its rural hinterland.

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Bourke, S.J., Seaton, P.L. , Sparks, R.T. , Lovell, J.L. Hoppé C. and Mairs, L.D. 1997. Preliminary Report

[34] Edwards and Segnit 1984: Edwards 1993. I thank Edwards and Segnit (Deakin University, Melbourne) for discussing their ongoing work on Ghassūl petrography with me, and Edwards for discussing the techno-social significance of kiln-firing. The adoption of the wheel, and the change from fire-pit to kiln production, need not have any socio-economic significance (Gilead 1988, Rosen 1993), although other mainfestations of Ghassulian culture (cult practice, differential burial customs) may well suggest something more than egalitarian society (Levy, 1986, 1995).

[35] Hennessy 1969; Lee 1973 for al-Ghassūl; Commenge-Pellerin 1987 and 1990 for Beersheba.

[36] See Gilead 1994; Joffe and Dessel 1995, for the radiometric parameters for Late and Terminal Chalcolithic. Hennessy's published al-Ghassūl dates are consistent with a Late Neolithic through Late Chalcolithic occupation (Hennessy 1982); none of our hypothetical Terminal Chalcolithic layers were sampled by Hennessy. Results from 1994/95 C-14 assays are not yet available.

[37] The archaeobotanical evidence, although rich, is equivocal at this point. Presence of fodder crops (vetches) and hay could imply deteriorating environment and the need to provide animal fodder in bulk, or simply reflect provisioning and stabling of beasts in a restricted foraging zone (i.e. a township). Analysis of another suite of samples concentrating on Terminal Chalcolithic loci is underway.

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Between the Plateau and the Rocks Edomite Economic and Social Structure

Visitors of what once had been Edom cannot be but fascinated by the view which opens from the edge of the plateau down to Wādī 'Arabah: behind them, an undulating highland provides a strip of secondary or tertiary agricultural terrain which becomes narrower and more scarce the further one penetrates south, and gradually declines towards the Syro-Arabian desert, scattered by recent settlements and the remnants of their ancient predecessors, the tulūl and the khirab; the view in front of them is a labyrinthine mass of rocks and gorges towards Wādī 'Arabah. It is this basic dichotomy of the Edomite landscape that we abbreviate by "the plateau and the rocks" (FIG. 1).

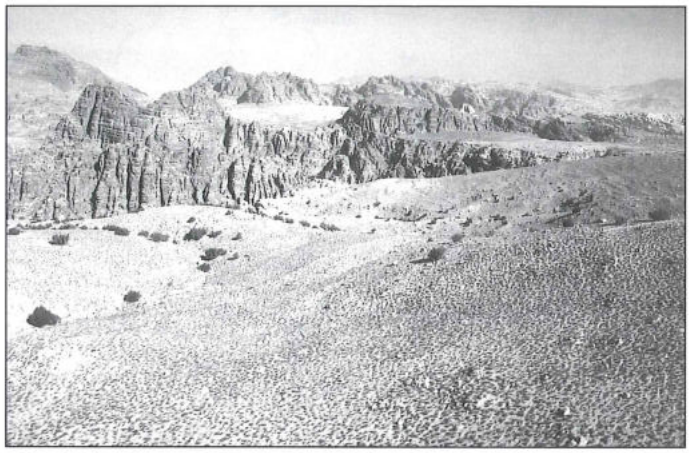
That both environments once were integrated into the texture of Edomite society and economy has very recently been elucidated. The archaeology of Edom was constituted by its pioneers, from N.Glueck to C.-M. Bennett and S. Hart, as the archaeology of the Edomite Plateau, with only occasional and perplexing outposts in the "wilderness"of the rocks, like Umm al-Biyāra, or down in Wādī 'Arabah (notably in the copper-mining district of Faynan see Bienkowski 1992a: 5-7 and 1992b). It can now confidently be stated that Umm al-Biyāra was by no means a phenomenon.

Surveys of the Naturhistorische Gesellschaft Nürnberg, directed by M. Lindner , have provided a number of "mountain strongholds" in the Greater Petra Area (Lindner 1986; 1992; Lindner and Farajat 1987. Lindner, Farajat and Zeitler 1988; Lindner *et al.*1990; 1996):

Ba'ja III (1984/86)
Umm al- 'Alā (1987/88)
Jabal al-Qṣeir (1992)
Jabal al-Khubtha (1994, 1995) (FIG. 2).

The four sites and Umm al-Biyāra have a number of features in common:

a- Situated outside the Edomite plateau, in an environment which does not encourage permanent settlement or facilitates stone architecture, which is nevertheless attested;
b- Restricted accessibility, experienced by everybody who ever climbed Umm al-Biyāra (Ba'ja III, invisible from the Jabu plain, but dominating it, characterizes this clearly);

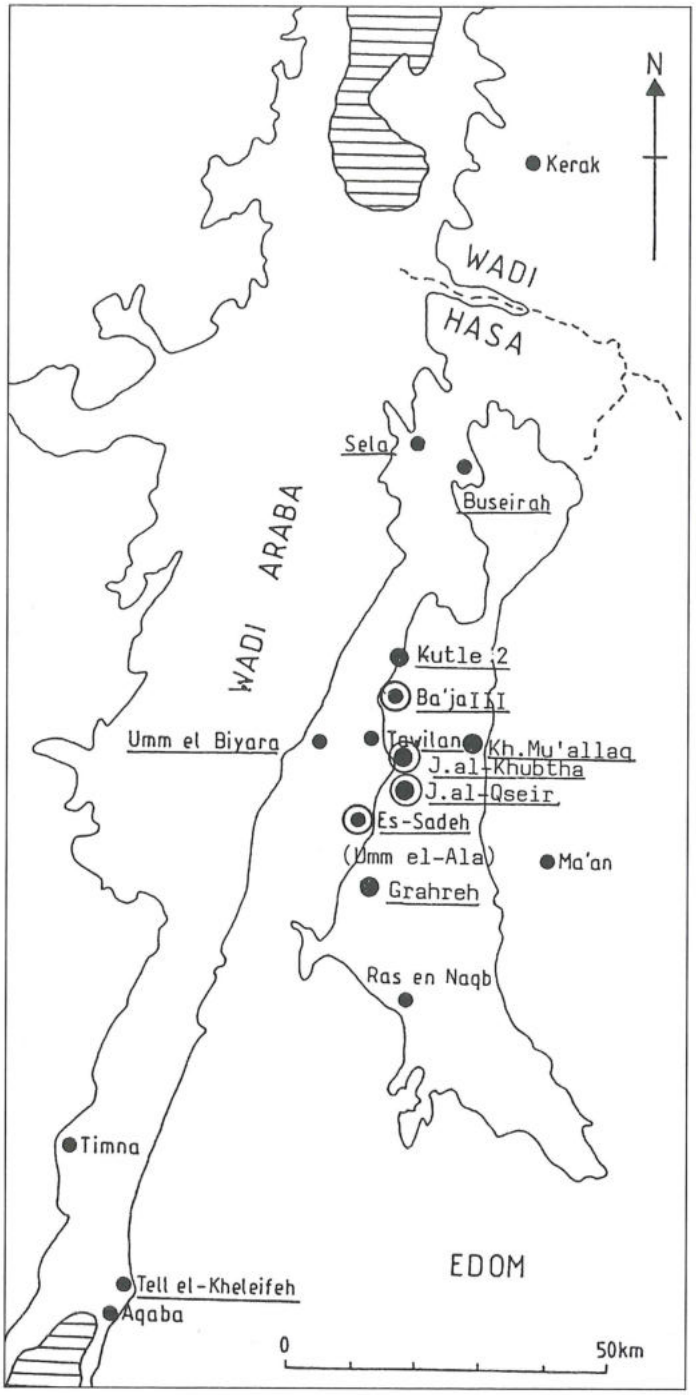


1. View from the Edomite plateau (Jibāl ash-Sharā) down to the sandstone rocks of Petra.

c- Storage facilities for agricultural products ("longhouses" as found at Umm al-'Alā, Jabal al-Qṣeir; at all the sites, sherds from coarse storage jars predominate - on Jabal al-Khubtha, one hardly finds anything else);
d- Pockets — or even stretches — of agriculturally and/or horticulturally useful land in close vicinity;
e- A total or nearly total absence of "fine ware". Es-Silc (es-Selac), visited and described several times as a "natural refuge" (Hart 1986a; Lindner 1992), may be added to the five sites mentioned.

One may now confidently state that the "rocks" formed part of the Edomite economic and social landscape. Which was , however, the relationship between the – Edomites "higher up", on the plateau, and those "lower down", in the rocks? What made the Edomites – or some Edomites – choose sites for settlement which seem to be more suited for goats? If the archaeologoical evidence now available is far from providing all the answers, it does pose some questions worth pondering.

Should one look for a diachronic or for a synchronic explanation? As the subtitle of this contribution suggests, we opt for the latter. Theoretically, one may try to establish an historical sequence: from the rocks to the plateau, or vice versa. Practically, this would lead to questions of factual history and neglect the representation of a past state of society and economy which is better gleaned from

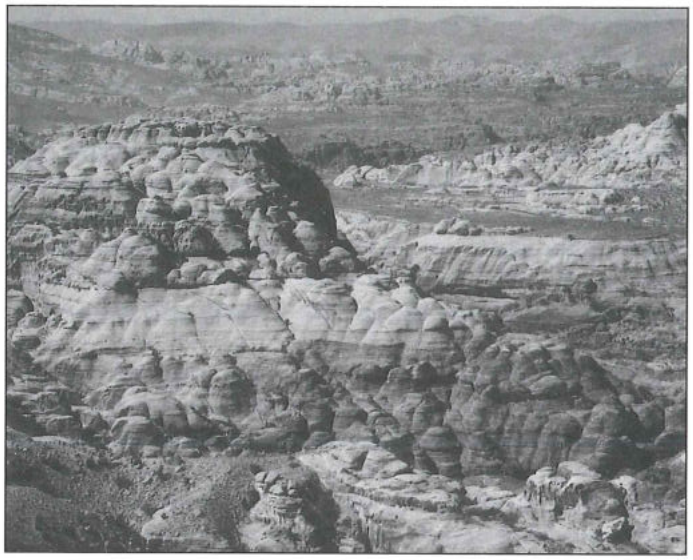


2. Sketch map of Southern Jordan (ancient Edom) with important Iron II sites. Mountain strongholds lately identified by Naturhistorische Gesellschaft Nürnberg are encircled.

archaeological facts. The more so in Edomite archaeology: to distinguish between "early" and "late" Edomite is impossible at present and will , in all probability, remain impossible for the future, given the extremely short-lived floruit of Edomite settled (and pottery-producing) culture. The Edomite civilization may not have commenced until the beginning of the seventh century BC, and it may not have survived very long or vigorously after the middle of the sixth century.

Choosing a diachronic approach does not mean, however, that the relationship between the plateau and the rocks could not have been different at the beginning, the height and the end of Edomite cultural history, a possibility which will be considered in due course.

It is highly questionable whether the sites served a permanent population. Jabal al-Qṣeir, at least, exhibits numerous rock-cut foundations but with no architectural remains. In all probability, these foundations were intended for temporary dwellings such as tents or huts. Temporary use of the sites would partially mitigate the inconvenience of getting there (FIG. 3).



3. Jabal al-Qṣeir, an Edomite mountain stronghold south of Petra. J4.

The main feature that all the sites provide is security, guaranteed by the geographical setting rather than by military architecture. The sites served, then, a population more experienced in mountain climbing than in fortress building, though minimal fortification works are attested (a watch tower at Umm al-'Alā, a stratigically placed curtain wall at Jabal al-Qṣeir). It has been suggested - with some probability - that Edomite monumental architecture on the plateau was influenced, and probably constructed with some technical assistance , by the Assyrians. In this case, it is in the rocks that we may observe "indigineous Edomite" architecture - the architectural heritage of a somewhat peripheral culture as compared to the urban civilisation in its western and northern vicinity.[1]

It is a matter of speculation to decide against whom the Edomite rock-dwellers wanted to protect themselves. Given the basically tribal nature of Edomite society, it can by no means be excluded that the people of the rocks sought refuge against the power of the nascent state on the

[1] The Neo-Babylonian relief and inscription recently reported from as-Sila' (probably depicting Nabonidus and recording his conquest of Edom in 552 BC) does not necessarily contradict our evaluation of the nature of Edomite settlement in this region, as the choice ot this site may simply be due to the existence of a convenient and not too inaccessible rock surface; cf. for a parallel the inscriptions and reliefs of Naḥr al-Kalb, cf. Winckler 1909.

plateau (Knauf 1992). It has to be noted, however , that in spite of a possible political/ethnic divide between the plateau and the rocks, both areas complemented each other within the framework of regional economy and ecology. Some interaction between the two areas is clearly attested by the seal of "Qausgabar, King of Edom" found at Umm al-Biyāra (Bartlett 1989. 213), although the question of how it got there remains unsettled: as the property of the local royal official, or as precious booty? The record of a delivery of oil, probably sent from Umm al-Biyāra rather than to the site (Bartlett 1989: 215) indicates, however , that at least at certain periods the "rock of Petra" had been integrated into the economic and administrative network of the Edomite state. Dependence of the "mountain strongholds" on the agricultural potential of the plateau, limited as the latter was, is indirectly attested by the large amount of storage jars at all sites investigated, which can hardly have contained a commodity other than grain, impossible to procure locally in sufficient amounts, and also attested by the few pieces of Edomite "fine ware" which was produced on the plateau. Agricultural land is situated at the feet of Umm al-Biyāra and of Ba'ja III; otherwise, the limited extend of agricultural pockets makes only horticulture feasible. The oil-delivery receipt mentioned above and the abundance of traces of Nabataean viticulture in the area surrounding Ba'ja III lead to the suspicion that the main commodity produced even at the two agriculturally most favoured sites was not grain.

The most obvious product of the rocky precipice must have been, if present patterns of land-use allow any prediction of ancient economic structures, an abundance of goats. The area of Jabal al-Qṣeir is presently inhabited by one extended family (which reoperates several Nabataean cisterns and storage facilities) with ca. 200 goats. Goods not produced by this household are bought at aṭ-Ṭayyiba (at a fair distance). Even on the plateau, agriculture is precarious (Hart 1986b). Edomite agricultural colonisation in the seventh century BC in an area which, before and after, was wisely left to husbandry can only be explained by a desparate struggle for the increase of food production. Given the irreconcilable conflict between goats and agriculture (Köhler-Rollefson 1988), the herds formerly husbanded on the plateau would have had to look for other grazing grounds. Under these circumstances, it was only natural to relegate goat-herding from the plateau to agriculturally even more marginal districts, that is the rocks. The tribes of this area, whatever their political outlook towards the state on the plateau was, became integrated into Edomite economy due to economic expansion initiated by an increase of demand for combustibles. That dispersed bands – or clans – of pastoralists (and, probably, of arbo - and viticulturalists) needed central storage and distribution facilities for imported grain (and other goods) is obvious; that they chose to install these facilities within their own territory instead of on the edge of the plateau, and that they chose them as inaccessible as possible, provides a glimpse at the fragmentation of Edomite society, and probably also a glimpse on intra-Edomite "tribal" conflicts (cf. also Mittmann 1973 and Knauf 1989 41 n. 185; 71 with n. 356).

The increased demand for agricultural products in Southern Jordan during the seventh century is , of course, in turn a consequence of Edom's integration into the Assyrian dominated world economy (Knauf 1994: 142-145). Edom participated eagerly in the Arabian trade, which had just commenced, and competed with Cyprus as copper producer. No major Edomite trade route can be suspected to have run through the Petra region, the centre of the Edomite state being situated further north at Buṣayra; and, the "mountain strongholds" are, by their very nature, everything else but trade stations (one may think of robbers' nests, but nothing can be detected in their immediate vicinity worth robbing). In a rather general, or "structural" way, however, trade was the primary *raison d'être* of Edomite economic development and hence, also of Edomite economic expansion into the area of the rocks as attested by the "mountain strongholds".

We saw that these installations can be perfectly explained as "central places" of a predominantly non-sedentary population. In addition to being opposed to the culture of the agricultural area, however , they must also have served as interface between the rocks and the plateau. This is not only attested by the epigraphic evidence from Umm al-Biyāra (see supra), but also by their spatial distribution immediately under, or close to, the edge of the plateau. Furthermore, the "mountain strongholds" seem to have had "counterparts" on the plateau, which served in turn as interface from the plateau to the rocks. as-Sil' is as clearly orientated towards the Edomite capital Bozrah/Buṣayra as Jabal al-Qṣeir must have been dependant, in antiquity as today, on aṭ-Ṭayyiba (the Edomite settlement at the latter site has not yet been located, though Edomite sherd scatters within or near the village have been reported; it is inconceivable that the Edomites, who settled much less promising sites , were not attracted by its abundant spring). Al-Khubtha (where the Edomite settlement is more extensive than previously suspected) and Umm al-Biyāra were evidently satellites of the extended farmstead, or village of Ṭawīlān; and Ba'ja III, situated halfway between Ṭawīlān and Kutleh II, an Edomite village on a veritable "outpost" of the plateau (Jabal as-Suffha) north of Petra (discoverd in 1994), is overlooked by an Edomite fortress on Jabal ash-Shdeifeh, a spur butressing from the plateau (discovered in 1995). State intervention in the interaction between the plateau and the rocks is also attested by the Edomite fortress of Khirbat al-Mu'allaq, situated between Petra and aṭ-Ṭayyiba on the very edge of the plateau (excavated by the Naturhistorische Gesellschaft Nürnberg under the direction of M. Lindner between 1991 and 1994).

It is not inconceivable, and indeed likely, that, due to

their history as centres of interaction between the plateau and the rocks, the "mountain strongholds" served also as points of refuge for the Edomite population of the plateau during or after the fall of the Edomite state in 552 BC when the major threat to the remaining settlers was posed by the bedouin-the rocks are no terrain for camels. After another economic collapse on the Edomite plateau in the Ayyubid-Mamluk period, settled life did continue in Southern Jordan (if mostly unobserved) in various sheltered places in the same area (discovered by the NHG survey in the course of the past ten years). But the function which the "mountain strongholds" held then was not the function that caused their construction (FIG. 4).



4. The spur of Umm al-'Ala above the valley of as-Sadah with longhouses and a tower.

The ideas presented here are only prelimary. Processing of the data furnished by the sites which we have mentioned has just begun. Attention is, however, directed at least to an aspect of Edomite, and probably not only Edomite, culture invisible from the trodden path.

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Water Management in Northern Jordan: The Example of Gadara Umm Qays[1]

Natural Conditions and Needs of the City

The old city of Gadara is situated on a spur high above the rivers Yarmuk and Jordan. The area is inside the 400-500 mm rainfall isohyet (winter and spring rains), which makes agriculture possible without irrigation. But it does not sustain the needs of a city of several thousand people, as a Roman Decapolis city would have been.

A Classical city with several thousand inhabitants, bath houses, fountains, nymphaeums and possibly even an artifical lake needed a constant and safe water supply.[2] The different Decapolis cities have managed their water-supply according to their setting: Philadelphia and Gerasa had been built around a river or wadi, which provided them with water, Pella was located in an area with strong springs, but cities like Capitolias and Gadara needed artificial supply for their public and private needs.

Only a few 100 m south but also 50 m below Umm Qays is a natural spring, which might have been used additionally in the same way it was used until modern times (people went there to get a supply of fresh water). The outlit of the spring has most probably moved, and was possibly closer and inside the city wall in Roman times.[3] But this spring was neither strong enough for the needs of a whole city nor would it have been possible to bring large amounts of water up into the city from a spring which is situated so far below the city.

Umm Qays is surrounded on three sides by steep slopes (towards the Jordan Valley/Lake Tiberias in the west, to the Wādī 'Arabah in the south and to the Yarmuk river in the north). This is for strategical purposes very convenient– but it is rather unfortunate for water transport. The only easy access to the site is from the east. In the next 12 km east of Umm Qays are three larger springs, but only one seemed appropriate in height and strength. Other, smaller springs were found during our research. The large spring is 'Ayn Turāb, which is situated 11.5 km east of Umm Qays in Wādī Samar and has today (when it hosts a small military camp) a waterflow of 7 l/s. But this spring would not have been enough to account for the amount of water, which was transported to Gadara.

The Gadara Water-System

Technique

Already some years ago water tunnels were found under the Ottoman village of Umm Qays (Kerner 1992: 409ff.; 1993: 369f.; Weber 1991: 127ff.). Two tunnels cross the limestone hill in order to bring water from east of the city to the west side of the hill, where the larger part of the city buildings were. They are ca. 410 and 400 m long, up to 2.50 m high (although the minimum height seems to be 1.60 m) and between 0.80 and 1.50 m wide (FIG. 1). Oil-lamp holes are cut in the walls at different heights with widely varying distances between them. The course of the channels is extremely curved and bent, which was difficult to explain, because neither geological reasons (for the course of the stone would have led straight from entrance to exit), nor technological reasons such as waterflow or inability[4] were responsible for the course. The reason lies in the combination of two well-known building techniques: At regular intervals shafts are dug down to the underground channel (qanat technique) and then the water channel is built from these shafts,[5] not straight from A to B, but from both points towards each other (FIG. 2). To make sure that both parts meet, both lines diverged in the same direction from the theoretical line and, therefore, must meet (this system is described for other tunnels like the Eupalinos-tunnel in Samos).[6] In Umm Qays it is clearly visible in the upper tunnel between E2 and E9 as well as between E9 and E10 and in the lower tunnel between KE5 and KE6 (FIG1).

In some cases the meeting-point in the middle was missed by a few metres and the tunnel course needed correction (like between E5 and E6), which can be recog-

[1] The work has been financed by the Lutheran Church of Germany and the German Research Foundation. Many thanks go to all Jordanian institutions, which helped us in our work. At the time of the work S. Kerner was the director of the German Protestant Institute for Archaeology in Amman and H.Krebs and D. Michaelis were students of the Leichtweiß Institute for water-studies of the Technical University of Braunschweig.

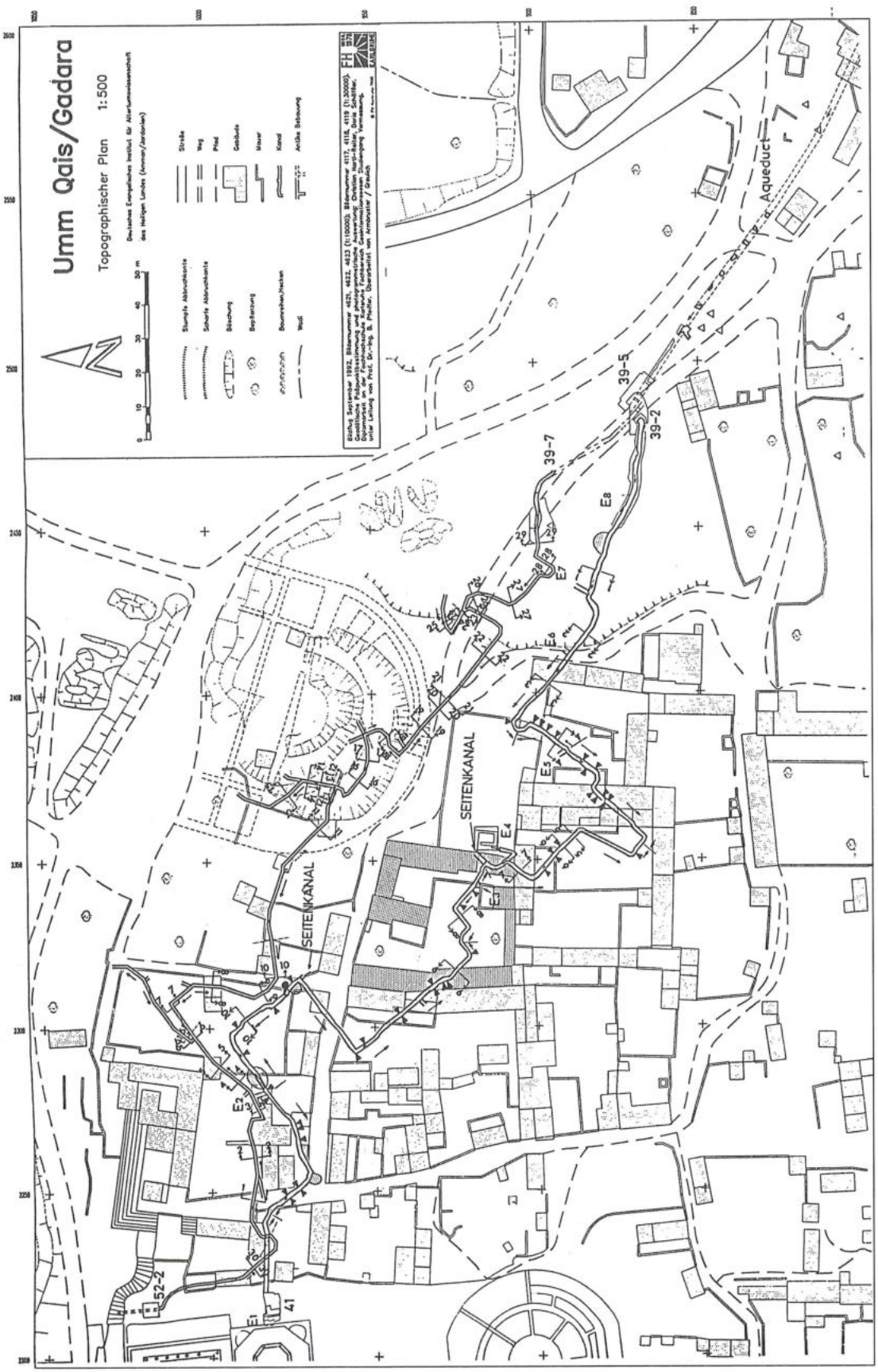
[2] We are best informed about the water-system in Rome, described by Frontinius, a Roman water commissioner.

[3] Perso. comm. A. Hoffmann, who has worked inside the city- wall area along the slope, where the spring would have been.

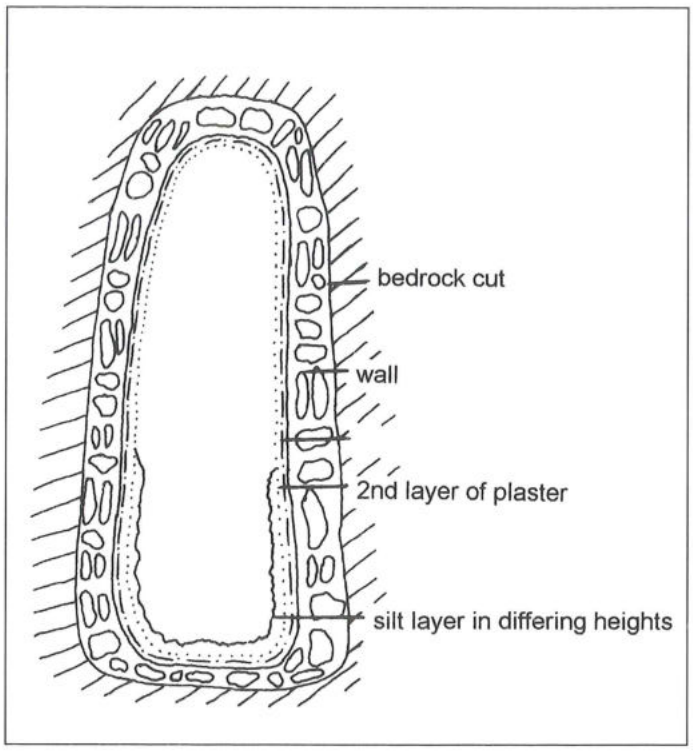
[4] Surveying and measuring instruments were available for Roman engineers (Forbes 1964: 171).

[5] This technique is called " Gegenort" in German (Fahlbusch, 1987:142). The qanat technique is well known in history, and probably developed in Urartu.

[6] Kienast 1983.



1. Plan of Gadara with both tunnels (survey and drawing: Fachhochschule Karlsruhe).



2. Sketch of tunnel construction (design: authors, drawing H.Barnes).

nized in the work-marks along the tunnel.[7] The starting points for the work are generally narrow shafts, which have steep stairs (between 50 and 60 degree) leading down from the town surface. They occur at regular intervals (ca. every 35 m) – as Vitruvius had suggested in his descriptions of tunnel – work (Vitruvius, VIII, 6.3), and, as well as having been used for the construction, might have been planned as maintenance entrances or well-shafts. These "putei" lead down to a landing above the supposed water level or to the tunnel floor.

Lower Tunnel

The older construction (channel A) is of late Hellenistic/ Early Roman origin and was built in at least three different stages. The oldest part is roughly 140m (subareas 7-10) long and has on both sides newer additions, which are slightly differently built. The point where the eastern addition meets the original tunnel is immediately recognizable (subarea 11/10), because of the rather odd angle.

The original building techniques were the following: first the tunnel is cut out from bedrock, the work starting at different entrances, then a covering is built on floor, sides, and ceiling to provide an entirely artificial surrounding for the water. This is a well-known practice mainly for Roman water tunnels like in Lyon or Pergamon.[8]

The eastern addition is very similarly built, and seems to have come in use at the same time or only a little later as the older part of the channel. The western continuation is generally less carefully done (no walling all the way around, less meticulously smoothed surfaces, i.e. the plaster sits straight on the bedrock etc.) and might have been done some time later than the older parts. It takes the water further to the west and into the Roman and later parts of the city.

The plaster consists of at least two different layers of Roman concrete *"opus signinum"*, which were able to hold water with hardly any loss (Lamprecht 1988: 141).

Several outlets from the main channels are made towards the north, all of these side-channels are smaller in diameter and have pipelines for the transport of the water.

The average gradient was 8.8 % in the entire system, while it fluctuates between 8.3 and 9.1%. The waterflow needed to be controlled in order to divide water in the side-channels. The control was achieved by different means: In one case (subarea 4) the waterflow was slowed down by a weir and could flow through a complicated bent pipe (Krümmer), which was supported by an enormous basalt slab, into a northern side-channel (FIG. 3). At subarea 8/7, where the original course of the channel was later changed, the waterflow into the side-channel was diverted by several basalt blocks, which were pierced to hold a clay-pipe. Therefore it was possible to control the outflow all along the line and adjust it according to need in different parts of the city and availability of water.

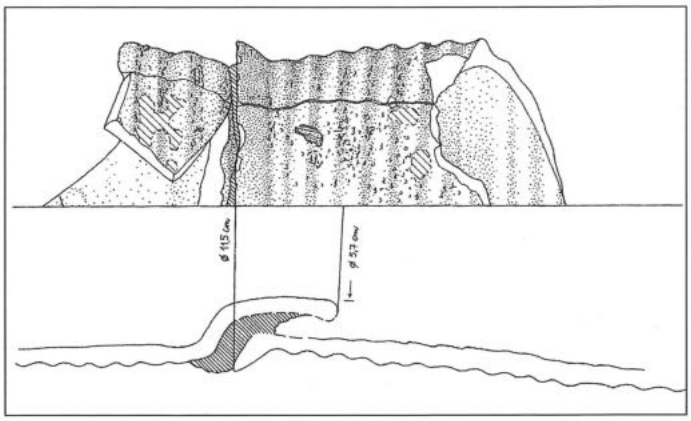
While purely Hellenistic tunnels have often pipes all along the way, here pipes are only used for side divisions. The same technique is used in Caesarea (Peleg 1992). Archaic clay pipes (like in Athens, Tölle-Kastenbein 1994: 46ff.) always had openings and strongly stepped ends, the Late Hellenistic and Roman pipes were without these maintenance features and of smoother shape. The single elements were held together by a mixture of lime, ash and oil (Landels 1978: 44). Towards the end of the channel a water-chamber with three different levels controls the outflow. So-called water castles are another common feature in Classical water systems. The construction here is rather small and less complicated than the ones in Pompei or Nîmes (Fahlbusch 1987: S.159). In the water-chamber the water is divided into three different directions. The main channel continues to the north with a nearly unchanged volume, the channel floor has even a small conduit in the middle, to make sure that even the smallest amount of water can be transported. The chamber has then two higher, well-plastered levels to the east and west of the channel. On the middle level, which is badly disturbed, the water most probably flowed through pipes into a small, closed basin, built of walls, where any sediments could sink down. Then the water flowed through other pipes into a much smaller channel towards

[7] Again, this is a very common pheneomenon as it is described for Bologna (Giorgetti 1988: 182) or Saldae (Fahlbusch 1987: 152/3).

[8] The Gier-channel through the Cave du Curée has completely artificially-built walls in the bedrock . The Aksu tunnel in Pergamon is differently built but has also an artificial surrounding (Fahlbusch 1987: 151).



3a. Lower channel (A) in detail (survey FHS Karlsruhe and authors).



3b. Section of pipe-join of lower channel (drawing S.Shreydah).

the west. The highest level to the east was blocked off by a wall with six pipes, through which the water could flow. The main channel and the east channel share the middle wall in the beginning of their course. The water-chamber also has a direct entrance from above. The neccessary level of water (up to 1.60 m) in the chamber was created by damming up the water. The channel was dammed by a weir some 25 m further to the north at the western end of the channel. The weir is built of stone, very well plastered and has four pipe-holes to control the amount of water, which could flow through. The weir had four stepping-stones on the outside, which made control visits possible.

Outside the acropolis hill — after the weir— the water is further distributed in smaller channels with slightly different plaster (Wagner-Lux 1980: 160) and into pipes and lead-pipes. Further down the line even basalt pressure pipes were used (Bol 1990: Figs. 3 and 7).

The younger construction (channel or tunnel B) is built similarly to the western addition of the older channel, but has never been finished. Both constructions, older channel and younger tunnel, are cut all the way from the spring in the east. As far as we can prove, two independent lines were built all the way through the rock. But in spite of all the work, which had been invested to build channel B so far, the finishing touches – levelling the floor, equalizing and smoothing the walls, plastering floor and walls – were never done and the construction was never connected to the aqueduct. Only the first 50 m in the acropolis hill show the first step of smoothing.

Overland Tunnel and Channel

Roughly 23 km of tunnels cut inside the hills (in an area, which is 12 km as the crow flies) were found. The length is due to the fact that the tunnels follow the contour-lines along the hillsides. It is impossible to follow the course inside the hill or excavate it all the way, because the tunnels are blocked up entirely at several points. But the different entrances (horizontal or vertical to a level above the waterflow), the partly accessible shafts and the different inner linings or cross-sections show very clearly, to which of the two constructions the part in question belongs. The younger channel shows rough walls all the way through, while channel (A) is plastered. It is possible to see through holes from one tunnel into the other at several points.[9]

Both tunnels run parallel and follow the contour line of the hills, which means the tunnels follow every valley all the way in and out. The only way to shorten this would have been the construction of an aqueduct, which has obviously been avoided except in Umm Qays itself. The natural stone is relatively easy to cut and in keeping inside the hill one avoids all risk, which an open construction such as an aqueduct might pose. The water is also safe from evaporation and pollution.

'Ayn Turāb is not the main watersource for the tunnel. This tunnel still holds water coming out of an artificially-cut tunnel, which continues for at least 200m to the east. We, therefore, assume at present, that the water of 'Ayn Turāb comes from a spring even further east or 'Ayn Turāb is not a spring in the normal sense but cuts into groundwater. To be certain about this question, further research in 'Ayn Turāb itself is needed.

'Ayn Turāb has 7 l/s, while the channel in Umm Qays would have had 124 l/s as a maximum flow. The hydraulic formula for this measurement includes the height, density and thickness of water-residues in the channel. So other springs must have been used as well. The tunnel possibly collected water from 'Ayn Umm al-Laja, springs at Ibdar, in the Wādī Umm Kahraq, and in the wadi at as-Sarif. If one climbs into the modern concrete spring linings, one finds the old channel course directly behind it. And as well as all these springs additional surface water was used: small channels (up to 20 cm wide) ran along the rocky surface and collected surface water over large catchment areas (FIG. 4). The water was directed through small shafts into the underground tunnels.

9 At the point where the tunnels cross from the north side of the modern road to the south side and at 'Ayn Turāb.

At a certain point the tunnels cut through the hills and continue on the south side of the road, which avoids the large bend around Malka. Only in modern Umm Qays the builders faced a problem, which they could only solve by building an aqueduct. Here, there was no possibility to exploit the natural conditions any more. But having been carried in an aqueduct over the valley the water-course then immediately turns again into tunnels (see above). This combination of different structures is very typical for a Classical water-system (Landels 1978: 40).

Only 11 piers and the last arch are left of the aqueduct; with its 60 m length it would have had only one row of arches and had been one of the smaller aqueducts in Classical history (Gabrecht 1987: 38).

The aqueduct was most probably contemporary to the older of the two water-courses, but could have been used for the younger one as well. The artificially-built beginning of the younger tunnel would have been able to hold an aqueduct 'offspring', but there is no sign of such a construction at all. The older channel was supplied from the aqueduct and again several constructions – most of them lost to us – controlled the waterflow carefully.

Dating

Unfortunately it is very difficult to date a construction cut from bedrock. It is not quite clear when the older line went out of use. Bearing in mind, that at least two baths, one nymphaeum and a whole city needed to be supplied, one wants to assume that it worked all the way to the Late Byzantine period. It definitely was repaired several times, as the plaster layers (sometimes straight over water residue and silt) show. At the eastern end and in the oldest parts of the channel plaster was renewed at least three times. The western end of the channel went through a cistern, which silted up and was filled with rubbish sometime during the sixth century AD (Kerner forthcoming).

The younger system – tunnel B – had a very strange history: it was built, never quite finished, certainly never used and finally given up as a project after the middle of third century AD, which is clear from the midden at its western end.

Tunnel B was probably planned as a supplement to channel A and might have been abandoned not long after its beginning, due to financial problems. The interesting difference between the construction of both tunnels is the fact that tunnel B cuts into several cisterns, while the slightly more northern course of the older tunnel A has avoided that completely.

The building time (for the entire course) is very difficult to assess without any information concerning the size of the working teams. The Eupalinos tunnel took 10 years (1040 m long) to be cut in very hard limestone, while the tunnel in Bologna took between 17 and 38 days per unit (a unit was 7.4 m).[10] The lower tunnel A in Gadara would point to a duration between 2 and 3 years depending on the amount of workmen.



4. Tunnel in 'Ayn Turāb.

Northern Jordan

The other – roughly contemporary – water systems in northern Jordan include the channels at Abila, Capitolias/Bait Ras and Khirbat Zeraqun. While the tunnels in Zeraqun have more the character of huge tunnel-shaped cisterns (no distribution outside the hills were found), both decapolis cities have elaborate systems. Capitolias has an enourmous cistern, which would have held several tens of thousand cubic metre of water. Surface water from the surrounding bedrock is channelled into it,[11] other sources are unknown. In no obvious connection with the main cistern is the water tunnel of Bait Ras. The tunnel is again cut out of the bedrock but shows an older design than the tunnel in Umm Qays. Here the actual water channel is cut into the floor of the larger tunnel like in the Eupalinus tunnel in Samos.

In Abila are different tunnels directly at the site but also close by at the Quweilbe spring. The excavators assume that they have tunnels from two different time periods: the Iron Age/ Persian/Hellenistic upper water-course and the Roman/Byzantine lower water-course (Mare 1995: 730). The construction technique seems to be remarkably similar to the tunnels in Umm Qays.

In the wider surrounding, Caesarea (Olami and Peleg 1977) and Humeyma (Oleson and Eadie 1986) show other impressive examples of water-systems from Classical times.

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[10] Samos: Kinast 1979.; Bologna, Giorgetti 1988: 182.

[11] The authors visited the cistern once in streaming rain and although the water was absorbed by the modern filling of the cistern, it was still possible to see the surface-collecting mechanism on the bedrock.

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Ancient Roads in the Roman District of South Peraea: Routes of communication in the Eastern area of the Dead Sea.

Josephus offers some principal statements about Peraea in Bell.Iud. III, 3,3. In length it extends from Machairous to Pella, in breadth from Philadelphia to the Jordan. In the South the so-called district of Moabitis forms the neighbouring country. The historian also writes exactly about its breadth being 120 stadia, that is about 50 to 60 km. In its total length South Peraea measured from Julias/Livias, the former administration centre, to the natural southern border of the Sayl al-Mūjib, also about 60 km.

Thus the Roman district of South Peraea had been a relatively definitive geographical area. The statements of Josephus are astonishingly exact. They reflect knowledge, not opinions. But until recent times this area had been virtually an unknown and non-accessible part of the Kingdom of Jordan. It was lacking clear historical outlines and it was uninteresting for foreign travellers and historians, with the single exceptions of U.J. Seetzen and A. Musil, two famous explorers of the 19th century.

Starting with a survey at az-Zāra and Khirbat Mukāwir in 1965 and 1973, where the German Protestant Institute with its director Martin Noth had made occasional excursions shortly before, I tried to collect more detailed information about the forgotten and burnt-out strip of land between the Dead Sea shore and fertile high country alongside the main north-south axis of the King's Highway. Already then the author was convinced that more attention should be payed, especially, to the first plateau. In the past it had been like a comfortable step leading up to the high populated tableland with its rich settlements and wide plains of agriculture. This lower area going down to the Dead Sea was still principally unknown, in any case unnoticed, and uninteresting for non-Bedouin inhabitants and visitors. At the fringe of the forgotten village of Mukāwir, the modern village succeeding the totally demolished fortress of Machairous, one could find a simple path 22 km long between Khirbit al-Libb and the next settlement nearest the erased cone. At that time the asphalt road leading down to the deserted geological fissure of the Wādī az-Zarqā' Mā'īn with its springs and natural hot water reservoirs did not exist. The road alongside the steep declivity down to the first plateau was still unfinished. It was relatively risky or nearly impossible to drive from Mā'īn to the thermal waters and up to the early seventies only the few enthusiasts would walk there. Moreover, there was no modern highway running southward from the village of ash-Shūna alongside the Dead Sea. In 1973 the modern road finished abruptely two kilometers after crossing the lower Wādī al-'Aẓīmī, at this point reaching the northern plain of the Dead Sea shore. Next to the abrupt end of the new road a lonely artillery observer did his military duty. A forgotten guard at a forgotten piece of country! This means, that the whole lower plateau and cliff area down to the Dead Sea was an inaccessible part of the country. There was a conviction since generations that this area had always been a closed district without any archaeological remains, and of course without any significance for historical studies. But this general opinion is erroneous and it had to be corrected. This part of the kingdom of Jordan had never been really an unhistoric *terra deserta.*

First working at Mukāwir in 1973 I was aware of the astonishing regular agricultural connections between the village and the fertile oasis of az-Zāra. It seems obvious that this basic dependence on the agricultural 'supply base' which lay 1 km lower and about 10 km farther has existed since centuries. Maps of the early 19th century provide evidence of such traditions. We may therefore conclude that this habit of life had always had an ancient basis. Three campaigns were necessary to excavate the Herodian villa of Kallirrhoë, today az-Zāra, about 1 km south in Wādī az-Zarqā' Mā'īn. The last season took place in 1989, together with a final geodesic survey started earlier by colleagues from the Fachhochschule Karlsruhe. This large fertile oasis, with its numerous thermal springs of 60 degrees Celsius radioactive waters, was once completely surrounded by a partially well-preserved stone fence. It had extensive harbour installations with moles and roofed corridors, and with staircases and narrow lanes leading up to the residential quarters. About 200 m inside the shoreline, on a rocky terrace, is the Herodian villa of the well-known type of Roman *villae maritimae*, consisting of a peristyle courtyard and extensive contiguous living quarters. The main installation of the courtyard was a swimming pool of about 12 m length and 5m depth, reached by an impressive staircase. Several inviting, adjacent basin-like lower pools served curative

functions. Near the villa area, among the rocks, is the quarry which provided the building blocks for the construction of the royal facilities. About fifty thermal sources with their creeks water the oasis of Kallirrhoë. The rich and singular oasis az-Zāra, northern centre of King Herod's spa, was also embedded in a network of roads, important for the whole region of South Peraea, supposedly developed since centuries and subsequently made permanent (FIG.1).

1. Primarily we must pay attention to the central north-south line, a kind of trunk road. It connected the Jordan Valley with the King's Highway. Until the last centuries this transversal road had the rank of a so-called 'sultaniye', in certain distances protected by watch-towers and consequently renewed and improved by the responsibles of the district. The order of the Turkish empire reflects ancient installations and traditions (FIG.2). After the Jordan ford, this main road to the south climbed up to the first plateau, using the convenient natural cavity of the Wādī al-'Aẓīmī and crossing older settlements, especially near the dolmen fields of Tulaylāt al-Ghassūl. Then, up on the plateau the road joins with a branch coming directly from the north. Both lines unite in the area of Wādī al-



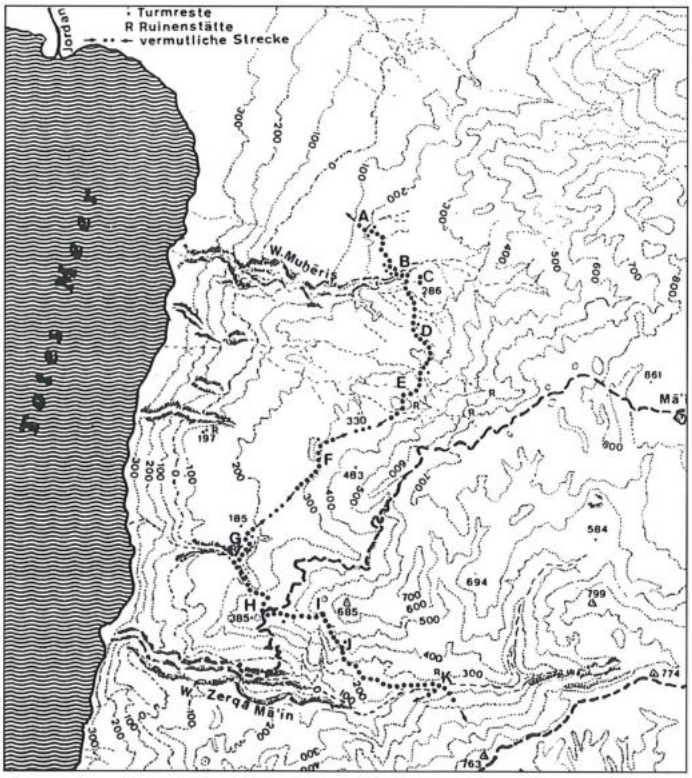
1. Schematic map of ancient roads in South Peraea.



2. Section of the map of Capt. Conder (1881).

Mukhayrīṣ, forming now one main line to the south on the first plateau. It hurries towards the longitudinal ridge alongside the Wādī ad-Dardūr in the west of ʻAyn al-Minye. There it is finally, climbing up a limited plateau elevation, called the "black hill", where nearby the Bedouins traditionally localize the mythical City of ʻAntar. Having crossed a black basaltic stonefield the road runs 3 km straight on to the south where the deep Wādī al-Himārā incision with its springs offers a place of rest and recreation amidst a walled enclosure. From here the sultaniye climbs up to southeast, always facing the height of Rujum al-Murīqib. After crossing the modern road down to the thermal springs, it goes first up to the ʻArqūb aṣ-Ṣuwān (about 380 m). Arriving at the southern flank of the long extended chain of mountains it makes a definite turn to south-east where one overlooks the whole upper valley of the huge Wādī az-Zarqā'-Mā'īn. Here the road begins to descend. In the upper course it uses a long wadi like a natural conduit. Then, further down, the road surmounts the hilly northern embankment alongside the tremendous geological fissure. Far in the east the valley, with its numerous thermal springs, can easily be crossed before the first cataract, which forms a huge step in the unique gorge down to the basin of the Dead Sea itself. The sultaniye on the first plateau from Wādī az-Zarqā'-Mā'īn may have had a total length of about 18 km. It uses the advantages of nature and area and it was protected by a series of watch-towers alongside. The sultaniye climbs to higher elevations as straight as possible, by about two or three turns. All in all the distance between the Jordan and Wādī az-Zarqā'-Mā'īn was a day's journey (FIG. 3).

2. The continuation from the crossing of the upper gorge up to the main road of the King's Highway on the plain of the Moabite plateau is a separate task and a special section of research. First the ancient road must again climb up the mountain 'threshold' of about 800 m asl. Here, the road first ascends the promontory of Boz al-Mushelle, a mighty summit at the edge of the mesa. It bears the impressive walls of a Moabite border fortress, once controlling the area of foothills and descent down to the Dead Sea. The site must be identified with the ruins of Zereth Shaḥar, the Reubenite town "on the hill of the valley" (Joshua 13:19). Based on existing knowledge and by means of survey work and some short excavations, we found definitely a border fortress of the Moabite kingdom of Mesha (FIG. 4). The large Bronze Age city itself must have covered

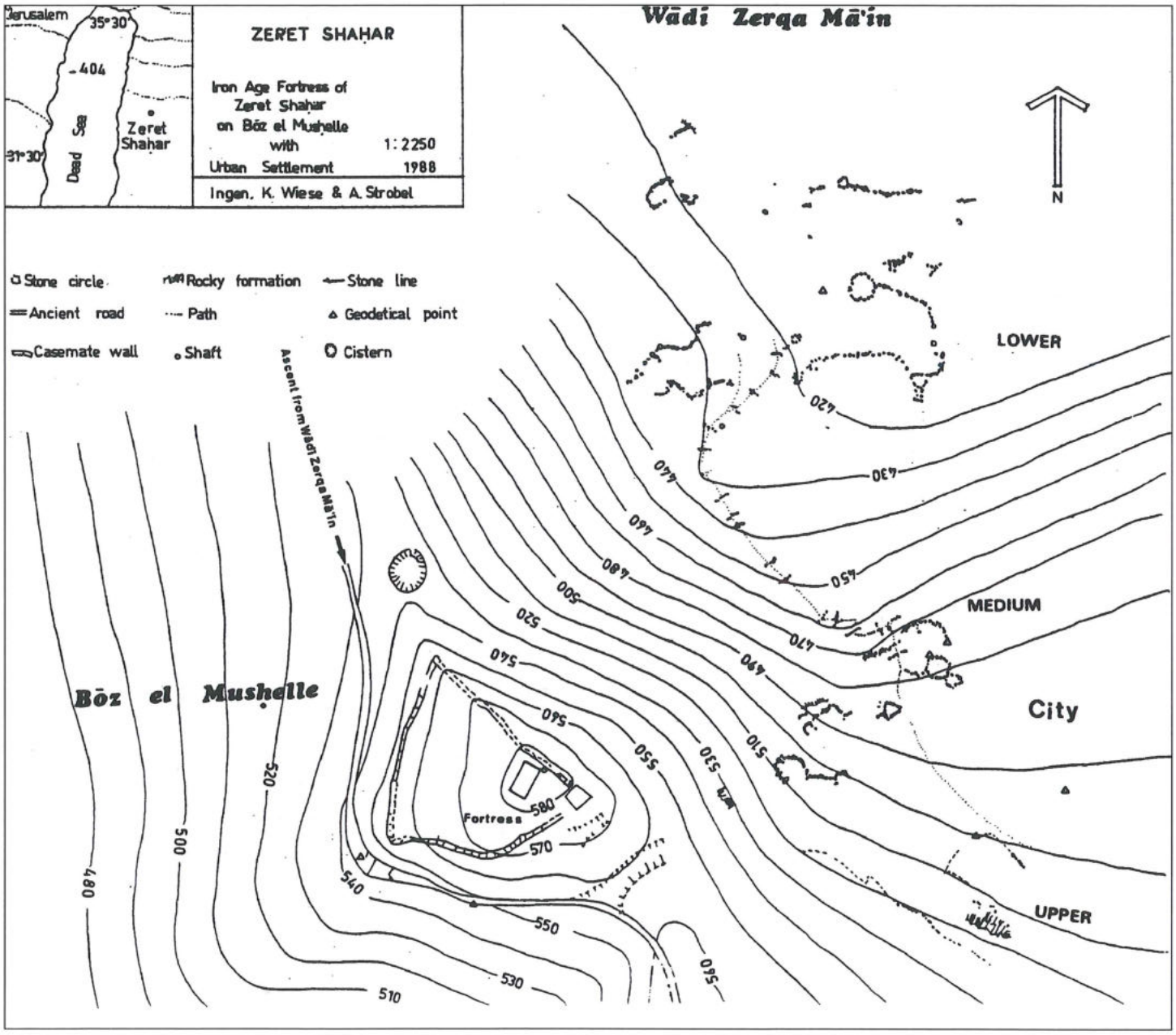


3. The ancient road (A to K) on the first plateau from Wādī al-Mukhayrīṣ to Wādī az-Zarqā' Mā'īn.

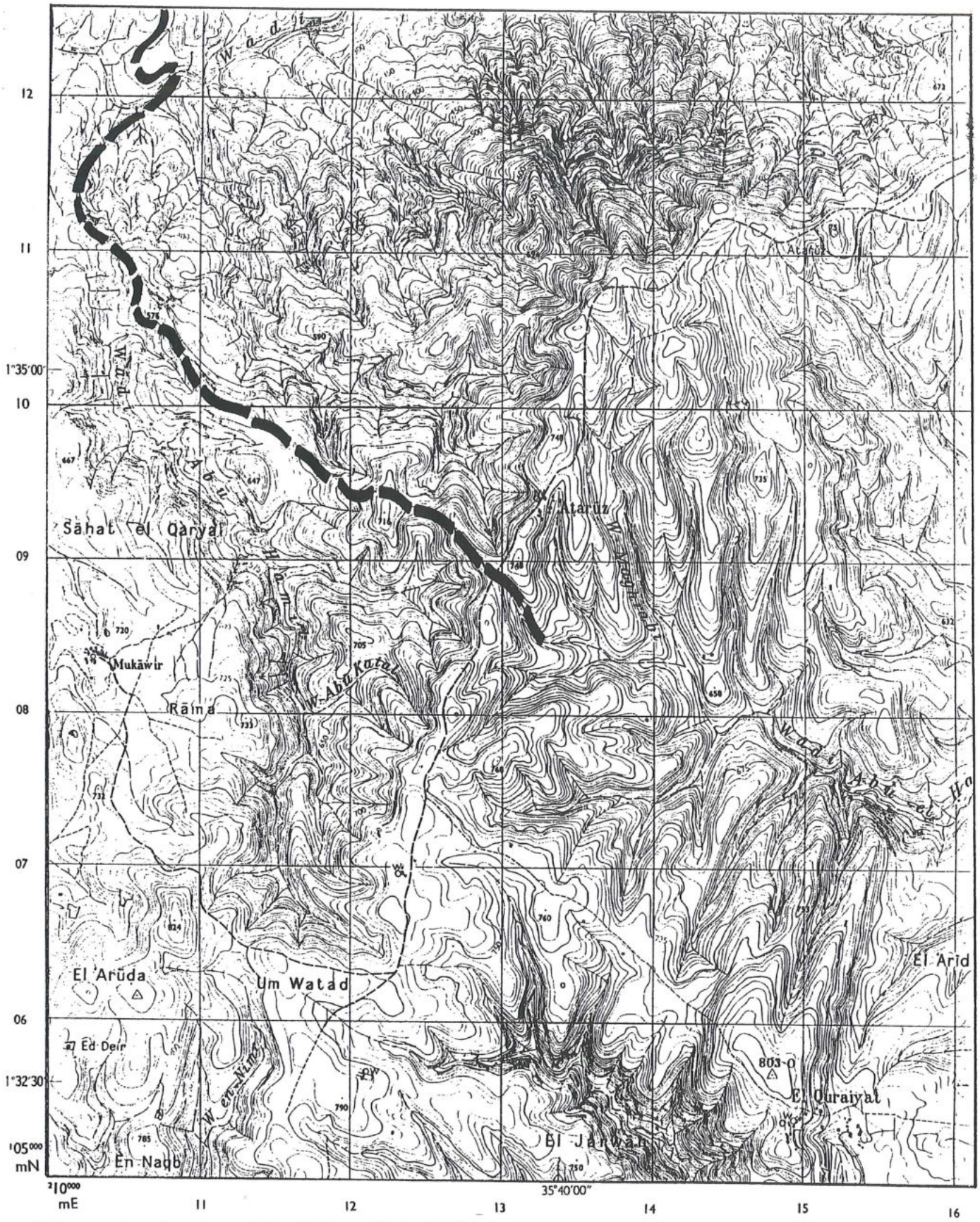
[4] The team on the fields, leaded by G. Gullini, was composed by C. A. Birocco, L. Ferraresi, M. Musso, D. Sangiorgio and the author.

several terraces and was dominated by a three-cornered fortress wall controlling road, foothills and plain. The road hurries from here to Khirbat al-'Aṭṭarūz, about 3 km in the east. There, it takes the south-east direction past the vast ruins of al-Qrayyāt straight down to the upper course of Wādī al-Wāla, where it joins at Khirbat Iskandar (supposedly the ancient site of Jahaz) the well-known central King's Highway (FIG. 5).

3. Having incorporated the side-road coming from the Jordan Valley, this main axis runs southward to ancient Dibon and from there a little bit south-east to the upper course of the Sayl al-Mūjib (or Arnon gorge) in the region of Khirbat 'Arāīr (i.e. Aroer) - according to our knowledge an Iron Age fortress controlling the descent down to the confluence of the two branches Sayl as-Sufīya and Wādī an-Nukhayla. Exactly here at the bottom of the valley one can locate an important site. The modern Arab name of it is Khirbat al-'Ajam, but the abundance and singularity of Bronze Age ceramics are a cogent reason for its identification with the "City of the valley" (Josua 13,9). It means that the fortress of Khirbat al-'Arā'īr and the "City in the valley" must be judged as an original dual settlement, consisting of upper fortress and lower domestic quarters. Importance and unity diminished when Dibon extended her supremacy on the plateau nearby. The original continuation of the highway can be found in the south-



4. The site of Zeret Shaḥar with road and fortress (on Boz al-Mushelle).



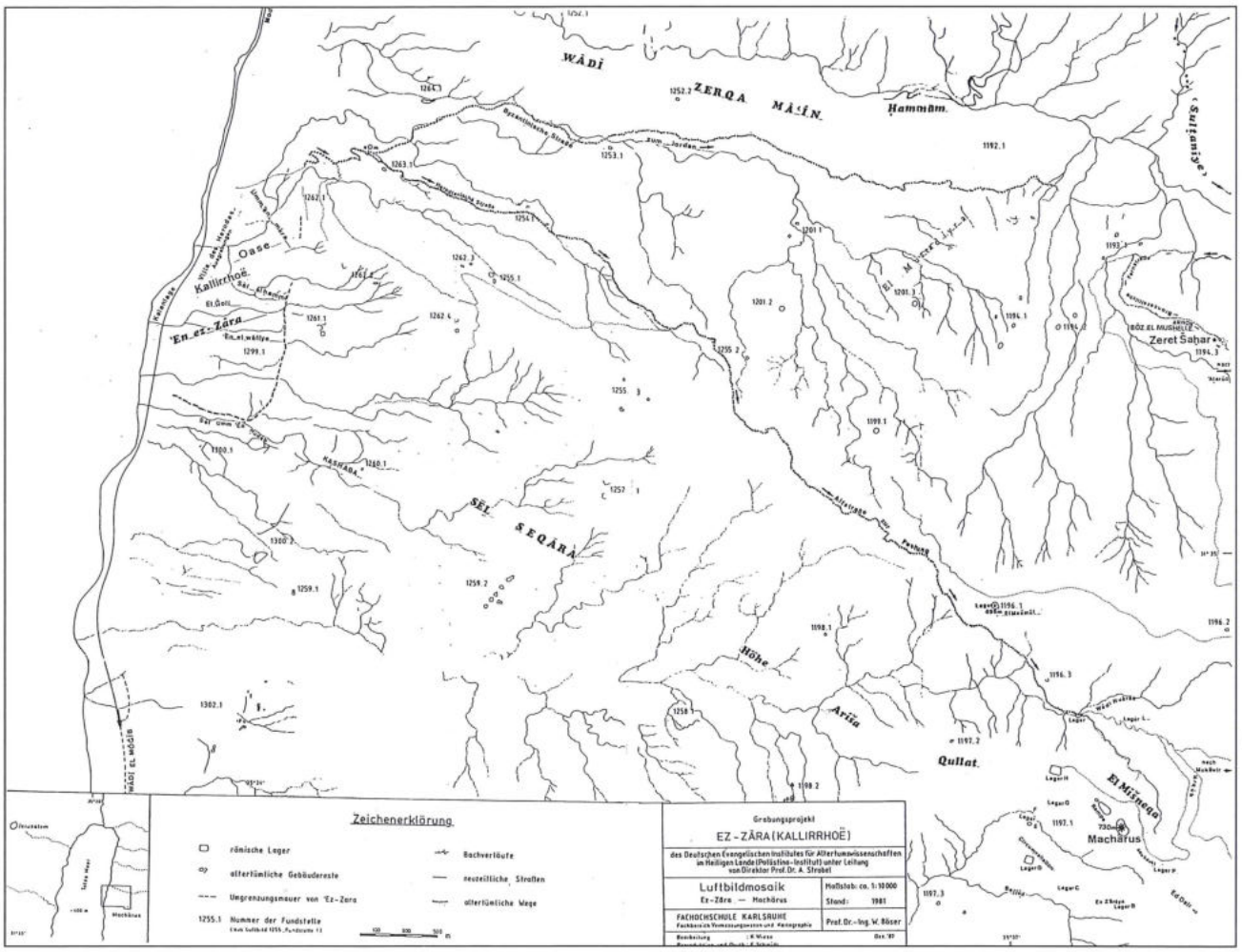
5. Transversal road running to Wādī al-Wāla and Wādī al-Mūjib.

ern branch of the Wādī esh-Shuqayla up to the Bronze Age fortress al-Balu'.

4. Taking stand again at the eastern bottom of the Wādī az-Zarqā' Mā'īn one may follow the whole net of ancient roads in South Peraea. By then, the territory in the south of the ancient transversal main road, representing a lot of fertile centres down to the invincible Arnon gorge, was made accessible for military and economical purposes.

In the southern chain of the al-Balqā' mountains Alexander Jannai had founded the mighty fortress of Machairous in the second century BC, according to Josephus by strength and importance the second one after Jerusalem itself. We must assume that between the transversal line to the King's Highway and the royal bullwork, there existed also a short feeder road. The fortress got its building plot about 3 km far away from the ancient ruins of Zeret Shaḥar.

As important as the dominating fortress had been so was the convenient and quick road connection down to the harbour Kallirrhoë at the Dead Sea with a length of about 10 km. It had to surmount a height difference of more than 1000 m (FIG. 6). Historical documents give sufficient information about the facts, supported and illustrated by research in the three campaigns (see above). The road up to Machairous, today still recognizable by its typical stone embankments, leaves the once fenced-in spa settlement in the east to climb up the first steep slope by several serpentines. From there, at the edge of the geological precipice down to the basin of the Dead Sea, one has an overwhelming view. Then the road runs up straight to the chain of mountains in the east, principally avoiding the basaltic region at the western Wādī az-Zarqā' Mā'īn. After gaining more and more height the road makes an abrupt turn after 4 or 5 km to the south, touching the Sekāra gorge. Here begins the final steep ascent, which brings one to the upper course of the huge geological fall. The road follows the dangerous edge and ends after 1 or 2 km at the terrain of al-Mashnaqa. The stronghold itself had its place upon a high longitudinal ridge. It could be entered at the north-western corner of the walls of the so-called Lower City, protecting the central fortress complex



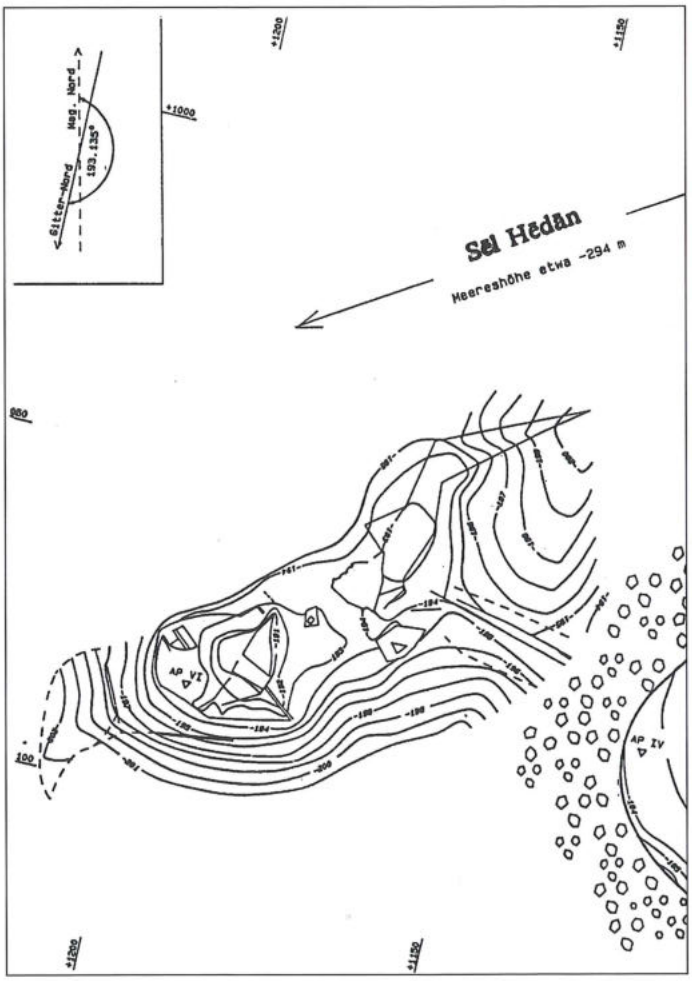
6. The Herodian road from Kallirrhoë up to the fortress Machairous (al-Mashnaqa).

on its northern side. This road was not paved. It was the simple type of the normal rural roads of that time, bordered by kerbstones and adjusted to the natural outlines of the landscape.

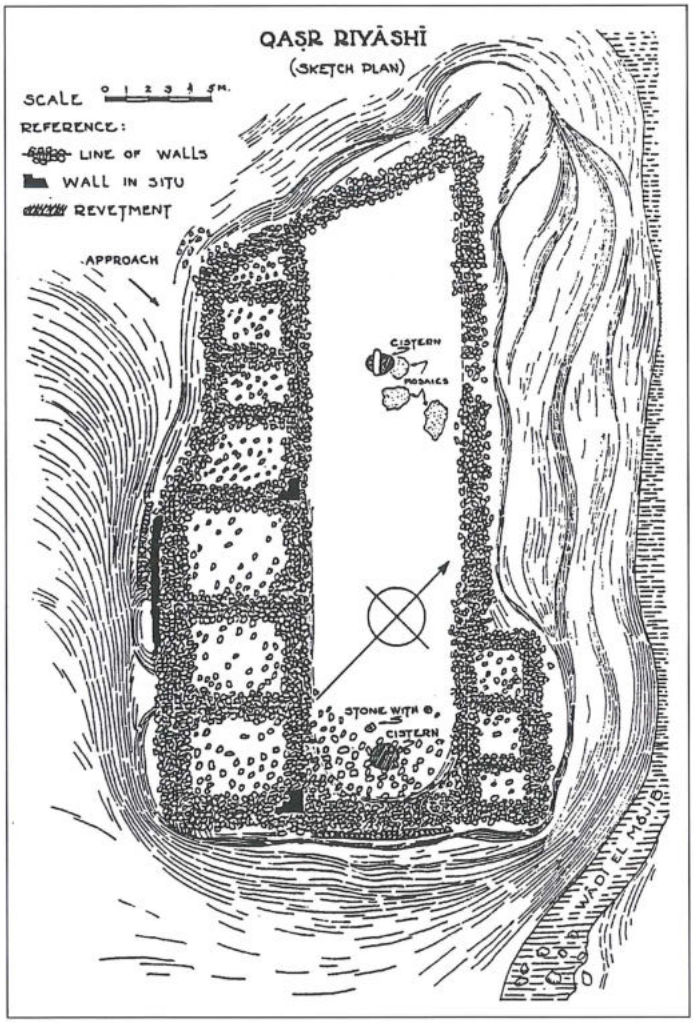
In the lower section of the road, about half-way between fortress and royal oasis, a sideroad to the hinterland of the shore can be detected. It first goes down to the bottom of the lower Seḳāra gorge. Yet we must assume that, once, the sideway had its extension to az-Zāra South and perhaps to the shoreline in the neighbourhood of Rās al-Ghawr. It was suitable for caravans and travellers, but not for heavy traffic. Down to the bottom of the gorge two Byzantine watch-towers are still *in situ*. Evidently there existed another road connection down to the southern coast with its original accumulation of Roman villas (FIG. 6).

There is also no doubt about a road down to the borderline of the impressive canyon of Sayl al-Mūjib, the traditional border between south Peraea and the Edomite country in the south (FIG.1). The road started in the dominion of Machairous, supposedly in the region of ad-Dayr, still in the Byzantine period a populous settlement, from where a descent down to the region of the confluence of Sayl al-Hidān and Sayl al-Mūjib existed. One km after the village, the present road passes three huge Roman cisterns called Umm ar-Rujum. Then the route, supposedly an original route, climbs down to Sayl an-Nimr, following the connection with the settlement complex of the Herodion border fortress, today still well-known as the ar-Riyashī sites, also surrounded by thermal springs. Altogether the large complex of the ancient royal buildings consists of three single localities, all attached to the area of the Qaṣr al-Bashīr Hill. The name reflects the strong ancient tradition which is still common among the Bedouins.

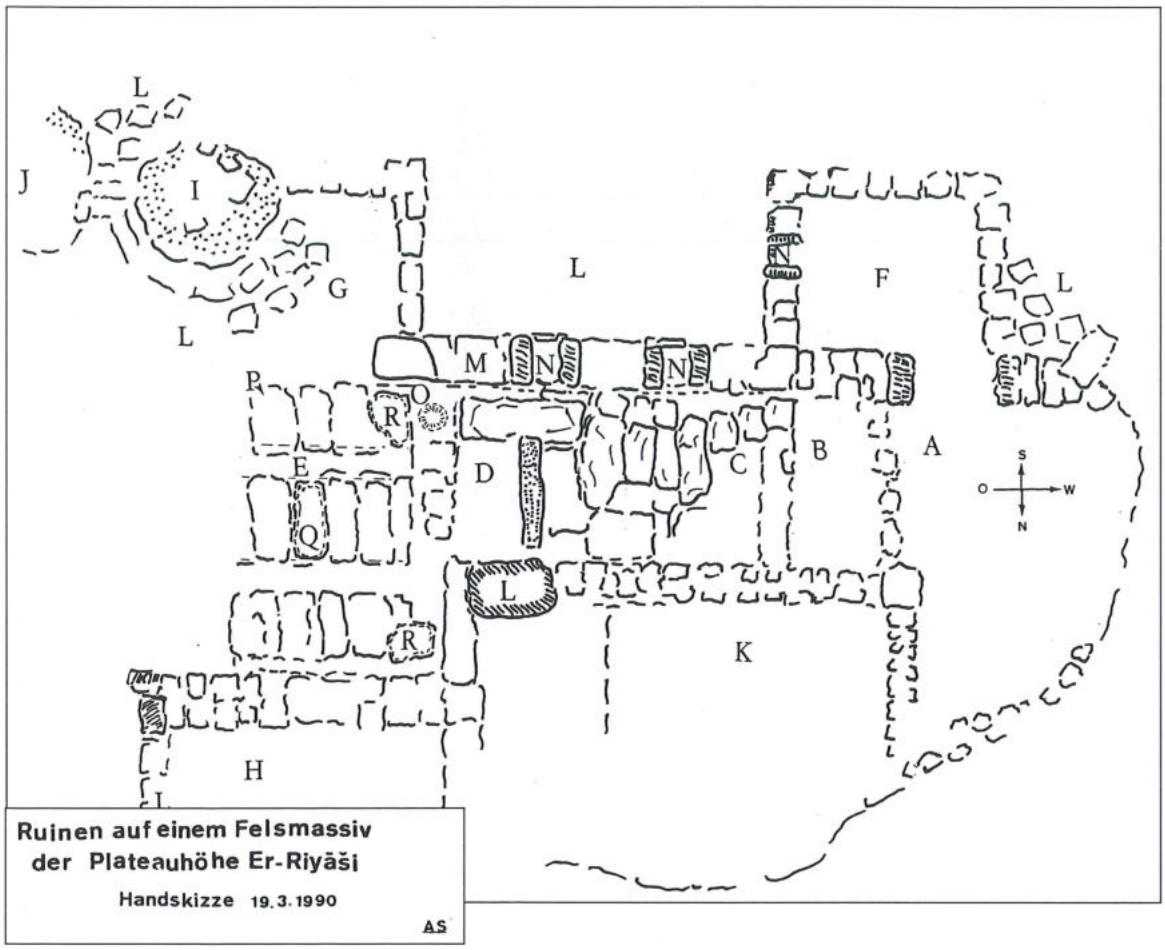
Three sites deserve special study. One is a pleasure retreat near the thermal springs in Sayl al-Hidān (FIG. 7), known as al-Ḥammām, that occupies a ridge overlooking the southern cliffs of the wadi. There are remains of many rooms, cisterns and an aqueduct, and mosaic-decorated terraces giving fine panoramic views. Second, nearby and to the south-east (FIG. 8), there is the main fortress looming over the Sayl al-Mūjib and dominating the northern borderline of Idumea. Third, in the immediate neighbour-



7. The Herodian castle (Qaṣr ar-Riyashī) near the thermal springs of Sayl al-Hidān.



8. The Herodian fortress (Qaṣr ar-Riyashī) at the Arnon gorge (Sayl al-Mūjib) according to the sketch plan of N. Glueck.



9. Sketch of the pavilion-like ruins on the plain near the fortress(J = place of the sundial in March 1990).

hood of both these royal structures there is a park-like plateau over a rocky formation with a special building and some interesting installations. The most exciting object found during the short survey and excavation work in the spring of 1990 was a conical Herodian sundial that had originally been situated on the peak of the 20 m high rocky massif which was once surrounded by walls and roofed forming a well-built pavilion-like structure. Today the Bedouins still call the large site Qaṣr ar-Riadji, "castle of Herod". They also call the pavilion-like ruins Tulūl Abū al-Filūs immediately over the confluence of the united rivers (FIG. 9).

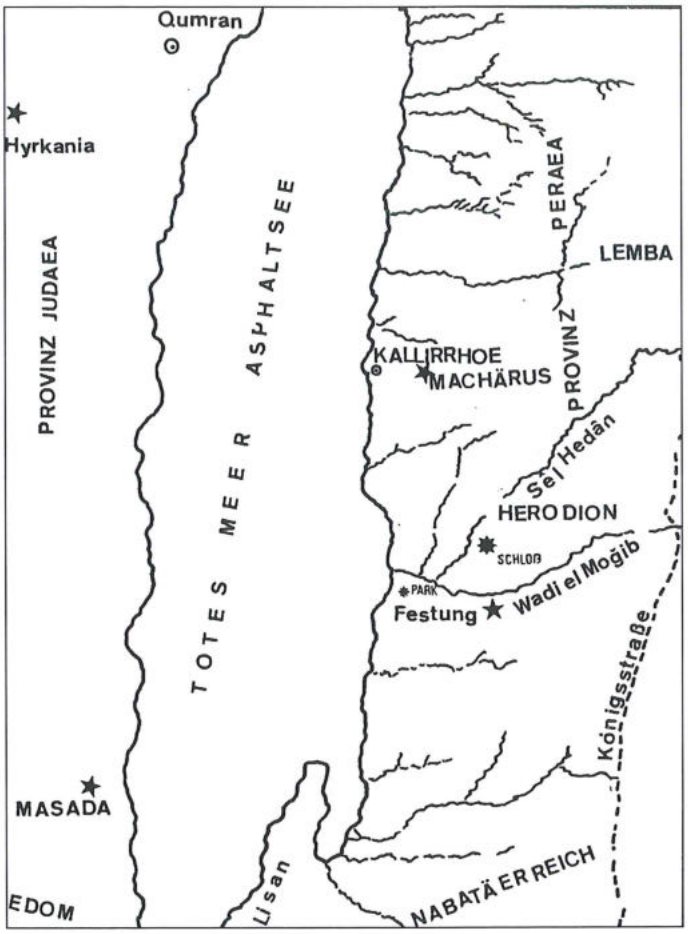
Castle and fortress were linked by a partially stepped passage, which we still can follow. A natural rock-bridge over the huge Arnon gorge granted the passage, supervized and controlled by its military authorities. The site itself gets special meaning by the following well-documentated historical affair.

Josephus delivers an impressive story *(Bell.Iud.* XVIII,5,1) about the love affair of tetrarch Herod Antipas with his cousin Herodias. The sovereign of Galilee and Peraea, already married to a Nabataean princess, had to expell his legitimate wife, - this was the condition of the new marriage contract. About this shameful agreement the princess received early information. Resolutely, the cheated woman made up her mind for separation and flight. The end of this matrimonial quarrel becomes clear in the geographic context of the frontier area of south Peraea. The Nabataean princess pretended, for reasons of health, a necessary stay in the castle of Machairous. At night, she ordered to be brought to the border nearest to her involuntary stay. There she could flee into the arms of her waiting father. The historical report is illustrated and supported by geographical and archaeological facts, the close connection between the two fortresses Machairous and Herodion (FIG. 10).

Conclusion

The main traffic routes of south Peraea can no longer be questioned. We must stress the fact that an ancient road connecting the Jordan Valley and the King's Highway is well preserved until today. It is also possible to suggest about further enlargements of the road in later periods, primarily in the Late Hellenistic and Roman eras.

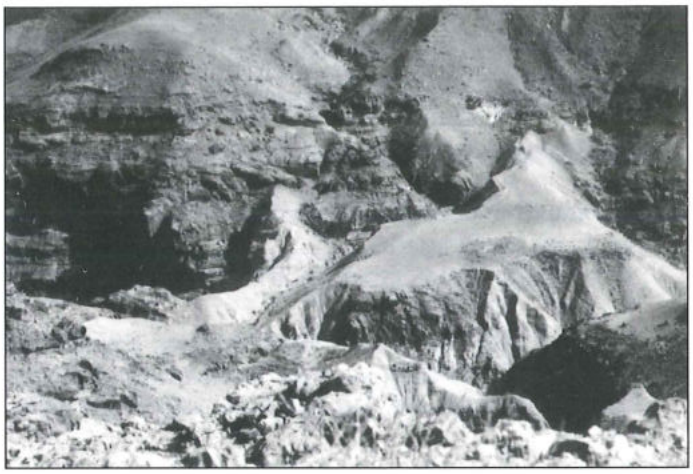
1. The most ancient, and without doubt the most important route, had always been from the lower Jordan River up to the central axis of the King's Highway - an Early Bronze Age installation with historical relevance for all ages and periods. It is accompanied by impres-



10. Sketch plan of the Herodian sites in South Peraea at the border of the Nabataeans.

sive settlements and cities like Zeret Shaḥar (Boz Mushelle) in the Upper Wādī az-Zarqā' Mā'īn, Khirbat al-'Aṭṭarūz on the High Plain, Khirbat Iskandar in the Lower Wādī al-Wāla nd above all the "City of the valley" in the Upper Wādī al-Mūjib. There is absolutely no question about the relevance of this road since the origins of biblical settlement history, starting with the so-called conquest of the Holy Land by Israelite tribes and followed by the coming up of the Moabite Kingdom and its followers.

2. In the Hellenistic period and especially at the height of the Roman empire, the network of roads was enlarged. We must especially take notice of the road between Kallirrhoë and Machairous that is between the harbour and the central fortress of south Peraea. Another junction between Machairous and the Herodion border fortress must also be presumed (FIG. 11). They both lost their basic functions after 70 AD.
3. Of course, there may have existed some other roads, especially within the periphery of the central crossing point in the area of the Upper Wādī az-Zarqā' Mā'īn, supposedly up to the city of Mā'īn and a route from here also to the supply line between the fortress and harbour oasis. A strip of Roman villas in the area of



11. View down to the fortress Qaṣr ar-Riyashī (i.e. "Herodian in the Arab Mountains") at the precipice of the Arnon gorge with rocky viaduct crossing nearby.

az-Zāra South must have had connections to the interior of the country. In each case one may suggest another ancient route near the southern hill countries of the Dead Sea.

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L'habitat rupestre dans le bassin de Pétra à l'époque nabatéenne

On a longtemps cru que le site de Pétra se composait exclusivement de nécropoles, de quelques sanctuaires et des monuments publics de la ville basse[1] mais on s'accorde généralement à y voir aujourd'hui une agglomération aux fonctions multiples, au sein de laquelle une large place était réservée à l'habitat.[2] Qu'ils soient rupestres ou construits en blocs d'appareils, les vestiges domestiques doivent donc être considérés, au même titre que les autres catégories de monuments, comme des éléments constitutifs de l'espace urbain de la capitale nabatéenne. Enfin, si on accepte comme hypothèse que les zones habitées et les nécropoles étaient, au moment de leur utilisation, géographiquement séparées, on peut admettre que l'analyse de leur répartition permet d'affiner la chronologie de l'occupation du site.

Malheureusement, si l'habitat construit en blocs d'appareil commence à être mieux connu, grâce notamment aux fouilles entreprises par R. Stucky sur la colline d'aẓ-Ẓanṭūr,[3] l'habitat rupestre n'a encore fait l'objet d'aucune étude d'ensemble. L'exploration archéologique menée depuis le milieu du siècle dernier s'est en effet peu intéressée à cette catégorie de vestiges moins spectaculaire que les tombeaux aux façades décorées, contribuant ainsi à véhiculer l'image d'une ville-nécropole ou d'une ville-sanctuaire aujourd'hui dépassée. G. Dalman est le premier qui, au début de ce siècle, se soit intéressé à ces grottes plus ou moins frustes, les qualifiant de "Kammer", de "Felsenkammer", de "Felsensaal", de "hoher Saal", de "Cella",etc.[4] Plus tard, dans les années trente, les travaux de G. et A. Horsfield ainsi que ceux de M. Murray ont permis de jeter un éclairage plus scientifique sur ces monuments.[5] Ils ont fouillé, relevé, ou simplement exploré plusieurs ensembles domestiques en différents points du site: dans le Wādī aṣ-Ṣiyyagh, sur le versant est d'al-Ḥabīs, sur les pentes du Jabal al-Mu'ayṣara, en face du théâtre, sur le plateau du Dayr et dans le Wādī Abū'Ullayqa FIG.1 Plus récemment encore, entre 1976 et 1978, une équipe du *Naturhistorische Gesellschaft Nürnberg* (NHG), en collaboration avec F. Zayadine et le Département des Antiquités de Jordanie, a procédé au dégagement d'une petite chambre rupestre située au pied du Jabal al-Khubtha.[6] L'ensemble de ces travaux représente un total d'environ 210 chambres rupestres plus ou moins bien documentées qui ont été intégrées dans l'inventaire nouvellement réalisé (voir ci-dessous).

En 1974, l'Institut Géographique National français (IGN) a pris, au-dessus de Pétra, une série de 197 clichés aériens avec recouvrement partiel. Cette couverture aérienne, réalisée au 10 000^{e} en noir et blanc et en couleur, a permis à une première équipe de chercheurs, composée de M. Gory, J.T. Milik, F. Zayadine ainsi que du regretté Père J. Starcky, de lancer un programme de prospection systématique du site afin d'en repérer les monuments et les inscriptions. L'objectif final était la réalisation d'une carte archéologique au 1:2 000^{e} qui ne verra cependant jamais le jour.[7] En 1988, le projet a été remis sur les rails par l'ERA n°20 du Centre de Recherches Archéologiques du CNRS.[8] Plusieurs campagnes de prospection (1988, 1989, 1991, 1993, 1995), menées avec l'aide efficace d'un ingénieur cartographe de l'IGN, René Saupin, ont abouti à l'enregistrement et à la cartographie de près de 3 000 monuments, parmi lesquels figurent 570 chambres rupestres inédites [9] qui viennent s'ajouter aux 210 chambres répertoriées depuis le début du siècle. L'essai de synthèse qui suit repose presque entièrement sur l'analyse de ces données et sur celle de la carte archéologique, désormais disponible au 1:2 500^{e} pour l'ensemble du site. Loin de prétendre faire le tour de la question de l'habitat rupestre à Pétra, il vise seulement à présenter quelques éléments de réflexion sur les modes d'installations

1 " ... despite their economic prosperity and artistic achievements in sculpture and architecture, the Nabateans never attained urbanisation - even Petra in the first century CE is more of a national shrine than a city" : Negev 1976: 235.

2 Voir les conclusions de McKenzie 1990: 105 : " Thus, as might be expected, Petra was an ordinary city of the living with most of its tombs outside the city walls."

3 Voir en dernier lieu Stucky, Gerber, Kolb et Schmid 1994 avec bibliographie antérieure donnée p. 271 et p. 275 n. 6. Pour une synthèse sur les fouilles d'ensembles domestiques non rupestres, voir McKenzie 1990: 105-107.

4 Dalman 1908 et Dalman 1912.

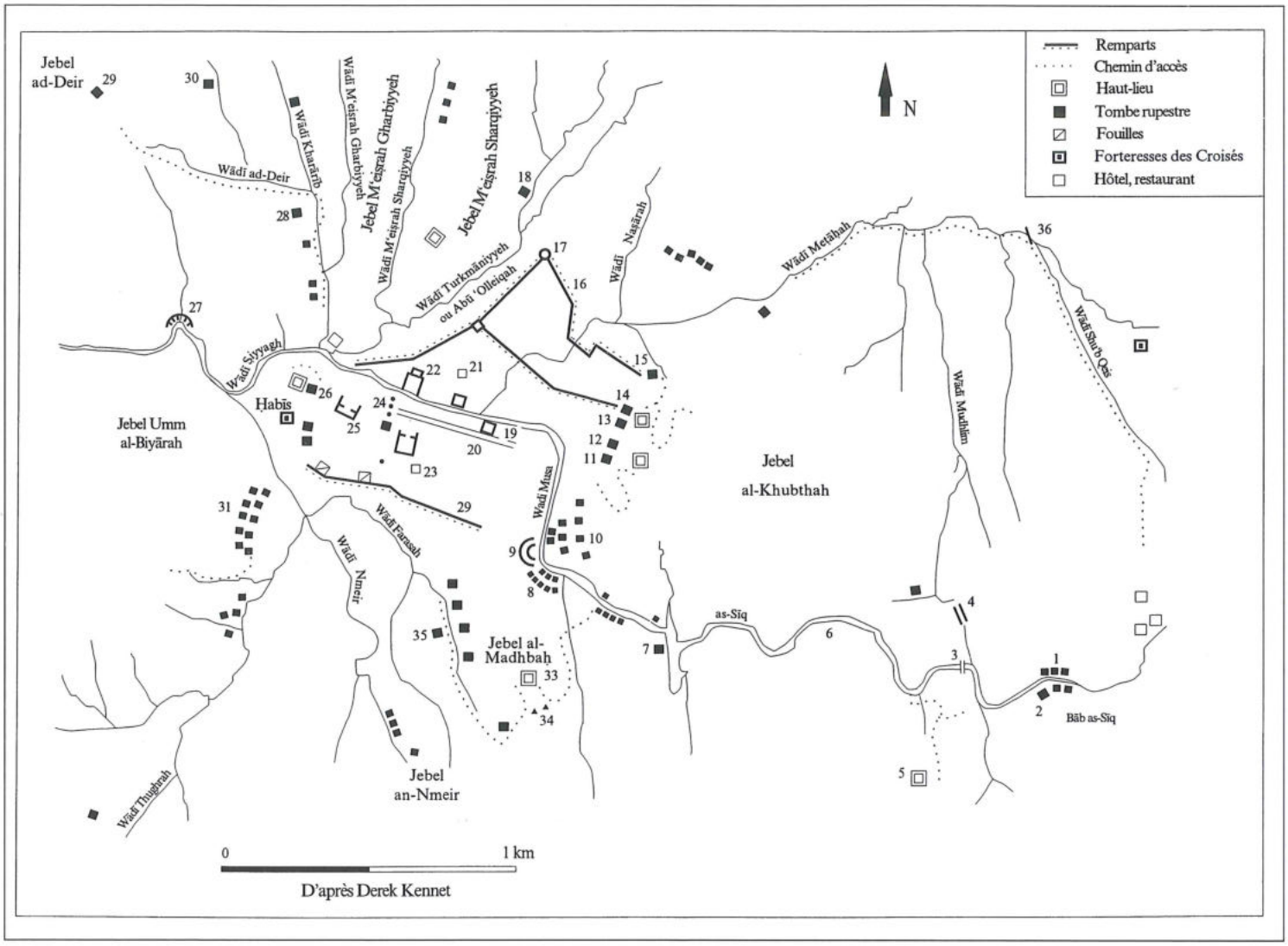
5 Horsfield et Sela 1938 et Horsfield et Sela 1938-1939; Murray et Ellis 1940.

6 Zayadine 1974: 135-139, FIG. 1-2 et pl. 58.

7 Sur les travaux de l'IGN à Pétra, voir Gory 1976.

8 Archéologie de la Syrie du Sud et de la Jordanie du Chalcolithique à l'avènement de l'Islam.

9 Pour les résultats auxquels ont abouti ces recherches, voir Dentzer et Zayadine 1992 ainsi que Nehmé 1994.



1. Carte schématique du site de Pétra .

1. Tombeaux "Djinn"
2. Tombeau aux obélisques
3. Digue
4. Tunnel de dérivation
5. Secteur d'al-Madras
6. Le Sīq
7. La Khazneh
8. Terrasses avec tombeaux
9. Théâtre
10. Tombeau d'Uneishū
11. Tombeau à l'urne
12. Tombeau soie
13. Tombeau corinthien
14. Tombeau à étages
15. Tombeau de Sextius Florentinus
16. Rempart nord
17. Tour Conway
18. Tombeau dit du Turkmāniyyeh
19. Nymphée
20. Voie à colonnade
21. Petra Church Project
22. Temple aux Lions ailés
23. Fouille de R.A.Stucky
24. Triple arche
25. Qaṣr al-Bint
26. Musée
27. Carriéres
28. Triclinium aux lions
29. Le Deir
30. Qaṭṭār ad- Deir
31. Nécropole d'Umm al-Biyārah
32. Rempart sud
33. Haut-lieu d'al-Madhbah
34. Obélisques
35. Tombeau du soldat romain
36. Aqueduc

domestiques à Pétra tels que le dépouillement bibliographique, la prospection de terrain et surtout la cartographie permettent de les entrevoir.[10]

Il est évident que les chambres rupestres taillées dans le rocher n'ont pas toutes une fonction domestique et les chiffres donnés ci-dessus excluent à la fois les chambres funéraires et les chambres dites cultuelles. La distinction entre ces trois fonctions est toutefois souvent difficile à faire en raison de la sédimentation d'origine naturelle ou humaine (fumier, cendres) qui sévit avec plus ou moins d'intensité sur le site. En l'absence de dégagement préalable, seule solution réelle au problème, le critère d'identification que nous avons adopté est le suivant: est considérée comme domestique toute chambre qui ne contient pas d'aménagement de type funéraire (*loculi*, tombes à fosses, etc.) ou cultuel (inscription dédicatoire, au moins une

10 Je voudrais remercier ici mon collègue et ami René Saupin. Sans sa précieuse collaboration de tous les instants, la carte archéologique de Pétra n'existerait pas.

niche avec bétyle ou autel, etc.) ou toute chambre dans laquelle aucun de ces aménagements n'est visible. Combiné à la cartographie des vestiges qui permet de déterminer le contexte archéologique de chaque monument, ce critère semble avoir donné des résultats qui, nous l'espérons, pourront être vérifiés un jour.

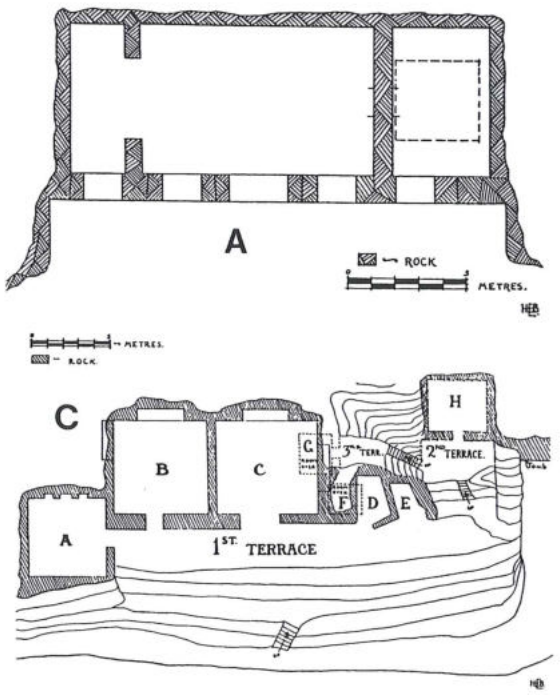
Il faut bien sûr garder à l'esprit que les chambres rupestres ne sont pas le seul type d'habitat attesté à Pétra. Les maisons construites en blocs d'appareil en sont un autre mais il existe également, semble-t-il, un habitat sous la tente identifié par Z. al-Muheisen dans la région d'al-Baq'ah au nord de Pétra [11] et surtout par R. Stucky dans un sondage profond réalisé dans l'une des pièces du complexe d'aẓ-Ẓanṭūr.[12] Ce dernier a en effet livré des couches d'un type particulier, associées par le fouilleur à un habitat sous la tente qui aurait perduré à cet endroit jusqu'au Ier siècle avant notre ère.

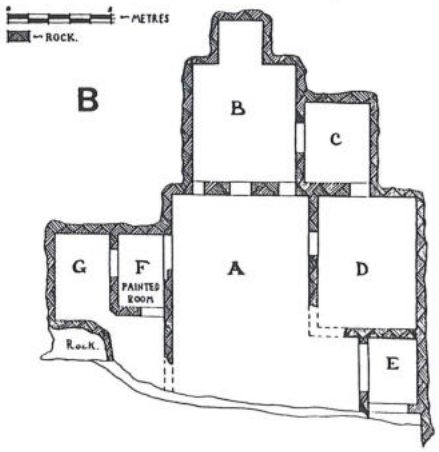
Formes et typologie de l'habitat rupestre

Hormis celles qui se composent d'une seule grotte, telles que le n°9001,[13] les habitations rupestres de Pétra se répartissent en trois catégories selon la disposition des pièces : le long d'une terrasse, les pièces communiquant ou non entre elles (n°400, FIG. 2A), autour d'une cour centrale (n°9006 [14], FIGS. 2B et 3), ou enfin l'une au-dessus de l'autre et reliées par un escalier (n°606-607, FIG. 2C [15] et Khb 35, FIG. 4). Il faut ajouter à cela d'une part les pièces d'apparat, chambres de grandes dimensions, hautes de plafond et généralement voûtées en berceau (n°758, FIG. 5, n°835) qui ont pu servir de lieu de réunion ou de festivités à plusieurs ensembles domestiques et d'autre part quelques ensembles à caractère luxueux, exceptionnels par le nombre de pièces qu'ils contiennent, le décor qu'ils ont reçu ou leur position sur le site (n°1363-1369,[16] FIG. 6, Sy15-18, 9005 [17]).

Les dimensions des grottes varient de 3 à 12 m de côté environ, la plupart des maisons à pièce unique appartenant cependant à un module moyen de 5 à 7 m. Dans les maisons à plusieurs pièces, par contre, les dimensions varient de l'une à l'autre, ce qui traduit vraisemblablement une spécialisation de l'espace habité. A seule fin d'illustration, on peut rappeler à ce propos les remarques formulées par les ethno-archéologues sur la façon dont les Bdul, les bédouins de Pétra, ont organisé leurs activités domestiques dans les grottes antiques qu'ils habitaient jusqu'à une date récente. Ils ont en effet observé que lorsqu'une famille occupait plusieurs grottes, chacune d'entre elles était dévolue à un usage particulier (bergerie, cuisine, four, salle de réception, etc.).[18]

De très nombreuses chambres rupestres sont largement





A. al-Ḥabīs (Horsfield et Sela 1938, QDAP 7,fig.6p.28)

B. Théâtre (*ibidem*,fig.3p.20)

C. al-M'eiṣrah est (*ibidem*,fig.a p.17)

2. Plans de maisons rupestres.

11 Al-Muheisen 1986: 191. Il s'agit de trous de poteaux à côté desquels l'auteur a repéré des tessons de céramique nabatéenne.

12 Stucky 1993: 50-52.

13 Voir n. 6. Les numéros inférieurs à 1000 correspondent au catalogue de Brünnow et Domaszewski 1904-1909, les numéros compris entre 1000 et 2000 correspondent à ceux de Dalman 1908 et 1912 (enlever le 1 initial pour retrouver la numérotation de Dalman), les numéros compris entre 2000 et 10 000 correspondent à des monuments décrits dans d'autres publications et enfin presque tous les numéros précédés d'une ou deux lettres, telles que Sy, WD, M, etc., sont inédits.

14 Horsfield et Sela 1938:19-20, fig. 3 et pl. 47 ; Zayadine 1987: 140.

15 Horsfield et Sela 1938: 17-18, fig. 1.

16 Pour cet ensemble, voir désormais Lindner 1989.

17 Horsfield et Sela 1938: 18-19 et fig. 2.

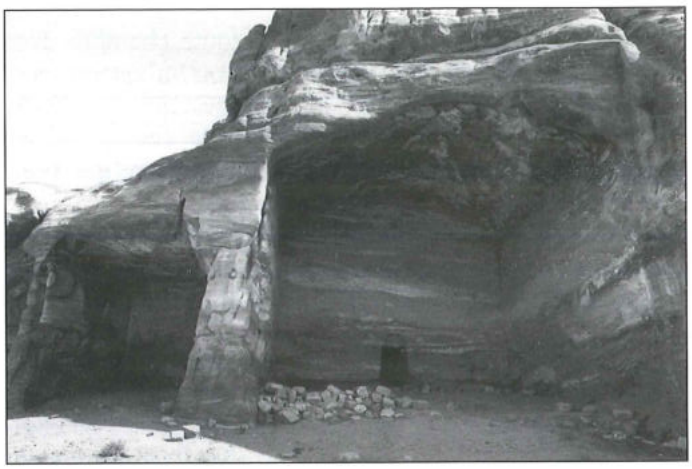
18 Ohannessian-Charpin 1986: 394. Pour une présentation générale de l'habitat bédouin à Pétra, voir Bienkowski 1985 et 1989.



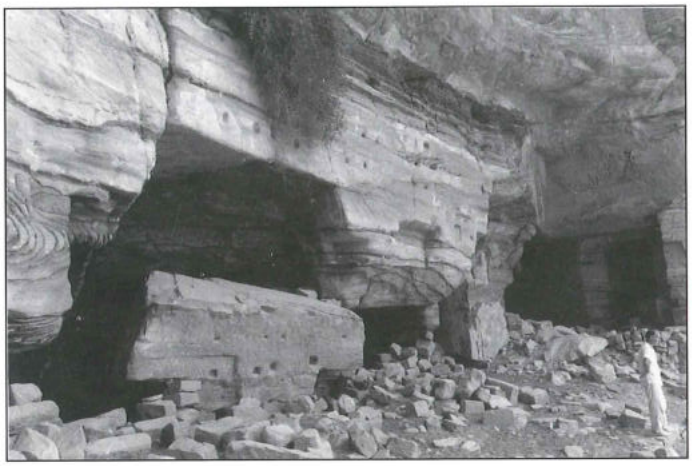
3. Maison n °9006 en face du théâtre.



4. Maison n °Khb35 le long d'al-Khubtha.



5. Chambres n °757(gauche) et 758 (droite).



6. Ensemble exceptionnel n°1363-1369 à Umm al- Biyāra.

ouvertes sur l'extérieur et ne possèdent donc aucun système de protection contre les intempéries ou les visiteurs indésirables. Les autres s'ouvrent par des portes, de largeur variable, mais l'érosion a souvent effacé jusqu'à l'encadrement plus ou moins élaboré dont elles étaient munies. A plus forte raison, les éventuels systèmes de fermeture ont presque tous disparu puisque moins de cinq exemples, tous inédits, sont conservés (By6, H37, Mg35). Quant aux vantaux des portes, qui étaient peut-être en bois, il n'en subsiste aucune trace sur le site. Enfin, les chambres pourvues de fenêtres son très peu nombreuses (n°400, M147, H54, Sy8 par exemple), celles-ci étant plutôt caractéristiques des salles de banquet qui en possèdent souvent une ou deux en façade.

La décoration intérieure ou extérieure des maisons est un phénomène rare qui semble limité à quelques ensembles luxueux. On compte quelques exemples de stucs et enduits peints, notamment dans le Wādī aṣ-Ṣiyyagh. Le plus connu est une pièce de 3x3 m (n°9005 [19]) pourvue d'une alcôve plus petite, dont les parois sont couvertes de fresques simulant une architecture intérieure (portes avec entablement et fronton notamment), peintes dans les tons bleu, orange, rouge-foncé et jaune et datées du premier siècle av. J.C. A proximité immédiate de celle-ci, deux autres pièces [20] présentent quant à elles un décor stuqué: Sy17 dont le plafond, orné d'un médaillon mouluré, est entouré d'une frise peinte de S entrelacés et Sy16 qui porte dans un angle un élément à denticules (FIG. 7). Lorsque les murs ne portaient ni peintures ni stucs, un effet décoratif pouvait être obtenu en ménageant aux angles de la pièce et sur toute sa hauteur une bande d'une dizaine de centimètres de large où le rocher était taillé verticalement ou en arêtes de poisson, le reste de la paroi portant les traces habituelles de la taille à 45°, dite nabatéenne [21] (Sy81). Enfin, quelques chambres rupestres présentent en façade des structures non rupestres comportant des éléments de décor architectural. C'est le cas de l'ensemble de chambres aménagées sur une terrasse de Umm al-Biyāra (n°1363-1369) où l'équipe de M. Lindner a noté la présence de tambours et de bases de colonnes.[22]

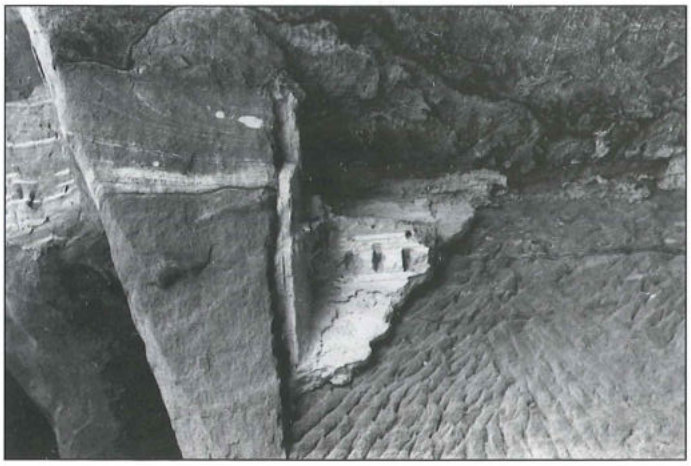
Les aménagements intérieurs associés aux maisons rupestres sont peu variés. Les niches sont les plus courants

19 Il s'agit de la pièce située au-dessus de la pièce H sur le plan de Horsfield et Sela 1938: 19, fig. 2 . Voir en dernier lieu Zayadine 1987: 140, fig. 22-23.

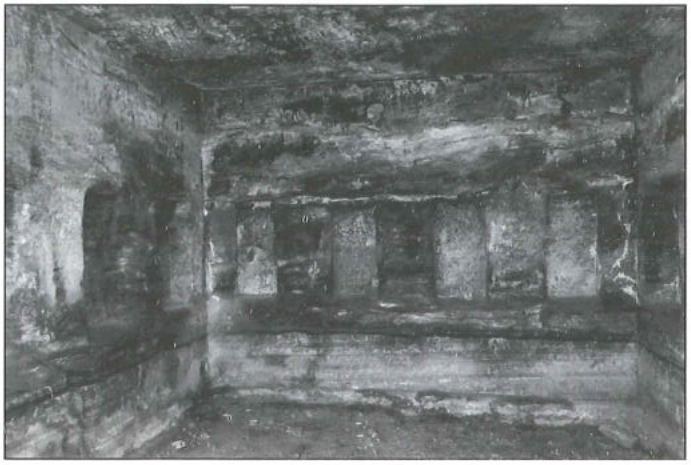
20 Il s'agit des pièces C et E du plan de Horsfield et Sela 1938, op. cit. n. 19.

21 Voir des illustrations de ce type de décor dans McKenzie 1990: l. 51 (il ne s'agit pas toutjours d'habitations).

22 Lindner 1989: 298-303, fig. 9-14.



7. Fragment de stuc à l'intérieur de Sy 16 (aṣ-Ṣiyyagh).



8. Intérieur de la chambre n°188 à Farasa est.

mais on note également la présence d'anneaux d'accrochage (n°357, 9015, 9001) et de petites cavités destinées peut-être à recevoir des lampes à huile (n°835).[23] La forme, les dimensions et le nombre des niches diffèrent considérablement d'une chambre à l'autre. Les modèles les plus simples sont les niches rectangulaires vides dont le nombre varie de une à neuf, voire même douze par pièce, chaque paroi en recevant alors trois ou quatre (n°188, FIG.8, n°425, 712, 1387-1388, D21-22). Elles sont très rarement pourvues de mortaises destinées à la pose d'étagères (un exemple seulement sur le plateau du ad-Dayr, Dalman n°506b) mais servaient très certainement de placards et non de reposoirs à bétyles. Le modèle le plus complexe consiste quant à lui en grandes niches, parfois hautes de plus de deux mètres, qui démarrent au niveau du sol et se composent d'une partie inférieure quadrangulaire, surmontée d'un bandeau plus large lui-même surmonté de deux ou trois protubérances allongées (cf. FIG. 9 et n°606-607, 1380, 1391, Sy11, WD2). Leur fonction n'est malheureusement pas définie précisément.[24] On peut signaler enfin qu'un très petit nombre de chambres très larges étaient divisées en deux par un mur dont il subsiste encore l'amorce dans la paroi du fond (Sy16).

La plupart des chambres rupestres s'ouvrent sur une terrasse naturelle plus ou moins plane et de largeur variable, qui peut être matérialisée à son extrémité par un mur (M43, M90, M154, Sy15, Sy69). Cette terrasse était vouée à la circulation mais pouvait également recevoir divers aménagements : murs construits perpendiculairement à l'axe de la terrasse (Mg15) et qui servaient peut-être à séparer des maisons appartenant à des propriétaires différents, appentis ou cabanes construits en matériaux légers dont les poutres étaient enfoncées dans les trous de boulin creusés à proximité de l'ouverture des grottes (B21, B34 ou M27, FIG. 10) et enfin annexes construites en matériaux plus lourds, comme l'attestent des niches à section en arc de cercle, taillées dans la paroi rocheuse et dans lesquelles s'encastraient des claveaux d'arcs (M71, 748, Bs13; FIG. 11).

L'absence quasi systématique de bassins dans les chambres rupestres (un exemple en WD21) est sans doute l'indice que les habitants de Pétra stockaient l'eau dans des récipients en matériaux périssables aujourd'hui disparus. Les habitants des secteurs proches des deux sources qui jaillissent à l'intérieur du site (dans le Wādī aṣ-Ṣiyyagh et dans le Wādī Abū 'Ullayqa) la puisaient sans doute directement à la source, ce qui expliquerait le petit nombre de citernes retrouvées dans un rayon de quelques centaines de mètres autour d'elles. Les habitants des autres secteurs, à l'exclusion des collines qui bordent immédiatement la ville basse, avaient quant à eux recours à la collecte des eaux de pluie dans des citernes (FIG. 12). Il faut supposer enfin que les canaux adducteurs qui acheminaient l'eau depuis les sources de Wādī Mūsā et de Brāq, situées à l'extérieur du site, étaient destinés à alimenter le centre monumental et ses abords. Dans cette perspective, les châteaux d'eau d'ar-Ramleh et le grand réservoir n°1751 doivent être considérés comme des aménagements publics et non privés. Des canaux, dont nous avons perdu la trace, alimentaient sans doute fontaines, bassins et ensembles résidentiels.[25] Comparativement aux bassins, le nombre de salles de banquet associées à des ensembles domestiques est relativement important puisqu'on en compte trente-deux sur les cent seize que contient le site.[26] Un même ensemble peut d'ailleurs en comporter plusieurs (n°1527 par exemple), de taille et de type différents (couverts ou hypèthres, *tri-* ou *biclinia*, etc.), qui étaient fréquentées à certaines occasions ou à certaines saisons seulement.

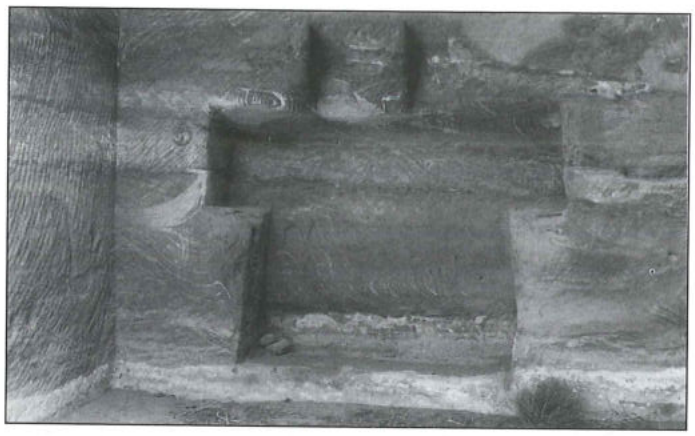
On ignore presque tout des activités domestiques et du régime alimentaire des habitants de Pétra.[27] Des frag-

23 Tarrier 1988: 35.

24 Horsfield et Sela 1938:16-17 et pl. 44.2, les interprète comme des placards.

25 Sur l'eau à Pétra, cf. Al-Muheisen 1986 et plus récemment Al-Muheisen 1990 a et b.

26 La très grande majorité des salles de banquet enregistrées dans la base de données sur les monuments de Pétra sont extraites du catalogue de Tarrier 1988.



9. Chambre avec niche à excroissance .



10. Chambre M27 avec rangée de trous de boulin à sa droite (al-Mu'ayṣara ouest) .

ments de meules, retrouvés à proximité des habitations (n°357, M3, Sy16), sont peut-être l'indice que des travaux de broyage des grains étaient effectués dans le cadre de la cellule familiale, la récolte provenant des plaines agricoles de Bayḍā ou d'autres secteurs de la périphérie.
Au total, et malgré la quantité de monuments enregistrés sur le terrain, la typologie de l'habitat rupestre de Pétra reste assez grossière. En effet, d'une part il manque les repères chronologiques qui permettraient de savoir si et comment les modes d'installations domestiques ont évolué entre le quatrième siècle avant notre ère et le quatrième siècle de notre ère et d'autre part, le remblaiement ou le mauvais état de conservation de très nombreuses chambres rendent leur interprétation incertaine.

Répartition et chronologie de l'habitat (FIG.1)
L'habitat relativement dense qui occupait les pentes dominant immédiatement le Wādī Mūsā au nord et au sud ne sera pas évoqué ici. Il a été révélé ponctuellement par les fouilles et sa présence est plus largement attestée par les nombreux segments de murs de maisons qui affleurent à la surface ainsi que par les grandes quantités de tessons de poterie qui jonchent le sol.[28]

Les secteurs habités apparaissent clairement sur la carte archéologique. Les plus importants, qui sont d'ailleurs presque exclusivement réservés à l'habitat, se concentrent dans la partie ouest du site : la paroi ouest d' al-Ḥabīs, le Wādī aṣ-Ṣiyyagh et les deux rives de la partie basse du Wādī ad-Dayr. Dans d'autres secteurs, l'habitat est parfois mélangé à d'autres catégories de vestiges, notamment à des tombes, ce qui traduit une extension de la ville habitée à une époque qui reste à définir. C'est le cas dans les basses terrasses du Jabal al-Mu'ayṣara, entre la tour Conway et les monuments du centre, dans la partie sud de Mughur an-Naṣāra, dans la partie sud-ouest de la paroi d'al-Khubtha, à l'extrémité nord du massif portant le théâtre (entre la nécropole du théâtre et celle de Farasah), enfin dans la partie nord de Rās al-Maghārīq.

Les ensembles exceptionnels, évoqués plus haut, peuvent être aménagés en dehors de ces secteurs privilégiés : en face du théâtre, sur les terrasses d' Umm al-Biyāra, à Jabal al-Mu'ayṣara est.[29] Enfin, des secteurs comme le Dayr et la partie nord-est d'al-Khubtha d'une part, Bāb as-Sīq et ath-Thughra d'autre part, qui ne sont pas en contact direct avec la ville basse, ont reçu une quantité non négligeable d'habitations rupestres. Il faut signaler que Bāb as-Sīq et ath-Thughra sont les seuls secteurs de Pétra où soient clairement associées tombes et habitations rupestres.[30] Cela est peut-être dû à leur éloignement relatif du centre (une demi-heure à pied) qui aurait amené leurs habitants à aménager le caveau familial à proximité de la maison et non dans l'une des nécropoles de la ville, mais ce n'est bien sûr qu'une hypothèse. Quant au ad-Dayr et à al-Khubtha, l'occupation domestique y a été favorisée par l'existence du monument du même nom pour le premier et par la présence de la canalisation qui permettait d'alimenter directement plusieurs ensembles rupestres pour le second (cf. la maison dite de Dorotheos, Dalman n°681-699)

Au-delà, des secteurs entourant la ville basse, on peut mentionner pour finir l'existence d'agglomérations périphériques telles que Bayḍā et Ba'ja au nord, Rās Sulaymān et Ṣabra au sud de Pétra pour ne citer que les principales.[31]

Le schéma chronologique que nous proposons repose à la fois sur l'observation directe de la carte archéologique et sur les quelques données fournies par les fouilles ou les inscriptions. Les travaux de P.J. Parr le long de la voie à colonnade ont révélé à cet endroit un habitat qui se serait développé du troisième au premier siècle avant J.C.[32] A-t-il été précédé ou est-il synchrone de l'utilisation du plateau d'Umm al-Biyāra comme refuge, rapportée par

27 Zeitler 1990: 396-397, tableaux p. 418-420.

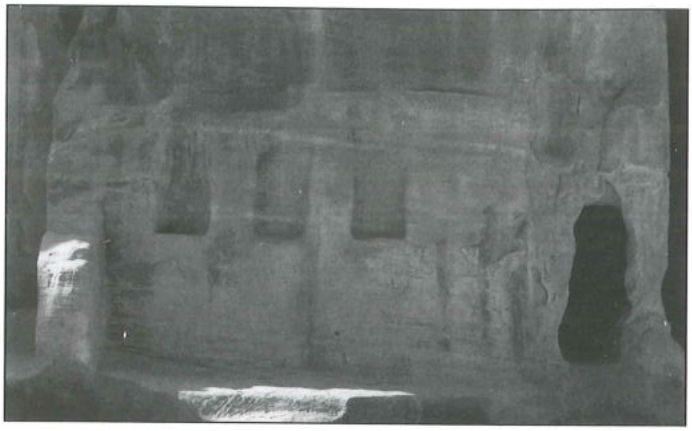
28 Sur les fouilles de maisons à Pétra, voir une synthèse utile dans McKenzie 1990: 105-107.

29 cf. respectivement Horsfield et Sela 1938:20, fig. 3 . et pl. 47 ; Lindner 1989, Dalman n°527 et 527.

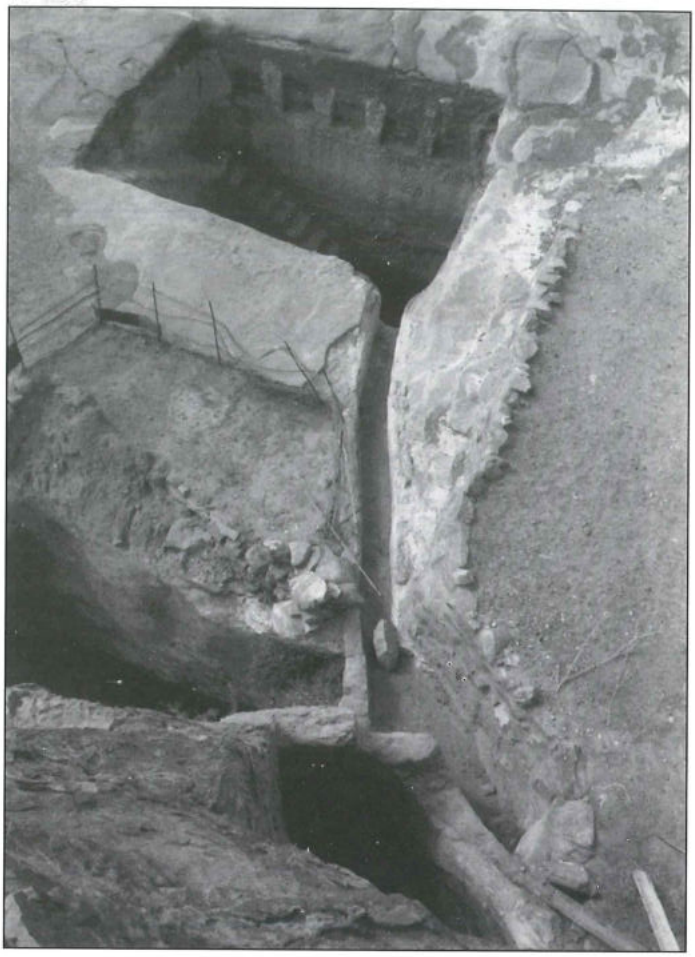
30 Voir notamment à Bāb as-Sīq le tombeau Brünnow n°6 et les aménagements situés dans le même ravin.

31 Des traces de village ou de hameau ont été repérées à Bayḍā, Ba'ja et Rās Sulaymān. Pour Ba'ja, voir Lindner 1986: 116-121.

32 Parr 1960.



11. Bs13 (Sīq al-Bārid). Niches à section en arc de cercle pour encastrement de claveaux d'arcs.



12. Citerne n°8193 à al-Mu'ayṣara ouest.

Diodore de Sicile?[33] Nous n'avons actuellement aucun moyen de le savoir. A cette époque, les tombes occupaient les environs immédiats de la ville basse, comme l'attestent d'une part la tombe fouillée par le NHG au pied du Jabal Khubtha, datée du premier siècle avant J.C.[34] et d'autre part les nombreuses tombes à fosse et à puits creusées dans la partie sud des Jabal al-Mu'ayṣara. Au premier siècle avant notre ère, les maisons fouillées par P. J. Parr sont abandonnées au profit d'une première voie de circulation, non pavée, dont le tracé est globalement identique à celui de la voie à colonnade construite sans doute un siècle plus tard.[35] L'apparition d'un espace public, aménagé au détriment d'habitations privées, est l'indice d'une première volonté de planification urbaine.

Dès le début du premier siècle avant J.C., l'espace habité s'est étendu vers l'ouest : vers le Wādī aṣ-Ṣiyyagh, al-Ḥabīs et la partie basse du Wādī ad-Dayr, où l'absence quasi complète de tombes signifie sans doute que ces secteurs ont d'emblée été consacrés à l'habitat et n'ont jamais été utilisés comme nécropoles. Il s'est ensuite peu à peu étendu aux autres secteurs limitrophes de la ville basse, parfois occupés jusque-là par des tombes qui sont alors abandonnées (cf. la tombe fouillée au pied d'al-Khubtha). Les nécropoles sont repoussées plus loin, comme cela est apparu clairement dans le Wādī ad-Dayr et à al-Mu'ayṣara où les tombes reculent devant la progression de l'habitat. Ce développement de la ville habitée s'est poursuivi tout au long du premier siècle de notre ère qui a également vu la construction de la plupart des aménagements urbains (voie à colonnade, système de canalisation du as-Sīq, théâtre, etc.).

On tend actuellement à penser que Pétra n'a pas connu de réel déclin après la conquête romaine de 106. En effet, on continue d'y construire des tombeaux, des thiases tiennent leurs réunions dans des salles de banquet et plusieurs chambres rupestres ainsi que des maisons sont occupées jusqu'au quatrième siècle de notre ère. C'est à partir de cette date seulement que le centre urbain semble perdre une partie de son aspect monumental puisque des boutiques sont construites le long de la voie à colonnade après le tremblement de terre de 363. Il serait trop long d'évoquer ici les résultats auxquels les recherches récentes sur l'occupation tardive du site (*Petra Church Project* et fouilles de R.A. Stucky notamment) ont permis d'aboutir. Nous nous contenterons de rappeler d'une part que c'est dans l'intervalle compris entre le deuxième et le quatrième siècle que la ville se rétrécit pour s'abriter derrière une ligne de fortifications plus régulière que celle qui protégeait la ville à l'époque nabatéenne[36] et d'autre part qu'au cinquième siècle, des ermites pensent qu'ils sont suffisamment retirés du monde en s'installant dans une grotte qui surplombe le chemin d'accès au ad-Dayr.[37]

Il aurait fallu, pour compléter cette revue de l'habitat rupestre, évoquer les problèmes de circulation, le rapport entre les vestiges domestiques et les monuments cultuels et enfin les données sur les habitants de Pétra que l'on

33 Diodore de Sicile, *Bibliothèque Historique*, XIX.95.1-2 .

34 Zayadine 1979:185-191 et Zeitler 1989: 309-310.

35 Sur les problèmes concernant la date de sa construction, voir McKenzie 1990: 35-36.

36 Sur les remparts de Pétra, voir surtout Parr, Atkinson et Wickens 1975. Voir aussi Dentzer et Zayadine 1992: 240-241.

37 Sartre 1993: 111.

peut tirer des inscriptions nabatéennes, mais cela aurait dépassé le cadre de cet article. Nous espérons seulement avoir donné au lecteur l'envie d'aller plus loin dans la connaissance de ce site complexe et original et avoir au moins montré que l'habitat rupestre, qui représente entre six et sept cents chambres, fait clairement partie d'un espace urbain qu'on ne peut désormais plus limiter aux seuls monuments de la ville basse.

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Les circulations internes et l'emprise urbaine sur l'espace à Pétra

INTRODUCTION

Une double série de photographies aériennes de la zone de Pétra, en noir et blanc et en couleurs, à l'échelle du 1: 10.000, a été réalisée simultanément par l'Institut Géographique National Français en 1974.[1] Elle est à l'origine d'un programme de cartographie engagé à partir de 1983 par l'équipe n°20 du Centre de Recherches Archéologiques (CNRS) en collaboration étroite avec le Department of Antiquities de Jordanie.[2] Après un orthophotoplan au 1: 10.000 et deux cartes au 1: 5.000 du centre de la ville et de la zone de Bayḍa-Slaysil, 12 secteurs de la ville ont été repris au 1: 1.000. Des levés topographiques classiques ont été effectués pour le Sīq al-Bārid et la zone de la maison de Dorotheos. L. Nehmé a créé une base de données enregistrant plus de 3.000 points archéologiques avec leurs coordonnées.[3] On peut réexaminer désormais la distribution des différents types de vestiges sur tout le site et secteur par secteur.

Sur ces bases l'originalité de l'espace urbain de Pétra commence à apparaître plus clairement. Les différentes orientations annoncées à Lyon en 1989 [4] peuvent désormais être précisées. Nous nous limiterons ici à quelques remarques sur les réseaux de circulations internes à l'espace urbain de Pétra. Ces réseaux représentent une perspective privilégiée sur l'organisation de cet espace.

Points de méthode

La visibilité et, par delà, l'interprétation de traces sont conditionnées à Pétra par la nature des terrains. Dans d'autres zones, dans des terrains peu accidentés et constitués de sédiments relativement épais et homogènes comme dans la steppe autour de Palmyre ou dans les sols de décomposition des basaltes en Syrie du Sud, les routes et pistes antiques apparaissent sur les photographies aériennes comme des traces linéaires, quelque peu floues mais continues, qui traduisent une différence de structure entre la voie et le terrain environnant.[5] Elles sont dessinées soit par des substructures aménagées qui marquent toute leur surface ou seulement leurs bords, soit, négativement et plus sommairement, par l'épierrage du terrain qui donne une texture différente à la route elle-même tout en soulignant ses limites par l'accumulation des pierres retirées au centre. On peut observer des faits analogues à l'intérieur d'agglomérations urbaines comme à Palmyre où l'on distingue, par exemple sur la rive sud du wadi, des tracés de rues et de constructions réalisées en partie en briques crues.[6]

À Pétra en revanche les traces sont souvent très nettes, mais ponctuelles ou réduites, au mieux, à des courts tronçons. Sont visibles, en effet, des vestiges taillés dans la roche (FIGS. 1, 2, 3). Comme dans le cas des lieux de



1. Route taillée dans le rocher de Pétra vers le sud dans la zone de ath-Thughra (cliché ERA n°20).

2 C'est Jean Starky qui a engagé, avec F. Zayadine, l'exploitation d'abord épigraphique puis archéologique de la documentation recueillie. La part essentielle dans le succès de l'entreprise revient à la compétence et au dynamisme de Maurice Gory et de René Saupin, ingénieurs à l'IGN.

3 Nehmé, L.. *L'espace urbain de Pétra (Jordanie) de l'époque nabatéenne à l'époque byzantine à travers les sources archéologiques et épigraphiques.* Paris thèse de doctorat, Université de Paris 1, 1994.

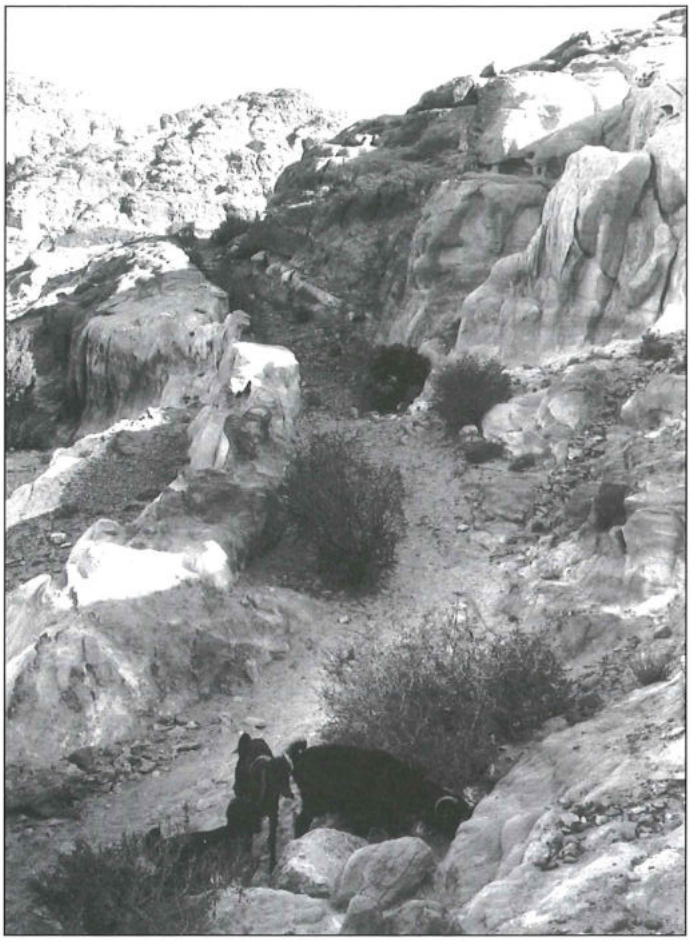
4 Dentzer J.-M. *et al.* 1992; parallèlement à la cartographie, des études thématiques ont été engagées et présentées sous forme de thèses à l'Université de Paris 1 : F. Zayadine, *Les monuments funéraires d'origine orientale à Pétra* 1971; M.-J. Roche, *Niches à bétyles et monuments apparentés à Pétra* 1985; Z. al-Muheisen, *Techniques hydrauliques dans le sud de la Jordanie, en particulier à l'époque nabatéenne* Thèse de doctorat, Université de Paris 1 1986; D. Tarrier, *Les triclinia nabatéens dans les perspectives des installations de banquet au Proche-Orient.* Thèse de doctorat, Université de Paris 1 1988.

5 Voir par exemple Poidebard, A., *La trace de Rome dans le désert de Syrie.* Paris,1934; *Le limes de Chalcis.* Paris,1934; Kennedy, D. and Riley, D., *Rome's Desert Frontier from the Air.* London, 1990.

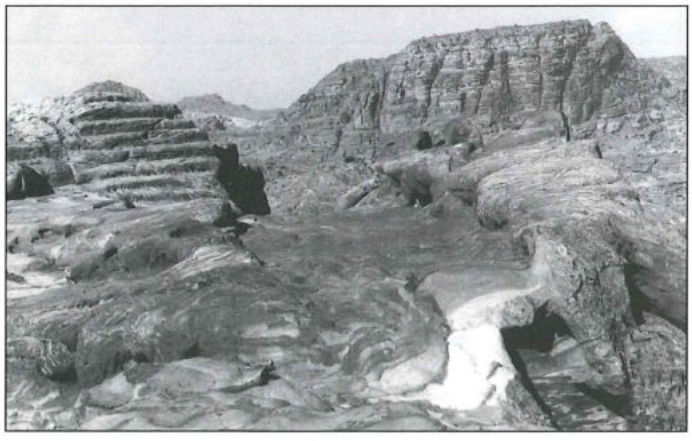
6 Dentzer, J.-M. et Saupin, R. L'espace urbain à Palmyre : remarques sur des photographies aériennes anciennes: Dans *Palmyra and the Silk Road. AAAS,* 42, 1996 : 298-318

cultes, des nécropoles ou de l'habitat, ce sont les traces rupestres qui continuent à dominer largement le champ de la recherche, tant que les fouilles ne sont pas plus étendues. Des entailles étaient effectuées dans la roche, sans trop de peine d'ailleurs, en raison la faible dureté du grès qui a facilité à Pétra les aménagements rupestres en tout genre.[7] On pouvait ainsi franchir les obstacles par des tranchées et inscrire des routes latéralement dans une pente. Les vestiges identifiés les plus nombreux sont des escaliers taillés dans le rocher (FIGS. 4,5).

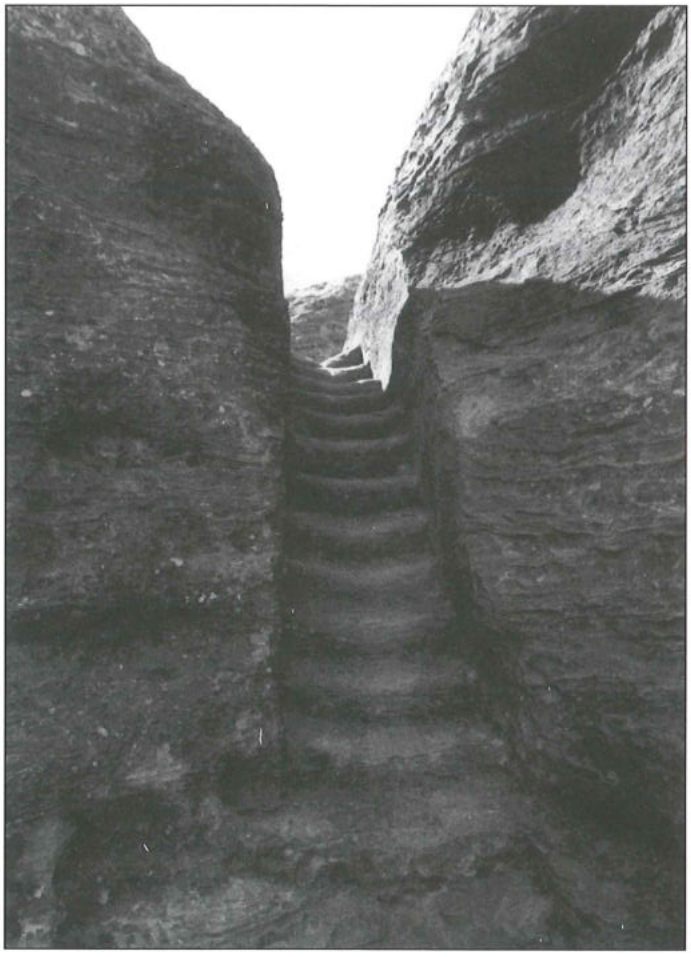
À l'inverse, à d'autres emplacements, les travaux de terrassements nécessaires ont laissé moins de traces. Les substructures ou rebords de routes construits visibles, par exemple dans la descente vers Ṣabra à partir du Rās al-Bṭaḥī, [8] ont souvent été emportés par une érosion particulièrement violente. Dans la zone de Pétra le réseau hydrographique présente un gradient très fort et la couverture végétale a été souvent réduite à la plus simple expression. La violence de ces phénomènes a pu être estimée à partir de crues récentes. En dehors des traces rupestres, les restes des aménagements de voies ont souvent été soit arrachés par l'érosion sur les pentes, soit recouverts, dans les zones basses, par les remblais abondants et souvent grossiers venus de l'amont. Ils ne laissent plus transparaître, contrairement à ce que l'on connaît dans la steppe, la trace d'itinéraires ayant suivi des fonds ou des bords de wadi. Or on sait que les caravanes empruntaient souvent ce type de tracés, disponibles à l'exception de quelques jours par an. Il faut aussi supposer une certaine souplesse dans ces itinéraires selon les



2. Route taillée dans le rocher, de Pétra vers le nord, par Mughur an-Naṣāra (cliché ERA n°20).



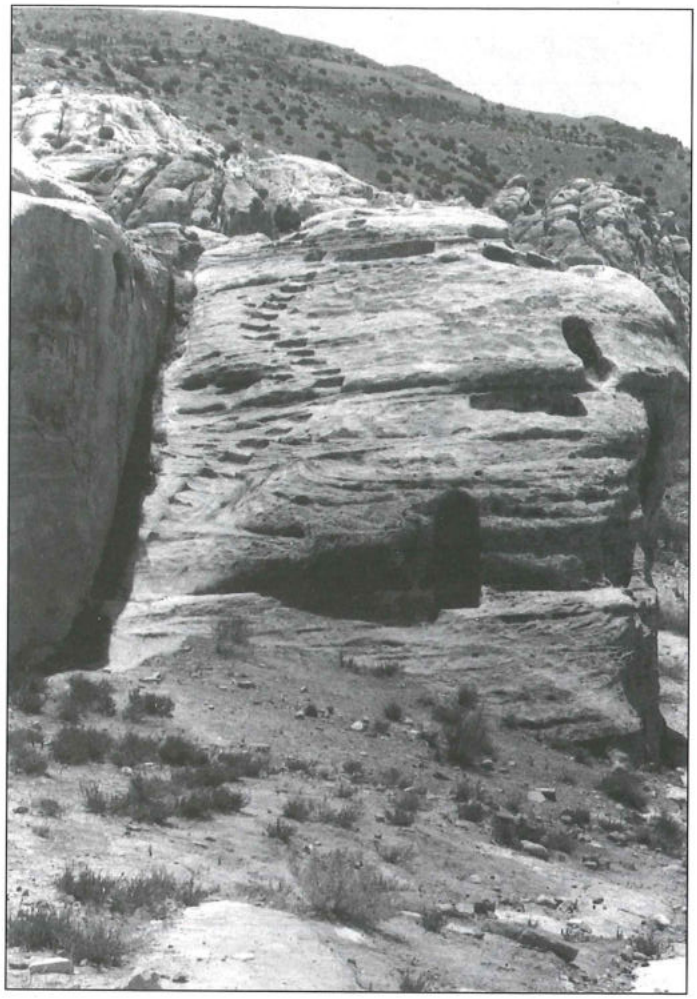
3. Route de desserte de al-Mu'ayṣra (cliché ERA n°20).



4. Escalier reliant deux ensembles d'habitat à al-Mu'ayṣra(cliché ERA n°20).

[7] On a utilisé aussi rationnellement les différences de dureté dans la stratification des grès pour créer des chambres rupestres en conservant comme plafonds les strates plus dures.

[8] Dentzer *et al.* 1992 : 241-243, fig. 7.



5. Escalier d'accès à un groupe de tombes à fosse à Bāb as-Siq (cliché ERA n°20).

saisons et les conditions locales, ce qui explique les variantes qui se dessinent dans la plupart des itinéraires.

Des routes ou des sentiers passaient également sur des grandes surfaces rocheuses planes, comme à al-Mu'ayṣra, où elles sont difficiles à observer lorsqu'il n'y a pas d'obstacle qui a entraîné des retailles. La dégradation continue de la surface des grès exposés à l'air a égalisé les surfaces en émoussant puis en effaçant toute marque. Dans les zones accidentées l'itinéraire passait souvent successivement par des entailles dans le rocher et par dessus des ravins autrefois remblayés mais à présent remis à nu par l'érosion. On voit ainsi, à la sortie d'un tronçon taillé dans le rocher, sur l'itinéraire qui monte vers ath-Thughra comme sur celui qui permettait d'accéder à al-Mu'ayṣra (FIG.6) des dénivellations de plus d'un mètre avec des ravins transversaux dans la roche qui devaient être remblayés pour autoriser la circulation. Les substructures devaient recevoir un revêtement de surface pour faciliter la circulation des piétons et des bêtes de somme. On sait que les chameaux supportent mal les surfaces rocheuses ou dallées comme les fortes pentes.

Un aménagement plus élaboré en forme de dallage reste une exception à Pétra où il a été trouvé, en place, dans la rue à colonnades, récemment dans un tronçon qui longe de près le Wādī Mūsā et dans un passage du as-Sīq.

Ainsi donc, selon la nature du terrain, l'aménagement de routes ou de chemins a imposé une marque plus ou moins nette et plus ou moins durable : l'image que nous avons des itinéraires sur le site en dépend. Les zones rocheuses y apparaissent privilégiées par rapport aux zones de remblaiement et les zones accidentées par rapport aux zones planes. Les cheminements verticaux (escaliers : FIGS.7,11) occupent une place disproportionnée. Les conditions géomorphologiques, climatiques et techniques qui ont marqué dans la zone de Pétra le choix et le tracé des itinéraires, leur aménagement puis leur destruction doivent être prises en compte dans l'interprétation des vestiges lacunaires conservés. Une fois relevées les traces visibles, discontinues, voire ponctuelles, il reste à restituer l'itinéraire vraisemblable d'après la logique de la configuration du terrain et des points à desservir supposés. La couverture de photographies aériennes au 1: 10 000, constitue l'aide la plus précieuse à cette étape en précisant, en particulier, les mouvements du relief. Les nouvelles cartes fournissent une image synthétique des différents tronçons d'itinéraires et permettent de s'interroger sur leur organisation. Les installations placées à leur extrémité ou à leur voisinage suggèrent des hypothèses sur la nature ou la fonction des circulations.

Des témoignages du XIX^{e} et du début du XX^{e} siècle. évoquant des caravanes reliant Pétra à l'Égypte, à l'Arabie ou encore à la Syrie et à la Palestine peuvent être invoqués pour confirmer certains itinéraires.[9] Mais il faut noter que les orientations dominantes du trafic ne sont pas les mêmes que dans l'antiquité et que ces sources ne précisent pas le détail des itinéraires. Elles n'apportent pratiquement rien sur les itinéraires internes à l'espace urbain.

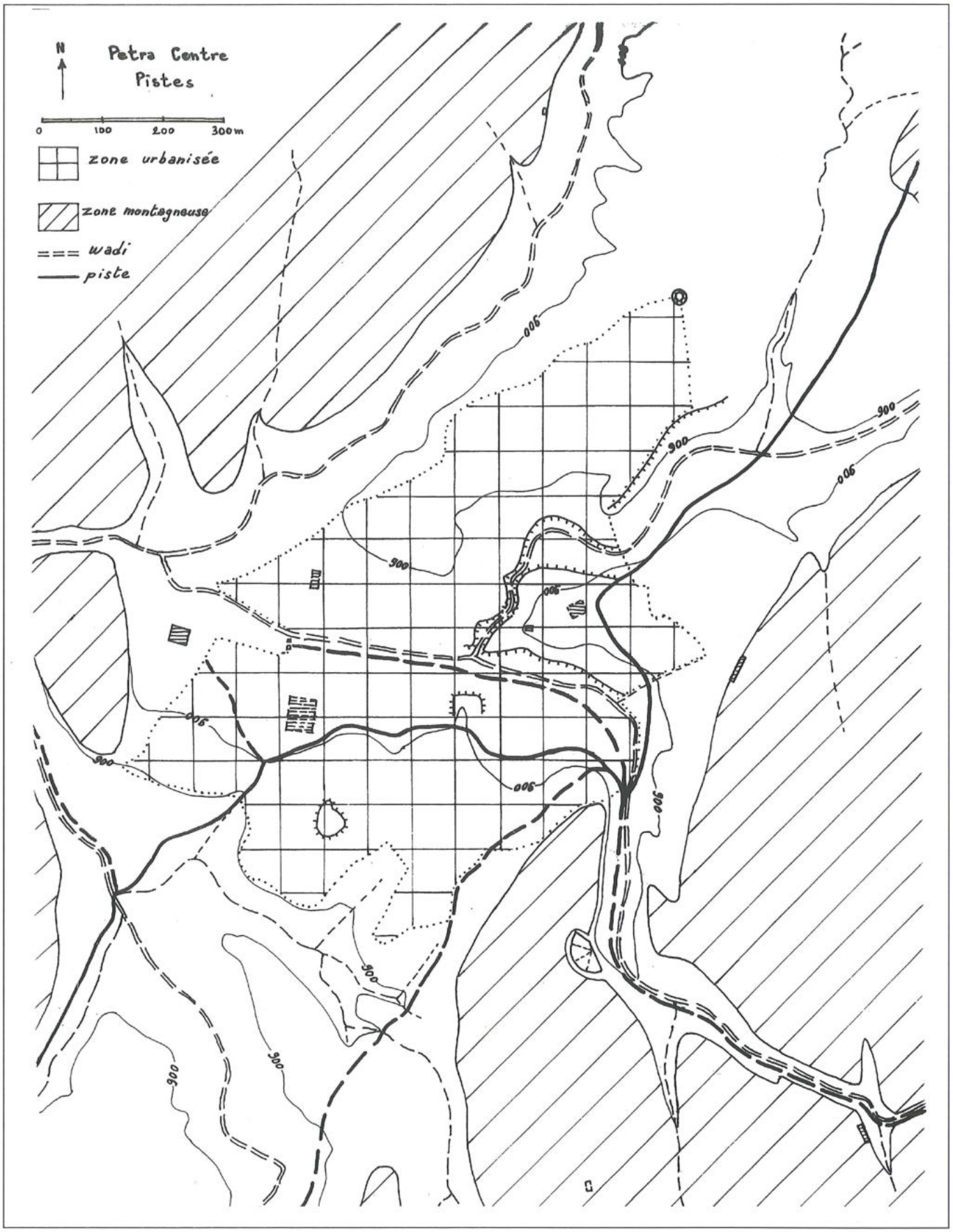
Les tracés identifiés ont été repris pour la plupart par des sentiers utilisés actuellement par les bergers ou les touristes ou encore par des pistes qui desservent les fouilles. Leur tracé dans l'antiquité laisse cependant peu de doutes car il s'agit d'itinéraires naturels et logiques, imposés par la topographie.

Les grands axes

On ne reprendra pas ici le réseau des routes caravanières qui ont été réexaminées à plusieurs reprises récemment.[10] Les itinéraires majeurs ont été bien reconnus mais le détail de leur tracé n'a pas été reporté de façon systématique sur les cartes à grande échelle. On hésite parfois entre plusieurs variantes, qui ont pu d'ailleurs être utilisées les unes et les autres selon les circonstances. De nouveaux itinéraires ou des variantes restent sans doute à découvrir : ainsi en confrontant l'interprétation des pho-

[9] Musil 1907 : 126; Dalman 1908 : 27-28; Horsfield et Conway 1930 : 383.

[10] Zayadine 1985 et 1992.



6. Plan du centre de la ville avec l'arrivée des pistes principales (R.Saupin ERA n°20).

tographies aériennes à des vérifications de terrain R. Saupin et L. Nehmé ont identifié un tracé comportant des aménagements construits et reliant par le nord Slaysil au Wādī Mūsā, en amont de Qaṣr Umm Rattam.

Aux approches du centre de Pétra les routes caravanières jouent aussi le rôle d'axes de communication internes majeurs pour la zone urbaine. Leur entrée en ville a été présentée récemment par F. Zayadine[11]. On peut proposer, sur la base des traces conservées et de la vraisemblance topographique, une cartographie plus précise pour trois voies d'accès principales qui s'ajoutent à celle du as-Sīq, l'une venant du nord, deux autres du sud-ouest et du sud-est (FIG. 6). Celle que l'on a supposée suivre le bord du Wādī Abū 'Ullayqa[12] ne pouvait assurer qu'une desserte locale car la tête du wadi bute sur des obstacles insurmontables (pente, rochers). A l'ouest le aṣ-Ṣiyyagh avec ses gorges ne fournit pas davantage de passage pour une circulation caravanière.

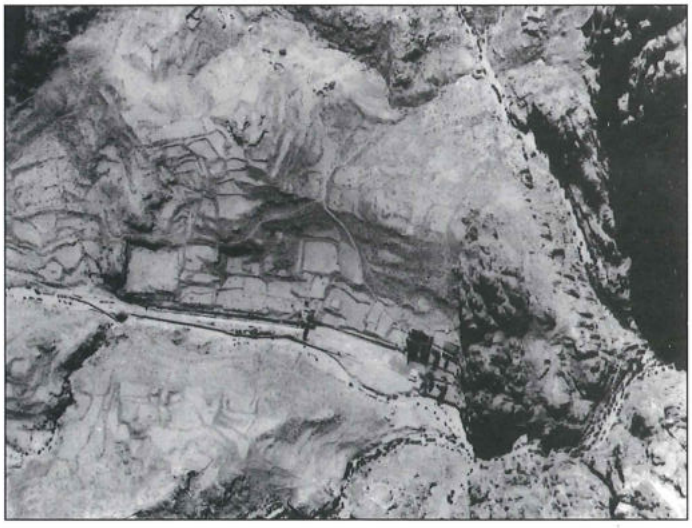
L'itinéraire du nord-est est clairement marqué dans sa traversée du Mughur an-Naṣāra (Fig.4) par des tronçons entaillés dans la roche[13], sur la rive gauche du Wādī Umm Ṣayḥūn[14]. L'étude des photos aériennes montre que cette route remontait la pente vers le nord-est et arrivait sur la crête à l'est du village moderne de Umm Ṣayḥūn. Cet itinéraire pouvait-il être utilisé par des caravanes ? La présence de marches conduisait Dalman à supposer que les chameaux ne pouvaient y passer alors que Musil affirme que, malgré la destruction des substructures, la route continuait à être utilisée par des chameaux même chargés. En fait ces marches basses, longues et espacées ne doivent pas faire obstacle au passage de bêtes de somme.

Cette route devait franchir le Wādī al-Maṭāḥa non loin du confluent avec le Wādī Umm Ṣayḥūn. De fait, on a retrouvé sur le Wādī Umm Sayḥūn, un peu en amont du confluent avec le Wādī al-Maṭāḥa, une substructure puissante construite en appareil régulier, qui devait servir à canaliser le wadi et à protéger les berges dans un terrain d'argile rouge très fragile (FIG. 7). Son extrémité pouvait constituer, en outre, une pile pour un pont[15]. Dans ce secteur la route pouvait se diviser, une branche franchissant ce pont, une autre continuant vers le sud et traversant le lit du Wādī al-Maṭāḥa dans une zone d'alluvions plate facile à franchir. Des traces laissent supposer que cette branche longeait ensuite le wadi sur sa rive gauche et à une certaine distance en direction du sud-ouest puis, marquant un angle à proximité d'un amas de ruines non identifiées, en direction du théâtre. Ainsi pouvaient être desservis à la fois le centre de la ville et la zone située près du débouché du as-Sīq (FIGS. 6, 8).



7. Piles de pont sur le Wādī al-Maṭāḥa (cliché ERA n°20).

Un noeud de communication majeur devait se situer à cet emplacement. En effet, c'est aussi sur ce point que convergent les deux itinéraires qui viennent du sud. Celui qui suit le rebord sud-est de la cuvette de Pétra en longeant les massifs de Farasa puis de an-Numayr, et celui qui provient de ath-Thughra (FIG. 9) en suivant le Wādī al-Maghārīq[16]. Le premier aboutissait à Ṣabra, le deuxième est l'extrémité commune de plusieurs routes qui relient Pétra au Wādī 'Arabah par le Wādī Abū Khushayba



8. Photo aérienne IGN de1974 du centre ville avec aménagement en terrasses et circulations.

11 Zayadine 1995.

12 Musil 1907:130; Horsfield Conway 1930:383. L'itinéraire aurait été emprunté encore à la fin du XIX^{e} siècle par des caravanes.

13 BrD. n°646; Dalman 1908:30; Musil 1907:126; Wenning 1987:272, 33; Zayadine F 1995:236.

14 Sidd al Hishe selon Musil 1907:126. Cette route assez large était protégée d'après Musil, sans doute plus au nord, par des substructures sur un tracé en épingles à cheveux, détruites de son temps.

15 Ce pont pouvait servir également à faire passer une branche d'aqueduc alimentant le quartier de Pétra situé au nord du Wādī Mūsā. Wenning 1987 : 272 n°33) signale dans le Wādī Umm Zu'qëqa (= W. an-Naṣāra), sans le localiser, un pilier de pont conservé.

16 Dalman 1908 : 220-221 et Zayadine 1985 et 1992, 1995 : 236; au sud de ath-Thughra des passages entaillés dans le rocher sont bien conservés. L'itinéraire descend de ath-Thughra en suivant le cours du Wādī al-Maghārīq jusqu'à son confluent avec le Wādī Kharrūbat Ibn Jurayma. De ce point il remonte la pente pour atteindre le col carrefour de Zibb Fir'aun. A ath-Thughra même il faut noter que la route se divise en deux : une branche dessert la petite agglomération elle-même, une deuxième la contourne par une grande boucle, avec une épingle à cheveux vers l'ouest.

en passant soit au sud du Jabal Hārūn[17], soit par le an-Naqab ar-Rbai, soit encore par une variante de la piste passant par Ṣabra. L'itinéraire sud-ouest franchissait le Wādī an-Numayr près de son confluent avec le Wādī al-Maghārīq et remontait la pente de al-Katūta jusqu'au col de Zibb Fir'aun. De là il descendait doucement vers l'est, le long de la pente, en suivant les courbes de niveau, pour rejoindre l'itinéraire sud-est. Réunis ils descendaient vers le cours du Wādī Mūsā. Ils y croisaient l'itinéraire du Sīq. On pouvait sans doute y franchir le lit du Wādī Mūsā par un pont et s'engager dans la route du Mughur an-Naṣāra. Ces tracés permettaient au trafic caravanier, qui pouvait d'ailleurs éviter entièrement la cuvette de Pétra par Bayḍa, de contourner en grande partie le véritable centre de la ville, comme sans doute à Palmyre d'ailleurs.[18]

Les axes majeurs évoqués jusqu'à présent semblent converger dans la partie située à l'est du centre ville et au débouché de l'itinéraire du as-Sīq. Ce secteur pouvait assurer la continuité du passage du nord vers le sud et vers l'est. On n'a pas encore identifié un itinéraire de type caravanier aboutissant directement à l'extrémité ouest du centre urbain, dans la zone située près de l'entrée du aṣ-Ṣiyyagh, ni vu de trace de route entaillée dans le flanc méridional raide de al-Ḥabīs. Il est vrai que le contournement de al-Ḥabīs par l'ouest pour rejoindre l'itinéraire de ath-Thughra pouvait passer par le fond du Wādī Kharrūbat Ibn Jurayma. D'autre part on peut supposer un passage assez raide au pied de al-Ḥabīs et à l'ouest du Qaṣr al-Bint, rejoignant un chemin toujour utilisé qui se dessine plus haut sur la pente et qui aboutit au carrefour de Zibb Fir'aun.

Le centre-ville (FIGS. 6, 8)

Ces trois itinéraires représentent, avec le as-Sīq qui se prolonge dans la voie à colonnades, les axes qui organisaient le noyau central de la ville. Celui-ci s'étendait au-delà de la limite constituée par les remparts vraisemblablement tardifs. Les portes[19] par lesquelles passaient les routes caravanières et dont Bachmann signalait trois dans le mur sud[20], sont actuellement difficiles à repérer sur le terrain, à l'exception d'une poterne visible dans le mur sud et déjà mentionnée par F. Zayadine: elle devait laisser le passage à l'itinéraire sud-est allant à Ṣabra.[21]

L'axe qui domine le centre-ville de Pétra est imposé par le cours du Wādī Mūsā doublé architecturalement par la rue à colonnades qui, dans son stade monumental, n'a sans doute plus été utilisée pour le trafic des marchandises. D. Kirkbride a attiré l'attention sur le fait que la chaussée dallée, fortement bombée, était peu praticable par des chameaux.[22] De plus elle butait à l'ouest sur la porte d'accès au *temenos* du Qaṣr al-Bint, sanctuaire principal de la ville. À cet emplacement la circulation pouvait cependant franchir par un pont le Wādī Mūsā et passer sur la rive droite. Sous sa forme monumentale la rue devait jouer le rôle de voie sacrée à l'approche du sanctuaire, selon un schéma connu ailleurs au Proche-Orient, à Palmyre, à Gerasa et sans doute à Bosra. Il faut noter que la voie à colonnades est l'aboutissement de l'itinéraire du as-Sīq, lui aussi pavé, au moins sur certains tronçons dégagés au cours des dernières années. Un nouveau tronçon situé à proximité des grands tombeaux et également dallé vient d'être identifié immédiatement à côté du Wādī Mūsā, dans le dernier coude de celui-ci. Ce tronçon forme un léger angle avec la rue à colonnades.

La formule de la rue à colonnades, qui se développe vraisemblablement dans le courant du premier siècle de notre ère, ajoute à l'axe de circulation un espace monumental dont les fonctions économiques et sociales sont sans doute comparables à celles d'une agora.[23] À Pétra elle donne accès aux terrasses situées sur la pente sud et aménagées en marchés ou en sanctuaires,[24] par des volées d'escaliers, exclusivement réservés à des piétons. Un ou plusieurs ponts sur le Wādī Mūsā la faisaient communiquer avec les installations, monumentales elles aussi, situées sur la rive nord du wadi.

Dans ces conditions on comprend que les axes de communications "utilitaires" aient contourné, par l'est essentiellement, ce centre monumental réservé aux monuments publics.[25] Il fallait cependant assurer la circulation interne du centre ville. Les quartiers situés sur les deux pentes au nord et au sud de ce noyau sont reliés latéralement aux axes majeurs qui viennent d'être décrits. Les photographies aériennes montrent les marques d'une organisation plus régulière dans leur partie inférieure, au contact immédiat de l'axe monumental (FIG.8). Les "marchés", comme les sanctuaires installés de part et d'autre du Wādī Mūsā, ont été "imposés" au terrain par de gros travaux de terrassements, nécessaires pour créer des esplanades hor-

17 Musil A. 1907 : 113-114; Horsfield G. et Conway A. 1930 : 383; Zayadine 1985, 1992, 1995.

18 J.-M. Dentzer et R. Saupin, 'L'espace urbain à Palmyre : remarques sur des photographies aériennes anciennes' *AAAS* 42, 1996 : 297-318; Gerkan, A. von 'Die Stadtmauer von Palmyra'. *Berytus,* 1935, 2:25-33.1935; Schlumberger, D. 'Etudes sur Palmyre: 1.Le développement urbain de Palmyre'. *Berytus, 2,* 1935, (1) : 149-162; Van Berchem, D. 'Le plan de Palmyre', dans *Palmyre, Bilan et perspectives,* 1976 : 165-174.; Will, E. *Les Palmyréniens : La Venise des sables.* Paris, 1992.

19 Parr, P., Atkinson, K.B. et Wickens, E.H. *ADAJ* 20, 1975:40, 44.

20 Bachmann 1921:3 sq, fig. 1; cf. Wenning, R. 1987:222 et Horsfield, G. et A. 1938 : 4, 8; 1939 : 88, 93 note 2.

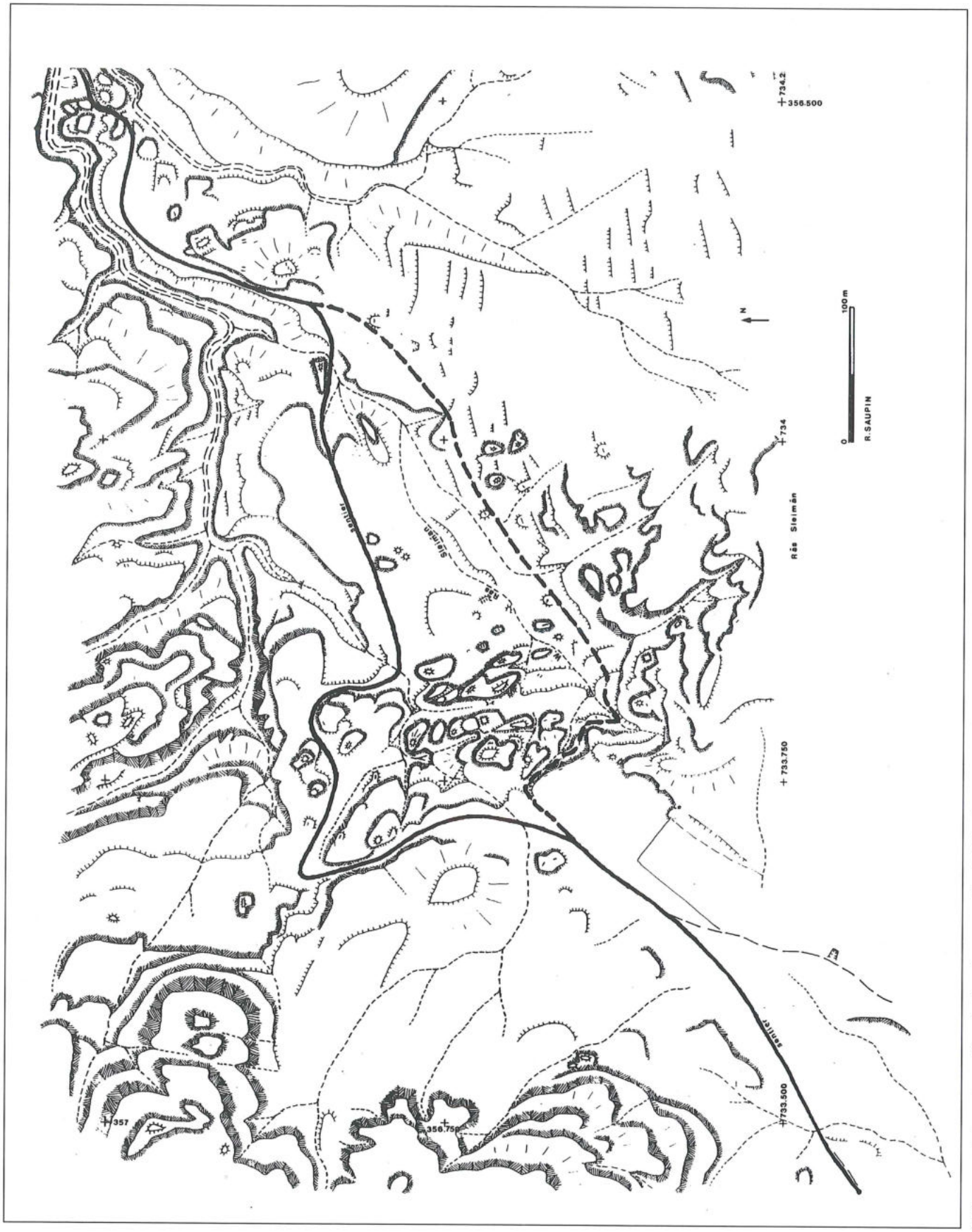
21 Dans Leriche, P. et Tréziny, H. *La fortification dans l'histoire du monde grec,* CNRS 1982 : 154.

22 Kirkbride, D. 1960 : 117-122.

23 Sur les rues à colonnades, Will, E. 'Les villes de la Syrie à l'époque hellénistique et romaine'. dans Dentzer, J.-M. , Orthmann, W., éds, *Archéologie et histoire de la Syrie, II, La Syrie de l'époque achéménide à l'avènement de l'Islam,* Saarbrücken, 1989:241-242 = Will, E.; *De l'Euphrate au Rhin, Aspects de l'hellénisation et de la romanisation du Proche-Orient,* Beyrouth, 1995:487-488; Les fonctions de la rue à colonnades apparaissent clairement dans l'*Antiochikos* de Libanios : traduction avec un commentaire de R. Martin dans Festugière, A.J. *Antioche païenne et chrétienne,* Paris 1959: 23-61.

24 Voir Bachmann W., Watzinger et Wiegand, T. 1921 et les travaux de M. Sharp Joukowsky, 'Archaeological Excavations and Survey of the Southern Temple at Petra'. *ADAJ* 38, 1994 : 293-332; *idem,* 'Archaeological Survey of the Southern Temple at Petra'. *Syria* 72, 1995 : 133-142.

25 Il faut rappeler que l'essentiel du trafic caravanier devait également contourner le centre monumental de Palmyre.



9. Passage de la route aménagée dans le secteur de ath-Thughra avec ses deux variantes (R.Saupin ERA n°20).

izontales de plan rectangulaire. Généralement alignés sur la rue à colonnade ils en suivent l'orientation. Celle-ci est peut être reprise de proche en proche par des constructions situés plus haut sur la pente, ce qui suggère l'impression d'une organisation orthogonale.

Il faut noter que l'approvisionnement des marchés situés sur la rive nord du wadi et ouverts sur la rue à colonnades pouvait être assurée par le haut, directement par l'axe de circulation majeur passant par Zibb Fir'aun et descendant vers le débouché du as-Sīq.

C'est sur les deux pentes dominant le Wādī Mūsā que se situait sans doute, à côté de monuments publics, la majeure partie d'un habitat dont on ignore encore la densité[26]. On identifie encore, en surface, de nombreuses traces de constructions. Comment était-elles desservies ? On ne dispose de relevé systématique que pour les secteurs très restreints qui ont été fouillés. Les plans anciens de Laborde représentaient un certain nombre de bâtiments et celui de Musil dessine, d'une façon schématique, un véritable réseau de rues relativement régulières. Sans doute l'érosion, dont on suit la progression en comparant des photographies aériennes successives, a-t-elle effacé un certain nombre de vestiges. Cependant les photos aériennes de 1974 , qui montrent très clairement que les articulations de la surface ne révèlent pas de grille d'organisation géométrique mais plutôt un aménagement en terrasses multiples qui suivent le tracé des courbes de niveaux et dessinent des bandes parallèles échelonnées en gradins sur les pentes. Dans le secteur est en particulier, l'espace apparaît fractionné en petites parcelles parfois trapézoïdales ou triangulaires, avec des éléments courbes. Par opposition à l'organisation -coûteuse- des monuments publics situés de part et d'autre de la rue à colonnades, on découvre ici un découpage qui se distingue à peine d'un aménagement de terrasses agricoles. On peut le comparer à celui qui a été mis en oeuvre, par exemple, dans le secteur de Wādī Mūsā où il continue à être exploité. Les habitations prenaient place sur ces terrasses de dimensions variables. Plutôt que par des rues elles devaient être desservies par des chemins de type "rural" qui s'inscrivaient, avec la même économie de travaux, dans les lignes privilégiées du paysage ainsi aménagé. Il est significatif que les fouilles d'habitat, à az-Zanṭūr, al-Katūta, et au pied de al-Khubtha ne semblent pas avoir révélé de rue aménagée d'une manière classique, au contact de l'habitat. Les transports de proximité devaient être assurés par des ânes ou des mulets. Le carrefour de Zibb Fir'awn, en position de col, représente le point de distribution des communications sur les hauteurs de al- Katūta et de az-Zanṭūr.

Le quartier situé au nord du Wādī Mūsā présente un profil sensiblement différent du versant sud. Sa partie basse sur laquelle est implanté l'accès au sanctuaire aux lions ailés est en pente raide, surtout à l'ouest. La partie est du versant, moins raide, a été aménagée en terrasses étroites. Au sommet la pente s'adoucit pour prendre l'extension d'un plateau au sol plus épais, aménagé en terrasses plus vastes. Quelques unes ont un plan rectangulaire avec des éléments orientés sur l'axe de la rue à colonnades. Plus haut encore la pente s'accentue jusqu'à la tour Conway qui domine tout le secteur. Sur ce terrain, plus rocailleux, on devine encore des traces de constructions (maisons ?). La zone est coupée par le mur interprété comme un rempart tardif.

Le système des circulations dans ce quartier n'a pas encore été identifié. Sur le flanc sud, des escaliers comparables à ceux qui desservaient le temple aux lions ailés devaient relier le plateau au niveau de la rue à colonnades. Des chemins faisaient communiquer les terrasses irrégulières. Un itinéraire majeur ouest-est rattachait à ce quartier un secteur situé, au-delà du Wādī al-Maṭāḥa, au pied du massif de al-Khubtha. De puissantes substructures soigneusement construites en appareil régulier de part et d'autres du Wādī al-Maṭāḥa, peuvent être interprétées comme les culées d'un pont dont les extrémités ont été emportées par les crues du wadi [27]. D'après l'alignement du pont cet axe de circulation majeur devait rejoindre, à l'est, le noeud de communications situé près du débouché du as-Sīq.

Le secteur situé au pied de la falaise de al-Khubtha était en pente et aménagé en terrasses irrégulières sur la face tournée du côté du Wādī al-Maṭāḥa . Le reste de sa surface, plus plane et au sol assez épais, est marqué par plusieurs traces linéaires. Elle conserve les traces de constructions importantes. Une sorte de levée de terre aboutissant au tombeau-Palais prolongeait-t-elle le mur tardif du 'Arqūb al-Hīsha? Devant le même tombeau un deuxième mur, parallèle et marqué à son extrémité d'un retour à angle droit, pourrait avoir délimité un grand enclos. On est tenté de penser à des installations caravanières. Une autre levée orientée nord-ouest / sud-est croise ce secteur plus au sud.

Ce secteur était traversé par une branche de la route de Mughur an-Naṣāra qui franchissait les différents murs identifiés sur les photographies aériennes.

Le centre et les secteurs périphériques : les faubourgs rupestres

Le centre de la cuvette de Pétra ainsi aménagé et occupé d'une manière sans doute assez dense, avec un grand nombre de monuments publics, apparaît comme un espace continu que l'on peut qualifier de noyau urbain. Les tronçons de remparts, au nord et au sud, le délimitent, au moins à époque tardive. Cependant l'habitat, surtout rupestre, débordait ces limites. En l'absence de fouilles étendues et seules capables d'identifier des constructions arasées, nous connaissons surtout l'habitat sous sa forme rupestre.[28] Les groupes d'habitations rupestres qui se sont

[26] Stucky, R. *et al. ADAJ* 34, 1990 : 249-283; *ADAJ* 35, 1991 : 251-273; *ADAJ* 36, 1992: 175-192; *ADAJ* 37, 1993 : 417-425; *ADAJ* 38, 1994 : 271-292; *Antike Kunst,* 35, 1992 : 129-140; Stucky, R. 'Das nabataeische Wohnhaus und das urbanistische System der Wohnquartiere in Petra'. Dans *Arabia Antiqua : Hellenistic Centres around Arabia,* Invernizzi, A. Salles, J.-F. (éd.) Rome 1993 = ISMEO série Orientale (dir G. Gnoli) LXX,2:37-53

[27] Zayadine 1995:236; ce pont pouvait supporter simultanément un aqueduc destiné à alimenter le quartier au nord du Wādī Mūsā.

[28] Voir la communication de L. Nehmé dans le même volume.

développés à la périphérie de la zone centrale, mais en continuité avec celle-ci, ne peuvent être séparés de la ville. Ses habitants se rendaient facilement au centre de la ville. On a identifié de l'habitat au-delà de la tour Conway. Ces habitations étaient groupées en quartiers d'importance variable. Dans la vallée du aṣ-Ṣiyyagh [29]on accédait aux maisons à partir du lit du wadi qui servait sans doute à la circulation pendant la plus grande partie de l'année, grâce à un système d'escaliers bien conservés.[30] D'autres habitations rupestres étaient alignées le long de la chaussée taillée dans le rocher et longeant le Wādī ad-Dayr qui aboutissait au sanctuaire de ad-Dayr. À l'est, quelques habitations rupestres prolongeaient la ville jusqu'aux environs du théâtre sur l'itinéraire du as-Sīq. On trouve encore un groupe d'habitations au sud, au-delà de al-Katūta, jusqu'au confluent du Wādī Umm Rattam et du Wādī an-Numayr. Il est desservi par l'itinéraire caravanier sud-est passant par Farasa et an-Numayr.

Lorsque ces "faubourgs" prennent une certaine importance on voit se dessiner une organisation dont l'unité semble être la terrasse. Sa longueur et sa forme peuvent varier, comme dans les secteurs en pente du centre-ville. Dans les deux cas elle fournit la base d'un réseau de circulations. Murray avait déjà qualifié de rue la terrasse où s'alignaient les habitations qu'il a fouillées.[31] L. Nehmé a relevé, sur les pentes de al-Mu'ayṣra, plusieurs grandes terrasses systématiquement organisées, avec des grottes taillées et aménagées dans la falaise complétées par des parties construites en avant de la paroi.

La plupart de ces groupes de maisons sont placées sur des voies d'accès au centre ville, à la manière des "faubourgs", selon un modèle de développement connu à toutes les époques. En revanche le quartier de al-Mu'ayṣra semble lié à la ville par une voie d'accès propre parfaitement reconnaissable, au nord du pavillon touristique, où elle a été entaillée profondément dans un relief rocheux (FIG. 10). Elle passait ensuite sur des remblais. De mêmes dimensions que les voies caravanières (de 3 à 4 m), elle atteignait un niveau à partir duquel on pouvait accéder à plusieurs terrasses en partie rocheuses réservées à l'habitat rupestre. Le détail des cheminements à ce niveau n'a pu être identifié, les zones traversées, planes ou en faible pente, n'ayant pas exigé d'aménagement particulier. Plus loin au nord-est, il faut sans doute interpréter comme deux groupes d'habitations deux ensembles jusque là interprétés comme des sanctuaires.[32] Le chemin qui les dessert décrit de larges courbes pour contourner les déclivités trop marquées.

Un autre accès propre, par escalier, revenait à une partie du faubourg du aṣ-Ṣiyyagh installé sur le flanc de al-Ḥabīs.

Un petit groupe de constructions qui semblent avoir été réservées elles aussi à l'habitat, était installé sur une terrasse basse sur le flanc ouest d'Umm al-Biyāra. Il n'était accessible que par la rampe monumentale qui donnait accès au sommet du massif rocheux. Comme cet accès pouvait être fermé par une porte, ces habitations se trouvaient particulièrement protégées. On s'interroge sur les habitants qui avaient droit à ce privilège.

Itinéraires cultuels

L'importance des voies de circulations de caractère cultuel, relevées en 1989, a été confirmée par les relevés effectués depuis cette date. La plupart des sanctuaires rupestres dispersés à la périphérie de Pétra semblent avoir été desservis par des itinéraires propres qui souvent ne se prolongeaient pas au delà. Le chemin aménagé paraît s'arrêter au sanctuaire ou au groupe de sanctuaires.

Les itinéraires les plus clairs sont ceux qui mènent vers des hauts-lieux: ils comportent alors un grand nombre d'escaliers et d'aménagements rupestres qui se conservent le mieux. Si les accès aux hauts-lieux du al-Madhbaḥ et du al-Khubtha étaient connus, la cartographie nouvelle les a précisés. Le véritable chemin d'accès à al-Khubtha part du tombeau de S. Florentinus.[33] On a pu préciser l'itinéraire qui se dirige vers an-Numayr à partir du confluent du Wādī an-Numayr et du Wādī Umm Rattam (FIG. 11). Il remonte le premier wadi puis prend un embranchement vers le sud-ouest et escalade la pente par des virages en épingles à cheveux et plus haut par un escalier spectaculaire (1281). Les sanctuaires situés dans des fonds rocheux de gorges ou près de points d'eau avaient eux aussi leur chemin d'accès aménagé, mais lorsque celui-ci passait par un fond de wadi il a été évidemment effacé. On peut suivre le chemin qui suit le Wādī an-Numayr puis des tronçons entaillés dans la roche et comportant des escaliers avant d'arriver à la chapelle d'Obodas (290), dans un vallon du massif de an-Numayr. Un des itinéraires les plus spectaculaires est celui qui se dirige vers l'ensemble de sanctuaires du Madras en partant d'une gorge latérale qui s'ouvre vers le sud à l'intérieur du as-Sīq, à environ 200 m de Bāb as-Sīq. Une variante partant de l'extérieur du as-Sīq rejoint rapidement cet itinéraire. L'itinéraire en partie taillé dans le rocher, en partie posé sur des soutènements construits, se divise en deux branches à son extrémité pour desservir deux ensembles de sanctuaires. On a pu reconnaître également des tronçons du chemin qui conduisait au sanctuaire d'Isis dans le Wādī al-Waqīt. Il prenait son départ de la voie caravanière du Jabal Hārūn. Deux autres sanctuaires situés plus bas sont reliés au al-Madhbaḥ.

Ces itinéraires sont le plus souvent jalonnés d'inscriptions de caractère religieux, de niches, de bétyles, de fontaine (comme le lion de la montée vers al-Madhbaḥ) ou de lieux de culte secondaires comme le Qaṭṭār ad-Dayr, sur le chemin de ad-Dayr. On est ainsi conduit à se demander si les voies d'accès ne font pas elles-mêmes

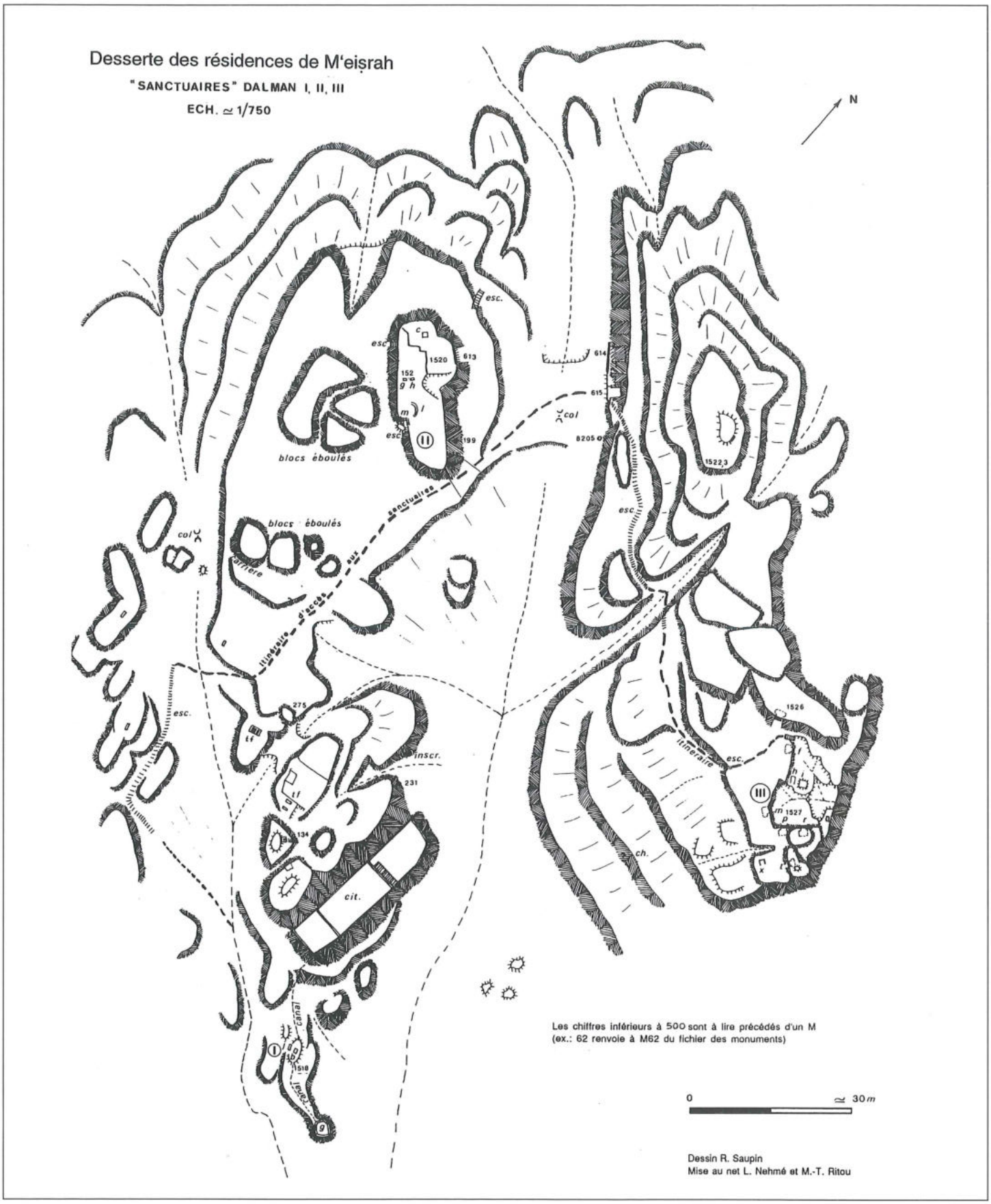
[29] Zayadine 1995 : 236-237; *SHAJ*, III, 1987: 140.

[30] Jusqu'à la première boucle du wadi.

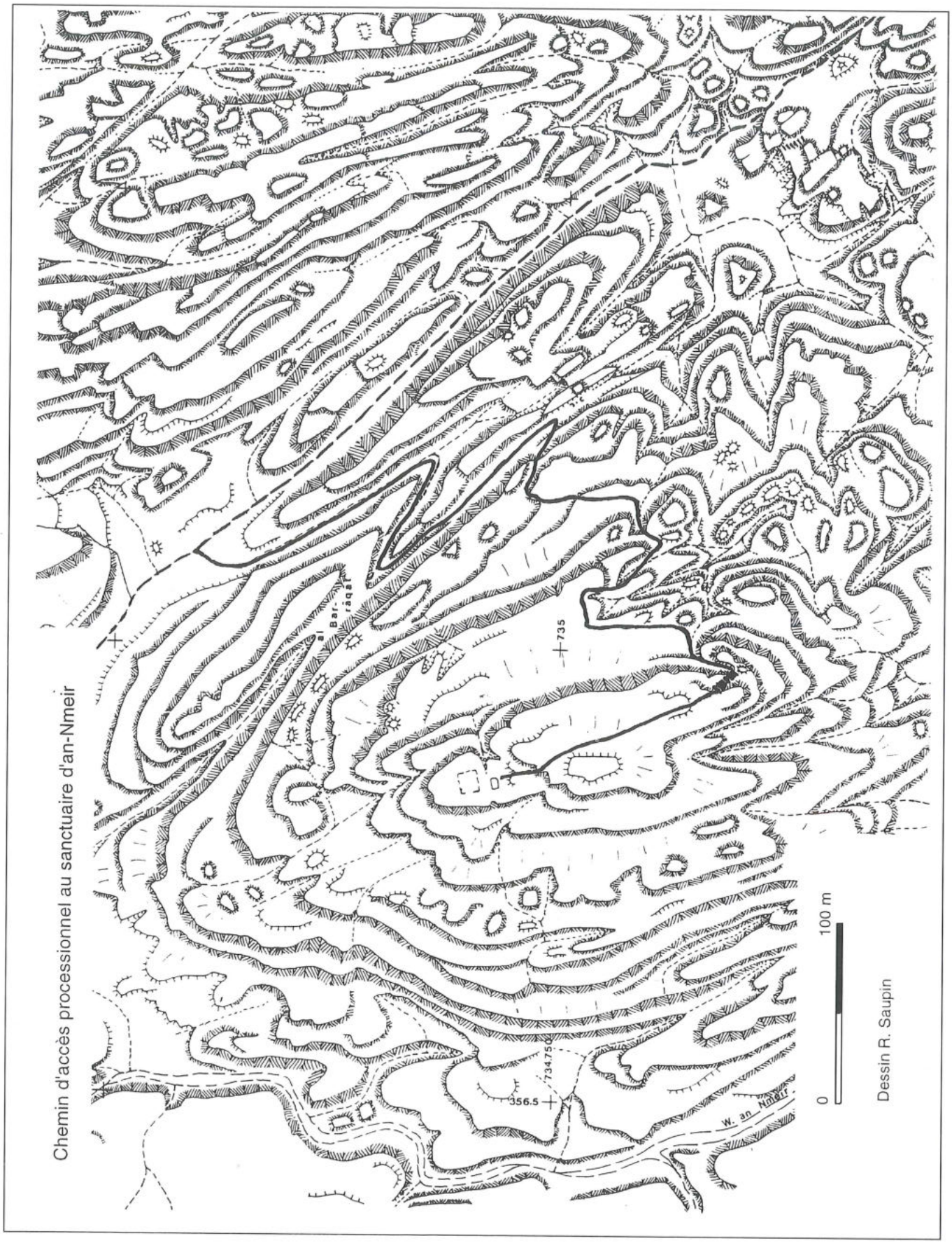
[31] Murray, M.A.; Ellis, J.C., *A Street in Petra.* BSA in Egypt. Public. LXII, Londres, 1940.

[32] Voir L. Nehmé dans le même volume.

[33] Avec deux accès au départ, près du tombeau.



10. Desserte des zones résidentielles de al-Mu'ayṣra, avec tronçons aménagés et escaliers (R.Saupin ERA n°20).



11. Chemin d'accès au sanctuaire de an-Numayr (carte R.Saupin).

partie des sanctuaires et si le cheminement sur ces voies ne constitue pas lui-même un rite processionnel. On retrouve exclusivement des monuments de caractère religieux dans le as-Sīq qui, avec le témoignage d'un panégériarque de Adr'a[34], pouvait prendre toutes les caractéristiques d'une voie processionnelle, à l'occasion de certaines fêtes sans doute et plus particulièrement pour le culte majeur de Pétra célébré dans le Qaṣr al-Bint : il faut noter que l'itinéraire du as-Sīq, pavé et donc mal adapté à un trafic caravanier, débouche directement dans la rue à colonnades et à la porte du *temenos* du al-Qaṣr.[35]

Il faut souligner l'importance donnée à ces voies qui atteignent souvent trois mètres de large, dimension proche de celles des voies considérées comme caravanières. Cela fait penser qu'elles étaient empruntées simultanément par un grand nombre de pèlerins, au moins dans certaines fêtes. La signification particulière du Haut-lieu du al-Madhbaḥ pourrait expliquer l'aménagement d'un double itinéraire d'accès par le Wādī Farasa et à partir du théâtre. Ainsi pouvait être assuré le cas échéant un mouvement continu, en sens unique.

La majorité des lieux de culte, quelque peu dispersés dans l'espace entourant le centre de la ville, sont bien liés à l'entité urbaine de Pétra avec laquelle ils communiquent par des itinéraires branchés sur les axes majeurs évoqués plus haut. Ils pouvaient être fréquentés par des habitants de la ville groupés en *thiases* en fonction de leur profession, comme l'indiquent les inscriptions de al-Madras, et sans doute aussi de leur appartenance familiale ou tribale. Ils devaient se rendre, à l'occasion de fêtes déterminées, dans tel ou tel sanctuaire installé dans un emplacement particulièrement sacré.

Postes de guet et communications tactiques

Nous avons analysé en 1989 le système des défenses de Pétra où les communications à distance jouaient un rôle de premier plan. Les courriers pouvaient bien entendu emprunter tous les cheminements disponibles. On est tenté de réserver plus précisément à cette fonction un certain nombre d'itinéraires spécifiques aux traits particuliers : sentiers étroits parfois à forte pente, inaccessibles non seulement à des bêtes de somme mais même à des troupeaux de chèvres et présentant cependant des traces d'aménagement avec des tronçons taillés dans le roc ou construits. À ces itinéraires de liaison il faut ajouter nombre d'escaliers généralement étroits. La nécessité d'accéder à un poste de guet ayant vue sur un secteur stratégique explique sans doute un grand nombre d'itinéraires verticaux courts. Il faudrait y ajouter les itinéraires de liaisons aménagés mais inaccessibles à des bêtes de somme ou à des troupeaux.

Une incertitude subsiste sur la fonction de certains itinéraires conduisant vers des hauts-lieux qui par leur position constituaient aussi des postes d'observation remarquables. Ainsi le chemin du Jabal an-Numayr atteint à l'extrémité nord du plateau sommital une construction rectangulaire complétée par une citerne (FIG.10). S'agit-il d'un haut-lieu ou plutôt d'un poste de guet? Du sommet (1117), la vue domine tout le secteur de ath-Thughra.

Comme les sanctuaires rupestres qui viennent d'être évoqués, ces postes de guet sont des points séparés les uns des autres et situés à l'écart du noyau urbain complété par ses faubourgs. Souvent plus éloignés encore que les sanctuaires, ils n'en sont pas moins indispensables au fonctionnement de la ville puisqu'ils assurent une part essentielle de sa défense.

Conclusions

L'analyse des circulations autour du site de Pétra et à l'intérieur de celui-ci confirme une organisations cohérente de l'espace groupant autour d'un noyau urbain central, complété par des faubourgs contigus, des zones discontinues et des éléments ponctuels souvent éloignés qui n'y sont rattachés que par des itinéraires linéaires (FIG. 12). Au moins dans une des périodes de la ville, tous ces éléments appartiennent fonctionnellement à un même "programme urbain". Il faudrait y ajouter les nécropoles qui n'ont pas été examinées ici.[36] Ces éléments sont répartis dans un espace qui dépasse largement non seulement les tracés des remparts continus, identifiés au nord et au sud de la ville, et vraisemblablement tardifs,[37] mais encore toute la partie centrale à laquelle on serait tenté de réserver le nom de ville. L'unité d'un espace beaucoup plus large était-il perçu par les contemporain ? La façon dont Strabon définit une ville sans rempart le suggère. D'autre part L. Nehmé a montré le caractère particulier des deux petites "agglomérations" de Bāb as-Sīq et de ath-Thughra. Contrairement à d'autres petits groupes de structures dans lesquelles une fonction (habitat, culte, funéraire, défense) prédomine nettement, on y constate un mélange de tombeaux, d'installations de culte et d'habitat. Les deux petites agglomérations sont implantées sur une voie de communication majeure et à un emplacement clef, entrée des gorges du as-Sīq d'une part, col de Rās Sulaymān d'autre part, que l'on pourrait considérer comme la limite de l'espace urbain au sens large. L'arc qui enjambe l'entrée de la gorge du as-Sīq en apparaît comme l'expression monumentale.[38] Ce n'est pas un hasard si ont été gravées là des *nefesh* commémorant des défunts morts à l'étranger, comme l'atteste explicitement une inscription à Bāb as-Sīq.[39]

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34 Starcky 1966 : 990, 1009; Zayadine F. *ADAJ* 26, 1982 ; 365, pl. 117,1; et dans Lindner 1986 : 223 sq.; Wenning 1987 : 209-210.

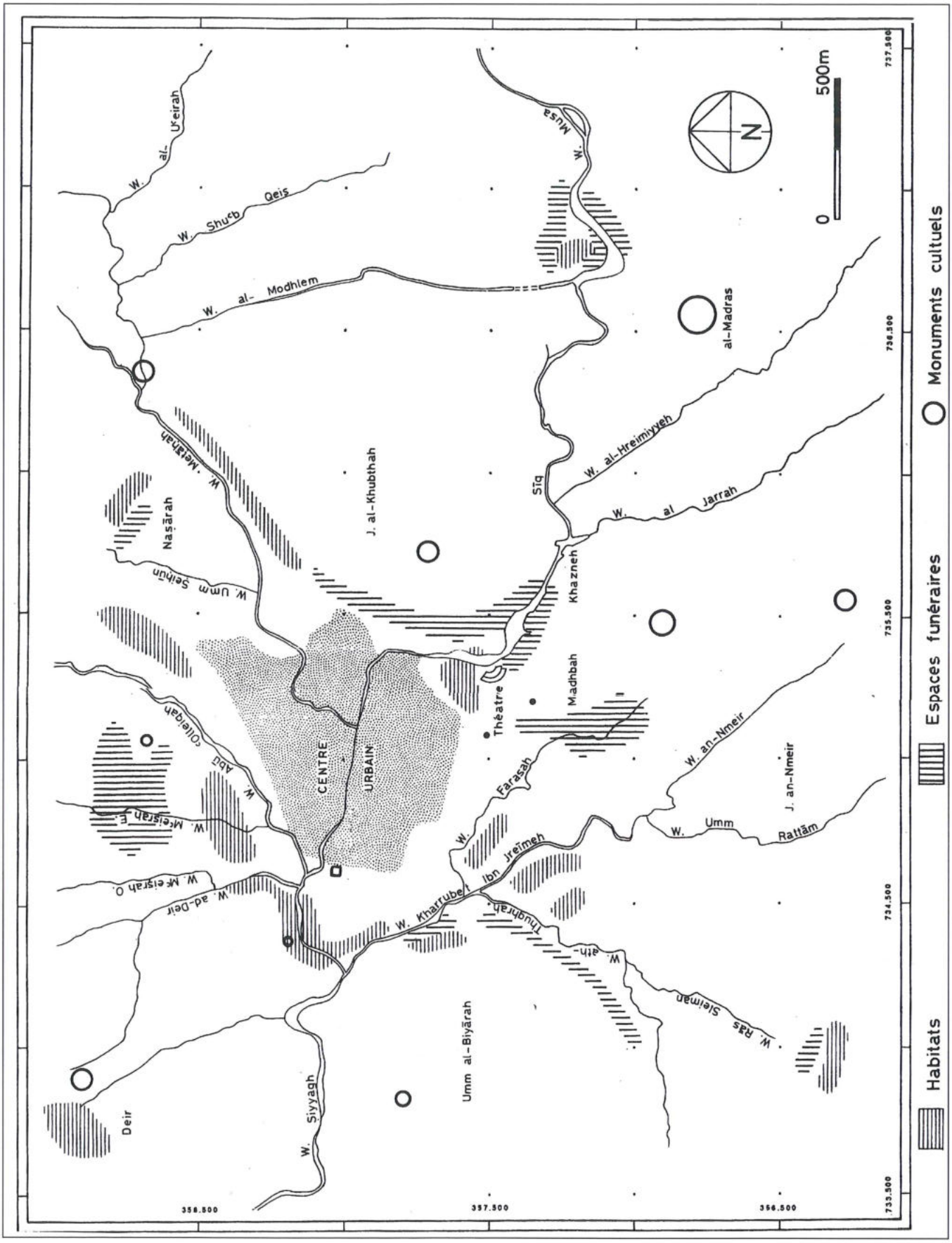
35 Zayadine F. dans Lindner 1986 : 223 sq.; Wenning 1987 : 209-210.

36 Dans la plupart des cultures antiques l'espace des nécropoles est clairement séparé de celui des vivants. La superposition des deux que l'on observe dans quelques secteurs doit être expliquée sans doute par le développement de l'habitat aux dépens d'une zone sentie auparavant comme extérieure. C'est la conclusion à laquelle aboutit l'étude de L. Nehmé sur le secteur de al-Mu'ayṣra comme les fouilles récentes de Zeitler au pied de la falaise de al-Khubtha. Une maison a, en effet, été construite dans une zone de tombes abandonnées.

37 Certains de ces remparts passent sur un habitat plus ancien *cf.* Dentzer *et al.* 1992 *SHAJ,* IV :

38 Wenning 1987 : 209, n°8.

39 Starcky J, *RB,* 72, 1965 : 95-97; *ADAJ,* 10, 1965 : 43-49; Parr P., *RB* 74, 1967 : 45-49; Starcky 1966 : 896-900.



12. L'espace urbain de Pétra (R.Saupin ERA n°20)).

C'est à l'extérieur de cet espace que se situent un certain nombre d'agglomérations autonomes, à Rās Sulaymān, à Bayḍa ou à Ba'ja. Elles sont séparées par un vide du centre de l'agglomération à laquelle ils sont reliés eux aussi par les routes caravanières. Si certaines pouvaient être des centres d'exploitation agricole, la plupart d'entre elles jouaient sans doute un rôle dans le trafic caravanier, en particulier Ṣabra qui a pris un véritable caractère plus monumental.

Plus loin encore du centre, des établissements fortifiés situés au débouché des vallées et des pistes vers la 'Arabah (Abū Khushayba, Qaṣr Umm Rattam...) devaient verrouiller les accès à Pétra et contrôler le trafic caravanier auquel ils pouvaient servir de haltes. Elles servaient éventuellement de première ou de dernière étape avant ou après Pétra.

Ce vaste espace composite de ville réseau ne pouvait être traité d'une manière homogène. L'urbanisation n'a finalement marqué d'une manière intensive que le coeur de Pétra, monumentalisé sur le modèle de la cité méditerranéenne hellénistique. Des ressources importantes ont également été investies dans l'architecture funéraire. Ailleurs l'emprise sur l'espace a été plus extensive et plus discrète. Le développement des quartiers d'habitations et surtout de la périphérie, qui représentent la part la plus originale de l'espace urbain, repose d'abord sur une observation et sur une utilisation intelligentes de ressources du site. Les aménagements ont été adaptés avec souplesse à l'espace naturel en retenant les solutions les plus économiques. L'aménagement en terrasses, sans gros travaux de soutènement, des pentes réservées à l'habitat dans le centre ville ou dans les faubourgs se situe à l'opposé des plans d'urbanisme autoritaires et géométriques imposés au paysage comme dans le cas extrême de Priène. Dans les deux cas cependant les voies de communications constituent l'épine dorsale et le système nerveux de l'entité urbaine dont elles assurent le fonctionnement.

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The Water Canalization System of the Petra Southern Temple[1]

Introduction

In Book II Chapter IV, Diodorus Siculus describes the Nabataeans as nomads who "inhabit a tract partly desert, and in other parts without water, and there is very little of it that bears any fruit..."

The Nabataeans, once nomads, became a settled people and as an investment in urban planning, their control of water was vital. They built Petra and it is well-known that one of their great achievements was to develop hydraulic engineering systems to collect water in underground cisterns and reservoirs, to cut out channels in the rock face to divert and direct water into their city, to dam the Wādī Mūsā, and to construct tunnels for water flow. With these irrigation systems, in effect, they redesigned nature and increased their control over their environment. From the Nabataeans' manipulation of the landscape, it appears that water resources were more than sufficient to serve the needs of their great city.

In the very heart of Petra lies the Southern Temple complex (FIG. 1).[2] Under the Temple Forecourt (FIG. 2), in Trench 1, a system of water tunnels was uncovered in 1993-1994 by Brown University archaeologists[3] excavating under the auspices of the Department of Antiquities of Jordan.[4] With the aid of a mining engineer - economic geologist,[5] the tunnels were made safe for entry and study. In 1995, ground penetrating radar [6] was used to plot these tunnels. Excavation during that year also uncovered other areas where the system could be followed.

This canalization system was in continuous use for many years. We assume the Southern Temple was constructed around the time of the city's greatest prosperity, the reign of Aretas IV (9 BCE - 40 CE), and that it was in use throughout the Roman occupation of Petra in 106 CE when the city was annexed by the Roman emperor Trajan, and became part of the Roman Provincia Arabia. Part of the Southern Temple may have survived the 363 earthquake, and the evidence from the 1995 Brown University excavations of the site suggests that the Temple saw reuse in the Byzantine period — thus it may have been in use for some 400 or more years. What is clear so far is that the water supply flowing through these channels must have been plentiful, for the system was carefully planned, in the Nabataean fashion, to maximize a sizable quantity of this most precious resource.

This paper will describe the results of the excavation analysis – the tunnels, their method of construction, the cause of their collapse, their purpose, the objectives for future study – and will conclude with a cursory look at water systems found at other Nabataean sites.

Discovery

On the final day of excavation during the 1993 field season, a small circular patch of loose soil located in the center of the limestone paved Southern Temple forecourt (FIG. 2) was cleared to a depth of 0.5 m, to reveal the main junction area of four subterranean water channels (FIG. 3). Lying obliquely across the top of the junction point, probably serving as a makeshift capstone to the tunnel ceiling, was a dressed ashlar block, which had a mason's mark etched into one side. Removal of this stone

1 I would like to thank the Centro Recerche Archeologique e Scavi di Torino per il Medio Oriente e l'Asia — The Sixth International Conference on the History and Archaeology of Jordan and President Gullini for this conference initiative. The conference title, "Landscape Resources and Human Occupation in Jordan Throughout the Ages," forced me to think about the water resources of the Southern Temple. I would also like to thank the Jordanian Department of Antiquities of Jordan and Dr Ghazi Bisheh, Director–General, for it is with the consent of the Department of Antiquities that our work continues at Petra. A Brown University Faculty Travel Grant made my participation in this conference possible.

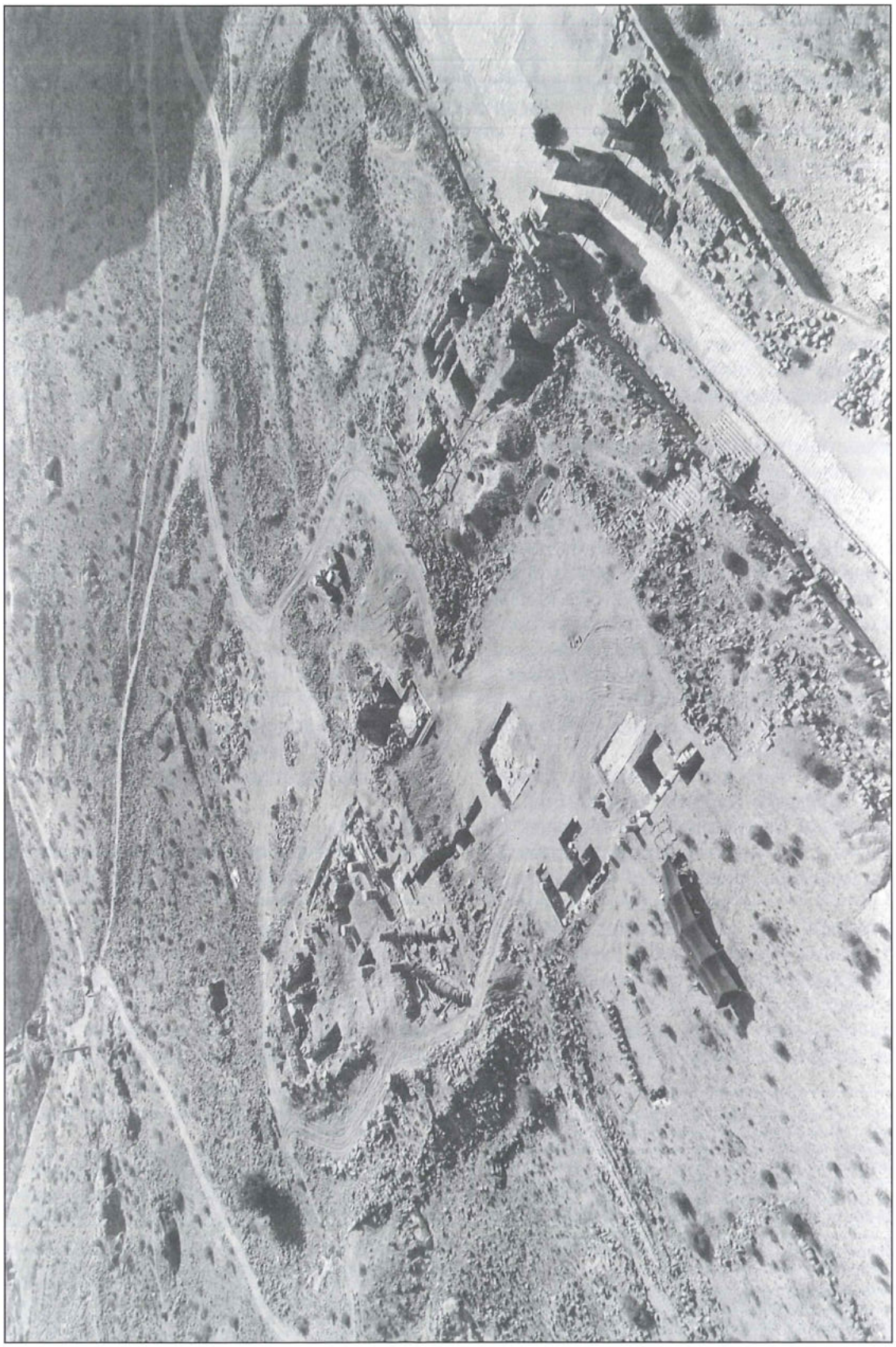
2 The Southern Temple represents one of the major archaeological and architectural components of the city, as well as one of the largest temple structures covering some 7000 square meters to be found at Petra. The Southern Temple lies to the south of the Colonnaded Street and southeast of the Temenos Gate. It occupies a position of paramount importance. From north to south the Petra Southern Temple complex is comprised of a Propylaea, which leads to a Sacred Area or Lower Temenos ending in a monumental Grand Stairway which in turn leads to the Upper Temenos, the sacred enclosure for the temple proper.

3 Trench 1 was excavated in 1993 by Erica Schuntz, a Brown University Ph. D. candidate in the Center for Old World Archaeology and Art.

4 Suleiman Farajat was appointed as our on-site Jordanian Department of Antiquities representative 1993-1994. And in 1995, our government representative was Mohammad Abdul-Aziz.

5 Peter B. Nalle has 50 years of mining and construction experience. He was on-site and advised us from 27 June to July 11, 1994. A 1994 excavation and study of these systems was undertaken by Elizabeth Ellen Payne, (now a Ph.D. candidate at Boston University), for a 1995 Senior Honors Thesis at Brown University. Lee Payne was also responsible for the 1995 excavation of the Trench 13 collapse and recovery of the system in Special Project 20.

6 In 1995, GPR was initiated and supervised by Terry Tullis of Brown University's Geology Department.



1. Petra Southern Temple, aerial view, 1995, facing southwest.



2. Petra Southern Temple Forecourt, showing the area of disturbance in the foreground,1994, facing south.

and its surrounding debris revealed narrow tunnels, sealed by stone slab stones at an elevation of 883.7 m, leading to the north, south, east, and west. Due to the potential risk of collapse, and because they were discovered at the close of the season, these passageways were only cursorily investigated, and then covered and sealed for the following season's investigation. Now, after the 1994 and 1995 full seasons of exploration, much more about this impressive water conservation and drainage system is known. Because elements of the same system have been found in different areas of the Petra Southern Temple site, we have designated the various areas as follows:

Channel A. The main north-south channel. We posit that it extends from the Southern Temple interior to the Temple Forecourt and progresses in a northward direction to the Wādī Mūsā where it discharges.

Channels B and C. These are the tunnels located to the east (Channel B) and west (Channel C) off of Channel A located in the Temple Forecourt.

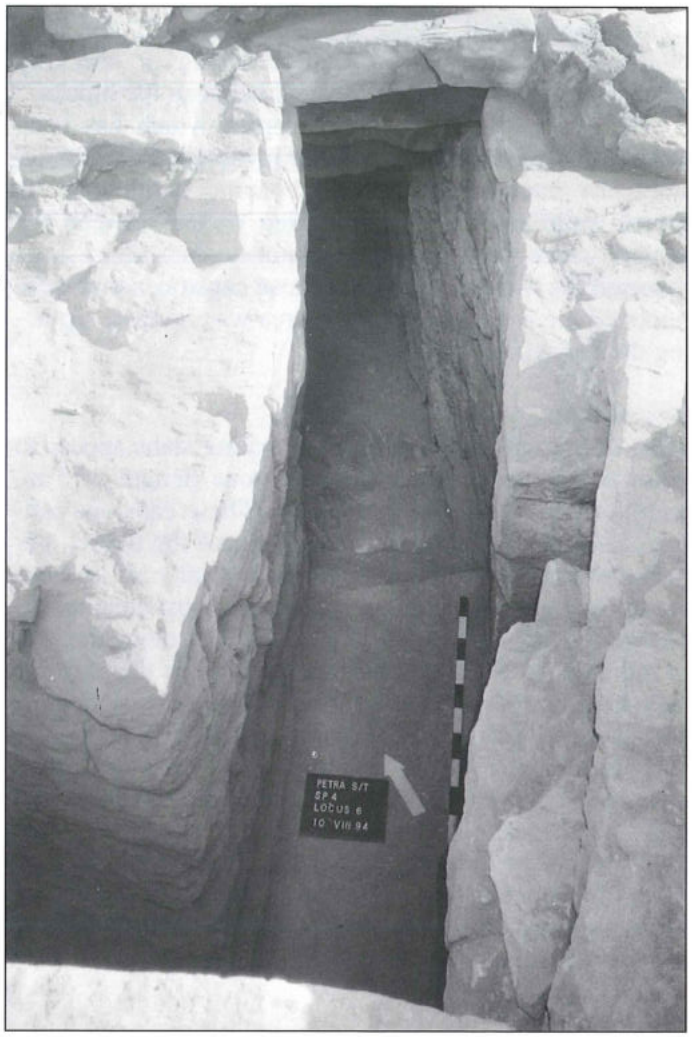
Channels D and E. The tunnels east (Channel D) and west (Channel E) that extend from Channel A in the Lower Temenos (Trench 13, Special Project 20).

Channel F. The artery located in the Temple East (Special Project 30, near Trenches 4 and 19.

Channel G. The continuation and part of Channel A in the Lower Temenos North, located just south of the Propylaea Steps.

The Stratigraphy of Channel A in the Temple Forecourt

Top soil fill, averaging 0.75 m in depth covered the hexagonal pavement which had been disturbed probably by the modern use of the area for growing grain. The white limestone hexagonal paving was uneven but had an average elevation of 884.41 m. Under the hexagonal pavement,[7] there was either a sand and clay fill or a pink



3. Junction of Channels A, B, C in Trench 1, 1994, facing north.

mortar bedding which has the consistency of hard clay. Under this was a pebble-filled yellow mortar which had the consistency of concrete.

Under the Temple Forecourt, the Channel A stratigraphy indicates two phases of construction — an original building at the earlier lower phase, and a subsequent later upper phase(s) of repair. The earlier phase walls of the passageways themselves were of a well-planned and well-executed construction, with uniform, well-built corners, which would indicate that the entire system was originally planned and constructed simultaneously. The later upper courses indicate a building up of the system perhaps to allow for a greater water flow. It is possible that this rebuilding may also indicate a repair dating to Phase 2 of the Temple construction.

These main tunnel side walls are vertically constructed with roughly dressed sandstone ashlars, ca. 0.60 -0.70 m in length and 0.30 - 0.40 m in width. The five to seven wall courses are generally dry-laid without mortar and

[7] These white limestone pavers measure about 33 cm in diameter. Each side measures 20 cm, and they are 0.12 m in thickness.

were closely-fitted. However, particularly in the later phase, in some instances small chinking or snecking stones were observed to be wedged between the blocks.

The second phase is one of repair, which has been crudely executed. Those who were involved in rebuilding, started by removing the hexagonal paving, building up the tunnel walls and inserting snecking stones between the ashlars when their joins were not sealed. They then reversed the process, replacing those capstones that were removed for entry and, after the area was refilled, replacing the hexagonal pavers.[8]

Description

Most of the tunnels' well-dressed ceiling slabs appear to be of limestone or fine white sandstone (length 0.75 m, width of 0.57 m, thickness 0.18 m). These capstone ashlars were positioned to span the width of the tunnel, but they did not overlap the side walls. Virtually all of these capstones have suffered some damage. Most have multiple breaks, and are stress split in the center, along the axis of the tunnels. This probably occurred when the massive temple columns fell, either from earthquake action or because there was a lack of structural integrity within the Temple structure itself. Sealing these capstones from above was a layer of sterile, densely packed wadi sand, which was clearly distinguishable from the loose, finer layers of fill and topsoil above. To facilitate the excavation of this portion of the Temple forecourt and the canalization system, five capstones, cracked but still *in situ* were recorded and then removed.

Channel A

The major water conduit is the north-south Channel A, which emerges from beneath the temple center, proceeding at a shallow, downward grade below the temple forecourt. The internal dimensions of the tunnel ranges from 0.60 to 0.70 m in width. After the intersection point, it descends at 26° to pass under the steps or wall that demarcates the Upper Temenos from the Lower Temenos. (The differential in elevation between the two areas is approximately six meters.) This main passageway, was lined on the bottom with a fairly thick layer (4 to 6 cm) of mortar, as were the secondary passageways to the east and west. The southern extent of the north-south passage is also uncertain, due to heavy collapse located below the area of the Southern Temple stylobate. But to the south, towards the Temple entrance, the tunnel at an 8.4 m distance ascends up grade to a point where it then pitches sharply upward. This is where collapse can be seen. Shortly before it reaches the northern limit of the Upper Temenos, the main north-south tunnel descends sharply, descending with the slope and passing below the Grand Stairway which leads down to the Lower Temenos area. At this point the channel bottom is stepped, apparently to slow the speed of the water running through it (FIG. 4). The ceiling, which ranges 1.7 m -1.9 m in height, is similarly stepped.[9] The tunnel to the north was found blocked by fine soil and sand at approximately 11 m to the south of the opening in the Temple forecourt. FIG. 5 is the west section of the canalization system.

Careful excavation of the uncapped portion of the north-south channel revealed two distinct layers of soil deposit above the mortar lining. The 0.24 m thick lower layer consisted of fine, silty soil. The fine-grained fill in the tunnels is surprisingly devoid of artifacts — the scant ceramic remains were Nabataean and Roman in date. The one datable lamp fragment was securely first century CE. Presumably this layer was deposited during the system's period of use. Within the tunnels, a second, 0.36 m thick layer of loose, topsoil-like fill and debris then accumulated, apparently after the temple area's abandonment.

Channels B and C

There are east and west tunnel passages to this main system in the Temple Forecourt. The east and west branches are slightly narrower than the north-south conduit, averaging 0.5 m in width. They are constructed 30 cm above the floor of the north-south tunnel, and their side walls are also not as high, Channel B on the west measuring 0.60 m in height, and Channel C on the east 1.1 m in height. The east-west walls are bonded to the north-south tunnel walls, thus again it can be assumed that the system network was constructed at one time. The two tunnels do not join the main passageway at the same point — rather, they are staggered, with the west tunnel joining the north-south 0.75 m further to the south. Our mining engineer observed that this offsetting of the passages was probably intentional, in that one single capstone could not have securely spanned the area of a four-branch join — about 1.5 m from its join to the north-south channel, the east branch curves to the northeast, and at 3.5 m collapse is visible. The west tunnel extends to the west for approximately 1.5 m and then curves to the northwest, and beyond 5.00 m, this passage curves too abruptly to see where it goes. At the end of their observable length, both tunnels are sand-filled up to their roofs. Curiously, these two channels slope slightly north to south, counter to the marked south to north grade of the main channel. Further investigation of these channels is necessary, but it may be that their opposing north to south grade is another method by which water speed was checked, or that the two served as run-off channels for overflow in the system. It may also be that the builders of the later phase just left the Southern Temple access steps, and constructed over them for water

8 In one of the latest phases of repair, crude ceramic pavers served as a substitute for the limestone pavers.

9 The author has questioned if the stepped portion of the tunnel originally may have served as part of the stairway from the Lower Temenos to the Upper Temenos and the Temple Forecourt. At this writing I reject this idea, but it has not been disproved — the elevations of the steps lying to the east of the tunnel in Special Project 4 will have to be aligned with the tunnel stairs for possible connections between them to be drawn.

evacuation. We just do not know.

Channel A and Channels D, E

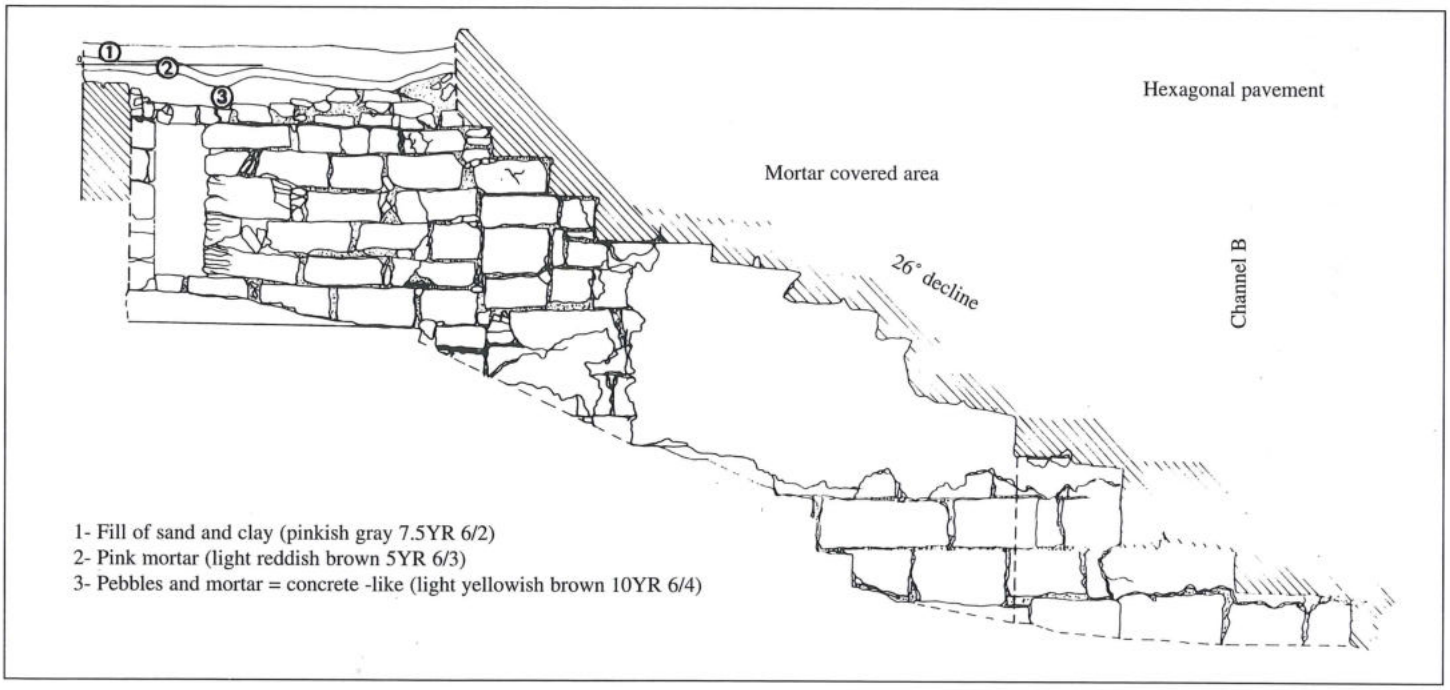
In 1994, accumulated debris and the threat of collapse prevented northward investigation in the interior of the passage beyond the area below the Grand Stairway. But within an area of disturbance below the white limestone hexagonal pavement[10] in Trench 13 of the Lower Temenos, explored in 1995 (FIG. 6), however, was the continuation of the north-south water channel with east and west branches, in direct line with the principal north-south channel, Channel A, of the Upper Temenos. (This investigatory excavation was labeled Special Project 20 — its opening elevation was at 879.17.) This area, a top priority during the 1995 field season, again confirmed the presence of yet another set of east-west tunnels, (Channels D and E) extending to either side of the main tunnel. Ground penetrating radar indicated that the principal channel, Channel A, then leveled out and extended the length of the Lower Temenos to Channel G.

Channel G

Channel G is designated by an area of collapse just south of the Propylaea Steps. Just before the Propylaea Steps, between Channel G and the steps, Channel A took a sharp pitch downwards to a depth of about seven meters. Somewhere in this vicinity there may have been a cistern or a catchment holding system. Additionally the evidence suggests that at least part of the system — perhaps only the overflow — continued to the north, under the Propylaea Steps down and under the Colonnaded Street,

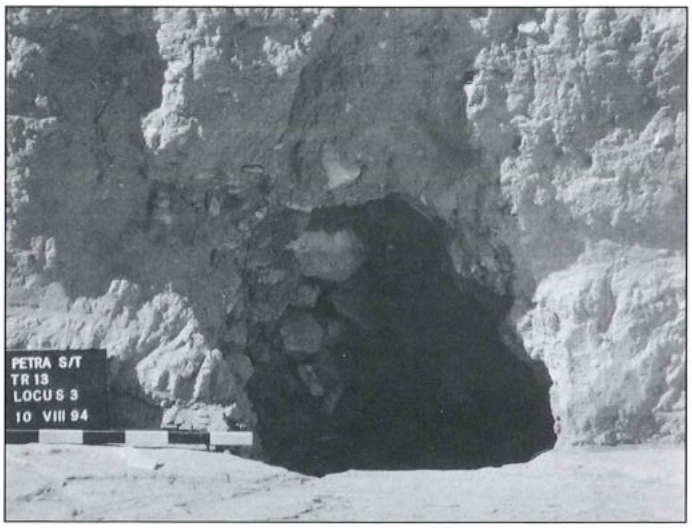


4. Petra Southern Temple, Stepped Channel A, 1995, facing south.



5. West wall of Channel A, Trench 1 and Special Project 4. (Drawn by G. Austin, 1994, Drafted by MSJ).

[10] These limestone pavers are among the largest known in Jordan. They are 0.77 to 0.80 m in width.



6. Petra Southern Temple, Trench 13 collapse, 1994, facing south.



7. Petra Southern Temple, East Forecourt, Channel F, 1995, facing west.

to empty into the Wādī Mūsa. We suspect that those great pavement blocks of the Colonnaded Street which are slightly sunken below the street level here have slumped into the fill located above its passage and may even have blocked the water discharge into the wadi. The system has now been charted under the approximate 25 m slope between our datum point 103 and the Colonnaded Street, which extends over an approximate distance of 100 m .

Channel F

Yet another artery of the system was unearthed in 1995 adjacent to the east Temple Crepidoma, just under the hexagonal pavers in the Temple Forecourt, in Special Project 30 in Locus 18 (near Trench 19 on the site plan).[11] The upper elevation is 884.46 and the canalization system was found to extend 12 m from the south to the north with a slight curve to the northeast. This canalization was constructed of three courses of sandstone ashlars which were covered by mortar. A dislodged capstone that brought our attention to a disturbance in the area had been moved in antiquity for repair or cleaning of the tunnels. (FIG. 7) shows the channel extending under the forecourt pavement on the Temple East.

Construction

Excavation from the surface of a 2.5 x 3.0 m trench located over one corner revealed repeated layers of large rock and rubble fill behind the tunnel walls, which clearly served as packing for support and stability. P. Nalle offers the following comment regarding the construction of the system:

> From the manner in which the tunnels are put together, they must have either been built in an open ditch or on a lower surface as free standing walls with the capstones placed on top. The ditch was then filled in or the entire area built up with fill to bury the structure. With the small amount of cover and the short cap stones at right angles to the center line of the tunnel, it would be virtually impossible to drive the tunnels underground. Further excavation will show if the ditch were used or if the whole area were filled. The small amount of excavation done to the NE of Trench 1 hints that the whole area was fill. Clay stabilized sand alternating with random stone paving in 15 to 20 cm layers was used to stabilize the area of fill. At the time of writing this report, [1994], the excavation had not gone deep enough to determine the depth of fill. Since the whole temple complex is built on a side-hill slope, this type of construction makes sense.

Other Studies and Conclusions

Pollen sample analysis [12] has proven the presence of non - arboreal field plants and suggests large open areas with few trees, and further opening of the tunnels this season will provide more material for study. The water that flowed through here must have had a high calcium content for there are heavy lime deposits coating the walls. Again, P. Nalle (1994:4) states:

> Gypsum ($CaSO_4$. $2H_2O$) forms under rather specific conditions of moisture and temperature. Too little moisture an anhydrite ($CaSO_4$) forms. With too much water the gypsum will dissolve and wash away. Gypsum will form under water but it must be in a saturated solution which would not be

[11] This area was excavated by Laurent Tholbecq, a Ph. D. candidate at the University of Paris I - Sorbonne.

[12] The Petra Southern Temple pollen analysis was researched by Peter Warnock of the University of Missouri, Columbia, Missouri.

> possible in the Petra tunnels. The appearance of the coating in the North tunnel indicates that moisture slowly evaporated on the wall allowing gypsum to crystallize over time...It is postulated that the coating started to form after the collapse and after the last major earthquake.

Much work still needs to be done on the water management system of the Southern Temple Complex. Ongoing investigations below the Upper Temenos courtyard area should reveal whether this system was itself set into bedrock or rather, as we suspect, into the artificial al-Katuta slope which was graded for the temple's construction. Continued exploration with ground penetrating radar may help to define the route of the east and west passages in both the Upper Temenos and the Lower Temenos. When we find the source intake of the system and find out how it served the Temple interior, how the water may have been stored and how it served the so-called "baths" located adjacent to the Temple northwest and the discharge under the Colonnaded Street, we will be on surer ground. Many questions remain to be answered: What was the character of the system intake? Was there a water diversion system at the back of the Temple? And where is the cistern? We suspect there is a cistern, perhaps even a great cistern located in the Lower Temenos precinct. The Lower Temenos area should reveal the further northern extent of the main channel, and perhaps even a cistern or catchment area for final water conservation.

Purpose of the Southern Temple Canalization

We may question the purpose of the Southern Temple canalization system.[13] This writer will argue that it principally served to evacuate a massive water flow away from the Southern Temple, possibly into a cistern or catchment area which has not yet been located. Logically, this is where the water would have been conserved. Not only is the Southern Temple vulnerable to flash floods, but its construction, on artificially filled sloping ground would leave the structure vulnerable and exposed to the elements.

Although the excavation of the Temple cannot confirm the roofing pattern of the cella, it might be suggested that the cella was unroofed and open to the sky, in which case flash floods would be considered an element to be reckoned with. The distance between the interior colonnade of the Temple is approximately 20 m in width and, to date, few roof tiles have been found in the excavation of this area, thus it is not unreasonable to theorize that the center of the structure was unroofed, and that its builders foresaw the necessity of having water channeled away from the structure. But this idea can only be tested by further excavation in the Temple cella, which up to this time has been unexplored. Thus its major purpose would have been to drain and thereby protect the Southern Temple, as well as to harness and conserve its precious water resources. (FIG. 8) shows a 1995 plan of the Southern Temple with the subterranean water system imposed on it.

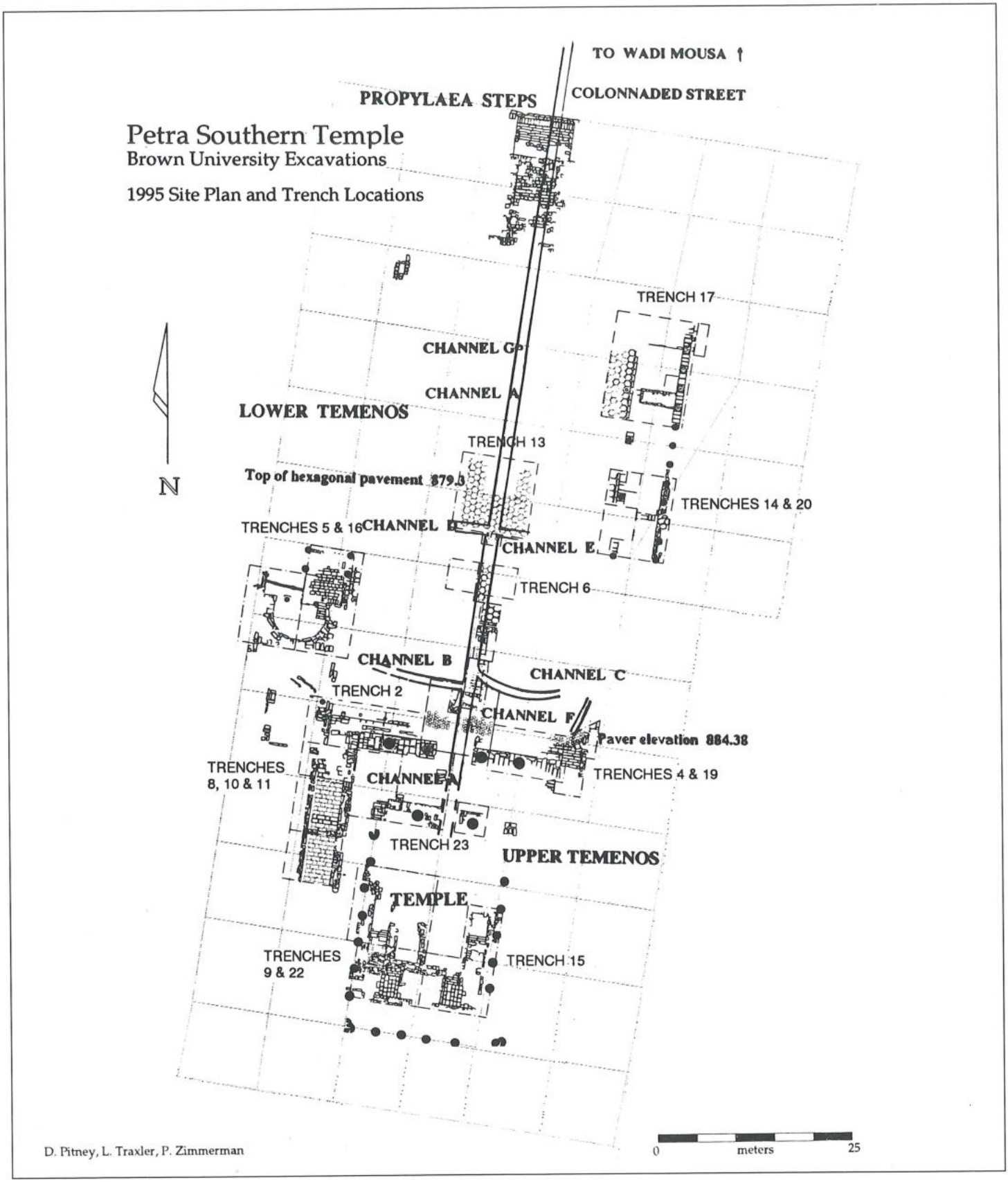
Other Nabataean Sites

The Nabataeans left extraordinary examples of the ingenuity and creativity to provide for water storage and conservation. Such water systems, including channels, cisterns, and dams are characteristic of Petra. The cisterns found at Umm al-Biyārā (which means, "the mother of cisterns") may date from the Edomite period. There is also the complex water system in the Sīq described by Judith McKenzie (1990:38) which is dated to 50 CE. Peter Parr (1967:49) suggested that the Sīq had to be dammed before al- Khaznah could be constructed, so that the building would not suffer damage from flash floods. The al-Khubtha water system carries water by aqueduct from the spring at 'Ayūn Mūsā over a six kilometer distance into Petra, where it is conserved in cisterns with a holding capacity of 1.5 million liters. This system has been studied by Manfred Lindner (1978) and E. Gunsam (1980). The subterranean Wādī Mūsā reservoir with its Dushārā niche and cistern has been restored by Sulieman Farajat — it serves as an excellent example of Nabataean water systems for their capital city.

Among other sites where such systems have been recovered are Ṣabra (M. Lindner 1982a) , Ḥumayma (J. Oleson (1984, 1990, 1991, 1992a, 1992b) and Mampsis (A. Negev 1988). Rediscovered for the west by Leon de Laborde, is the system at Ṣabra which was surveyed and reported on by Manfred Lindner (1982a). Here at Ṣabra, the system is associated with the theater, which Lindner suggests was flooded for sea battles (Lindner 1982b. 232). Well up behind the theater is a series of four terraces and pools which flow into a reservoir with a dam. From the dam there are channels leading down into the theater. In the mountains surrounding Ṣabra, there is also an enormous Nabataean dam and reservoir complex that Lindner (1986:6) has estimated to hold 3.6 million liters of water. A water channel system was used to evacuate water from here to its settlement as well. For years the site of Ḥumayma, 80 kilometers north of 'Aqaba has been excavated by John Peter Oleson (1984, 1990, 1991, 1992a, 1992b). This city which was founded by Aretas III Philhellen (87 - 62 BCE) boasts 51 cisterns, four springs, an aqueduct some 27 kilometers in length (Oleson 1991:59), a dam, wadi barriers, and terraces. These systems exemplify remarkable Nabataean engineering know-how.

Located in an area of only 80 mm of rainfall per annum is the site of Mampsis (in Arabic, Kurnub), situated inland from the Dead Sea, in the Central Negev desert, 40 km southeast of Beersheba. Avraham Negev (1988) excavated here from 1965-1967. This site has long been recognized as having important water systems that were

[13] It was proposed that the tunnels were used by people, but the east and west are far too cramped and narrow and their height precludes standing in them. The N-S tunnel was not intended as a passage way — the steps are too irregular.



8. Petra Southern Temple Water System, hypothetical Plan 1995.

planned for public use — Sir Leonard Woolley and T. E. Lawrence surveyed the area in 1914, and P.L.O. Guy in 1937-1938 (Negev 1988:21). In the Wādī as-Sidd, west of Mampsis, are a series of dams, reservoirs, and cisterns. Of interest to us is one rock cut cistern in particular. Like the Southern Temple system, one system with a massive cistern is located under the paved courtyard of Building Va (Negev 1988: Fig. 32), which Negev dates to the Middle Nabataean period (end of the first century BCE through the first century CE). In the Late Nabataean period (second and third centuries CE) there is an arched public reservoir, Building VII, with steps leading to the water. Apart from these structures, Negev located cisterns throughout the site, including two outside the 'Palace' Building I (Negev *op. cit.* Fig. 32), Buildings IX, XII, and the Bath House, and Building V, which the excavator dates to the Late Nabataean period (Negev, *ibid.*179-181).

In conclusion, I think what is most interesting about the archaeological examination of the relationships and interactions between the Nabataeans and their environment is that it dramatically illustrates humanity's total dependence on the surrounding world. While we may presume that science and technology (whether represented by lamp fragment, a temple or a canalization system) are unlimited in their ability to sustain and insulate humanity from the constraints of the environment, it is painfully clear that there are environmental limitations for human civilization in general, as there were in antiquity for the Nabataeans. As humanity increasingly lives in urban settings, people begin to think that food comes from the supermarket, and they forget that its origins are in the ground, and from the animals that walk on the ground.

As we look at the archaeological record, we can see ebbs and flows of settlement into different areas – the Bedouin still move their herds into the desert during moist years and retreat during wet ones. Modern scholars are finding more clues that civilizations abandoned sites because of environmental collapse — such as dessication of the land or devastating earthquake action, as we find at Petra — and the inability to provide food and water. All resources hinge on water supplies. Humanity has experienced periods of collapse when it ignored the environment and focused too closely on human ingenuity and science: the Romans were unable to sufficiently provide grain for their large civilization, and the Babylonians fell victim to over-irrigation of their soil which caused salinization and water logging, turning their wheat and barley fields into desert. The archaeological evidence provided by this conference in Torino should demonstrate the ancient as well as modern needs and alterations of the Jordanian landscape. We must thoughtfully examine our current interactions with the Jordanian environment so that our own society does not experience similar collapses and problems. For these reasons, the Petra Southern Temple water system warrants further detailed archaeological study.

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At-Tuwāna - the Development and Decline of a Classical Town in Southern Jordan (with a Note on the Site Preservation)

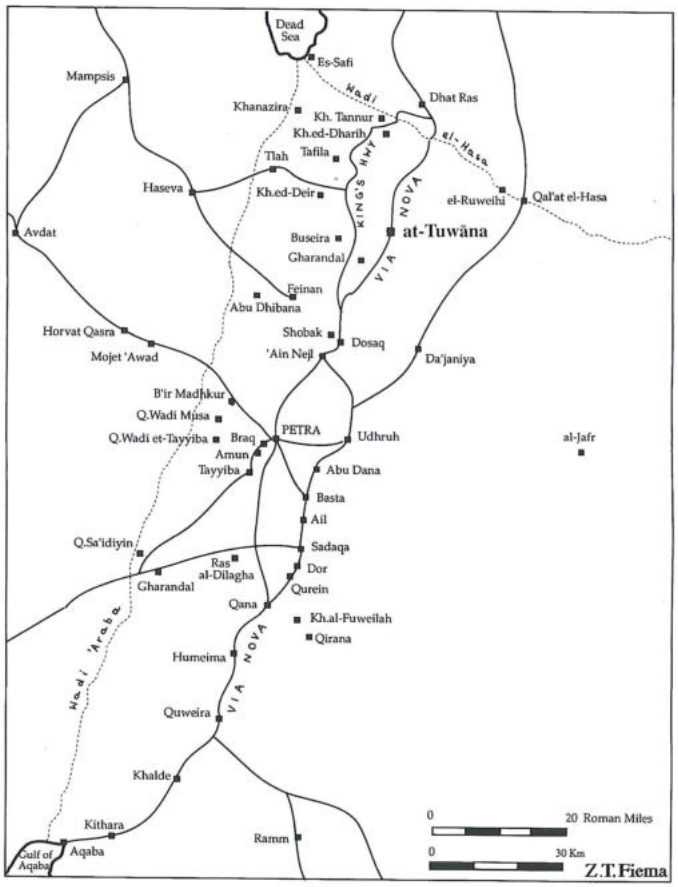
Introduction

The site of at-Tuwāna is located ca 5 km south off the road between aṭ-Ṭafīla and Jurf ad-Darāwīsh, in southern Jordan (FIG. 1). Despite the considerable ruins on the site, at-Tuwāna has received only limited scholarly attention in the past. The site was visited and described by Brunnow and Domaszewski (1904: 88-91), Musil (1907-8 I: 31-32), Glueck (1934: 80-81; 1939: 53) and Hart (1986: 340), and accorded brief notes by Wenning (1987: 87) and Negev (1977: 608).

The settlement at at-Tuwāna is generally identified with *Thana / Thoana* of Ptolemy's Geography, and with *Thornia* of the *Tabula Peutingeriana* (Bowersock 1983: 175). The major Roman highway in Jordan, the *Via Nova Traiana,* passes through the site. Previous descriptions of the site were largely inadequate, and concentrated on the so-called "temple," the most impressive and best preserved structure on the site. General implication of these early researches was that the settlement flourished during the Roman times as a result of its location on the trade route from Petra to Syria. However, the earliest as well as post-Roman occupational periods at at-Tuwāna are equally shrouded in uncertainty. *Thornia* was seemingly not mentioned by either the *Notitia Dignitatum* or the Bi'r as-Saba' Edict. The early Arab historians do not mention at-Tuwāna in their accounts on post-seventh century Syria-Palestine.

The rapid agricultural and urban development in the aṭ-Ṭafīla region deemed it necessary to launch an intensive field investigation at at-Tuwāna, assisted by the survey of other archaeological sites and roads in the area. The first season of the at-Tuwāna and the *Via Nova Traiana* Project was conducted in March-May 1992.[1] The following remarks are based upon the preliminary results of that season.

The area of at-Tuwāna presents optimal environmental conditions for potential inhabitants. The northeastern part of Edomite Plateau (the Jabal) enjoys an abundance of rainfall - up to 400 mm per year. Loess, Gray Steppe and Terra Rosa soils, prevalent in the area, are conducive to the cultivation of non-irrigated winter and summer crops (Feinbrun and Zohary 1955: 8-9, 14). Despite the relative severity of the winter climate in the entire aṭ-Ṭafīla region, the area of at-Tuwāna is well-known for the production of fruit trees which can withstand sub-freezing



1. At-Tuwāna and some major sites, roads and tracks in southern Jordan, during the Nabataean-Roman period.

[1] The project was made possible through a grant from the U.S. Information Agency. The author, being the principal investigator of the project, gratefully acknowledges the assistance of the American Center of Oriental Research and the Department of Antiquities of Jordan. In particular, thanks should be offered to Dr Pierre Bikai, ACOR Director, Dr Sawfan Tell, former Director-General of the Department of Antiquities of Jordan, and Mr Jihad Darawish, the Inspector of Antiquities at aṭ-Ṭafīla. Glen Peterman, ACOR, should be credited with the GIS-generated computerized landscape modelling. The author is also grateful to Dr Khairieh 'Amr, DAJ, for pottery readings, and to Drs Geoffrey Clark and Gary Rollefson for the information on dating of stone tools. The final report, which will include the catalogue of sites, will appear at a later date.

temperature. Limestone, basalt, chert and marl are abundant, with sandstone implementing the list of superb construction material available in the area. Traces of extensive quarrying were noted to the northeast and south of the site. Although no substantial natural springs were located during the site survey, nor was their existence known by the local population, numerous cisterns at the site, some of them utilizing natural bedrock cavities, imply the extensive water conservation methods employed by the inhabitants of ancient *Thana*.

The region of at-Tuwāna must have already been frequented or inhabited during prehistoric times. Several samples of Middle Palaeolithic (ca 40 000 BP) through Neolithic periods stone implements (blades, scrapers, flakes, lithic shatter) have been collected from the surface of the site. The nearby quarries and rock outcrops contain good flint and chert stone material. Despite Glueck's claims (1939: 53), the site displays little of the possible pre-Classical urbanistic evidence. Some of the structures may have originated in the Iron Age, but the ceramic material of that time period is much less than 1% of the total sample collected from the surface.

Urban Origins and Development

While the environmental conditions were clearly suitable for the foundation of a settlement at at-Tuwāna, its expansion beyond village-size would have been due to socio-economic factors. As stated elsewhere "..the characteristic small town of the ancient Mediterranean is a peasant settlement, though in certain circumstances it may become a market town.." (Sherwin White 1944: 8). It is postulated that the incentive for the rapid urban development of the settlement in the first century BC was trade.

Relevant information is provided by sites, mainly watchtowers, located along the surveyed sections of the *Via Nova Traiana*, north and south of at-Tuwāna. The pottery collected at the sites is predominantly Nabataean through Byzantine. Numerous sherds date to the first century AD, which should indicate that this communication route was already used in the times prior to the annexation of the Nabataean Kingdom and the construction of Trajan's road, that is well before AD 106-114. While the *Via Nova* largely follows the course of the old Nabataean caravan route commonly known as "King's Highway" (Graf 1995: 264), the Roman road in this part of southern Jordan runs on a more easterly although roughly parallel course (see FIG.1). The relationship between the King's Highway and that postulated predecessor of Trajan's road during the Nabataean-Early Roman Period is not fully understood. It is apparent, however, that that branch was sufficiently important and convenient for the Romans to set their all-weather highway there rather than to use the course of the King's Highway, as was done south of ash-Shawbak and north of Wādī al-Ḥasa. At any rate, that branching off benefited settlements in the eastern part of the Jabal Plateau, such as at-Tuwāna.

To be situated on the major Roman highway meant receiving a constant traffic of travellers, both military and commercial. Despite a relatively small ceramic sample – ca 1200 sherds collected from the surface – the abundance of painted, and imported wares on the site is impressive. Fine examples of the first through fourth century AD Nabataean Painted and Plain Ware (including Nabataean rouletted ware, Nabataean *sigillata* and *pseudo-sigillata*) are abundant. The surface ceramics also include imported wares, such as Eastern *Terra Sigillata* A (first century BC/AD) and B (first century AD), Western *Terra Sigillata* (Arezzo Ware), and Late Roman Red Ware. Although the evidence for the existence of a city wall is very fragmentary, the settlement and the traffic passing through it were guarded by watchtowers located on the high spots in the outskirts of the town.

When coupled with the evidence of monumental architecture at the site, the ceramic material confirms the suggestion that the settlement at at-Tuwāna had passed the phase of being a local village of simple agriculture-related economy, and entered the stage during which it performed a function of a service town located on a major highway of commercial and military importance. Imported wares and monumental architecture further suggest the emergence of a social elite, probably wealthy landowners who could have become actively involved in trade and/or provision of services to travellers passing through the town.

Intrasite Spatial Organization

At-Tuwāna is located on the slopes of the two opposite hills separated by the Wādī at-Tuwāna which runs roughly in a north-south direction. The *Via Nova Traiana* passes between these hills, ca 2m above the wadi bed. The site measures roughly 800 m (E-W) by 450 m (N-S), thus belonging to the group of largest sites in Jordan. The remains occupying the NW hill of the site are less impressive than those on the opposite hill, yet clearly contain several monumental structures of public character, built of well-carved lime and sandstone (FIG. 2). Also the spatial distribution of architectural complexes there suggests a more intensive and widespread occupation than on the opposite hill's slope. It is suggested that the urban foundations of at-Tuwāna developed first on the slopes of the NW hill, and only later the town spread to the other side of the wadi.

The rapid development of the town stimulated by the intensive traffic on the *Via Nova* in the Nabataean- Roman period resulted in the emergence of a large commercial and travel-related infrastructure on the SE hill (FIG. 3), opposite the residential quarter of the town located on the slopes of the NW hill. The occupation on the SE hill seems to be of low density; architectural complexes are relatively far apart from each other and more isolated, especially on the top of the hill. The higher density of occupation is noticeable only on the NW slopes of that



2. Architectural complexes at the NW hill at at-Tuwāna. (Photo by Z. T. Fiema).



3. The view of the SE hill at at-Tuwāna. Complex 14 (caravanserai) is visible at the top right site. (Photo by Z.T. Fiema).

hill, facing the wadi. The hill itself is dominated by C14, the most impressive structure preserved on the site.[2] Brunnow and Domaszewski considered the complexes 14, 15A and 15B as one unit, and had published a highly idealized sketch-plan which showed a large rectangular building, a Nabataean temple in their opinion, associated with two adjacent courts (1904: 89). Recent analysis suggests that these are three separate entities. Complex 14 is a tripartite, rectangular building with walls of well-dressed and embossed ashlar blocks, preserved up to 4m high. The internal division, and architectural details suggest at least two phases of use, and largely exclude its supposed sacral character. The author tends to support the opinion of Hart (1986: 340) who suggested a caravanserai. Ceramics found inside C14 range from Nabataean through Mamluk material, with the Roman-Byzantine periods predominant. At least one of the courts (C15B) seems to be contemporary with C14, on the basis of architectural analysis. The other court (C15A) may have been constructed at the later date.

Complex 11 is a large court (ca 120 x 80m) surrounded by a massive wall (ca 3 m thick). Within this court Complexes 14 and 15A, B are located as well as some other structures and subdividing walls. The construction of the enclosing wall – basalt and limestone, roughly hewn, slabs – is, however, much different from that of C14 and 15, suggesting, perhaps, a later date. All three courts, however, could have served as marshalling yards, storage places, or even market spaces auxiliary to the main caravanserai building. On the same hill, Complex 16 is notable for the large number of ceramic pipe fragments found on the surface. The center is occupied by a robbers' pit in which a face of a well-preserved brick wall is exposed. Together with the adjacent fragment of an octagonal stone wall, the brick construction could have been a part of a large bathhouse, possibly a *caldarium.* This suggestion is also supported by the evidence of a large number of square and round bricks which were probably used as the posts in a *hypocaustum* system.

It is evident that the settlement existed in the Byzantine period, although Late Byzantine wares (sixth century AD) are very few, and the transitional types into the Umayyad period, practically non-existent. Although the final demise of the town cannot be fully understood without excavation, it is highly probable that the settlement declined considerably or ceased to exist toward the end of the Late Byzantine period. This assumption is supported by the finds at sites located along Trajan's road, both north and south of at-Tuwāna. Although Late Byzantine sherds were also found there, their frequency seems to decrease with the increasing distance away from at-Tuwāna. In fact, the watchtowers and/or fortlets located furthest north and south of at-Tuwāna, within the survey area, did not produce any Late Byzantine sherds. Apparently, some sections of the Roman road in the area could have become defunct, while the others (closer to at-Tuwāna) were still used in traffic, maintained, and guarded by attendant military structures.

The evidence of the Ayyubid-Mamluk pottery on the site indicates that some parts of the Classical-Byzantine period town had been reinhabited, and some ruins consolidated. This observation is also supported by the presence of numerous secondary walls and masonry of simple type in complexes associated with these ceramics. That limited occupation is reflected by the general contraction of the inhabited area and its concentration only in the southern part of the classical site as well as in the lower slopes of both hills, close to the wadi bed.

Conclusions

The origins of human settlement at at-Tuwāna should be associated with particularly suitable environmental conditions. The area had experienced relative prosperity during the Nabataean-Late Roman periods (first century BC–late third century AD), associated with an intensive long-distance commercial traffic, and reflected in the urbanistic growth of at-Tuwāna and the well-maintained and guarded road system, as well as evidenced through

[2] The entire area of the site has been divided into architectural complexes (C) – spatially recognized clusters of structures, or isolated structures.

imported items. Long-distance trade was probably the dominant factor in the transition from an agricultural village into a large market town at at-Tuwāna .

It is probable that the town continued to flourish in the Early Byzantine period (fourth-fifth century). That period is marked by well-developed settlement patterns, reflecting the unparallelled expansion into marginal lands, and the intensive agricultural production, as well as the continuity of interregional trade (Fiema 1991). However, the Late Byzantine period (sixth - early seventh century) must have witnessed a gradual decline in urbanism, disappearance of main communication routes and the abandonment of military infrastructure. The decline of the intensive trade-related traffic in southern Jordan would have seriously affected the life of communities such as at-Tuwāna. Possibly, the town was largely deserted already before the invasions of the early seventh century. Future studies to be conducted on the site and in the environs of at-Tuwāna should further strengthen these conclusions.

A Note on Site Preservation

Although the site was spared the interference of modern housing, it still suffered much from other modern activities. Numerous walls were dismantled in the process of field clearing for farming, or were modified as animal corrals. The greatest damage was done by the construction of a new road leading south of the aṭ-Ṭafīla-Jurf ad-Darāwīsh road, toward Gharandal. Although the exact date of construction is not clear (1988?), it is apparent that these activities were conducted with a total disregard for archaeological remains. As opposed to the old beaten track which runs in the valley, ca 1m above the wadi bed, this new road is located higher up the slope of the NW hill, and it cuts through numerous ancient structures located there. Deep bulldozer cuts into the slope, and construction dumps situated on both sides of the road, further obscure the ancient remains. It is also obvious that the wadi bed was extensively exploited for sand and gravel used during the construction, and that much of the bulldozer excavated material was dumped in the wadi. During that process, two of the wadi cisterns mentioned by early travellers must have been covered up, and thus disappeared.

A similar deterioration was also observed during the survey of the *Via Nova Traiana*, directly north and south of at-Tuwāna. While this section of the Roman Road is one of the best preserved in Jordan, the road itself and archaeological remains along it face almost certain extinction through human activities. New roads are being constructed, fields cleared of stone structures for farming and stone material reused. It was noticed in several spots that the Roman road became clearly visible only through the activities of bulldozers which expanded the existent tracks. Through the same activities, many milestones were displaced, overturned, or, unexpectedly, resurfaced.

At least in two cases, the author was able to record more fragments of milestones spotted on the ground, than the German scholars did at the turn of the century.

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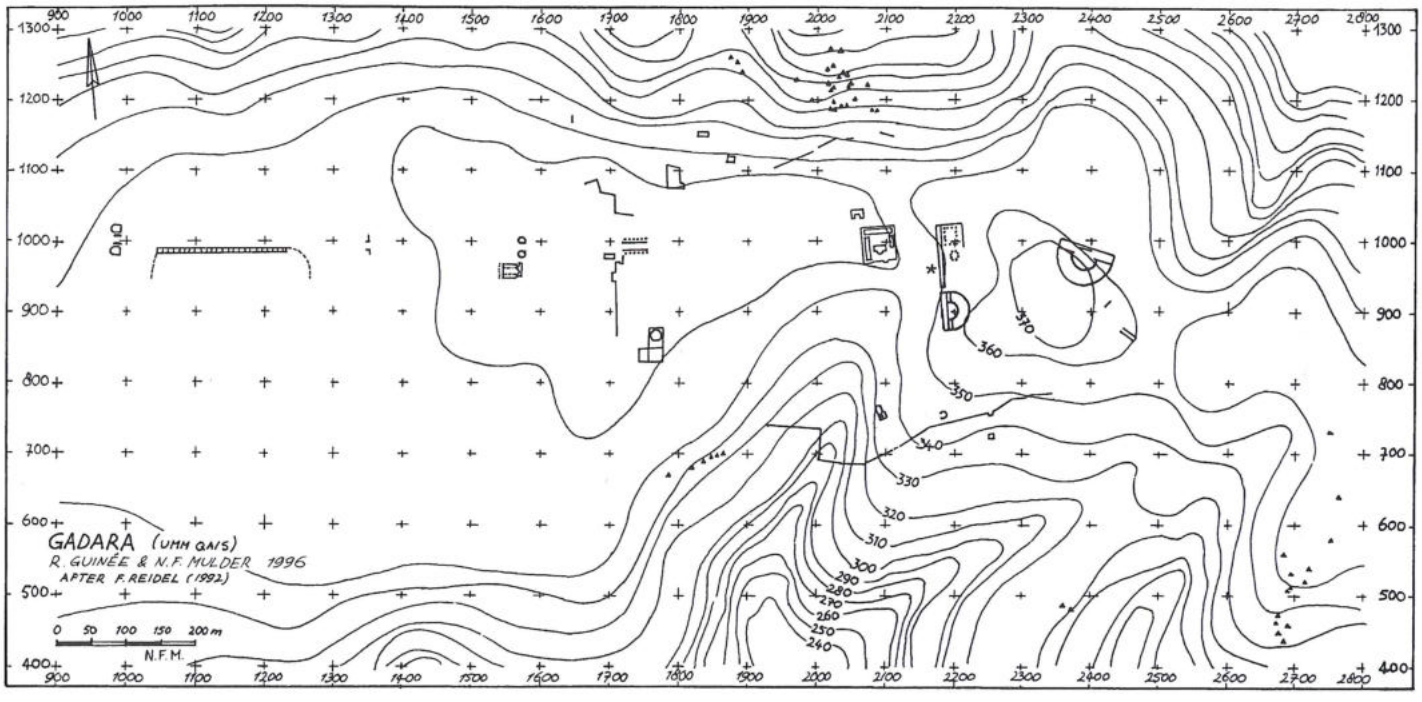
Robert L.J.J. Guinée and Niede F. Mulder

Gadara. The Terrace, Theatre and *Cardo* Quarter in the Roman period. Architectural Design Integrated in the Landscape: the Design of the West Theatre

During the excavations of areas I and III, which were carried out in 1992 and 1993 by the team headed by Ute Wagner-Lux, an archeological-architectural survey of the Terrace, Theatre and *Cardo* Quarter was made. The aim of this project is to set up a comprehensive documentation of the area and to present a reconstruction and interpretation of the buildings in their urban setting based on a comparative study of remains in other Decapolis cities.

In this paper, we discuss how one of these buildings, the West Theatre, was built using the advantages of the already existing landscape. First, we describe how the landscape offered possibilities for the contruction of the West Theatre and its surrounding buildings. Then we will focus on the West Theatre and try to reconstruct its theoretical design scheme.[1]

The landscape offered sufficient scope to arrange several functional aspects of the ancient city (FIG. 1). A few of the requirements for this city are present in the form of the natural landscape of the site as it may be reconstructed. There is a clear distinction between the higher hill to the east, where the Ottoman village is now situated, and the lower area to the west. In Roman times, this setting was exploited in order to construct an acropolis on the east side and a lower city on the west side. As a consequence, a differentiation in the function of the city districts as well as in the architectural presentation was carried through. On the acropolis, it may be supposed that the monumental edifices of the religious centre of the town were situated, together with other large public buildings, such as the two theatres of Gadara. The lower city,



1. Topography map of Gadara (Umm Qays) (after F. Reidel in Kerner 1992: 407-423, FIG. 1) * = Terrace, Theatre and Cardo Quarter.

1 We would like to thank Prof Dr H.A.A.P. Geertman of the department of Archaeology of the State University of Leiden, who over the last years has inspired and encouraged us both to study and to work on ancient achitectural design. We also thank Dr K.J.H. Vriezen for critically reviewing this paper. Except for FIG.1, all photographs and drawings by Robert L.J.J.Guinée and Niede F. Mulder.

on the other hand, may have been used to house public buildings of minor importance, along with the residential quarters. Between these two features of the landscape, the Terrace and West Theatre area can be considered as the connecting element, located between high and low, to facilitate transition from the former to the latter and vice versa.

With the help of an example we will illustrate how Roman architectural design has been integrated into the landscape. The construction of the Terrace, Theatre, *Cardo* and adjacent parts of the Decumanus can be provisionally dated to the end of the first century or the second century CE. These buildings must be considered as a complete unit. This claim is held to be correct by the comparison of the axis of the theatre with that of the façade of the vaulted rooms along the *Cardo*, which shows that these axes are perpendicular within less than half a degree. This has been calculated precisely, with the help of a computer. Even the *Decumanus Maximus* seems to fit into this orthogonal system, having an axis that crosses the axis of the *Cardo* at an angle very close to 90 degrees. However, we were not able to measure as many reference points as could be desired on the Decumanus.

Therefore, the Terrace and West Theatre Quarter may be treated as part of one single urban concept. Not necessarily constructed at the same time, but undoubtedly conceived and planned as one coherent layout, it shows an axial plan for the city. Although this particular area only represents a small part of the ancient city, it may be assumed that its axial layout was projected to the west along the *Decumanus Maximus* in such way that, whereas the *Decumanus* stretched along the ridge of the plateau, the several *cardines* followed the contours of the hills. The ridge may be treated as the backbone of the ancient city, to which, in accordance with the possibilities offered by the landscape, the various quarters were subsequently added. It seems reasonable to conclude, that, therefore, despite the form of the landscape, a pure mathematical scheme was used for the city plan. In elevation, however, the differences in height within the landscape have been utilized.

In order to illustrate how the architectural design has been integrated into the landscape one element of the area needs to be examined in detail, because it offers an unparalleled opportunity to understand the methods of the Roman architects when they adapted the landscape to their ideas.

This element is the West Theatre (FIG. 2). In this building, a typical Roman theatre was conflated with the traditions of the Hellenistic culture. Greek theatres were traditionally created on the slope of a hill in order to save labour which would be required when building higher and higher elevations. The West Theatre in Gadara, however, although it is built against the slope of the hill, is definitively a Roman rather than a Greek theatre as it shows characteristics of the Roman theatre tradition: the semicircular *orchestra*, the existence of *vomitoria* (entrances) connected to an *ambulacrum* (vaulted corridor) running underneath the tiers of seats, and the vaulted *aditus maximi* (side-entrances).

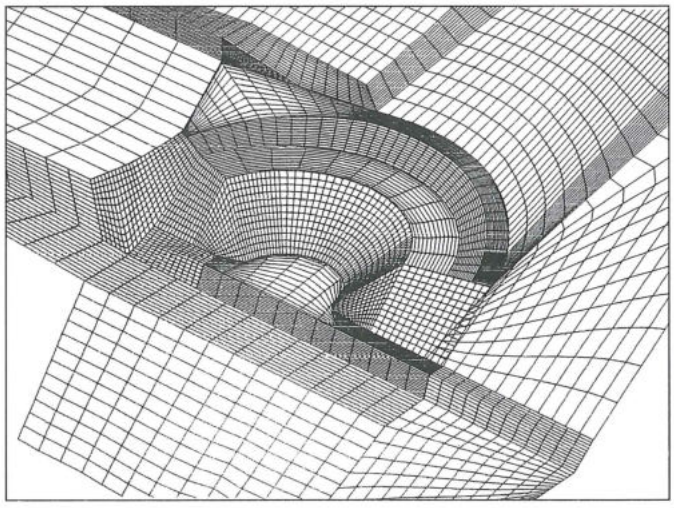
For the West Theatre, buttresses have been constructed to create space on which the architecture could subsequently be erected. In section, corresponding with the east-west axis, the theatre reveals four different levels of building (FIG. 3).

On the first level (the lowest part of the slope) the foundations of the *scaenae frons* (the back wall) were erected. Unfortunately, the level of the bedrock has not yet been established here, because, at the time of this survey, that part of the theatre had not yet been excavated. However, as a provisional height, a level of 340.46 m asl was taken, representing the lowest point of the backwall visible above the earth and the debris.[2]

The second level is the floor of the *orchestra*, together



2. The West Theatre in 1995 after clearance by the Department of Antiquities.



3. Reconstruction by computer of the surface contours with the different building levels of the West Theatre.

2 These heights are related to a network of points, established by E. and A. Gramlich (Fachhochschule Karlsruhe) within the already existing geodetical grid on the site.

with the floor of the entrances leading to it. Here, bedrock was indeed found at a level of 341.20 m.

The third level represents the floor of the *ambulacrum*. It is on the same level as the first *praecinctio* (a semi-circular passageway dividing the seating complex of the *cavea* into horizontal sections). Here, too, bedrock was found at 348.10 m. The flagstones of the floor are laid directly on the rock.

The fourth is the level from which the staircases in the entrances at the exterior begin to descend into the theatre. Unfortunately, they have not yet been completely uncovered, thus making it impossible to establish the exact height of this particular level. However, in one entrance (FIG. 4) as many as seven steps were exposed, which data enabled us to calculate provisionally the height of the fourth level at 351.70 m.[3] This level not only carried the outside wall of the theatre, but presumably also a street, which gives access to the staircases which descend into the entrances. In summary, the following elevations may be established:

Table 1. Heights of different building levels.

Level	Description	Height in metres asl
1	Back wall of the scaenae frons (lowest point visible in 1992)	340.46
2	Orchestra floor	341.20
3	Ambulacrum/ First praecinctio	348.10
4	Bottom of external wall;entrance- level	351.70

It is possible that every building level may be connected with a stage in a design that, in plan as well as in elevation was developed according to principles, like the ones in Vitruvius' *De Architectura*. In fact, though the rules for building a Roman theatre (as explained by him) have never been followed for any theatre, the hidden principles in these rules allow one to make a hypothesis on theatre design. They seem to offer general principles to the Roman architects on how to handle complex designs, which are based on simple geometrical and arithmetical calculations. Not all of the relevant elevations have been established for the West Theatre in Gadara, therefore only the design scheme of the theatre plan can be discussed here. We hope that, after further research, it will be possible to relate the elevation of the building to this scheme.

From the existing situation of the West Theatre as measured in the field, it has been possible to reconstruct a theoretical design scheme for the plan. During the efforts to find this scheme, every hypothetical design scheme has been verified by comparing it with the measurements that



4. Steps in one of the eastern entrances. View from the *ambulacrum*.

were collected during the survey. However, before this study could be commenced, two elementary points had to be established.

First and most important, in order to verify the design scheme it was necessary to establish the exact central point of the building. As will be shown in the following, this central point is the centre of a circle that forms the basis for the design of the theatre. After all, the classical theatre building is generally based on a circular pattern.

There are several ways to establish this centre; but the only reliable method was found to be the following. The line, dividing the orchestra into two equal parts, being the median between the *aditus maximi* to the orchestra, is the very line on which the central point should be sought. Because a large number of fix-points could be measured in the first *maenianum* (rank), indicating every single tier of seats (which in fact are semicircles), it was possible to establish corresponding central points for every one of those tiers. Each of the central points appears to be situated on or very close to this median. It appeared that these central points indicated that the centre of the theatre was placed on the intersection of the median with the line connecting the eastern side of the stairs ending the *cunei* (part

[3] This level was calculated by projecting the height of the internal arch of one of the eastern entrances (FIG. 4) towards the external wall. At this point the highest level of the bedrock is expected.

of the *maenianum*) on the north and south side (FIG. 5) of the *cavea* (public seating area). Because the tiers in the lower *maenianum* do not seem to have moved much during several earthquakes which destroyed other important parts of the building, this method seemed to be the most reliable one.

The second basic fact which needed to be established was the standard length used in its construction. Having stated previously that the theatre is Roman, it seems reasonable to try to establish the length of the Roman foot that was used. During the survey, it appeared that almost everywhere stone layers of 59 or 29.5 cm were applied. This suggests that the foot, in this case, was 29.5 cm.

Having established these two basic facts, we will try to reconstruct the Roman design scheme of the theatre. This will be done in four stages. Each step of the design scheme determines the position of several elements of the building. These elements were erected on terraces built at elevations corresponding with the building levels described above. Furthermore, every stage in the design scheme is based on the preceding one.

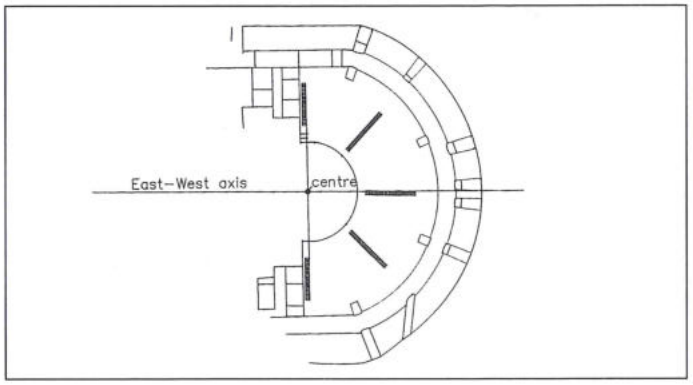
First, from the established central point of the theatre a circle of 90 Roman feet in radius can be drawn. This circle determines the position of the outerside of the external wall, and corresponds with our measured points, except for those at the south side where the bond of the wall has been disturbed (Step I: FIG. 6).

Second, an equilateral triangle is drawn in this circle with its base on the west side and its perpendicular to the east-west axis of the theatre. This base of the triangle probably defines the outside of the wall of the *scaenae frons* as well as its foundations. Unfortunately, at the time of the survey, only the top of the remains was visible and only two points could be measured, on which basis no definite conclusions could be drawn. This means that, for this part of the theatre, the reconstruction of the design scheme is still hypothetical (Step II: FIG. 7).

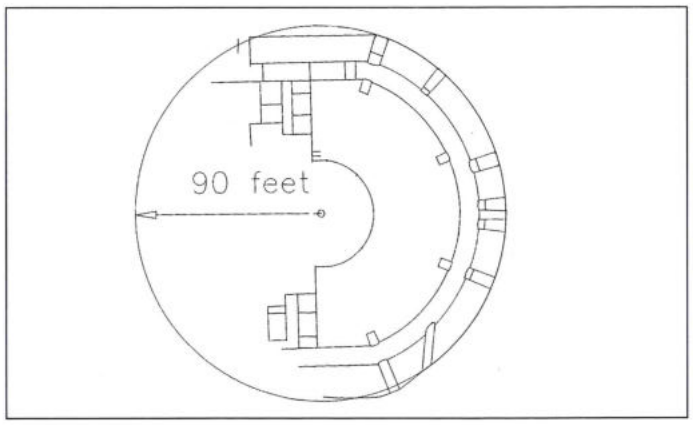
Now that the position of the external walls of the theatre on the highest and lowest terraces have been defined, the position of the internal elements on the two intermediary terraces can be established.

Third, from the central point of the theatre, a new circle, (with a radius of 26 feet) can be drawn. This circle defines the semicircular eastern boundary of the *orchestra* on the same elevation as the second terrace. In total, six points could be measured and used for verification. Although, at the north side, there is some deviation, these points correspond with such precision that there is a reasonable certainty that this particular method is valid (Step III: FIG. 8).

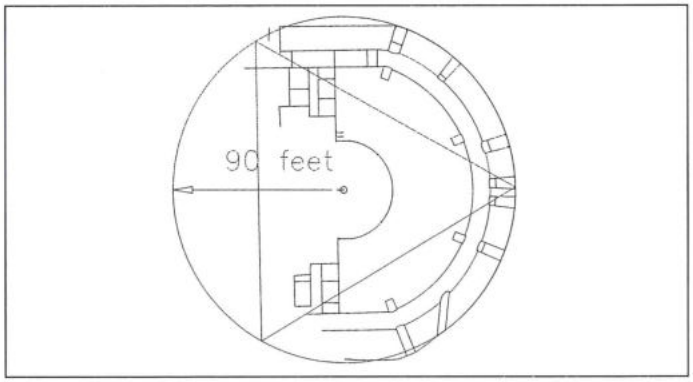
Fourth, two equilateral triangles can be drawn with their bases on the north and south side within the first circle of 90 feet. The intersection of these two triangles on



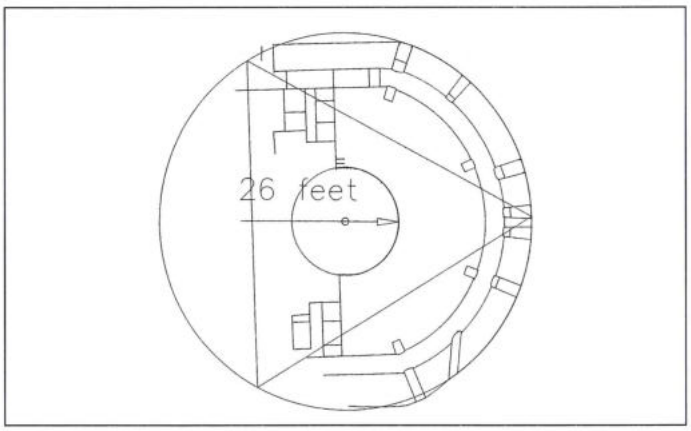
5. Derivation of the exact central point of the West Theatre.



6. Step I: a circle of 90 feet that determines the external wall of the theatre.



7. Step II: an equilateral triangle drawn in the circle of 90 feet with its base on the west side defining the platform that carries the foundations of the *scaenae frons*.



8. Step III: a circle of 26 feet defining the wall of the *podium* limiting the *orchestra*.

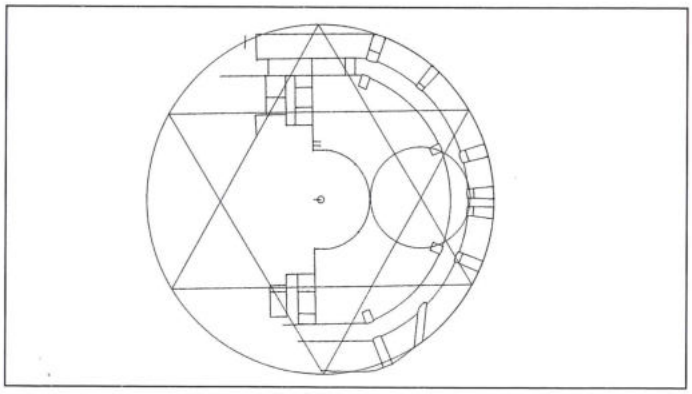
the east side defines the central point of a circle of 26 feet. The east side of this circle touches the outer wall of the *ambulacrum* and thus the outer boundary of the third terrace, being on the level of the floor of the *ambulacrum* as well as of the first *preacinctio*. The radius of the circle that defines the outer wall of the *ambulacrum* is 78 feet (Step IV: FIG. 9).

In TABLE 2 it can be shown that the points which have been measured correspond to the requirements of the theoretical design scheme:

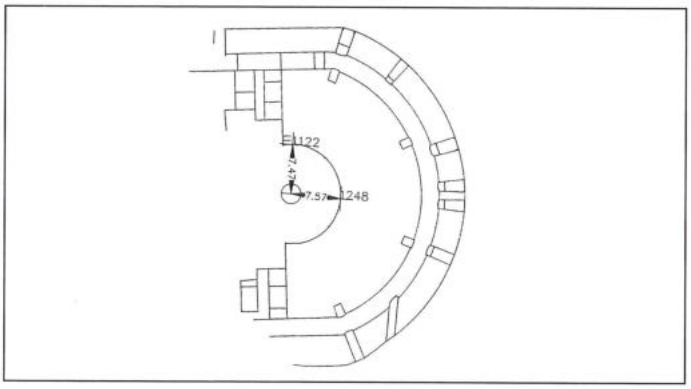
Table 2. Distances to the central point of the theatre (see also FIGS. 10 and 11).

Object	Number of measurepoint	Distance to central point (m)	Theoretically required distance (metre)	Deviation (metre)	Distance (foot)	Theoretically required distance (foot)	Deviation (foot)
Orchestra 1	1248	7.57	7.67	-0.10	25.66	26	-0.34
Orchestra 2 *	1246	7.53	7.67	-0.14	25.53	26	-0.47
Orchestra 3 *	1247	7.57	7.67	-0.10	25.66	26	-0.34
Orchestra 4 *	1249	7.50	7.67	-0.17	25.42	26	-0.58
Orchestra 5 *	1250	7.52	7.67	-0.15	25.49	26	-0.51
Steps **	1122	7.47	**	**	**	**	**
External wall 1	3031	26.59	26.55	+0.04	90.14	90	+0.14
External wall 2	3036	26.65	26.55	+0.10	90.34	90	+0.34
External wall 3	3048	26.69	26.55	+0.14	90.47	90	+0.47
External wall 4	3064	26.61	26.55	+0.06	90.20	90	+0.20
External wall 5	3203	26.75	26.55	+0.20	90.68	90	+0.68

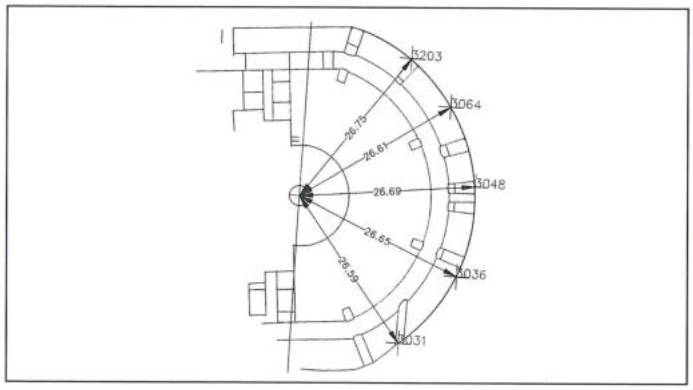
* These points are not shown in the illustration
** This point is not directly defined by the circle of 26 feet, as it belongs to the steps



9. Step IV: two equilateral triangles with their bases to the north and to the south side drawn in the circle of 90 feet. The intersection of these two triangles on the east side defines the central point of a circle of 26 feet. The circle of 26 feet defines the outer wall of the *ambulacrum*.



10. Distances of the *orchestra* to the central point.



11. Distances of the external wall to the central point.

Some discrepancies exist between the theoretical design and the current situation presented in our measurements. This can be explained, however, by some causes that had their effect on the building as it still is. First of all, throughout its existence of almost 2000 years, this building has suffered various disasters such as earthquakes. The walls of the theatre have been constructed by building two wall faces of basalt blocks, the interior space having been filled with soil and stone chips *(opus caementicium)*. During an earthquake, the filling will move downwards and push like a wedge between the two wall faces. In this process, the outer walls will be pushed outwards and, at the same time, the inner walls will be pushed inwards. Second, the site was quarried for stone, especially when the Ottoman village was built. Thus many of the stone blocks have moved their relative position to each other. Since only the present (and not the original) position of these blocks can now be measured, many deviations can possibly be explained. It is also possible that during the construction of the theatre the work was not executed with strict adherence to the design. This may also explain deviations of several centimetres.

It seems plausible that, before the contruction of the theatre, the plans of the design stages were incised in the bedrock or, where this was not directly on the surface, marked in the earth by using wooden stakes (for example). Then the bedrock or earth was removed to create the terraces on which, according to the instructions of the architect, the building was erected.

It can be concluded that the architect who designed the West Theatre wanted to exploit the possibilities offered by a landscape which could be enhanced by a building. He conceived his plans having been firmly based on these natural foundations. As it seems, geometrical patterns formed the basis for the design scheme of the theatre, which will probably be more complicated by using arithmetic calculations when we will look at the details. In this way, the West Theatre of Gadara reveals that the architect must have been quite familiar with design techniques which are very similar to those we already recognize as Roman building principles.

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Umm Qays: The Byzantine Buildings on the Terrace.The Building Materials of Stone and Ceramics

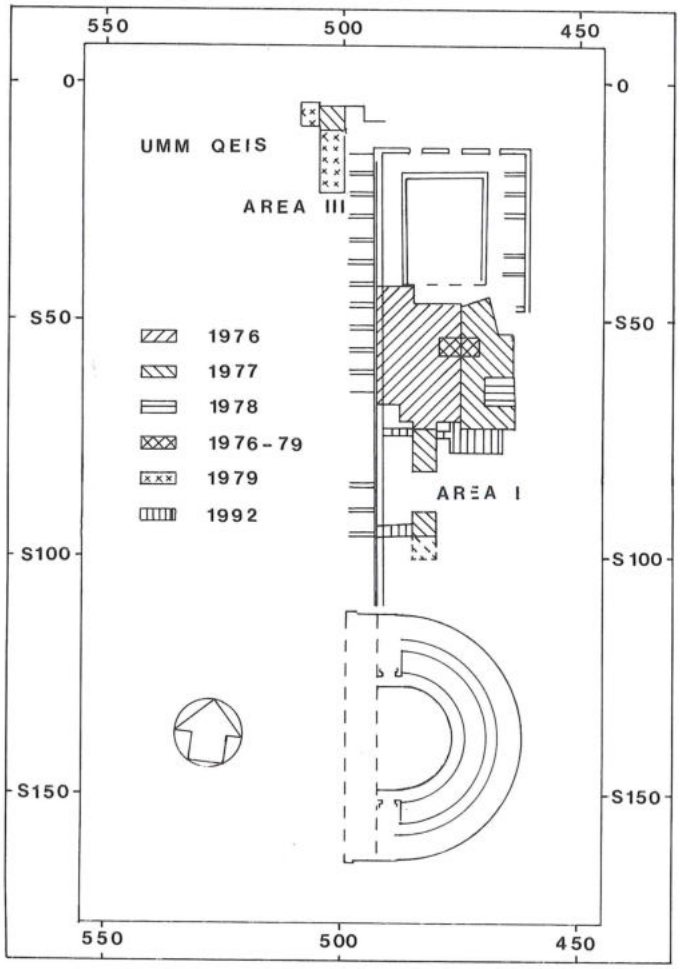
The ruins near Umm Qays (ancient Gadara) were surveyed in 1974 by a team from the German Protestant Institute for the Archaeology of the Holy Land headed by Ute Wagner-Lux.[1] The ruins of the ancient buildings cover a site measuring approximately 1600 x 450 m consisting of a walled city area and an extramural area. Inside the walled city, two areas can be discerned: an Acropolis (approximately 250 x 250 m) in the east and a large Lower City in the west. The main street of the city, *Decumanus Maximus*, runs east-west.

Wagner-Lux and her team made a series of excavations on the large Terrace, situated at the bottom of the western slope of the Acropolis in 1976-1979 and in 1992. This site was labelled Area I. The Terrace, measuring 95 x 32 m, is bounded on the north by the *Decumanus Maximus*, to the south by a Roman theatre, whereas to the west a street, a *cardo*, aligned with vaulted rooms built against the Terrace's retaining wall, ran south from the *decumanus* to the theatre. In 1977 and in 1979 the northern end of the *cardo* (Area III) was excavated (FIG.1).[2]

The Terrace may be divided roughly into three parts. In the northern part (32 x 32m), a colonnaded courtyard (a so-called *atrium*) was found. The courtyard is entered from the *Decumanus Maximus* by means of three entrances. The inner space was open to the air and on three sides (perhaps on all four sides) surrounded by a colonnade and a covered passageway. A line of rooms along the eastern side of the terrace open onto the eastern passageway.

In the central part, a church complex has been excavated, which consists of two churches. The larger one is situated right in the middle of the Terrace. It is a church of the "centralised type" consisting of a square building with a narthex attached to its west side. The second church is of the "basilica type". It is built against the south wall of the centralised church. The construction of the centralised church has been tentatively dated to the first half of the sixth century. Then, there was a courtyard to the south of it, similar to the one on its northern side.

The basilica was built at a later date, that is in the middle of the seventh century. Both church buildings were destroyed by an earthquake presumably the earthquake of 749.



1. Plan of Umm Qays (ancient Gadara) Areas I and III.

The centralised church and the colonnaded courtyard represent the Byzantine building phase on the Terrace. The basilica is attributed to the Late Byzantine or the Early Omayyad Period. Underneath the floors of the

[1] U.Wagner-Lux, E.W.Krueger, K.J.H. Vriezen and T. Vriezen-van der Flier, 'Bericht über die Oberflächenforschung in Gadara (Umm Qês) in Jordanien im Jahre 1974'. *ADAJ* 23 (1979) 31-39. This survey added to the archaeological study of the site by Gottlieb Schumacher almost 90 years earlier; G.Schumacher, *Northern 'Ajlun*, London 1890, 46-80.

[2] U.Wagner-Lux and K.J.H.Vriezen, 'A Preliminary Report on the Excavations at Gadara (Umm Qeis) in Jordan from 1976 to 1979'. *ADAJ* 24 (1980) 157-161. U.Wagner-Lux, K.J.H.Vriezen, F.van den Bosch, N.F. Mulder and R.Guinée, 'Preliminary Report on the Excavations and Architectural Survey in Gadara (Umm Qeis) in Jordan, Area I (1992)'. *ADAJ* 37 (1993) 385-395.

church buildings and the courtyard, a pavement from the Roman period has been found.[3] To the Roman phase also belong the Terrace's retaining walls and the structures along the *cardo* and *Decumanus Maximus*. This building phase has been tentatively dated to the end of the first or the beginning of the second century AD.

In the construction of both churches, *spolia* have been used. It appears there are indications that some of these *spolia* may previously have belonged to the Roman building phase on the Terrace. This raises the question of what was built on the Terrace in Roman times.

It has been suggested that there was once a temple on the Terrace.[4] However, although the Roman pavement is reached in various places on the Terrace, there are not yet any traces of a substantial building connected to this pavement.[5] Apparently, the idea is inspired by general historical information from the fourth and the fifth century about the destruction of temples and the construction of churches in their place. However, it is doubtful whether a model of 'churches-built-on-temples' is applicable to a large extent in the area of *Palaestina/Arabia*, as the historical record and the archaeological data have not produced substantiating evidence for such a model.[6] As for our churches in Area I, it remains to be seen whether future excavations will produce new finds.

Instead of a supposed temple, however, another building in the area of the Terrace may contribute to the question, namely the Roman theatre. Like the Terrace, the construction of the theatre is tentatively dated to the end of the first or the second century.

During the fourth to sixth centuries, a stream of imperial decrees was issued against theatres, plays and games.[7] Finally, it is related by Procopius of Caesarea[8] that Justinian caused the theatres, hippodromes and circuses to be closed, and that later he ordered the games to be abandoned.

Now this closure of the theatres by Justinian complies with the time scale in which the construction of the centralised church in Umm Qays is dated. This circumstance seems to form the background for the construction of this church: when the West Theatre in Gadara had fallen into disuse and was closed, the time had come to use the square immediately north of the theatre for new purposes.[9] So, a Christian *martyrion* was built on the Terrace. Because of its location between the Acropolis and the Lower City, it assumed a prominent place in the ancient town of Gadara.

As mentioned before, *spolia* have been used in the Byzantine-Umayyad building phase on the Terrace. A study of the constructions of the walls and the building materials was made in order to define the types of masonry which were used and to distinguish between the types of the different building phases. In this analysis a study of the mortar used was also included.[10] For the buildings on the Terrace dating from the Byzantine period, we can distinguish between two types of wall construction: Type I and Type II. Later alterations to the buildings may be considered as a third type.

In the wall construction Type I (FIG.2), the lowest course consists of basalt blocks. These may be the remains of earlier walls of the Roman period still *in situ* or a foundation made by reusing Roman *spolia*. For the elevation of the



2. Construction Type IB. Façade of one of the rooms east of the *atrium*.

3 U.Wagner-Lux and K.J.H.Vriezen, *o.c.* (n. 2: *ADAJ* 24 [1980]) 158-160.

4 G.Schumacher, *o.c.* (n. 1) 62f.

5 There are still no data indicating that the Terrace was used to serve as the lower platform of a temple higher up the Acropolis hill; cf. the Zeus Temple in Jarash. However, the archaeological investigations higher up the Acropolis have as yet been very limited.

6 On this, see K.J.H.Vriezen, 'Churches built over pagan sanctuaries: a frequent phenomenon in Byzantine *Palaestina/Arabia*? On churches, temples and theaters'.Pp.69-79 in P.W. van der Horst (ed.), *Aspects of Religious Contact and Conflict in the Ancient World* (Utrechtse Theologische Reeks 31), Utrecht 1995. Editor's comment :see , however , B. Brenk *el al* ., *ADAJ* 39(1995) , 211ff. and in *AJA* 100\3 (1996) (Archaeology in Jordan), on the temple foundations beneath the 'Cathedral' of Gerasa .

7 So, again and the production of plays and games were prohibited on Sundays and Christian festivals (*Codex Theodosianus* [furthermore: *C.T.*] II.8.23-24; XV.5.2,5; *Codex Iustinianus* [furthermore: *C.I.*] III.12.9; dated 386-469 AD). From the decrees on the rights and duties of the actors and actresses collected in *C.T.* XV.7 (*De scaenicis*) it appears that these people were considered indecent/*infamis* and their conduct was regarded as incompatible with a Christian life (*C.T.* XV.7.1-2,4-5,7-9,11-12; dated 367-394 AD; also: *C.I.* I.4.14, dated to 457-474; *Digestae Iustiniani* III.2.2.5, 6th century).

8 *Anecdota* XXVI.7-8.

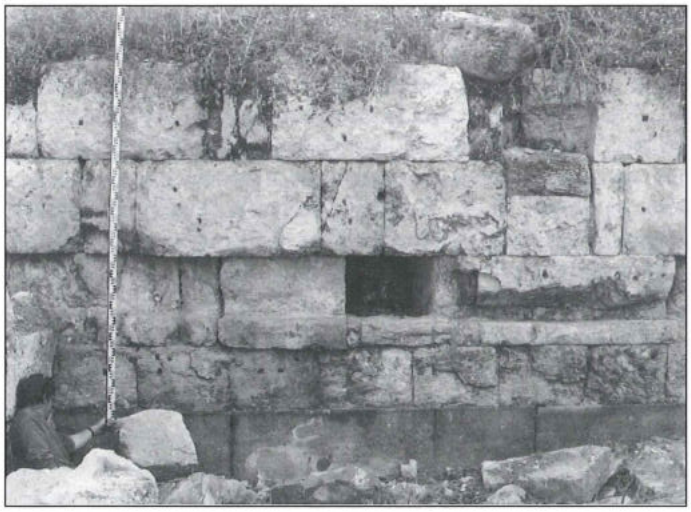
9 In support of this interpretation, three other sites from the area of ancient *Palaestina/Arabia* may be mentioned, where a Byzantine church was built beside a Roman theatre/odeon apparently without a temple nearby. In Ṭabaqat Faḥl (anc. Pella) in the Civic Complex a church was built about 400 AD on a square beside the Roman odeon, which - according to the excavators' hypothesis - became possible after strong Christian opposition caused theatrical performances to cease; A.W.Mc.Nicoll, R.H.Smith and J.B.Hennessy, *Pella in Jordan 1. An Interim Report on the Joint University of Sydney and the College of Wooster Excavations at Pella 1979-1981,* Canberra 1982, 82,108; A.W.McNicoll, P.C.Edwards, J.Hanbury-Tenison, J.B.Hennessy, T.F.Potts, R.H.Smith, A.Walmsley and P.Watson, *Pella in Jordan 2. The Second Interim Report of the Joint University of Sydney and College of Wooster Excavations at Pella 1982-1985*, Sydney 1992, 120f.,147. A similar situation may be suggested for the Church of Bishop Isaiah and the North Theatre in Jarash (anc. Gerasa) and for the theatre and the East church in Haluza (anc. Elusa); F.Zayadine (ed.), *JAP* I *1981-1983*, Amman 1986, [205-341] 247,322; A.Negev, 'The Cathedral of Elusa and the new typology and chronology of the Byzantine churches in the Negev'. *LA* 39 (1989), [129-142] 130; *idem*, 'The Cathedral at Haluza (Elusa)', in Y.Tsafrir (ed.), *Ancient Churches Revealed*, Jerusalem 1993, 286; *idem*, 'Halusa - 1980', *Excavations and Surveys in Israel 1982*. Vol.1, Jerusalem 1982, [34f.] 34.

10 However, the plaster layer that once covered the walls has not yet been examined in detail.

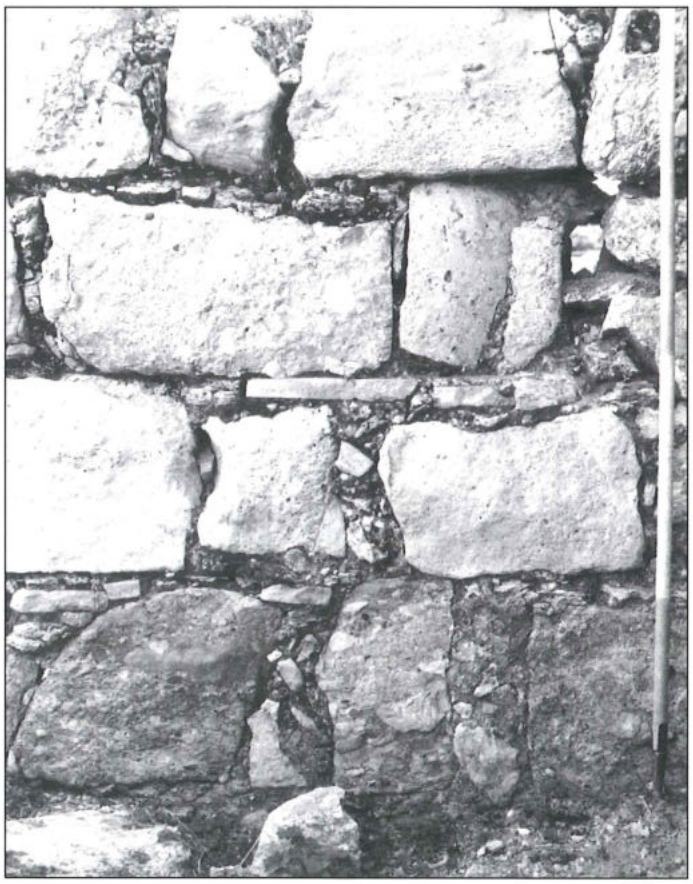
wall, blocks and architectural elements of basalt have been used again to construct thresholds and door frames, whereas the rest of the wall is made of rectangular white limestone blocks. In some of them, ornamented architectural elements can still be recognised. Only the undecorated sides of these architectural fragments are visible in the wall face. Mostly, the blocks have been put together without using mortar.[11] In Type I, two subtypes may be distinguished according to the kind of limestone used: Type IA and Type IB. Type IA is used for the eastern Terrace wall and partly for the northern façade of the *atrium* (FIG.3). For this type, predominantly white, rose-veined, coarse limestone blocks have been used in elevation.[12] Type IB was used in the walls of the centralised church and in the façade walls of the rooms east of the *atrium* (FIG.2). Here, white fine limestone architectural elements and blocks have been used and occasionally a piece of rose breccia limestone (e.g. in the north-east apse of the centralised church).

In the wall construction of Type II (FIG.4), predominantly blocks of rose breccia limestone have been used which, in part, still show the curvature of a column shaft together with some white fine limestone blocks made mainly of remodelled ornamented architectural elements. In this type, the wall is built up in courses of building stones (ca. 40 cm high) alternating with thick (5-10 cm high) layers of mortar. Also between the stones of one course mortar is added.[13] The construction Types I and II can be found side by side in the building phase, to which the centralised church belongs. Type I was mostly used for façades and visible walls and Type II for internal walls.

Only small parts of the Roman building phase on the Terrace still remain *in situ*; these parts were used as a foundation for the Byzantine buildings. The rest of the Roman buildings has disappeared from the Terrace. It is suggested that much of its building material was reused for the construction of the centralised church and the *atrium* and its rooms. This applies certainly for some of the architectural elements of basalt. As for the *spolia* made of other stone material, it is not yet clear whether they originate from earlier buildings on the Terrace. By studying the *spolia* used for the Byzantine buildings, the building material of the earlier periods may be reconstructed in part. The building material consists of basalt architectural elements such as: columns, bases, capitals and door frames; of white rose-veined coarse limestone blocks; white, fine limestone architectural fragments of capitals, friezes and bases and of rose breccia limestone columns. These different materials and *spolia* were not only used in elevation, but also for the pavement of the *atrium* . All these building materials were presumably quarried and prepared in the area of Umm Qays. [14]



3. Construction Type IA. East terrace wall.



4. Construction Type II. Internal wall of one of the rooms east of the *atrium.*

11 When mortar is used, this consists of light grey (quick) lime mixed with small pieces of rose breccia limestone and stone slabs (possibly taken from the Roman pavement of the Terrace) and occasionally white limestone and basalt.

12 The construction of the northern façade forms one bond with the eastern wall.

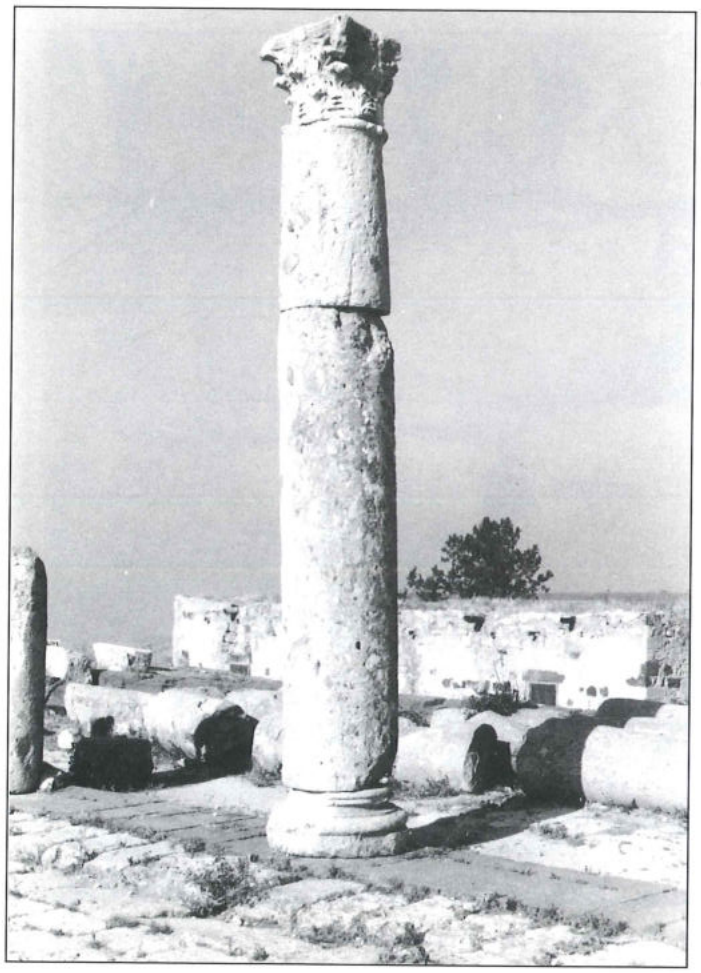
13 The mortar of Type II consists of light grey (quick) lime, with pieces of stone slabs and small pieces of rose breccia limestone, white limestone and occasionally basalt. This mortar is very similar to the mortar of Type I.

14 Only detailed examination of the geological situation can demonstrate this. A general representation for the north of Jordan is given by G.R.H. Wright, *Ancient Building in South Syria and Palestine.* (Handbuch der Orientalistik. Abt. 7, Kunst und Archäologie. 1.Bd., Der alte Vordere Orient. 2. Abschnitt, Die Denkmäler. B., Vorderasien: Lfg. 3). Leiden/Köln, E.J. Brill, 1985, figs. 8 and 9. Basalt as well as different types of limestone are present in the region of Umm Qays.

The following is presented as a tentative conclusion: for the construction of the Byzantine buildings on the Terrace, four kinds of *spolia* were available: rose breccia columns, white fine limestone architectural elements and white rose-veined coarse limestone blocks.[15] These were used together with the basalt architectural elements available from the earlier buildings on the Terrace. The best preserved *spolia* were reused in their original function (columns, door frames; see the centralised church and the *portico* of the *atrium*, FIG. 5); the other *spolia* were reused in wall constructions and for the pavement of the *atrium* (FIG.6).

Two other categories of building materials to be discussed here are the roof tiles and the *tubuli* found in Areas I and III. These objects are ceramic building materials made by hand. The fact that, in Area I, roof tile fragments constituted about half of the volume of all ceramic finds, required further specialised study.[16]

In the following, some of the preliminary results are presented. Basically the rooftiles may be divided in two types:



5. *Spolia* reused in their original function: columnshaft of rose breccia, capital and base of white fine limestone. *Portico* of the *atrium.*

1. The *tegula*, a flat slab with flanged rims on the two long sides;
2. The *imbrex*, a curved tile covering the seam between two *tegulae.*

Both types reveal a wide variety of forms, which might suggest a series of *tegula* types and a series of *imbrex* types based upon rim forms. A closer inspection of the fragments, however, demonstrated that, despite the variety of rim forms, there is only a limited number of different wares and construction processes to be discerned. By the use of one raw material together with one construction process, various forms were produced. Therefore the roof tiles were studied according to the principles of ceramological analysis in which typology is mainly based on ware and manufacture and only roughly on form.[17]

In order to study the ware types, of all kept roof tile fragments an edge was taken off to inspect the fresh break. As a result, fourteen ware types were identified: eight ware types, two of which have three subtypes each taken (TABLE 1: I-VIII). Moreover, two different clay samples were inspected: one from a natural clay resource from Umm Qays still used by potters in the village (clay B) and one from a clay deposit excavated in 1994 from an industrial area of ancient Gadara [18] (clay A) (TABLE 1: A-B).

When the types and subtypes of low frequency (≤ 1.3%) are not considered, there remain seven main types. Of these, Type I shows the same characteristics as the sample of the natural clay bed from Umm Qays (clay B): clay with a natural admixture of quartsite silt and angular and rounded quartsite and manganese grains of <1mm and sporadical sand and gravel grains added. Type II seems to correspond to the clay deposit excavated (clay A). These wares seem to be closely related; the temper added is characterised by the absence of rounded quartz grains. Ware Type III is characterised by a high percentage (22,5%) of non-plastics, almost exclusively angular basalt grains. Types IV and V-2 are characterised by mixed temper, in which sieved rounded quartz grains make a dominant element. Type V has a virtually exclusive sieved quartz grain temper. Finally Type VI is characterised as a very pale brown/yellow firing clay with a very low percentage of non-plastics (4%).

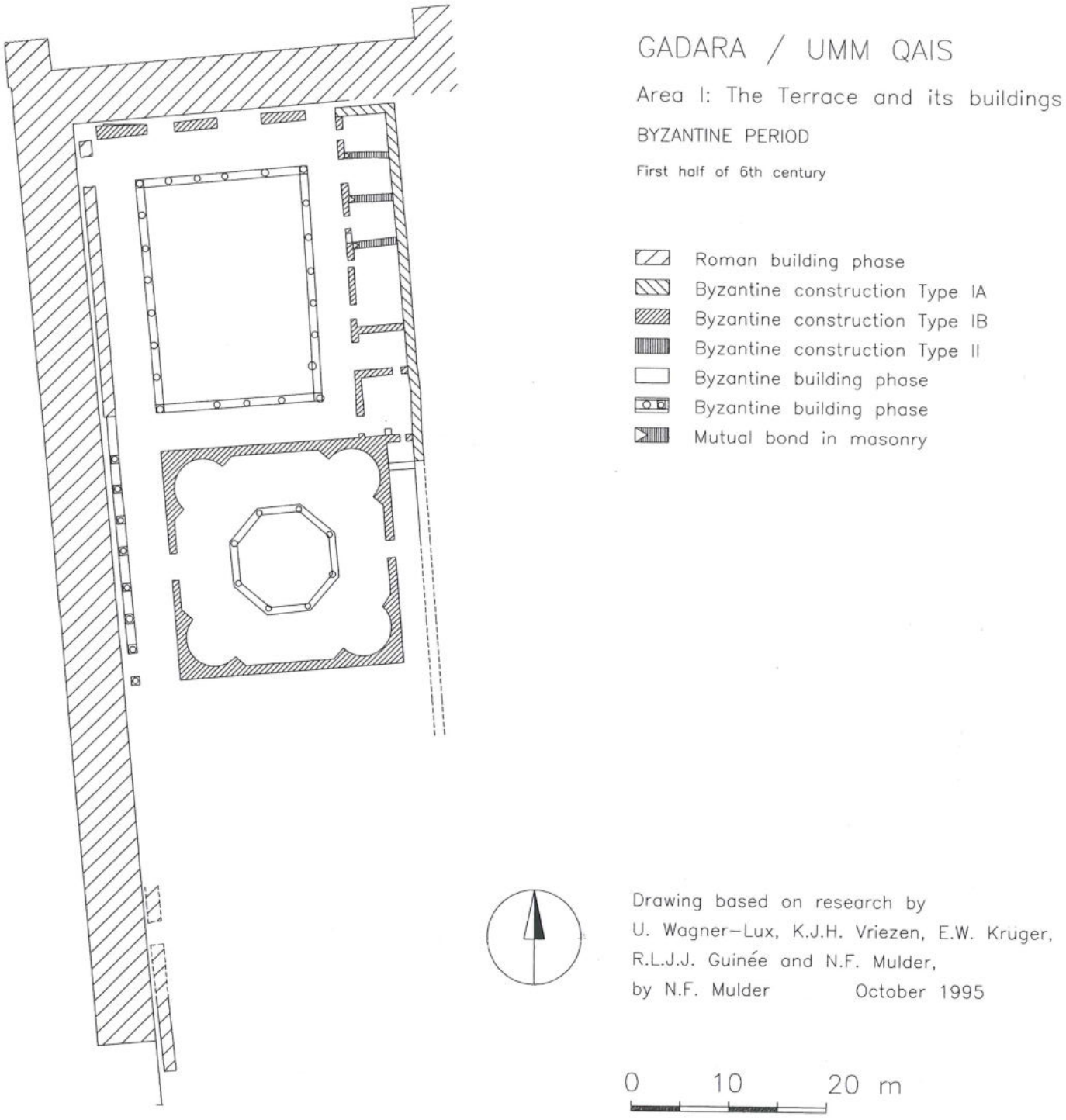
It is surmised that the wares I and II may come from the Umm Qays plateau itself: together they make more than one-third of the total repertoire. The wares, which are characterised by the admixture of sieved, rounded quartz grains, Types IV, V and V-2, may originate from the area of a river bed or a seashore; they make almost half of the total repertoire. Type VI (8.7%), the clear coloured and almost untempered ware, is distributed in a far larger area then the region of Umm Qays, as will be discussed below. Possibly the basalt tempered Type III (4.2%) is also non-local.

15 Possibly the *opus quadratum* blocks and the matching architectural elements originate from one building.

16 This study was financially assisted by travelling grants from the Netherlands Organisation for Scientific Research (NWO).

17 The typology achieved by this method has a rather limited range of types and may eventually be refined by the introduction of form typology.

18 We are thankful to Susanne Kerner for presenting this sample to us.



6. The Terrace and its buildings in the Byzantine Period (first half of sixth century).

Table 1. Analysis of excavated roof tile wares (I-VIII), excavated clay deposit (A) and natural clay source (B).

Type	nonplastics size / percentage											
	1000-600μ	600-250μ	250-150μ	150-75μ	75-38μ	size/numb. >1mm/cm²	characte-ristics	voids organ.	voids anorgan.	poro-sity	weight cm²	presence %
I	2	2	1,5	2.5	6	1,5	r/b,rnd/ang	l	vl	20.3	3.9	28.7
I-1	1.5	1.5	2	2.5	7	2	r/b,rnd/ang	l	vl	23.4		1.3
I-2	2	1	2	5	5	3	r/b,rnd/ang		h	13.9	4.3	0.6
I-3	1.5	1.5	1.5	2.5	8	2	undiss.clay			20.2	3.4	0.2
II	1	1.5	1.5	2	5	1.5	r/b,rnd/ang	l	l	20.6	4.2	9.7
III	1	2.5	2	2	15	2	basalt	m		23.9	2.8	4.2
IV	1.5	4	2.5	1.5	14	<1	basalt/qrtz		l	18.6	3.0	26.3
V	1.5	6	2	1	0.5	<.5	quartz		h	21.8	3.1	13.1
V-1	0.5	3	2	2	20		lime		h	21.6	2.7	1.1
V-2	1.5	7	4	2	1.5		lime/quartz		l	18.9	2.6	5.4
V-3	1	1.5	2	7.5	3.5	1.5	quartz	l	h	10		0.1
VI	1	0.5	1	0.5	1	1	quartz/lime		vl	21.5	2.8	8.7
VII	2	7	6	6		sng	r/b,rounded			16.2		0.1
VIII	1	1	1	4	2		quartz			19.1		0.5
A	0.5	0.5	1	1	3		r/b,rnd/ang		m	12.6		
B	0.5	1.5	2	3	5		r/b,rnd/ang	l	h	24.9		

LEGENDA:

ang	angular	h	high	undiss.	undissolved clay
b	black	l	light	sng.	singular
r	red	m	medium	(an)organ.	(an)organic
rnd	rounded	vl	very light		

In the manufacture of the roof tiles, various construction processes may be discerned. Information on the tile manufacture from classical sources[19] seems to corroborate with observations of brick and tile making in more recent times.[20] In their study of tile manufacture in the Eastern Mediterrenean region, Hampe and Winter illustrated the manufacture of the curved tiles.[21] There, it may be seen how a lump of clay is pressed into a wooden frame in order to form a clay slab. Then the slab - still in plastic condition - is pressed over a more or less semi-cylindrical mould to form a curved tile, which is then is laid out in the yard to be dried. The inspection of the *imbrex* fragments from Umm Qays showed that for all ware types except one (VI), the same basic method of manufacture was used (FIG.7).

The manufacture of tiles of the *tegula* type may be studied on account of the visible traces which the process left on the surface of the tiles (e.g. clay ridges) and in the tile itself (e.g. air holes and folds), and may be reconstructed as follows. After a lump of clay was pressed into a wooden frame to form a slab, the two longer sides of the rectangular slab were curved up and folded over. The final rim form depended on the position of the fingers and on the kind of tools used to press and finish off the flange (FIGS.8 and 9).

Both the *imbrices* and the *tegulae* show a notable difference between the items made of Ware Types I and II (FIGS.7 and 8) and the items made of Ware Types III, IV and V (FIGS.7 and 9), as the latter are more carefully finished than the former and therefore they are finer and show a wider variety of forms.

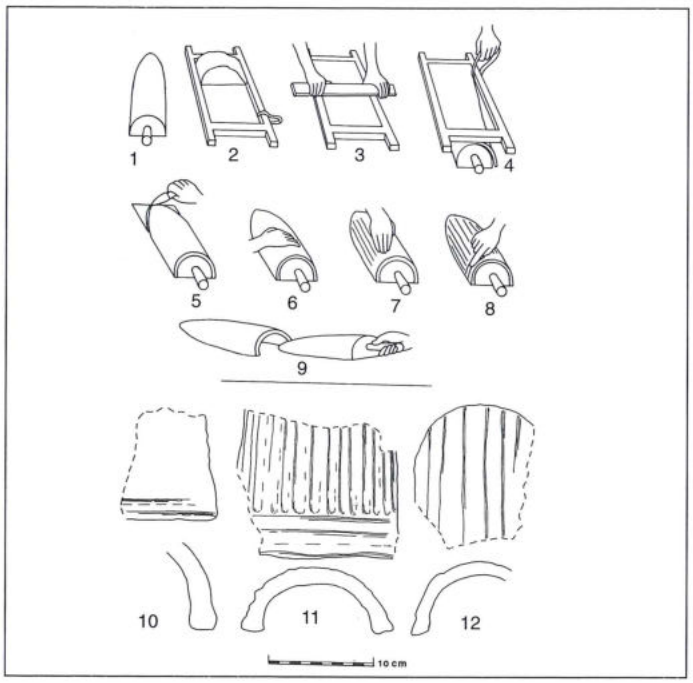
The tiles of Ware Type VI stand out, not only because of the ware, but also by their manufacture. Contrary to the *imbrices* already mentioned above, these *imbrices* were not pressed over a mould but into a mould, resulting in a more angular formed *imbrex* tile (FIG.10). Also the *tegulae* of Ware Type VI show a distinct form and surface treatment: both surfaces of the slab have been finished with a tool and with fingers, the folded-over flanges are angular in section and continue a little around the corner on one of the short sides, whereas parallel to the opposite short side a ridge is attached to the surface (FIG.11). These tiles, in ware and in shape, correspond to the rooftiles Type B from Tall Keisan.[22] Therefore, these ware VI roof tiles are supposed to have a wider area of distribution, covering northern Palestine and northern Transjordan as well.

19 H.Blümner, *Technologie und Terminologie der Gewerbe und Künste bei Griechen und Römern II*, Leipzig 1879 [reprint: Hildesheim 1969], 14f.,18,30f.

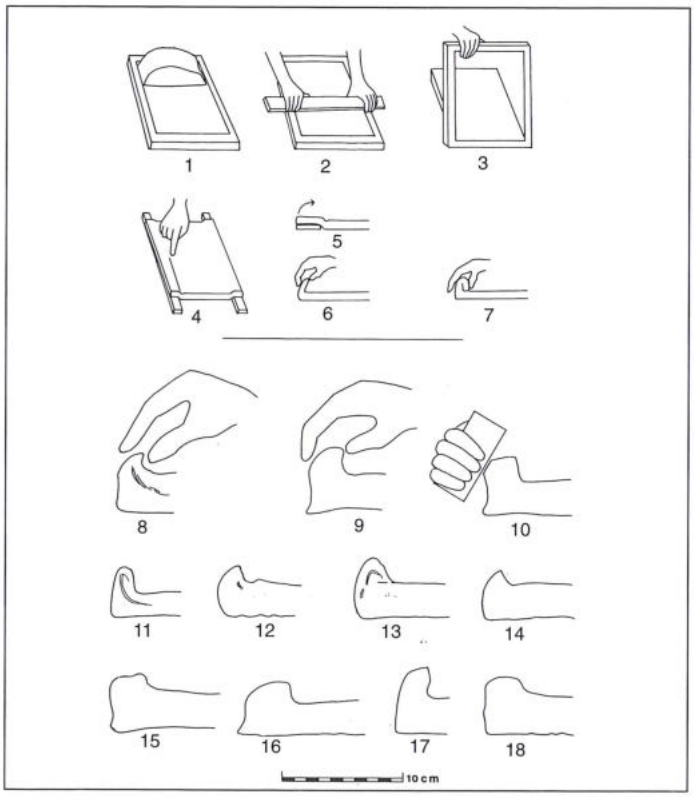
20 See e.g. for the Netherlands: J. H. Holwerda and W. C. Braat, *De Holdeurn bij Berg en Dal. Centrum van pannenbakkerij en aardewerkindustrie in den Romeinschen tijd* (Oudheidkundige Mededelingen, Suppl.N.R. 26), Leiden 1946, 104ff.

21 R.Hampe and A.Winter, *Bei Töpfern und Zieglern in Süditalien, Sizilien und Griechenland*, Mainz 1965, 26-29; Taf.15,42,48f.,55.

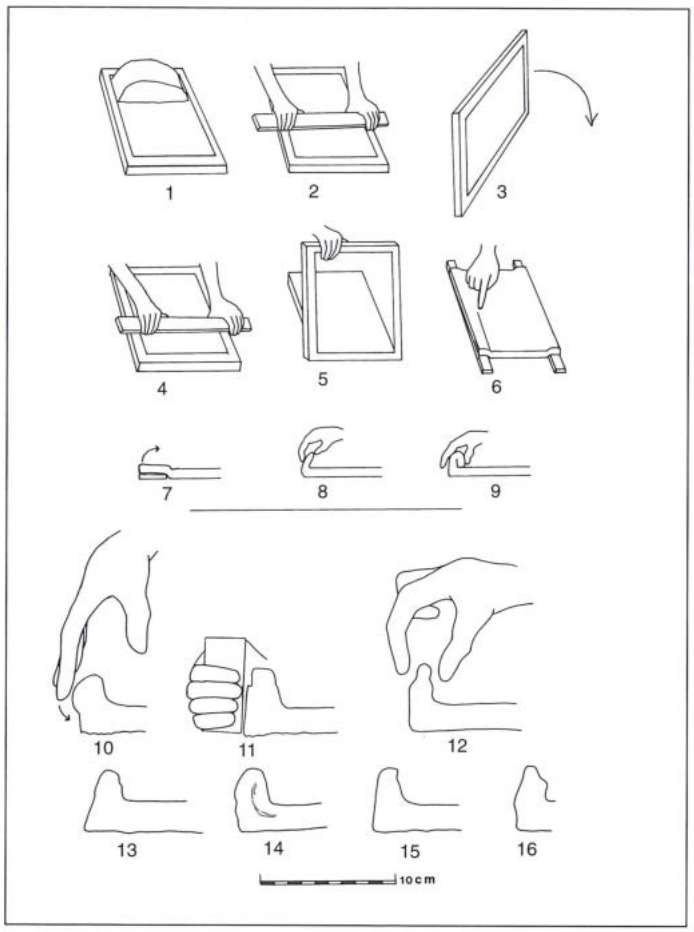
22 J. Landgraf, Pp. 84-87 in J.Briend and J.-B.Humbert eds., *Tell Keisan (1971-1976), une cité phénicienne en Galilée*, Fribourg-Göttingen-Paris 1980.



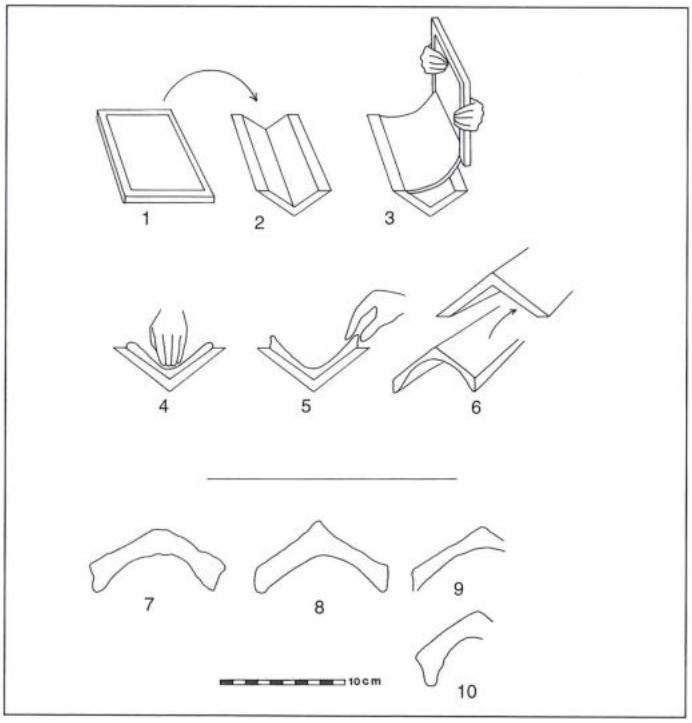
7. *Imbrex* manufacture: Ware Types I and II (1-6,9), Ware Types III-V and V-2 (1-9).Semi-cylindrical mould (1), pressing a lump of clay into a wooden frame (2-3), cutting the clay slab free from the frame and pressing it over the mould (4-6), finishing the *imbrex* surface (7-8), removing the mould (9), *imbrex* sherds Ware Type I/II (10) and Ware Types III-V (11-12).



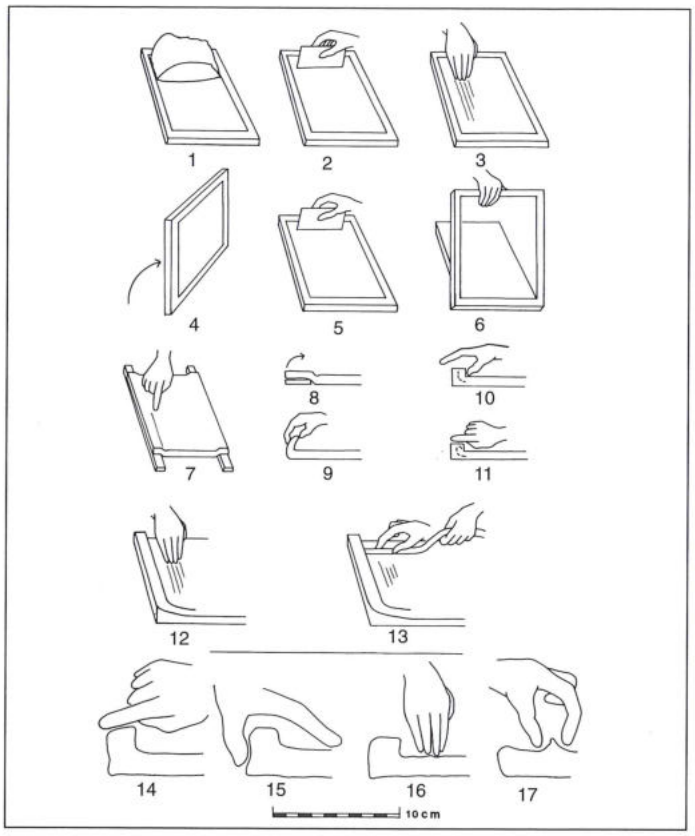
8. *Tegula* manufacture: Ware Types I and II. Pressing a lump of clay into a wooden frame and smoothing the upper surface (1-2), removing the frame (3), preparing the folding of the rim (4-5), folding over the rim and finishing the flange (6-7), *tegula* sherds and the finishing of their flanges (8-18).



9. *Tegula* manufacture: Ware Types III-V and V-2, see FIG. 8; here the lower surface is also smoothed (3-4). *Tegula* sherds and the finishing of their flanges (10-16).



10. *Imbrex* manufacture: Ware Type VI. Pressing the clay slab into a mould and removing the mould (1-6), *imbrex* sherds (7-10).



11. *Tegula* manufacture: Ware Types VI, see FIG.8; a clay ridge is added (13,17).

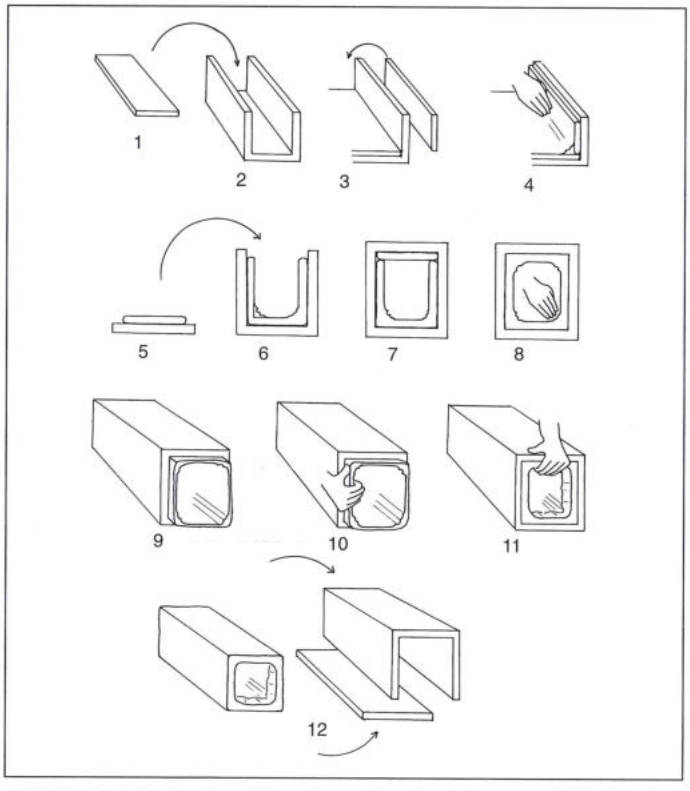
An even larger area of distribution can be assumed for a type of roof tiles not yet mentioned, namely the tiles made of Ware Type VII. They constitute only 0.1% of the repertoire in Umm Qays Area I and are identical to one of the roof tile wares known from Jerusalem.[23] Thus, in the study of the ware different types were identified and some of these could be grouped together according to corresponding main characteristics and each of these groups was supposed to have a different area of origin and distribution. Also in the study of the manufacture, different processes were identified and each of these appeared to be related to one of the groups of ware types:

- Ware Types I and II; local?; poor surface treatment;
- Ware Types IV, V and V-2; quartz sand region; form finish and surface treatment;
- Ware Type III; basalt region; form finish and surface treatment;
- Ware Type VI; Galilee/NW Transjordan; angular forms, *imbrex* pressed into mould.

In order to understand the presence of such a variety of Ware Types, a preliminary study of the distribution of the Wares in Areas I and III was made. As a result certain concentrations and gaps in the distribution of wares I, IV and VI are revealed. This may be due to differences in roof construction or roof repairs, but this issue will be subject to further study.

The second category of handmade ceramic building materials to be discussed is that of the *tubuli* (box tiles): rectangular ceramic pipes used for wall heating. The fragments found in Area I are all made of Ware Type I. Not only in ware, but also in manufacture they resemble the roof tiles, as they are built of rectangular flat tiles. However, as can be seen in the construction drawing (FIG.12), their manufacture is more elaborate and a different type of "mould" was used. The air-holes and the deep finger-made grooves inside the rectangular corners are the traces of the assembling process. They make up the characteristics of these tiles together with the inward folded rims around the more or less round opening in the smaller sides.

This contribution based on Umm Qays Area I may show that in the study of the natural resources of Jordan used throughout the ages, the less attractive objects such as building materials must also be taken into account. Because they represent massproduced commodities, their study may give new insights into questions of distribution patterns.



12. *Tubulus* manufacture. Pressing a clay slab into a mould (1-2), placing a second clay slab into the mould and assembling the slabs (3-4), adding the fourth slab (5-8), folding the pinched-out clay back over the rim of the short side (9-11), removing the mould (12).

[23] Excavations underneath the Church of the Redeemer: roof tile ware 4; K.J.H.Vriezen, *Die Ausgrabungen unter der Erlöserkirche im Muristan, Jerusalem (1970-1974)* (Abhandlungen des Deutschen Palästina-Vereins, Band 19), Wiesbaden 1994, 259f.

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Thermal Springs, Medical Supply and Healing Cults in Roman-Byzantine Jordan

"et in locis plurimis (scil.: Palaestinae) aquae suapte natura calentes emergunt ad usus aptae multiplicium medelarum . . ."
Ammianus Marcellinus, Res Gestae VIII 14,12

Introduction

Early in the fourth century AD, 'Amr ibn-Luhayy usurped the custody of the shrine at Mecca from al-Harith and expelled the Jurhumite kings from the Holy precinct of the Ka'ba. As he took over the rule on the Sacred House he became very sick. According to Ibn al-Kalbi[1] an Iraqi scholar of the eight/ninth century AD, he was told about a hot spring in Syrian al-Balqa which has to be identified with the region south of Amman in central Jordan. If he would go there, he would be cured. So he went to the thermal spring, bathed therein, and was delivered from evil. During his stay there, he noticed that the inhabitants of the place worshipped idols. He queried them saying, *"What are these things?"* and they replied, *"To them we pray for rain, and from them we seek victory over the enemy"*. Thereupon he asked them to give him [a few of those idols], and they did. He took them back with him to Mecca and erected them around the Ka'ba.[2]

This is not the place to review the historical authenticity of this particular journey and the medical cure. 'Amr ibn-Luhayy is said to having introduced various idols to Central-Arabian Lihyan from Syria[3], where statues of Greek and Roman gods and goddesses were common before the spread of Christianity. In the pre-Islamic period, there are alleged to have been 360 idols venerated at the shrine of Mecca (FIG. 1).[4] Of these the most important were al-'Uzza, Allat, and Manat – all three regarded as female deities –, and Hobal, a large male image.

Tradition in this respect may well be correct because the names of these idols are attested in Bilād ash-Shām by Nabataean inscriptions already several centuries earlier.[5] On the other hand, the anecdote by ibn al-Kalbi sheds considerable light on thermal springs and their medical exploitation in Jordan, well comparable to those mentioned by Ammianus Marcellinus for Palestine (above).[6] Healing cults during the pre-Islamic periods obviously stood in syncretism with fertility and military gods. It is the aim of this paper to give an account of the sites, the nature of the cults and, if possible, evidence of therapeutic practice. It should be pointed out that healing cults are not an exclusive feature of pagan religions: Judaism, Christianity and Islam as well in their holy scripts focus on healing of diseases, metaphorically for the delivery of the soul.[7] The majority of the miracles of Jesus the Nazarene consisted in healing and exorcism. In this consequence the redeemer was already in the Byzantine period assimilated to the Greek healing god Asklepios, as is firmly evidenced by a notice on the church history of Eusebius on a statuary group in Caesarea Philippi/ Paneas.[8]

The topic of healing cults and medical supply coincides quite well with the general theme of the Sixth Conference on the History and Archaelogy of Jordan:

1 Hisham ibn-al-Kalbi, *Kitab al-Asnam* 5,13 (34 ed. R. Klinke-Rosenberger (Leipzig 1941).

2 *The Book of Idols,* being a translation from the Arabic of the *Kitab al-Asnam* by Hisham ibn-al-Kalbi, transl. N. A. Faris, Princeton Oriental Studies XIV (Princeton, N. J. 1952) 7. For the historical background F. Altheim - R. Stiehl, in: *Abriß der Geschichte antiker Randkulturen,* ed. W. D. v. Barloewen (Munich 1961) 180 f.

3 Cf. F. Grohmann, *Arabien. Kulturgeschichte des alten Orients.* Handbuch der Altertumswissenschaft III.1,3,3,4 (Munich 1963) 85; J. B. Glubb, *The Great Arab Conquests* (London - Melbourne - New York 1963) 30f.

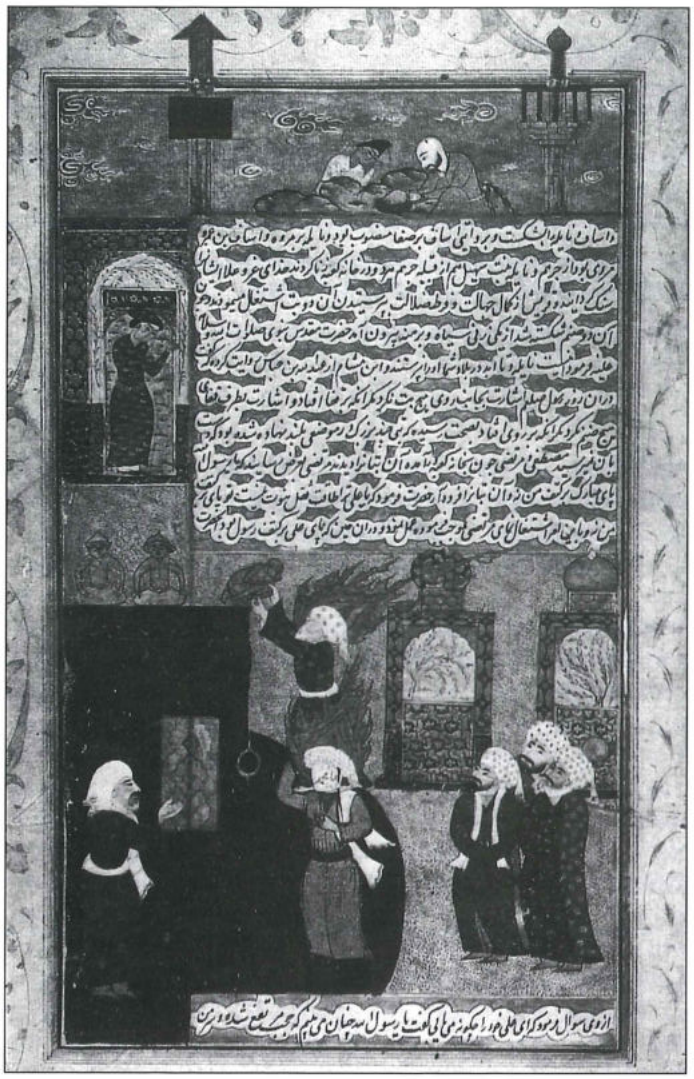
4 Cf. the representation of the Holy Prophet Muhammad removing the idols from the *al-Ka'ba* shown on a Persian book illumination of the late 16th century AD, tempera on paper: Museum für Islamische Kunst Berlin - Staatliche Museen Preußischer Kulturbesitz, 2nd ed. by K. Brisch - A. Hauptmann-von Gladiss - J. Kröger *et al.* (Berlin-Dahlem 1979) 17 Abb. 2.

5 Cf. D. Sourdel, *Les cultes du Hauran `a'époque romaine.* B.A.H. 53 (Paris 1952) 67f.74 (al-'Uzza); 69 ff. (Allat); M. Gawlikowski, *Aufstieg und Niedergang der römischen Welt* 18,4 (Berlin - New-York 1990) 266ff.; H. Donner, *Isis in Petra* (Leipzig 1995) 7.

6 In general on this subject cf. H. Dechent, *ZDPV* 7, 1884, 173ff.; S. Krauss, *Ha-Kedem* 1, 1907/8, 105ff.; idem, *Ha-Kedem* 2, 1909/10, 32ff.; A. Friedmann, *Zeitschrift für Balneologie, Klimatologie und Kurort-Hygiene* 6, 1913, 429ff.; S. Lachmann, *Palästina* 7-9, 1933, 221ff.; I. Simon, *Revue d'histoire de la médecine hebraique* 122, 1977, 53f.; *ibid.* 124, 1978, 7ff.; *ibid.* 125, 1978, 33ff.; *ibid.* 126, 1978, 57ff.; E. Dvorjetski, *Progress in Rheumatology* 4, 1990, 134ff.; idem, *Medicinal Hot Springs in Eretz Israel during the Period of the Second Temple, the Mishna and the Talmud I-II* (Hebrew, unpublished). Ph-D. (Jerusalem 1992); idem, *Aram* 4, 1992, 425ff.; idem, in: Eleventh World Congress of Jewish Studies (Jerusalem 1994, in print).

7 For this subject in general cf. *Heil und Heilung in den Religionen,* ed. K. Hoheisel - H.-J. Klimkeit (Wiesbaden 1995) passim.

8 Eusebius, Eccl. Hist. 7,18,1; cf. O. Keel, in: *Peregrina Curiositas,* Festschr. D. van Damme, Hrsg. A. Kessler - Th. Ricklin - G. Wurst, Novum Testamentum et Orbis Antiquus XXVII (Friburg/Switzerland 1994) 162ff. (with further reference).



1. The holy Prophet Muhammad with the help of Ali removes the pagan idols from the Ka'ba. Book illumination from Shiras/ Iran, dated between AD 1585 and 1595, tempera on paper, Height 29.3 cm; Width 17 cm. Berlin, Museum for Islamic Art, Staatliche Museen Preußischer Kulturbesitz, Inv.-Nr. 44/68.

Landscape resources and human Occupation in Jordan throughout the Ages.

Betomarsea/ Maiumas and the Source of 'Ayn Sara of al-Karak

The mosaic map of Mādabā figures a site named ΒΗΤΟΜΑΣΡΕΑ Η Κ(ΑΙ) ΜΑΙΟΥΜΑΣ [9] by inscription (FIG. 2). The locality is symbolized as a centrally domed building flanked on both sides by vaulted wings. One may also assume that it was a theatre with annexes. Beneath this structure some unidentifiable plants and perhaps flowing water of a brook are shown, apparently indicating that the place is near water and rich in vegetation. H. Donner[10] convincingly indentified Betomarsea with 'Ayn Sara at the north-western foot of the steep hill of al-Karak, nowadays a recreation centre. The source flows cold water only, which is important for the drinking water supply of the modern town. In the environment of the spring a limestone capital of Aeolic type (FIG. 3)[11] was found and indicates that the occupation of the site goes back at least to the Iron Age. In the Greco-Roman period Betomarsea was obviously a house for cultic purposes or a club. Maiumas was the name of a popular licentious feast with water amusements and symposia, widespread in the ancient Near East.[12] It remains to be known if medical cures were practised at Betomarsea.



2. Byzantine mosaic map of Palestine (detail), Saint George, Mādabā.

The Thermal Springs of Baaras

The springs of Baraas are variously mentioned by Flavius Josephus,[13] Eusebius[14] and Petrus the Iberian.[15] The site was identified as modern Hammāmāt az-Zarqā'.[16] situated in the gorge of Wādī az-Zarqā', Mā'īn (FIG. 4). Shown at the eastern littoral of the Dead Sea on the mosaic map of Mādabā (FIG. 5), the fragmentary inscription . . .] ΑΑΡΟΥ must be conjectured as *[ΘΕΡΜΑ Β] ΑΑΡΟΥ.[17] According to Flavius Josephus a mysterious red plant, probably a mandrake belonging to the species of the rue *(ruta graveoleus L)*,[18] growing in that area provided magical power to expel demons. He further refers to the ther-

9 H. Donner, *The Mosaic Map of Madaba. Palaestina Antiqua* 7(Kampen 1992) 40f. s.v. I owe thanks to U. Hübner (Mainz) who attracted my attention to this site.

10 *ZDPV* 98, 1982, 181ff.

11 The capital was found in 1982 in the foundation trench dug for the construction of the rest-house at the site, measurments 124 x 74 cm, today reused in the masonnry of a modern wall. For the type cf. Y. Shiloh, *PEQ* 109, 1977, 39ff.

12 Donner, *Madaba Map,* loc. cit. 40. For the Maiumas festivals see also n. 61.

13 Bell.Jud. VII 6,3.

14 Onomastikon 44:21-46:2.

15 87-90 ed. Raabe (Leipzig 1895).

16 H. Donner, *ZDPV* 98, 1982, 175ff.; idem, *Madaba Map* loc.cit. 39 Nr. 9; U. Hübner (forthcoming). I extend my thanks to U. Hübner for making results of studies on the site and photographical material available to me.

17 First identified by J. Manfredi, *RB* 13, 1903, 266ff.

18 cf. S.S. Kottek, *Medicine and Hygiene in the Works of Flavius Josephus. Studies in Ancient Medicine* 9 (Leiden - New York - Cologne 1994) 130f.



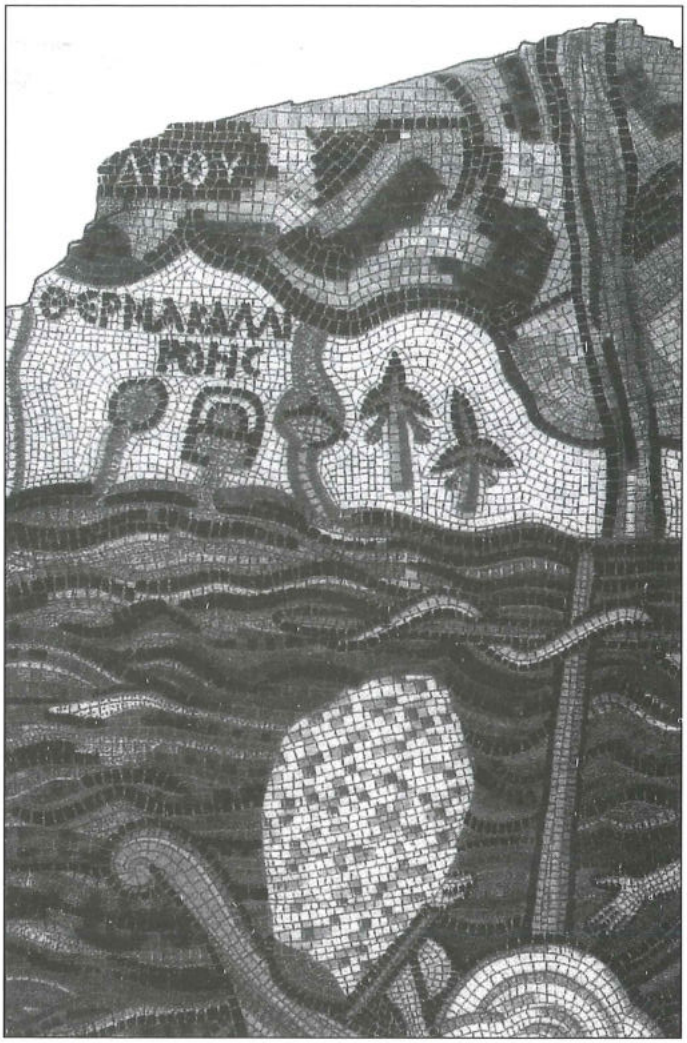
2. Iron Age limestone capital of "proto-Aeolian" type, found at 'Ayn az-Zāra springs close to al-Karak.

mal springs with waters of different taste and oscillating temperatures. A cure in the spa of Baraas was considered suitable for the treatment of various diseases, especially to strengthen the nervous system. Apart from the botanical and hydrological conditions the valley has geological deposits of brimstone, alum, and ferrous sulphate - minerals well known in ancient pharmacy.

The site has never been investigated archaeologically. U. Hübner[19] recently emphasized the connection of a votive inscription [20] found at al-Harra in southern Syria to the local cult of the Baaras springs. The altar ist dedicated by a certain Diomedes Charitos, a Roman official of the Batanaea in the rank of a governor *(eparches)* and military commander *strategos*). Probably this man was cured by the same therapy at Baraas as later 'Amr ibn Luhayy. For the sake of his recovery he donated the votive offering to Zeus Beelbaaros, the local Baal of Baaras, who perhaps was identical with the Moabite god Kemosch.[21] Unfortunately no imagery survived to tell the features of this deity.

The Hot Springs of Kallirhoë

The oasis of az-Zāra [22] nestles on a slope of the Jordanian plateau at the eastern shore of the Dead Sea; at a distance of about 1,5 km south of the az-Zarqā' Mā'īn. The steep mountain range recesses to a semicircular bay with rock terraces. Based on the Mādabā map[23] the site is firmly identified with Kallirhoë, which is mentioned in the Natural History of Pliny the elder.[24] King Herod the



3. Byzantine mosaic map of Palestine (detail), Saint George, Mādabā.

Great was taken there to find relief from his pains prior to his death in 4 BC.[25] Ancient geographers such as Solinus Polyhistor[26] and Claudius Ptolemaeus [27] refer to Kallirhoë with relatively exact geodetical data. Rabbinic tradition [28] influenced even Christian geography: In accordance with these Hieronymus [29] states that the thermal water of the springs flows into the Dead Sea.

The mosaicist of the Mādabā map represented three contructions (FIG. 4): a round pool from which water flows, a square reservoir with an apse, probably a nymphaeum of customary type, and a channel widening in the plain, barraged by a wall or a dam, pooring water into the

19 Hübner, *loc.cit.* (in print).

20 D. Sourdel, *Les cultes du Hauran à l'époque romaine.* B.A.H. 53(1952) 45f. Pl. 4,1.

21 U. Worschech, *Ugarit Forschungen* 24, 1992, 393ff.

22 Cf. H. Donner, *ZDPV* 79, 1963, 59f.; A. Strobel, *ZDPV* 82, 1966, 149ff.; idem. *ZDPV* 93, 1977, 247ff.; idem, in: J.B. Hennessy - D. Homés-Fredericq, *Archaeology of Jordan* II 2. *Akkadika* Suppl. VIII (Leuven 1989) 633ff.; idem, Jahrbuch des Deutschen Evangelischen Instituts für Altertumswissenschaft des Heiligen Landes 1, 1989, 173ff.; G. Reeg, *Die Ortsnamen Israels nach der rabbinischen Literatur.* Beihefte Tübingen Atlas des Vorderen Orients Reihe B Nr. LI (Wiesbaden 1989) 51f.; 482; 559f; C. Clamer, *ADAJ* 33, 1989, 217ff.; A. Strobel, in: S. Kerner, *The Near East in Antiquity.* German Contributions to the Archaeology of Jordan, Syria, Lebanon and Egypt I (Amman 1990) 81ff.; R. Deines, 'Jüdische Steingefäße und pharisäische Frömmigkeit', *Wissenschaftliche Untersuchungen zum Neuen Testament* 52(Tübingen 1993) 159ff.; Hübner, loc.cit note 3.

23 Manfredi, *loc. cit.* 266ff.; Donner loc.cit. 39f. Nr. 10.

24 Nat. Hist. V 16,9.

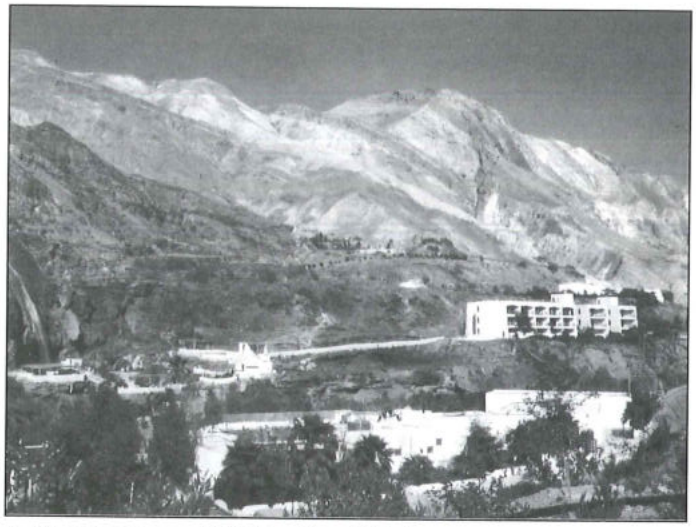
25 Flavius Josephus, Bell. Jud. I 617 = Antiqu. XVII 171.

26 Coll. rer. memor. 35,4.

27 Geogr V 16,9.

28 Targ. Jon.; jMeg I 9.

29 Quaest. ad Gen. 10,19.



5. The hot springs of Wādī az-Zarqā' Mā'īn.

lake. This construction was probably a basin for bathing filled with flowing hot water which could be mixed, when required, with cooler waters or with minerals. The archaeological remains at the site are rather poor. Only the third installation might perhaps be identical with a rectangular depression, which local people call *al-Madās,* chiselled into the rock. All other constructions vanished entirely. This is due to the construction material available at the site: It consists of coarse basaltic tuff, a rather porous and layered stone which is easy prey to corrasion.

Traces of ancient harbour installations have been destroyed by road works. What has been excavated in the mid-80s by C. Clamer and A. Strobel looks much like a Roman villa compound with rooms aligned along a central peristyle courtyard. The whole oasis, the lushness of which is indicated on the Mādabā map by two date palms, was obviously fenced by a massive masonry wall.

The Hot Springs at Ḥammāt Abū Dāble and the Cult of Sarapis in Pella

The baths of Abū Dāble [30] located in the upper Jordan rift valley at a distance of approximately two kilometers north of the Decapolis city of Pella / Ṭabaqat Faḥil. According to the only literary reference in the Jerusalem Talmud,[31] Rabbi Zeira made a trip from Palestine to Transjordan between AD 279 and 359 for the purpose of using the hot springs of Pella. The relating rabbinic dispute concerns the problem of ritual clean and unclean localities, whether the Pella baths were within the customary boundaries of Judaism or not. Most interpreters of this passage followed



6. Statuary fragment of enthroned Sarapis, found in the fill of the staircase of the civic complex at Pella.

A. Neubauer [32] in assuming that the thermal spring was near Pella rather than within the city's territory itself. If so, the present hot spring of Ḥammāt Abū Dāble is a possibility although the scarce ruins at the spot are insufficient to conclude the existence of monumental buildings. It is not convincing to locate the famous Nymphaeum of Pella here, which is shown on numerous quasi-autonomous coins of the late second - early third century AD.[33]

G. Schumacher,[34] on the other hand, supposed that the spring should be located at downtown Pella. This locality, nowadays known as the Wādī Jirm al-Mawz in the local dialect, was renowned in antiquity for its abundance of water.[35] Several sources still today grant outstanding fertility to this place. In antiquity the city's centre must have housed a pagan shrine which was later transformed into a Christian church. Traces of the former building were uncovered at the site of the so-called civic complex: Two fine columns of dark chloritic limestone were reused in the atrium of the Byzantine sanctuary to flank the central portal:[36] In the fill of the staircase leading up to the Cathedral, a fragment of a statue (FIG. 6) made out of blue Egyptian schist was uncovered. It features an enthroned deity draped with a thick garment covering the legs up to the hip. The dark stone and the characteristic drapery indicate that the Pella fragment once belonged to a copy of the

30 G. Schumacher, *Pella* (London 1888); S. Kraus, *Talmudische Archäologie* I (Leipzig 1910) 216 note 74; C. Steuernagel, *ZDPV* 49, 1926, 20f. = Der Adschlun (Leipzig 1927) 404f.; H. Bietenhard, *ZDPV* 79, 1963, 28 n. 30 = *Aufstieg und Niedergang der Römischen Welt* II 8 (Berlin - New-York 1972) 225f. note 30; R.H. Smith, *Pella of the Decapolis* I (Wooster, Ohio 1973) 57f. Nr. 60; M. Avi-Yonah, *Gazetteer of Roman Palestine. Qedem* V (Jerusalem 1976) 63 sv.; Th. Weber, Pella Decapolitana. Abhandlungen des Deutschen Palästinavereins XVIII (Wiesbaden 1993) 6 with n. 5.

31 jShev'it 6,1; Smith *loc. cit.* 57f. Nr. 60.

32 *La géographie du Talmud* (Paris 1868) 274.

33 H. Nicolet, in: *Coins, Culture, and History in the Ancient World.* Numismatic and other Studies in Honour of B.L. Trell, ed. L. Casson - M. Price (Detroit, Mi 1981) 51ff.

34 *Loc.cit.* 88f.

35 Cf. Pliny, Nat. Hist. V 14: ". . . Pellam aquis divitem . . ."; Weber *loc. cit.* 8 n. 18.

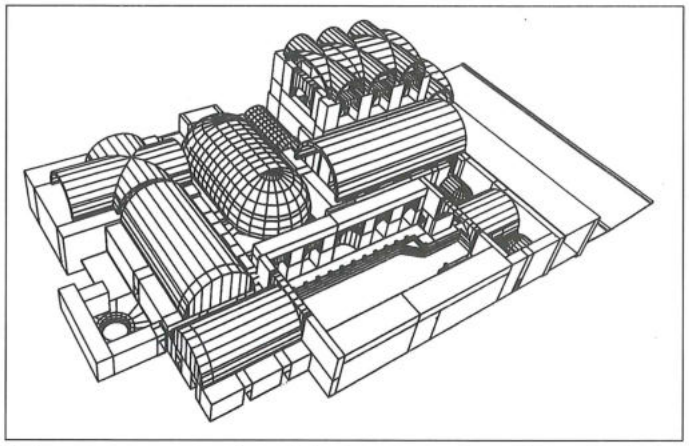
36 R.H. Smith - L.P. Day, *Pella of the Decapolis* II (Wooster, Ohio 1989) 56f.; R. H. Smith, *Aram* 4, 1992, 205 n. 25.

famous Alexandrine cult statue of Sarapis, created in the early Hellenistic period by the Greek sculptor Bryaxis.[37] Consequently one may conclude that there was a Sarapeion in the centre of ancient Pella. Egyptian Sarapis integrated multiple functions: He was a fertility god and the master of the underworld. Apart from this, Sarapis had also a distinctive medical aspect as indicated by a considerable number of marble votive feet found in Palestine and Transjordan.[38]

The Hot Springs at Emmatha / Ḥammāt Gader and the Cult of Asklepios at Gadara

Already in the Hellenistic period Gadara seems to have been a city where medical therapies were practised. The Philinna-Papyrus of the first century BC preserves an incantation in metrical Greek prose against every type of inflammation.[39] The earliest evidence for the nearby thermal springs in the gorge of the river Yarmouk and the development of a spa settlement at the site of Emmatha/ Ḥammāt Gader dates back to the reign of Antoninus Pius. There are no literary references to that site before the middle of the second century AD. Even well informed authors of the first century AD such as the geographer Strabo, the Jewish historian Flavius Josephus or the polymath Pliny do not know anything about the place. It is first mentioned by rabbinic sources in connection with a seasonal food-market[40] and with an interpretation of the sabbatical rules.[41] But in the early third and fourth centuries AD both Origenes [42] and Eusebius [43] refer to Gadara as a city with "famous" thermal springs in its territory. According to Cyril,[44] bishop of Jerusalem (348-386 [?] AD), after an earthquake, most likely that of the year 363 AD, the Gadarene springs ('Aina d-Gader) turned into blood. Modern eyewitnesses of such natural catastrophes confirm our assumption that this apocalyptic metaphor might be explained by the red soil of the area mixed with groundwater during seismic activities. A considerable number of restoration inscriptions found in the thermal building indicate that major damage caused by this and subsequent earthquakes were urgently repaired.[45] Between 423 and 460 AD empress Eudokia, spouse of Theodosius II, dedicated a metric Greek inscription in dactylic hexameters for the lyric praise of the main bathing hall (*clibanus*).[46] Building activities are still proved in the Islamic period, for instance by a Greek inscription dedicated on December fifth, 663 AD, referring to a clearance and restoration of the *clibanus* during the reign of Abdallah Mu'awiya.[47]

Due to the hot spring 'Ayn Maqle, the thermal complex (FIG. 7) lacks artificial heating installations. The water emerges with a temperature of 51 °C from a small pool in the southwestern part of the building and is circu-



7. Isometric reconstruction of the thermal complex of Ḥammāt Gader.

37 Cf. W. Hornbostel, *Sarapis. Études préliminaires aux religions Orientales dans l'empire Romain* (Leiden 1973) passim.

38 For votive feet in Palestine and Transjordan see *Enciclopedia della Biblia* IV (Barcelona 1963) 1091f. with Fig. (Askalon); Weber loc. cit. 93f. Pl. 53,3 (Petra); B. Bagatti, *Excavations in Nazareth* I. Publications of the Studium Biblicum Franciscanum XVIII (Jerusalem 1969) 315f. Fig. 238 (Nazareth); M. Avi-Yonah, IsrExplJ 2, 1952, 118ff. (Mount Carmel); R.-Dussaud, *Monuments Palestiniens et Judaiques* (Paris 1912) 29 (Jerusalem, votive of Pompeia Lucilia). For these monuments in general see S. Dow - O. S. Upson, *Hesperia* 13, 1944, 58ff.; D.K. Hill, *Hesperia* 15, 1946, 60ff.; L. Castiglione, *ZfS* 97, 1971, 30ff.; idem, *StAeg* I, 1974, 75ff.; M. Le Glay, in: *Hommages à M.J. Vermaseren* (Leiden (1978) 573ff.

39 P. Maaß, *JHS* 62, 1942, 33ff.; K. Preisendanz, *ChronEg* 26, 1951, 406f.; idem, Mitteilungen aus der Papyrussammlung der Österreichischen Nationalbibliothek zu Wien 1956, 113; R. Merkelbach, *ArchPF* 16, 1958, 85f. Nr. 1046; L. Koenen, *ChronEg* 37, 1962, 167ff.; A. Henrichs, ZPE 6, 1970, 204ff.; E. Schürer, *The History of the Jewish People in the Age of Jesus Christ* (175 B.C.-A.D. 135), 2nd rev. ed. by G. Vermes - F. Millar - M. Black II. (Edinburgh 1979) 136 n. 255; M. Hengel, *Judentum und Hellenismus.Wissenschaftliche Untersuchungen zum Neuen Testament* X (3rd ed. Tübingen 1988) 152f.; R. W. Daniel, *ZPE* 73, 1988, 306; Th. Weber *JbÖsterrByz* 42, 1992, 266 n. 35; D.F. Graf, *Aram* 4, 1992, 33 n. 99; M.W. Dickie, *ZPE* 100, 1994, 119ff.

40 *Midrasch Kohelet rabba* V 10,1.

41 jErubin V 8.

42 Comm. in Evang. Ioanni XLI.

43 Onomastikon s.v.Γαδαρα; s.v. Αιμαθ. cfl. Georgios Synkellos, Ecloga Chronographica 559; Ioannes Cotovicus, Itinerarium Hierosolymitanum 360.

44 S.P. Brock, *BSOAS* 40,2, 1977, 271.

45 J. Green - Y. Tsafrir, *IEJ* 32, 1982, 91ff.; J. Meimaris, *Theologia* 54, 1983, 393; SEG XXXVI (1986) 411 Nr. 1343; L. Di segni - Y. Hirschfeld, *IEJ* 36, 1986, 251ff.; L. Di Segni, *Aram* 4, 1992, 311f.; 311ff.

46 J. Green - Y. Tsafrir, *IEJ* 32, 1982, 79; SEG XXXII (1982) 414f. Nr. 1505; J. Green - Y. Tsafrir, *Qadmoniot* 16, 1983, 28ff.; I. Meimaris, *Theologia* 54, 1983, 388ff.; J. and L. Robert, BullEpigr 1984 Nr. 505; L. Di Segni - Y. Hirschfeld, *IEJ* 36, 1986, 266 Anm. 86; D. Feissel, *BullEpigr* 1987 Nr. 520; Y. Hirschfeld, *ZDPV* 103, 1987, 106; H.-P. Kuhnen, *Palästina in griechisch-römischer Zeit. HbArch* II 2 (München 1990) 212 mit Anm. 292; L. Di Segni, *Aram* 4, 1992, 313; 323 FIG. 5; *New Encyclopedia of Archaeological Excavations in the Holy Land*, ed. E. Stern - A. Lewinson-Gilboa - J. Aviram II (New York - London - Toronto 1993) 565 FIG. s.v. Hammat Gader (M. Avi-Yonah - Y. Hirschfeld).

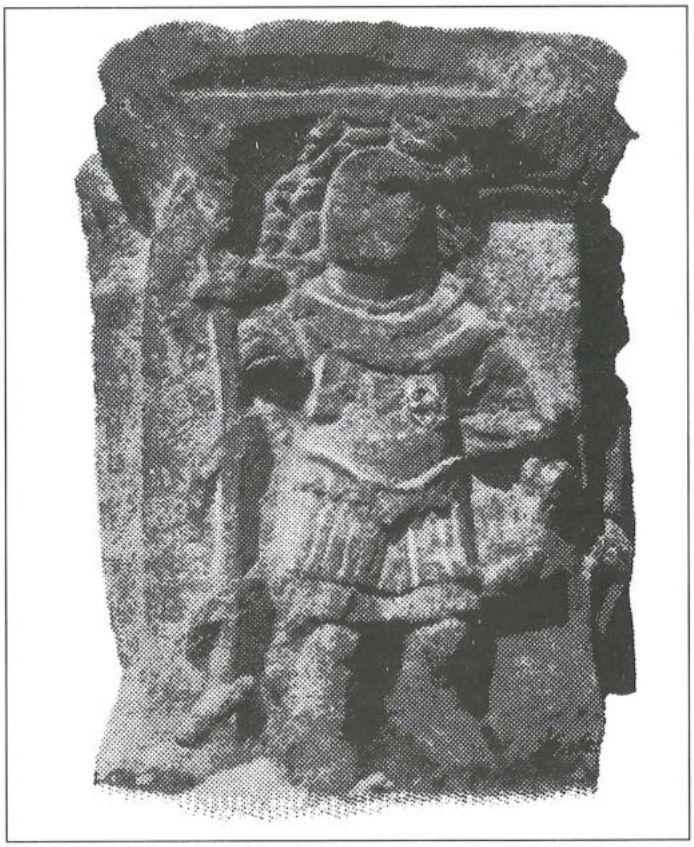
47 Y. Hirschfeld - G. Solar, *IEJ* 30, 1980, 70f. SEG XXX (1980) 482 Nr. 1687; Y. Hirschfeld - G. Solar, *IEJ* 31, 1981, 203f.; J. Green - Y. Tasarir, *IEJ* 32, 1982, 94ff.; I. Hasson, *IEJ* 32, 1982, 97ff.; J. Blau, *ibid.* 102; SEG XXXII (1982) 414 Nr. 1501; I. Meimaris, Theologia 54, 1983, 391 n. 5; J. Bingen, *Byzantion* 54, 1984, 369f.; P. A. Jannopoulos, *ibid.* 370; Y. Hirschfeld - G. Solar, *Biblical Archaeologist Review* 10,6, 1984, 39; L. Di Segni - Y. Hirschfeld, *IEJ* 36, 1986, 265f. n. 63; SEG XXXVI (1986) 413 Nr. 1348; R. Schick, *The Fate of the Christians in Palestine during the Byzantine-Ummayyad Transition, A.D. 600-750,* Ph. D. (Chicago 1987) 481f., Nr. 72; Y. E. Meimaris, *Sacred Names, Saints, Martyrs and Church Officials in the Greek Inscriptions and Papyri pertaining to the Christian Church of Palestine. Meletemata* II (Athens 1987) 180 Nr. 6; Th. Weber - R. G. Khouri, *Umm Qais - Gadara of the Decapolis.* A brief Guide to the Antiquities (Amman 1989) 11; E. Dvorjetski - R. Last, *IEJ* 41, 1991, 162 n. 35; E. Künzl - Th. Weber, *DaM* 5, 1991, 82 n. 6; L. Di Segni, *Aram* 4, 1992, 315f.; 328 FIG. 10; Y. Hirschfeld - E. Cohen, ibid. 284; S. M. Moors, *De Decapolis. Steden en Dorpen in de Romeinse Provinciens Syria en Arabia.* Ph. D. Leiden (s'Gravenhage 1992) 190 f. n. 5; I. Nielsen - Andersen - Holm-Nielsen (Wiesbaden 1993) 148 n. 5.

lated via channels into various basins. The hall of the fountains is most impressive because of ist dimensions. This was the place where the majority of the building inscriptions had been uncovered. Closely situated to the spring is the most important bathing hall which has an oval plan and was once barrel-vaulted. Its general shape and the heat of the water in this part of the building recalled an oven to the visitors and this is surely the part, that was called the *clibanus*. Two smaller rooms in the north-west of it were the location for therapy, as vividly described by the anonymous pilgrim from Piacenza who visited the place in ca 570 AD: „*We went to a city called Gadara, which is Gibeon, and, three miles from the city, there are hot springs called the Baths of Elijah. Lepers are cleansed there, and have their meals from the inn at the public expense. The baths fill in the evening. In front of the basin is a large tank. When it is full, all the gates are closed, and they are sent in through a small door with lights and incense, and sit in the tank all night. They fall asleep, and the person who is going to be cured sees a vision. When he has told it, the springs do not flow for one week*".[48]

The liturgy described by this eyewitness recalls the pagan rite of incubation as executed in the cults of Asklepios or other healing gods in the Greco-Roman world. Even in Byzantine inscriptions the bathing complex of Emmatha is named a holy place. Even though of its mysterious character, the baths of Gadara must have been the place where specialized surgeons and physicians provided a reliable treatment of various diseases: In 1988 a tomb [49] was uncovered within the Early Byzantine crypt of the great mausoleum in the western suburb of Gadara. Beside various glass vessels it produced a set of cosmetic instruments made of metal. A pair of iron forceps evidences that one of the individuals buried in the grave was a dentist.

Apart from the bathing complex the spa of Gadara comprised a number of houses, inns and hostels. A colonnaded avenue divides the settled area into perpendicular compounds. A small theatre[50] was connected by the excavators to the healing cult of the site, but his *opinion* finds no support neither by architectural features nor by archaeological evidence. Vestiges of a Christian church have been located east of the main street junction. That this spot was formerly occupied by a pagan shrine remains a vague hypothesis.[51] One may generally assume that Asklepios and Hygieia were venerated at Emmatha. Apart from that, Y. Meshorer [52] identified a temple of the three dancing Graces shown on a ring medaillon and various Gadaran coins at Emmatha, but if so, nothing of it remained.

Even though there is no convincing epigraphical evidence up to now, there were certainly cults of Sarapis and Asklepios practised on the territory of Gadara. A bearded marble mask found at Gadara [53] is most likely a pilgrim's souvenir from the Alexandrian Sarapeion,[54] but proves that the Egyptian fertility and healing God was venerated in this Transjordanian city as well. Asklepios is shown on a lost altar from Umm Qays (FIG. 8) [55] in a military attitude, wearing an armour and holding the spear with the serpent in the hand. A similar representation of the same warrior/healing god comes from Kufr Ma [56] on the Golan Heights, a third one has no provenance and is preserved at the Louvre in Paris.[57] The military attitude of the healing god seems to be a local feature, well comparable with the



8. Altar made of basalt showing Asklepios in military attitude, from Umm Qays, today lost.

48 Antoninus Piacent., Itinerarium 7; J. Wilkinson, *Jerusalem Pilgrims before the Crusades* (Warminster 1977) 81; Y. Hirschfeld - G. Solar, *IEJ* 31, 1981, 202 with note 14.

49 Künzl - Weber *loc. cit.* (n. 47) 81 ff.; F. Garcia-Martinez, *Journal of the Study of Judaism* 24, 1993, 157.

50 A. Segal, *Theatres in Roman Palestine and Provincia Arabia*. Mnemosyne Suppl. 140 (Leiden - New York - Cologne 1995) 45f. No. 5.

51 Y. Hirschfeld, *ZDPV* 103, 1987, 113ff.

52 IsrExplJ 29, 1979, 221f.; idem, *City Coins of Eretz-Israel and the Decapolis in the Roman Period* (Jerusalem 1985) 83 Fig. 225.

53 *Der Königsweg*, Exhibition Catalogue Cologne - Schallaburg - Munich 1988/89 (Mainz 1988) 276f. Nr. 250.

54 Cf. L. Castiglione, in: *Alessandria e il mondo Ellemistico-Romano*. Studi in onore di A. Adriani I. Studi e Materiali VI (Palermo 1983) 139ff.

55 P.-L. Jabalert, *MélBeyrouth* 1, 1906, 159f. Pl. II 3-5; Sourdel loc.cit (see supra note 5) 47 mit note 2; S.B. Downey, *GettyMusJ* 6-8, 1978/79, 117 with n. 16; E. Künzl - Th. Weber, *DaM* 5, 1991, 82 n. 5.

56 G. Schumacher, *Der Dscholan* (Leipzig 1886) 173 Fig. 118 (= *ZDPV* 9, 1886, 337 Fig. 118-119); idem, Across the Jordan (London 1886) 81 Figs. 33-334; S. Abdul-Hak, *Catalogue illustré du Département des Antiquités Gréco-Romaines au Musée de Damas* (Damascus 1951) 66 Nr. 31 Pl. XXVII 2; Downey loc.cit. 115 Fig. 4.

Palmyrene healing god Sadrafa. A limestone relief from Palmyre, now in the British Museum, shows the god in armour, holding the spear in ist right hand, around which the snake winds.

Birkatayn and the Cult of Asklepios at Gerasa

A few kilometers north of Gerasa two large spring-fed pools of *Birkatayn* [58] provided a generous extra-urban layout for cult, as individual health resort and for public recreation. The site is comparable to the spa of Emmatha or to the shrine of Daphne close to Antioche: It has the character of an holy enclosure to be reached from the city by a colonnaded ceremonial promenade or *Via Sacra.*[59]

The visitor entered the area through a monumental gateway, a *propylaeum*. It has always been assumed that the small theatre located to the south of the pool was functionally linked with it. Most promeninent were the festivals of Maioumas, epigraphically attested for the site.[60] The goings-on at the water orgies were severly attacked by the church fathers due to their licentious character. If they also had a special medical aspect remains obscure.[61]

A fine marble head of a bearded god [62] from the basilical complex of Saints Cosmas and Damian, John the Baptist, and Saint George at Gerasa evoked a scholarly discussion [63] in how far Christian art adopted the iconography of Asklepios for the representation of Jesus Christ. A comparsion of the Jarash head with a similiar piece in the Museo Civico at Foligno[64] proves the identification of Zeus-Asklepios. Information by Eusebius, that in Caesarea-Philippi a statue of the Greek healing god had been reused for such a purpose,[65] seems to support the theory of such an iconographical transition from a pagan god to Jesus. The Jarash head was found by K. Stemmer [66] to support this assumption. On the other hand, we must critically assert, that the find situation throws considerable doubt on the validity of this theory. The excavation report by J. Garstang [67] clearly states: "*Between the doorway of the Basilica and that of the circular church, nearer to the former, and in the cloister into which their doors open, the head was found lying upon débris about a foot from the door, and covered with more débris mixed with architectural remains*". The head was not found inside the church building but in the courtyard in front of it. If we take it for granted that the ancient statue was re-erected there during the Byzantine period,[68] it is peculiar that no other fragments of the statue were found. It is thus more conclusive to regard the Jarash head as a more or less accidential spolium reused in a later architectural context.

The Cult of Asklepios at Philadelphia / 'Ammān

During the Jordanian excavations at the Roman theatre of Philadelphia [69] some fine marble statues were uncovered. One of them (FIG. 9) represents a male torso with a cloak wrapped around the hip and draped at the back to fall across the shoulder. The left arm is slightly bent at the elbow, which is covered by drapery. The style of execution and surface finish points to a date in the second half of the second century AD. Even though head, right arm and both legs are missing, the torso can be identified as a Roman copy of a fairly known cult statue, named after the most complete copy "Asklepios Florence".[70] A small-sized marble replica of this statuary type in the Palazzo Barberini in Rome (FIG. 10) indicates that the 'Ammān torso belongs to a sculptural group representing the god of medicine together with his female counterpart, the personification of health, Greek Hygieia or Roman Salus.

For the case of ancient Philadelphia such an attribution is supported also by epigraphic evidence: A dedicatory

57 S. Ronzevalle, *RA* 1905 I, 44f. FIG. 1; Jabalert *loc.cit.* 159 n. II Pl. II 1; D. Homés-Fredericq, *Petra Inoubliable*, Exhib. Catalogue (Bruxelles 1980) 100 Nr. 69.

58 C.C. McCown, in: C. Kraeling, *Gerasa, City of the Decapolis* (Baltimore 1938) 159ff.; E. Will, *MélBeyrouth* 37, 1960, 209ff.; I. Browning, *Jerash and the Decapolis* (London 1982) 211ff.; R.G. Khouri, *Jerash - A Frontier City of the Roman East* (London - New York 1986) 134ff.

59 On the Gerasene Via Sacra and ist date cf. H. Bloedhorn, Die Kapitelle der Synagoge von Kapernaum. *AbhDPV* XI (Wiesbaden 1993) 31.

60 C. B. Welles, in: Kraeling loc.cit. 470f. Nr. 279.

61 For the festivals of Maioumas, which were celebrated in the cities along the Levantine littoral see RE XIV 1 (Stuttgart 1928) 612f. s.v. (S. Preiflendanz.); A. Segal, *Theatres in Roman Palestine and Provincia Arabis*. Mnemosyne CXL (Leiden - New York - Cologne 1995) 11 n. 33 (further bibliography). Only in Gaza it was transformed to a Christian holiday, the "day of the rosaries".

62 H.B. Walters, *BMQ* 1, 1926/27, 114 Pl. 60; J.N. Garstang, *ILN* July 31, 1926, 193; A. Futterer, Palestine Speaks (London 1931) 523; E. Capps Jr, *Hesperia* 7, 1938, 544 with n. 8; A.B. Cook, *Zeus - A Study in Ancient Religion* II 2 (Cambridge 1940) 1197 Pl. LXXXIII; J.H. Illife, in: *Studies presented to D.M. Robinson*, ed. G. Mylonas I (Saint Louis, Mo. 1951) 711 n. 24; N. Glueck, *Deities and Dolphins* (London 1965) 312 Pl. 43a; *BClevMus* 1967, 83 FIG. 35; *Encyclopedia of Archaeological Excavations in the Holy Land*, ed. M. Avi-'Yonah - E. Stern II (Oxford - Jerusalem 1976) 420 s.v. Gerasa (S. Applebaum); K. Stemmer, *ADAJ* 21, 1976, 33ff.; A. Kempinski - M. Avi-Yonah, Syrien - *Palästina* II (Munich - Genëvre - Paris 1978) 216 FIG. 75; E. Dinkler, in: Sitzungsberichte der Akademie der Wissenschaften Heidelberg, phil.-hist. Klasse 1980, 2, 32 n. 79-80 Pl. XIII FIG. 20; LIMC II 1 (Munich - Zurich 1984) 888 Nr. 352 s.v. Asklepios; II 2 664 FIG. (A. Holtzmann); M. C. Bitti, *AAJ* 30, 1986, 208 n. 3; H.-P. Kuhnen, *Palästina in römischer Zeit* (Munich 1990) 290 with n. 28; M.-J. Roche, Syria 67, 1990, 379 with n. 7; U. Hjübner, Die Ammoniter, *AbhDPV* XVI (Wiesbaden 1992) 259 n. 62; *New Encyclopedia of Archaeological Excavations in the Holy Land,* ed. E. Stern - A. Lewinson-Gilboa - J. Aviram II (New York 1993) 473 s. v. Gerasa (S. Applebaum - A. Segal); O. Keel, in: *Peregrina Curiositas,* Festschr. D. van Damme, ed. A. Kessler - Th. Ricklin - G. Wurst, *Novum Testamentum et Orbis Antiquus* (Göttingen - Fribourg 1994) 164 note 38; Th. Weber, *Gadara Decapolitana* (forthcoming) 472 Cat.-No. C.5.

63 See Dinkler 32f.

64 Stemmer *loc. cit.* 38f.

65 See supra n. 8.

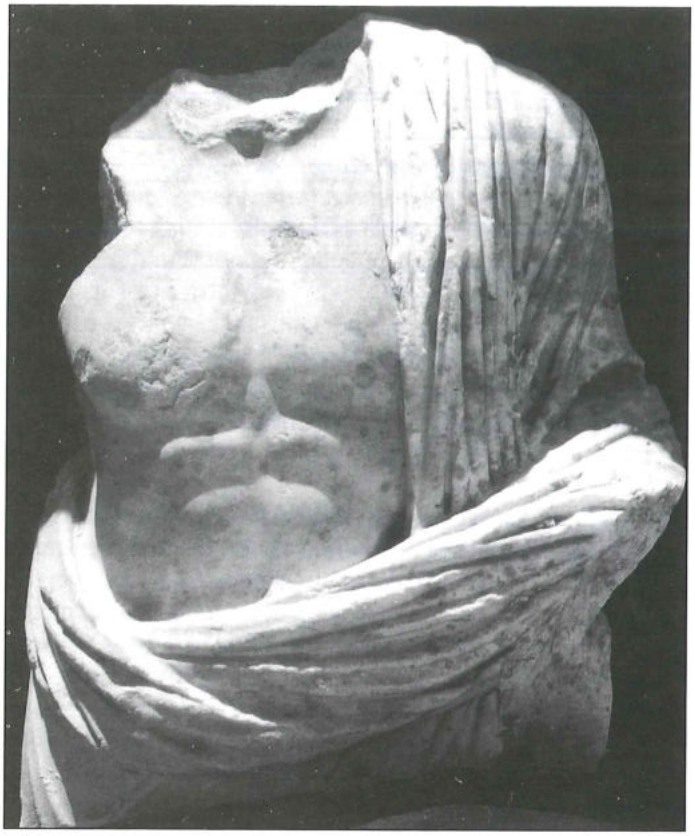
66 *loc. cit.* 39.

67 *loc. cit.* 193.

68 For the reinstallment of ancient statues in Late Antiquity see H. Brandenburg, in: *Migratio et Commutatio. Studien zur Alten Geschichte und deren Nachleben,* Festschr. Th. Pékary (St. Katharinen 1989) 235 ff. For the reuse of sarcophagi see G. Koch, *Boreas* 17, 1994, 115ff.

69 A.K. Hadidi, *The Roman Forum at Amman,* Ph.-D. Thesis University of Missouri, Columbia, Mo (Columbia 1970) 61ff.; F. el-Fakharani, *AA* 1975, 377ff.; A. Northedge (ed.), *Studies on Roman and Islamic Amman* I. British Academy Monographs in Archaeology III (Oxford 1992) 58.

70 LIMC II 1 (Munich - Zürich 1984) 878f. Nr. 145-151; 895; II 2 646f. Nr. 146-148 s.v. Asklepios (B. Holtzmann).

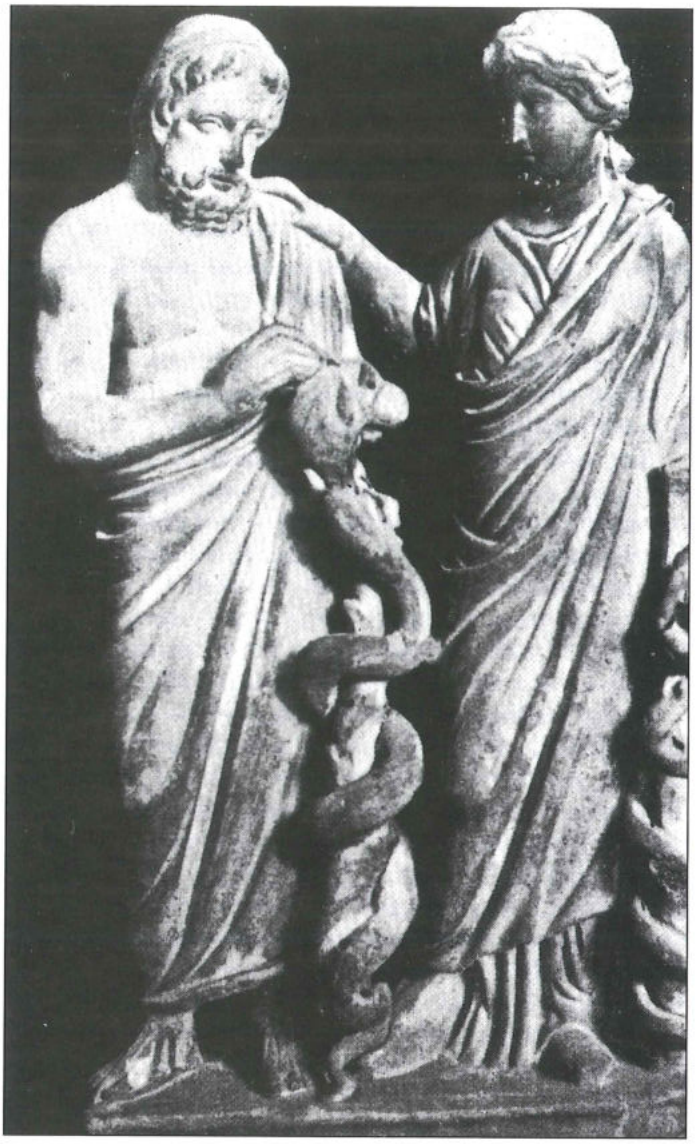


9. Marble torso of Asklepios "type Florence", found in the Roman theatre at Philadelphia -'Ammān.

inscription found at 'Ammān, republished by Pierre-Louis Gatier,[71] refers to Aesculapius/Asklepios and Salus/Hygieia as "very holy deities". The stone dates to the mid-third century AD and was donated by Terentius Heraclitus, a beneficiary of Claudius Capitolis, then governor of the *Provincia Arabia.* There is little doubt that the healing cult at Philadelpia had strong links to the Roman imperial house of Philippus Arabs. which appears in the inscription as "bonus divinae".

Conclusions

Returning to the anecdote of ibn al-Kalbi, we are now able to draw some conclusions on the nature and iconography of those pre-Islamic idols that were introduced to the shrine of Mecca by 'Amr ibn-Luhayy after his visit to the thermal springs east of the river Jordan. According to archaeological documents, predominately male divinities were venerated there. Greek Asklepios coincided with Zeus and could easily be identified with older local gods such as Baal or Kemosch. At Philadelphia /'Ammān he was venerated with Hygieia, the personification of health. Beside these Greco-Roman gods, also Egyptian Sarapis played an important role in Jordan as a healing and fertility god. It was most likely he who was meant by the visitors of the Jordanian spas in ibn al-Kalbi's story saying



10. Statuary group of Asklepios and Hygieia, marble, Rome, Palazzo Barberini.

about their idols: *"To them we pray for rain"*. Also the second aspect of these idols can be confirmed by the monuments: Reliefs like those from Umm Qays or Kufr Ma showing the armed healing god provide firm evidence for those of the idols with military character: *"For them we seek victory over the enemy"*.

Photographical References

FIG. 1: K. Brisch - A. Hauptmann-von-Gladiss - J. Kröger (ed), Museum für Islamische Kunst - Staatliche Museen Preußischer Kulturbesitz (2nd ed. 1979) 17 FIG. 2.; 2, 6, 9: Photos by the author. 3, 5: H. Donner, The Mosaic Map of Madaba. *Palaestina Antiqua* (Kampen 1992); 4: Photo Ulrich Hübner, Kiel; 7: Y. Hirschfeld - E. Cohen, *Aram* 4, 1992, 306 FIG. 16; 8: P.-L. Jabalert, *MélBeyrouth* 1, 1906, Pl. II; Photo German Archaeological Institute Rome.

[71] P.-L. Gatier, *Inscriptions de la Jordanie* II: *Région Centrale, Inscriptions Grecques et Latines de la Syrie* XXI = B.A.H. 114(Paris 1986) 38ff. Nr. 13.

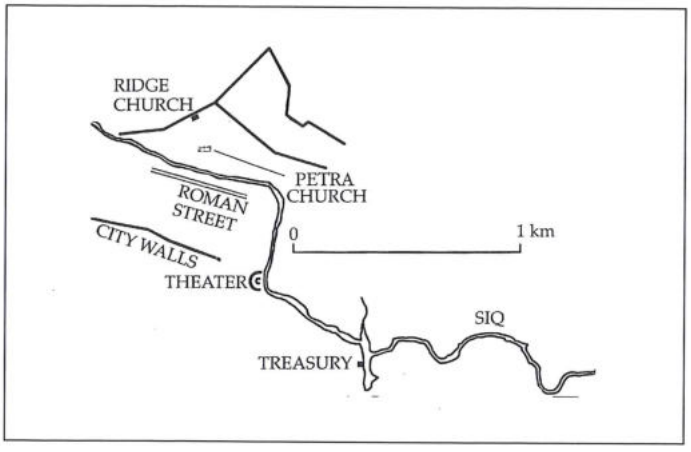
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The Ridge Church in Petra

The Byzantine church is located approximately 160 m NNW of the church uncovered by ACOR during excavations in 1992-94 (FIG. 1). For ease of reference that church, the one with the spectacular mosaics and where the Petra Papyri were found, is referred to here as the 'Petra Church'. This second church has been dubbed the 'Ridge Church' because of its location.

The Ridge Church is located at the northwestern edge of the Byzantine-era city and is just inside the city walls which run along the ridge overlooking Wādī Abū 'Ullayqa. Its location on a sandstone ridge, which rises to 924 m, has subjected the structure to severe erosion (FIG. 2). Most of the stones of the walls and the other architectural elements have been washed down the slopes around the structure. It may have been described by A. Musil in the early part of the century. He described two churches in the general vicinity (1907: 105-6, 108, Fig. 76), but matching his descriptions to either of the two known churches is difficult. According to Robert Schick (in press), the Ridge Church may have been identified in December of 1916 by Theodor Wiegand (Wiegand, Bachmann, and Watzinger 1921:33). The structure definitely appears on A. Kammerer's map (Carte III) of 1929 (FIG. 3). It was noticed again by Thomas Dailey and Pierre M. Bikai on January 2, 1994, and they encouraged documenting it before it deteriorated further. It was partially cleared during excavations over six days in October of 1994 and one day in April of 1995.[1] Five probes were made and features uncovered as well as those visible on the surface were documented. There was only ca. 20 cm of fill over the floor. This consisted of sandy rubble directly on the floor.



1. Map of Petra showing the location of the Ridge Church.

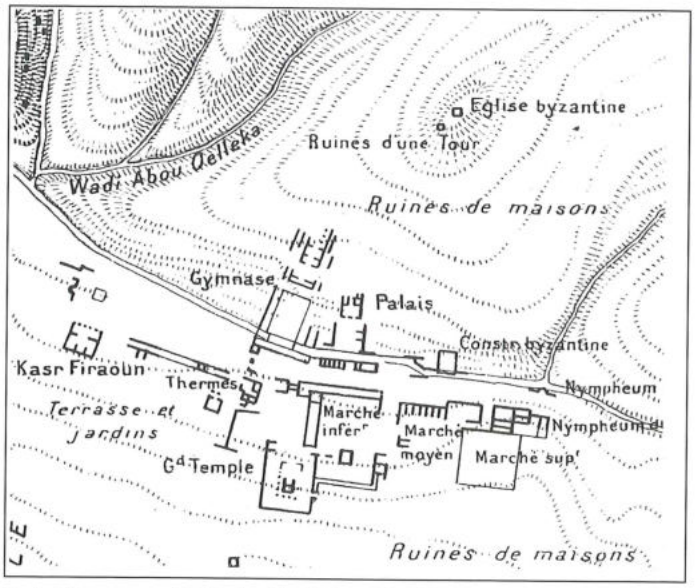
The building measures 18.1 m in length and 13.5 m in width (FIG. 4). It is oriented ca. 35° north of true east. To the west is a 2.6 m deep portico which, in the area excavated, is approached from the west by two steps. The church has a nave and two aisles. The aisles are separated from the nave by stylobates which once carried five columns on each side and, thus, the church was six intercolumniations long. At the eastern and western ends, there were pilasters. What appear to be the remnants of the foundations of these are found at the eastern ends of the colonnades and the foundation of the north-east pilaster was also found. On the slope to the south of the church a pilaster capital with vine tendril decoration was located. Its size corresponds to the foundations located.

The colonnades do not line up with the apse walls. Architect Chrysanthos Kanellopoulos noted that this was an unusual feature in the Petra Church and cites (1995) the following parallels: "The nonalignment of the colonnades to the apse's outer walls occurs in three examples from Ostrakine (Oren in Tsafrir 1993: 306-8); the church in Dora-Dor (Dauphin in Tsafrir 1993: 92); the church in Maresha (Kloner in Tsafrir 1993: 262); the church in the Roman fortress, Khirbat al-Samrā' (Piccirillo 1993: 309, Fig. 615); the west church in Burj Heidar (Tchalenko 1990: 242.1; pl. 18:36); the north church in Sugane (Tchalenko 1990: 247.16; pl. 62:114); the church in Kafr Nabo (Tchalenko 1990: 247.18); the church in Gerade (Tchalenko 1990: 250.29); and a church in Yatta (Bagatti 1983: 94, Fig. 13). In all these examples, the colonnades end at a wall."

[1] Excavations at the church were directed by Patricia M. Bikai of ACOR with the assistance of Virginia Egan. Other participants were Karen Asfour, H.E. the Ambassador of Switzerland Gian Frederico Pedotti, Maria Pedotti, Maroussia Zimmermann, Elaina Coyne and Don McCrea. ACOR appreciates the assistance given by Faisal Qudah, then the Acting Director-General of the Department of Antiquities, and by Suleiman Farajat, the Department of Antiquities representative at Petra.



2. Detail of an aerial view of the ridge, May 26, 1993, (by J. Wilson Myers and Eleanor Myers). The white lines show the location of the Ridge Church.



3. A. Kammerer 1929: detail of Carte No. III.

The column bases of the southern side have apparently all been removed. On the northern side, two columns bases are *in situ* in the church and a third one is displaced but near its probable original location. The three bases are of different styles and were apparently reused from Nabataean/Roman buildings. The diameter at the top of one of these (Base 1) was approximately 69 cm, while the other (Base 2) was 60.5 cm (see FIG. 4) A third *in situ* base (the northeasternmost one) is surrounded by construction and was not documented. A fragment of the volute of a capital, also Roman/Nabataean, was also found. The nave and the two aisles are paved with sandstone blocks which are in a good state of preservation. At the eastern end of the northern aisle is a raised platform of sandstone blocks. The platform is 4.2 m deep and leads to a rectangular room which measures 2.1 m in depth and is 3.2 m wide. This area was apparently raised above the level of the rest of the aisle floor because of the level of bedrock at the north-east corner of the church. The equivalent section of the southern part of the church has been completely eroded.

At the eastern end of the nave is a raised platform or chancel which was once reached by two steps. Only remnants now remain of the steps. The chancel is 3.5 m deep and 5 m wide, while the apse is 2.4 m deep and 3.5 m wide. The chancel and apse floors were eroded but quantities of mosaic fragments found at the site indicate that they were originally paved with a mosaic consisting mainly of large white limestone tesserae. Set into this there was a colored mosaic, but only fragments of that were recovered. There is also evidence (in the form of small displaced stone and glass tesserae) that there were once wall mosaics in this church. Wall mosaics made from very similar glass tesserae were found in the Petra Church.

From an architectural point of view, the church is of standard Byzantine construction. It is a mono-apsidal basilica with two rectangular pastophoria. There is no evidence that the pastophoria were later converted to apses.

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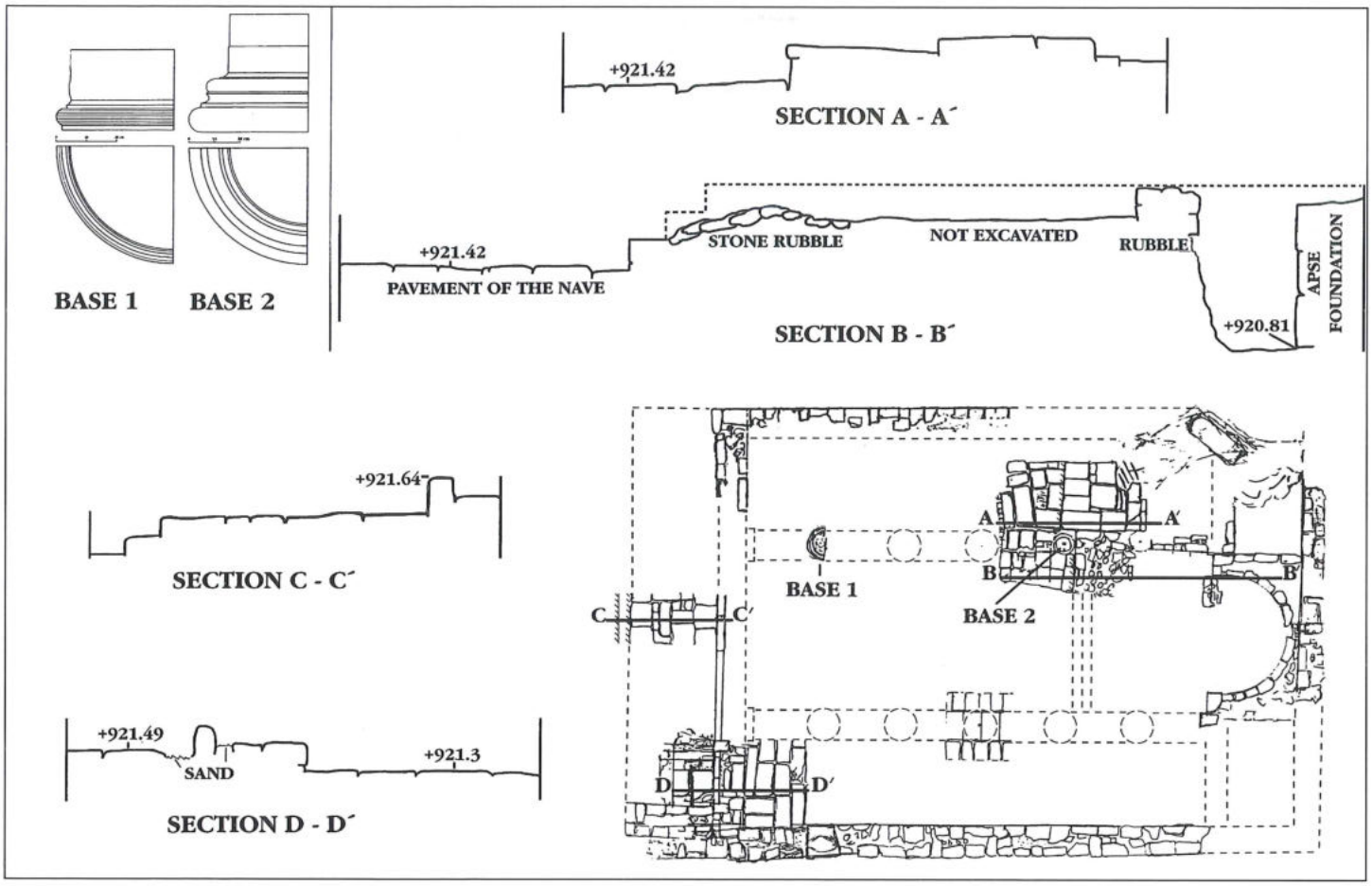
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4. Plan of, and sections through, the Ridge Church, and Bases 1 and 2 (by Pierre M. Bikai, Patricia M. Bikai, and Virginia Egan).

There were some constraints at the site because of the location on the ridge and because of bedrock so the architect may have had to accommodate the building to those realities. It is also possible that the proper was a preexisting building and that the apse and pastophoria were added. There is a notable difference in construction visible in the foundation of the apse; its stones are very well cut by comparison to the rest of the walls. Thus the wall whose foundations are now visible to the west of the pastophoria may have been the original eastern wall of a prior building. One clear adjustment that the architect made was in the width of the aisles. While the width of the northern aisle is 3.15 m, the southern aisle is 2.85 m. What would have been expected is a width of 2.875 m, a quarter of the width and the southern aisle is correct. The northern aisle apparently had to be accommodated to the presence of bedrock higher than the desired floor level, so it was widened, thus depriving the nave of some of its desired width of 5.75 m; it is actually 5.5 m wide.

It was noted that there was a narthex to the west. There was apparently an entrance to this at its southern end. In the area excavated to the west of the narthex, two steps leading down were found. This is not what would be expected as the ground begins to rise at that point and goes up to the top of the ridge which is ca. 2.5 m above the floor level of the church. The steps must lead down to some feature, perhaps a cave, below the high point of the ridge. There is a second cave at the site, in the bedrock under the northern pastophorion and a third cave to the south of the structure.

Because of the eroded condition of the building, very little was recovered that can aid in dating it. On the basis of the mosaic fragments and the general form, it is preliminarily dated to the fifth - sixth centuries AD. The pottery found in the fill above the floor included everything from first century AD Nabataean wares through modern ceramics. The presence of the Nabataean pottery is actually a mystery. In another location, one might posit that it was washed down on to the Byzantine floor from above. Here there is essentially no 'above' to speak of, so it is possible that the Nabataean wares came to be in the church through the activities of more modern inhabitants. The other finds included a few iron nails, and marble fragments which may have once belonged to chancel screens, altars, or other such furnishings, but they are very fragmentary.

This church may mark the north-west corner of the Byzantine city. The other limits of Byzantine construction in Petra are not known but evidence appears to indicate that Petra as a Byzantine city was smaller than it had been in prior eras.

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The Petra Papyri*

In its special issue "1994: The Year in Science", the magazine *Discover* lists the Petra Papyri as one of the top 75 science stories of the year.

The scrolls were found in a room adjacent to the fifth-sixth century Byzantine church excavated by the American Center of Oriental Research (ACOR). The church had been destroyed by a fire which also burned the scrolls.

Conservation work on the carbonized Petra papyrus scrolls was conducted in the conservation lab at ACOR in 'Ammān. The conservation team began its work at the beginning of September 1994 under the leadership of Jaakko Frösén (Department of Papyrology at the Academy of Finland). The team consisted of eight Finnish graduate and postgraduate students from the University of Helsinki: Marjo Lehtinen, Mari and Matti Mustonen, Tiina Purola, Erja Salmenkivi, Marjaana and Sampo Vesterinen and Jan Vihonen; Fatma Marii, a Jordanian student of archaeology and conservation from Yarmouk University; photographer R. Henry Cowherd; and the archaeologist Zbigniew T. Fiema. In January 1995, they were joined by Ludwig Koenen of the University of Michigan and Clement A. Kuehn of Loyola University, Chicago, who are beginning work on the transcription of the scrolls assigned to the University of Michigan for publication.

Although a fire would seem to be a sure way to destroy any type of writing material, in the case of the papyri just the opposite happened. Stored in tight rolls, the papyri were only carbonized and the dull black ink is still legible on the charred shiny black background. As of March 1995 more than 120 Petra scrolls had been 'unrolled'. Conservation work on the rest is due to be completed in May 1995. It is estimated that there are about 30 more scrolls to be opened.

Due to the fragility of the material and to the fact that most of the scroll layers were very thin (about one tenth of a millimeter) and tightly packed together by the carbonizing process, it was not possible to actually unroll them. The fragments of layers had to be lifted, piece by piece, and consolidated or fixed by gluing them by the blank back on pieces of acid free Japanese tissue paper. A neutral (PH 7) polyvenylacetate glue (Planatol BP) was used. Then, the fragments were sandwiched between wax paper, under slight pressure. When dried, the fragments were put together and the original document—the opened scroll—was reconstructed with the aid of the preliminary transcriptions, and then put between glass plates. The whole process has been documented by photographing and video. The extremely fragile written material was photographed using special methods of overexposure in order to obtain black and white prints from the black on black pieces, as well as to obtain transparencies which can be used for the computer-generated enhancement of the pictures.

Publication work will be undertaken jointly by the University of Helsinki and University of Michigan, under the leadership of Jaakko Frösén and Ludwig Koenen, respectively.

The texts found in the scrolls constitute the largest group of written material from antiquity found in Jordan. All the scrolls opened so far contain documentary texts written in Greek. The handwriting varies from the very cursive that is difficult to decipher, to the easily legible, indicating different scribes.

The earliest date found so far in the scrolls is AD 523, and the latest AD 559. The dates were written using four dating systems: the regnal year of the Emperor Justinian; the consular year; the year of indiction (i.e. taxation period); and the era of the Province of Arabia, or the era of Gaza. Many of the documents refer to the city of Petra as the metropolis of the Province *Palaestina Tertia Salutaris*. One of the scrolls containing the date AD 538 is a notice to the record office about a cession of agricultural land. This document, written in two wide columns, was found lying open—perhaps someone was consulting it when the fire broke out.

The papyri are yielding information on the population of Petra and its economic and social situation. At least half of the texts read so far deal with wills and inherited property. About 60 different individual names have been deciphered. Among the key figures of the archive are men

* This paper relies in great part on materials provided by Drs Jaakko Frösén, Ludwig Koenen, and Zbigniew T. Fiema.

representing administrative ranks both ecclesiastic (bishop, archdeacon, deacon, prior or abbot, steward of the bishop, primate, presbyter, physician), and civic (governor, curator, collector of taxes, public advocate, notary). They bear typical Byzantine honorific titles referring to the ecclesiastics as, for example, very reverend, divinely favored, most pious, most holy, orthodox, Christ-loving, or to the laymen, for example, most magnificent, most brilliant, most admirable (to men) and most decorous (to women). Also some slaves have been identified.

Names of settlements other than Petra, such as Augustopolis and Eleutheropolis, are mentioned, together with numerous places around Petra and Augustopolis. From historical and archaeological points of view, Augustopolis may be identified with Udhruḥ, a Roman-Byzantine fortress-cum-town, located ca. 10 km east of Petra. The other names include villages, farming lands, threshing-floors, water cisterns, roads, streams and dunghills. Churches and other buildings in the cities of Petra and Augustopolis are also mentioned. Historically, the early to mid- sixth century in Petra is an almost blank page. Thus, the texts are especially important, providing a plethora of information on the social and economic life of the city and its rural hinterland. This information should allow for a substantial reassessment of the history of Petra and southern Jordan in the Byzantine period.

Particularly interesting information coming from the texts concerns the survival of Nabataean culture during the Byzantine period. Despite the fact that Greek was the main language of Roman and Byzantine *Arabia* and *Palaestina*, traditional Nabataean names appear among Christian and pagan Greek and Roman names. Thus, the Nabataean tradition, at least in the onomastic form, was still alive in Petra in the mid-sixth century. Fragmentary signatures written in a script other than Greek (Semitic ?) have also been found. A variety of topographical names around Petra and Augustopolis seem to represent a Greek rendition of names in early Arabic, and indicate the importance of this language among farming communities around Petra at this date, before the coming of Islam.

Simultaneously, the investigation of scrolls from the archaeological standpoint, and their significance in a wider historical perspective is being conducted by the archaeologist Zbigniew T. Fiema. It was initially suggested that a disastrous earthquake of AD 551, recorded in Byzantine sources, was responsible for the final demise of the ecclesiastical complex of Petra and for the destruction of the archive. That interpretation is now untenable in light of the evidence provided by one of the scrolls. It is significant, however, that the documents can be used for an improved chronological assessment of the church complex. The location of the scrolls, and their initial reading suggest that the scrolls represent an archive related to a limited number of people, perhaps associated with the church as parishioners or benefactors. Furthermore, the place of the discovery seems to be a storage area where documents were deposited and consulted, rather than a scriptorium.

Charred wooden fragments recovered with the scrolls provide important information on the manner in which the scrolls were stored. Remains of what seem lightweight 3-shelf bookcases may have been located in the NW corner of the room. Layers of thin, charred shelves were recovered from among the scrolls found there. Other scrolls may have been stored in separate wooden containers. The finds include fragments of vertical staves (?), probably elements of barrel-like, wooden containers. These would have been joined together by wooden pegs, and reinforced by horizontal straps made of bronze/copper strips.

Tightly rolled scrolls were tied with strings and wrapped in textile before being deposited in the barrels. Available iconographic and archaeological evidence from elsewhere supports such a manner of storage. There may also have been wooden boxes. Additionally, the surface of two charcoal fragments, either of barrels or boxes, preserves scratches, perhaps letters or signs, made with a pointed tool.

The scrolls were excavated by conservator Catherine Valentour and Zbigniew T. Fiema, chief archaeologist of the Petra Project, with the assistance of staff archaeologist Deborah Kooring and Suleiman Farajat of the Department of Antiquities. Excavations at the Petra church site were conducted under the direction of Pierre M. Bikai of ACOR in cooperation with the Department of Antiquities.

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Land , Resources and Industry in Early Islamic Jordan (Seventh - 11th Century). Current Research and Future Directions

INRODUCTION

Landscape Studies and the Late Antique–Early Islamic Transition

Issues of socio-economic continuity and change continue to dominate research into the transition from Late Antiquity to the early Middle Ages. Particular attention is being paid to urban studies (the "fate of Classical towns") and the economic structures—agriculture, industry and trade—that supported them (Cameron 1993; Christie and Loseby 1996; Clover and Humphreys 1989; Rich 1992). Thus the themes of landscape, resources and industry lie at the heart of Late Antique and Early Islamic studies in Jordan today.

Although research into resources and their exploitation has the potential of offering much valuable information on questions of social and economic change in the Byzantine – Islamic transition, these themes have received scant attention. One of the major obstacles to this research has been the disregard of environmental data at many sites with Late Antique and Early Islamic levels (mirroring the standard treatment of *all* post-Byzantine material 25 years ago). Indeed, it can be safely asserted that the archaeology of historical periods in Jordan has concentrated almost exclusively on architecture and manufactures, commonly ceramics. While admirable in itself, using this data alone limits our ability to write a comprehensive social history of the period. Research into the resource base of the society that produced these objects has taken second place, to the detriment of our understanding of the socio-economic conditions in a period of considerable change. Today the issue is seen as of equal importance to the aims of "traditional" archaeology, in that it presents a whole new body of data on the changing nature of human occupation in Jordan in the transition to the Islamic Middle Ages. Note, for instance, the clearly stated objectives of the Fāris Project in Mo'āb (Johns, McQuitty and Falkner 1989) and the food-systems model applied to the Ḥisbān region (LaBianca 1990; but Dever's [1993] glowing assessment should be tempered with McQuitty's [1993] rigorous review).

SOURCE MATERIAL

Limitations and Potential

While acknowledging the limits of available data, a preliminary study is now possible on the natural resource base of Jordan and its exploitation in the earlier Islamic periods (c. seventh - 11th century AD). The evidence — admittedly very patchy, often selective and almost exclusively dealing with larger urban sites — comes from two major but disparate sources: textual (literary) works in Arabic and archaeological results.

Textual sources. Of particular note are the geographical works in Arabic written in the later ninth and tenth centuries AD. The leading work of the ninth century is al-Ya'qūbī's *Kitāb al-Buldān* (completed by AH 278/AD 891), a critical assessment of material gathered firsthand during his extensive travels (Arabic text: de Goeje 1892).

Of considerable importance in the next century are the comparatively detailed geographies of Ibn Hawqal and al-Maqdisī (d. c. 390/1000), both again based on personal observations. Ibn Hawqal undertook two major journeys in the Islamic world during 331/943 and 357/968 before writing his informative *Kitāb Sūrat al-Ard*. This work was completed by 356/967, and followed by two redactions in 367/977 and 378/988 (Arabic text: Kramers 1938; French translation: Kramers and Weit 1964; biography: Miquel 1971). Al-Maqdisī, a native of Jerusalem, also travelled very widely before writing his highly regarded *Kitāb Ahsan al-Taqāsīm fī Ma'rifat al-Aqālīm* by 375/985 (revised 378/988; Arabic text: de Goeje 1906; biography and French translation: Miquel 1963; English translation: Collins 1994).

Archaeological data. In the last two decades archaeological work at a number of major urban sites in Jordan has resulted in a growing body of data on resource exploitation in the Early Islamic period, and some very illuminating material now exists on the industrial economy of towns particularly for the Umayyad and early Abbasid

* The author is engaged in a major research project directed by Associate Professor Ahmad Shboul on 'Urbanisation and Social Change in Early Islamic Syria (Bilād ash-Shām), 7th to late 11th century AD, with support from an Australian Research Council Large Grant. The project, now (1995) in its second year, is investigating questions of continuity and discontinuity in Syrian urban history through an interdisciplinary study of literary, documentary and archaeological evidence.

periods. Much less data is available on agricultural activity and the rural economy, in part due to the almost complete absence of hinterland studies (but see LaBianca 1990 (P. Watson: Pers. comm). Consequently information on the later ninth to 11th century (later Abbasid and Fatimid periods) is especially scarce, as Jordanian society was predominantly (although not exclusively) rural at this time (Walmsley 1992a).

Despite these shortcomings (and the methodological problems of combining two quite disparate data bases) the textual and archaeological sources do contain valuable information on aspects of the urban and rural landscape in the Umayyad, Abbasid and Fatimid periods in Jordan. They are particularly informative when attempting to track changing patterns in the exploitation of resources and the production of manufactured items.

PRIMARY PRODUCTION AND ITS RESOURCE BASE

The introduction of New World crops has radically altered the agricultural base and diet of Jordan in recent centuries. A similar period of rapid change may have occurred after the Islamic Conquest with the introduction of new crops (e.g. sugar cane, rice, cotton, bananas and citrus fruits) and the improvement of established crops (e.g. dates, grapes and figs): the oft-cited "Medieval Green Revolution" (A. Watson 1981; 1983).[1] While having the potential of initiating considerable economic and (possibly) social change, the impact of this "revolution" has not been assessed for Jordan. What does the evidence indicate to date?

Textual Evidence

Although limited in scope and content, the textual sources of the later ninth and tenth century contain little evidence for any major change in the primary economy of Jordan in the Byzantine – Islamic transition.

For north Jordan (Wādī al-Yarmūk to Wādī az-Zarqā', FIG. 1), the geographical sources depict a prosperous and fertile region populated with villages, which earned it the name *as-sawād* (al-Ya'qūbī, *Buldān* 327.22; also al-Balādhurī 116.20). In the tenth century the area was expanded to include Jarash and was noted for its olives, various fruit types (unspecified except for grapes, which were probably eaten fresh, dried or processed into syrup and vinegar) and honey (al-Maq., *Aqālīm* 162.4–6). Other literary sources single out Abil (Quwayliba, Abila) as a producer of olive oil (Yāqūt, *Buldān* vol. 1, 50.5–6), while Bayt Rās was renowned for wine in Umayyad and Abbasid times (Lenzen and Knauf 1987: 21–46).

The al-Balqā' of the ninth and tenth century sources encompassed the 'Ammān hills and the tablelands south of Ḥisbān to the Wādī al-Mūjib, with 'Ammān as its chief



1. Regions and sites in Jordan during the Early Islamic Period.

town. This was a rural region of villages, fields and water mills with grain, sheep, goats, fruit (unspecified) and honey as its principal products (al-Maq., *Aqālīm* 175.3–7, 180.16). Further south lay Mo'āb (ar-Rabba), again with numerous villages cultivating grapes and almonds, and exporting the latter (al-Maq., *Aqālīm* 178.7, 180.18).

South of the Wādī al-Ḥasā were the two districts of Jibāl ash-Sharā, both described as fertile and prosperous by Ibn Hawqal (I.H. *Sūrat al-Ard* 170.21, 173.12). In the Jordan Rift Valley to the west was Zughar (Khirbat ash-Shaykh 'Isā), a busy market town noted for its indigo and yellow dates in the tenth century when it was the chief

[1] However, Watson makes the interesting observation that some of the new crops, specifically rice and cotton, could have been introduced to the Jordan Valley prior to the Islamic Conquest, perhaps during the Sassānid occupation.

town of the *kurah* of ash-Sharā (I.H. *Sūrat al-Ard* 184.17–185.3. al-Maq. *Aqālīm* 178.5; for ash-Shaykh 'Isā and associated sites see: King, Lenzen *et al.* 1982). At the southern end of the Wādī 'Arabah stood the port and market town of Ayla (al-'Aqaba), with palms and fishing (al-Maq. *Aqālīm* 178.11, 179.4).

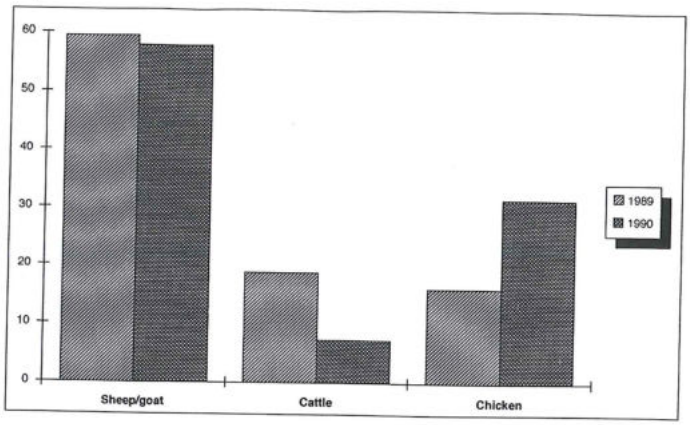
The ninth and tenth century sources reveal an active rural economy in Jordan. The cultivation of fruit- and nut-trees, specifically olives, dates and almonds, and grape vines, was of particular interest to the geographers. This arboriculture encouraged the keeping of bees, as honey was clearly a valued product. Pastoral activity was typified by sheep and goat herding. The blue dye indigo was a commercial crop, used in the dying of cotton cloth (Watson 1981: 47). Few other tropical crops are mentioned, as the Jordanian range lacked the required warm temperatures and abundant water supply. However the Jordan Rift Valley was particularly suitable, and most probably some of the rice, dates and indigo for which Baysān was famous were cultivated in water-rich areas on the opposite east bank between the Wādī al-Yarmūk and Wādī al-Yābis (al-Maq. *Aqālīm* 162.6–7, 180.18). Similarly, bananas and indigo could have been grown around Bayt al-Rām (Livias), a stop on the Iliyā - 'Ammān road opposite Jericho (al-Maq. *Aqālīm* 192.10).

Archaeological Evidence

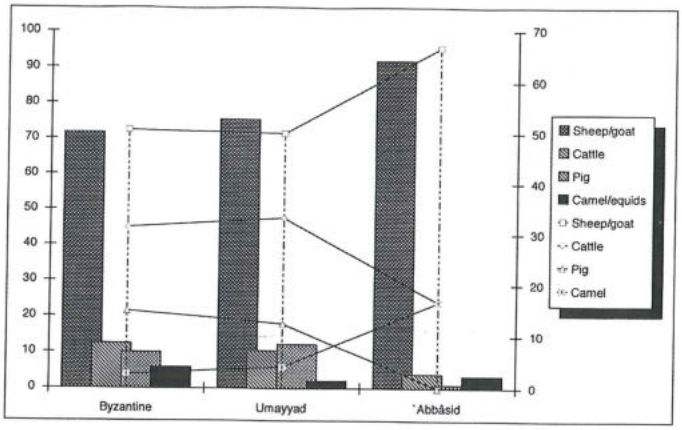
Archaeological research, while limited, has helped to expand our understanding of primary production in Jordan during the earlier Islamic periods. Firstly at Pella (Ṭabaqat Faḥl, Early Islamic Fihl) an earthquake destruction level of the mid-eighth century contained olive pips, date stones, pistachio, the common club wheat and two species of hulled barley (2-row and 6-row), all cultivatable locally (Wilcox 1983: 256). Common animals from the same level were sheep and goats (for milk, hair, wool and meat), cows (mostly for milk), camels (transport and milk) and chicken (eggs and meat). Whereas 9% of the identifiable bone from the Byzantine levels on Tall al-Ḥuṣn were domestic pig, this fell to a negligible figure in the Abbasid-period levels of Area XXIX (5 fragments from a total bone count of 3,521) (Rielly 1993: 218–21). Sheep/goat were the dominant species (almost 60%), with a good representation of cattle and chicken (FIG. 2). Camel, deer, gazelle, small birds (certainly dove) and fish played a small part in the diet. At Ḥisbān, analysis of the animal bone has confirmed the major role of sheep/goat in the diet of Early Islamic Jordan, followed by cattle and chicken, and the continued consumption of pig-meat in the Umayyad period but its demise in Abbasid times (FIG. 3); however, caution must be exercised when generalising from the data due to the very small sample size (LaBianca 1990: 215–18, 228–31).

A possibly serious challenge to the economic viability of primary production stemmed from land degradation in Late Antiquity. The identification of wadi infilling, known as "the younger fill", has been linked to a combination of factors: overgrazing, excessive tree felling, the neglect of agricultural terraces and/or climate change (Vita-Finzi 1969: 83–88, 101–102).[2] Certainly at Pella there is evidence for the exhaustion of native wood supplies by the Byzantine period, when cultivatable willow/poplar and pine were in common use; conversely native wood species were rare or absent. Lack of accessible forest species in the Umayyad period saw greater reliance on shrubby plants specifically oleander and tamarisk (Wilcox 1992: 256). This indicates that the clear felling of the hillsides around Pella was largely completed by the sixth century and regeneration prevented by continued agriculture and grazing.

This possible inference is supported by evidence for accelerated infilling of the Wādī al-Jirm in Byzantine and



2. Percentages of identifiable animal bone fragments by species from the Abbasid town centre (Area xxix) at Pella, Jordan (source: Rielly 1993: 218–21).



3. Percentages of identifiable red-meat animal bone fragments (bar chart, left Y-axis) and bone weight (line chart, right Y-axis) by species from Tall Ḥisbān, Jordan (source: LaBianca 1990: Tables 7.1 and 7.3.)

[2] On page 115, Vita-Finzi settles for climatic variation as the causal agency for the "younger fill". He saw human activity as contributing to wadi downcutting, not in-filling (p. 110).

Early Islamic times. Today debris metres thick overlays what may remain of the colonnaded *decumanus major* and forum/markets depicted on the AD 183/4 Roman period city coin of Commodus (177–92). According to Smith and Day (1989: 8, 18, 29, 90), the infilling became a serious problem in the later sixth to early seventh century, ending the useful life of the odeum, baths and Roman "down-town". This may have encouraged the relocation of the city markets to another central location north of the Cathedral church in the seventh century (Walmsley 1992b: 252–54). Elsewhere evidence for erosional deposits invading urban areas is attested as early as the later fourth century in the Forum of 'Ammān (Hadidi 1974), and the early fifth century over the north decumanus at Jarash, although here a series of gravel foot tracks was laid over the wash deposits (Walmsley 1986: 351–57). A rapid infilling of the decumanus marked the late sixth to early seventh century when this area of Jarash was abandoned.

The case can be argued in two ways. Excessive tree felling, intensive cultivation and over-grazing to support a larger and more affluent population in the fourth to sixth centuries resulted in land degradation and increased erosion. Hillsides were denuded and low lying areas subject to flooding and silting. Alternatively, the wash levels represent the declining ability or willingness of town authorities to keep uneconomical public areas of towns free of water-born debris after the boom years under Justinian I (527–65; cf. Smith and Day 1989: 8). Other evidence suggests that towns entered a period of protracted crisis beginning with the usurpation of imperial power by Phocas in 602 and culminating in the Persian invasion of 614 (Walmsley 1996: 144–45). However, this reasoning fails to account for the evidence of accelerating valley infilling or "the younger fill". The combination of both factors may account for the urban wash deposits, but the whole question remains open.

The complex nature of change and the causes of change to the agricultural regime in Early Islamic Jordan may be demonstrated by an example from Pella. As P. Watson has reported, Byzantine-period farmsteads associated with an extensive wine industry in the Jordanian foothills east of Pella show no evidence of sustained use during the Early Islamic period. The immediate assumption would be to link this discontinuity with the Islamic Conquest and Muslim prohibition of alcohol, but the issue is almost certainly more complex, especially as this pattern is not universal. For instance, wine continued to be produced in the Abbasid period along coastal Palestine (Ayalon 1981: 111–25) and around Bayt Rās (above).

Multiple, unrelated factors can be proposed: a retreat to the security of towns during the Sassānid threat resulting in the neglect of vineyards, cumulative loss of soil fertility due to erosion, and changes to the crop regime—either during the Sassānid occupation or after the Islamic Conquest, or both—to more labour-intensive tropical cash crops. Together, these factors resulted in an economic and population shift to the soil-and water-rich Jordan Valley floor and the application of less intensive exploitation strategies, probably in favour of animal herding, in the Pella hinterland. Hence it can be safely argued that much of the change in land-use around Pella was well advanced at the time of the Islamic Conquest. While overall the demand for wine may have declined with a quickening of conversion in the Abbasid period, especially after the eighth century, this might well have been offset by a shift to grape cultivation for raisins, syrup and vinegar in the better growing areas as reflected in the geographical sources.

Manufacturing Industries

Apart from indigo production at Zughar, industrial activity in Jordan is rarely mentioned by the geographers for the later ninth and tenth centuries. In al-Maqdisī's description specialised manufacturing industries were located in the urban centres west of the Jordan River. For example, Ṭabarīya (which, nevertheless, drew half its wealth from Jabal Jarash according to al-Maqdisī) manufactured kapok, cloth, paper and straw mats (al-Maq. *Aqālīm* 162.4–6, 180.16) — the eye-witness description of Nāsir-i Khusraw in the 11th century should also be noted (Marmardji 1951: 129). Yet the archaeological evidence reveals that Umayyad Jordan, by way of contrast, had a very active industrial sector. Manufacturing industries based on local resources played an important role in the Late Antique and Early Islamic urban economy, with evidence for regional centres of pottery production, glass-blowing and metalworking.

Jarash was a major provider of domestic pottery in the Early Islamic period, a continuation of a flourishing tradition several centuries old (see in particular P. Watson 1989; Kehrberg and Ostrasz 1997). Kilns of the Umayyad period were excavated in the forecourt of the Artemis Temple, in the domestic quarter west of St Theodore's church and in and around the North Theatre (Schaefer and Falkner 1986: 411–35; Pierobon 1983–84: 85–111; Pierobon 1986: 185–87). A potters' complex of the Abbasid period was uncovered north of the South Decumanus, consisting of four kilns producing lamps, cooking pots, bowls and cups (Gawlikowski 1986: 107–36; 1992: 357–61). The reliance of Jarash on its industrial base in Umayyad and early Abbasid times — not just ceramics but also glass making and mosaic laying — is reflected in the rapid contraction of the town after the collapse of its industrial economy in the ninth century (Walmsley f.c.).

A commercial potting industry has recently been identified at Ayla (al-'Aqaba) in Umayyad times. Numerous forms were produced, especially heavy basins, juglets, pilgrim flasks and amphorae, the latter for the transhipment of traded goods on the Red Sea trade (Melkawi, 'Amr and Whitcomb 1994: 447–68; Whitcomb f.c.). The

clear differences between the later Byzantine and Umayyad ceramics of al-Balqā' with those found in north Jordan at Jarash, Pella and elsewhere suggest at least one other potting centre at 'Ammān or Mādabā. At variance are large, hand-made off-white to pink or cream basins and storage jars often with scallop-decorated rims, and cream-surfaced bowls and jars lavishly decorated with abstract designs in red paint ('Amr 1986). Both are found in proportionally larger numbers in the al-Balqā' district, and the popular application of mosaic geometric patterns to the straight-sided bowls nominates Mādabā as the source of this ware, for this sizeable town supported a major mosaic school in Umayyad times (Piccirillo 1991).

The manufacture of glassware is evident in the Abbasid town centre of Pella (Area xxix; O'Hea 1992, 1993). Free-blown cylindrical beakers with rounded bases and inturning rims were produced in a bluish-green glass, very reminiscent in shape to thin-walled cups in "Fine Byzantine Ware". The glass beakers were either plain or decorated with rows of small s-shaped nips. Large numbers of pincered glass beakers and bowls were recovered from the later Abbasid levels (later ninth–early tenth century, FIG. 4). The discovery of glass ingots suggests the importation of the raw material from the Mediterranean coast (Caesarea region?) and its processing into vessels, especially beakers, at Pella. It also suggests a readily available fuel source, probably the waste from olive pressing in the region.

The large number of metal implements, especially iron and copper/bronze, recovered from Early Islamic levels at several urban sites in Jordan reveals an extensive metal-working industry. A blacksmith's shop of seemingly Abbasid date was excavated at Jarash by the South Tetraconia (Kraeling 1938b), probably for shaping and sharpening iron implements rather than their manufacture, and a pile of iron implements found in the Civic Complex at Pella may have been awaiting similar treatment (Smith and Day 1989: 115–18). While no copper/bronze foundry has been located to date and evidence for Early Islamic copper mining at Faynān is lacking (Hauptmann and Weisgerber 1987: 421–24), vessels in this metal have been recovered in respectable numbers at Pella, Jarash, 'Ammān, al-Fidayn (Mafraq) and Umm al-Walīd. Of particular note is a superb flat bowl with a fenestrated ring-base from Pella (McNicoll, Smith and Hennessy 1982: 140, Pl. 59a), and a magnificently decorated brazier from al-Fidayn (Philip 1991: 98, Pl. 118). Both objects exhibit a close affinity with Coptic art of the period, and may be Egyptian imports. The Pella bowl, probably also a brazier, is paralleled by a number of examples in the Coptic Museum, Cairo (compare FIG. 5 with FIG. 6), while the arcade setting for the fervent 'romp' scenes on the al-Fidayn brazier is a very popular Coptic composition —not only in metal but textiles, book illuminations, murals, wood and stone (Badawy 1978: 321–23, Figs 5.1–2; Strzygowski 1904: 253–62).



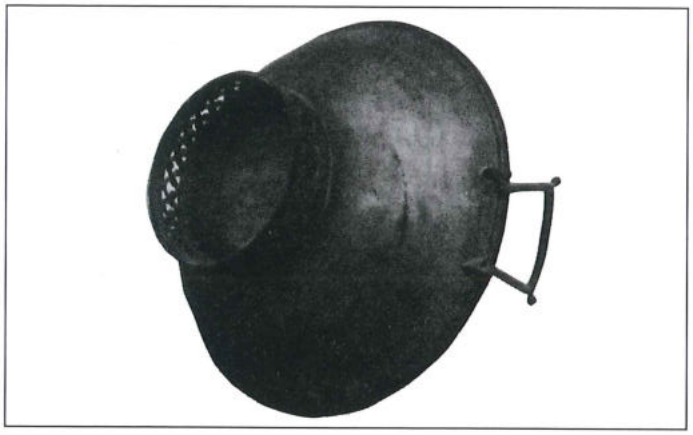
4. Pale green, free-blown glass beaker with pincered decoration from the Abbasid town centre, Pella (later ninth to early tenth century AD).

Conclusion

While the geographical accounts and the archaeological evidence may be patchy and selective, they do show that the land, the resources it provided, and the manufacturing



5. Copper bowl (probably a brazier) with fenestrated ring-base and two drop handles from the mid-eighth century AD earthquake destruction level, Area IV, Pella.



6. Copper brazier with fenestrated base and drop handles in the Coptic Museum, Cairo. Dated fourth–fifth century by Strzygowski.

industries it supported formed the economic backbone of Early Islamic society in Jordan. Archaeological research has identified an important industrial base producing manufactures, especially ceramics and glassware, for daily consumption in the Umayyad and early Abbasid periods. Yet the evidence also suggests that these industries were no longer functioning on any appreciable scale by the end of the ninth century. Thereafter the resource base of Jordan was predominantly agricultural and pastoral, a view in keeping with the village landscape proposed for the period. Nevertheless, this conclusion does not imply the total collapse of manufacturing activity. Red-painted pottery continued to be produced in the ninth and tenth centuries, suggesting a major ceramic workshop in the al-Balqā', while scant attention has been paid to the role of village industries in the Early Islamic economy (note for instance Donner 1989, especially pp. 76–78). The silence of the geographical sources on industrial activity in late Abbasid and Fatimid Jordan may, rather, simply reflect scholarly disinterest in more mundane matters.

Abbreviations

BGA *Bibliotheca Geographorum Arabicorum.*

JAP1 F. Zayadine (ed), *Jerash Archaeological Project 1981–1983*, I Amman, 1986: Department of Antiquities.

PIJ 2 A.W. McNicoll, P.C. Edwards *et al., Pella in Jordan 2. The Second Interim Report of the University of Sydney and College of Wooster Excavations at Pella 1982–1985.* Sydney: Mediterranean Archaeology Suppl. 2, 1992.

SHAJ *Studies in the History and Archaeology of Jordan.* Amman: Department of Antiquities.

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Effect of Natural Environment on the Development of al-Ḥumayma and on the Abbasid Movement 68-132 AH (687-750 AD) *

INTRODUCTION

Location, Nomenclature and Site Characteristics

Al-Ḥumayma is the diminutive form of the Arabic word "hummah" which means black. Its location was defined by Yaqut Al-Hamawi and Ibn Fadlullah al-'Umari as being "a place belonging to Amman administrative area in the outskirts of al-Sham (Greater Syria), within al-Balqa region of the province of Damascus in Al-Sharah district and al-Balqa includes al-Sharah district where Humaymah is located. This latter village was the place of residence of Ali ibn Abdullah ibn al-Abbas".[1]

Modern al-Ḥumayma lies in the south of the Hashemite Kingdom of Jordan (latitude 29°9 north and longitude 37°5 east). It is one of the main centres of the Ḥisma region.[2] Ḥisma is a desert belt extending from Rās an-Naqab in the north, and Harrat ar-Raha in the south. It consists of high barren mountains and plateaus of sandstone of different colours like dusty white, yellow, red and black. It is surrounded with granite hills, remains of sandstone and alluvial plains (FIG.1).[3]

The al-Ḥumayma region embraces the wide lands between the 'Ammān-'Aqaba road in the east and the al-Ḥumayma mountains in the west. It is divided into two main parts: western al-Ḥumayma (the old one) and eastern al-Ḥumayma (the new one). The Department of Land and Survey (in Jordan) conducted a survey of the of region during the period February-May 1975. The survey covered Area 11- western al-Ḥumayma which consisted of 93 plots of land and Area 12- eastern al-Ḥumayma which consisted of 38 plots. These plots were divided into two parts one of which was registered in the name of the Treasury of the Hashemite Kingdom of Jordan under the title of "Unused land", and the other was registered in the names of al-Ḥumayma landowners (FIG .2).[4] This paper concentrates on old western al-Ḥumayma which was deserted by its inhabitants 30 years ago when they close to the main highway of 'Ammān-Ma'ān-'Aqaba and where they founded a village called New al-Ḥumayma. They have piped water supply, electricity, a modern secondary school, a clinic, a municipal council, a mosque, as well as other services and facilities. Old al-Ḥumayma's



1. Al-Ḥumayma site on the map of the Hashemite Kingdom of Jordan.

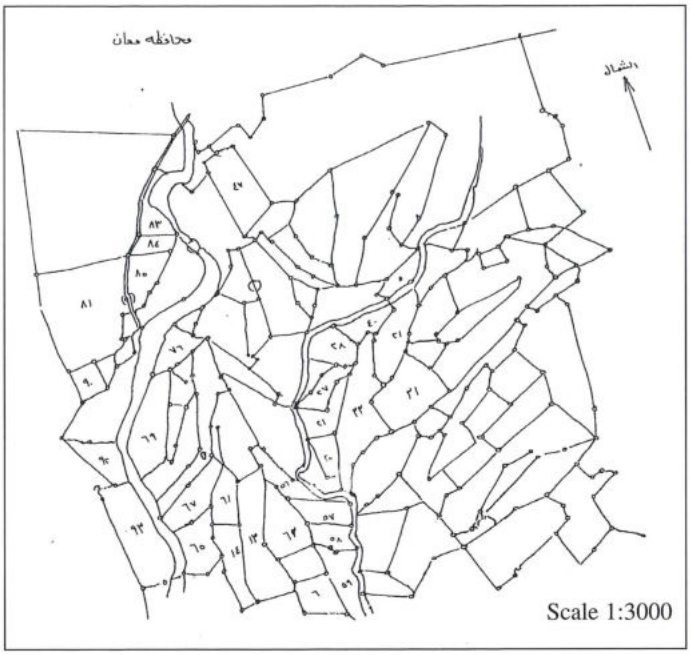
* This study financed by the Deanship of scientific research: Jordan University of Science of Technology.

1 Rasheed Ayman Fuad, al-Hamawi Y. 1985, *"Mu'jam al-Buldān"*, Beirut, Dar Iḥyā al-Turāth al-'Arabi, part II, p. 302 and Ibn Fadlullah al-'Umari *"Masālik al-Absār fi Mamālik al-Amsār"* ed. Cairo, French Institute of Orient of Antiquities, part II, page 199.

2 S. Hamarneh 1990. *"Mawāqi' wa Mudun fi Janūb Bilād ash-Shām wa Dawruha fi al-'Aṣr al-Abbassi al-'Awwāl* (Sites and cities in southern Greater Syria and their role in the first Abbasid period. *"Fifth International Conference of the History of Bilād ash-Shām"* March 4-8, Amman: Department of Antiquities. page 3.

3 B. Salahuddin 1973 *'Jaghrafiyyat al-Urdun'* (Geography of Jordan), ash-Sharq Press, Amman (1st ed): 140.

4 Department of Land Registration, 'Aqaba, Pls. 11,12 Table of al-Ḥumayma Village.



2. Western al-Ḥumayma. Land No. 81 represents the ruin sites recorded under the name of the Jordanian treasury Wādī Umm Surah and Wādī al-Gharīd are seen here.

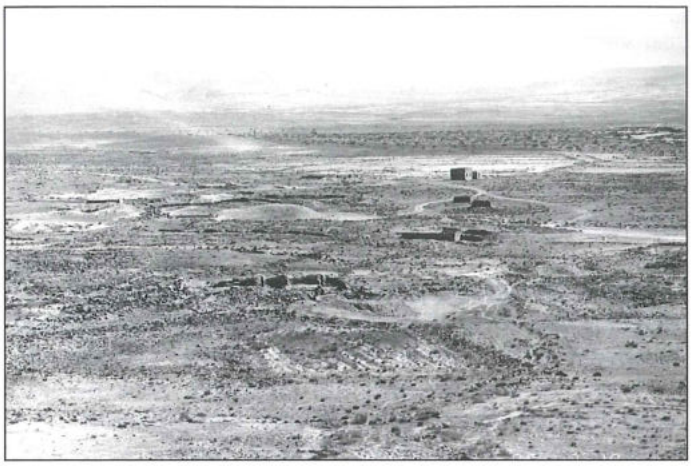
maximum length (north-south) is about 5.2 km and from east to west about 5.25 km. Its height is about 1000 m asl while the surrounding plateaus range between 1030 and 1237 m asl.[5] It is rather level but with relative declivity. It is surrounded by hills from all sides cut by some passageways. It is transversed by ravines which meet together at a dry valley to the east called Wādī Umm Surah. There is another arid valley called Wādī al-Gharīd which lies in the middle and provided al-Ḥumayma with an important rainwater drainage outlet channelled in the past into canals leading to the reservoirs or wells and pools which were prepared as catchments of water for clinking, domestic use and irrigation in times of drought (FIGS. 3-6).[6]

Al-Ḥumayma, unlike other neighbouring areas, is characterized by its variegated fertile soil created by the ravines and valleys converging from all directions which swept along calcite rocks and some alluvial and mud soils which can conserve water for long periods and reduce evaporation during drought periods. Its fertile soil has provided al-Ḥumayma with a plant cover, winter crops and fruit-trees for which it was famous throughout its history.

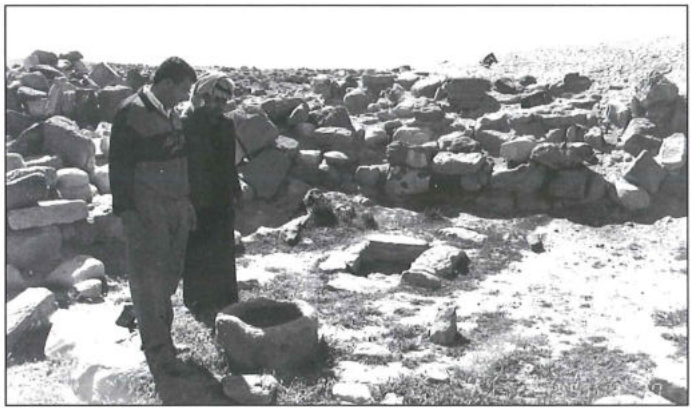
Historical Development of al-Ḥumayma

A visitor to al-Ḥumayma may see antiquities consisting of heaps of stones, some ruins, wells, reservoirs and pools scattered over a piece of land whose area is nearly 1388.4 donums (each donum is 1000 m^2) as estimated by the Land and Survey Department (FIGS.3-7). These remains indicate that the site, owing to its geographical location, was utilized as a centre throughout antiquity from the Neolithic until the Abbasid period.

During the Islamic era al-Ḥumayma played a prominent role when Ali Ibn Abdullah Ibn Abbas resided there during the caliphate of the Umayyad Abdul-Malik Ibn Marwan around the year 68 AH (687 AD).[7] The Caliph had advised him to live in the al-Balqā' region because it



3. A general view for al-Ḥumayma ruins after it was left by its people.



4. An old well sheild which is still used. A basin carved from rock seen beside it for water.

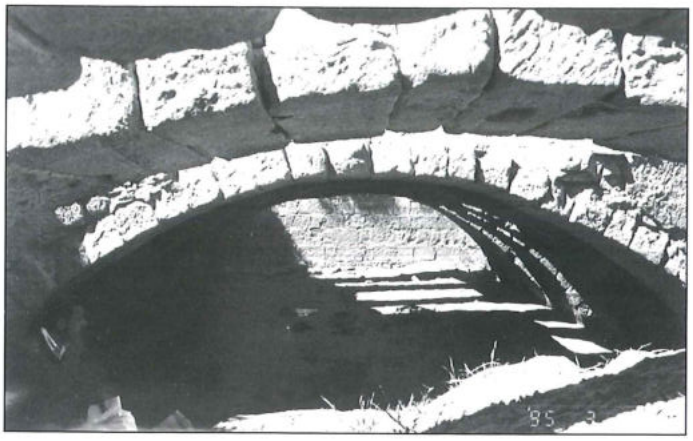


5. A well carved in rock in one of the western hills and is still used.

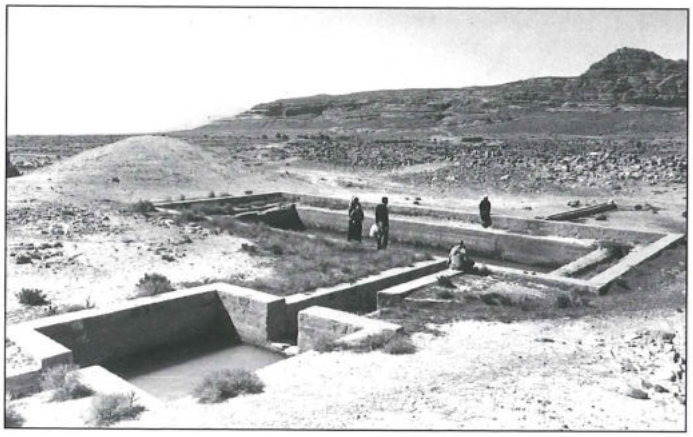
5 Al-Quwayra Contour Map, 1960, 'Aqaba Region Authority.

6 See Pl. 11, Department of Land and Survey, Directorate of Land registration, 'Aqaba.

7 H. Atwan, *Ad-Da'wa al-'Abbāssiyya: Tārikh wa Taṭwīr. The Abbassid propagandist Movement: History and Development.* Beirut: Dar al-Jil: 148.



6. A covered Byzantine water reservoir, The roof is supported by a series of arches.



7. A modern pool, newly built for storing rainwater.

lies between Damascus and Ḥijāz. Thus Ali lived in al-Ḥumayma[8] where he built a palace for himself. his sons also built houses around him. He also built a mosque where he used to perform prayers. Moreover, was also careful to most and helpful to everyone who passed from there on his way from Ḥijāz to Syria or vice versa offering his hospitality.[9]

Historical accounts indicate that Ali Ibn al-'Abbas was the first to embark upon advocating the caliphate for the Abbasids. After his death his mission activity spread to al-Kufa and Khurassan.[10] He had 22 sons, including Mohammed Ibn Ali Ibn Abdullah Ibn 'Abbās who consolidated the pro-Abbasid movement He lived in al-Ḥumayma where he had an orchard of 500 trees under each of which he performed a prayer everyday.[11] He made al-Ḥumayma his "Khurassan", a centre of propagandistic activity, and al-Kufa another centre for pro-Abbasid acti-vities because it was nearer to Khurassan than al-Ḥumayma. His arch-propagandist was Bakir Ibn Mahan who visited Mohammed in al-Ḥumayma, disguised as a merchant, whenever he wanted to seek advice from the latter about the progress of the movement.[12]

Ibrahim Ibn Muhammad succeeded his father in heading the movement. He made Abu Salamah al-Khallal his agent in al-Kufa where the latter frequently moved between al-Ḥumayma, al-Kufa and Khurassan. He also ordered Abu Muslim al-Khurassani, who joined the movement, to go to the propagandists in Iraq and inform them of the death of Imam Muhammad and his (Ibrahim's) succession to the vacant post. Abu Muslim did as he was told and gained strength in Khurassan, and after he won the allegiance of one hundred thousand Khurassanis he proved to be a formidable foe for Nasr Ibn Sayyar, the Umayyad viceroy. When the Umayyad caliph Marwan Ibn Muhammad knew of this, he sent his provincial governor of al-Balqā' to al-Ḥumayma to arrest Ibrahim Ibn Muhammad. The governor acted accordingly and found Ibrahim sitting in his mosque. He arrested him and sent him to Marwan who put him in prison.[13]

After that, the Abbasids moved from al-Ḥumayma to al-Kufa in 132 AH (749 AD) where they all stayed in the house of al-Waleed Ibn Sad and where they kept in hiding for 40 days until the city fell to the Abbasids. Abu Salamah saw fit to swear allegiance (and also others to do the same) to the person whom Ibrahim had designated for the caliphate. Allegiance was duly sworn to Abū al-'Abbās Abdullah Ibn Mohammed, born in al-Ḥumayma in 104 AH (722 AD) who was proclaimed caliph at the mosque of al-Kufa on Rab'i al-Akhar 13, 132 AH (749 AD). He assumed the title of 'Amīr al-Mū'minīn (Commander of the Faithful), which signalled the beginning of the Abbasid Caliphate.[14]

Sources of Natural Environment and their Impact on the Abbasid Movement

The geographical location of al-Ḥumayma is suitable for the establishment of urban centres. Throughout its historical development the location was utilized to establish important settlement centres who utilized its natural resources, including water and fertile land, and constructed a number of water sluices, pools, dams and reservoirs and made it a significant agricultural centre famed for its vine and olive orchards.[15] Al-Ḥumayma also became a thriving market place on the north-south caravan route.[16]

Because of plentiful water, elaborate irrigation, fertile

8 A. A. Al-Douri, 1972.'Anonymous Authors, *Akhbār al-'Abbās wa Waladihi* annotated by Beirut: 131, 145.

9 S. Hamarneh, *op. cit.* (n.2): 4.

10 Al-Massoudi; Abul-Hassan Ali, *Murūj ad-Dhahab wa Ma'ādin al-Jawhar,* Beirut ed., part 3: 238 and Hussein Atwan *op. cit.*: 159.

11 Al-Baladhuri, Ahmad ibn Jabir, 1978, *Ansāb al-Ashrāf* (lineages of nobles) annotated by abdul Aziz al-Douri, Beirut ed., part 3, 87, 1978.

12 H. Atwan, *op. cit.*: 172. S. Hamarneh, *op. cit.* n.1: The anonymous author of "*Akhbār al-'Abbās*" tells us about the visits as a perfume traded to sell his commodity in the ash-sharā region, which indcates that its people were leading a comfortable and well-to-do life as perfume is a luxury.

13 Al-Dainawari, Abu Hanifah, Ahmad ibn Dawud, 1960, "*Al-Akhbār aṭ-Ṭiwāl* (lengthy chronicles) annotated by abdul-Munim Majid Cairo, ed. Dar Ihyia al-Kutub al-Arabiyyah 1960: 343, 355, 357; see also abdul-Munim Majid *al'Aṣr al-'Abbassī al-'Awwal* (The first Abbassid era), Cairo: Anglo - Misriyyah Library, 1973, part 1: 36-40.

14 *Op. cit.*: 358, Abdul- Munim Majid *op. cit:* 36-40.

15 S. Hamarneh *op. cit.* n.2.

laud and the central location between Greater Syria and Ḥijāz, the Abbasids dose al-Ḥumayma as a suitable place for their political activities and social needs. Al-Ḥumayma became a symbol of the Abbasid political social and religious system which brought about prosperity.

1. Sources of Natural Environment

Some studies stress the importance of natural environment in the origin and growth of urban population concentrations because of the food and water resources it provides. This makes natural sites vary as a result of differences in topography and variety of land which, due to its inherent produce a diversification characteristics and potentials and variety of land which, due to its inherent diversification and potentials, produce a diversification which enables was to choose the most suitable to further his interests and provide for his basic needs.[17] which enables man to choose the most suitable to further his interests and provide for his basic needs.

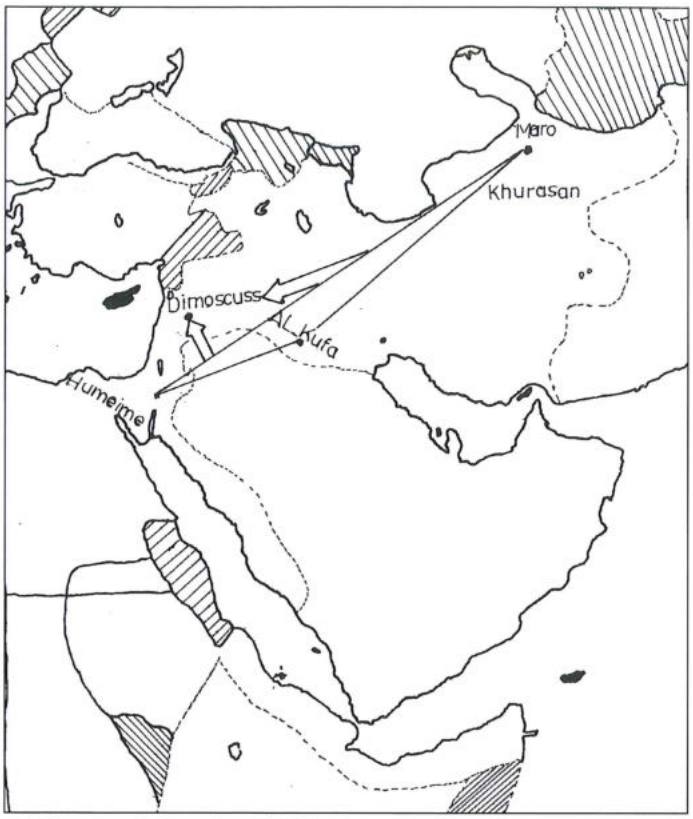
Nikita Eliesieve believes that there are three necessities that have made people get together food, defense and trade. Each one represents a constructive factor. Other factors contributing to the development of settlements are considered as growth factors, like political systems geographical boundaries.[18]

In the light of what has been said above, al-Ḥumayma held a distinguished place with regard to natural resources which have made the place suitable for al-Ḥumayma's growth and development as a social aut political centre within successive historical periods, the most significant of which was the period of the underground Abbasid movement.

2. Central Strategic Location

The central location of al-Ḥumayma between north and south has made it a focal point of attracting human movement for several purposes such as trade, pilgrimage and social visits. All these factors have convinced the Abbasids to select it as headquarters of their anti-Umayyad political movement. Al-Baladhuri says that everyone who travelled from Syria to Ḥijāz or vice versa passed by al-Ḥumayma and was attracted to stay there for some time.[19]

The fact that al-Ḥumayma was located in the middle of a barren region, its proximity to Damascus, and the apparently peaceful attitude of Ali Ibn Abdullah Ibn Abbas-the founder of the movement- towards the Umayyads, have made of al-Ḥumayma a suitable place and cover for underground political activity. It was one of the angles of the geographical triangle of the Abbasid movement which extended from al-Ḥumayma in south Jordan to al-Kufa in Iraq to Khurassan in the far Muslim east (FIG. 8).[20]



8. The strategic location of al-Ḥumayma and its effect on the abbasid mission.

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16 *Op. cit.*: 3.

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The Town and Name of 'Aqaba: An Inquiry into the Settlement History from an Archaeological Perspective

The 'Aqaba region has been occupied and a sequence of separate settlements, from the Chalcolithic to the modern period, have been identified archaeologically. Recent excavations have brought to light the Early Islamic city of Ayla in the heart of the modern city of 'Aqaba. This town was occupied from ca. 650 AD to the arrival of the Crusaders in 1116 AD, a period of ca. 450 years. This paper will discuss the geographical and historical information for settlement in 'Aqaba from the end of the early Islamic occupation until the development of the modern town.[1]

Other than a temporary aberration under the Ptolemies (who "founded" yet another Berenice at this place), the settlement here has always taken its name from the root attested in the Bible, Elath or a variant Elam. The classical variant Ailana is connected with the Greek name of the Elanitic gulf. The modern town of Elat (Eilat) continues this tradition, a name imposed on a small Egyptian police post after 1948. Study of archaeological remains have begun to explore this toponymic change, how Ayla became 'Aqaba. This discussion may begin with the Byzantine name of Aila. A section of the Byzantine town wall has been discovered northwest of the Islamic town.[2] Indeed, the hypothesis has been advanced that, soon after the Islamic conquest and during the caliphate of 'Uthman (ca. 650 AD), a new Ayla was founded beside the older settlement (a pattern common to many Islamic foundations, e.g. Fusṭāṭ Cairo, Baṣra *inter alia*.; Whitcomb 1994:22). Muqaddasi visited this new city in the tenth century and notes that... "It is usually called Ayla, but [the true] Ayla, ruined is very near."[3] He was so concerned about the potential confusion of the two places with the same name that he introduced the name, Wayla, probably a diminutive, the little Ayla.[4]

In 1116 AD, King Baldwin I of Jerusalem appeared at Ayla with a small group of knights. Accounts agree that the inhabitants fled to the sea and that the Crusaders left a small garrison at Elim or Helim (as they took the name from the Bible) and returned to Jerusalem. The Crusaders apparently built a small fort for this garrison; this is generally assumed to be the foundation of remains on Jazīrat Pharaon but also thought to be associated with Ayla. The evidence from excavations strongly indicates that the condition of the town in the late 11th century was not good and the city was in no condition to put up a fight. In fact, the old, dilapidated condition suggests that, like Aila before it, a settlement some 450 years old might easily be abandoned. The situation is rather like that of modern inner cities, but also attested for medieval Cairo,[5] namely, that it is less expensive to begin new buildings on another site than restore and reconstruct older buildings. Thus one may suggest that the Crusader attack may have put the coup de grace on the earlier Islamic town and that the Crusaders did build a small fort for their garrison – at a safe distance from the old, dilapidated city. This site is probably the present castle of 'Aqaba (FIG. 1), mainly Mamluk and Ottoman in its extant form.[6]

The village or old town of 'Aqaba was situated around and behind this castle, stretching inland along the Wādī ash-Shallāla (FIG. 2). This is the 'Aqaba mentioned by travelers of the 19th and early 20th centuries. The question remains, how the medieval transition in name from Ayla to 'Aqaba corresponded to the movement of settlement. According to Glidden, "The term 'Akabat Ayla appears as early as the time of al-Idrisi (d. 1166) but the town was still generally known as Ayla" (1956: 314). Al-'Abdari refers to 'Aqabat Ayla in 1290 (Hamed 1988: pl. 5). In the 14th century, Ibn Baṭṭūṭa uses only 'Aqaba, while his contemporary, Ibn Faḍl Allāh al-'Umarī (d. 1349), refers first to 'Aqabat Ayla and later to al-'Aqaba

1 Pre-Islamic occupation is discussed in Meloy 1991. This is now superseded by the work of Thomas Parker (in this volume).

2 The reader should note the spelling convention adopted by these two investigations. Aila follows common transliteration of classical languages and refers to the Roman/Byzantine town. Ayla follows the usual Arabic transliteration and refers to the Islamic town. These ruins may have been seen by Musil: "North-west of the ruins of Ajla [sic] we visited a grove of luxuriant date palms in which we found other remains of old buildings, called ad-Dejr or ad-Dar" (1926:87).

3 Al-Muqaddasi, 178, 10-13; The meaning of this sentence has become clear only with the discovery of the physical remains of the two towns. One may note that Bowersock (1983:172-3) is entirely incorrect, the modern Elat is a toponymic invention.

4 This new name, Wayla, remained idiosyncratic to Muqaddasi; it is inappropriate to use this name for the Islamic city. Not all linguists accept Wayla as a diminutive form of Ayla.

5 Goitein gives a long discussion of urban ruins in medieval Fusṭāṭ (1983:21-24).

6 Glidden 1952. The castle has been the subject of extensive restoration under Ghazi Bisheh and others , though no excavations have been undertaken.



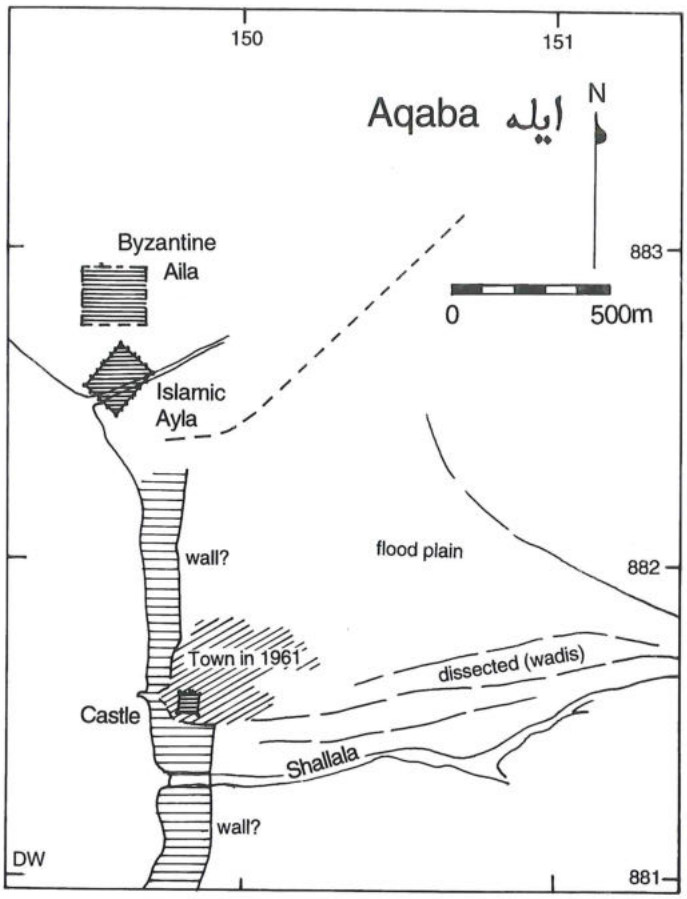
1. Leon de Laborde's etching of 'Aqaba castle, with a pilgrimage caravan in 1828.

(Glidden 1956:315; Tamari 1987).

The usual explanation of the name 'Aqabat Ayla, following the prevalent meaning of *'aqaba*, is that this name refers to a mountain pass. Glidden and others believe that it refers to the Wādī al-Yutum caravan route to the north. Tamari and still others would have this be the western entrance into the Sinai. Musil on the other hand, claims the *'aqaba* to be the pass to the south through the mountain of Umm Nusayla. Historical references indicate the pass should exhibit evidence of improvements, cuttings and pavings, such as those accomplished by Fa'iq at the orders of Khumaraweh b. Ṭūlūn in 884-95 (recorded by Maqrīzī), by Muḥammad b. Qalaun in 719/1319 (Maqrīzī), by Khairbek, under Qānṣūh al-Ghūrī in 1508 (Ibn Ilyas), and by Daud Pasha in 1534 (Tamari and Hashimshoni 1973; Tamari 1971, 1982). Archaeological evidence has been observed by Musil to the south near al-Burj (apparently now destroyed) and recorded by Tamari to the west.

Each of these localities presents the same problem, in that these *'aqabat* may have been improved and guarded but that they are unlikely to have been settlements in any sense. While settlement in this region had certainly declined from the urban center of Ayla, these same geographers and travelers imply the continuity of some occupation, if only a limited seasonal settlement for provisioning pilgrims. This economic incentive combined with the constants of abundant fresh water and agricultural and marine resources have guaranteed a continuity of occupation in the immediate vicinity of modern 'Aqaba. It is suggested here that a settlement beginning from the 12th century was at a place called 'Aqabat Ayla and that this name derives not from the nearby pass(es) but from an urban topographic feature.

One may note a secondary meaning of *'aqaba*, the root of which seems to imply a difficulty, as being a hillock or "slopes." This meaning takes on some interest in light of the use of the term *'aqaba* to describe hillocks or slopes in several medieval Islamic cities. Thus, the hillock on



2. The succession of settlements at 'Aqaba, Jordan.

the western edge of the old city of Aleppo was the mound of the early ruins of Ḥalab. Sauvaget states that "The 'tell' of Aleppo ... rises up in a quarter where the declivity of its streets has given the name, "the slopes" (el-'Aqabé) ...." (1939:61). Likewise, there is a section of Damascus, just outside of the Bāb al-Fardis, called al-'Uqaiba. In his discussion of the circulation patterns of medieval Fusṭāṭ, Kubiak notes that "the street mounting a hill could be called *'aqaba...*" (1979:18). This toponym at Fusṭāṭ is discussed in detail by Denoix (1992:135). One may note a last example, the topography of Jerusalem in which numerous localities maintain the description, *'aqabat*.[7] What is being suggested here is that a lexical distinction may be made between the general, broader usage as a mountain pass and its medieval usage as a hillock or slope in an urban context. A parallel to such lexical differentiation may be Conrad's explication of *ṣaḥrā'* as "an undeveloped tract of ground within a town," a meaning which extends "far beyond the simplistic notion of a 'desert' " (1991:274-77).

Thus one may suggest that the shift from the early Islamic name of Ayla to the modern 'Aqaba corresponded to the development of the modern city, occurring in the following stages:

[7] Among these localities are: 'aqabat el-Bustani, 'aqabat el-Mawlawiyeh, 'aqabat Shadad, 'aqabat Darwish, 'qabat Takieh, 'qabat el-Beriaq, and Khan el-'aqabat. These are all older terms within the Old City.

1. The early Islamic town of Ayla, severely damaged by the earthquake of 1068, was not restored (Whitcomb 1994:10). With the arrival of the Crusaders in 1116, the inhabitants decided to abandon this site, possibly for Jazīrat Pharaon (Ile de Graye) on the Sinai coast.
2. A small fort was constructed on the site of the modern castle of 'Aqaba. This was either a Crusader or more likely an early Ayyubid construction, around which a new settlement began to grow. Selection of this particular point on the coast was no doubt based on defensibility, since the fort was on a prominence. The fort was named 'Aqabat Ayla, the "hill" of Ayla, in order to distinguish it from the abandoned but still visible ruins of the Early Islamic town. This dual relation of Ayla and 'Aqabat Ayla continued through the 14th century.
3. The next stage saw the growth of a village around the fort, embellished and expanded by the Mamluks (FIG. 3). At the same time, memory of the Early Islamic town had faded with the obscure traces of its ruins. The toponymic distinction no longer necessary, 'Aqabat Ayla became contracted to simply 'Aqaba. It is this village of 'Aqaba which entered the modern world and expanded into the prosperous port of today.
4. This fort was located on a rise in the direct alluvial discharge of the Wādī ash-Shallāla (see FIG. 2), and the village had to contend with an accretion of land levels until the castle was surrounded by a gradient.[8] The major discharge of the wadi was to the south, as it is today. Channeling this discharge may account for the wall described by Lawrence in 1914, "a huge bank 100-200 yds from the beach and parallel to it; this was 10-30 ft. high towards the sea and 3-10 ft. toward the land and presumably constructed to deflect water from the hills away from the town." (1914-15:128). This embankment may be the foundation for the modern corniche, the road of which is raised high above the beach at the described distance; its purpose may have been to deflect flood waters from the gardens (FIG. 4), as well as the town.

The above scenario is offered as more than a lexical or toponymic curiosity , that is, as an hypothesis for the settlement history in the medieval and premodern period. This hypothesis is the result of a continuing interest in the region of 'Aqaba, beyond the specific focus of the early Islamic city now being excavated. This broader concern follows the long tradition of ecological histories developed in other, more intensively settled regions of the Middle East. The succession of settlements in the 'Aqaba region begins with the Chalcolithic and features notable



3. Interior view of the 'Aqaba castle.

8 Lawrence also noted that the village "lies at the foot of the slopes of the Arabian hills, and wady after wady descends from them, each pointing directly at the town; a flood from any one of these would sweep away every building in the place..." (1914-15, 128).



4. Garden scene near the beach at 'Aqaba.

remains of the Iron Age, Nabataean, Roman and Byzantine and Early Islamic periods. The utilization of lexical/historical documentation in conjunction with archaeological/environmental evidence offers great potential for the study these periods. The origin of "Aqaba" is a problem which brings this research directly into the present and offers a relevancy which make all the more remote periods increasingly understandable.

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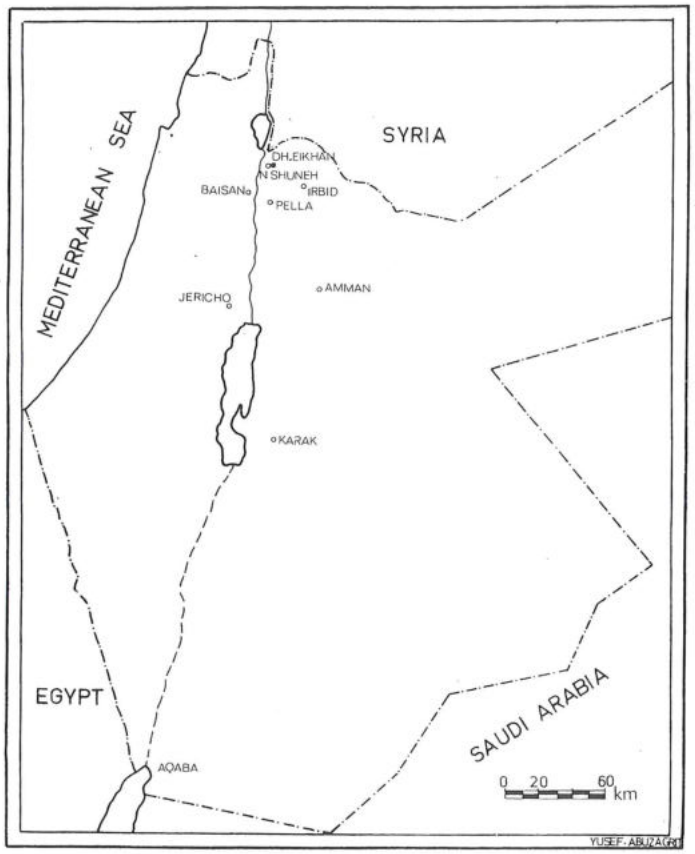
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The Site of Dhrā' al-Khān: A Main Caravanserai on Darb al-Qufūl

The aim of this paper is to locate the trade routes which passed through the northern part of Jordan and Palestine, between Damascus and Cairo in the post-Umayyad period. In order to achieve this aim, historical and archaeological evidence was used.

R. Hartmann (1910: 675-676), using historical and geographical data from Ibn Khurdadhabah, Ibn Qudama, al-Maqdasi and al-Ya'qubi, argues that the main trade route between Damascus and Egypt passed through Fiq, Tiberias, Baysān and Marj Ibn 'Āmir during the Abbasid period. However, a complex public building, which may have served as a central market or a *Khān* (Caravanserai), and other material culture remains dating to the Abbasid-Fatimid period were found in Area XXIX at Pella (Ṭabaqat Faḥil) (McNicoll *et al.* 1986: 182; Walmsely 1989: 438). Excavations at Tall al-Qudsiyya, located between Pella and Baysān, resulted in the recovery of extensive material remains dated to the Abbasid period (Kareem 1987; 1990a; 1990b). Moreover, excavations at the site of al-Qam, located in the mountainous area between Irbid and North ash-Shūna, also recovered material remains dated to the Abbasid-Fatimid period (Tarawneh 1990: 164). Although, it is said that the nature of occupation in the last two sites was rural, a small portion of these two sites was excavated. The archaeological data from Pella, Tall al-Qudsiyya and al-Qam all encouraged the writer to assume that a trade route passing through the northern part of the Jordan Valley was used in the Abbasid period (FIG 1). Further excavations in the Jordan Valley and in the mountainous area may shed light on this trade route.

At the beginning of the 12th century the Crusaders were able to establish their rule in Palestine and in parts of Jordan (Beyer 1942: 166-172; 1954: 183-260; Fedden 1950; Runcimann 1968-68; Smail 1975; Richard 1985). The Crusaders frequently cut the main trade route connecting Egypt and Damascus which passed through the northern part of the Jordan Valley (Ibn Iyas 1975: I/28); instead, Darb al-Badriyya, which passed through the southern part of Palestine to connect with Wādī Mūsā in Petra, was used (on the main stations used on this route see Zayadine 1985: 161-163). In addition to this main route, there was a subsidiary route that was also used and



1. Map of the Jordan Valley and beyond.

that passed through al-Khalīl (ancient Hebron), Ghawr aṣ-Ṣafī, al-Karak and eastward through Jordan (Hartmann, 1910: 681-83).

It seems that the trade route through the northern part of the Jordan Valley prospered once again during the early Mamluk era (in the early second half of the 13th century). In AH 659/AD 1261 a chain of post stations was constructed on this route by Sultan Baybars (Ibn Iyas 1975: I/332). Some of the stations located in the Jordan Valley and in the northern part of Jordan were Baysān, al-Majami', Zahar, aṭ-Ṭayyiba and Irbid (al-'Umari 1988: 55; Fig. 2). Depending on the historical data, this route which passed most probably through the Jisr ash-Shaykh. Hussein region in the Jordan Valley (Mittmann 1970:

228), was shifted ca.15 km northward. Al-Qalqashandi (XIV/380) mentioned these stations in the following order: 'Ayn Jālūt, aj-Jisr, al-Quṣayr (North ash-Shūna), aṭ-Ṭayyiba, Zahar al-'Aqaba and Irbid (FIG. 3).

In order to facilitate movement on the Jordan river, many bridges were built over it during the Mamluk period. In AH 664/AD 1265 Sultan Baybars ordered the building of a bridge across the Jordan river near Duma (Damiya) (al-Maqrizi I/544; Ibn Taghribardi VII/941; Ibn Shaddad 1983: 352; Lapidus 1967: 246). In the year AH 784/AD 1382, Sultan Barquq ordered the building of another bridge across the Jordan river, located between North ash-Shūna and Baysān (Ibn Taghribardi XV/291). However, it seems that many other bridges were constructed over the Jordan before Barquq's bridge. Al-'Umari(1988: 55) who died in AD 1348 recorded that there were many other bridges across the Jordan river; among these were Ya'qub as-Sunbara, al-'Adili, Samat al-Maqarin and Jisr Shāma.

In the 14th and 15th centuries the main stations located in the Jordan Valley on the main route between Damascus and Cairo were Baysān, al-Majami', and al-Quṣayr (North ash-Shūna) (al-Qalqashandi XIV/380; Ibn Taghribardi XVI/48). This route was identified as the Darb al-Qufūl by the Arab and European Travellers who visited Palestine in the 17th century and in later periods (an-Nabulsi ms. 207-208; Schumacher 1890: 42-43). Ibn Taghribardi (XVI/48) mentioned that this route was established by the ruler of Damascus, Sayf ad-Din Tenkiz, in the year AH 741/AD 1340. It seems that this route was established earlier than the dating of Ibn Taghribardi. Khān al-Aḥmar was among the khāns located in the Baysān region on this route. This khān was built by the Damascus al-'Amīr Sallar in the year AH 708/AD 1308 (al-Maqrizi II/398).

The Mamluk sultans and amīrs paid special attention to the needs of the inland trade routes and, in particular, to the khāns and commercial centers (Jaussen 1922: 99-103; Sauvaget 1940; 1-19; Abu Khalaf 1983: 178-187; Ghawanmeh 1982: 325). Khān al-Aḥmar, in the Baysān region, and Dhrā' al-Khān, in the North ash-Shūna region, were among those khāns founded by the Mamluk Amīrs on the trade route between Damascus and Egypt (al-Maqrizi II/398; Kareem 1993).

R. Hartmann (1910: 694-702; 1918: 55-56) argues that the trade route which passed through the northern part of the Jordan Valley from the 13th to the 15th centuries was rerouted northwards at a later period, sometime between 1470 and 1700 AD.

This new route passed through Ṣafad, Jisr Banāt Ya'qub and al-Qunayṭira, through the aj-Jawlān region. A number of khāns, including one named Khān at-Tujjār, were constructed along this route (Gal 1985: 69-75). However, this route through aj-Jawlān had its security disadvantages. According to an Ottoman document, Bedouins and robbers used the area near the khān (called 'Uyūn at-Tujjār in this document) as a meeting place. They threatened pilgrims to Jerusalem as well as merchants (Heyd 1960: 110 -112). This situation was also mentioned by the Arabian traveller an-Nabulsi (ms. 207-208) who visited Palestine in the 17th century by the way of Fiq - Jisr Banāt Ya'qub route (FIG. 3). He recorded that many of the khāns located on this route were abandoned and reported that in the al-Hula region the route was dangerous because of robbers.

In the late 18th/early 19th century the route passing through the northern part of the Jordan Valley, Darb al-Qufūl, was normally not in use (Karmon 1960: 251). During this time, travellers used the route passing through Jisr al-Majami' - al-Ḥamma - Umm Qays; this route was known as the Darb al-Ḥawārneh (Gal 1985: 69-75; Fig. 3: 3). Later, in the 19th and early 20th centuries, the Darb al-Qufūl was used once again by travellers to the plains of Ḥawrān and the Ḥijāz railway (Karmon 1960: 251; Steuernagel 1926: 134-137). It is more likely that the prospering of Darb al-Qufūl in post 1843 AD was mainly related to the new Ottoman policy to increase its control over Jordan. As a result of this policy, the destrict of 'Ajlūn was the first to come under the government administration and Ṣkhūr al-Ghawr and 'Arab as-Sa'di who threatened the villages of 'Ajlūn and Darb al-Qufūl, were heavily defeated (Schumacher 1889; Steuernagel 1927: 130; Peake 1958: 91-92; Issawi 1966: 262-263; al-Mousa 1983: 385-391). As a result the trade activity was returned back to this route. G. Schumacher (1897: 108) reported that the Darb al-Qufūl was the main route for transporting wheat from Irbid and 'Ajlūn regions to the ports of Ḥayfā and 'Akkā. Caravans on this route carried between 80,000 and 100,000 tons of wheat every year.

Excavations at Dhrā' al-Khān

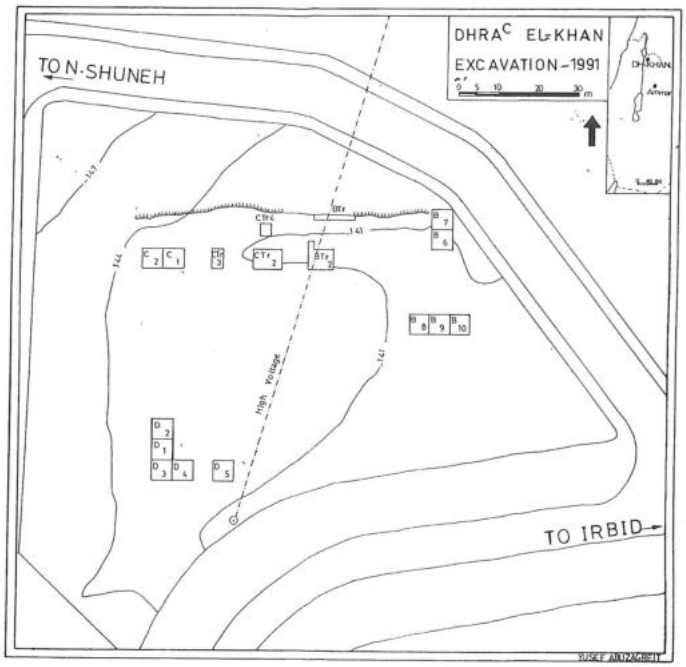
The site of Dhrā' al-Khān is located 2km south-east of Tall ash-Shūna ash-Shamālīyya, 33km west of Irbid and 15km north of Ṭabaqat Faḥl (ancient Pella) (FIG.1). More precisely, Dhra' al-Khān is found on map coordinates between 208.2 E and 223.6 N, at 138-141 m bsl. The present Irbid-al-Ghawr road passes along the southern border of the site. A branch of this road splits off just at the southeastern corner of the site, passes along its eastern and northern limits, and leads to ash-Shūna ash-Shamālīyya. The main source of water for this site is a natural spring, 'Ayn Abū Ṣafī, which is located 100m north of the site.

The village of Mu'adh, which was built around the tomb of the early Muslim hero Mu'adh bn Jabal and which was near the site of Dhrā' al-Khān, was visited or mentioned by several European travellers, among them Burckhardt and Schumacher. Burckhardt (1822: 275) mentioned that the only inhabited villages in the northern part of the Jordan Valley during his visit to Palestine in 1812 were Tall al-Arba'īn and Mu'adh. He also reported that a khān was found near the tomb of Mu'adh (Burckhardt 1822: 180). G. Schumacher (1890: 190)

reported that the population of this village was 140 souls and also reported that "the great Hauran road passes near the village. The ancient remains existing here were not thoroughly explored".

The site of Dhrā' al-Khān was surveyed for the first time in 1975 by Ibrahim, Sauer and Yassine as part of the "East Jordan Valley Survey Project". Material culture remains retrieved from the surface of this site by the surveyors were dated "few poss. Um., Ay/Mam., Ott., Flints" (Ibrahim *et al.* 1976: 49; Yassine 1988: 168). Furthermore, the surveyors pointed to the site as "unique in that it clearly preserved the outlines of a large square structure with a central courtyard which was probably a caravanserai (Khan)" (Ibrahim *et al.* 1976: 63; Yassine 1988: 183).

The site was partially subjected to bulldozing operations in 1990 and consequently several parts were either damaged or completely levelled. A deep bulldozer cut currently exists in the northern side; others are also notable at the eastern and western portions. Five of these cuts were selected for trimming to 1.5m back and 5m wide. Beside this excavation two other methods were used; the first was the opening of squares measuring 5 x 5m; and the second was the horizontal exposure of layers A total of 421m^2 were excavated by using the three excavation methods

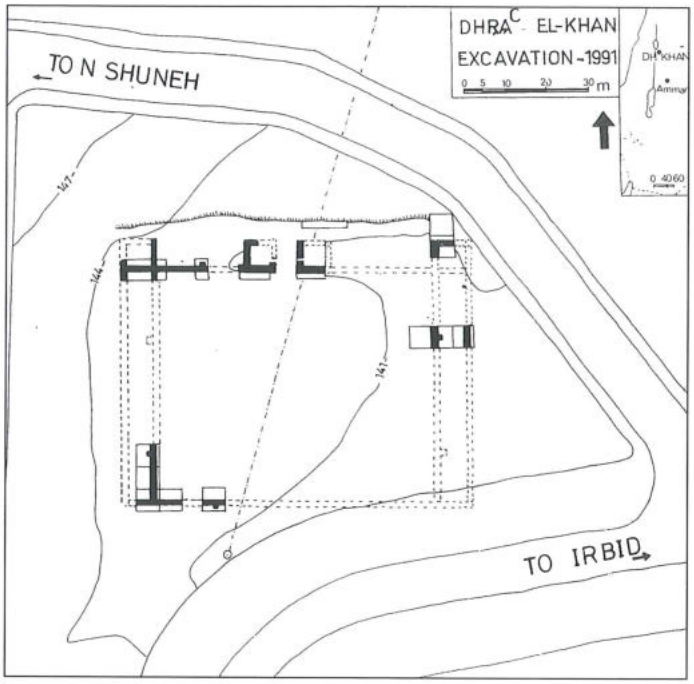


2. Excavation areas of Dhrā' al-Khān.

(FIG. 2).

Excavations were conducted at the site of Dhrā'al-Khān in the weeks between November 2 and December 10, 1991. Work at the site yielded the following results.

1. The Dhrā' al-Khān complex is rectangular in shape and its walls abut at right angles. The dimensions of these walls are 50 x 66 m (FIG. 3).
2. The walls of this comlex were mainly built of lime-



3. The Dhrā' al-Khān complex.

stone, with a bottom course of large, hewn limestone blocks. The area located between the two edges was filled with small pieces of unhewn limestones fixed with a mud mortar. White plaster was used as mortar between the hewn stones and the interior faces of the walls were plastered. The width of these walls is 1.20m. Basalt stones were only used in the area around the gate for constructing the "gate block", lintel and threshold. The main gate was located in the middle of the northern wing.

3. The walls of this khān were strengthened by buttresses. Two forms of buttress were recognized; the first is square in shape (1.5 x 1.5m). This kind of buttress was found on the exterior side of the walls and each one is in 10 distance from the other. The second form is elongated (1.5 x 3 m). This type was only found in the northwestern corner of the complex.
4. Rectangular storage rooms were found in the northern wing. The eastern wing, where vaulted rooms were found, was apparently used as a residence. The function of the western and southern wings have not yet been determined.
5. The area located to the north of the main entrance of the khān was paved with stones. Two stone pavements were found; the first was dated by a copper coin struck during the reign of Sultan Abū Bakr (1341 AD); the second was dated by two copper coins struck during the reign of Sultan Barquq (1382-1399 AD). However, soundings in the middle part of the courtyard failed to find these stone pavements.
6. A total of 124 coins were found at the site. Seventeen copper coins were retrieved from the surface; 107 were found in a stratified context. The dates of the coins

found in a stratified context range from the reign of Sultan Qalāwūn (1280-1290 AD) to the reign of Sultan Jaqmaq (1438-1453 AD). Thus, the stones of the collapsed roof which were uncovered on top of the stratified coins are believed to have fallen as a result of the earthquake which occurred in 1456/57 AD (Amiran 1950-51: 229).

7. Judging from the elevation of the plaster or stone pared floors, the differences in the construction technique, the legible coins found in a stratified context and a tomb stone belonging to the owner of the khān who died in 1375 AD (Kareem 1996), this khān was first built in the reign of Sultan Qalāwūn (1280-1290 AD) and then rebuilt or modified in the third reign of Sultan an-Nasir Muhammad (1310-1340 AD).
8. Archaeological evidence, for example a copper coin dated to the reign of Sultan Murad (1574-1595 AD), pottery sherds and sherds of tobacco pipes, shows that the site was used during the Ottoman period. Evidence from oral history also supports this conclusion.
9. Dhrā'al-Khān was a main trading station on the main road between Damascus and Cairo which was used from the 13th to the 16th centuries. Pottery sherds of Syrian, Egyptian and local production were found at the site. Moreover, two crusader coins and one Il-Khanid coin were found in a stratified context. Archaeological as well as historical evidence shows that ash-Shūna ash-Shamālīyya represented by the site of Dhra' al-Khān was a main trading station on Darb al-Qufūl in the Mid-to Late Islamic periods.

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Mediaeval Petra.The Stratigraphic Evidence from Recent Archaeological Excavations at al-Wu'ayra*

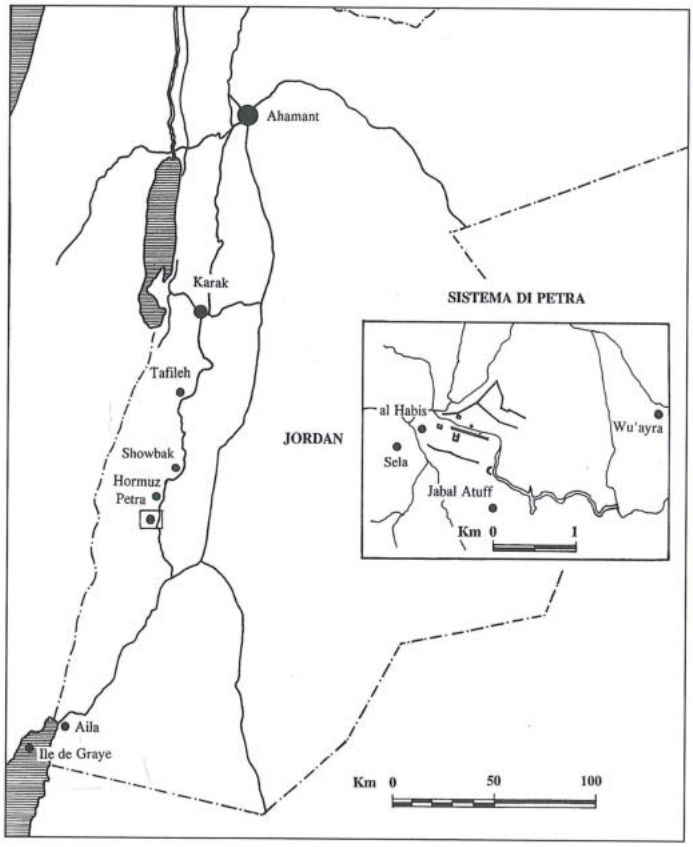
1. Introduction

The following preliminary report concerns some of the partial results achieved by the archaeological project of the University of Florence. The goal of the project was to analyze the characteristics of the Western settlement system in the territories corresponding to the Lordship of Transjordan in the 12th century and their relationship to the indigenous peoples and cultures of that period.[1]

Research in the past few years has been aimed for the most part at understanding the modes of Western and Ayyubid reoccupation of the region of Petra (al-Ḥabīs, Jabal 'Aṭṭūf, al-Wu'ayra, al-Bayḍa, ash-Shawbak) which, at present, is emerging as the focal point of the renewed settlement system of Crusader Transjordan, from al-Karak to *Ile de Graye* (al-Qurayya) (FIG. 1).[2]

Within this framework, the results obtained during the last three seasons (1992-1994) at the fortified site of al-Wu'ayra acquire crucial significance. The research methodology was based on a topographical-territorial analysis involving a wide ranging preliminary survey at the Transjordan Crusader sites and surface reconnaissance throughout the Petra valley. [3]

The site of al-Wu'ayra was crucial for the strategic control of the entire Petra valley. The archaeological investigation shows that it had been an important sacred and funerary site since prehistoric times [4] and an interest in controlling the zone persisted down to the Byzantine era. The Crusader reoccupation of the site is therefore an explicit confirmation of the renewed strategic interest of Petra as a whole in the new political situation that was emerging in the 12th century (FIG. 2). [5]



1. Map of Transjordan. Crusader Castles and major routes (12th century). a- Ahamant; b- al-Karak; c- aṭ-Ṭafīla; d- The Petran system (ash-Shawbak, al-Wu'ayra, al-Ḥabīs, Jabal 'Aṭṭūf, Sela, Hormuz); e- Ayla; f- Ile de Graye (al-Qurayya); _____ The road network.

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* This report provides an account of the fieldwork of the project 'Settlements of the Crusader-Ayyubid period in Transjordan', funded by grants from the Ministero dell'Università e della Ricerca Scientifica e Tecnologica (the so-called '40%' grants to Professors Marco Bini, Franco Cardini and Guido Vannini: University of Florence) and from the Ministero degli Affari Esteri (to the director, G. Vannini). Parts 1 and 2 are by G. Vannini; part 3 is by C. Tonghini; part 4 is by both authors. Parts 1+3 and 4 were translated by Anna Valeri Moore and Giulia Battiti Sorlini. Geoffrey King, SOAS, University of London, has kindly read the English manuscript. The photographs are by Anna Marx (FIGS. 6, 19, 20) and G. Vannini (FIGS. 7b, 9-11, 13); drawings are by. Stefano Bertocci (FIGS. 1, 3-5, 12), Riccardo Berretti (FIG. 8) and Stefano Tuzzato (FIG. 7a). The pottery drawings are by C. Tonghini and Andrea Vanni Desideri, and were inked by Paola Puma (FIGS. 17-18).

1 Only in recent times has archaeology been employed to investigate the history of Jordan in the 12th century. In this respect, a remarkable study of the settlements in the region, including Crusader sites, was carried out by R. Brown (*ADAJ* 31, 1987: 267-288 (al-Wu'ayra); 32, 1988: 225-245 (ash-Shawbak); 33, 1989: 287-302 (Karak); unpublished Ph.D thesis, 1992), by D. Whitcomb (see in particular his paper in this volume) and by J. Johns, A. McQuitty *et al.* (1989: 63-95).

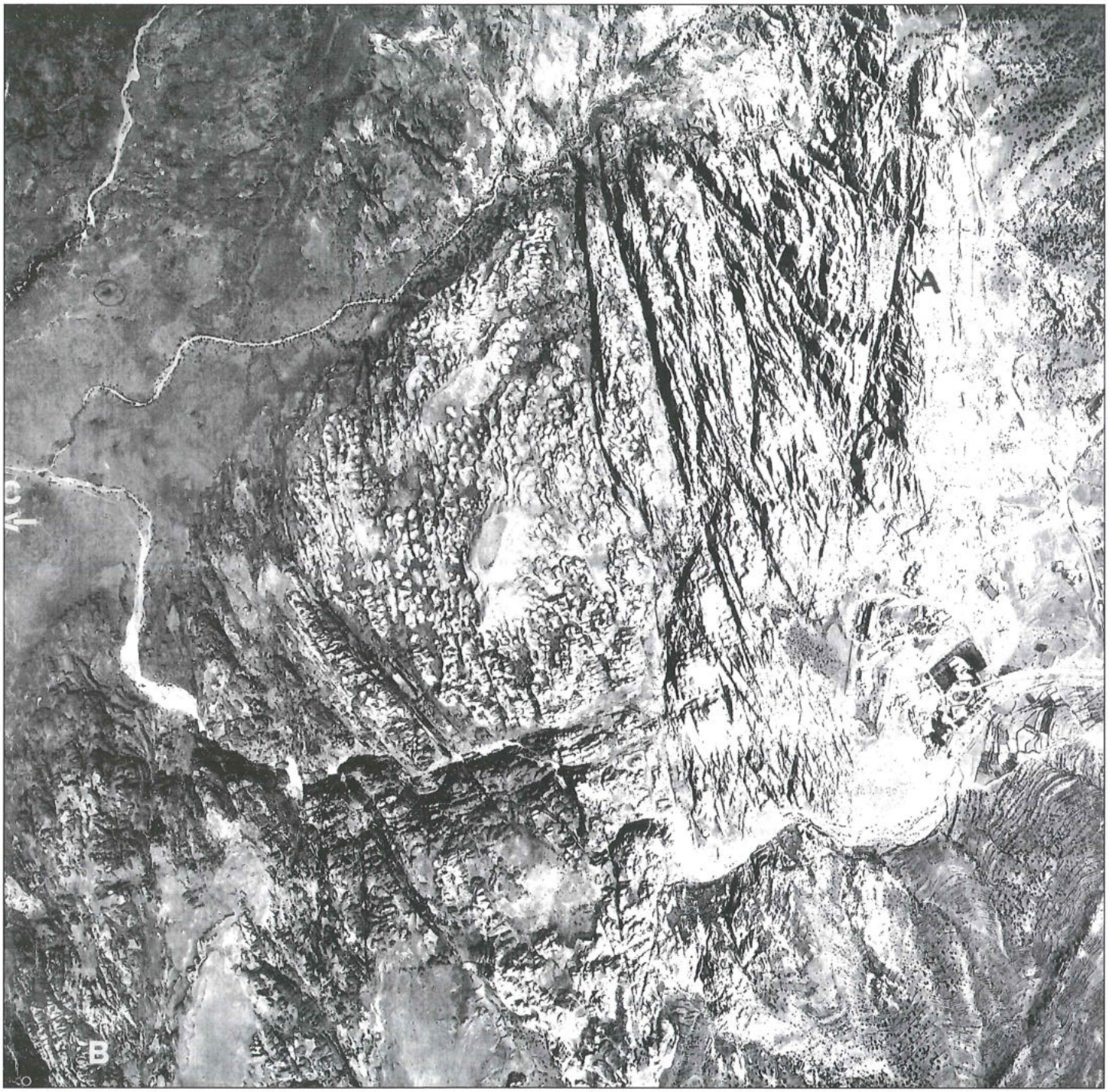
2 For the general research project and a list of bibliographic references see Vannini and Vanni Desideri 1995.

3 In short, our field research strategy (characterized by an interdisciplinary approach) combines data from 'vertical' stratigraphy ('open area' excavations, sondages and stratigraphic interpretation of structures) with data from 'horizontal' stratigraphy (surface survey, identification of Topographical Units, 'Activities', etc.), in the attempt at reconstructing a picture of the site that is as complete as possible.

4 Cf. R. Berretti and M. Frau, at Torino conference.

Our goal is to document and understand the historical, territorial and topographical motivations that led the Crusaders to decide from the very beginning of their presence in the region to settle in Petra and from there to control Transjordanian territories. This control was exercised directly from the Kingdom of Jerusalem for at least the first forty years. Later, when the Lordship of Transjordan was established in 1142, the ancient city of al-Karak was chosen as the autonomous capital for political reasons.

This choice had no substantial consequences in the



2. Petra (aerial photograph). The Crusader settlement at Petra can be described as a fortified system for the control of the valley, with both tactical and strategic purposes. The tactical centre of this system was the fortress of al-Ḥabīs (A), probably connected to the towers of Jabal ʻAṭṭūf (B). Strategically, the system was connected with the neighbouring castles of Hormuz and Crac de Montreal (ash-Shawbak) and with the fortified area of Li Vaux Moises (al-Wuʻayra) (C), converging point for the whole system.

5 See earlier observations on this point (Vannini and Vanni Desideri 1995:510-514).

role of Petra. Al-Wu'ayra was constantly fought over by the Muslims throughout the second half of the 12th century. After the battle of Ḥiṭṭīn in 1187, al-Wu 'ayra was the last Transjordanian stronghold to fall.[6]

The key to understand the topographical and urban layout of the fortified site – as documented during this investigation – is to be found in the territorial policy carefully programmed and stubbornly defended by the Crusaders. This policy was maintained in respect of the immediate surrounding territory through the control by the Crusaders of major and local roads, the Petra valley disposition of fortifications, and the control of the entirety of southern Transjordan between al-Karak and al-'Aqaba.

2. The Occupational Phases of al-Wu'ayra

The subject of this report is limited to a preliminary general interpretation of the site's archaeological phases and a presentation of the ceramic finds in a stratigraphical sequence within a limited and precisely dated chronological range.[7] This preliminary interpretation will be based on the data produced from one of the 'open area' sondages (Sondage 3), which highlights a clear stratigraphic sequence documented at the site by other sondages as well.[8]

It has been possible to demonstrate that the castle as a whole was divided into large areas, whose general role was to control the complex rock formations dominating access to Petra.[9] As to the *cassero*, a much more complex picture emerges (FIG. 3). On the basis of 120 Topographic Units recognised archaeologically and in many cases put into relative chronological order, the structure of the *cassero* appears to have undergone successive alterations. This sequence is indicated by the stratigraphy of the walls and the occupation floors.

For example, the *cassero* consists of a monumental citadel and a lower bailey with buildings of lesser significance, while certain areas are characterized by their functions with a remarkable coherency, both on account of their locations and their structural and architectural features (FIG. 4).

This is true in particular of the access point, effectively isolated from the rest of the castle, and consisting of a narrow and rugged ramp excavated into the natural rock and a gatehouse (*antiporta*). The gatehouse consists of a reused prehistoric tomb completely lined by a covering of stone blocks, probably both on the inside and the outside.[10]

The same is true of the fortified church, in a carefully selected location that makes it the key point in the internal organisation of the entire castle. This position projects from the north-east corner of the citadel, and dominates the bailey area from above; the church is connected to the lower bailey by an access ramp (Sondage 8) and by the north postern gate found in Sondage 4. Inside the church we reached a floor paved with flagstones (Sondage 5) and we identified the collapsed remains of the access portal on the southern side *in situ* (Sondage 8). The church is the central point of communication between the *cassero* and the external fortified areas, and also concerning for the system of internal communications .

It controlled the two posterns, found during excavations, to the north (Sondage 4) and the west (Sondage 6) and one of the two protected accesses between the citadel and the lower area. It also guarded the main access to water (i.e. the great cistern underneath: UT11); this system of control is encountered at other Crusader castles, such as ash-Shawbak, although it differs in design, and probably has symbolic significance (FIG. 5).[11]

The defensive system consists of a curtain wall, in some cases a double curtain (as along the Wādī al-Wu'ayra, to the east), supported by large towers at the corners (as on the north-east and south-west) or along the sides, and most of which project from the wall (as at the north and west sides). This system would appear to include the earliest structures built in the internal spaces according to a relative chronological sequence. This fact confirms the primarily military motivation of the settlement of al-Wu'ayra, the most significant within the Crusader fortified system at Petra, and that also underlines the fact that all fortresses were intended for the protection of the inner valley.[12]

The same interpretation may be ascribed to the careful organisation which is apparent in the plan of the complex system for collection, storage and distribution of water.

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6 Al-Wu'ayra was probably abandoned after ash-Shawbak's capture by the Muslims (1189). Similarly, *Chastel Pelerin* was captured shortly after the conquest of the capital of the last Crusader State, St. John of Acre: see Prawer 1981: 365-371. Prawer also refers to the work of C. Johns, who conducted the first excavation at a Crusader castle in the early 1930s with the methods of the *'Archaéologie Monumentale'*.

7 An attempt was made by Brown (1987: 277-287), on the basis of a limited number of finds. Although her conclusions may need amending in the light of recent research, they were the first effort in this respect and still deserve attention.

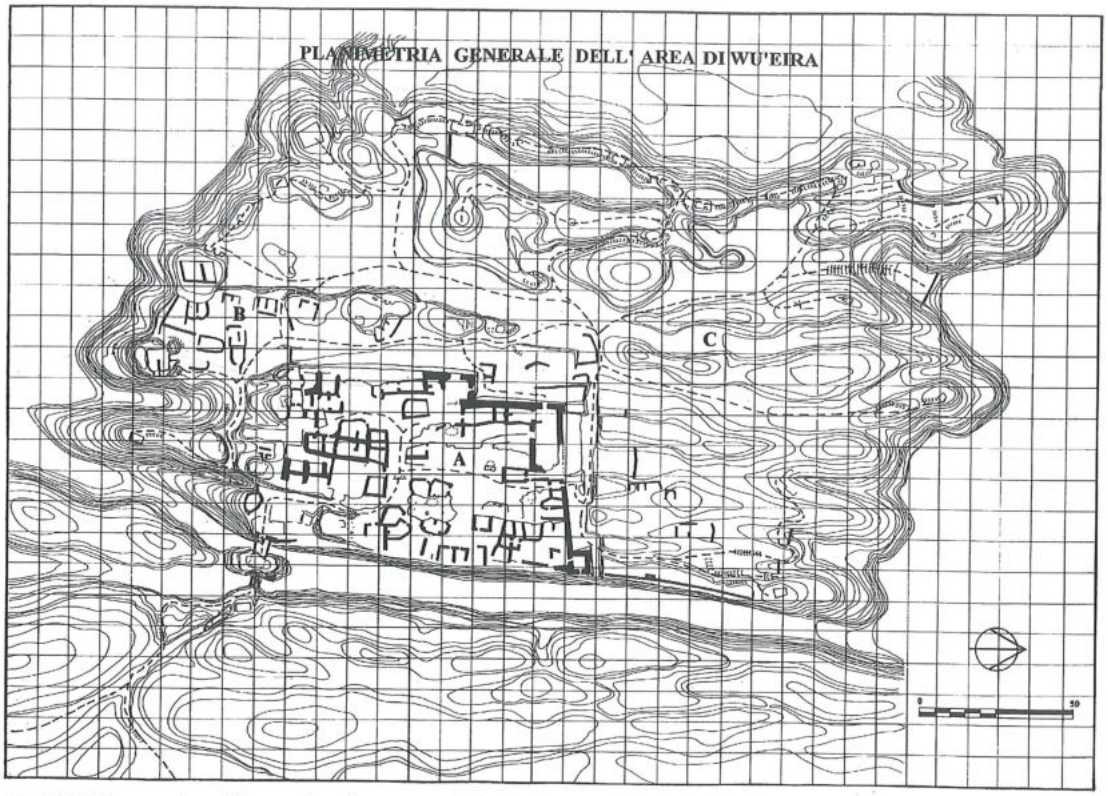
8 Within the main project, various research sectors aim to define the material and cultural characteristics of the Crusader settlement in the Petra region. These include the study of various man-made finds, including baked bricks and building materials, carried out on the basis of laboratory analysis by Roberto Franchi, University of Urbino; environmental studies, under the direction of Claudio Bini, University of Venice, including palaeobotany, palynology and archaeozoology; the study of building techniques; the systematic investigation of internal and external paths at the site itself. See also the computer-aided survey and mapping methodology, applied both horizontally and vertically at the site of al-Wu'ayra, in the Petra valley and in the region, and presented at the sixth conference of *SHAJ* in Torino by M. Bini, S. Bertocci, Paolo Peduto, and Ugo Santoro.

9 Vannini and Vanni Desideri 1995:514-519.

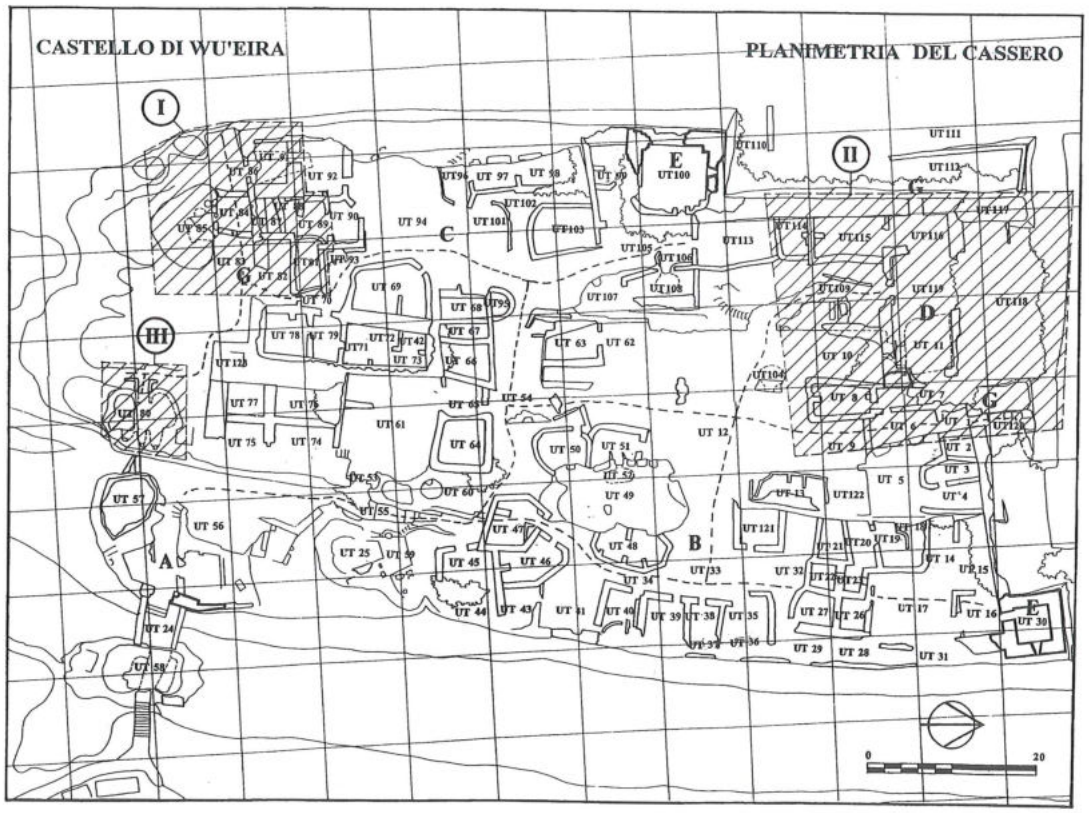
10 R. Berretti, M. Frau, at Torino conference.

11 The planned layout and the actual construction of the church at Li Vaux Moises (al-Wu'ayra) shows similarities with the church at Montreal (ash-Shawbak), completed in 1115. The building of the church at al-Wu'ayra may be ascribed to the phase of alterations occurred in the following year (see *infra* n.16); this interpretation is based on the stratigraphic sequence observed during the excavation (Area II). On the project and chronological relationship between the two churches, see Langendorf and Zimmermann 1964:125-143. M. Bini and S. Bertocci, at Torino conference.

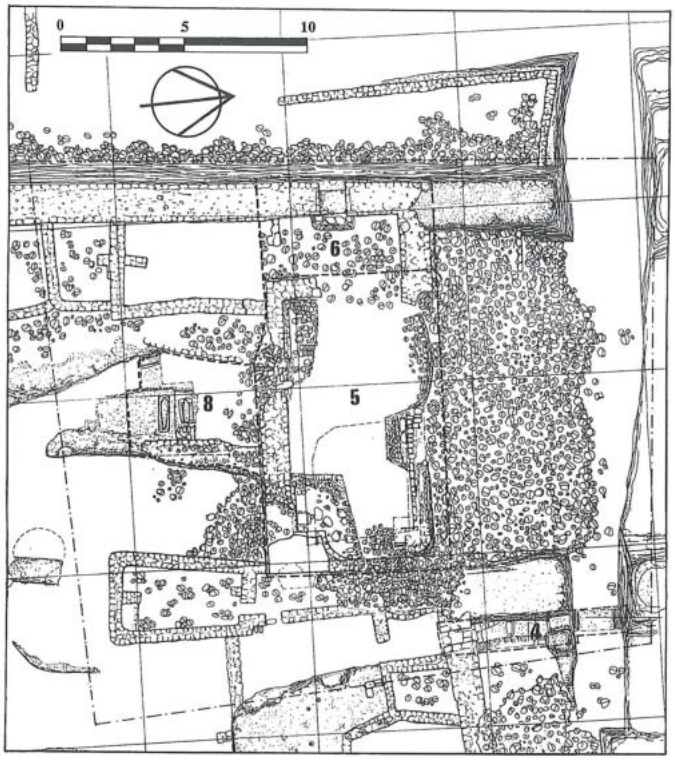
12 On the NE tower see *infra*, M. Bini, S. Bertocci, ok. on the Western Tower see Vannini and Vanni Desideri 1995:524, FIG. 10.



3. Al-Wu'ayra, plan of the castle. The cassero (A), the 'borough' (B), the fortified area (C), and the internal communication system.



4. Al-Wu'ayra, plan of the *cassero*. The various Topographical Units identified were organised in a relative chronological sequence. In the figure are illustrated the access (A), the lower bailey (B), the monumental citadel (C), the church (D), the towers (E), the internal pathways (————), the northern, the southern and the western posterns (G); the excavation areas (I-III), the Sondages (area I: 1-3; area II: 4-6, 8, 9; area III: 7, 10).



5. The fortified church system (excavation Area II). a. Sondage 8: the access ramp to the church with burials on the eastern side; b. Sondage 4: the northern postern gate; c. Sondage 6: the western postern gate with bent access ('sceo'); d. Sondage 5: church.

This system consisted of a network of collecting basins, covered or subterranean cisterns, small tanks (some of which were restorations of earlier tanks) and channels formed by cutting into the bedrock and by building masonry structures. As a result separate parts of the site had their own autonomous water system, such as towers and defensive outposts, which were thus able to resist in the case of their temporary isolation (FIG. 6). [13]

In addition, a complex and sophisticated system of internal communications is now emerging, strictly related to the fortification as a whole. The external routes leading in a north-south direction to the valley and in an eastern direction to the major Transjordanian north-south road to ash-Shawbak, al-Karak and Ayla, are connected to this system.

The internal communication system of pathways from the lower area of the bailey converge on three narrow defended passages leading to the only access gate to al-Wu'ayra and the citadel through the two ramps mentioned above. The connecting points between the *cassero* and the external fortified areas are among the best protected, and include a gatehouse, movable bridges over the moat cut into the bedrock, and *sceo* accesses.[14]



6. Cistern. A natural cavity was enlarged with masonry. A series of marks carved into the rock were identified, indicating that this cistern was once covered (western fortified area).

Sondage 3 was opened in a point where surface reconnaissance had suggested the location of crucial connection between the *cassero* and the north fortified area, interpreted as the borough. On the rocky ridge were remains, mostly foundations, of the southern curtain wall. Their discovery made it possible to identify one of the original accesses to the Crusader castle (Phase I); this appears to be the key for the overall interpretation of the area and of the role that it served.

If we leave aside the prehistoric phase – represented by the robbed tombs and a series of residual artefacts – the overall picture for the historic periods, indicated in all areas explored up to the present time, relates to the construction and occupation of the Crusader castle itself followed by the period of its abandonment and the ruin of its structures. This confirms the assumption that the site was an 'abandoned village' in the post-Crusader period. It offers a picture of the nature of the first Crusader settlement in the Holy Land.[15]

In excavation Area II (Sondages 4, 5, 6, 8), the occupation floors of the last Phase (III) of occupation, when the castle was still functioning as such (US1/7, 116/5), were directly covered by the earliest collapse of the contiguous walls of Phase V (US1/6, 120/3, 119/9, 16) (FIG. 7).

Only in Sondage 3 does this sequence appear to be interrupted by a third period of occupation, which can be ascribed most probably to an Ayyubid presence after the capture of the castle in 1189.

To summarize, the first period with occupation levels in primary deposition (together with correlated wall stratifications) seems to be divided into three stratigraphic phases with no apparent interruptions (FIG. 8).

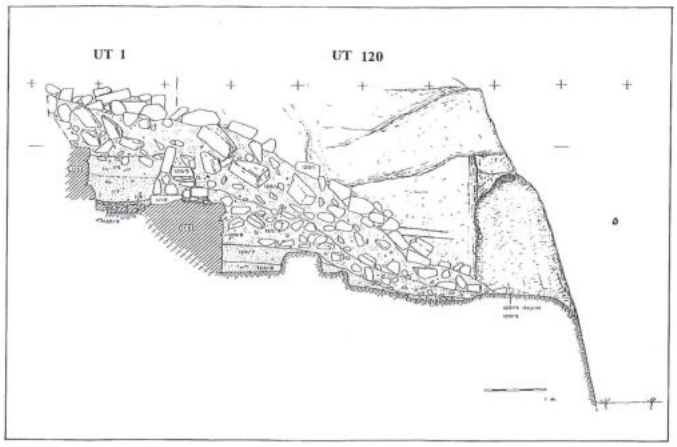
The first phase (Phase I) can be directly related to the fortification of the area[16] with an access door to the *cassero* and the corresponding occupation levels of the

[13] See Vannini and Vanni Desideri 1995: 518-519, FIGS. 7, 12; a first attempt at classifying the water system at al-Wu'ayra was made during the preliminary phase of the research project (see Marino *et al.* 1990). Of great value is still Deschamps 1932: 163.

[14] The term '*sceo*' describes a bent entrance in which the attacker is always compelled by its disposition to expose the unprotected parts of the body to the defenders.

[15] Pringle 1989: 171-202. A remarkable synthesis on the subject has been recently published by Kennedy 1994.

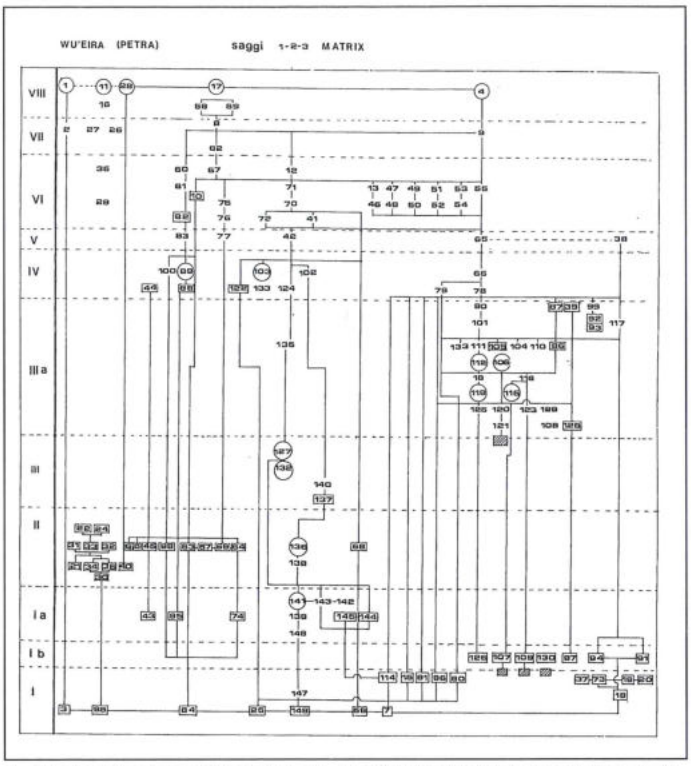
[16] In this phase, a number of earlier structures were reused, such as the niches cut into the rock, which show marks of later alterations.



7. a. Sondage 4 (northern postern). Section of the collapsed structure.



7. b. The collapse on the paved floor of the church.



8. Excavation area I (Sondages 1, 2, 3). The 'matrix'. Phase I: prehistoric period and reused structures; Phases Ib-a: Crusader foundation (beginning of the 12th century); Phases II-III: subsequent alterations carried out at the castle (mid-12th century); Phase IIIa: Ayyubid reoccupation (end of the 12th-beginning of the 13th century); Phase IV: final abandonment (early 13th century); Phases V-VIII: series of collapses and squatter occupation layers (13th-20th century). Stratigraphic Units: ⓵= occupation surface; **16** = fills; **10** = structures.

southern moat (US141, 143). A similar situation marks the relationship between the original occupation levels (US120/8) and the postern inserted into the north curtain wall (FIG. 9).

If this phase can be attributed to the construction of the Crusader castle, the beginning of building must be dated between 1107 - when king Baldwin defeated a force of 3000 Syrians who were building a fortress at Wādī Mūsā - and the new building projects started in 1116, as part of the general programme of building a network of fortresses in Transjordan.[17]

Typical characteristics of Phase II are the radical modifications of the ground plan, consisting in the removal of the passageway and the construction of a new section of curtain wall. Three courses of this wall have been preserved, showing that a simpler construction technique was used, which was efficient in view of the strong mortar used but constructed in a slovenly and perhaps hurried manner (USM68). To this period of rebuilding we can ascribe a slight rise in the terrain and a new occupation level (US136) (FIG. 10).

[17] King Baldwin was in Wādī Mūsā from December 1100 (Deschamps 1939: 40-41; Hammond 1970:34; Foucher de Chartres, *Gesta Francorum Jerusalem expugnantium*, 1, II, c. 5, in *Recueil des Historiens des Croisades, Hist. Occidentaux,* Paris 1841, III: 381; Albert d'Aix, *Histoire*, 1, VII, C. 41, in *Recueil, Hist. Occ. Crois.*, IV: 535). However, in 1104 the Atabeg Tughtekin marched with his force from Damascus through Transjordan to help the Egyptian army fighting Baldwin in Sinai. The fortification built in 1116, quoted as *"praesidium novum"* in the historical sources, may convincingly refer to the neighbouring castle of al-Ḥabīs (Hammond 1970: 34; Deschamps 1934, I: 22; Albert d'Aix, *Histoire*, XII: 21 in *Recueil*, IV:702). This implies that at least one other fortress already existed in the region, the *Li Vaux Moises* of the Franks. Its construction may thus be ascribed to other visits of King Baldwin to al-Wu'ayra in 1107 (Ibn al Qalanisi, in Gibb ed, 1932: 81-82; Albert d'Aix, *Histoire,* X, c. 28, in *Recueil, Hist. Occ.*, IV:644; see also Deschamps 1939: 41: Hammond 1970: 7) or his campaign of 1112 in the region (Albert d'Aix, *Histoire*, XII-XXXI, in *Recueil, Hist. Occ. Crois.*, IV:693; Ibn al-Qalanisi, in Gibb ed.1932: 131-132).



9. Sondage 3. Hinge and threshold of the southern gate to the *cassero* (during excavation).

As already mentioned, the castle of al-Wu'ayra appears frequently in the documentary sources of the 12th century, and always as the subject of some royal activity or as a centre of military episodes; this leads us to conclude that it had an important role in the protection and survival of the Crusader presence in Transjordan.

One of the most clearly understood of these operations, which probably involved a new plan for a considerable restructuring of the castle, was be that carried out in 1142 by the future Lord of Transjordan, Payen le Boutellier, as part of an overall project for the reinforcement of the defences of the new Lordship which was soon to have al-Karak as its capital.[18] Al-Wu'ayra was captured by the



10. Rebuilt curtain wall (US68). Only the lower courses, set directly on the natural bedrock, were found. This original gate was blocked during subsequent Crusader alterations (cf. FIG. 9).

Turks in 1144 and almost immediately reconquered by the Crusaders, with king Baldwin himself intervening.[19] This episode may be related to the reconstruction of the defensive walls and the closing of the original door of the *cassero*.

This arrangement did not change with the continuous sequence of occupation levels of Phase III (US132, 127); the interface of the latest level is totally burnt and can be related to the deposit of abandonment of the site for military purposes (FIG. 11).

The following Phases IIIa and IV, reveal a radical change in the use of the site which loses its military function, even though they also show evidence of continuation from the preceding phase.[20] Most of the material from the massive collapse of the curtain wall was removed from the defensive moat, though it had already filled up the adjacent area (US101), and it was occupied by a metal foundry.[21] This occupation, however, does not seem to have lasted long: already the upper occupation level (US66) shows a Phase (IV) of abandonment of the area, covered by subsequent collapse (US65).

It is thus reasonable to interpret Phases IIIa and IV in relation to the Ayyubid occupation which immediately follows the capture of the castle in 1189; at the same time, on the basis of what has emerged so far, this later occupation must be considered limited within the site as a whole. This reoccupation is limited to a reuse of the ruins after their radical destruction for a very brief although not precisely identified period.[22]

The last period which can be ascertained archaeologi-

18 William of Tyre, *Historia*, XVI, VI, in *Recueil* 1844, I, 2: 692-693 (see Hammond 1970: 9-10; Deschamps 1939: 46).

19 Hammond 1970 :7; William of Tyre, *Historia,* XVI, VI, in *Recueil* 1844, I, 2: 712-714. Our conclusion has to be regarded as a working hypothesis, because in relation to such a limited span of time (the foundation and occupation of the castle and the military events described in the sources in relation to it), the archaeological data may not be as easy to interpret as expected. An alternative interpretation of the archaeological data can be offered in relation to yet another, but fruitless siege of al-Wu'ayra carried out by an Egyptian army in 1158 (Ibn Moyesser, in *Recueil*, *Hist. Orientaux Crois.*, Paris 1872, III: 472; Runciman 1952, II: 341-342). This second hypothesis, however, does not substantially modify the general interpretation of the archaeological data and historical records.

20 Continuity appears very clearly in the stratigraphic sequence in the case of layer US124, whose interface is barely distinguishable from US127 above it.

21 Vannini and Vanni Desideri 1995: 526-527, Figs. 12, 13.

22 R. Brown, in her sondage at al-Wu'ayra (Homès-Fredericq and Hennessy (eds) 1989, II2: 625-631; see n. 1), also identifies a "phase II"; this phase is described as limited in terms of its importance and duration, and it is attributed to the Ayyubid period on the basis of the ceramic finds (see Vannini and Vanni Desideri 1995:535-538 and *infra*).



11. Occupation levels: Phase I (US 141), Phase II (US 136), Phase III (US 132, 127). These levels are related to the Crusader occupation of the castle. They overlook the moat of the original layout.

cally refers to a complex but perfectly clear stratigraphy of collapses, with at least four main phases (Phases V-VIII). One of these (Phase V) relates to the definitive abandonment of the site, with massive wall collapses (US83, 42, 65, 38) with masonry often falling consistently in a uniform direction, suggesting a particularly violent earthquake (one is in fact attested at Petra in 1201-1202). [23]

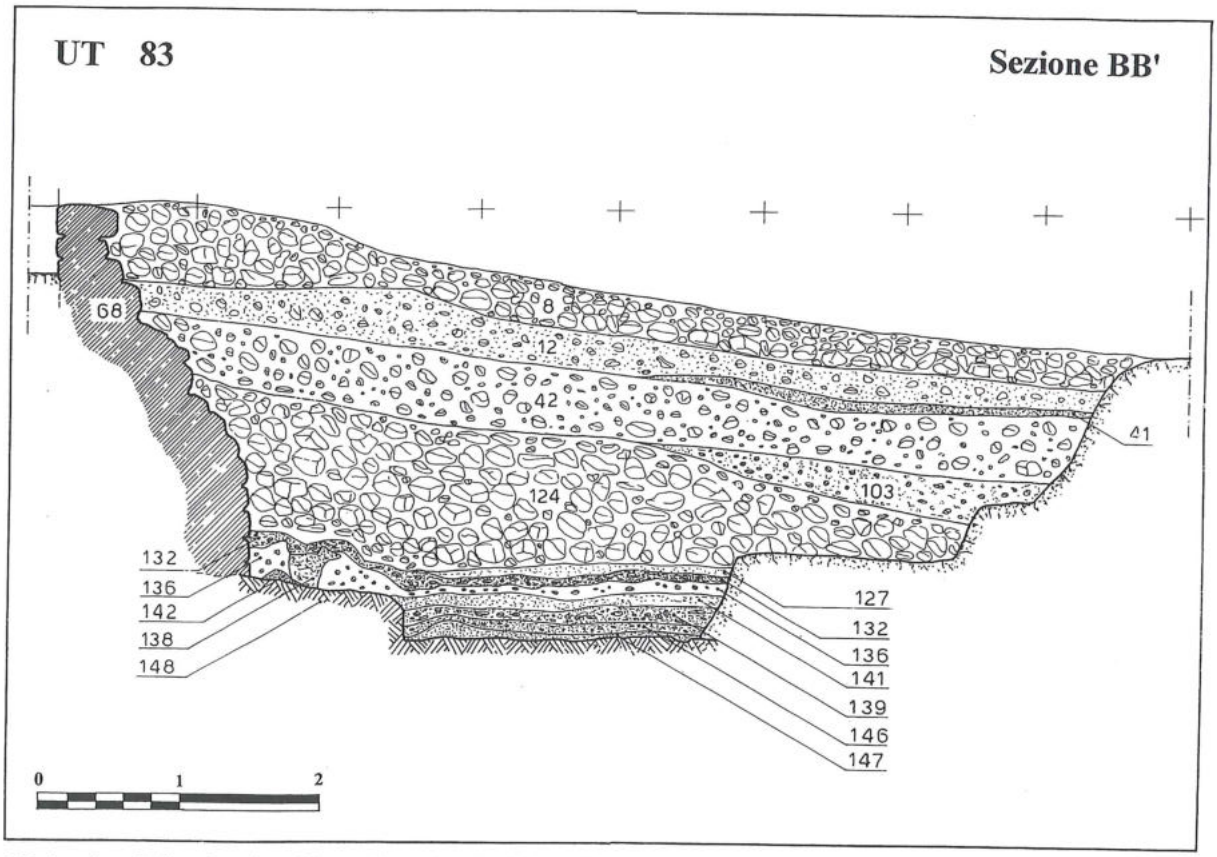
These collapse levels, which were also noted in this phase in numerous other sondages,[24] appear on several occasions to alternate with soil surfaces showing traces of squatter occupation.[25]

The last phase of collapse (Phase VIII) can be attributed to the present century since the vault of the apse of the church was still standing when Savignac visited the site in 1903 (FIG. 12) .[26]

This historical framework is supported as far as can be ascertained by a sealed and well dated archaeological sequence. The picture which emerges helps to delineate the *charactères originaux* of the European presence in the Holy Land, here more readily recognisable archaeologically than in the Latin Kingdom of Jerusalem. It also contributes its stratigraphic data to a reconstruction of the typological and chronological sequence of several assemblages of artefacts dating to the period between the 12th and the 13th century.

3. The Pottery

The pottery studied so far came to light in the course of the excavation of Sondage 3, the stratigraphic sequence of which has been discussed above (FIG.13). Needless to say, a much clearer picture will be available in the future,



12. Sondage 3. Stratigraphy of the collapsed walls (Phases IV-VII: US 8, 12, 42, 124): N-S section.

[23] See Hammond 1970:36; Deschamps 1934, I: 111.

[24] See, for example, US120/3, and US 1/6 in Sondage 4, Phase V.

[25] A number of fireplaces and evidence of camping were found; see, for example, US 47, 49, 51, 53 in Phase VI.

[26] Savignac 1903: 115; in this respect, cf. M. Bini and S. Bertocci, at Turino conference.



13. Ceramic fragments *in situ* (Crusader occupation layer of Phase II, Sondage 3).

taking into consideration the finds as a whole.[27] Since the sample of pottery considered here is fairly limited, in particular as far as the earliest phases are concerned, results must be treated with caution (see FIG.14 for a quantitative assessment of the pottery finds). In spite of its limited size, the assemblage is of a certain value for several reasons: 1) it represents one of the few corpuses of stratified pottery available for the area; 2) it is related to a limited span of time; 3) reference to historical sources has provided absolute dating for the stratigraphic sequence examined so far.

Since the nature of the assemblage is closely related to the function of the area, in considering the sequence of the finds one should bear in mind that the excavation area was located outside the *cassero*; especially in the first phase, as pointed out in the first section of this paper, the area was not occupied in a strict sense, but has been interpreted as an area of passage, connecting the inner citadel to the lower bailey (see above).

Although at a preliminary stage of study, the assemblage reveals interesting trends and provides working hypothesis to be developed in future research. As already discussed, nine phases were distinguished in the course of the excavation of Sondage 3. For the purpose of this preliminary assessment of the pottery, the last four phases (a

	Number of Fragments
Phase Ia	522
Phase II	69
Phase III	493
Phase IV	1705
Phase V-VIII	4683

	Min. Forms Number
Phase Ia	195
Phase II	50
Phase III	172
Phase IV	179
Phase V-VIII	595

14. The pottery assemblage from Sondage 3: quantitative data.

series of collapses) were grouped together, since the pottery was extremely homogeneous and the proportions were consistent among the various groups.[28]

Graphs 1 and 2 (FIG. 15) illustrate the proportion of the major groups of pottery identified at the site.[29] In both graphs, the handmade pottery group is numerically the most significant, with variations which can be broadly attributed to chronology, but also to the change of function of the area within a limited span of time.

The *handmade pottery* assemblage has been further subdivided into the *plain handmade pottery* group, which only occasionally has incised and/or carved decoration (group A), the *painted handmade pottery* group (group B) and the *slipped handmade pottery* group (group C).[30] Sherds of this latter group (C) very likely correspond to undecorated fragments of vessels with painted decoration (B).

The *plain handmade pottery* group (A) is numerically the most significant among the various groups of pottery, and it is present in a large variety of shapes, jars and basins of various size, lids and filters (FIGS. 16 and 17).[31] Vessel shapes do not seem to vary from the earliest to the latest phase but, as already said, the assemblage consid-

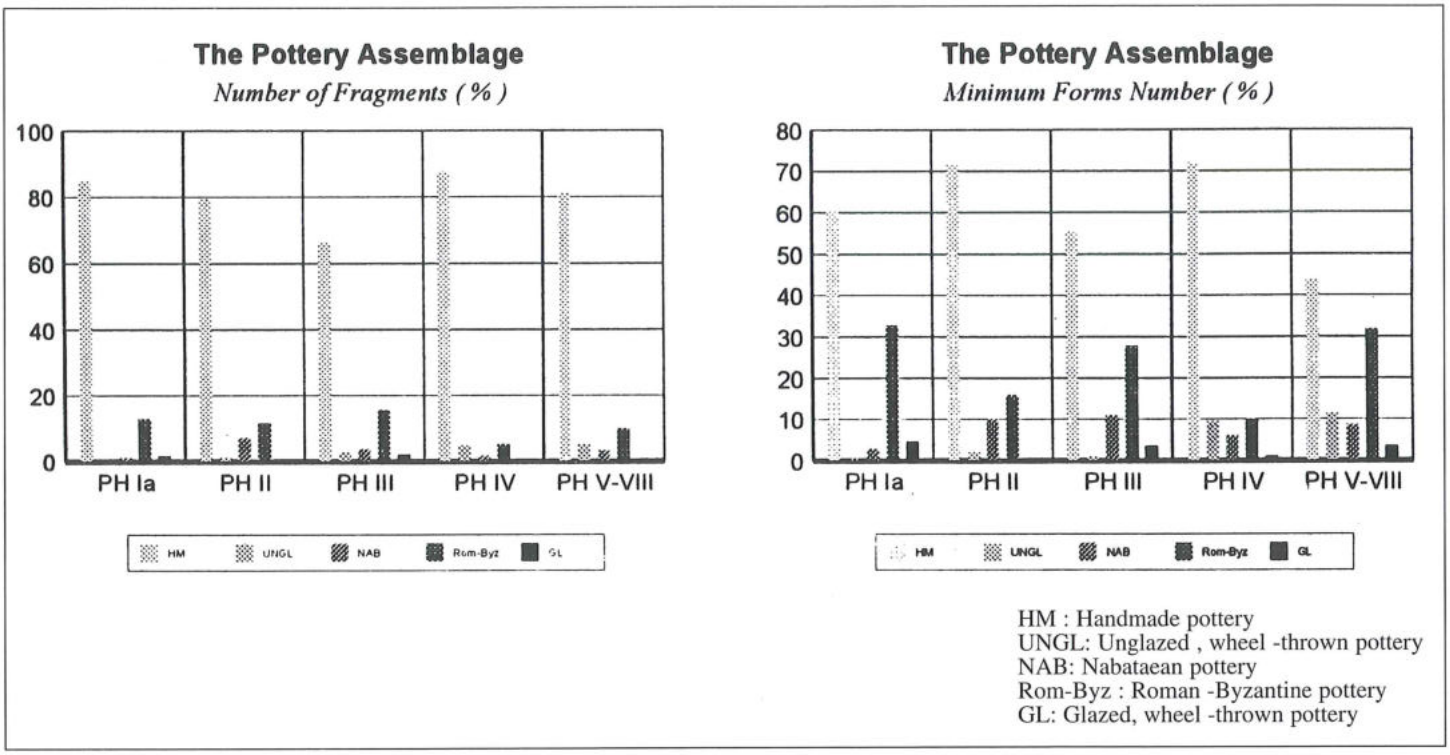
[27] The study of the entire assemblage of finds from the excavation, currently in progress, is conducted by C. Tonghini and A. Vanni Desideri. Their contribution will appear in the volume, currently in preparation, devoted to the publication of the results from various seasons of research at al-Wu'ayra (1989-1995).

[28] Phase III was subdivided into III and IIIa, but only Phase III has provided finds in Sondage 3.

[29] It is important to note the considerable difference between the picture offered by figures related to the 'total number of fragments' (TNF) and those referring to the 'Minimum Forms Number' (MNF). This accounts for the difficulty of assessing the MFN, particularly unreliable in the case of *handmade pottery* productions and, in general, is related to the difficulty of establishing an objective system to assess quantity. The comparison between the two figures (TNF and MFN), however, allows a better evaluation of the proportion issue. An attempt to calculate the MFN on the basis of rims only will be made in the future on this same assemblage to test if such an approach is more valuable. In particular, whatever system is used, numbers often seem inadequate to compare pottery from collapse and pottery from occupation phases.

[30] The so-called *handmade pottery* has been attested at various archaeological sites of Jordan and Palestine. The group has yet to be precisely defined in terms of chronology; its use may have lasted for a considerable span of time: handmade wares are already attested at Ayla in a period which could correspond to the 11th century (Whitcomb 1988: 212), but the production may have started even earlier. C14 analysis, recently conducted by Manfred Lindner's team on a *ṭābūn* context from Khirbat al-Mu'allaq, from where a handmade pottery vessel was also recovered, provided a 785-1015 AD date. Results are at press. We are particularly grateful to Dr Lindner for kindly providing this information. *Handmade pottery* may have been still produced in the Ottoman period. See Brown 1992: 189-198, 256-259, 310-336; Franken and Kalsbeek 1975: 143-159 in particular; Pringle 1984: 95; 1986: 139-140. A description of this type of pottery can be found in Brown 1987: 277-287, and Vannini and Vanni Desideri 1995:530. See also Pringle 1985: 176; Johns *et al.*1989, p. 89.

[31] See Vannini and Vanni Desideri 1995: Figs. 16-19.



15. The pottery assemblage from Sondage 3: the pottery groups and their proportions (graphs 1 and 2).

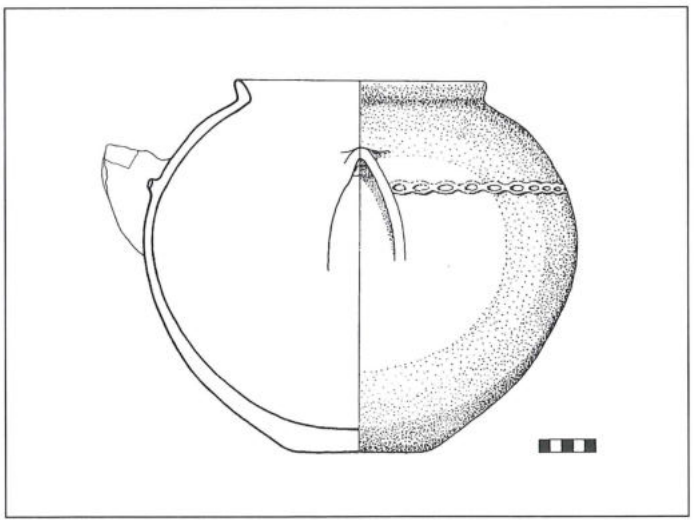
ered so far is fairly limited in terms of quantity.

The *painted handmade pottery* group (B) has caught the interest of scholars only in recent times; in general, this group has not yet been very precisely dated and its evolution over time is still very difficult to assess, as is the case for other handmade wares.[32] The assemblage recovered at al-Wu'ayra does not show significant variations within the stratigraphic sequence.

On the basis of the pottery excavated at al-Wu'ayra, it is not possible to confirm the hypothesis, put forward by a number of scholars, that a so-called 'linear' type of decoration preceded the more complex so-called 'geometric' style.[33] Sherds decorated in the 'geometric' style are present from the earliest phase identified in Sondage 3. In the same assemblage, some sherds are decorated with lines, but their size is too small to safely conclude that they belong to the 'linear' group. Only three sherds of this group are painted in two colours, red and brown. They appear in Phase I, III and IV; for this reason, the use of two colours may not have chronological connotations. All the other sherds are painted in brown, red, or reddish brown.

The colour of the paint used for the decoration varies a great deal as a consequence of fire, and a great difference in the colour of the surface, of the slip, and of the decoration is often detected on the same vessel. This allows us to conclude that the group is extremely homogeneous and overclassification according to the colours of the decoration or to the colours of the slip must be avoided.

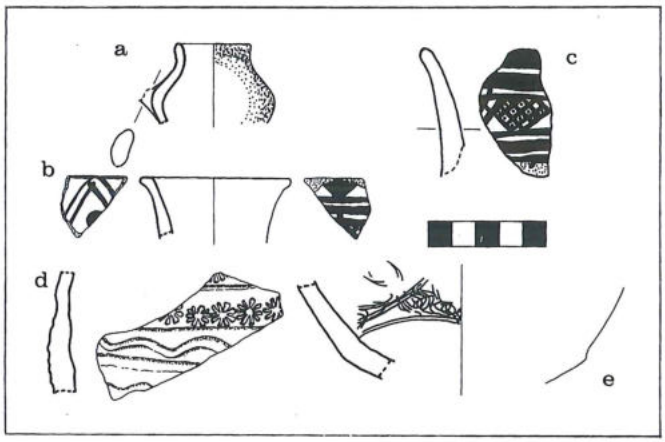
The analysis of proportions reveals interesting trends (FIG. 18): *painted handmade pottery* is numerically quite significant in Phases II and III of occupation, and gradually diminishes from Phase IV onwards; its percentage is very low in the latest phases. This data is very difficult to interpret in the light of our present knowledge, especially because *painted handmade pottery* is attested at a number of sites in post-12th century assemblages.[34] A satisfacto-



16. A selection of pottery from Sondage 3: Handmade pottery - cooking pot (US 127, Phase III)

[32] An exhaustive survey of *painted handmade pottery* has been recently provided by Johns 1992. See also Brown 1987: 284-287 and 1992: 189-203, 243-256. Franken and Kalsbeek 1975: 167-203. Pringle 1984: 97-99; 1985:176; and 1986:140-142.

[33] See in particular Brown 1987: 284-287.



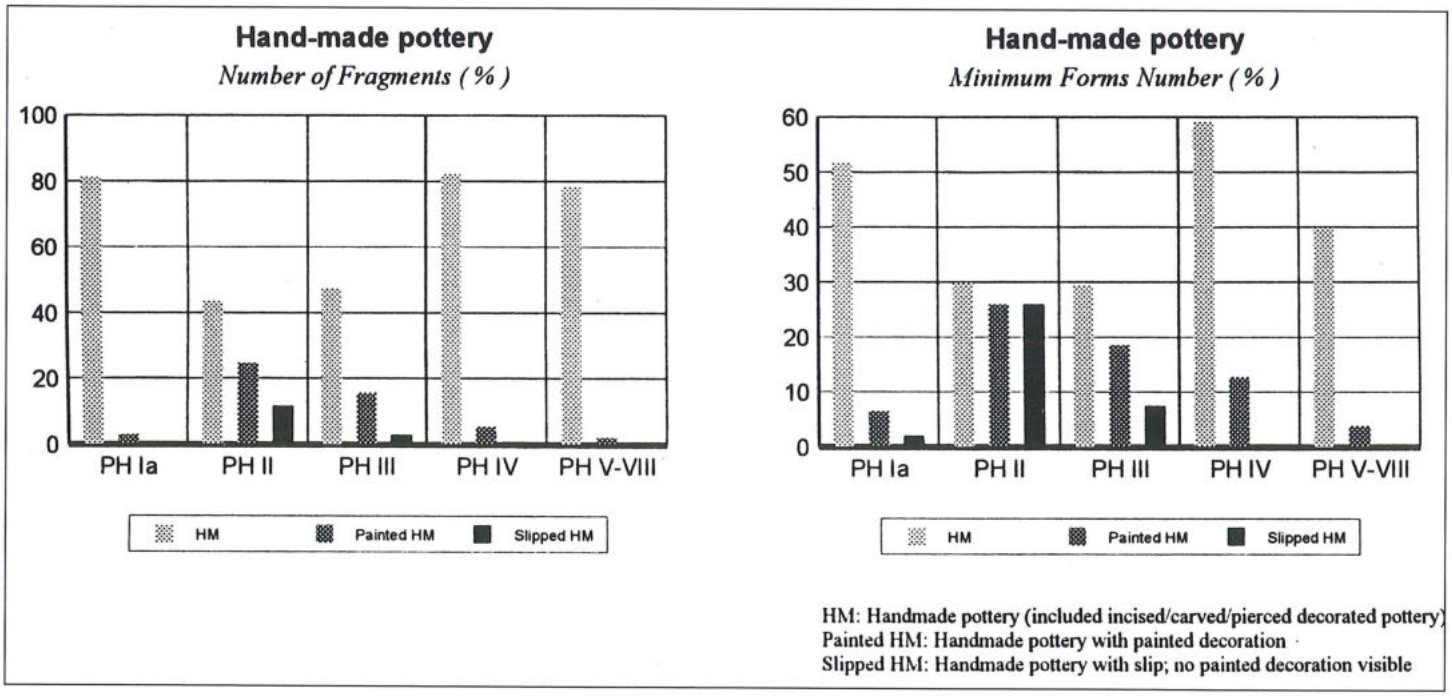
17. A selection of pottery from Sondage 3:
a) handmade pottery - small pot (US 127, Phase III)
b) painted handmade pottery (US 127, Phase III)
c) painted handmade pottery (US 127, Phase III)
d) cream-ware with stamped decoration (US 124, Phase IV)
e) graffita ware, monochrome yellow glaze (US 124, Phase IV)

ry explanation has not been found yet for the gradual diminution of the group over time; further research at the rest of the site is likely to provide new evidence to interpret this data.[35]

The group termed 'Roman-Byzantine pottery' is also quantitatively significant; it includes wheel-thrown pottery of various types but with pre-Islamic characteristics,[36] and the 'Nabataean pottery' group. All this pottery has been interpreted as residual, since it consists in most cases of very small and worn fragments. Only small sondages have been dug, but they were sufficiently numerous and covered a significant proportion of the site as a whole to allow this conclusion to be drawn. A part from the residual pottery, they have provided so far no evidence for the site being occupied during the Nabataean, Roman or Byzantine period.

The large quantity of the pottery found reflects industrial production,[37] but it may also be related to the already mentioned difficulty of accurately assessing the significance of quantity (see above, n. 28). On the other hand, the use of Nabataean, Roman, and Byzantine pottery in the mortar mix in masonry is well attested at the site, used to plaster the inside of water tanks and cisterns, and it is probably to this reuse in masonry that the quantity present at the site should be related. In particular, a thickly potted ware with a well levigated, brick-red, well-fired body is extensively used for laying water tanks; this pottery may be attributed to the late Byzantine period (FIG. 19).

The *unglazed pottery* group includes wheel-thrown pottery, probably from various areas of the Islamic world.



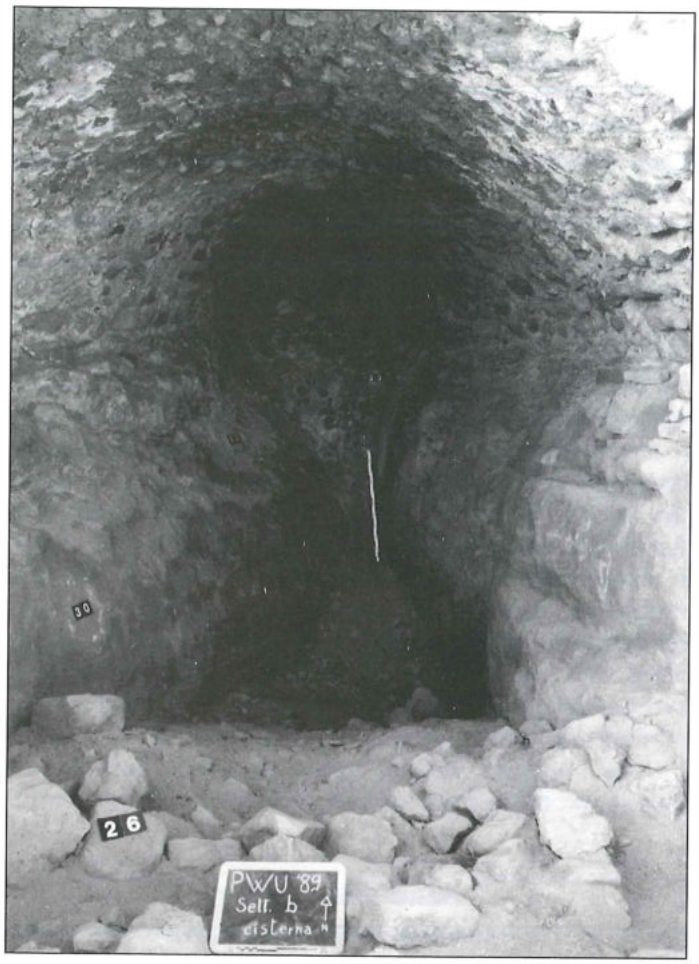
18.The pottery assemblage from Sondage 3: the handmade pottery group graphs 3 and 4) .

[34] See Brown 1992:243-256, and Johns forthcoming.

[35] See Brown 1988:237: at ash-Shawbak, painted handmade ware is poorly represented in Phase III, which can very likely be considered to belong to a late Ayyubid and Mamluk date.

[36] The classification of this group has been conducted at a very preliminary level. A more detailed analysis of it conducted by experts specialised in the pre-Islamic period has been planned. The re-examination of this assemblage by a specialist may provide a much more detailed classification, especially in relation to chronology. The authors would like to thank Yvonne Gerber, University of Basel, for having looked at part of this assemblage and for providing valuable information and advice.

[37] A very high proportion of residual Byzantine pottery has, for instance, been recovered at the Red Tower; see Pringle 1986: 135.



19. Water tank inlaid with pottery sherds.

Most of the pottery classified in this group may be contemporary to the Crusader occupation of the area, but it may also include some Late Byzantine-Early Islamic wares, which were not immediately recognised and could not be readily classified in the above mentioned group of Nabataean, Roman and Byzantine pottery. A general survey of contemporary pottery at non-Crusader sites will provide more information about the provenance of the sherds classified in this group.[38]

Glazed pottery forms a very low percentage of the assemblage. The graphs illustrate the incidence in the various phases of the entire *glazed pottery* group and do not differentiate among the various categories of glazed pottery.

In the earliest phase, Phase I, *glazed pottery* is characterised by the application of the glaze directly on the body, without employing slip. The sherds recovered belong to the so-called *Turquoise-glazed ware* group of possible Syrian and Arabian provenance, infrequently found at other sites in Transjordan and Palestine. A sherd of glazed cooking pottery was also present in this phase.

In Phase II, no *glazed pottery* was recovered; in general, this phase has provided very little material.

In Phase III, *glazed pottery* consists exclusively of *fritware*. *Fritware* was produced in Syria, Jazira, Egypt and Iran from the 11th century. The fragments found seem to be imports from the Euphrates valley; most of them may correspond to the first phase of *fritware* as it has been identified in Syria, the group which preceded the so-called *Raqqa ware*.[39] Only one of the fragments is decorated with the underglaze-painted technique; this technique was introduced in the second half of the 12th century in Syria, but was also extensively adopted in Egypt, and characterised the second phase of production in Syria and in the Euphrates valley, the so-called *Raqqa ware* phase. The presence of *fritware* sherds in Phase III suggests a date towards the end of the 12th century; this confirms the dating proposed above for this phase, based on historical sources. The presence of these imports in the last Crusader phase (i.e., pre-1189) may attest the link of the site with the rest of the Levant, directly with northern Syria and Jazira (Antioch and Edessa) or at least with the trading network of the coast.[40]

Unfortunately, this sondage provided no evidence in terms of pottery finds to illustrate Phase IIIa, which should correspond to the early Ayyubid period.

From Phase IV, the inventory of *glazed pottery* varies significantly: *monochrome glazed slipped-ware* makes its appearance, together with *graffita ware*. These wares circulated in Transjordan from the 12th to the 15th century, as attested by finds at a number of sites [41] and especially in 13th-14th century assemblages. It is generally considered a Southern Levantine production, but further studies are needed to better understand its chronology and its production centres and to precisely assess the distribution of the ware. In Phases V-VIII the assemblage of pottery includes all the types described above, but the proportion of slipped and glazed pottery is definitely greater than other types.

The passage from *fritware*, the product of northern Syria and Jazira, to a Southern Levantine glazed ware may be interpreted in context of the political change which occurred in this period. As a Crusader site of strategic importance, al-Wu'ayra was well connected with northern Syria markets (directly or indirectly); in the following, post-Crusader phase, glazed ceramics were supplied by more local markets and those found correspond to a fairly common group of glazed wares which were extensively produced and circulated in the southern

[38] Great caution should thus be exercised in dealing with quantity, since it is especially this group whose percentages may significantly change when more information is provided.

[39] For a recent classification of Syrian *fritware*, see Franchi *et al.* 1995 and Tonghini 1995.

[40] *Fritware* of both kinds has for instance been found at Antioch and Caesarea, see respectively Waagé 1948 and Pringle 1985; for a survey of *fritware* finds in the Southern Levant see Brown 1992: 298-304; it is very difficult to classify with precision most of the *fritware* found at the various sites mentioned by Brown 1992 on the basis of the publications alone.

[41] Brown 1988: 237; 1987: 284; and 1992: 267-280. Franken and Kalsbeek 1975: 131-141. Pringle 1984: 99-103; 1985:177-179; and 1986: 147-149.

Levant between the 13th and the 15th century.

4. Conclusion

The Crusader presence was unusual both for the intensity of the occupation and for the persistent search for settlement solutions in the region of Petra. This persistence, we believe, can be explained if the primary objective was total control of the valley. This policy may have been motivated by local conditions, such as the presence of water from rain and also from springs.[42] Documentary sources demonstrate that these conditions differ from those of the present day. However, these conditions did not attract settlement during the centuries immediately preceding the 12th and 13th century, apart from sporadic or nomadic presence. The area was in fact peripherical by comparison with the rest of the Islamic world, highly civilized and sophisticated at the time.[43]

This is not the time or place for a discussion of the problems of understanding the local settlement during the 11th to 13th centuries, a crucial gap in our knowledge of Transjordan. Suffice it to say that what has been described above is probably related to logistical requirements, perhaps the requirements of an integrated defence system, and the restoration for the first time for centuries of a frontier in the region.[44] This settlement model probably derives from European culture which is feudal, accustomed to administer from rural areas. This is equally true of the Normans in southern Italy. This model is quite different to the urban culture of the Near East which is a legacy of the ancient eastern Mediterranean tradition.[45]

As for the archaeological results at al-Wu'ayra, they confirm a stratigraphic picture in which the traces of occupation prior to the 12th century have been virtually erased by erosion, particularly severe for a site like al-Wu'ayra located on the edge of a steep cliff.[46] This situation also confirms the abandonment of the area after the Crusaders had departed except for the brief Ayyubid occupation, indicating the lack of interest in al-Wu'ayra by the Muslims as a military stronghold of strategic interest. The valley of Petra evidently soon again became a peripheral area.[47]

In conclusion, the character of the stratigraphic picture which has been presented and is still under study can be summarised as follows:

- a precise sequence of occupation levels (also connected with the structural phases), with the opportunity of comparison between layers of collapse.
- stratigraphy relative to the occupation of the castle 'squeezed' within a limited span of time, in all probability a span of less than a century;
- a possibility of precise and reliable absolute dating related to written sources.

It is, moreover, possible to make a few further observations regarding the apparently sporadic nature of the occupation of the site of al-Wu'ayra in antiquity.[48] The artifacts recovered, although in significant quantity, all come from secondary strata pertaining to the Middle Ages or later. They are of a residual nature both from a quantitative point of view (not a very great percentage, considering the scale of the production in Late Antiquity and the more modest production of Mediaeval times), as well as from a qualitative point of view (most of them are body-sherd fragments of small size).

However, the site, which was essential for the control of Petra, may also have been occupied by Nabataeans, Romans and Byzantines. In all probability, the rare but noticeable residual material evidence must be considered the remains of a presence. Traces of this may have been washed out by the rains in the steep location of the al-Wu'ayra site during the long state of abandonment, lasting probably from at least the seventh century up to the Crusaders' resettlement.

This interpretation can be proposed even though the exploration of al-Wu'ayra was limited to a relatively small area, the surface survey was very systematic. Further evidence in this respect may emerge from the excavation of a new sondage opened in the area of the gullies, which were filled up at some stage (FIG. 20).

Finally, we would also like to point out that the data collected will supply the scientific basis and the knowledge necessary for the development of a plan for restoration, conservation, maintenance and limited tourist utilisation of this monumental complex.[49] This archaeological area can again become a point of passage at the centre of the new entry paths to Petra, which UNESCO and the

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42 William of Tyre mentions "woods" and "little woods", olive groves and fruit trees in the region of al-Wu'ayra at the time of its reconquest by the Crusaders in 1144 (see *supra* n. 18; Deschamps 1939: 47). In more general terms, for the problem of erosion, the progressive abandonment of terracing and for the dicrease in the population in the region during the Middle Ages, and in particular in the 12th century, (see Ashtor 1982:49-54).

43 See, for example, Lombard 1980; Ashtor 1982: 69-115. A more articulated picture is now emerging, especially as a result of the British archaeological project at Khirbat Fāris, co-directed by J. Johns and A. McQuitty. See the synthesis presented by J. Johns (1992: 363-368). He describes a complex and dynamic demographic picture for the 11th-13th centuries, much richer than that provided by the interpretation of the archaeological data available so far. At present, in the light of archaeological evidence, we can only conclude that in the region, the inner plateau differs from the rest of the area (compare, for example, the 'urban' and more central al-Karak area with the pre-desertic region of Petra). In spite of these differences, the whole region (especially Petra) remains a peripheral area if compared with Syria, Egypt, Palestine and Ḥijāz, at least until the 12th century.

44 See Vannini 1987: 10-16; Vannini and Vanni Desideri 1995: 511, 538.

45 From the 11th century, this urban tradition gradually spread from the Mediterranean coasts, from Italy in particular, towards Europe. On the urbanisation of the Islamic world, see Lombard 1980: 145-172.

46 This is suggested by the traces of various features carved into the bedrock and by residual finds. The finds cannot be the result of erosion from another higher site, given the elevated location of al-Wu'ayra.

47 Vannini and Vanni Desideri 1995: 538. The settlement at Wādī Mūsā has yet to be studied, but from the evidence examined so far, it does not appear to have been a very important urban centre.

48 Apart from the important prehistoric settlement represented by the monumental cemetery area of the Early Bronze period (see *supra* n. 4).

49 A comprehensive programme for the consolidation, conservation and touristic development of the site is currently being planned by a team directed by Pietro Ruschi (University of Udine). A preliminary outline of this project has been presented at the Sixth International Conference of the History and Archaeology of Jordan (posters section).



20. Al-Wu'ayra. View from north; in section are visible the gullies filled up to obtain an adequate flat surface for settlement.

Jordanian Government are currently proposing.

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Agriculture in the Al-Balqā' District During the Nineteenth Century*

Guesthouses, or al-Maḍāfāt [1] as they are known in Jordan, were centres of social life during the nineteenth century and definitely for many centuries before. Gatherings in them were occasions when people discussed the general situation in the countryside and exchanged views about happenings in their communities and elsewhere. Agriculture and animal breeding were the two most important factors in their life and it was therefore natural that both were the topics most frequently discussed during these gatherings.

One such occasion happened during August 1916 when ash-Shaykh Farhan Abujaber, owner of al-Yādūdā,[2] a large estate ten kilometers south of 'Ammān, was entertaining his friend ash-Shaykh Fawaz ibn Fayiz,[3] the paramount chief of the strong Banī Ṣakhr tribe and the governor of the Giza (Sizia) district under the Walī of Damascus. The times were unstable and people were restless as the great war was still raging in Europe and at the Suez Canal front.[4]

The conversation during the evening centered around the serious subject of food shortages and rising prices, especially of wheat when the *Ṣā'* (six kg) was being sold for one gold pound. The situation, it was mentioned, was greatly worsened by Turkish Government confiscations of food supplies to assist the war effort and the new wave of corruption that was developing under difficult circumstances. The guest, whose tribe owned large herds of camels and flocks of sheep, maintained that the countryside had what could be considered a sufficient supply of livestock in the Banī Ṣakhr Dīrā of tribal domain. He then asked his host about his opinion whether the supplies of wheat were sufficient to save the people from any possible famine. Farhan believed that these were just sufficient to meet a hardship situation and added the reassurance of a famous proverb "*Mithl al-Balqā mā tilqa*" meaning that the agriculture in the area will continue to provide its people with enough food to be saved from famine.

Fortunately both the guest and the host were right and it so happened that the people of al-Balqā', in spite of rising prices, did not suffer any serious shortages during the four years of that cruel conflict. Palestine on the other hand, had real hardship and a good number of its inhabaitants moved during 1917 to al-Balqā' in the hope of producing food for their families. Amongst other places, al-Yādūdā had over 500 refugees from the Jerusalem and Bethlehem areas while a larger number settled in Mādabā.[5] They were in bad need of food and shelter and although every possible assistance was extended to them the already deteriorated health conditions of many amongst them lead to their becoming easy victims to an outbreak of a Typhus epedemic.[6]

Nearly a hundred years before this event, the famous Swiss traveller Burckhardt, had mentioned the same proverb. He wrote in 1812 that the superiority of the pasturage of the al-Balqā' over that of all southern Syria is the cause of its possession being contested. The Beduins, he said, have the saying "*Mithl al-Balqā mā tilqa*" which literally translated means "Thou canst not find a country like the Balqa".[7]

Such reference to al-Balqā' during the nineteenth century, uttered with an expression of fondness and admiration, could have been in use since time immemorial. Comprising the middle part of Transjordan, the area enjoyed a moderate climate, sufficient water supply, fertile soil, and good pastures. This rendered life in it much more comfortable than in the east or the south.

This area which was already occupied by people in the

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* Modern maps of the Nineteen-Nineties give an excellent idea about the topography of al-Balqā'. However locations and boundaries in earlier maps were not so clearly defined especially at the start of the study period in 1800. It has therefore been found suitable to add copies of three older maps that will give an idea about the knowledge that was available to map-makers at three different stages.

1 Hospitality in the Arab World was and continues to be a cherished quality. In addition to receiving guests in them, guest houses served the purpose of being the meeting places for social gatherings especially in the evenings.

2 Established just before 1860, it is the oldest family estate in Transjordan. Its founder was Farhan's father Salih, a dignitary of as-Salṭ, born around 1820, who died in 1897.

3 The Banī Ṣakhr were the strongest Transjordanian Tribe and during the nineteenth century were estimated at 1500 tents. In the census of 1596, their taxes amounted to 36000 Access whereas those of as-Salṭ amounted only to 12000.

4 A.P. Wavell, *The Palestine Campaigns.* Constable & Co. London 1938: IX.

5 Yousif Salim Shwayhat *Al-Uzaizat in Madaba.* Arab Army Press, Amman 1966: 115.

6 The epidemic persisted until the end of 1917. To avoid it, Beduin tribes moved into the desert while the settled population suffered many deaths until the Ottomans could extend medical aid. Farhan and seventeen of his family perished with Typhus during 1917/8 .

7 John Lewis Burkhardt, *Travels in Syria and the Holy Land.* John Murray, London 1822:369.

Stone Age, was considered among Arab Geographers to signify, in the narrower sense, a district, the capital of which was 'Ammān. It denoted to them the land between the two rivers az-Zarqā' 'Ammān and az-Zarqā' Mā'īn, corresponding roughly to the ancient paraea.[8] But in practice, the name was still also used by the Beduins until the fifties of this century as including a district south of the al-Mūjib river.

Nevertheless, and in spite of all these special qualities, al-Balqā' had its difficult times due to lack of stability and security in its countryside. Prosperity prevailed whenever there was a strong government that could apply law and order within the land and check the incursions of the nomads from the south or the east. Archaeological studies in modern times have been of great help in determining the cycles of intensification and abatement between ca. 3000 BC and the present. Five season's of excavation during the seventies at Tall Ḥisbān by the Mādabā Plains Project [9] "revealed that the intensifies portions of the cycles saw extensive settlement in many sites and an agricultural system characterized by high investment strategies such as fruit and vegetable production along with less risky crops like grains. During abatement, permanent settlements were rare, while a large part of the population practiced nomadism with an economy centered on pastoralism (sheep and goats) and low grain production at seasonal sites. Intensification occurred during the Early Bronze Age II - III (ca - 2800-2400) Iron Age (ca 1200 - 500 BC) Roman to Byzantine periods (ca O - 650 AD - present)." This is indeed a survey that truly coincides with the historical facts about these five periods when security amongst the people of the land and the stability of govenment provided the incentives for intensification. The last period however, did not start in the year 1918 but probably in the eighteen sixties when cultivators from as-Salṭ started to venture eastwards. A complete study about these activities is fully covered by the six case studies of agricultural ventures in the book "Pioneers over Jordan".[10] However it is of benefit to confirm that this activity has been due, in great measure to the fact that stability in the countryside was imposed by the Ottomans from 1867 onwards.

In the Summer of that year a Turkish Force supported by Beduin Irregulars advanced into al-Balqā'. After taking action against the al-'Adwān tribe at Hajar al-Mansub near az-Zarqā' Mā'īn, where fifty of the tribe's horsemen were killed, the authorities started to make their presence felt in the countryside. Within two years the Banī Ṣakhr and Banī Ḥamīda tribes became more law abiding and the stage was set for a real going out for agriculture in the whole area. Salṭi farmers moved out to till fields in 'Ammān, al-Yādūdā and the villages of the Banī Ṣakhr. Palestinian farmers started to settle in the Banī Ṣakhr domain and the Balqawieh villages. Circassian and Chechen farmers started their settlements in 'Ammān, Nā'ūr, Wādī as-Sīr and Sūwayleḥ. Christian tribesmen in 1880 moved from al-Karak to Mādabā. This new agricultural advance eastwards could not have happened without a noticeable inrease in population and the spread of stability, thanks to the government's stiff measures to regain law and order.

However this healthy development during the eighteen sixties should not be taken to mean that there was no agricultural activity prior to that. Far from it, as al-Balqā' had to provide yearly for its population the necessary quantities of cereals. Although there are no statistical figures about the number of people living in the area at that time, we fortunately have the information derived from surveys that were carried out in Syria in the year 1839, during the Egyptian occupation.[11] The population of Bilād ash-Shām was estimated to vary between 1,262,238 as given by Werry and 1,864,000 as given by Colonel Campbell. The Government, on the other hand gave the figure as being 1,449,446. Damascus was considered by all as being the largest city with a population varying between 10000 and 100000 .

Earlier, in 1596, a fiscal census by the Ottoman Government gave the figures for Transjordan to be :-

Irbid and the North	18625
'Ajlūn and al-Kūrah	12370
Al-Balqā'	11170
Al-Karak and the South	9720
	51885

However since the Beduins accounted for by the census were only those who paid taxes, it is safe to assume that al-Balqā's population at the start of the seventeenth century was about 20000. [12]

During the two hundred years that passed between the census in 1596 and the start of our period of study in 1800, al-Balqā' has continued to be missing in records and registers. Due to the fact that the Ottoman Government did not have either the need or the resources to give attention to the poor and outlaying parts of the Empire, people, in areas like al-Balqā', had to fare on their own. This in turn lead to instability, insecurity and sometimes a decrease in number of people on the land. It is, however, reasonable to assume that the number of people in al-Balqā' remained at the low level of 20000. Considering that agriculture and pastoralism were the only two possible vocations for most of the people, the researcher becomes entitled to assume that half of the working force, at least, were engaged in

8 Old edition *Encyclopedia of Islam*: 622.

9 *Syria* 10 Rapport Communiqué par Larry G. Herr Paris 1993.

10 Raouf Abujaber, *Pioneers Over Jordan*. I.B. Tauris & Co.Ltd. London 1989. The six study cases were about, al-Yādūdā, al-Nu'ayma, Banī Ṣahkr Domain, Circassians and Chechen, Mādabā and Saḥāb.

11 John Bowring, *Report on the Commercial Statistics of Syria*. William Clawers & Sons. London 1840.

12 Wolf Hutteroth and Kamal Abdul Fattah.*Historical Geography of Palestine, Transjordan etc*. Palm and Erke. Ehrlangen 1977.

agricultural activities. This can mean about two thousand men when one accepts that around 20% of the population were able to work. Half of them probably were engaged in agriculture and the other half in pastoralism as few only were engaged in crafts and trade. This agricultural labour force, supported by the participation of women and children, as was customary in those days, was spread over the different districts of al-Balqā'. The major part of them, were at as-Salṭ, a town that had 3000 people in 1812 [13] and 6000 in 1879. [14] Probably the position in the area of as-Salṭ, Fuḥays and al-Baq'a did not change much in the 1860's from the report written about it by Burckhardt on the seventh of July 1812 , reading:

> "The Arable Fields are at Least 8 Miles distant from Salt in the low Grounds of the Neighbouring Mountains where they take Advantage of Winter Torrents. In the time of Harvest the Saltiyeh Transport their Families Thither where they live for Several Months Under Tents like the Beduins. The Principal Encampment is at a Place called Fuheis about one Hour and a half to the S.E. of Salt. The Culture Consists of Wheat and Barley, the Superfluous Produce of which is Sold to the Beduins, Vast Quahntities of Grapes are also Grown which are Dried and Sold at Jerusalem".

Although as-Salṭ was the largest populated district, other areas included the middle al-Ghawr, Ḥisbān, Ṣuwayleḥ, Yājūz and Western 'Ammān for the 'Adwān tribe, and 'Ammān and its environs for the D'aja, al-Ḥadiid and Northern Balqawieh tribes; Na'ūr and its neighbouring lands for the 'Ajārmeh tribe and Mā'īn and its neighbouring lands for the Ghnaimat, Awazim and Southern Balqawieh tribes. Although detailed reports about agriculture are not available before the early 1870's, it is useful to know the findings of these travellers who visited the area in that period. H.B. Tristram who visited during 1872, wrote "These Ajarmeh are a wealthy tribe and more given to agriculture than most of the nomads. The long tracts of corn we had passed through and also the wide extent of arable land stretching from hence to Hesban, is chiefly cultivated by them and their slaves and they sell much to Southern 'Anizeh with whom they have friendly relations." Another reference to the areas between Mā'īn and Mādabā is made by the author as follows . "Much of the country was under cultivation. The Abu Wendi (Awazim) on the one side of us, the Bani Sakhr on the other ." [15]

Another traveller was Selah Merrill who visited the area between 1875 and 1877 on two expeditions. Speaking about grapes he confirmed that "neither in Europe nor California have I ever tasted sweeter or more delicately flavoured fruit of this kind, nor seen clusters of such immense size as I have seen and tasted in Eastern Palestine. About al-Ṣalṭ, the grape crop is a perfect marvel both in regard to the amount produced and the quality of the fruit." He also speaks of wheat cultivation amongst the Beduins around 'Ammān. "One would not expect to see much land cultivated in the deserts beyond the Jordan. The contrary however is true and in the valleys and on the fertile portions of the plains, numerous fields of wheat and barley beautify the landscape." [16]

The grape crop that seems to have so favourably been mentioned by Sellah Merrill had also impressed, some thirty years earlier, two seasonal travellers. In 1844, The Hon. Charles Irby and the Commander in the British Navy James Mangles, could not but notice during their trip from al-Baq'a to as-Salṭ that " we passed on the left some vineyards enclosed with some walls. The neighbourhood abounds in vineyeards and olives. We found the finest raisins here that we had seen in Syria. The inhabitants of Salt are numerous ." [17] The mention of olives is proof that these trees survived a 'dark age' for agriculture that may have stretched over three hundred years. However, this could not have been common in other areas and perhaps olive trees in as-Salṭ were the only ones in the whole of al-Balqā' region.

The exploitation of the land that has been alluded to in the above mentioned references, has definitely given al-Balqā's population a higher than usual per capita income. An anonymous Turkish report that was written probably by an Ottoman official in the year 1881 stated that in view of exceedingly high fertility of fields in al-Balqā', it is suitable for agricultural development to a high extent. Its main products are wheat, barley, lentils chickpeas and sesame and its total production may exceed yearly 35000 Istanbuli Kayls.This would add up to 13597.68 tons of produce at the rate of 25.656 kg. to the Kayl, [18] realizing a per capaita cereal production share for al-Balqa's population of 679.8 kg.

As the annual per capita consumption could not have exceeded 179.8 kg such a surplus of 500 kg per person, totalling around 10000 tons of different cereals in the area, meant that the population had a strategic advantage that could be used in certain circumstances. The people of as-Salṭ applied this advantage to their relations with the Banī Ṣakhr as well as with the nomadic tribes that visited them during the summer to procure wheat and barley.

These tribes were mainly ash-Sharārāt of northern Hedjaz and Wādī Sirḥān (around 5000 tents) and the Ruala of the Syrian desert (around 6000 tents). A good part of it must have also been sold yearly to the pilgrim-

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13 Burckhardt's Travels in Syria etc: 349. He gave as-Salṭ's population as being 480 families, and estimated total of 3000 people.

14 Laurence Oliphant, *The Land of Gilead.* William Blackwood and Sons. Edinburgh 1880: 200.

15 H. B. Tristram, *The Land of Moab.* John Murray. London 1873 :162, 306.

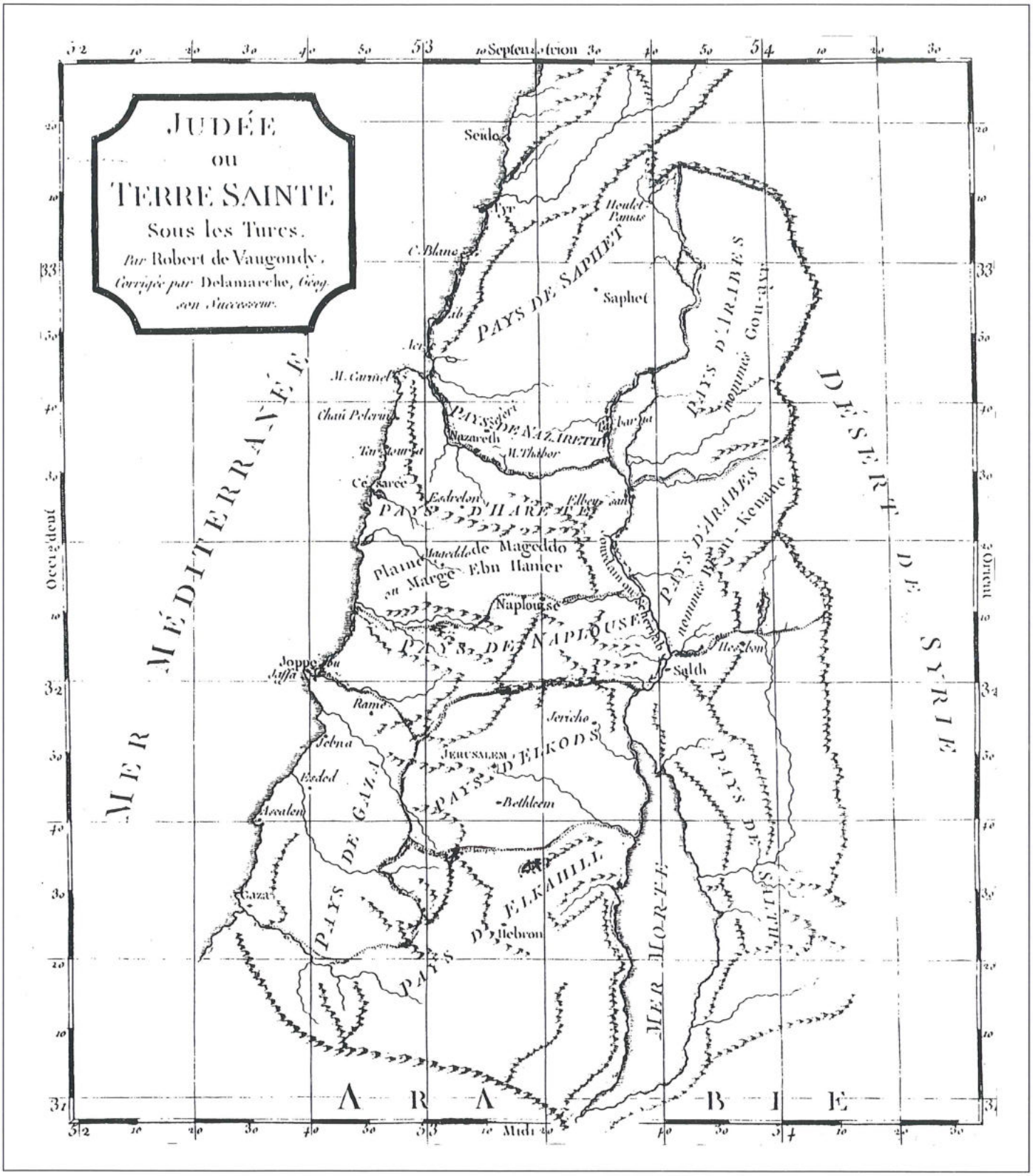
16 Sellah Merrill, *East of The Jordan.*Charles Scribner's Sons. New York: 91, 476.

17 The Hon. Irby and Mangles, *Travels in Egypt, Nubai, Syria and the Holy Land.* John Murray. London 1845: 97 - 98.

18 Walther Hinz (Transl. K. J. Asali), *Islamische Masse Und Gewichte.* University of Jordan publications. Amman 1970: 72.

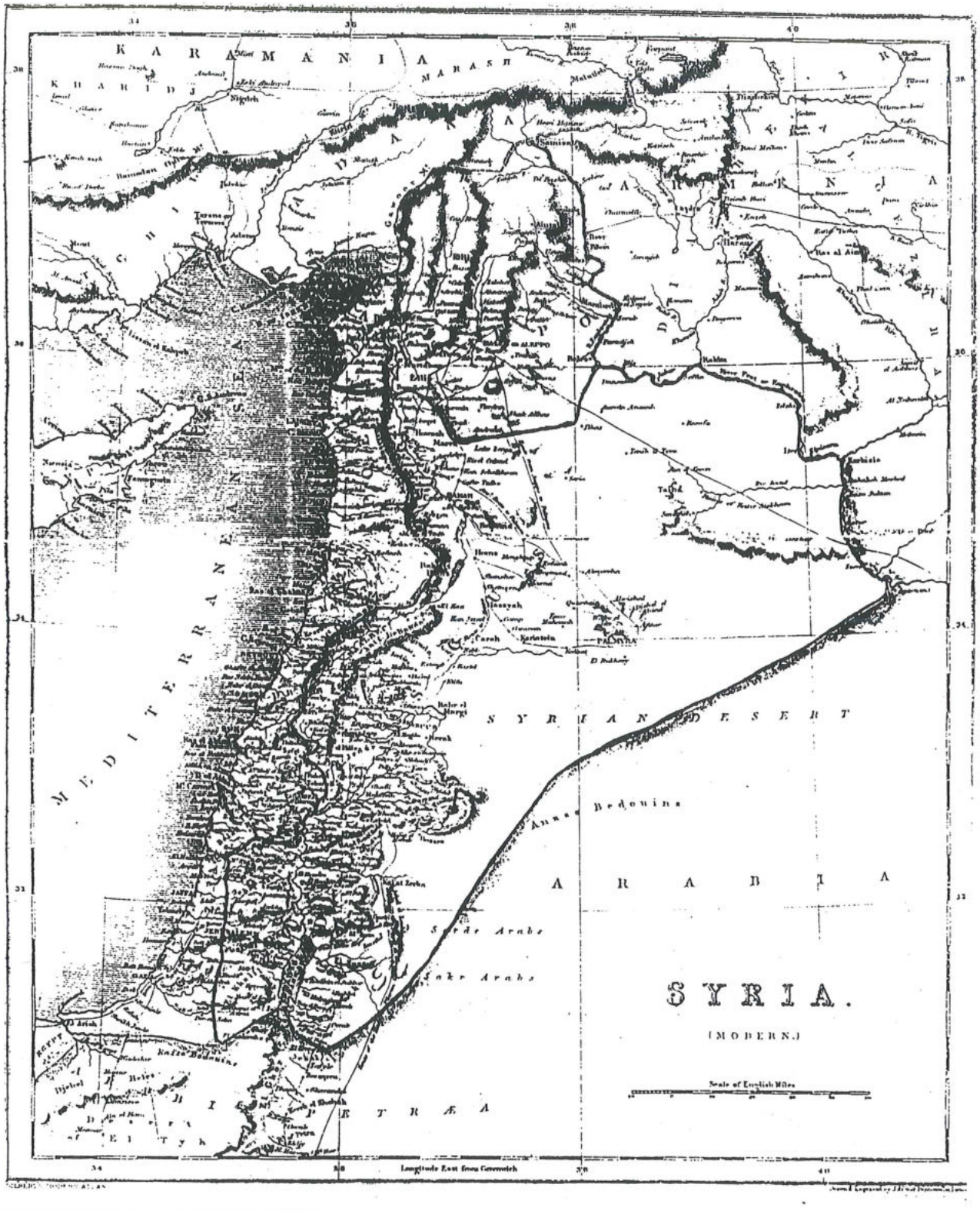
age caravan. Furthermore the Salṭi exported their raisins to the markets of Palestinian towns were it was used for food and the production of the famous alcoholic drink 'Araq. Olive oil was not exported as the quantities produced were not even sufficient to meet the local demand. It was therefore customary to import olive oil from the villages of Jabal Nablus which were and continue to be famous for their production of good quantities of high quality oil.

Agriculture in the nineteenth century, like in previous centuries, has been the basic human endeavour in al-Balqā' and its great importance has been in its providing the population, even during times of instability and insecurity, with the ability for exploitation of its resouces. There is no doubt that it expanded and contracted with the cycles of intensifcation and abatement and that it was all through al-Balqā's history the major source of its population's livelihood.

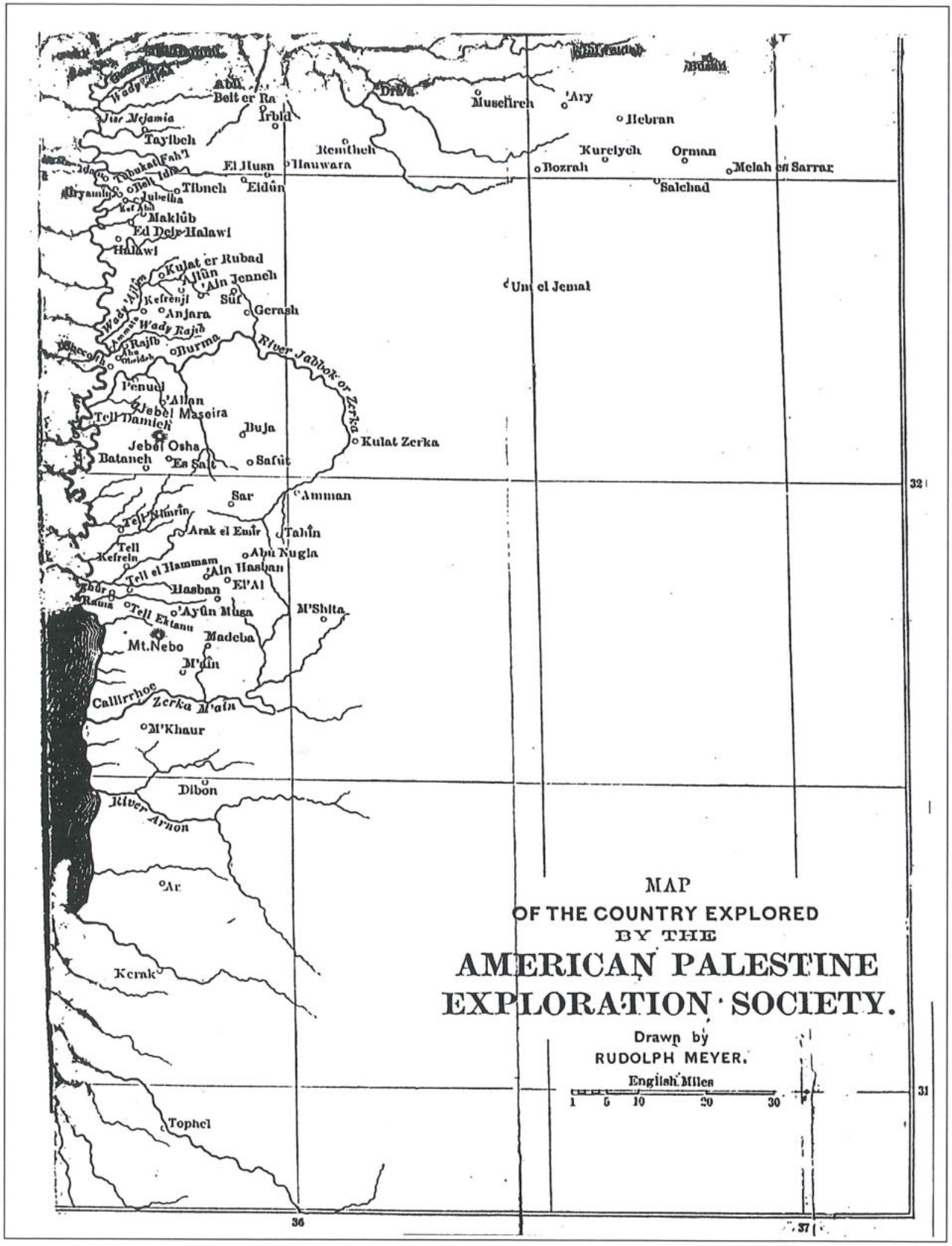


1. *Judee ou Terr Sainte,* by Robert de Vaugondy 1778. This map shows clearly the scanty knowledge that Robert de Vaugondy had about Transjordan. He has given the name of Pays De Salth or Bilād as-Salṭ to al-Balqā' and placed Ḥisbān to the north-east of the town of as-Salṭ.

MAP SHOWING THE FIVE WILAYATS
OF SYRIA, (BILAD AL-SHAM) IN 1842



2. Syria (Modern) 1842. Published by appointment to the Hon. Board of Ordnance in London, this map shows the southern boundaries of the province of Damascus up to the south of al-Karak. It does not mention 'Ammān or Mādabā but gives the name Jabal al-Balqā' for the area between as-Salṭ and Mā'in.



3. Map of the Country explored by the American Palestine Exploration Society 1881. This shows the improvement that has taken place between 1778 and 1881, in the drawing of maps. It shows clearly the area and location of al-Balqā' between the az-Zarqā' (Jabbok) river and the al-Mūjib (Arnon) river.

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Remarks on Landscape Resources and Human Occupation in Jordan According to some Nineteenth Century Travelogues[1]

Introduction

The Annales school inaugurated a new understanding of history that has enabled us to augment, to expand and to deepen our perspectives in regard to and our scientific engagement with the past (Knapp 1993:20). It has also affected a shift in approach and focus in the field of archaeology; that is to say, it has precipitated an unsurpassed interest in the *longue durée* of living conditions of people in earlier times (cf. Dyson 1993:195). Emphasis is now given to demographic and environmental factors, subsistence strategies, technological innovations, regional trade and so on; thus conditions that dictated the modes of existence. The food system approach, for example, serves as heuristic device for reconstructing and analysing changes in peoples' daily lives throughout the past by focusing "on the complex unity that exists between the quest for food and other aspects of culture and human experience, including the interactions between the present and the past, the short term and the long term, the material and the symbolic, the biophysical and the cultural, local food getting and the world system" (LaBianca 1991b:221). While it holds true that archaeology cannot provide any specific details other than approximations with regard to the living conditions of people in earlier times, it is here surmised that the nineteenth century travelogues constitute one of the best "control mechanisms" of archaeological research (Olivier 1994:4). They constitute a major source of information regarding the living conditions of the rural communities in the more remote regions that were unaffected by modern industrial developments, agricultural practices and market policies (Antoun 1972). Because these communities continued to exist uninterruptedly in the same environment, their subsistence strategies and living conditions may serve as a paradigm to describe those of much earlier communities on account of which certain inferences can be made hypothetically, provided no dramatic ecological changes had occurred (Miller 1991:6). By retrieving and implementing the factual descriptions of the natural resources on the one hand and of the conditions of human occupation on the other in the nineteenth century records, we may contribute to the understanding of the interaction between man and his environment in Jordan throughout the ages (Harlan 1982:75).

Travelogues as Relevant Sources

Although the nineteenth century travelogues have been subjected to various lines of investigation, for example historical geography, topography, political history and so on. (cf. the studies of Ma'oz 1975; Ben-Arieh 1979; Silberman 1982; Polkehn 1986; Schölch 1986; Shepherd 1987; Abujaber 1989; Gilbar 1990), no systematic study has been carried out in regard to their observations on and their descriptions of the interaction between landscape resources and human occupation.

Most of the nineteenth century travellers were conceivably not concerned with the living conditions of the inhabitants of the Holy Land but rather naively interested in promoting back home the "science of the Bible" in concordance with the "Geistesgeschichte" of their time. In many instances their observations are characterised by racial prejudice, arrogance and indifference towards the locals (Olivier 1988:87). However there are some that were astoundingly frank in their observations and well articulated in their perceptions. The explorers frequently remarked on the conspicuous discrepancies between the evidence of impressive cultures of the past and the present lack of any signs of land utilisation and human occupation. Their travelogues reflect and contain a wealth of relevant information, which when once retrieved, systematised and applied would certainly serve to elucidate the topic of man's interaction with his surroundings.

The most valuable accounts are those of Seetzen and Burckhardt, of 1806 and 1812 respectively. They both studied at Göttingen under Professor Johann Friedrich Blumenbach (1752-1840). They both considered travelling as a European counter-productive to their objectives of describing in a scientific way the different Near Eastern landscapes and their resources as well as the different cultures representing the different occupational phases thereof. They therefore travelled in almost perfect disguise (Seetzen as ash-shaykh Mūsā and Burckhardt as

[1] I would like to acknowledge the financial support of the Alexander von Humboldt Foundation and of the Centre for Research Development of the Human Sciences Research Council that has enabled me to carry out the research that led to this essay.

ash-shaykh Ibrāhīm) after attaining an effective mastery of Arabic and of Muslim customs. Both were meticulous observers and recorded precisely the occurrence and characteristics of natural phenomena, landscape resources, weather patterns, plants and animals, and of the different places and customs and practices of their occupants (Olivier 1990:132). Their perfect disguises enabled them to experience as no European before the plight of the poor, the arrogance of the local *Shuyūkh,* the cunning of the merchants in the sūqs, the dirt and vermin among the destitude in the khāns, etc. Travelling as a poor Syrian doctor Seetzen recorded the different medicines used for treating the sick, as botanist he carefully noted the different herbs and spices and where they grow, as a previous farmer he was aware of the agricultural potential of the territory, as linguist he made notes on the different dialects, and so on. Before implementing their information we need, however, to take account of the political, social and especially the economic situation in Palestine during that time (cf. Abujaber 1989:24f).

Circumstances in Ottoman Palestine in the Nineteenth Century

The economic situation of a given territory depends on both the landscape resources and the way in which the occupants are utilising them. Human conduct is, generally speaking, closely interlinked with social dynamics and value systems, governmental policies and ideologies, and economic conditions and incentives. In order to comprehend this intricate relationship between landscape resources and human occupation as far as Transjordan is concerned, one has to take cognizance of the Ottoman administrative practices in the distant regions of the empire (cf. Gilbar 1990:1). The dominating perception reflected in the travelogues is that of an unknown desolate and devastated land due to the lack of interest in Palestine by the Ottoman authorities (Ben-Arieh 1990:37). Count De Volney who visited many villages in the remote parts of Syria in the late eighteenth century ascribes the destitude economic situation to a variety of factors (De Volney 1787) among which are the following: excessive taxation by means of the *iltizām* system of tax farming, the coercion and extortion practices of the *janiceri*'s, the frequent raids by the Bedouin, strife between the Qaysī and Yamanī factions, antiquated agricultural methods and implements, exorbitant rates of interest and usury practices. The economic decline was the result of social disorder and political instability. For these reasons many subsistence farmers simply left their land and became marginalised squatters with conceivable results for the natural resources (Issawi 1966:9). Of course there were some attempts to rectify the situation, a prime example of which was the regulation of local government by ash-shaykh Dahir al 'Umar (1750-1786). He fortified specific strategic centres and established law and order before embarking on economic development by market orientated trade and by promoting the local industry (Cohen 1973:42-45). Trade incentives demanded more skilled labour which improved the social and economic position of the various guilds. Goods from Acre that were traded at Marseilles were cotton, rice, indigo, wool, linen, olive oil, tobacco, copper utensils, glass products and so on. At Acre and some of the adjacent territories a certain degree of political stability and social security continued during the reign of his successor, Ahmed al-Jazzar (1775-1804), as long as Bedouin leaders like Agila (Agha) al Hasi were willing to cooperate, the demands in terms of taxation and conscription were curtailed and the government did not interfere too much in local affairs (Shepherd 1987:116). However, in the Transjordan region a completely different situation prevailed. The Ottoman Imperial Porte was forced by his European allies to make concessions such as *capitulations*, to abolish the *janiceri's* in 1826, to introduce social and economic reforms such as the *Tanzimat* in 1839 (expanded in 1856) (Hurewitz 1956:113, 156) but they all seem to have had no effect in Transjordan (Hill 1891: 232). Compared to the degree of prosperity and security that had existed in sixteenth century it is evident that profound social and economic changes took place subsequently (cf. Cohen and Lewis 1978). They reflect quite the opposite, namely poverty, insecurity, internal strife, a reversal to pastoralism as predominant mode of existence, and discord between man and his environment. Metaphorically speaking, it would seem that the desert overtook the sown during most of the nineteenth century. No wonder that Palmer could remark: "ruined villages and towns, broken walls that once enclosed gardens and vineyards, the remains of ancient roads; everything in Moab tells of the immense wealth and population which that country must once enjoyed" (1871:473).

The fortunes started to change somewhat after the Banī Ṣahkr *al-Badawyyīn* were subjected in 1867, a consequence of which was the return of the *al-fallāḥīn* to Transjordan from Hebron and elsewhere (Ma'oz 1968:130). After the discovery of the Mesha stele in 1868 Transjordan became a focal point among European scholars, clerics, adventurers and even politicians (Graham 1989:49). In 1880 a report was published on how the al-Balqā' region could be developed as a British colony! (Oliphant 1880). The Turkish government also thought it wise to resettle some Circassians at the ruins of 'Ammān and in the Wādī as-Sīr in 1878 (Hill 1891:62). They brought along new agricultural methods and skills that would affect greatly the relationship between landscape resources and human occupation in Jordan in the decades to come (Issawi 1966:265). In the last decade missionary activities also brought about some industrial activity and trade incentives, for example, the building of the St George Church at Mādabā (Libbey and Hoskins 1905:264). Their reports on the local living conditions forced the Ottoman Government in 1893 to station a police force of 2000 in Transjordan (Mousa 1982:338). Their

presence established law and order and enhanced the subsequent exploration and development of the territory (Brünnow and Domaszewski 1904-1909; Musil 1907-1908).

The Ottoman Empire was, however, already on its knees. It was technically bankrupt in 1875 due to the prolonged Russian Wars, bad policy decisions, corrupt administration, the lack of training and expertise, the absence of policies regarding the management of natural and human resources, and so on. (Schölch 1986:156). The 1872-73 statistics show that 45% of the state income was from the agricultural sector; 25% from excess duties on tobacco and alcohol and 16% from levies on remission on conscription, and so on whilst expenditure consisted of 44% for the redemption of state debts; 22% for the military; 13,6% for administrative and 7% for the royal household expenses. 0,4% and 0,3% were budgeted for education and health services respectively. When 82% of the population (1927 census) are farmers and they have to produce 52% of the state income, but in return receive less than 1% in terms of services and development, it surely constitutes a recipe for an economic, social and political disaster (Issawi 1966:108). Clearly, neither the development and responsible utilisation of landscape resources nor that of the human occupants were ever addressed by those wielding the power, least to say in regard to the peripheral regions of the Empire.

Descriptions of Landscape Resources in the Travelogues

It is assumed that the nineteenth century records contain highly significant descriptions of landscape resources now already extinct. The occasional references to "innumerable fish" in the rivers (Burckhardt 1822:370) or crab (Seetzen 1854:417, 420) or to the gazelle, the wild boar and "Steinbock", the "knotty horns" of which were worked into handles for knives and daggers (Burckhardt 1822:405) are but examples of their awareness of the natural assets of the different landscapes which they traversed. Burckhardt refers to the numerous Katta birds (wild partridge) in the mountains of al-Karak, the eggs of which served as additional food supply (1822:406). The wild pistachio, wild pear, tamarisk and willow are mentioned as resources with a wide variety of usages (Seetzen 1854:397). The fruit of the Asheyr "contains a white substance, resembling the finest silk, and enveloping some seeds. The Arabs collect the silk, and twist it into matches for their fire-locks, preferring it to the common match, because it ignites more readily" (Burckhardt 1822:392). Reference is also made of the high quality indigo of the al-Ghawr and of the Gharrāb and Ṭalḥ trees from which "Beyrouk honey" and gum are produced respectively, as well as of the *'Ar'r* tree from which an extremely nutritive juice is extracted. Seetzen refers to the Karnub plant from which a syrup, eaten with butter, is made (1854:392). Sulphur, asphalt, saltpetre, and salt were considered as important mineral products from the Dead Sea area (Seetzen 1854:400; Burckhardt 1822:393).

Both Seetzen and Burckhardt also showed an enormous interest in the soils and water resources. "Der Boden war trefflich, allein nur hier und da sahe man einen Fleck kultivirt" (Seetzen 1854:406). Their records indicate the locations of fertile agricultural land or verdant pasture ground (Seetzen 1854:405; Burckhardt 1822:374). Seetzen's remarks that caves were used as temporary dwellings or pens (397) coincides with renewed interest in the role of caves in antiquity (LaBianca 1991a:353). They liked to elaborate on strange botanical and zoological phenomena and assembled in fact a large body of scientific information (cf. Tristram's appendix on the flora) that facilitates reconstructions of the interaction between man and his environment.

Descriptions of Human Occupation in the Travelogues

Some travelogues contain very precise observations on the utilisation of landscape resources and factors that could have had some bearing on, for example, the food production, such as weather patterns, wild animals, and the agricultural practices of the human occupants. They serve as primary sources for compiling the TAVO (*Tübinger Atlas des Vordern Orients*) Map A X 9 that deals with land utilization ca 1880. It is indicated on the map in terms of continually or sporadically cultivated land and in terms of the produce of the different territorial units as are alluded to in these sources. Accordingly, the products of the continually cultivated landscape resources of es-Salt comprise mainly wine, olives, vegetables (water-melon, tomato, cucumber, pumpkin, lettuce) while those of Karak entail olives, figs and pomegranates. "Doch schien der Boden zum Getreydebau ganz fürtrefflich zu seyn, obgleich kein Fleck angebaut war"(Seetzen 1854:411). Depending on the rainfall and security situation wheat and barley were cultivated sporadically on the al-Karak plateau and along the banks of the Mujib.

"Grains, animals, and their produce were the mainstay in the nineteenth century Kerak" (Gubser 1973:26). There exists an acute awareness with regard to the local inhabitants' ability and willingness to cultivate the lands, to produce vegetables and to practise horticulture (figs, pomegranates, wine) (Burckhardt 1822:396). The travelogues refer to the setting of traps and snares to catch birds or small deer in order to augment their food supplies.

Secondly, the travelogues disclose how natural resources were used in order to construct houses, or to develop and to expand the local crafts and small industry. Referring to the houses (ca 60 sq. m on average) of al-Karak Burckhardt has pointed out that their roofs are supported by arches over which thick branches of trees are laid, and over the latter a thin layer of rushes. "Along the wall at the extremity of the room, opposite to the entrance, are large earthen reservoirs of wheat" (1822:389). Seetzen provided elaborate comments on the manufacturing of rosaries from olive wood and of the production of wine (by the pastor!), raisins and *dibs* at as-Salṭ (1854:398). Irby and Mangles

refer to "a sort of travelling artist, or a jack-of-all-trades, a desert Arab, who travelled from camp to camp among the Bedouin tribes, and obtained a competent livelyhood among them by his labours. His chief occupations were as a farrier, a blacksmith, and a saddler; occupations which embrace the whole range of a Bedouin's wants... This man had his anvil, his bellows, and his smaller tools, all with them" (1823:279). The important point is that craftsmen and artisans made use of their landscape resources.

Thirdly, both Seetzen and Burckhardt made observations on the demographic situation on the al-Karak plateau stating that only four towns were inhabited, namely al-Karak, al-Kathrabba, al-Khanzire and Iraq (Seetzen 1854:416; Burckhardt 1822:389). At al-Karak about one third of the people lived two to three hours' distance from the town. The Sharārāt Arabs, who usually tend their flocks at a distance, also work as day labourers at harvest time (for 10 piasters per month!). The population of al-Karak numbered 400 "Turkish" and 150 Christian families, who could supply 800 and 250 armed men respectively. "The Turks are composed of settlers from all parts of southern Syria, but principally from the mountains of Hebron and Nablous" (Burckhardt 1822:381). It is interesting to note that excellent trade relations were kept between these towns by these families (Seetzen 1854:414), and that during the devastating drought of 1847 as much as 150 Transjordanian families had resettled in Hebron and its vicinity. The prosperity of the sixteenth century when al-Karak's inhabitants had experienced the same *aqja* (standard of living) than those of Ramlah, and even better than those of Jerusalem or Nāblus (Hütteroth and Abdulfattah 1977:109), was obviously something of the past at the beginning of the nineteenth century: "the richest man in town is not worth more than about £1000 sterling" (Burckhardt 1822:384). Burckhardt ascribed the dismal socio-economic conditions on the al-Karak plateau to the Bedouin: "it may be remarked generally of the Bedouin, that wherever they are the masters of the cultivators, the latter are soon reduced to beggary, by their unceasing demands" (1822:381). The situation did not improve, because in 1881 Klein remarked: "If the poor people have only corn enough to make their bread, they consider themselves well off " (115). Describing the situation in which a seriously ill person found himself Forder writes: "Let me describe to you what the varied inmates of our tent were: men, women and children, goats, kids, sheep, lambs, dogs and puppies, two donkeys, three cows and one calf, two horses and one mule, and fowls without number" (Forder 1898:39). In 1905 it was said of al-Karak: "This ancient eagle's nest has been stirred and broken and its fiery brood is at last reduced to a state of poverty, degradation, from which they never will recover "(Libbey and Hoskins 1905:346).

Interface between Landscape Resources and Human Occupation

Modern archaeological research has time and again underscored the observations contained in the travelogues regarding the coherence between landscape resources and human occupation, the best example of which is Miller's archaeological survey of the al-Karak plateau. He was in a position to check his data against a wide spectrum of observations in the earlier travelogues and in the later exploration reports such as those of Brünnow and Domaszewski, Musil and Glueck (cf. the report *Palestine and Transjordan* by the British Naval Intelligence in 1939-1943). Seetzen's remark in 1806 that in spite of the indications of a previously much larger occupation only four towns were inhabited on the fertile al-Karak plateau demands an explanation. The Miller survey has revealed an astonishing picture of sites that were occupied over the millennia: Early Bronze II-III 29, Iron Age II 28, Nabataean 172, Roman-Byzantine 39, Late Byzantine 54, Mamluk 75, Ottoman 4. It would seem that in times of peace, stability and effective government people are inclined to settle permanently and to utilize and develop the landscape resources. The numerous reservoirs, roads, fortifications, (four-room!) houses, farming installations, household utensils, ceramics, objets d'art, and so on, testify to the times of dignified and prosperous occupation. On the contrary, in times of political uncertainty, excessive tax claims and social disorder, people seem to revert to other forms of existence, either in fortified enclosures or in caves and dolmens in the inaccessible marginalized zones such as indicated by a few sites on the slopes of the escarpment (Worschech 1985) or as pastoral nomads. It goes without saying that some were occasionally forced into an existence of inhuman conditions as is evidenced by some travelogues: "Their tents are very miserable; both men and women go almost naked, the former being only covered round the waist, and the women wearing nothing but a loose shirt hanging in rags about them" (Burckhardt 1822:371). Clarke's remark at the beginning of the nineteenth century (Shepherd 1987:22) indeed took a very long time to materialize: Under a wise and beneficial government the produce of the Holy Land [read: Jordan] would exceed all calculation.

Concluding Remark

The travelogues ascribe the unfavourable situation regarding landscape resources and human occupation to several factors, such as intertribal feuds, the absence of respect for law and order, the corrupt taxation and conscription practices, raids, laziness, occasional droughts and pestilences. It is clear, however, that those then responsible for the government and for law and order were not really interested in the well-being of the people whom they ought to have served. Their attitude was rather to enrich themselves and to secure their positions. They did not take initiatives to develop the human potential or the landscape resources. They were not held accountable for the lack of assistance in times of need and for the absence of educational programmes.

Fortunately the situation has changed considerably during this century. All incentives and decisions for the cultivation and preservation of the Transjordan landscape would lie firmly in the hands of its own occupants. Two World Wars, colonial policies and attitudes, social structures and customs, antiquated production methods and implements. would retard this process considerably, but since Jordan's independence major progress took place according to the UNO report (cf. El-Sherbini 1979:203).

The mere fact that an international conference on landscape resources and human occupation is taking place under the auspices of the Jordanian government shows a concern for both the landscape and people of Jordan as was never done before.

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Tall al- Fukhār 1990-1991: A Preliminary Report[1]

Introduction

In the years 1990 to 1993 four campaigns were conducted by a Scandinavian team at Tall al-Fukhār (PG 2397.2219).[2]

Tall al-Fukhār is situated in the Wādī ash-Shallāla, a wadi flowing into the Yarmouk River, ca. 11 km north-east of Irbid and ca. 5 km north-west of Ramtha in the fertile plateau of northern Jordan. The tall lies on a natural spur reaching ca. 375 m from the plateau towards the south-west into the wadi, being ca. 205 m at its broadest point. On top of the tell there is an "acropolis" measuring 80 x 100 m, and the highest point of the tall is situated 457.24 m asl. Part of the tall has been heavily eroded, probably both by rain and by the strong winds at the place. Next to the tall there is a small plain in the bottom of the valley watered by a strong spring, the 'Ayn ash-Shallāla which emerges from a cave in the cliff.

Finds of olive and oak tree, olive pits and grain (barley and emmer) in the excavation testifies to the fertility of the area in antiquity, and today the plateau around Tall al-Fukhār is well suited for dry farming, and the small plain in the wadi next to the spring is used for cultivation of olives and fruit trees. As for communications, Tall al-Fukhār is well situated. Not far south of the tall the Wādī ash-Shallāla is crossed by a Roman road with remains of a bridge and guardhouses. The road connected Gadara/ Umm Qays and Arbel/ Irbid with Adraa/Dar'a and the caravan cities further to the east. Earlier roads could also have passed the site from south to north in the vicinity, while the modern road goes through Ramtha 5 km to the east; there was thus easy access to other towns.

Tall al- Fukhār is one of a cluster of talls comprising Tall al- Fukhār, Tall Umm ar-Riglen in the plain below to the south, Tall al-Subba to the north and Khirbat az-Zarāqūn on the other side of the wadi on the plateau above a steep cliff. A preliminary survey has shown evidence of occupation at Tall al-Subba in the Chalcolithic and the Iron IIC-Persian periods, and at Tall Umm ar-Riglen in the Early Bronze Age, the Late Bronze Age, the Iron IIC-Persian, Hellenistic, Roman and the Late Byzantine/Early Umayyad periods; earlier surveys have also reported Middle Bronze Age sherds. Excavations on Khirbat az-Zarāqūn have revealed a large town dating primarily to the Early Bronze II-III periods .[3]

Tall al-Fukhār is not known from any ancient sources. An identification with Zarqu, known from Amarna letter 256 to be in the region between Pella (Ṭabaqat Faḥal) and Ashtaroth (Tall Ashtara) has been proposed,[4] but must be considered a possibility only at the present time. In this connection it must be mentioned that no stratified deposits were found from the Amarna Age at the tall, but this may be fortuitous.

Tall al-Fukhār was visited and sherded by S. Mittmann in the years 1963-66 who reported finding the periods Early Bronze II-III, Middle Bronze I (our Intermediate period/ Early Bronze IV- Middle Bronze),[5] Late Bronze IIb, Iron Age I-II (12th-ninth century BC), Late Hellenistic and Middle Roman (second century AD) represented.[6] Later on a topographical map was prepared by Fayez Tarawneh in connection with the German excavations on Khirbat az-Zarāqūn.[7] In September 1989 a German team made a systematic search for sherds on the tall, partly published by J. Kamleh in 1992.[8] In November 1989, at the suggestion of S.

1 See also Patrick E. McGovern, in this volume.

2 The first two years Magnus Ottosson from Uppsala was director and John Strange from Copenhagen director of field operations, the last two years John Strange was director. Patrick E. McGovern from Philadelphia served as pottery specialist and stratigraphic consultant, and Flemming G.Andersen from Copenhagen served as registrar and specialist in Hellenistic and later pottery. Other members of staff were: 1990: Hans Barstad from Oslo, co-director, Carl-Johan Axelsson and Helena Riihiaho, site supervisors, and Ulla Valukievitz, surveyor; 1991: Helena Riihiaho, site supervisor, Ann-Marie Billing-Ottosson and Lisbeth Strange, surveyors, and Anette Danbæk, assistant registrar; 1992: Allan Rosengren Petersen and Helena Riihiaho, site supervisors, Lisbeth Strange, surveyor, and Anette Danbæk, assistant registrar; 1993: Allan Rosengren Petersen and Helena Riihiaho, site supervisors, Ann-Marie Billing-Ottosson and Lisbeth Strange, surveyors, and Anette Danbæk, assistant registrar. Furthermore we had help from Ali Omari, Yusuf Zoubi, Shaher Rababeh and Munther Dahash. Ibrahim Zoubi was an invaluable friend and supporter throughout the excavation and hired the workmen all four seasons.

3 See Ibrahim, M. and Mittmann S., 'Zeiraqun (Khirbet El)'. Pp. 641-646 in Homés-Frederick, D. and Hennessy, J.B. (eds), *Archaeology of Jordan* II,2, 1989: *Akkadica.*

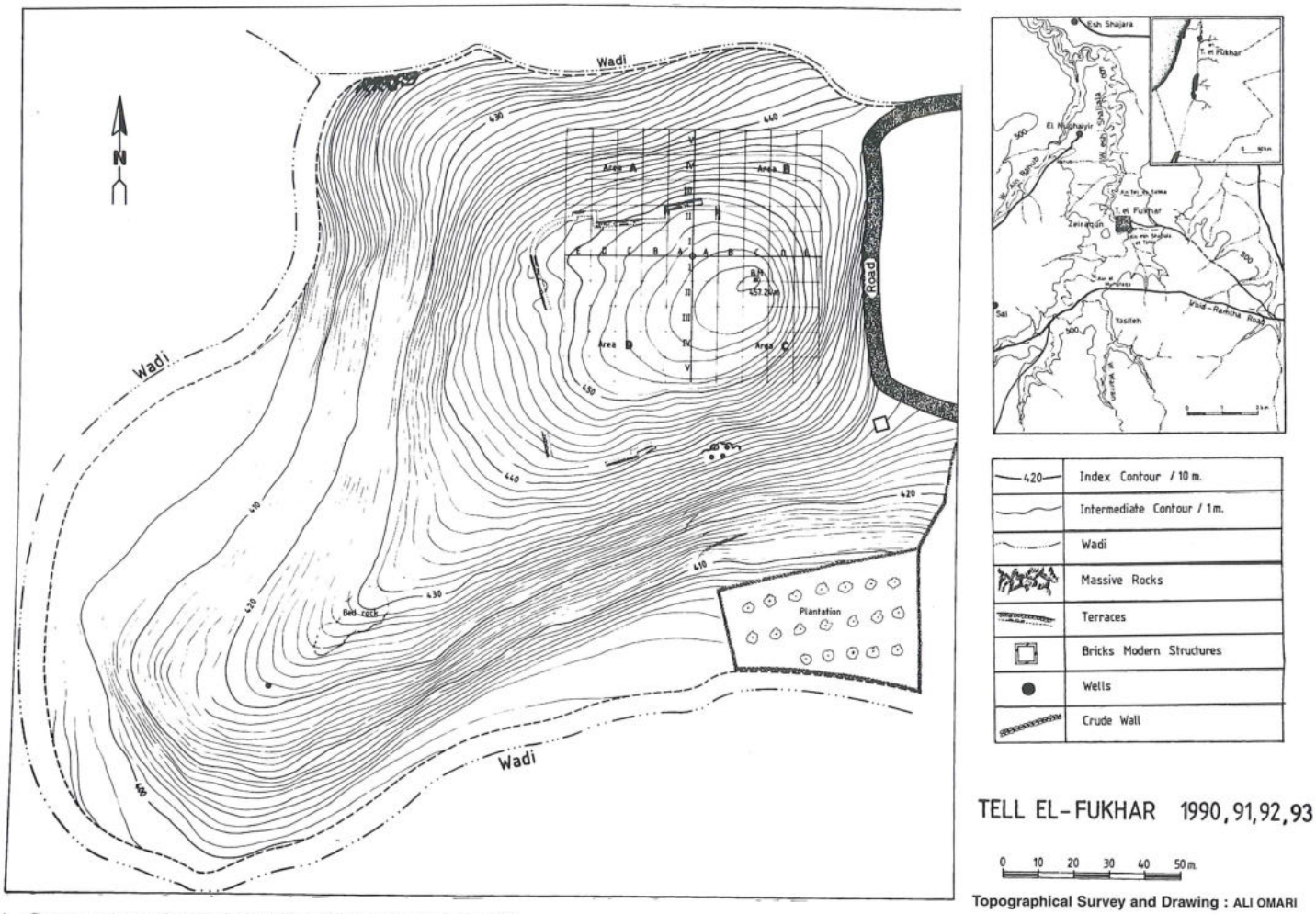
4 J. Kamlah: 'Tall al-Fuhhār (Zarqu?) und die pflanzenhaltende Göttin in Palästina - Ergebnisse des Zeraqon-Surveys 1989', *ZDPV* 109,1993 :101-127.

5 This paper uses the chronological periods proposed in D. Homés -Fredericq and J.B. Hennesy: *Archaeology of Jordan* I *Akkadica.* Amman 1986:10.

6 See Mittmann, S.: 'Beiträge zur Siedlungs- und Territorialgeschichte des nördlichen Ostjordanlandes,' *ADPV* 2, Wiesbaden 1970: 13.

7 Published Kamlah 1993 : 102.

8 Kamlah 1993.



1. Contour map of Tall al-Fukhār with superimposed grid.

Mittman, I visited the tall and collected sherds, and after they had been examined together with Magnus Ottosson, it was decided to start excavations there in 1990.

A standard dog-leash survey was carried out by P.E. McGovern at the beginning of excavations in 1990. All possible artifactual materials (sherds, flints etc.) were exhaustively collected from circular areas (5 m in diameter) that were systematically spaced along the main east-west axis of the site. Less rigorous surface collections were also made on the northern and southern terraces. Preliminary pottery readings indicated that the late Iron Age was well-represented over the whole of the tall, except in an area near the middle of the "saddle" where Late Bronze Age pottery, especially Late Bronze I types, was most prevalent and associated with exposed straight and circular walls. Already before excavation and contrary to earlier surveys, the middle Iron Age appeared to be absent, although several sherds attested to early Iron Age occupation. Early Bronze Age materials were confined to the middle and lower parts of the "saddle" and the northern and southern terraces. The few Hellenistic, Roman and Late Byzantine/Early Umayyad sherds recovered (6 out of a total of 2011) were concentrated near the top of the "acropolis".

In 1990 Ali Omari laid a grid of 10 m squares on the top of the tall linked to the grid on Khirbat az-Zarāqūn, here shown on the topographical plan surveyed and drawn by Ali Omari in 1992 (FIG. 1). At the northeastern section where the easiest approach to the tall is to be found, Magnus Ottosson traced the wall system and tried to find the gate to the city.[9] On the top of the tall, the "acropolis" inside walls were visible on the surface, John Strange dug a number of trenches to trace any public buildings[10] and made a deep sounding to bedrock to assess the stratification of the tall.[11] Finally a trench was dug against the wall around the "acropolis" to determine its age.[12]

The excavations have shown that Tall al-Fukhār was occupied in the following phases (FIGS. 2 and 3):

Early Bronze IB

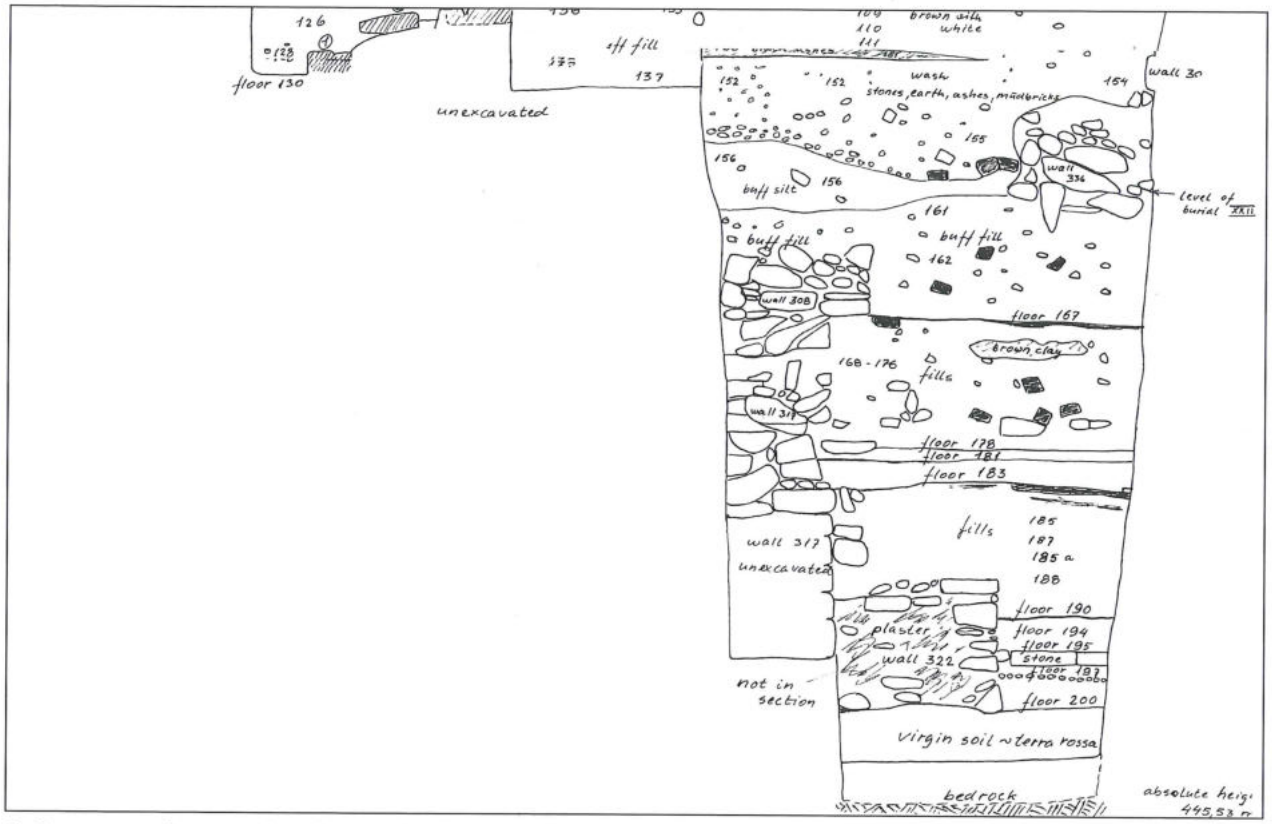
Very little is known of this period, as we have found no stratified deposits, only a few sherds of EB IB band slip/

9 Squares B: AIII, BI-II, C,I-II, D,I-II.

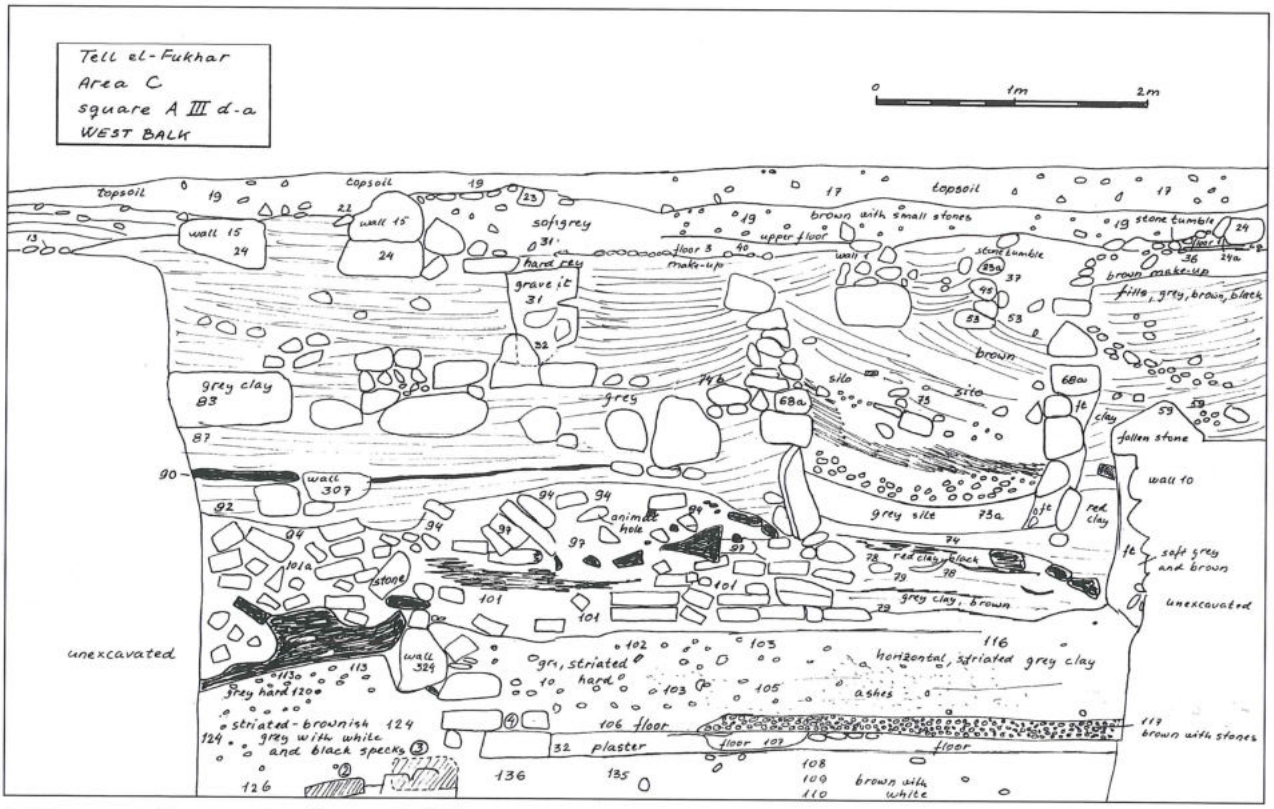
10 Squares C: A II-IV; D: A II-IV, B II-IV, C III-IV.

11 Square C: A III a.

12 Square D: H I.



2. Lower part of west section of square C AIII .



3. Upper part of west section of square C AIII .

grain wash ware; however, the deepest layers of a tall are not always found,[13] and it must be emphasized that the geographical setting of Tall al-Fukhār is typical of many Early Bronze sites built early in the period.[14]

Early Bronze II-III
Only a small (2 m x 2 m) sounding reached the lowest levels, so also here our knowledge is limited. The site must, however, have very early been important to judge from a fine floor from Early Bronze II between two walls, paved with large flat ashlars. A later floor from Early Bronze II had two well-used basalt mortars imbedded in the floor, and the latest floor from the Early Bronze III had a post-hole for a pillar, perhaps indicating a rather large room in a house. Altogether nine floors, some of which were repaired, with walls were found from this period.

Middle Bronze IIA
This period was represented by a burial in a fill with two skeletons, a man in a crouched position and a woman. The burial was accompanied by three wheel-made unpolished vessels, indicating a very early time in the period.[15] Possibly also some walls were found.

Late Bronze IA-IIA
Although no stratified deposits were found, a number of Late Bronze IA Chocolate-on-White, other characteristic Late Bronze IB-IIA pottery,[16] together with other artifacts many of which were found in the debris of the destruction level of the public building in stratum V (see below), indicated that Tall al-Fukhār was inhabited during this period (see FIG.3).

Late Bronze IIB
From this period comes the most spectacular find in the excavation (FIG 4):[17] A large public building which must be either a temple or a palace, probably the latter. Only part of the building was dug, but enough to assess its importance. In another square[18] we reached a layer of mudbricks, obviously from the north wall of the building, testifying to a length of the building of at least 25 m.

The outer walls were very thick, ca. 1.5 m, with a 1.5 m foundation of large stones, and a mudbrick superstructure, both together standing up to a height of 2.1 m. In the rooms there was a thick white plaster floor, with later floors above it, one of which was associated with a repair of the outer wall, indicating several phases in the use of the building. The rooms were filled with a 2m thick destruction layer, consisting of burnt bricks, charred oak roof beams, and so on suggesting an upper floor (FIG. 5). The two rooms that were only partially dug had entrances to other rooms to the south, and to the north presumably the main entrance with a staircase with 5 steps leading down from an outer court paved with thick white plaster. The doorway, only half of which was dug, was flanked by a "pillar" built of large boulders 1 x 1 m square.

The finds in the building attest to its importance and international relations during the period. They include a large pithos, a precursor of the collared-rim jar, Mycenaean and Cypriot sherds and a number of heirlooms from probably the Late Bronze I period, that is a unique "knob" of glazed pottery, possibly for a piece of furniture or wall decoration (FIG. 6);[19] a bronze lamp in the same shape as the common Late Bronze ceramic lamp, and a female figurine pendant of moulded glass showing a nude, pregnant goddess, probably dating to the 16th or 15th century BCE and widely distributed throughout the Eastern Mediterranean and the Near East (FIG 7).[20] In a fill below the courtyard floor, one small fragment of a crucible or a furnace was found with possibly iron slag on its interior which may be evidence of some of the oldest iron ore smelting and working.

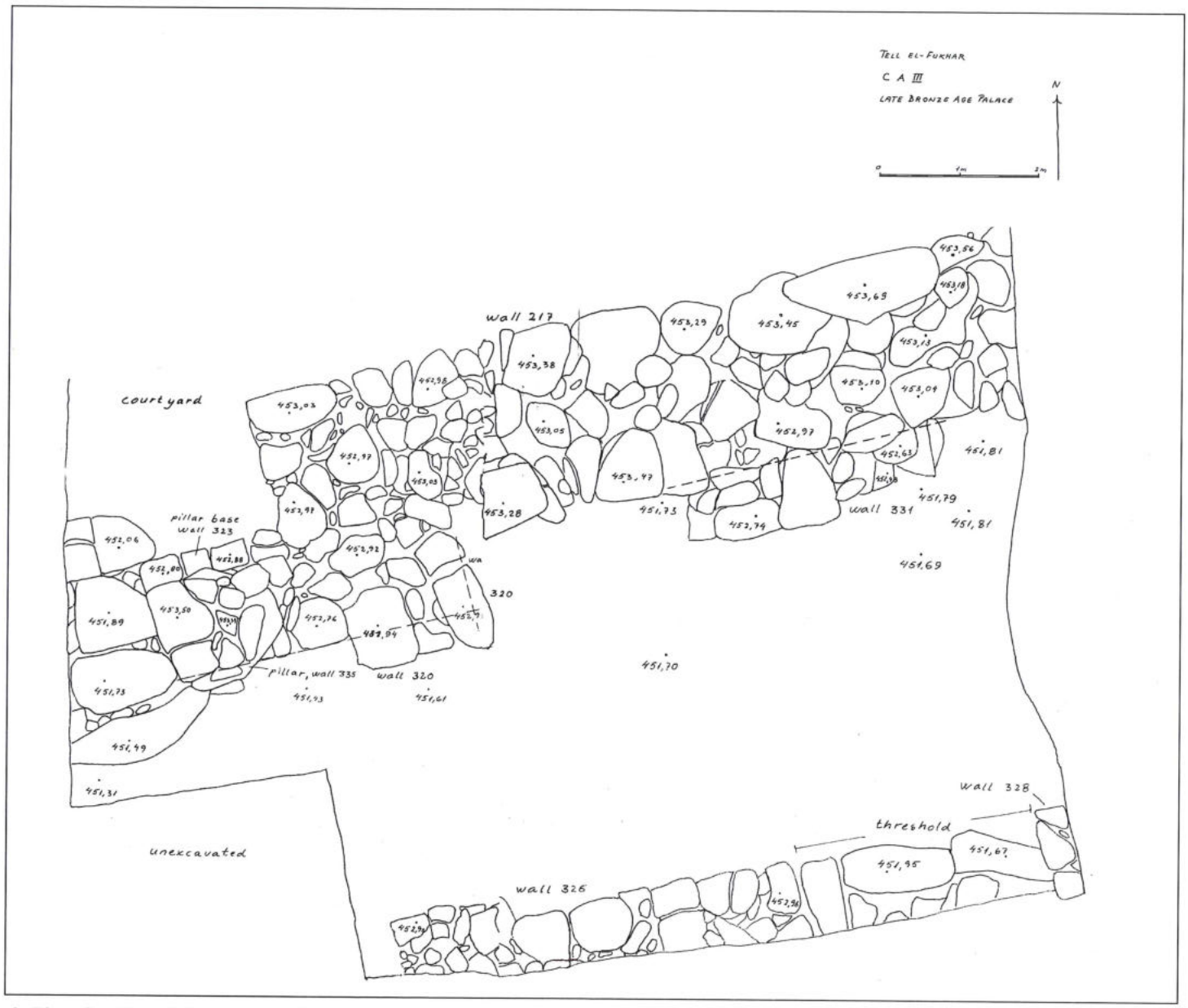
The building was destroyed at the end of the Late Bronze Age in the 13th century BCE.

At the northern side of the tall a massive city wall was found, and, at the place where access to the plain was easiest, the remains of a possible gate.

Late Bronze/Early Iron Age Transition including Iron IA and Iron IB.
On the top of the tall there is evidence of occupation in the ruins of the palace, and a number of floors, walls and ovens testifiy to a longer period of occupation; at first there is evidence of temporary occupation, and later more substantial walls are built over the early occupational phase with a different layout in the Iron Age IB. A characteristic pottery type is the collared-rim jar,[21] which was recycled for making ovens by putting two jars upside down, one inside the other, breaking off the bottom and making a firing hole in the side; finally the whole thing was isolated with clay and earth.

At the north side of the tall, the wall system and a possible city gate had been rebuilt at the end of the Late Bronze Age. A number of finely paved floors were built up to the wall with Early Iron Age houses having doorposts and pillars, in one instance with a reused column base and -drum of basalt, probably from the Late Bronze Age city (FIG 8). Also in this area we found ovens made from collared-rim jars. In the fills near the Late Bronze Age gate we found an imported Philistine sherd,[22] indicating that the

13 cf. Joffe, A.H.: *Settlement and Society in the Early Bronze I & II, Southern Levant*. Monographs in Mediterranean Archaeology 4, 1993: 11-16.
14 cf. Joffe 1993 : 41-48.
15 cf. McGovern, this volume.
16 cf. McGovern, this volume.
17 In square C AIII.
18 D AIV a.
19 cf. McGovern this, volume.
20 See P.E.McGovern: *Late Bronze Age Palestinian Pendants*, Sheffield 1985: 30 with Pl.5.
21 cf. McGovern, this volume.
22 cf. McGovern, this volume.



4. Plan of public building in square C AIII.

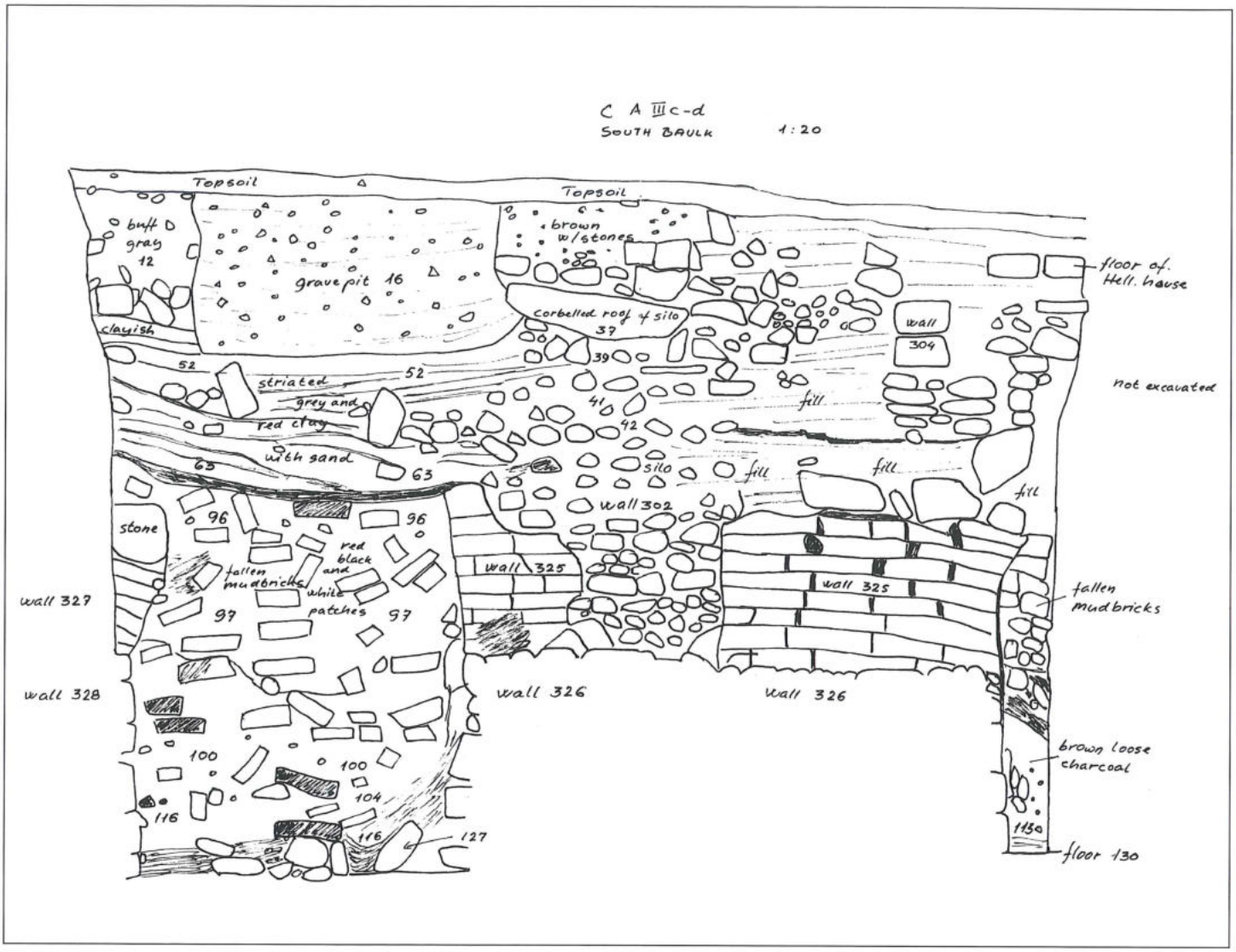
occupation continued into the Late Iron IB period (FIG. 9) .

Iron Age II C - Persian

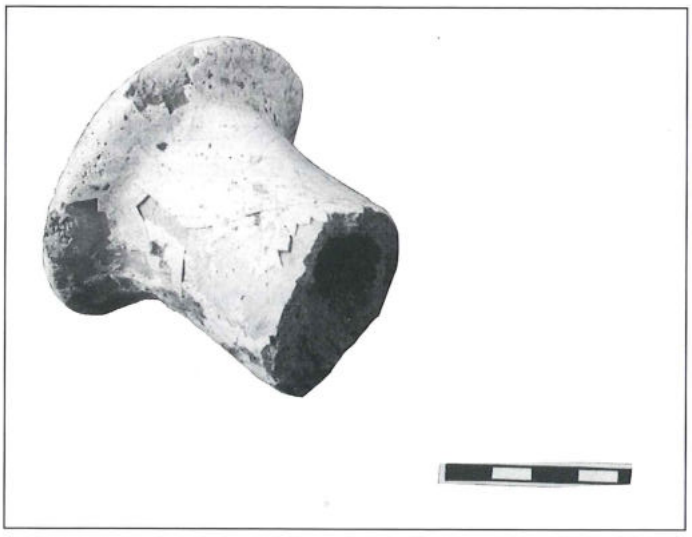
After a hiatus of more than 400 years Tall al-Fukhār was again occupied. More than 20 silos or bins were found scattered all over the area dug on the top of the ta ll. They were all lined with stones and some of them were also paved in the bottom. Some of them even had a stone construction covering them, but mostly broken and fallen down into the silo. They were very deep, some of them reaching down to the stone foundation of the Bronze Age palace. Disappointingly, they were all empty except for fills from the building of the Hellenistic villa above, or debris. Close to the area of the silos there were some building remains which must be ascribed to the same period as the silos, but because of the disturbed character of the layers no connection between the silos and the buildings could be proved.

Hellenistic Period

In this period Tall al-Fukhār was dominated by a villa consisting of 16 rooms around a courtyard (FIG 10). The walls lie directly on the destruction layer of the previous period, and partly between some earlier walls, or at least in one place using an earlier wall for foundations giving the villa a skewed ground plan, and with only a thin layer of surface soil above. Only the foundations were found, and a large part of the plan had to be reconstructed from robbers' trenches. The actual remains seemed, however, to be sufficient to reconstruct the plan; only the entrance has



5. South section of square C AIII showing wall in Late Bronze public building and destruction layer .



6. "Knob" of glazed ceramic from destruction layer in public building .



7. Fertility figurine pendant of cast glass from destruction layer in public building .



8. Column of reused basalt drums from house in area D.



9. Philistine sherd from area D.

completely disappeared, but it was likely in the north, where an opening between two rooms seemed the natural place in view of the topography of the tall.

The date is given by the pottery in a foundation trench and mainly from the pottery in two dumps just outside the building where locally produced Hellenistic pottery of types that derive from the Iron IIC-Persian pottery is mixed with fine Hellenistic tableware from the third century BCE. A copper coin with a head of Zeus on the obverse and an eagle with its wings spread out, holding a cornucopia and standing on a thunderbolt on the reverse, and with the inscription PTOLEMAIOS BASILEUS, dated to either the age of Ptolemy III (246-221 BCE) or Ptolemy IV Philopater (221-203 BCE) was found imbedded in the floor of one of the rooms.[23]

Roman, Byzantine and Later Periods.
After the Hellenistic villa, Tall al-Fukhār was never again occupied except for occasional squatters, as shown by graves, and probably responsible for the extensive robbing of the stones from the walls of the villa.

1932
According to the local people a battle was fought between bedouins and townsmen from Ramtha in 1932. The bedouins buried their dead on the top of Tall al Fukhār.

Main Results
Although the exploration of Tall al-Fukhār and the processing of the results from the first four campaigns are still in progress, Tall al-Fukhār may already be regarded an important site in the following respects:

1) It provides a very long sequence of occupation (although with some breaks) ranging from the Hellenistic period back to Early Bronze I, in a region which up till now has not had a firm chronology;
2) It has a very large public building from the Late Bronze Age showing its importance in this period.
3) Tall al-Fukhār has rich deposits from the Late Bronze-Iron Age Transition and from the Early Iron Age;
4) The Hellenistic villa and its deposits will, because of the mixture of types derivative from the Iron IIC/Persian pottery with fine Hellenistic tableware, give us a better dating of the local Iron IIC and Hellenistic pottery and may thus have an impact on the dating of other buildings in Jordan, thus perhaps throwing a new light on the Ptolemaic period in Jordan which is, from an archaeological point of view, a "dark age";[24]
5) And finally, the analysis of the finds, though far from completed, has already shown a surprising net of trade relations in the various periods of occupation ranging from Rhodes to Gaza, and will enrich our knowledge of the international importance of Jordan in antiquity.[25]

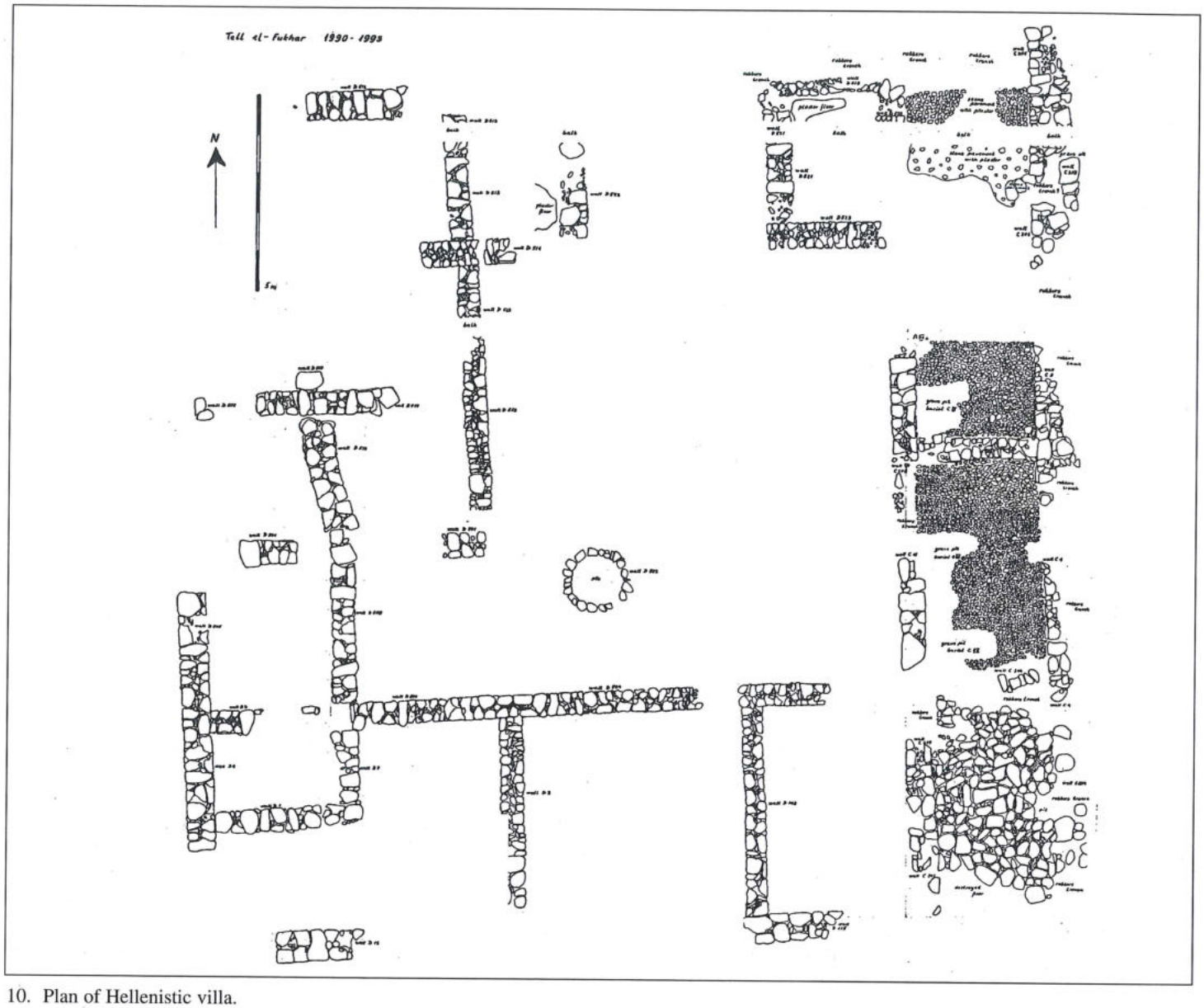
Acknowledgements
The excavations received generous support from the Department of Antiquities, especially we are grateful to the two Director-Generals during the period, Dr Safwan Tell and Dr Ghazi Bisheh, who appointed the departmental representatives at the dig, Ibrahim Zoubi and Hikmat Ta'ani, and who took a personal interest in our excavations.

Special thanks are also due to the Yarmouk University and its president, Dr Ali Mahafza, where the Institute of Archaeology under the directorship of Dr Zeidan Kafafi was a great support to us. The excavations were financed in the two first years mainly from the Nordic Research Council (NOS-H) and later mainly by H.P. Hjerl-Hansen

23 I wish to thank Anne Kromann from the National Museum in Copenhagen for her help in the dating of the coin.

24 cf R.H. Smith: 'The Southern Levant in the Hellenistic Period', *Levant* 22 1990 : 123-130.

25 cf. McGovern, this volume.



10. Plan of Hellenistic villa.

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Thanks are due to H.P.Hjerl-Hansen Mindefondet for Dansk Palæstinaforskning and Danmarks Nationalbank for enabling Patrick E. McGovern to work on the pottery in Copenhagen, and for generous grants from The Theological Faculty of Copenhagen, from Consul-General Einar Høyvalds Fond and JL-Fondet for the work with the publication.

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The Nabataean Coarse Ware Pottery: A Sequence from the End of the Second Century BC to the Beginning of the Second Century AD

History

A team of archaeologists from the Archaeological Institute of Basel University, Switzerland, has been working since 1988 under the direction of R.A. Stucky on two terraces on the slope of az-Zanṭūr in Petra. The main purpose of our project is to study Nabataean domestic architecture in the city of Petra. The author's task within this project is to study the Nabataean coarse ware.

Very little has been written about this ware except for brief mentions in preliminary reports and catalogues.[1] The Nabataean fine ware, of course, is more spectacular and therefore gets more attention. It was assumed that its painted decoration would provide a basis for stylistic analysis providing absolute dates. The opportunities for dating the coarse ware were sparser. What was neeeded was a datable, well documented stratigraphy in which both wares were present, so that their development could be investigated. The excavation at az-Zanṭūr provides just this opportunity.[2]

Nabataean and Late Roman structures were found on both terraces. It was difficult to make out the structure of the Nabataean house on the upper terrace which had been altered several times and then built over in the Late Roman period.[3]

There are only a few places where the Nabataean house is not covered by later walls or paved floors. In order to investigate what had been built before the fourth century we had to rely on trenches of various depths. We also made use of the conservation work on the Roman ruins – during which some of the floors were removed for restoration – in order to investigate what was underneath them.

Remarks on the Stratigraphy

During the five campaigns we dug a number of trenches on the upper terrace. The order of the layers was largely undisturbed. There were no architectural remains in these layers – only pottery, lamps, bones and botanical remains. Trenches A-H together with the large trench EZII [4] allowed us to establish a relative chronological sequence for the fine and coarse ware. The other finds – imported pottery, coins and lamps – enabled us also to date the sequence absolutely. We discovered that the trenches did not all cover exactly the same period and not one of them contained material prior to the first century BC. Trenches F and H and the large trench EZ II contain pottery from the first half of the first century BC; trenches A, D, G and H (again) contain pottery from the second half of the first century BC. The pottery finds from trenches A-B and D-H and from the large trench EZ II stop just after the turn of the first century BC.

The pottery of the first century AD is known to us mainly from the excavations on the lower terrace. A kitchen area with an enormous quantity of coarse ware rim fragments which lay on the NW side of the lower terrace gave us an insight into the pottery of the middle and second half of the first century AD.[5] Most of the Nabataean pottery from the upper terrace from the first century AD had been cleared away during the construction of the Late Roman houses. During the 1993 campaign we uncovered a collapsed room which contained negative plaster moulds of bells and lamps as well as probable furniture casts. We called this room 'the storage room of a bronze foundry'. It lay on the northern edge of the upper terrace and was probably destroyed by a catastrophe in the fourth quarter of the first century AD.[6]

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1 E.g.: N. Khairy, *A Typological Study of the Unpainted Pottery from the Petra Excavations.* London, 1975; N.Khairy, 'Die unbemalte nabatäische Gebrauchskeramik'.Pp.142-144 PL.86 in G. Hellenkemper Salies ed., *Die Nabatäer. Erträge einer Ausstellung im Rheinischen Landesmuseum Bonn 24. Mai – 9. Juli 1978.* Führer des Rheinischen Landesmuseums Bonn 106. 1981; P.Parr, 'A Sequence of Pottery from Petra'. Pp.348-381 in J.A. Sanders ed, *Near Eastern Archaeology in the Twentieth Century. Essays in Honor of Nelson Glueck.* New York, 1970; F. Zayadine, 'Schachtgräber am W-Hang von Khubta'. Pp. 248-258 Figs. 55.57.62 in M. Lindner, ed., *Petra. Neue Ausgrabungen und Entdeckungen.* München, 1986; J.P. Zeitler, Die Siedlungsabfolge am Fusse des el-Hubta-Massivs von Petra (Jordanien). Pp. 314-317 Figs. 13-14 in M. Lindner ed., *Petra und das Königreich der Nabatäer.* München, 1989; The list is not complete.

2 On the chronology of the Nabataean fine ware, see S.G. Schmid, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38 (1994): 281-284 Figs. 10-11.

3 B. Kolb and R.A. Stucky, 'Preliminary Report of the Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1992. The Fourth Campaign'. *ADAJ* 37 (1993): 417-422.

4 Trenches A-E are indicated on the map in S.G. Schmid, 'Nabataean Fine Ware from Petra'. P. 641 Fig. 4 in *SHAJ* V. Amman, 1995; Trenches F and G are indicated on the map in R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38 : 272 Fig. 2. Trench H runs from SE to NW in the western part of Room XVII *ADAJ* 38: 272 Fig. 1.

6 R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38: 274.284. R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at az-Zanṭūr in Petra 1994. The Sixth Campaign'. *ADAJ* 39: Fig.1:114-115/K-L.

There was a middling quantity of pottery from slightly later – end of the first / beginning of the second century AD – in the ash layers on the edge of both terraces.[7] We still know very little about the coarse ware from the first half of the first century AD.

A Short Introduction to the Coarse Ware Pottery [8]

First Half of the First Century BC

In the early phases we have almost only jars — no jugs or bottles / flasks and practically no coarse ware bowls. We do not have many complete vessel profiles. The typology for this period therefore refers mainly to rims.

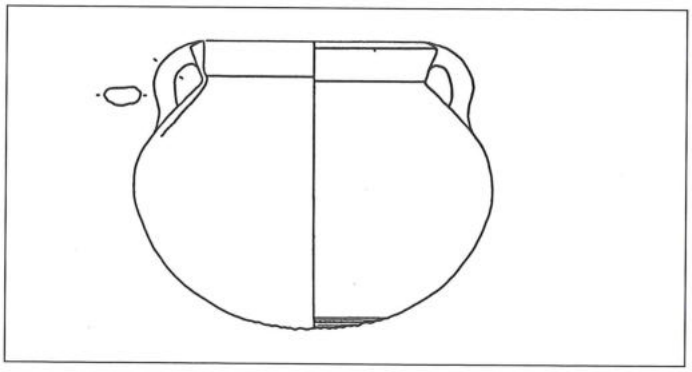
Typical for and exclusive to this period are simple conical rims,[9] bevelled rims[10] (FIG. 1) and short straight rims[11] (FIG. 2). There are also profiled rims with a rounded ridge.[12] Outwardly sloping smoothed rims appear for the first time here and then evolve into one of the commonest forms in the second half of the century.[13] The bowls with an outer ridge are usually fine ware but a few are made of coarser clay.[14]

The colour of the slip ranges from pink through light brown to dark brown. The jars were probably half dipped in the watery slip. Traces of its trickling down the walls are occasionally still visible. The pots are thick-walled.

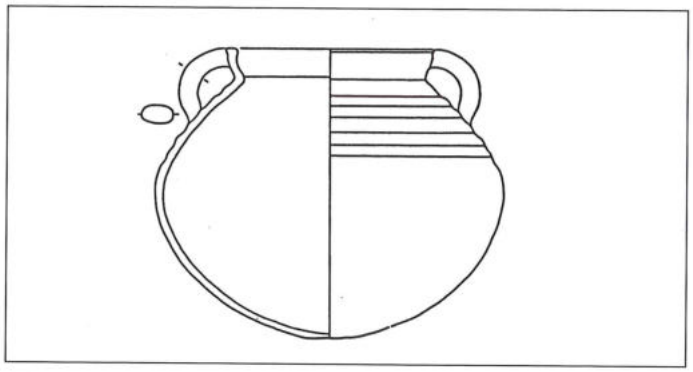
Second Half of First Century BC

The situation does not change very much in the second half of the century. Large pots are still the dominant form together with a few bowls. The same bowl types are more frequent among the fine ware, smaller and made of finer clay. There are a few small fragments from the rims and handles of flasks or jugs. One new form which appears is the deep wide open bowl.[15] Again, we do not have many complete vessel profiles. One complete profile is a singular type (FIG. 3). The pots are still thick-walled and the diameter of their rims is on the increase. Some of them are decorated with wavy lines on the shoulder of the vessel. The bodies are lightly ribbed.

The rims with rounded ridges have also undergone a development in which the edge is now usually bent outwards.[16] The outwardly sloping smoothed rims are more



1. Petra, az-Zanṭūr: Nabataean coarse ware jar from the large trench EZ II: with bevelled rim (1st half of 1st century BC) . (KEZ 89/II.21.62; light red [Munsell 2.5YR6/8] , surface:very dark gray [Munsell 2.5 YRN3] . Diam. rim: 11 cm).



2. Petra, az-Zanṭūr: Nabataean coarse ware jar from the large trench EZ II: with short rim (1st half of 1st century BC). (KEZ 91/II.12e.*128*; light red [Munsell 2.5YR6/8] , surface: reddish brown [Munsell 2.5 YR5/4] . Diam. rim: 10.6 cm).



3. Petra, az-Zanṭūr: Nabataean coarse ware pot from the large Trench EZ II: (KEZ 89/II.12.*73*; light red [Munsell 2.5YR6/8] Diam. rim: 12 cm).

7 Brief mention of 'ash-layers' in: R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38: 275, 284, 286 .

8 The Nabataean coarse ware from Petra and southern Jordan is the subject of a doctoral dissertation. The investigations are not yet completed and this paper is only a brief interim report. Some preliminary conclusions are subject to revision. The presented examples are only a small selection from hundreds of types.

9 R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38 : 288 Fig. 15,A-B.

10 *Ibid* : 288 Fig. 15,C-D.

11 *Ibid* : 288 Fig. 15,L.

12 *Ibid*:. 288 Fig. 15,G-K.

13 *Ibid*: 288 Fig. 15,E-F.

14 *Ibid*: 288 Fig. 15,M-N.

15 *Ibid*: 292 Fig. 17.

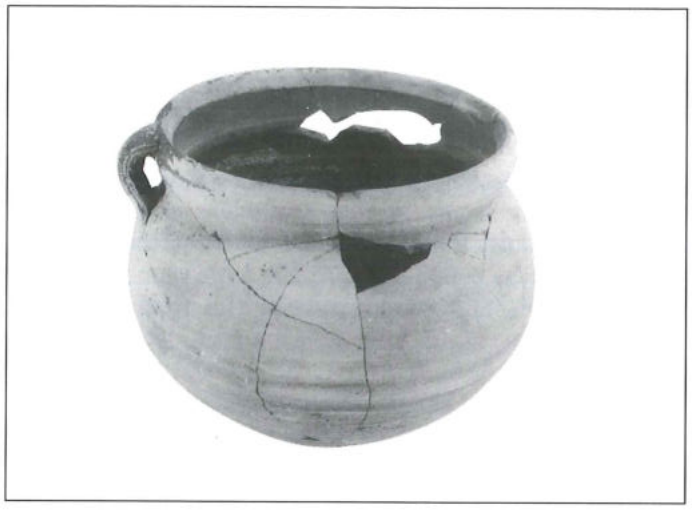
16 *Ibid*: 288 Fig. 15,O.

frequent. The slope becomes somewhat rounder or even concave.[17] This rim profile, still rounded, develops into a sharply formed vertical rim with a bevelled lip in the late first century AD – the standard jar (see below FIG. 7). Rims with a horizontally smoothed ridge are new in this period.[18] Generally, the insides of the edges now have a slightly concave swing instead of being straight. The colour of the slip still ranges between pink and dark brown.

Middle and Second Half of the First Century AD

The pottery from the upper levels of the trenches ends at the beginning of the first century AD, as already mentioned, while that from the so-called big kitchen on the lower terrace probably dates from the middle and second half of that century. Unfortunately, we do not have any dated contexts from the first half of the first century AD, so pottery forms of this period remain hypothetical. It seems likely that the development of the rim with a concave ridge [19] dating from the end of the first century BC into those jars variants (FIG. 4: A-E) from the 'big kitchen' occurred during this phase.

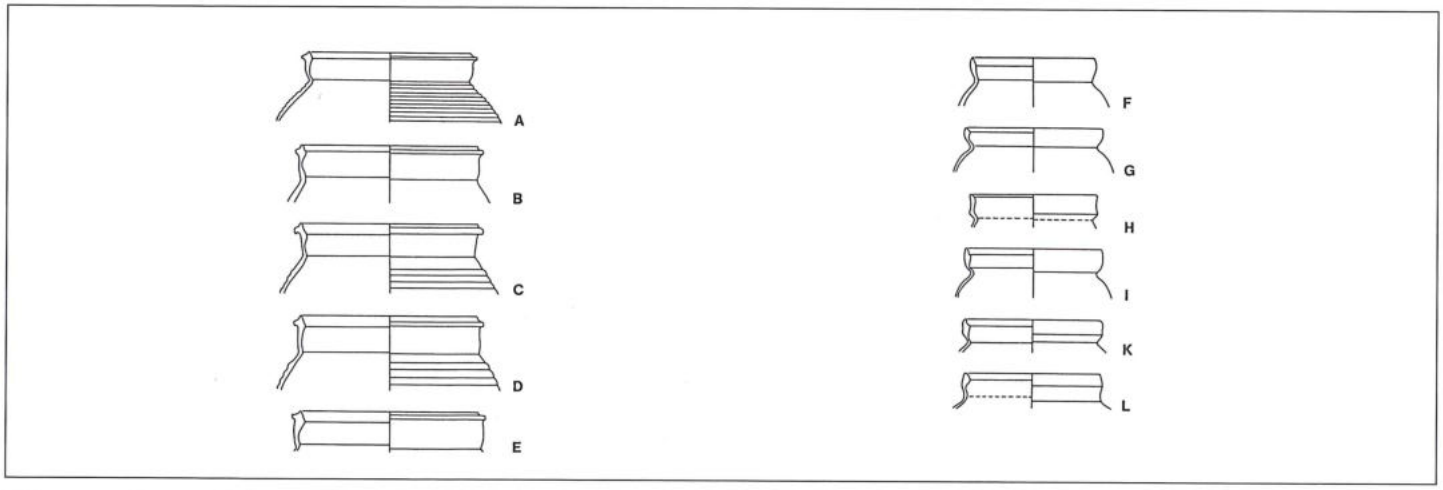
Among the myriads of rim forms from the 'big kitchen' were a few thin-walled pots with short, very slightly concave rims which are sometimes cut at an angle on the inner edge (FIG. 4: F-L and FIG. 5). The same form is represented in the fine ware and ours may even be copies of the fine ware. They appear suddenly without any local predecessors. They disappear as suddenly as they appeared. At least we found no examples in the (storage room of the bronze foundry) or in the destruction layers from the early second century.



5. Petra, az-Zanṭūr: Nabataean coarse ware pot from the 'storage room of a bronze foundry'.(K 899; light red [Munsell 2.5YR6/8], surface: pinkish white [Munsell 7.5YR 8/2] . Diam. rim : 9.6cm).

Any further statement about the dating or use of the coarse ware from the lower terrace, except of the 'big kitchen', is as yet impossible.

The pottery from the storage room on the upper terrace is slightly later than the pottery from the 'big kitchen'. There are large storage vessels with profiled rims rounded at the ridges, sometimes decorated with wavy lines



4. Petra, az-Zanṭūr: Nabataean coarse ware from the lower terrace (middle and 2nd half of 1st century AD) (scale 1:3).

A K 1122.1038 Light red (Munsell 2.5 YR 6 /8) , surface : white (Munsell 10YR 8/2). Diam. ri:12cm.
B K 1122.1039 Light red (Munsell 2.5 YR 6 /8), surface : white (Munsell 10YR 8/2). Diam. ri:13cm.
C K 1122.1040 Light red (Munsell 2.5 YR 6/8), surface white (Munsell 10YR 8/2). Diam.rim: 13cm.
D K 1122.1041 Light red (Munsell 2.5 YR 6 / 8), surface: white (Munsell 10YR 8/2). Diam. rim: 13cm.
E K 1122.1042 Light red (Munsell 2.5 YR 6/8), surface : brown and white (Munsell 7.5 YR5.5/4 + 10 YR 8 /2). Diam. rim:13cm.
F K 1134.1101 Light red (Munsell 2.5 YR 6/8), surface: white (Munsell 10YR 8/2). Diam .rim:9cm.
G K 1028.737 Light red (Munsell 2.5YR 6/6). Diam. rim: 10cm.
H K 1029.742 Light red (Munsell 2.5 YR 6/8). surface: white (Munsell 10YR 8/2). Diam. rim: 9.4cm.
I K 1038.759 pink (Munsell 5YR 6.5/3). Diam. rim: 10cm.
K K 1022.828 Light red (Munsell 10 R 6/8), surface: white (Munsell 10YR 8/2). Diam. rim: 10cm.
L K 1006.671 Light red (Munsell 2.5 YR 6/8), surface :white (Munsell 10YR 8/2). Diam. rim: 10cm.

around the shoulder (FIG. 6). The storage jars have four handles. The fact that the fine pots just discussed were not represented in this room does not necessarily imply that they had already disappeared from the repertoire — they may simply not have belonged in a storage room.

What we can say is that the walls of the pottery become gradually thinner over the course of the first century AD and the pots get smaller. A large number of new forms of bowl, flask and jug appear. The number of finds is, however, too small to establish a complete repertoire for this period.

The slip is now usually pinkish white to white. There is practically no decoration on the bodies of the pots, but they are ribbed.



6. Petra, az-Zanṭūr: Nabataean coarse ware storage jar from the 'storage room of a bronze foundry'.(K 495.1148; light red [Munsell 10R6/8], surface: white [Munsell 10YR 8/2]. Diam. rim : 12cm).

End of the First / Beginning of the Second Century AD

Most of the vessel forms which are found in huge quantities in the ash layers from the early second century are already present in the second half of the first century.[20] Other forms from the second half of the first century disappear completely, for instance the small pot just discussed.

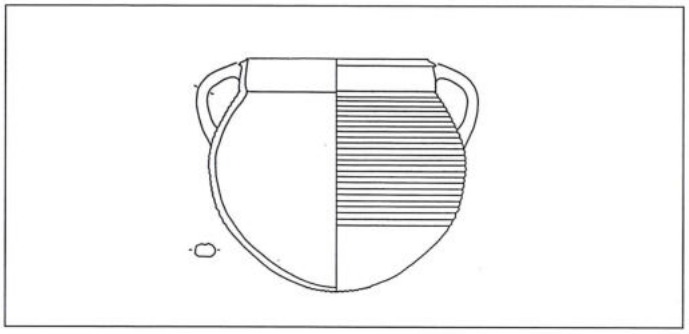
The pots have now become very thin-walled, with the exception of the storage jars. The ware is of very good quality. The pots [21] and bowls are fine and small, their rim profiles sharp and markedly formed, only the rims of the storage jars [22] are rounder. The jars have rounded bases; other high pots sometimes have a ring to support them. The following forms are present in almost every ash layer:

The standard jar with a rim with a bevelled lip (FIG. 7) is the commonest, in various sizes.[23] There are variants of that jar, for example with superposed bi-concave inner rim.[24] Small bottles, jugs and coarse ware bowls appear in enormous quantities.[25]

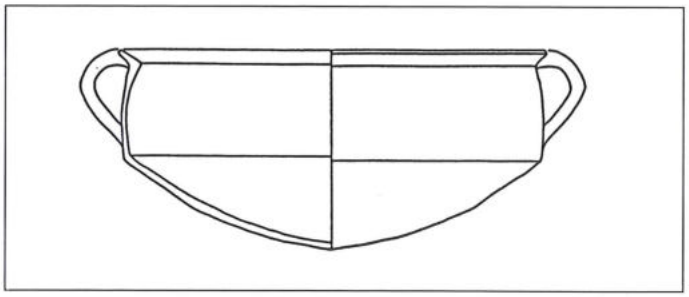
The clay is light red and a white slip is used on all vessels which are now fully immersed in the slip. The larger vessels are finely ribbed. Some of the jars have blackened bases. There were no food remains inside the pots, probably because of the soil conditions. Some of the round-based bowls (FIG. 8) must have stood in the fire as well, to judge from their blackened bases, but possibly more to keep things warm than to actually cook in them.

Second to Fifth Centuries AD

Since the 1994 campaign we have several rim forms and a couple of entire profiles from the second and third centuries AD. The pottery of the second and third centuries, as well as that from the Late Roman period have recently been presented at other conferences. The former in Amman,[26] December 1994, the latter in Irbid,[27] April 1992.



7. Petra, az-Zanṭūr: Nabataean coarse ware jar: rim with a bevelled lip (2nd half of 1st /beginning of 2nd century AD) (K 459.*816*: light red [Munsell 2.5 YR5.5/8], surface: white [Munsell 10YR 8/2] . Diam .rim :14.4cm).



8. Petra, az-Zanṭūr: Nabataean coarse ware bowl, with a blackened base (end of 1st /beginning of 2nd century AD)(K 546.1144; light red [Munsell 2.5YR6/6], surface: pinkish white [Munsell 7.5YR 8/2]. Diam. rim: 20cm).

[20] E.g.: R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at ez-Zanṭur in Petra 1993. The Fifth Campaign'. *ADAJ* 38 : 290 Fig. 16,A-B.D.

[21] *Ibid*: 290 Fig. 16,B-C.E-G.

[22] *Ibid*: 290 Fig. 16,A.D.

[23] *Ibid*: 290 Fig. 16,E-F.

[24] *Ibid*: 290 Fig. 16,B.

[25] *Ibid*: 290 Fig. 16,H-Q.

[26] Y. Gerber in R.A. Stucky *et al.*, 'Swiss-Liechtenstein Excavations at az-Zanṭūr in Petra 1994. The Sixth Campaign'. *ADAJ* 39; Y. Gerber, 'A Glimpse of the Recent Excavations on az-Zantur/Petra: The Late-Roman Pottery and its Prototypes in the 2nd and 3rd Centuries A.D. In *Actes du colloque 'La céramique byzantine et proto-islamique en Syrie-Jordanie', Amman, 3-5 décembre 1994,* BAH, forthcoming.

[27] Y. Gerber and R. Fellmann Brogli, 'Late Roman Pottery from az-Zanṭūr, Petra'. Pp. 649-655 in *SHAJ* V. Amman, 1995.

Summary

As we have seen the excavations on az-Zanṭūr have provided a more or less continuous sequence of Nabataean and Late Roman pottery from the beginning of the first century BC until the beginning of the fifth century AD.

The rim profiles of the Nabataean coarse ware pottery changes from roundly shaped during the first century BC to sharply cut in the first and early second century AD. The early specimens are comparatively large with considerable diameters; they are rather thick-walled. The later pottery is very thin-walled, the vessels are smaller and finer and they show a thin white slip.

From the mid-second century AD on the trend reverses. The walls get thicker, the pots get bigger, the rims become rounder and the variability of the repertoire diminishes.

Outlook: Areas to be Investigated

The origins of the first Nabataean vessel forms and rim profiles are not yet clear.

During the period under scrutiny their development seems autonomous. We have seen how some coarse ware forms evolve out of earlier ones while others are copied from the fine ware. In general, coarse ware appears rooted in a tradition of its own.

The local coarse ware has not yet been compared with that from other sites in the area. For the pottery of the first century BC there are no meaningful parallels since there are practically no Late Hellenistic pottery complexes excavated in southern Jordan.[28] The comparison of the pottery from the late first/early second century AD with, for example that from the Roman Citadel of Amman,[29] second century AD, showed that they had little in common. Right now it seems reasonable to assume that the 'ceramic province' to which Nabataean coarse ware belonged was a fairly small one.

A further question is whether the change in the pottery forms from the first century BC to the first century AD reflects a dietary change. What can we tell about the use of certain pottery forms? Is there a connection between the function of the room and particular pottery types?

Many such unanswered questions promise a lot of interesting research.

28 Some good comparisons are possible with published specimens from Petra itself. E.g.: Compare J.P. Zeitler, 'Die Siedlungsabfolge am Fusse des el-Hubta-Massivs von Petra (Jordanien)'. P. 315 Figs. 13:8-9.14.16-17 in M. Lindner, ed., *Petra und das Königreich der Nabatäer.* München, 1989, with the coarse ware from the second half of the 1st century BC from az-Zanṭūr; P. 316 Fig. 14:4.5;16, with the coarse ware from the end of the 1st/beginning of the 2nd century AD from az-Zanṭūr. Compare also *ibid:* 315 Fig. 13:6 with Fig. 3 in this text.

29 Jean-Baptiste Humbert kindly showed us in autumn 1993 myriads of sherds from excavations on the Citadel of 'Ammān.

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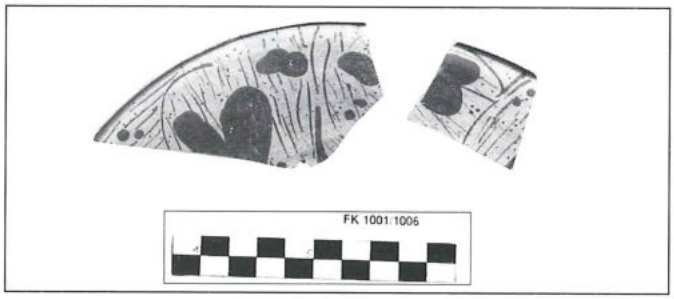
Stephan G. Schmid

Nabataean Fine Ware Pottery and the Destructions of Petra in the Late First and Early Second Century AD

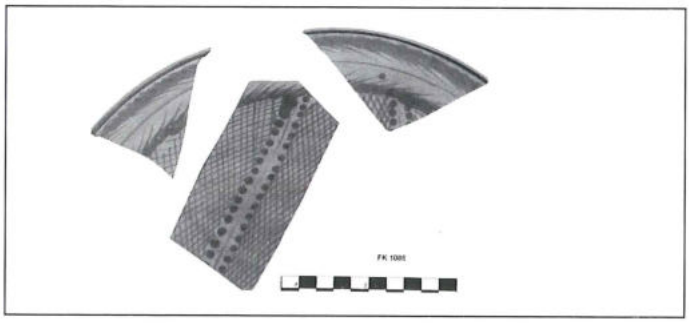
·ntroduction

\ team from the University of Basel, Switzerland, has ·een excavating in the domestic quarters of az-Zanṭūr, 'etra, since 1988.[1] The main purpose of these activities is ɔ increase our understanding of Nabataean domestic archi·cture. The limited state of research on Nabataean pottery 1988 made a dating of layers and wider contexts on the ·sis of pottery analysis impossible. It was therefore solutely necessary to establish a typology and chronol·y of the Nabataean fine ware, in fact a *desideratum* ıce the first description of this ware by G. Dalman in ·08 and its identification by G. and A. Horsfield in)29/30.[2]

After seven years of investigation a detailed typologi·l and chronological scheme is at our disposal, showing ree main phases and several sub-phases, usually datable ithin a range of not more than 20 years.[3] A combined ıalysis of the development of the shapes and the develop·ıent of the different decoration systems allows the most ·recise results. This discussion concentrates on phase 3, ·unning from ca. 20 AD until the beginning of the second century AD, divided into sub-phases 3a (ca. 20 AD - ca. 70/80 AD), 3b (ca. 70/80 AD - ca. 100 AD) and 3c (ca. 100 AD-?). The painting of sub-phase 3a is characterised either by clusters of small raws and peacock-eyes in various combinations or by trellised motives of ivy- and lancet-shaped leaves in violet or light brown which cover the body (FIGS. 1-3). In sub-phase 3b the painting consists of stylized palmettes, geometric shapes and pomegranates; characteristic are further the lines covering the background and the dark colours used for the painting which range from brown to black (FIGS. 4 and 5). In sub-phase 3c the motives are predominantly the same as in 3b but they are cruder and more carelessly applied and the lines have disappeared, so that the vessels from sub-phase 3c are easy to distinguish from those of 3b.



1. Fragments of a shallow bowl with painting of sub-phase 3a, from az-Zanṭūr.



2. Fragments of a shallow bowl with painting of sub-phase 3a, from az-Zanṭūr.

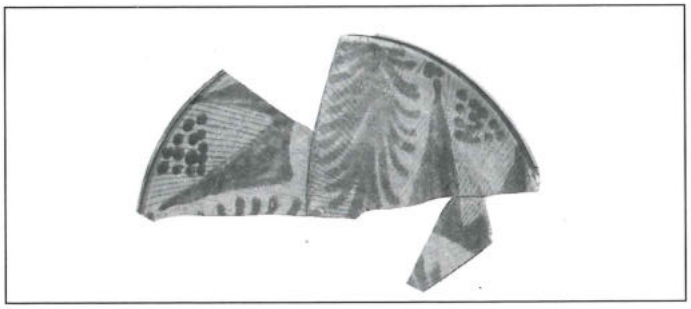
1 See the preliminary reports by R. A. Stucky *et al. ADAJ* 34: 249ff.; *ADAJ* 35: 251ff.; *ADAJ* 36: 175ff.; *ADAJ* 37: 417ff.; *ADAJ* 38: 271ff.; the first volume of the excavations results is in press and should appear in 1996 (Petra az-Zanṭūr I. Die Ergebnisse der schweizerisch-liechtensteinischen Ausgrabungen 1988-1992, afterwards referred to as "Petra I"). The author would like to thank R. Wenning (Münster) for his comments on the paper and J. Wolff (Basel) for her help in preparing the English text. With few exceptions the quotations and abbreviations follow the suggestions of the "Deutsche Archäologische Institut" as described in *Archäologischer Anzeiger* (1992): 743ff. and *Archäologische Bibliographie* 1993: IXff. Beside this the following abreviations are used:
-Bowersock (1983):G. W. Bowersock, *Roman Arabia* 1983.
-Fiema (1987): Z. T. Fiema, 'The Roman Annexation of Arabia: A General Perspective'. *Ancient World* 15 (1987)25-35.
-Russell (1985): K. W. Russell, 'The Earthquake Chronology of Palestine and Northwest Arabia from the 2nd through the Mid-8th Century A.D.', *BASOR* 260 (1985)37-59.
-Wenning (1987): R. Wenning, Die Nabatäer - *Denkmäler und Geschichte. Eine Bestandesaufnahme des archäologischen Befundes, Novum testamentum et orbis antiquus* 3, 1987.
-Wenning (1993): idem, Das Ende des nabatäischen Königreiches. P. 81-103 in A. Invernizzi - J.-F. Salles eds. *Arabia antiqua. Hellenistic Centers around Arabia,* 1993.

2 G. Dalman, *Petra und seine Felsheiligtümer* 1908 P.357; A. Conway - G. Horsfield, 'Historical and Topographical Notes on Edom: With an Account of the First Excavations at Petra'. *The Geographical Journal* 76. (1930) 386; A. E. Conway, 'Exploring a City of Mystery. The First Excavations at Petra: Discoveries in the Remains of the "Built" City, and a New Explanation of the Rock-Cut "Sanctuaries" '. *ILN* 1. Feb. (1930):160.

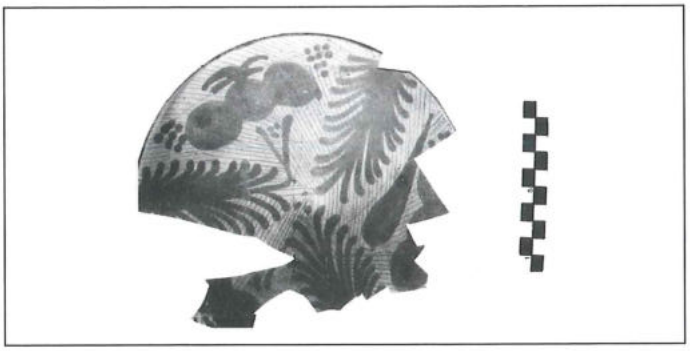
3 See also S. G. Schmid, 'Nabataean Fine Ware Pottery from az-Zanṭūr, Petra' Pp. 637ff. in *SHAJ* V, 1995; S. G. Schmid 'Die Feinkeramik der Nabatäer'. Pp.55ff. in *Petra und die Weihrauchstrasse. Catalogue of an Exhibition Zurich/Basel,* 1993; *ADAJ* 38. (1994): 281ff.; S. G. Schmid, Die Feinkeramik, in *Petra I,* chap. VI.; a comprehensive study of the Nabataean fine ware is the subject of the author's dissertation: S. G. Schmid, *Die Feinkeramik der Nabatäer. Typologie, Chronologie und kulturhistorische Hintergründe* (Doctoral thesis, University of Basel 1996).



3. Restored bowl with painting of sub-phase 3a, Petra Museum (JP660). Courtesy of Department of Antiquities.



4. Fragments of a shallow bowl with painting of sub-phase 3a, from az-Zanṭūr.



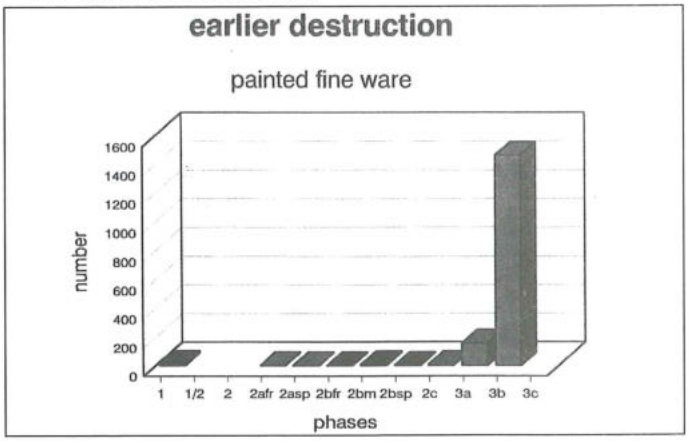
5. Fragments of a shallow bowl with painting of sub-phase 3a, from az-Zanṭūr.

The Destructions of the Nabataean Buildings on az-Zanṭūr

The analysis of the Nabataean building remains on az-Zanṭūr revealed a number of building and destruction phases.[4] Some layers can be tentatively assigned to a tent-phase in the early and middle first century BC. A first house was built in the last quarter of the first century BC; this building was replaced in the very early first century AD by a bigger and more luxurious house. After roughly half a century this complex was destroyed by an enormous fire which produced huge ash layers full of pottery and other finds. It was especially fortunate that room XXI (FIG. 6) was not reused after it collapsed, so that a detailed observation of its inventory was possible. In room XXI several plaster casts, representing negative forms of lamps, bells and legs of couches, were found as well as positive moulds taken from metalware, like the bust of the goddess Athena and a piece with the representation of an *aegis*.[5] On the basis of these finds it seemed reasonable to designate this complex as the storage room of a bronze foundry. In the same room huge quantities of painted and unpainted fine ware were found. The debris from the destruction of the house on the upper terrace was dumped on the collapsed remains of room XXI at the time of its reconstruction. The destruction layers consisted of large quantities of bricks, ashes and painted and unpainted pottery. The pottery analysis makes it clear that there is absolutely no difference between the destruction layers of the lower rooms and those of the building above them. All units contain mainly pottery from sub-phase 3b with a few sherds from sub-phase 3a (FIG. 7). This means that the destruction happened shortly after the change from sub-phase 3a to 3b, which – according to our evidence as well as to the results of other excavations – took place around 70/80 AD. Three coins of Rabbel II were found in the destruction layers giving *termini post quos* of 72, 76 and 85 AD. Although these coins could have been in use until



6. Az-Zanṭūr, upper terrace . Room XXI with a part of earlier destruction debris *in situ*, from west.



7. Graph showing the fine ware composition of the layers of the earlier destruction.

4 On the Nabataean architecture from az-Zanṭūr see R. A. Stucky, *ADAJ* 37(1993) 417-420; idem, *AntK* 35(1992) 129ff.; idem, Pp.37ff in A. Invernizzi and J.-F. Salles eds., *Arabia Antiqua. Hellenistic Centres around Arabia* 1993 Pp. 37ff.; idem, pp.41ff. in *Petra und die Weihrauchstrasse* (above n. 3) 41ff.; idem, *ADAJ* 38(1994) 271ff.; idem, in: *SHAJ* V, 1995 pp.193ff.; idem, in *Petra I*, chap. II.

5 See also R. A. Stucky, *ADAJ* 38(1994)274, 278ff. and Figs.3. 9, 1. 4; idem, in *Petra I*, chap. XI.

the end of Rabbel II's reign in 106 AD the pottery remains from sub-phase 3a make a dating close to 85 AD likely.

A similar destruction is reported from the building complex on the lower terrace of az-Zanṭūr although the remains of the fire are not so extensive as on the upper terrace.

After the reconstruction of most of the Nabataean buildings on the two terraces so far investigated, the settlement flourished for approximately two decades. Then a second conflagration destroyed the entire complex. The most impressive proof of this are the ash and debris layers, more than two metres high, from the lower terrace (FIGS. 8 and 9). On the upper terrace most of this destruction level was removed around 300 AD when the Late Roman building activities started and therefore was found partially in the big trench on the north-eastern slope of az-Zanṭūr. When considering the Nabataean fine ware, an important difference in the composition of these layers to those of the first destruction comes to light: sherds of sub-phase 3c are most common with some remains from sub-phase 3b (FIG. 10). No unit has a composition similar to those from the first destruction which means that we must be dealing with a different event. Besides the pottery considerable quantities of Eastern Sigillata A have been found in this destruction level. According to J. W. Hayes' fundamental work [6] they can be assigned to types Nos. 39 (1 item), 51 (2 items), 54 (2 items), 55/57 (1 item), 56 (2 items), 58 (2 items) and 60 (2 items). The combination of shapes that occur in the later part of the first century AD (Form 39, 60-100 AD) with shapes from the turn of the century (form 51, 70-120 AD; form 54, 75/80-130/150 AD) and shapes from the first half of the second century AD (forms 55-58. 60, 100-150 AD) gives a date for the second destruction around 100 AD or shortly afterwards (FIG. 11).

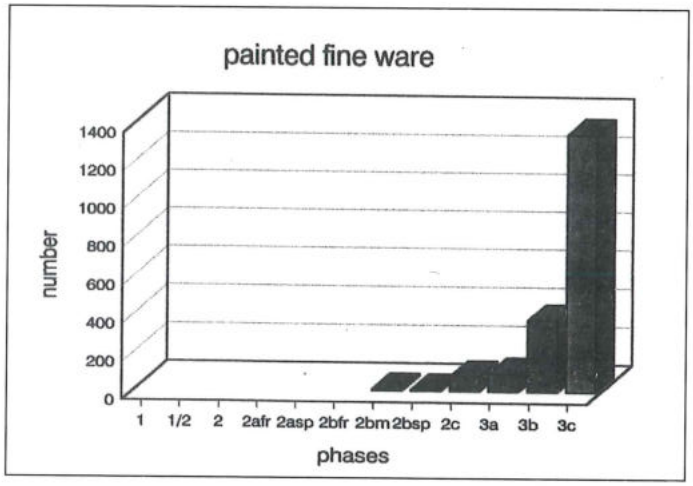
After this event most of the area so far excavated was abandoned until ca. 300 AD when new settlers started cleaning and rebuilding the site.[7] The aim here is a more precise dating for the second destruction or, if possible, its assignment to an historical event.



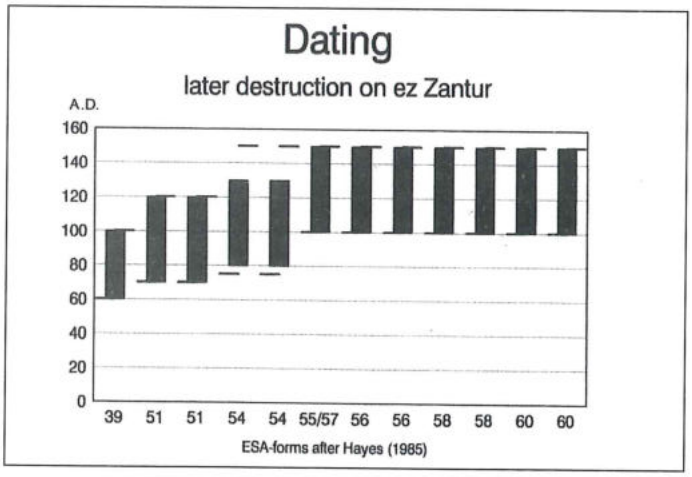
8. Az-Zanṭūr, lower terrace. Debris of the later destruction *in situ,* from south.



9. Az-Zanṭūr, lower terrace. Area of the later destruction after cleaning, from south.



10. Graph showing the fine ware composition of the layers of the later destruction.



11. Graph showing the datable elements found in the later destruction.

6 J. W. Hayes, *Sigillate Orientali, EAA, Atlante delle forme ceramiche II. Ceramica fine romana nel bacino mediterraneo,* 1985: 1-96 Pl. I-XXIII.

7 For the Late Roman architecture on az-Zanṭūr see the paper of B. Kolb in this volume; B. Kolb, in *Petra I*, chap. III.

The Cause for the Later Destruction

1. *The presumed earthquake*

In contrast to the first destruction the second one seems to have parallels at other sites as well as at Petra. In the Temple of the Winged Lions a partial destruction of the roof is reported for the beginning of the second century AD, being manifested in a 1mm thick ash layer and some burned tiles while the rest of the building seems to have remained undamaged.[8] This led K. Russell to the hypothesis of an otherwhise unreported earthquake in 113/14 AD to which he tried to ascribe the destruction of several other sites such as Caesarea, Jarash, Hesbon, Masada, Khirbat at-Tannūr, Oboda, Mampsis, Moje 'Awad, and Mezad Sha'ar Ramon.[9] The evidence raises some problems and requires a commentary. One of the crucial points is that K. Russell listed not only places with evidence for destruction but also sites showing only building activities in the early second century AD implying that building activities necessarily depended on a preceding destruction which is certainly not true.

- Mampsis has no destruction level in the early second century, on the contrary, it profits from economic input during this period.[10]
- On the other hand Oboda seems to have been entirely destroyed in the early second century AD although the dating depends on a not precisely identified Trajanic coin.[11]
- Moje 'Awad - according to the preliminary report - continued to be used by the Romans as a station on the road from Gaza to Petra, but a thick ash layer with Nabataean pottery and coins of Rabbel II suggest a preceding destruction.[12]
- For Mezad Sha'ar Ramon the same preliminary report lists similar findings but a destruction is not reported and this station also existed well into the third century AD.[13]
- For Hesbon K. Russell referred to a then unpublished doctoral thesis.[14] In the meantime this work has been published and the results for the destruction in question are far from being clear.[15] Contrary to preceding suggestions connecting the destruction of Hesbon with the earthquake of 31 BC,[16] L. Mitchel shows that certain elements from the destruction layers indicate a later date,[17] although a secondary filling is not to be ruled out.[18] Finally, L. Mitchel suggests a destruction due to the historically reported earthquake of 130 AD.[19]
- From Jarash a kind of potter's depot is reported which, according to the finds, was installed in the early second century AD,[20] but there is no information about the time or the manner of its end. Jarash - like Mampsis - shows a considerable flowering after provincialisation, which is also manifested in building activity.[21]
- Caesarea was indeed destroyed by an earthquake

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8 P. C. Hammond,'Survey and Excavation at Petra', 1973-1974, *ADAJ* 20(1975) 16f. "phase XIV"; idem, 'Excavations at Petra 1975-1977' *ADAJ* 22 (1977-78) 91 "phase XVII"; idem, 'Die Ausgrabung des Löwen-Greifen-Tempels in Petra' (1973-1983). Pp.41 in M. Lindner ed., *Petra. Neue Ausgrabungen und Entdeckungen*, 1986 Pp. 22ff, 29; Russell (1985) .

9 Listed by Russell (1985) 40f.; for the different sites see also Wenning (1987). The earthquake catalogue for Palestine by D. H. K. Amiran,'A Revised Earthquake-Catalogue of Palestine I'. *IEJ* 1(1950/51) 223-246 does not list an event for the time in question; after the article by K. Russell, (Russell [1985]) D. H. K. Amiran, E. Arieh and T. Turcotte,'Earthquakes in Israel and Adjacent Areas: Macroseismic Observations since 100 B.C.E.'. *IEJ* 44, (1994) 289 have drawn up the presumed earthquake of 113/14 AD under the rubric "Earthquake Reports of Doubtful Authenticity".

10 Russel (1985) 40 reports to A. Negev, 'Mampsis: A Report on Excavations of a Nabataeo-Roman Town'. *Archaeology* 24 (1971): 166 as proof for a destruction but there one can read that: "its [early Nabataean settlement] buildings were obliterated in the extensive building activities of the second Nabatean (sic!) settlement, dated to the early second century. (...) Mampsis continued to prosper in the late Roman period. The Nabatean dwellings were still in perfect condition, so that no new houses were built". The architecture of Mampsis as well as the analysis of the pottery from the necropolis of Mampsis show that there is a perfect continuity from around the middle of the 1st until the mid-2nd century AD; cf. Wenning (1987) 148; for the pottery analysis see Schmid (1996, above n. 3) chap. VI. 6.

11 A. Negev,'The Nabatean Potter's Workshop at Oboda'. *ReiCretRomFautActa* Suppl. I (1974) 24; the excavator comes to the conclusion that: "The rule of the independent Nabatean (sic!) kings was abruptly brought to an end in 106 A.D. by the kingdoms annexation - generally presumed to be peaceful - to the Roman Empire, under the emperor Trajan. The peaceful transfer of government did not, however, apply to Avdat, which was entirely destroyed in the process. A very thick layer of ashes was reached wherever the spade penetrated the latest Nabatean stratum in the acropolis area" (A. Negev, 'Avdat. A Caravan Halt in the Negev'. *Archaeology* 14 [1961](125). In later publications the date for that destruction is given as around 50 AD; cf. Wenning (1987) 161f. with further references. However, the analysis of the fine ware from the "Nabatean Dump" shows that it contained numerous fragments from sub-phases 3b and 3c and therefore there must have been a settlement after the middle of the 1st century AD; see S. G. Schmid, in *Petra I*, chap. VI. 4; Schmid (1996, above n.3) chap. VI. 1.

12 R. Cohen,'New Light on the Date of the Petra-Gaza Road'. *BA* 45. 4 (1982) 243.

13 Cohen (1982, above n. 12) 244.

14 Russell (1985) 40 refers to L. Mitchel, *The Hellenistic and Roman Periods at Tell Hesbân, Jordan.* Th. D. Dissertation, Andrews University.

15 L. A. Mitchel, 'Hellenistic and Roman Strata: A Study of the Stratigraphy of Tell Hesban from the 2nd Century B.C. to the 4th Century AD', *Hesban* 7 (1992) 60ff.

16 Listed by Mitchel (1992, above n. 15) 61.

17 Mitchel (1992, above n. 15) 61ff. referring to a coin of Aretas IV and pottery from phases "Early Roman I-III (63 B.C. - 73 A.D.)" and "Late Roman I (135-193 A.D.)"; for the phasing see Mitchel (1992, above n. 15) 8.

18 Mitchel (1992, above n. 15) 62: "Contamination of these latter samples is possible, but not likely".

19 One may wonder why in the destruction layers no pottery of phase "Early Roman IV (73-135 A.D.)" was found but from phase "Late Roman I (135-193 A.D.)", while the earthquake happened in the year 128/9, 130 AD respectively!

20 J. H. Iliffe, 'Imperial Art in Trans-Jordan. Figurines and Lamps from a Potter's Store at Jerash'. *QDAP* 11 (1945) 1-26. The deposit was found in a cave that was used first for a burial, then for an oil-press, and finally to deposit lamps, plaster forms for lamps, and terracotta figurines. The finds all date from the Roman period and show some Hellenistic but no Nabataean influence.

21 C. H. Kraeling (ed.), *Gerasa. City of the Decapolis* 1938 Pp.46ff.; I. Browning, *Jarash and the Decapolis* 1982 37f.; R. Wenning, 'Die Dekapolis und die Nabatäer'. *ZDPV* 110 (1994) 1-35 re-examined the archaeological evidence for Jarash (13f.) and found no evidence for destruction in the early 2nd century AD but considerable economic flowering. Jarash shows destruction evidence from 130 AD that can be connected with the second Jewish revolt but no earlier destruction from the 2nd century AD (kind comm. by J. Seigne).

according to the archaeological evidence.[22] The chroniclers Eusebius Pamphili and Elias from Nisibis both report an earthquake devasting Caesarea and Nikopolis but both give a date of 126/7 AD.[23]

- In Masada a Roman garrison was domiciled after the revolt of 74 AD. Although there is evidence for one or even several earthquakes, one can only say that they took place before the Byzantine period.[24] The end of the Roman garrison is not clear but it can be connected to several coin hoards from the early second century AD, the latest dating from 110/1 AD.[25] Usually the withdrawal of the garrison is explained by historical, that is military reasons, because there is no evidence for a destruction in connection with it.[26]
- A construction phase in the early(?) second century AD is reported for the sanctuary of Khirbat at-Tannūr but no preceding destruction.[27]

Further confirmation for the presumed earthquake is seen in an honorific arch from Petra (114 AD) and in a monumental gate from Jarash (115 AD) where Trajan is called "saviour and founder".[28] But neither monument is necessarily connected with the presumed rebuilding of these cities after the hypothetical earthquake. Trajan was present in person in the Near East in command of the campaign against Parthia from the end of 113 or beginning of 114 AD.[29] His presence offered the newly provincialized cities a perfect opportunity for the manifestation of their loyalty and sympathy in the form of building-dedications, as had been common in the Near East for centuries.[30]

So, for the only site where the archaeological evidence indicates an earthquake – Caesarea – everything points to a date of 126/7, 130 AD respectively. Several of the sites reported show either no destruction evidence for the time in question (Mampsis, Jarash, Masada) or the stratigraphy is far from clear (Hesbon). All the other places with a confirmed destruction level have – if anything – coins of Rabbel II as *termini post quos*, while nothing points to a date later then his reign. To those sites a few others can be added. The detailed study of Nabataean fine ware and its chronology allow a more precise dating of destruction evidence from other places. The destruction layers from the oil-presses of Khirbat adh-Dharīḥ for example have exactly the same composition of Nabataean fine ware as the later destruction levels from az-Zanṭūr.[31] The same is true for Dhibon and, although the publication situation is unsatisfactory, probably for Sbaita as well.[32] Finally a number of smaller stations in the Wādī 'Arabah may be included as well.[33]

Considering the spacial distribution of the places with a confirmed destruction in the early second century (FIG. 12) one is struck by an astonishing phaenomenon: the sites are all situated within the borders of the former Nabataean kingdom, within its central area. Further, the fact that Oboda and the roughly 100 km distant Petra were destroyed while Mampsis, which is only about 50 km away from Oboda, was not does not really favour the earthquake hypothesis. But the evidence from Petra itself is also somewhat puzzling: while the buildings on az-Zanṭūr were completely devastated, in the Temple of the Winged Lions only the roof collapsed after a fire while the rest of the building remained undamaged. After an earthquake one would expect the whole complex to collapse

22 I. Karcz and U. Kafri,'Evaluation of Archaeoseismic Damage in Israel'. *JASc* 5 (1978) 240. 245 dating to the early 2nd century AD; see also L. E. Toombs, 'The Stratigraphy of Caesarea Maritima'. in R. Moorey - P. Parr (*eds*), *Archaeology in the Levant. Essays for Kathleen Kenyon,* 1978, 230 dated in the late Roman period.

23 Russell (1985) 40; Amiran (1950/51, above n. 9); Amiran *et al.* (1994, above n. 9) 265 with further sources but dated to 130 AD K. Russell evades this contradiction by pretending that the chronickers write about two identically named cities in north-east Anatolia which is completely hypothetical.

24 Y. Yadin, 'The Excavation of Masada 1963/64', *IEJ* 15, 1965, 30: "The stratigraphical position of this cell proves clearly that the Byzantine settlement (of the fifth century C.E.) began in Masada after the earthquakes...".

25 Yadin (1965, above n. 24) 118f.; idem, *Masada. Der Kampf um die letzte Festung des Herodes,* 1967, 45.

26 Yadin (1965, above n. 24) 119; Yadin (1967, above n. 25) 45.

27 N. Glueck, *Deities and Dolphins. The Story of the Nabataeans;* 1966, 138. Several sherds from this construction phase can be ascribed to our sub-phase 3c (Glueck [1966] Pl. 73a. 75a. b) indicating at least a date after 100 AD but one must bear in mind an extensive subjective selection for the illustrations; for the controversial dating of this construction phase see Wenning (1987) 77ff. and J. S. McKenzie, 'The Development of Nabataean Sculpture at Petra and Khirbet Tannur'. *PEQ* (1988) 81ff.

28 Russell (1985) 41.

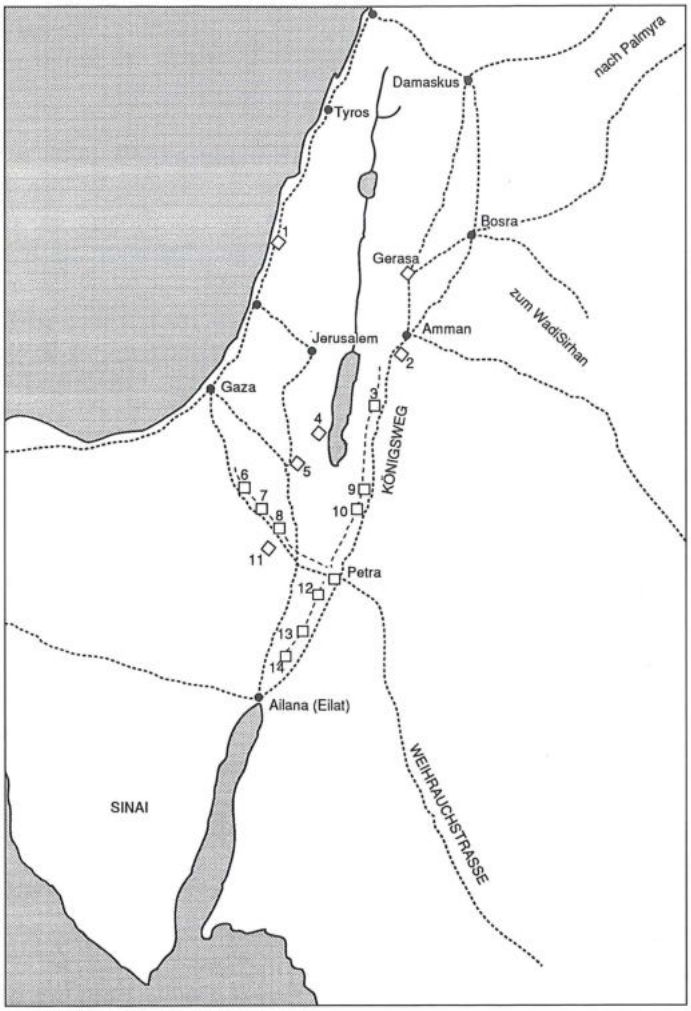
29 For Trajan's chronology see D. Kienast, *Römische Kaisertabelle. Grundzüge einer römischen Kaiserchronologie,* 1990, 122f.; the exact date of Trajan's arrival in the Orient is discussed by F. A. Lepper, *Trajan's Parthian War,* 1948, 28ff.; cf. C. S. Lightfoot, 'Trajan's Parthian War and the Fourth-Century Perspective'. JRS 80 (1990) 115 with n. 2.

30 Honorifications in form of building dedications and designations such as "saviour and founder" stand in the long tradition of the Hellenistic ruler cult, which were applied with increasing frequency to Roman officials with the increasing involvement of Rome in the politics of the Eastern Mediterranean. For example several inscriptions from Mytilene call Pompeius σωτηρ και κτιστες (*SIG*^{3} 751-753; *IG* XII Suppl. 39. 40) referring to his victory over Mithridates VI, Eupator of Pontus and to the following declaration of freedom of Mytilene, but not, however, to a real (new))founding of the city; for further examples see K. Tuchelt, 'Frühe Denkmäler Roms in Kleinasien. Beiträge zur archäologischen Überlieferung aus der Zeit der Republik und des Augustus', *IstMitt,* Beih. 23 (1979) 61ff.; R. R. R. Smith, *The Monument of C. Julius Zoilos. Aphrodisias* I 1,993,9 with n. 33. 34. It becomes clear from the evidence collected by Tuchelt that the title as κτιρστες is quite rare compared to σωτηρ and ευεργετες and was applied only for great merit, beside declarations of freedom and (new) foundings especially (restored) economic prosperity, a fact that is of special interest in the case of Jarash, owing new economic input to the organisation of the new province of Arabia in 106 A.D.; cf. Kraeling (1938, above no. 21) 46ff.; Browning (1982, above no. 21) 37f.

31 F. Villeneuve, 'The Pottery from the Oil-Factory at Khirbet Edh-Dharih (2nd Century A.D.)', *ARAM* 2, (1990) First International Conference, *The Nabataeans,* Oxford, 26-29 September (1989) 367-384; Schmid (1996, above n. 3) chap. VI. 8.

32 Dhibon: A. D. Tushingham, 'The Excavations at Dibon (Dhibân) in Moab, The Third Campaign 1952-53'. *AASOR* 40 (1972); Schmid (1996, above, n. 3) chap. VI. 9.; Sbaita: G. M. Crowfoot, 'The Nabataean Ware of Sbaita', *PEFQS* (1936) 14-27; Schmid (1996, above n.3) chap. VI. 7.

33 On several excursions to the Wādi 'Arabah Y. Gerber and D. Keller reported to the writer many places with ash-layers, which had - as far as this could be determined from a superficial inspection - a similar composition; see also Wenning (1987) 130ff. and passim. It is somewhat astonishing that Wenning (1993) 102 states: "Aus dem gesamten Gebiet der neuen Provinz [Arabia] ist kein Zerstörungshorizont aus dieser Zeit erkennbar", because Wenning (1987) 65 Nr. 60 (Aroer); 132f. Nr. 14. (Bi'r el-Muleh); 180 Nr. 264 (Qasr Wadi es Siq) lists at least three sites with a reported destruction from the time in question; it does not matter for what reason the sites listed above were destroyed, the fine ware analysis proves, however, that they all took place in the very early 2nd century AD.



12. Map showing the various sites discussed in the article.

1 Caesarea
2 Hesbon
3 Dibon (nearby, on the other side of the King's Higway, lies Aroër)
4 Masada
5 Mampsis
6 Sbaita
7 Oboda
8 Moje `Awad (lies *realiter* more to the south-east, Qasr Wadi es-Siq is ca. 10 km in the west of Moje 'Awad)
9 Khirbat at-Tannūr
10 Khirbat edh-Dharih
11 Mezad Sha`ar Ramon
12 Bi'ir el-Muleh (*realiter* more to the west)
13. 14 small sites in the Wādı Araba

□ = sites with destruction evidence in the early 2nd century AD.
◇ = sites without destruction evidence in the early 2nd century AD.
- - - - - = possible route taken by the Roman troops

first and the fire to break out afterwards.

These facts should lead to a reconsideration of the event responsible for the reported destructions. According to the points listed above, an earthquake can be ruled out. When we search for other historical events in the early second century that could have affected the area in question there is one obvious possibility.

2. *The Roman annexation in 106 AD*

The Roman annexation of the Nabataean kingdom and the creation of the province of Arabia is generally believed to have occurred peacefully. That the Romans were at least prepared for possible resistance is shown by the movements of their forces: not only the III Cyrenaica from Egypt and probably the VI Ferrata from Syria had sent considerable detachments into Arabia, but two additional *cohortes* (I Hispanorum and I Thebaeorum) were transferred to Judaea on the eve of the annexation,[34] so that the Nabataeans were hemmed in on three sides. Two unfortunately undated Safaitic inscriptions mention "the year of the Nabataean war" and another one reports "the year when the Nabataeans revolted against the people of Rome".[35] These grafiti together with the archaeological evidence listed above suggest that the annexation did not occur without military confrontation. This seems to be confirmed by a passage in Ammianus Marcellinus saying that "It [the Nabataean kingdom] was given the name of a province, assigned a governor, and compelled to obey our laws by the emperor Trajan, who, by frequent victories crushed the arrogance of its inhabitants...".[36] Further, the promotion of a military tribune from the III Cyrenaica as well as the *ornamenta triumphalia* bestowed upon the commander of the annexation, A. Cornelius Palma, in 107 AD suggest military activities.[37] G. W. Bowersock observed a kind of an unofficial *damnatio memoriae* of the Nabataeans in the literary sources of the second century AD that could be very well interpreted as a reaction against their resistance to integration into the Roman empire.[38] This would also explain why in the contemporary sources there is – besides the scanty mention in Dio Cassius – almost no report of the annexation, only in Ammianus Marcellinus, writing in the fourth centuryAD.

The annexation of the Nabataean kingdom has to be

34 Bowersock (1983) 79ff.; on the troops and their movements see also F. Zayadine and Z. T. Fiema, 'Roman Inscriptions from the Siq of Petra. Remarks on the Initial Garrison of Arabia', *ADAJ* 30 (1986) 199ff.; Fiema (1987) 28 with nos. 20. 21; D. L. Kennedy,'Legio VI Ferrata: The Annexation and Early Garrison of Arabia', *HarvStClPhil* 84 (1980) 283ff.

35 M. Sartre,'Trois études sur l'Arabie romaine et byzantine', *Collection Latomus* 178 (1982) 131f.; idem, 'Bostra. Des origines à l'Islam', *Bibliothèque archéologique et historique* 117 (1985) 63ff. especially 68f.; Bowersock (1983) 80 with n. 13; Wenning (1993) 100f.; on these and other Safaitic Inscriptions where Rome and Romans are mentioned see M.C.A. Macdonald, 'Nomads and the Hawran in the Late Hellenistic and Roman Periods: A Reassessment of the Epigraphic Evidence', *Syria* 70 (1993), 328ff.

36 Amm. Marc. 14, 8, 13: "Hanc provinciae imposito nomine, rectoreque adtributo, obtemperare legibus nostris Traianus compulit imperator, incolarum tumore saepe contunso, ... "(after Loeb Classical Library); Wenning (1993) 100ff. with n. 97 sees in this passage some proof for a Nabataean rebellion that justified the Roman intervention. For another translation of *tumor* see J. W. Eadie, in J. W. Eadie and J. Ober (eds), *The Craft of the Ancient Historian. Essays in Honor of Ch. G. Starr,* 1985, 407ff.; cf. also Wenning (1993) 100 with n. 97.

37 The tribune's promotion is discussed by R. Syme, 'Governors of Pannonia Inferior', *Historia* 14 (1965), 353 and was - like the *ornamenta triumphalia* for Palma - not necessarily connected to the annexation of Arabia, although it is likely; the bestowing of the *ornamenta triumphalia* upon Palma is mentioned on an honoric statue in Rome (*CIL* VI 1386); the statue is also reported by D. C. 68, 16, 2; cf. Wenning (1993) 101 with n. 107. There are only rare cases known where the *ornamenta triumphalia* were bestwowed for non-military successes; cf. B. Zimmermann, *JberAugst* 13 (1992) 289ff., especially 295f.; R. Matteotti, *JberAugst* 14 (1993) 194.

38 G. W. Bowersock, 'The Three Arabias in Ptolemy's Geography', in P.-L. Gatier, B. Helly and J.-P. Rey-Coquais (eds.), *Géographie historique au Proche-Orient (Syrie, Phénicie, Arabie, grecques, romaines, byzantines).* Actes de la Table Ronde de Valbonne, 16-18 septembre, 1985-1988, 47-53; G. W. Bowersock suggests that this supression of the Nabataean *ethnikon*

seen in a wider context within the planning of Trajan's further activities in the East. The annexation was probably not planned for 106 AD because at that time the Roman army was still involved in the war against the Dacians; the death of Rabbel II may have led to the decision in favour of immediate annexation.[39] After the annexation the project most quickly realised in the new province was the building of the *Via Nova Traiana*, connecting the gulf of 'Aqaba with Syria.[40] It was built not simply with an economic but primarily with a military goal in mind because this road became one of the main routes for the supply of the Roman army during its war against Parthia. It seems that Trajan did not have too much trust in the loyalty of the Nabataeans and decided to integrate them into the Roman empire.[41]

Reported contacts between the Parthians and the Nabataeans go back at least to the first century BC when the Nabataean king Malichus I in 38 BC was fined by the Romans for supplying the Parthian commander Pacorus during his invasion into Roman territories 41-38 BC.[42] Antony's donation of Nabataean territories to Cleopatra may also be viewed in this context.[43] Parthian influence on Nabataean policies can also be deduced from an episode during the Jewish throne quarrels, when Herod the Great asked Malichus I for refuge; the latter refused and argued that the Parthians had forbidden him to accept the refugee.[44] Trajan could therefore not exclude the possibility of Nabataean supplies to the Parthians during his own campaign into Mesopotamia and Babylonia, for the Nabataeans would probably not have accepted the loss of their only potent trading partner in the Near East. That both events – the annexation of the Nabataean kingdom and the campaign against Parthia – were already seen as connected in antiquity may be deduced from the above mentioned passage by Ammianus Marcellinus where he continues: "It was given the name of a province, assigned governor, and compelled to obey our laws by the emperor Trajan, who, by frequent victories crushed the arrogance of its inhabitants when he was waging glorious war with Media and the Parthians".[45]

The factor of international trade in this confrontation was not only important for the Nabataeans but for the Romans as well.[46] This is shown by Trajan's successful efforts to control Spasinou Charax, the most important port in Mesopotamia, as well as his statement that he would like to travel to India if he were only younger.[47] The partners of the Far East trade quickly reacted to the new situation created by the provincialisation of Nabataea: It is certainly no coincidence that in 107 AD – immediately after the annexation – an Indian delegation made its way to Rome.[48]

Conclusions

Using the results of the excavation in the habitation quarters on az-Zanṭūr, Petra, especially in the field of Nabataean fine ware, it became possible to identify a partial destruction of the city around 85 AD and a destruction that struck several sites in the Nabataean kingdom in the very early second century AD.

For the destruction level of the early second century AD several parallels in- and outside Petra have been found. Fine ware analysis makes it possible to connect the different destruction levels more precisely. The hypothesis of an earthquake in 113/14 AD had to be reconsidered,

had been instigated (among others) by the cities of the Decapolis who had suffered economically under Nabataean competition (51f.). It seems unlikely that writers such as Ptolemaios of Alexandria and others would have been influenced by such local animosities. It is much more probable that they followed Roman policies. For Rome on the other hand there would have been no reason for treating the Nabataeans differently to other subdued peoples, if they had not shown considerable opposition against their integration into the empire.

39 See also J. Starcky, 'Pétra et la Nabatène', *Dictionnaire de la Bible*, Supplément 7 (1966) 920; Bowersock (1983) 82; Sartre (1985, above note 35) 70; Wenning (1993) 97f. has doubts, argueing that Rabbel II could n. have been very old in 106 AD. In any case the dynasty of the Nabataean kings did not come to an end with Rabbel II because according to one of the Babatha-papyri and one inscription from el-Hubta (Petra) Rabbel II had two sons: RES 1434; Y. Meshorer, 'Nabataean Coins', *Qedem* 3 (1975) 87f.; Bowersock (1983) 80 with n. 15; D. F. Graf 'Qura Arabiyya and Provincia Arabia', in Gatier *et al.* (1988, above n. 38) 177 with n. 39; for further considerations about the annexation see Fiema (1987).

40 For the *Via Nova Traiana* see Graf, 'Nabataean Settlements and Roman Occupation in Arabia Petraea In *SHAJ* IV (1992) especially 265ff.

41 Fiema (1987) 28f. is somewhat sceptical; he thinks Roman planning did not go that far. On the other hand Domitian had already made preparations for a campaign against the Parthians that were afterwards taken over by Trajan; cf. J. Wolsky, *L'empire des Arsacides, Acta Iranica IIIème série*, vol. XVIII, 1993, 176ff. This shows that the Roman emperors had freed themselves from the earlier republican step-by-step policies towards their provinces and clientels and tried to integrate them in further planning.

42 D. C. 48, 41, 5; see also N. C. Debevoise, *A Political History of Parthia* 1938, 108ff.; J. Wolski, *Les Parthes et la Syrie, Acta Iranica IIIème série*, vol. V, 1976, 413f.; Wolsky (1993, above n. 41) 122ff. especially n. 2.

43 D. C. 49, 32, 5; Plut., Ant. 36, 2; in the case of the Ituraean king Lysanias his execution and the donation of Ituraean territories to Cleopatra are explicitly explained by him supplying Pacorus.

44 Jos., ant. 14, 14, 1f.; Jos., bell. iud. 1, 274ff.; although Josephus claims this was just a pretext, this seemed plausible to Herod for he continued his flight into Cleopatra's Egypt.

45 Amm. Marc. 14, 8, 13: "Hanc provinciae imposito nomine, rectoreque adtributo, obtemperare legibus nostris Traianus compulit imperator, incolarum tumore saepe contunso, cum glorioso Marte Mediam urgeret et Parthos" (after Loeb Classical Library); see also Sartre (1985, above n. 35) 72.

46 On this see also J. Eadie, 'The Evolution of the Roman Frontier in Arabia' In Ph. Freeman - D. Kennedy (eds), *The Defence of the Roman and Byzantine East*. Proceedings of a Colloquium held at the University of Sheffield in April, 1986, BAR Int. Series 297, 1986, 243ff. especially 248f.

47 D. C. 68, 28f.; cf. R. Delbrueck, 'Südasiatische Seefahrt im Altertum', *BJb* 155/156, (1955/56) 245. The period from the conquest of Mesopotamia and Babylonia by Trajan (115-17 AD) until Hadrian shortly afterwards abandonned them is the only period in history when Rome directly controlled all starting points for the Far East trade - except the South Arabian ports.

48 D. C. 68, 15, 1; the Indians were not the only delegation but they were probably the most exotic which explains their special mention by Dio. It is further remarkable that the Chinese who were very interested in contact with the West withdrew exactly in 107 AD completely from the Middle Asiatic Sea, their starting point for trade with the West; on this see Delbrueck (1955/56, above n. 47) 251. 264ff. It seems therefore that in the Middle and Far East the political and economic changes around the Mediterranean were sharply observed.

because it became evident that all sites with a reported destruction at the time in question are situated in the centre of the Nabataean kingdom (see FIG. 12) and that there is no evidence that one or more of these destructions should be dated after the reign of Rabbel II. The only historical event that fits all conditions to be ascribed to the archaeological data is the Roman annexation of the Nabataean kingdom in 106 AD. It seems likely that the Romans faced considerable opposition to the integration of Nabataea into their empire. The great Roman interest as well as the Nabataean opposition to creating the new province has to be seen in the wider context of the planned Roman campaign against Parthia as well as the organisation of Far Eastern trade.

Whether there was first a revolt of the Nabataeans leading to the annexation or whether the annexation provoked the Nabataean opposition cannot yet be decided.[49] It may be that in future more sites with a similar destruction level can be ascribed to the Roman annexation. For the time being the sites reported above together with the not yet investigated sites in the Wādī 'Arabah could give us the routes that the Roman military contingents would have taken moving from the north (Syria), west (Judaea) and south (Egypt) towards Petra (see FIG. 12).[50]

[49] Fiema (1987) 29. If the confrontations continued after the Roman annexation this would mean that the destructions took place betweeen 106 A.D. and 111/2 AD when the new territories - according to coin legends - were definitively regarded as being *redacta in formam provinciae.* In this case one would expect further excavations to yield Trajanic coins with a *terminus post quem* of 106 AD or later from comparable destruction layers.

[50] This is, however, purely hypothetical, because the distribution of sites with a destruction may very well be influenced by the state of research.

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A Ceramic Sequence for Northern Jordan: An Archaeological and Chemical Perspective

Four seasons of excavation (1990-1993) at Tall al-Fukhār in northern Jordan have yielded a rich, diverse collection of Bronze and Iron Age pottery and silicate artifacts (also see J. Strange, this volume). This corpus is particularly important for the archaeology of Jordan, because it constitutes the first long-term stratified sequence from this region.

A review of the primary stylistic and technological features of the pottery and silicate artifacts from the main periods sets the stage for materials analyses that reveal local industrial developments and the foreign relations of Tall al-Fukhār. The methodology follows that which is outlined and used in a series of publications (e.g., McGovern 1986, McGovern 1989a and 1989b, James and McGovern 1993, and McGovern, Fleming and Swann 1993; also see McGovern 1995a). In brief, technology and style are viewed as interacting variables in their larger cultural and environmental contexts, and are reconstructed from the archaeological record using the appropriate techniques in conjunction with relevant contemporaneous literary and pictorial evidence and ethnoarchaeological analogy.

Ceramic Overview[1]

The earliest occupation of the site is represented by only a few sherds of Early Bronze (EB) IB band-slip/grain-wash ware. The subsequent nine phases of EB II-III, however, yielded pottery types that are comparable to those of EB Palestine generally, including bowls, large and small jars, juglets, and amphoriskoi. Except for more careful execution of patterned burnishing, painting, slipping, and combing on EB II vessels, the forms and other stylistic details of the vessels show marked uniformity throughout the period. The bodies of the larger vessels were usually built up of coils, although several examples had been thrown. Necks and rims were often finished on a tournette. Firing appears to have been carefully done, although thick black cores of unburnt carbon are the rule. One bowl sherd of Khirbat al-Karak ware, with a polished red interior and black exterior, was found in an EB III context.

After a probable gap in EB IV, Middle Bronze IIA is represented by a burial of probably two adults (male and female), in which three whole vessels, viz., a globular jar, platter bowl, and carinated bowl, had been deposited. All were thrown on a wheel. The absence of slips, the employment of irregular hand-burnishing or more careful wheel-burnishing in the case of the carinated bowl, relatively unstable disc bases (string-cut off the wheel), and specific stylistic features point to the vessels belonging to an early phase of MB IIA. Handmade, flat-bottomed cooking pots of the standard MB IIA type, with a finger-impressed ledge below the rim, were found in associated contexts. Levantine Painted Ware, employing simple bichrome geometric designs, is also represented in the group.

The Late Bronze (LB) Age, a transitional Late Bronze/early Iron, and Iron IB are among the best attested periods at Tall al-Fukhār. To date, however, only a few sherds of Chocolate-on-White ware and of other characteristic pottery types indicate reoccupation of the site in LB IA, following a hiatus in MB IIB-C.

The repertoires of LB IB-IIA and IIB pottery include most of the types that are documented elsewhere in Palestine and Jordan (for comparable material from the al- Baq'ah Valley and Bayt Shān, see McGovern 1986 and James and McGovern 1993). Of particular interest are several handleless collared-rim jars or pithoi (exceeding 1 m in height) of an early type with a rope appliqué at the upper mid-body, which also occurs at LB IIB Hazor and Bayt Shān (compare Yadin, *et al.* 1960: pl. 129.2 and James and McGovern 1993: II FIGS. 14.2 and 32.4). The "collar" at the juncture of the neck and shoulder is most often the lower terminus of a coil or rarely a separately applied coil. Oblique notching on the collars is rarely used to indicate rope decoration. The cooking pots were manufactured by applying one or more clay coil to a mold-made body; the coil(s) were folded back and forth to produce two rim types, either the common flaring triangulated form, or, more commonly at Tall al-Fukhār, an upright form with a slight gutter on the interior and two ridges on the exterior.

[1] Space limitations preclude presenting the detailed results here. A full discussion, with pottery descriptions, NAA data and statistical evaluation, is to be published in a monograph on the first four seasons of the excavation, (in preparation).

In other respects, small- and medium-sized vessels are generally made on the wheel, but a shift to more hand-built vessels is already apparent in the separately applied coils for ring bases of bowls and the interior or exterior development of krater rims. Bichrome and monochrome painted decoration, rarely over white slips, are fairly common, especially on kraters, jugs, and pilgrim flasks. In addition to the usual simple horizontal straight and wavy bands, metope-triglyph designs occur.

Sherds of several Mycenaean IIIB vessels, probably from jars and especially *kylikes*/cups, were recovered from the large public building "palace". A fragment of a Cypriot White Slip II "milk" bowl came from a mixed context.

The "palace" also yielded a unique blue-green glazed pottery "knob" (FIG. 6, J. Strange, this volume), possibly used as a wall decoration (attested at Nuzi in northern Mesopotamia in the 15th c. BC—compare Starr 1939: 408, pl. 98A) or an ornamental finial, a fragment from a blue-green glazed pottery jar or bottle, a glass female figurine pendant (FIG. 7, J. Strange, this volume) that is among the earliest molded glass artifacts ever made (McGovern 1986: 30, type II.B.1.a), and a blue-green glazed faience bottle and bowl. In general, the silicate artifacts are dated to LB I, predating the final use and destruction of the building, so that they must be heirlooms.

The Late Bronze-Early Iron transitional phase is characterized by numerous collared-rim jars and cooking pots. The collared-rim jars now have lower necks, more elongated bodies, and two relatively small loop handles at the upper mid-body. Evidence of coil manufacture is very clear from the impressions of ropes applied horizontally every 5-6 cms to hold each coil during the drying process, the next lower coil having been smeared over the top of the one added above it. As in the preceding LB IIB period, the cooking pots were manufactured by applying one or more clay coil to a mold-made body. Folding and subsequent shaping, sometimes using a sharp-pointed instrument or turning, now has resulted in a profusion of rim types, clearly related to what has gone before but more ridged and grooved and sometimes more inturned than the LB IIB prototypes.

Monochrome red painting, sometimes on a white slip (occasionally irregularly hand-burnished), predominates. A greater variety of designs than in LB II, albeit more poorly done, are attested, including filled triangles, criss-crossed lines, concentric circles on pilgrim flasks, figural designs including palm tree and the unique side and top views of a highly schematic bird on either side of a pilgrim flask, etc. One Philistine sherd (FIG. 9, J. Strange, this volume) that belongs to a type derived from a Mycenaean drinking vessel, the *skyphos*, had a well-executed looped spiral in black paint on a white slip (compare Dothan 1982: 98-106, Fig. 2, pl. 2).

The ensuing Iron IB level, which may date as late as 1050 BC in Jordan (see McGovern 1986: 9), is marked by collared-rim jars of LB/early Iron types which were evidently recycled as ovens by cutting off their bases and burying the necks of the vessels upside-down in the ground. Often two jars were used, one inside the other, with a stoking hole broken through the sidewalls. Medium-sized vessels, including jugs, juglets, and bowls, are generally coil-built; only small bowls and lamps are thrown off-the-hump. Cooking pot types are difficult to distinguish from LB/early Iron varieties. Painted decoration decreases, but coil appliqués on vessel exteriors and rows of reed impressions, especially on loop handles, are popular.

Following an apparent hiatus of occupation from Iron IB through IIB, the pottery repertoire of the Iron IIC-Persian period (ca. 650-400 BC, although likely continuing down to the Hellenistic times), which is primarily associated with silos covering a large area of the tall, is remarkably similar to that found in the 'Ammān region (McGovern 1983). Vessels are generally made on the wheel, including cooking pots, and probably fired quickly to a high temperature, leaving a carbon core. A ridge, forming a groove below the rim on bowl and krater exteriors and along the top of everted cooking pot rims, however, was achieved using a coil; ring bases could also be made by adding a coil. Decoration includes very fine wheel-burnished red slips on bowls and monochrome and bichrome horizontal bands, sometimes over a white slip, on jugs and kraters. Several Cypro-Phoenician sherds of late type have brown or black painted horizontal bands and concentric circles applied over a hand-burnished surface.

Ceramic Analyses

Neutron activation analysis (NAA) of 98 sherds for the main periods reviewed above, including 20 of the Hellenistic date, have revealed that pottery was produced locally in the vicinity of Tall al-Fukhār and imported from several regions of the Eastern Mediterranean. The physicochemical method of NAA has been extensively employed in pottery provenience studies, because of its sensitivity and precision in measuring as many as 35 elements, including rare earths which often characterize a clay source, and because it requires very small samples (50-200 mg) that are non-destructively analyzed (for analytical procedure and references, see James and McGovern 1994).

Relating the chemical composition of a particular ancient pottery sample to a given clay source, thereby "fingerprinting" the pottery and its presumed place of manufacture, is based on what has become known as the Provenience Postulate. Briefly, the assumption is made that the chemical variation within a given clay source is less than that between different sources. A native clay, however, was often modified by the ancient potter. Inorganic aplastics (temper) or organic materials might be added to the clay body, to improve its workability, drying and firing properties, and functionality. If these inclusions

The most important group of silicate artifacts at Tall al-Fukhār belong to LB IIB, and are probably heirlooms of 16th-15th c. BC date, near the beginnings of glassmaking in the Near East. The glazed pottery artifacts are particularly unusual, only a few other examples being reported from LB Palestine (for Bayt Shān, see James and McGovern 1993). The molded glass female figurine pendant, the forms of the faience vessels, and a unique glazed pottery "knob" suggest an origin in northern Mesopotamia, but the chemistry of the glazes and neutron activation analyses of the pottery of the glazed pottery artifacts do not provide a definitive answer.

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are relatively "pure" (e.g., quartz, calcite, or straw), the diluent effect on the chemical composition of an ancient sample will be spread across the range of elements and correction factors (e.g., least-means fitting) can be readily applied. The addition of complex heavy minerals, which can unpredictably enhance or diminish certain elemental concentrations, are less easily corrected for statistically.

A range of univariate and multivariate algorithms — means and standard deviations, and correlational, clustering, and principal components analyses of a range of elements — are used to define local chemical groups of ancient pottery, with widely divergent samples (outliers) being excluded. Archaeological and geological criteria are important in refining and testing these groups, whether well-dated pottery types, clays from specific geochemical regimes, clay beds within a single deposit, etc. For example, cooking pots, as well as walls and kilns of mudbrick (sunbaked clay), are often made of local clay and are not transported to another site. The NAA analyses of such samples should then serve to confirm a hypothesized local group based on other pottery types. This approach is essential when an ancient clay source has been totally exploited or systematic clay sampling has not yet been carried out in a region.

In general, our Old World data bank has excellent temporal and spatial coverage of the Levant and Egypt (approximately 2700 samples from 150 sites), together with other regions of the Near East and Mediterranean, including the Sudan, Greece, Iraq, Iran, and parts of Turkey. Tall Abū al-Kharaz, Tall as-Sa'īdiyya, Kataret as-Samrā', Pella and Jericho in the Jordan Valley, Khirbat Umm ad-Danānīr and Rujm al-Henu (West) in the al-Baq'ah Valley, the 'Ammān Citadel, Bāb adh-Dhrā', and aṣ-Ṣāfī are among the Bronze and Iron Age sites in Jordan for which material has been analyzed. This wide areal coverage, coupled with large numbers of samples for locally defined groups, enable us to apply powerful multivariate statistics in determining the archaeological origin of the pottery from Tall al-Fukhār. The clays included in the data bank date from the Lower Cretaceous period to recent times and derive from deposits thoughout the Levant (e.g., the red loess clays of the southern Palestinian coastal region, the yellow limestone-derived clays of the Palestinian hill country, and Jordanian smectites and kaolin clays).

It is quite common for the elements in clays and minerals to covary with one another. For example, the high correlation ($r > 0.99$) of iron (Fe) and scandium (Sc), both trivalent ions of about equal size, in nature is well known. Univariate statistics can be very misleading if this relationship goes unrecognized. If the variance-covariance matrix for many elements of a presumed local group is calculated, however, a new set of standardized orthogonal coordinates (eigenvectors) can be defined in multi-dimensional Mahalanobis space that takes advantage of elemental correlations. For statistical calculations, oxide data are also converted to logarithms, since many chemical elements appear to be lognormally distributed in nature, and are also standardized by this procedure. The Mahalanobis distance of a given sample from the origin or centroid of the group is directly related to the probability of the group membership of that sample, assuming a multivariate normal distribution. With high correlations between many elements, such as is characteristic of Levantine clays and pottery, it is possible to achieve extremely good results. A Mahalanobis probability above 5% for a sample tested against a group with a high sample number to variate ratio is a strong guarantee that it belongs to that group.

One of the most significant results of the NAA study of the Tall al-Fukhār pottery[2] is that the largest group, representing every major period, was produced somewhere in the vicinity of the site, since the group is very close chemically to alluvial clay deposited in the Wādī ash-Shallāla below the site. This result is also substantiated by preliminary petrographic analysis.The overwhelming majority of the EB II-III pottery tested (13 out of 21 samples) is of local origin, including bowls, jars, jugs, and holemouth cooking pots. Two jars with well-executed pattern burnishing and an EB II bowl that had been tournette-burnished along the rim and highly polished by hand elsewhere were of uncertain provenience, as was the Khirbat al-Karak sherd (cf. Chazan and McGovern 1984, *re* local production in the Jezreel Valley). Six of 9 MB IIA vessels analyzed were of local origin, including cooking pots, jars (one whole vessel from the burial—above), and a Levantine Painted Ware sherd. For LB IIB, a red-painted cylindrical stand fragment, cooking pots, and a range of macroscopically different wares were produced locally.

During the Late Bronze/early Iron transition, a pyxis and possibly the pilgrim flask with the unique painted bird design (above) are of local origin. In Iron IB, of the few examples tested, only a cooking pot was made locally. It should be noted that all except one collared-rim jar of transitional LB/early Iron and Iron IB date are of uncertain origin, suggesting that they were imported into Tall al-Fukhār from a region not well represented in the data bank (for the one exception from southern Palestine, see below). The pattern of primarily local production is again evidenced for cooking pots in the Iron IIC-Persian period. The three Cypro-Phoenician sherds, which were available for analysis, are of uncertain origin. Although not reviewed above, the Hellenistic pottery corpus retains many of the technological and stylistic features of the Iron IIC-Persian repertoire. Correspondingly, 9 out of 20 Hellenistic storage jars, jugs, and a cooking pot and bowl are of local origin.

The main source of pottery imports to Tall al-Fukhār from MB IIA through the end of the Iron Age was southern Palestine, viz., the Gaza region, extending along the

[2] See n. 1.

coast north to Ashkelon and as far inland as Tall Bayt Mirsīm, which is chemically characterized by its red loess clays (for a more extended discussion, with data, see McGovern *et al.* 1994). This finding stands in marked contrast to the lack of imports from this region in EB II-III.

The pottery types for each main period imported from southern Palestine are as follows:

(1) MB IIA – cooking pot and jar/goblet
(2) LB IIB – cooking pot
(3) Iron IB – collared-rim jar and Philistine bowl
(4) Iron IIC–Persian– cooking pot, bichrome–painted jug, undecorated bowl, and wheel– burnished red–slipped bowl
(5) Hellenistic– two cooking pots, red–slipped bowl, and alabastron

Pottery of special types were clearly being imported from the Gaza region. The prevalence of cooking pots is more difficult to explain, since these vessels have generally been considered as more intransigent to technological change, due to their association with traditional cuisine, and thus tied to local household and/or village production. The NAA data from Tall- al Fukhār, however, suggests that cooking pots were produced on a larger scale and distributed to other regions of Palestine from workshops in southern Palestine, at least during the periods represented at Tall- al Fukhār. Alternatively, it might be argued that people from southern Palestine moved to the site, bringing their important belongings with them, or visited friends or relatives there and left the cooking pots behind. Some kind of economic activity, trading the vessels for their own sake or possibly for what they contained, is more likely, but lacking contemporaneous texts, other explanations cannot be ruled out..

Several other regions of the Levant and Egypt account for other imported pottery and silicate artifacts into Tall-al Fukhār, In LB IIB, a probable jar came from 'Affuleh in the Jezreel Valley; in the Persian period, a multiple-handled and knobbed krater was from the al-Baq'ah Valley in central Jordan (see McGovern 1986) and a red-painted jar was made of Egyptian Nile alluvial clay; and during the Hellenistic period, high quality slipped and painted bowls were imported from eastern Cyprus and storage jars from Rhodes and probably the Cilician plain of southern Anatolia.

Three Chocolate-on-White sherds from a bowl, pyxis and jar, dating to LB IA, fit the same chemical profile as other examples of this ware analyzed from Bayt Shān, Tall Abū al-Kharaz, Pella, Kataret as-Samrā', the'Ammān Citadel, and sites in the al- Baq'ah Valley. A northern-central Jordan Valley origin is probable based on the NAA results, and accords with the high frequency of the unique ware in this region and probable wasters found at Kataret as-Samrā'. As yet, however, a clay source has not been located.

Four Mycenaean *kylikes*, which are particularly associated with wine drinking in Greece, and a probable piriform jar fragment were tested by NAA. Three had been produced in the Mycenae region itself in central mainland Greece. One *kylix* and the jar were of uncertain origin.

The glass of the female figurine pendant and the glazes on the pottery knob, pottery jar/bottle, and faience vessels are all of similar composition, according to non-quantitative energy-dispersive spectrometric analyses using a scanning electron microscope. The blue-green coloration, which has been extensively leached out on all the artifacts, is due to copper ions in the +2 oxidation state. Potassium oxide exceeds soda, suggesting that a plant material was used as the main flux. These results could fit with local Palestinian production (McGovern, Fleming and Swann 1993; McGovern 1986), but stylistic considerations point rather to a northern Mesopotamian origin. The NAA data for the pottery of the knob and jar/bottle sherd did not match any site or region in the data bank.

Conclusions

The stratigraphic sequence of pottery and silicate artifacts from Tall al-Fukhār, coupled with stylistic and technological analyses, provides the first long-term perspective on the Bronze and Iron Age material culture of northern Jordan, and enables this region to be integrated into broader developments of Jordan and the Levant (see, e.g., McGovern 1987 and 1995b).

The neutron activation analysis study of a wide range of pottery types from the main periods at the site shows that Tall al-Fukhār was not the isolated, uninhabitated tall that it is today. Contacts were especially strong with southern Palestine from the Middle Bronze Age onwards. A local pottery industry, which had already begun in the Early Bronze Age and used alluvial clays deposited in the Wādī ash- Shallāla, continued to produce the majority of the pottery found at the site through Hellenistic times.

Specific contacts, most probably trade connections, are documented for northern Palestine, the Aegean, and Cyprus in Late Bronze IIB, central Jordan and Egypt in the Iron IIC-Persian period, and the eastern Mediterranean (Cyprus, Rhodes, and probably southern Turkey) in the Hellenistic period. Thus, Tall al-Fukhār shared in the economic prosperity of these cosmopolitan times.Some political integration with central Jordan in the Iron IIC-Persian period is possible, since the pottery types are almost identical in the two regions.

Some pottery was probably imported for its own sake, whether as drinking vessels (e.g., the Mycenaean *kylikes* and the Philistine *skyphos*) or because of traditional associations (e.g., cooking pots which were used to prepare particular foods). In case of the Philistine import, this opens the question of Sea People influence in northern Jordan (McGovern 1994). Other pottery, especially jars, probably functioned as containers for other goods, yet to be determined (see Biers and McGovern 1990; Michel, McGovern and Badler 1993).

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The Weathering Behaviour of Ancient Glass as a Function of its Composition

Introduction

Ancient glass forms an important part of our material heritage. The scientific study of glass can yield information of value to archaeologists in their study of the past. Therefore, conservation and preservation of ancient glass material has attracted the attention of many scientists and has been the subject of many studies. A great deal of these studies is aimed at understanding decay processes of ancient glass and the causes behind this decay (Sykes 1965; Scholze and Corbach 1971; Hench 1975; Paul 1977). The results of these studies show that the main factors that affect the type and rate of glass decomposition are the composition of the glass and its environment. Other less important factors are the pH value of an aggressive solution (El-Shamy 1973a, 1973b; Brill 1975; Hench and Clark 1978), surface roughness and surface area of the glass, inhomogeneity in the glass (phase separation), internal and applied stress, time and early conservation treatments (Griffiths 1980; Newton 1985; Newton and Davison 1989). Obviously some of these parameters are interdependent, but the complexity of the situation is apparent.

Among the factors governing the corrosion of ancient glass, the chemical composition of the glass is of prime importance. This is because the nature and proportions of the basic components of ancient glass have been found to have a strong impact on the durability of ancient glass and its behaviour toward various corrosive environments (Newton 1985; Newton and Davison 1989).

In this study, the state of preservation of a collection of Islamic glass objects and fragments and the correlation of the latter with the glass composition was investigated. The studied glass was found at the time of excavation in a very good condition with a very slight degree of decomposition and alteration. The glass was exposed during burial to various types of weathering agents for over 1000 years. Both groups were excavated at the same archaeological site and at the same time.

Materials and Experimental Methods

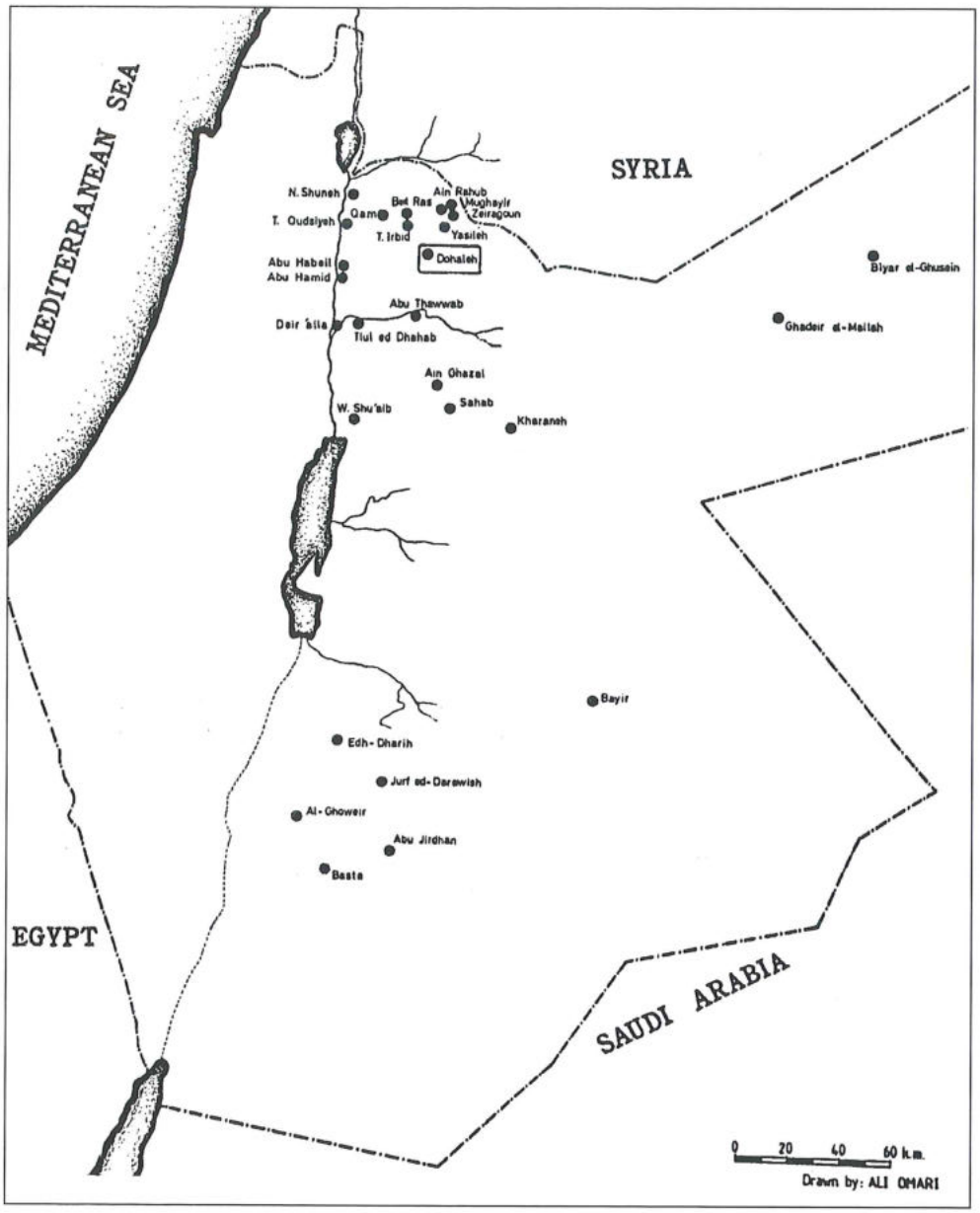
The materials used in this study consist of a collection of glass objects (bracelets and bowls) and a large number of glass fragments coming from recognizable objects such as bowls, bottles, flasks and vessels. The glass was excavated at Doḥaleh, an archaeological site in northern Jordan (FIG. 1) (Sari 1991; 1992). Most of the studied glass came from area C (the cemetery). The glass was dated, by the pottery and coins found in the same context, to the Islamic period, most probably Umayyad.

Sample Preparation

For the purpose of the chemical analysis the samples were prepared in the following steps: Prior to sampling, all extraneous concretions adhering to the surface of the glass pieces were completely removed to prevent any possible contamination. Then the weathering crusts were mechanically separated from the unaltered glass core. Care was taken to make the separation complete since the original glass and the weathering products have different chemical compositions. Two samples were taken from every glass fragment; one from the weathering corrosion and one from the unaltered original glass. The samples taken from the weathering crusts were powdered and placed in an oven (at a temperature of 120° C) for 24 hours to expel the water of hydration.

A slightly modified method of Huges *et al.* (1976) was used for the preparation of the samples for Atomic Absorption analyses. A 10-15 mg sample was accurately weighed and transferred to a platinum crucible. A 100 mg of lithium metaborate was added to the crucible and the sample was then mixed thoroughly with a spatula. The sample was then fused at 900° C using a burner until a clean melt was obtained. The melt was then cooled to room temperature and after that 7 ml of 3% V/V nitric acid was added. The mixture was stirred continuously using an electric stirrer until completely dissolved and then transferred to a 50 ml volumetric flask. The flask was filled to the mark by adding more of the 3% nitric acid.

For quantitative analysis of the samples, a Perkin Elmer Atomic Absorption Spectrophotometer (model SP 9) with an air-acetylene flame was used. The emission mode was used for the determination of sodium and potassium while the absorption mode was used for the determination of the other elements. Analyses were carried out for the following elements expressed throughout as weight percentages and mole percentages of their oxides: silicone (SiO_2),



1. Map showing the Archaeological site of Doḥaleh.

sodium (Na_2O), potassium (K_2O), calcium (CaO), aluminium (Al_2O_3), iron (Fe_2O_3), manganese (MnO), magnesium (MgO), copper (CuO), lead (PbO) and tin (SnO_2). Concentrated standard solutions containing 1000 ppm of each element were prepared using Perkin-Elmer (1973) methods. These concentrated solutions were used to prepare dilute – standard – solutions covering the concentration range of the samples. Five standards for each element were prepared and used to plot calibration curves. Duplicate and in some cases triplicate determinations starting with new samples were run for any questionable values. The Atomic Absorption results have an accuracy of ± 2 % for the major elements, ± 10 % for the elements between about 0.5 and 0.05 weight and ± 20 % for trace elements under 0.05 weight percentage.

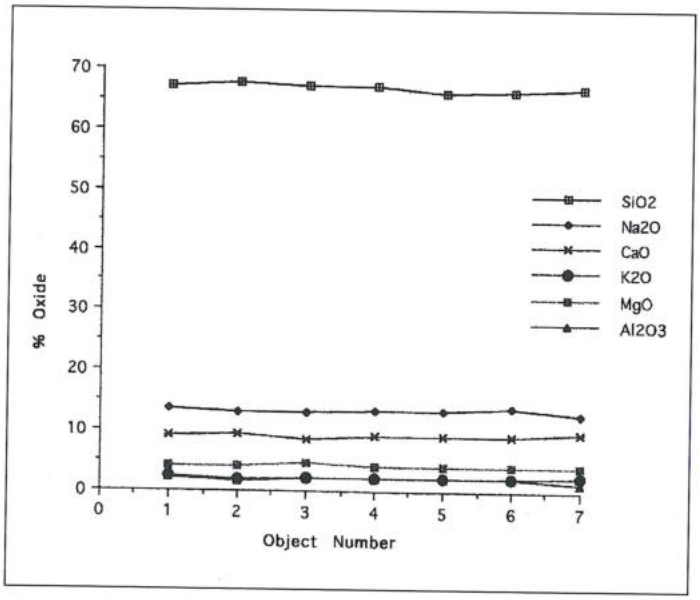
Results and Discussion

The results of the chemical analyses of the unaltered original glass as well as the weathering products for all studied glass are tabulated in TABLE 1 . On the basis of the nature and proportions of their major constituents, all the studied glass belongs to the same general compositional category of soda-lime-silica (Na_2O-CaO-SiO_2) glass. The glass is characterized by its moderate soda, high lime, high potash and high magnesia contents (average Na_2O = 13.32%, CaO = 9.24%, K_2O = 2.27%, MgO = 4.29%). The types of glass comprise a rather tight chemical group with very slight variation in their major and minor constituents (FIG. 2). This is a strong indication that the glass samples were made of the same raw materials and were probably made by the same glass workshop. The high lime, high potash and high magnesia contents of the glass samples point to the nature of the raw materials used in their manufacture. The glass was probably made by fusing sand as a source of silica with plant ashes as a source of alkali (Smith 1963; Forbes 1966).

Table 1. Chemical analyses of the unaltered core and the weathering crust of glass.

	Unaltered glass								Weathered glass							
chem. comp. %	No.1 bowl yellow	No.2 bracelet Blue	No.3 flask Pale violet	No.4 bowl Colou-rless	No.5 bracel-ets Purple	No.6 flak turqou-ise	No.7 plate dark blue	Average	No.1	No.2	No.3	No.4	No.5	No.6	No.7	Average
SiO_2	67.23	67.82	67.21	67.28	66.23	66.24	66.80	66.97	69.11	69.32	69.24	68.74	68.23	68.41	68.79	68.83
Na_2O	13.61	13.10	12.98	13.32	13.43	13.89	12.91	13.32	12.45	12.60	11.59	12.72	12.61	12.31	12.45	12.39
CaO	9.19	9.41	8.72	9.27	9.28	9.17	9.64	9.24	8.54	8.67	8.76	8.51	8.79	8.24	8.43	8.56
K_2O	2.41	2.02	2.36	2.15	2.28	2.21	2.43	2.27	2.00	2.01	1.99	1.96	1.99	2.12	2.01	2.01
MgO	4.27	4.08	4.72	4.32	4.08	4.24	4.32	4.29	3.51	3.58	3.47	3.57	3.98	3.99	3.89	3.71
Al_2O_3	2.29	1.71	2.27	2.15	2.14	2.34	1.27	2.02	1.97	2.41	3.00	2.76	3.01	3.22	3.11	2.78
Fe_2O_3	0.74	0.60	0.55	0.29	0.68	0.47	0.68	0.62	0.96	0.86	0.84	0.54	0.94	0.74	0.84	0.82
MnO	-	0.26	0.79	0.62	1.13	0.17	0.64	0.52	0.46	0.14	0.83	0.59	-	0.67	0.10	0.40
PbO	0.12	-	-	-	-	-	-	-	-	-	-	-	0.32	-	-	*
CuO	-	0.69	-	-	0.35	0.56	0.84	0.37	0.76	0.39	0.27	-	-	-	0.36	0.28
SO_3	-	-	-	0.44	0.33	-	0.21	-	0.21	-	0.20	0.30	-	-	-	*
Total%	99.86	99.69	99.60	99.84	99.93	99.89	99.74		99.97	99.98	100.19	99.69	99.87	99.70	99.98	

– : searched not found, * : Not determined

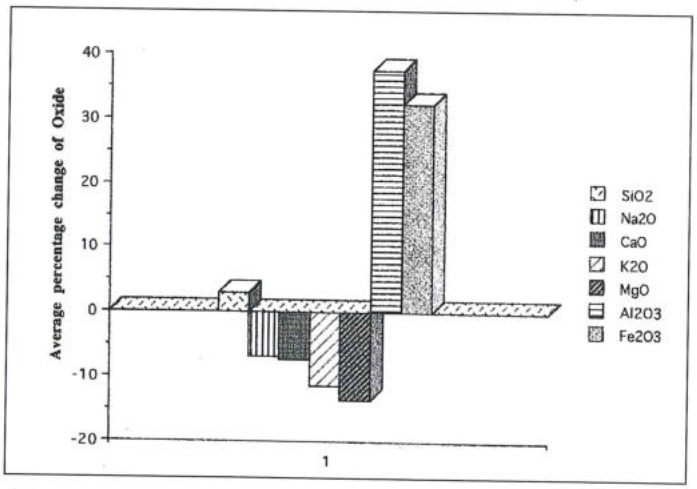


2. Variations in the percentages of the basic ingredients of glass.

Plant ashes usually contain significant amounts of potash and magnesia which inevitably would have incorporated in the manufactured glass. It is known that plant ashes recipes were the most common methods used for glass manufacturing during the Islamic period (Al-Hassan and Hill 1981; McKinnon and Brill 1987). These findings are entirely consistent with Islamic traditions of glass-making. The source of soda used by the Islamic glass-blower were the woody ashes *(al-Qalī)*. *Al-Qalī* was a major Syrian product that was used in the concentrated form of the salt *milḥ al-Qalī*. When the sand was mixed with *al-Qalī* a durable glass of the soda-lime-silica type was produced.

The chemical analyses results of the weathering products of the glasses calculated on anhydrous basis are given in the second part of TABLE 1. In the last column of the table the average percentage changes in the proportions of the individual components between the unaltered glass and the weathering crusts are given.

The results show that the weathering products of both groups have higher proportions of silica, alumina and iron and lower proportions of alkalis and alkaline earths compared to the original glass (FIG. 3). The differences in the composition between the unaltered glass and the outer decomposition encrustation could be accounted for, being based on the differential solubility of the various glass components in water. This is because formation of the weathering crusts was mainly the result of the hydrolytic



3. Average change in the proportions of the basic constituents of glass caused by weathering .

action of ground water during burial. The water soluble components such as soda, lime, potash and magnesia formed by this action were leached away and greater part of the silica network was precipitated in an amorphous hydrated form. The other components which form water insoluble decomposition products such as iron, alumina and lead oxide, remained behind with the silica and therefore their relative proportions would be higher.

It is evident from the chemical analyses results that the glass had suffered from a very slight degree of decomposition and deterioration. The silica contents of the glass had slightly increased from an average content of 66.97% in the original glasses to 68.83% in the weathering crusts. This means an average proportional change of 2.78 %. This indicates a very little degree of decomposition and alteration.

The above conclusion is further confirmed when the proportional changes in the contents of alkalis and alkaline earths of the glass are considered. The calculated average proportional changes in the percentages of these components (average percentage proportional change of Na_2O = -6.98%; CaO = -7.36%; K_2O = -11.45%; MgO = -13.51%) show that the level of these components had slightly decreased in the decomposed glass indicating a low level of decomposition and alteration.

The proportions of iron oxide and aluminium oxide are noticeably higher in the decomposed layers compared to the original glass. This is expected since these oxides form water insoluble decomposition products and therefore no leaching out of these oxides is expected. So, the decrease in the concentration of the soluble alkalis and alkaline earths would result in an increase in their relative proportions in the glass network. However, the increase is too high to be solely accounted for on the basis of preferential rates of solution of the products of hydrolysis. More of the iron oxide and aluminium oxide which come from the mineralised ground water might have been adsorbed on the surface of the glass.

The constituents of ancient glass may usefully be divided into three groups according to their effect on the durability of the glass: network former (mainly silica), network modifiers (alkalis, mainly soda and potash) and network stabilisers (alkaline earths, mainly lime and magnesia). The corrosion resistance of glass is largely governed by the nature and proportions of these constituents (Newton and Davison 1989).

However, these constituents exert their effect on the durability of glass by their relative number of molecules rather than their relative weight. Therefore, it is considerably more enlightening to deal with the molar percentages of the constituents than their weight percentages. The difference would not matter if all the molecules had a similar weight but the oxides involved in the glass making have remarkably different molecular weight. Thus, for the sake of realistic conclusions regarding the durability of glass, the obtained weight percentages should be converted into mole percentages. The molar percentage values which have been calculated by the method described by Newton and Davison (1989) are tabulated in TABLE 2.

The first component that might have a strong impact on the durability of glass and its corrosion resistance is silica. It has been found that the silica content of glass is

Table 2. Relative molar proportions and molar percentages of glass.

	Relative molar proportions								Molar Percentage							
Oxide	Factor	Object No. 1	Object No. 2	Object No. 3	Object No. 4	Object No. 5	Object No. 6	Object No. 7	Object No. 1	Object No. 2	Object No. 3	Object No. 4	Object No.5	Object No. 6	Object No. 7	Average
SiO_2	***0.601***	111.86	112.85	111.83	111.95	110.20	110.22	111.43	67.34	67.74	67.29	67.17	66.42	66.65	67.12	**67.10**
Na_2O	***0.620***	21.95	21.13	20.94	21.48	21.66	22.40	20.82	13.21	12.68	12.60	12.89	13.05	13.55	12.54	**12.93**
CaO	***0.561***	16.38	16.77	15.54	16.52	16.54	16.35	17.18	9.86	10.07	9.35	9.91	9.97	9.89	10.35	**9.91**
K_2O	***0.942***	2.56	2.14	2.51	2.28	2.42	2.35	2.58	1.54	1.28	1.51	1.37	1.46	1.42	1.55	**1.45**
MgO	***0.403***	10.60	10.12	11.71	10.72	10.12	10.52	10.72	6.38	6.07	7.05	6.43	6.10	6.36	6.46	**6.41**
Al_2O_3	***1.020***	2.24	1.68	2.22	2.11	2.10	2.29	1.24	1.35	1.01	1.33	1.27	1.27	1.38	0.75	**1.19**
Fe_2O_3	***1.597***	0.46	0.38	0.34	0.18	0.43	0.29	0.43	0.28	0.23	0.20	0.11	0.26	0.17	0.26	**0.32**
MnO	***0.710***	*	0.37	1.11	0.87	1.59	0.24	0.90	*	0.22	0.67	0.52	0.96	0.14	0.54	**0.43**
PbO	***2.232***	0.05	*	*	*	*	*	*	0.03	*	*	*	*	*	*	*
CuO	***0.796***	*	1.15	*	*	0.44	0.70	0.46	*	0.69	*	*	0.25	0.42	0.28	*
SO_3	***0.801***	*	*	*	0.55	0.41	*	0.26	*	*	*	0.33	0.25	*	0.16	*
Total%		166.10	166.59	166.20	166.66	165.91	165.36	166.02	100.00	100.00	100.00	100.00	100.00	100.00	100.00	

*: Not determined

significant in determining the tendency of glass to weather and therefore in the formation of the crusted layers. El-Shamy (1973a) has proved that there is an increased tendency of glass to form crusted layers as the silica content of glass decreases. Weathering rates start to accelerate when the silica content falls below a critical silica content of 66.5 mole per cent. This particular silica content corresponds to a point at which every silicon atom in the glass is associated with a modifier atom (Ca, Na, K, etc.) as its second neighbour. Consequently there is always an interconnecting path of neighbouring silicon oxide (Si-O-) groups that provide sites for the movement of interchanging species between the solution and the glass. Above the critical value the Si-O groups are isolated by Si-O-Si groups that suppress the movement of ions involved in leaching (Newton and Davison 1989). The results tabulated in TABLE 2 show that the studied glass has a silica content that is either very close or well above the critical value. This enhances its resistance to proton penetration .

The nature and percentages of alkali ions in glass have been found to play a major role in its weathering behaviour (Brill 1975; Scholze 1978). Alkali ions, mainly soda and potash, were added by ancient glass makers to lower the high fusing temperature of silica (M. P. of pure silica = 1720° C) and to reduce its viscosity. Because alkali cations bear only a single positive charge they can move from one space in the glass network to another. When glass comes in contact with water alkali ions can move right out of the glass network into the water. This severely reduces the durability of glass. In addition, alkali ions increase largely the polarisation of the non-bridging oxygen ions in the network. This largely encourages the protons of water to penetrate the glass network and consequently increases the rate of hydrolysis of the glass. Also alkali ions exhibit antagonistic effects on the strength of the Si-O-Si bonds in the glass network. The high field strength of these cations tends to draw the electrons of the bridging oxygen atoms so weakening the Si-O-Si bonds which means less durable glass.

It is obvious from the previous discussion that there is a negative correlation between the durability of the glass and its alkali ions' content. The studied glass is characterized by itslow soda and potash contents with an average molar percentage of 12.93 and 1.45. These values are low enough and their negative impact on the durability of the glass can be counterbalanced by the stabilisation effect of the alkaline earth oxides.

Ancient glass usually contains alkaline earth oxides, mainly lime and magnesia. These might not have been added deliberately by the ancient glass maker but might have been a component of the raw materials used to make glass. The presence of alkaline earth oxides, especially lime, enhances the durability and weathering resistance of glass. This is due to the ability of these ions to co-ordinate with oxygen ions in the glass network. This co-ordination lowers the polarizibility of the oxygen atoms and thus making glass more resistant to proton penetration and hydrolysis. Therefore, the alkaline earth ions contents of glass are of great importance where the weathering behaviour of glass is concerned.

It has been found that the optimum lime content that imparts the maximum stabilisation effect on silicate glass is 10 mole per cent (Bacon 1968). Above or below that optimum level, the weathering resistance of glass starts to decline. The glass has a lime content (average CaO = 9.91 mole per cent) which is astonishingly very close to the optimum 10 mole per cent value. The small variations in the lime content of the glass and the closeness of these contents to the optimum value might strongly indicate that the glass maker during the Islamic period was aware of the stabilising effect of lime on glass. The divalent magnesium oxide has a similar effect on the durability of glass as calcium oxide when its proportion is calculated on a molar basis rather than on a weight basis (Newton 1976). The high magnesia content of the glass (average MgO = 6.41%) has definitely contributed to its high durability and weathering resistance.

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