GEOELECTRIC AND ARCHAEOLOGICAL WORK AT SĀL, JORDAN A PRELIMINARY REPORT ON THE 1999 SEASON AT THE CHALCOLITHIC AND EARLY BRONZE AGE SITE

by

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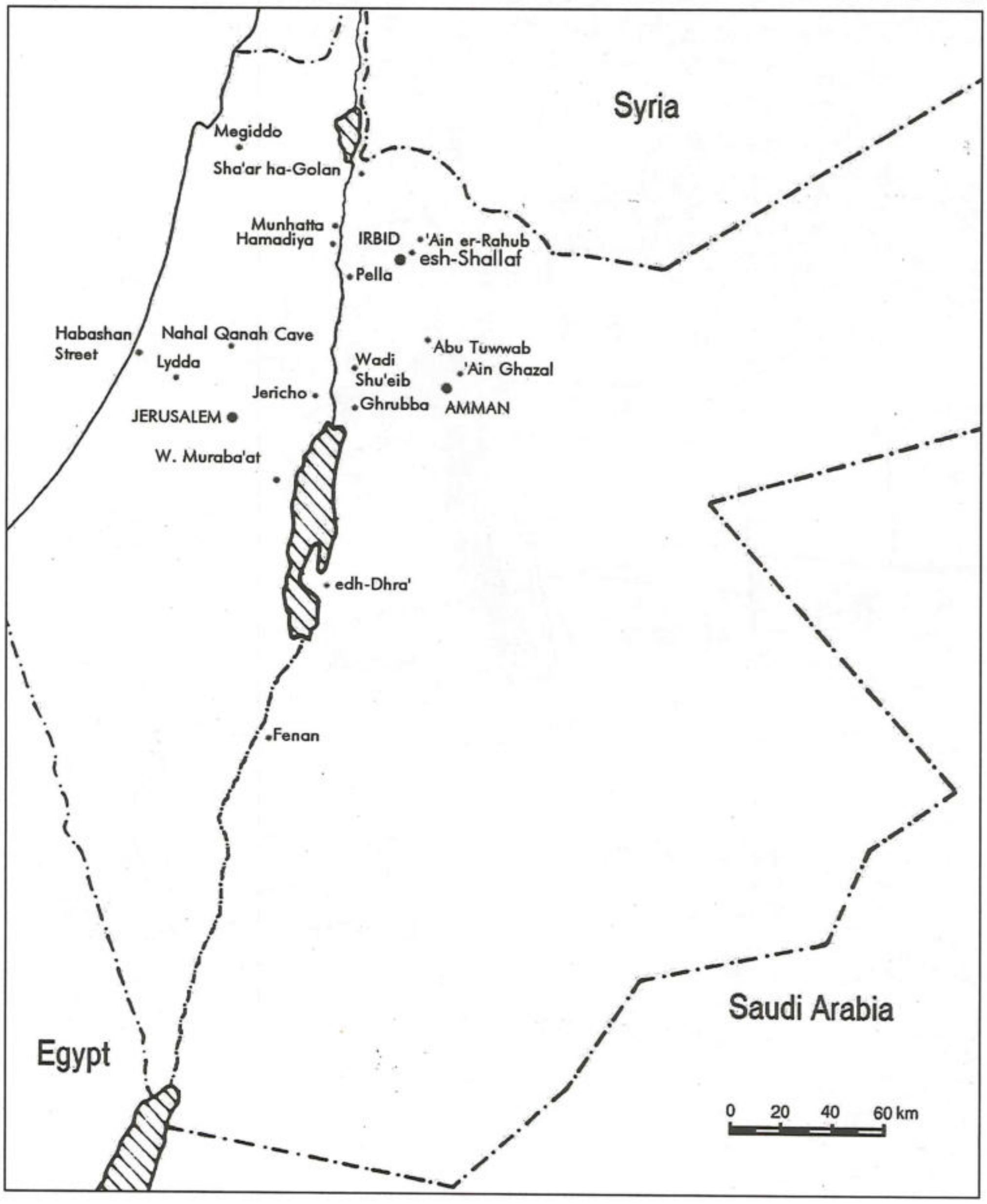
Introduction

The Jordanian-German archaeological expedition started on September 11th and ended on September 30th 1999, at the site of Sāl (Fig. 1), approximately 6.5 km north-east of Irbid (Palestine grid 2358.2195), represented by Yarmouk University Irbid, the Kirchliche Hochschule Wuppertal, and the Department of Antiquities of Jordan. The co-directors of the project were Zeidan Kafafi and Dieter Vieweger.

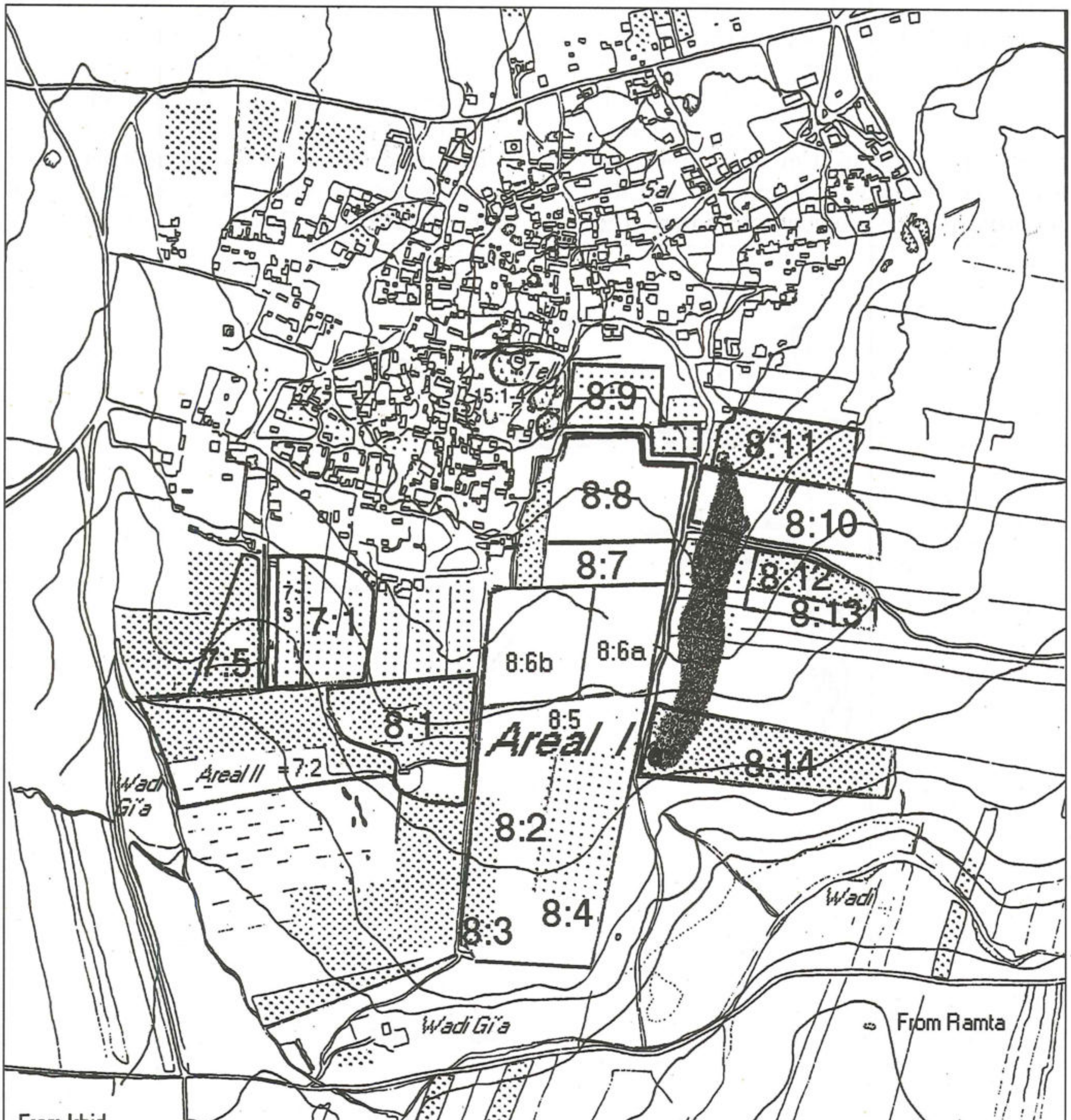
The aim of the project is the following: 1) To start a geoelectric exploration to define the artificial remains at the site before excavating it; 2) To inspect the archaeological remains dating to the fourth millennium and to look for any possible relationship between this area and the Golan. 3) To check the re-



1. The location of Sāl in northern Jordan.

sults of this year and assess the potential for future excavation campaigns at this site that is heavily affected by modern agriculture.

The modern village of Sāl (approximately 400.000 m^2) is situated on the south-west end of a flat ridge which runs north-east to Wādī ash-Shallālah. High above the wadi, the approximately 16 m high Tall (585 m NN) of Sāl dominates the entire ridge as a landmark. The large slope south of Tall Sāl goes downwards to Wādī ad-Dshi'a (West) and is called Khirbat al-Bayaz al-Gharbīyya by the villagers (Fig.2). There are no old structures visible on the surface of Sāl and Khirbat al-Bayaz. Around the western, southern and south-eastern flank of Khirbat al-Bayaz,



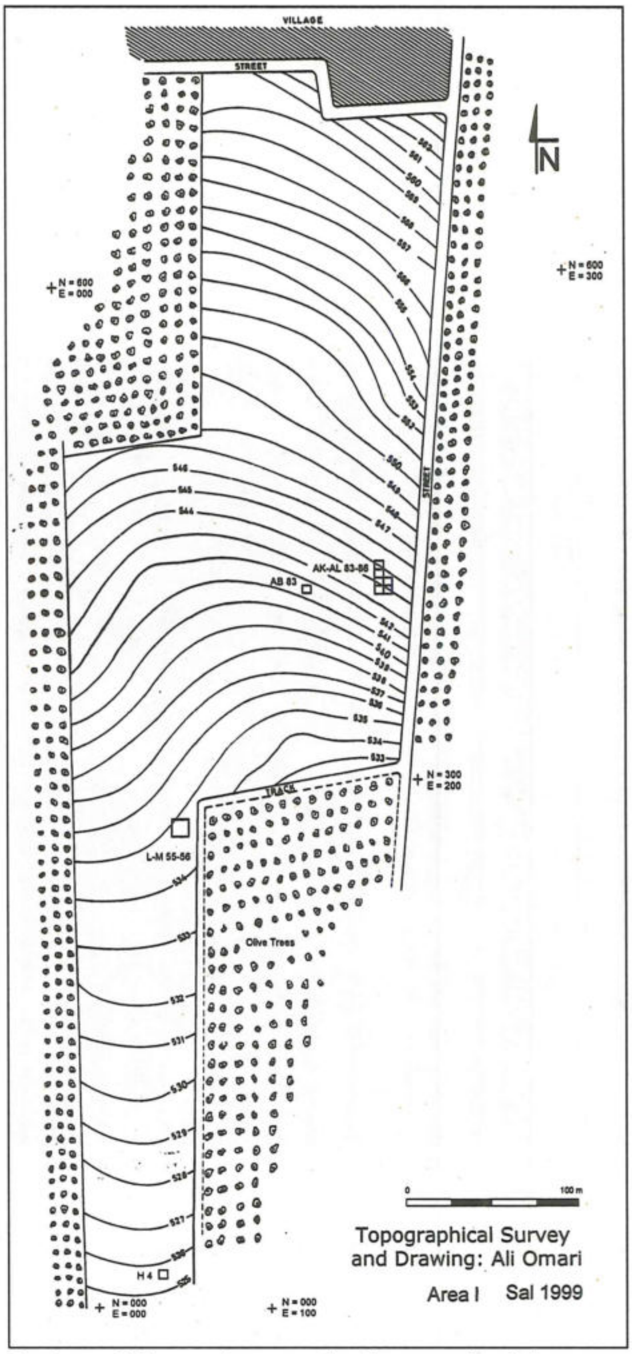
2. Slightly changed map of the Vicinity of Sāl and Khirbat al-Bayaz.

Wādī ad-Dshi'a winds and carves into the land at about a 20 m depth. South of Khirbat al-Bayaz, a modern road leads from Irbid to ar-Ramtha along the bottom of the wadi. A small valley marks the end of the site in the west.

The site of Sāl has, by nature, outstanding conditions for archaeological investigations: the strategic position in the vicinity of Wādī ash-Shallālah at the northern edge of the Irbid ar-Ramtha-basin guaranteed very good possibilities for trade and agriculture at this place. This offered the existence of the large Chalcolithic site of up to 36 ha.[1] However, as expected, during our visits to Sāl prior to the excavation work, we found that the state of the Khirbah was poorly preserved. Additionally, the modern village Sāl has recently expanded, covering parts of the archaeological site. Not only the Tall, but also the cultural area, untouched for millennia, is in constant danger of being completely destroyed. First, the modern village has carved deep into Tall Sāl itself, and, a large water basin made of concrete covers the highest point of the Tall. All other areas of the Tall, are densely covered up with modern tombs. Therefore, the Tall itself cannot be regarded as an excavation area. Second, the adjacent area around the Tall is covered by streets, and modern houses with their courtyards. So, there is also no possibility for testing that area.

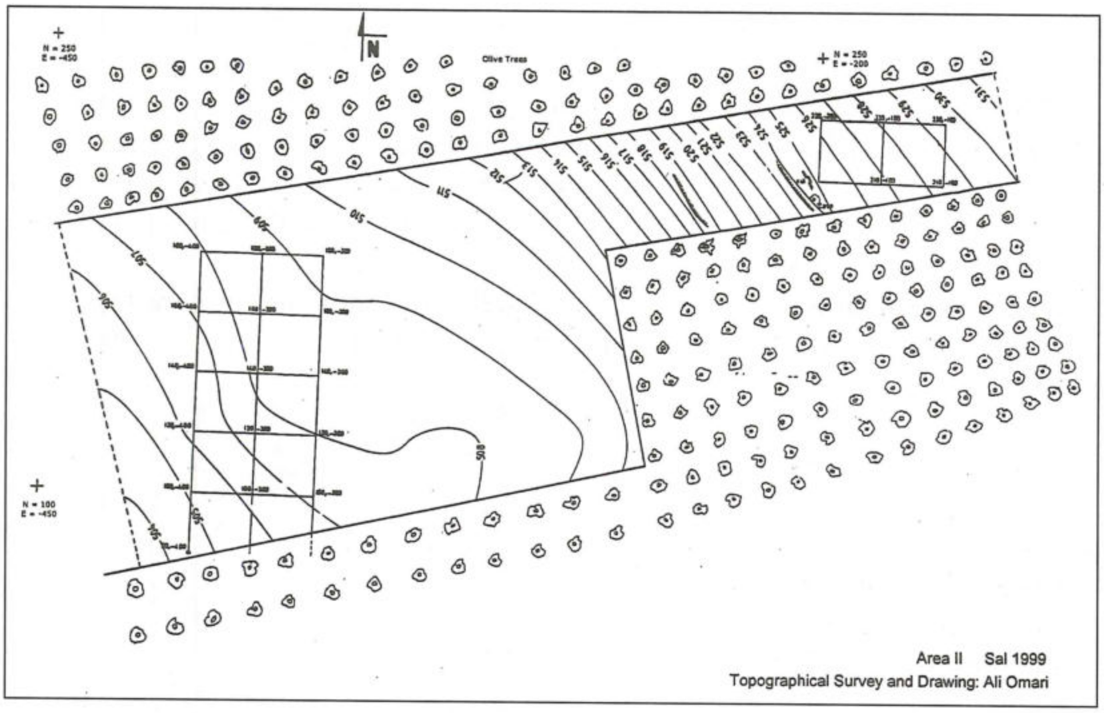
Therefore, we concentrated our attention on the large area from the south-east to the south-west of the Tall, Khirbat al-Bayaz al-Gharbīyya that is currently used for agriculture. About one half of the area is covered with olive trees. The farmers destroyed most of the archaeological remains by digging holes for planting the olive trees and by ploughing the space between the trees up to 30-35 cm deep. Considering that the stratigraphical layers are not usually covered by large amounts of earth, there seems to be a great destruction of antique remains. The roots of the trees destroyed the area as well. For this reason we decided to start our archaeological research in the large open fields between the olive plantations (area I; Fig. 3) and the area to the west of them (area II; Fig. 4).

The authors of this article carefully examined these fields in the spring of 1999 (Fig.



3. Area I is nearly completely examined by geoelcectric work. Excavated squares are marked.

1. Cf. the similar estimation by Kamlah 2000: 49.



4. Area II, with 20x20m squares for geoelectric work.

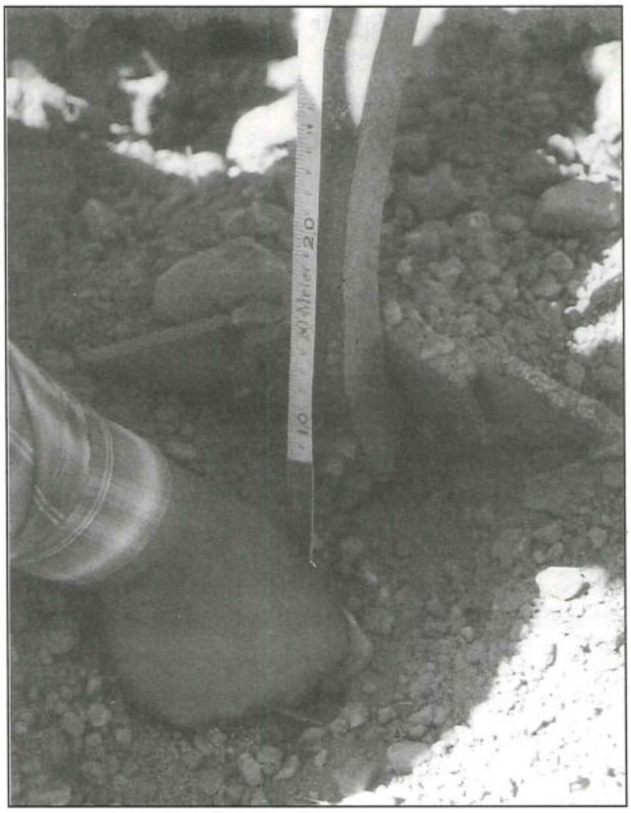
5. A painted chalcolithic pottery sherd found during the survey

5). We expected difficulties in fieldwork because in some parts - especially in the southern part of area I - the bedrock is already visible on the surface. In addition, a 'test trench' made by treasure hunters near the later excavated square AB 53 (in the vicinity of field 8:6a; see Fig 2, Khirbat az-Zayraqūn-survey) showed that the cultural strata in this area are not deeper than 30-40 cm below the surface.

Because the farmers plough the field with tractors every year, we expected destroyed archaeological layers in parts of areas I and II. Two different ploughing methods were used in Sāl in the past. There are 'normal' ploughshares (Fig. 6 a and b) which usually cannot plough deeper than ca. 15 cm. But we also saw more modern long ploughshares with additional wheels which penetrate up to a 35 cm depth in the fields.

Knowing this, we decided to base our excavation campaign mainly on geoelectric prospecting. There are many advantages of such an approach in this region and under

6a. Agricutlural work.



6b. The destruction of cultural layers.

these special conditions. First, the undisturbed areas - not destroyed by agriculture - are much easier to find than is typical in archaeological work. We were able to examine between 1,600 m^2 to 2,400 m^2 a day with only one geophysical system. On the basis of these results, we could decide in which parts of the fields in Sāl we should expect architectonic features and undisturbed areas. Second, archaeological work - like test trenches or some squares in special selected areas - can accurately and sufficiently interpret the geoelectric results over a large region. Third, we can leave undisturbed areas - examined but not excavated (this also means 'destroyed') for further investigations. Fourth, in some parts olive trees will very soon be planted. So we could seize the last opportunity to get a lot of information about a large territory - which could not be obtained by traditional excavation work with the available budget.

Additional geomagnetic or geo-electromagnetic work was not carried out in Sāl for geological reasons. The high percentage of basalt stones in the earth makes it impossible to obtain archaeological information with those geophysical methods.

Chalcolithic settlements and culture in Palestine[2], based largely on systems of villages of farmers and animal breeders, as well as the developing craftsmanship[3], have become a central topic of investigation in recent years. At the end of the 5th millennium BC, Neolithic development came to an end in northern Transjordan. A more specialised Chalcolithic culture developed, sometimes called 'Enéolithic' (after the chronological subdivision in Byblos), Ghassūl-Beersheba-culture (after the two most important places of discovery), or in its late stage 'proto-urban' (with respect to the following early Bronze Age). One may date this period in Palestine between 4500 and 3200 BC[4].

The discussion concerning the rise of specialised societies and preliminary stages of urban culture as well as their religious ideas are especially important subjects of research. We know more and more about complex and permanent societies rising up in (sometimes large) villages during the fifth and fourth millennium BC. The concentration of great population groups in some places created new organisational and logistical

2. Cf. the results of excavations and surveys in the eastern Jordan valley (e.g. hinterland of Tabaqat Faḥil (Pella) and Tulaylāt al-Ghassūl, Wādī Maleh), and in the areas of Jarash, Jericho and Saḥāb as well as of other places. To the excavated settlements in the Jordan area see e.g. Abū Habil, Abū Ḥāmid, Khirbat ash-Shūnah and Neve 'Ur.
3. See also to the woodworking (carpenter and joiner like in Tulaylāt al-Ghassūl) the silex production (e. g. drills, scrapers, knifes, sickle blades), the industry of bones (e. g. pins, shuttles), and stones (e. g. basins, hoes, millstones) and the ceramic production as well as the smelting of copper (a limited repertoire of arrowheads, knives, axes and others) shows the sometimes brilliant metal work (wax smelting, open forms); mining of malachite (copper ore) in the Wādī Faynān.
4. Chronology after Homés-Fredericq and Hennessy 1989: 10.

problems for human societies.

The location of ancient Sāl seems to be one of the large Chalcolithic 'mega-villages' in Palestine. Because of this, the very good geopolitical position in the Irbid ar-Ramtha-basin and the excellent agricultural environment, it seemed to be an outstanding place for an excavation; we hoped to uncover areas of the different, maybe specialised, housing areas of the Chalcolithic society. Different functional uses of some parts of the village can be assumed.

History of Investigation[5]

The site was discovered by G. Schumacher (1914: 51 f.) on March 8th, 1913 and later described in a report by N. Glueck (1951: 113 f.) after his visit on May 4th, 1943. He described the Tall as "a high knoll, which is used today as a cemetery", "commands an excellent view, - both Irbid to the w. and er-Remtha to the e., e.g., being visible from it".[6]

S. Mittmann (1970: 14f., No. 18 and 19) started his investigation in this region in 1964 during his survey of the northern Transjordan. He visited not only the Tall but also the adjacent environment, which includes the whole region of Khirbat al-Bayaz. On the Tall and the subordinate slopes, he found pottery of the Early Bronze Age I, Late Bronze Age I-II and a large number from Iron Age I-II, in addition to sherds from the Early Roman to the Mamluk period. He classified a large number of pottery from Khirbat al-Bayaz which was Chalcolithic as Early Bronze Age I (Mittmann, in print). He already presumed that "die wenigen spätbronzezeitlichen, eisenzeitlichen (12.-9. Jh.v.Chr.) und frührömischen Stücke, die man hier findet, ... wohl nur zufällig von den Hauptsiedlungen auf und bei dem Tall herübergeraten" seien (Mittmann 1970: 15).

The '1984 Survey of the Irbid-Bayt Rās Region' carried out by C. J. Lenzen and A. M. McQuitty concentrates only on the Tall, and so the only report says: "The retrieved pottery from the tell indicates occupation during the period between ca. 1300 B. C. to 1000 B. C." (Lenzen and McQuitty 1988: 270).

In October 1989, S. Mittmann, M. Ibrahim and J. Kamlah (University of Tübingen, Germany) carried out a further systematic survey as part of the Khirbat az-Zayragūn project. According to results of their work, the surface pottery of fields 7 and 8 at Khirbat al-Bayaz (see Fig. 2) must be mainly dated to the Chalcolithic period. The density of the pottery on the surface indicates that the large site was situated southeast, south and southwest of the modern village of Sāl and included the large area including fields 7 and 8 as well as the Tall (field-no. 15). The Tall and its adjacent area was also used for settlements in later periods.

As Kamlah reports, the number of Chalcolithic sherds is normally low over the whole area of about 333000 m^2. In several places - as in the southern fields 7:3-4 and field 8:3 - striking accumulations of Chalcolithic pottery became evident, maybe because of the continuous erosion and modern ploughing. In other fields, the culture layers should be much more covered by recent earth. The surface collected pottery would allow the dating of the Chalcolithic settlement of Sāl to the time of the Ghassūl.[7] However, it could not be excluded that the place was already settled in Early Chalcolithic times. One single fragment points in such a direction (Kamlah 2000: Pl. 54:5). In addition, early Chalcolithic pottery of the

5. See also the detailed report about the history of archaeological research: Mittmann, in print.
6. Glueck 1951: 113; see also Mittmann, in print.
7. "Der C-14 Wert der mittleren chalkolithischen Schicht aus Pella/Tabaqat Fahil ("5,430 ± 60 BP" ...) darf auch für Sāl als Anhaltspunkt für ein absolut-chronologisches Datum gelten ... Nach den neuen C-14 Werten, die Carmi/Epstein/Segal 1995 für den Golan veröffentlicht haben, mufl diese Ansetzung korrigiert werden. So ergibt sich für Ra's Harbush eine Zeitspanne von 4000-3600 v.Chr." Kamlah 2000: 48 Fn. 95.

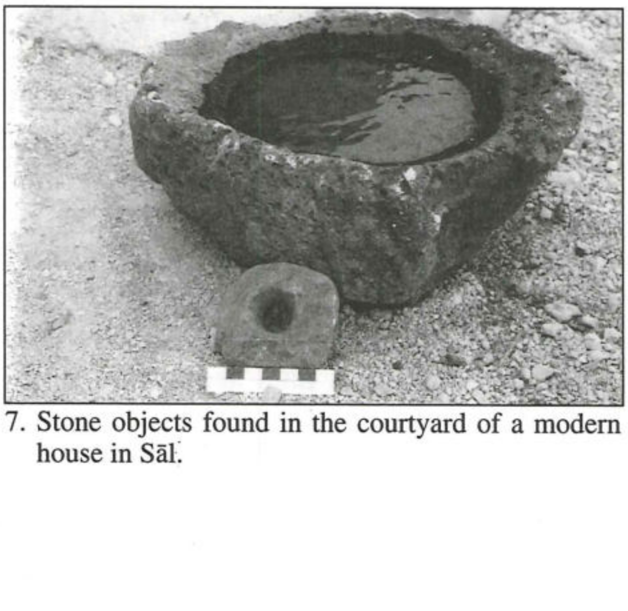
northern Transjordan could be different from that of the Jordan valley (Kamlah 2000: 48-50).

The vicinity of Sāl and Khirbat al-Bayaz was mapped in 1990 as 'Topographische ‹bersichtskarte/Topographical Map' of Sāl (Fig. 2), made by the Institut für Photogrammetrie und Kartographie of the Fachhochschule Karlsruhe (Prof. Dr. W. Böser, evaluated by H. Stöker).

The co-directors carefully examined - as mentioned above -the excavation field of Sāl in the spring of 1999 (Fig. 7). They saw the extreme density of Chalcolithic and Early Bronze sherds in the south of area I - which could be found in a smaller amount all over the area - while fragments of basalt could be seen all over the Khirbat al-Bayaz al-Gharbīyyah area in nearly the same large number and density. All the visible artefacts remained in their place.

The Methods

Based on our investigations, and on the basis of results from the geoelectric mapping work, we decided to excavate the large, in some areas possibly destroyed, Chalcolithic (and transitional Early Bronze Age) site of Sāl . It is impossible and therefore not wise to excavate such an extensive and in large parts possibly destroyed site in a normal time schedule (i. e. with extensive test trenches) and with a reasonable budget. The geophysical prospecting should be combined with a vicinity survey and with small excavations and soundings to verify and interpret the acquired data.



7. Stone objects found in the courtyard of a modern house in Sāl.

The Geoelectric Prospecting - Method and Instruments (by Patrick Leiverkus and Erich Lippmann)

1. Basics: Resistivity is a basic physical property of any material. It describes how much current flows, if a voltage is applied across a unit volume. For example if a voltage of 1 Volt is applied across two opposing sides of a cube of 1 m length and the resulting current is one Ampere, the resistivity of the material of this cube can be calculated as the ratio of voltage to current, divided by the length of the cube times the area through which the current flows - in the above example resistivity would be 1V / 1A * 1 m^2/1 m = 1µ m.

The resistivities of naturally occurring material varies by many orders of magnitude. Highly conductive ores like pyrite may have resistivities of as low as 0.001 µ*m, whereas massive, fractureless and dry granite rock or basalt conduct electricity very poorly, resulting in resistivities of more than 100.000 µm. The resistivity of some other common rocks and minerals are shown in Table 1 (Milsom 1989: 74).

In principle, resistivity measurements can thus distinguish between different materials.

2. Measurement of Resistivities in the Field: The determination of resistivities in the field is rather simple. Under the assumption of a homogeneous material extending to infinity, the resistivity of this material can be determined using a set of four electrodes. Two of these electrodes are used for in-

Table 1. resistivities of rocks and minerals (µm)[16]

Topsoil	50-300
Loose sand	500-5000
Clay	1-100
Weathered bedrock	100-1000
Limestone	500-10000
Pyrite	100-0.001
Magnetite	1000-0.01

jecting current into the ground, whereas the resulting voltage is measured between the other two (voltage) electrodes. Depending on the geometric arrangement of the two sets of electrodes, resistivity can then be calculated as the ratio of voltage to current, multiplied by a K-factor determined by geometry. It is very important to note this concept of separating the current and the voltage electrodes. Using only a set of two electrodes and measuring the voltage across them while applying current would only yield the contact resistance of the electrodes to ground and does not give information on the physical properties of the underlying layers. As the distribution of resistivity in the ground is usually not homogeneous, the values thus calculated are called apparent resistivities.

3. Resistivity Mapping for Archaeology: Mapping of apparent resistivity means the determination of resistivity using a set of electrodes of constant geometry at closely spaced intervals. If some material of high resistivity like limestone is covered by a homogeneous layer of low resistivity topsoil, it is possible to detect this underlying structure by resistivity mapping. However, some caution is necessary as three important things need to be kept in mind: First, the contrast between the resistivity values of surrounding material and the material should be high enough to detect. Second, the structures to be detected have to be used within the penetration depth of the electrode array used. As a rule of thumb, the penetration depth is equal to the dimensions of the electrode array. Third, the dimensions of the object to be detected must not be too small. In this context too small means that it should be sized around the dimensions of the electrode array and the sample interval, which - again as a rule of thumb, is between 0.5 and 1 m. Objects of sufficient contrast of 0.5 m in 0.5 m depth should thus be detectable, using a 0.5 m electrode array.

All the above values are intentionally kept very vague as detectablility depends on a lot of factors like distortions of the homogeneity of the topsoil due to man-made interference such as ploughing or trees and stones or the varying composition of the topsoil.

4. The Instrument '4Point light μC': As straightforward as it may sound in the first place, the actual determination of resistivity in the field is not so easy because of polarisation effects at the electrodes and man-made noise. Using the simplest approach of applying a DC current and measuring DC voltages would require currents in the order of several amperes and corresponding voltages of 500-1000 Volts at the current electrodes in order to produce voltages at the voltage electrodes that are high in comparison to the voltages that result from the polarisation effects - essentially chemical reactions. As this experiment would drain off even a heavy car battery within 30 minutes, alternating current (AC) methods were developed to overcome the limitations of the polarisation effects and work with much smaller currents in the order of 0.001 - 0.05 Amperes or less. These methods usually work with frequencies between 0.1 and 100 Hz. Care has to be taken. The interference from power lines can also raise problems. Noise voltages from this source can be as high as 0.5 Volts, whereas the voltage resulting from the injected current that needs to be measured may be as small as 0.00001 Volts.

The resistivity instrument used in the Sāl survey is the 4Point light (C, manufactured by LGM Geophysikalische Messgeräte, Germany. The unit only measures 25 x 12 x 5 cm and weighs less than 800 grams. It has a storage capacity of more than 6000 data points, which corresponds to approx. 6-10 hours of continuous data acquisition in the field. The power supply for the unit are four internal, rechargeable NiMh-AA cells that can power the instrument for up to 40 hours. In case the internal batteries should be discharged they can easily be replaced by any Alkaline-AA cell.

The unit operates on AC current of 8.33 Hz and has a high suppression of the main frequency of 50 Hz. The current setting used for the survey was either 1 or 0.1 mA. At the maximum output voltage of the instrument, which is 40 Volts, this provided for a very safe operation - the electrodes can be touched with bare hands without any danger. Therefore, field operation became much easier. After some research for resistivity tools on the market, we found this instrument to have the best performance-to-price-ratio by far.

5. Electrode Arrays, Frame and Performance: For mapping the lateral distribution of resistivity, there are two main arrays that can be used: the Wenner and the Twin (or Pole-Pole) array. The Wenner array uses four equally spaced electrodes mounted on a beam that have to be moved over the area under investigation, whereas the Twin array uses two mobile electrodes of constant separation with two stationary distant electrodes - one for the current and one for the voltage - that are placed far from the instrument and need to be connected to it with long cables. This need for long cables is a disadvantage of the Twin versus the Wenner array; another one is the relatively high electrical noise level between the two voltage electrodes spaced some 10 meters apart. We decided to use this configuration for two reasons: first and foremost, the penetration depth of the Wenner array is only about half of the Twin array at a given length of the mobile part of the array and second, we thought it was very difficult to place four electrodes so as to have good contact to the ground for each. This is especially true when the surface is covered by pebbles and small stones; even getting good contact for only two electrodes proved to be difficult at times.

We constructed a lightweight frame that carries the instrument and a trigger switch to start the data acquisition. The two electrodes are mounted on a bar of special, very hard wood and they are electrically isolated by PVC pipes and nylon washers. This frame has proved to be very sturdy and has withstood all the abuse of fieldwork so far. Another advantage is that it can easily be disassembled and transported in a small bag.

Using this arrangement we were able to acquire up to 800 data points within 45 minutes - equivalent to an area of 400 m^2. At this time we only wished to gather data. The preparation of an area of that size for a survey may take another 20 minutes, depending on the circumstances.

6. Data Processing and Interpretation: The acquired resistivity data is usually displayed as a black and white image where the different apparent resistivities are visualised by different shades of grey. For a campaign like this, where we took more than 90,000 readings which had to be visualised immediately for archaeological interpretation, we had to use software which was capable of managing such amounts of data. Therefore we developed a software package which consists of several components for downloading, managing, converting and visualisation of the resistivity data.

The data is downloaded from the 4-Point Light (C resistivity meter by a serial connection. The data of one square is stored in one file. These files can be edited with a special editor. There one can correct the data by hand, which is often useful, e.g. in case of false order of data acquisition. The area manager combines the different squares of one area. The data is converted into apparent resistivity values. False readings are replaced, and offsets in the data among the different squares can be corrected automatically or by hand. The user can immediately view the data which is optionally filtered. The data is then exported to Idrisi, a GIS software package, where the extensive filtering work can be done.

The Prospecting Results

Only three examples of our geoelectric work is presented in this article. The work extends across 3 hectares in all, both in areas I and II. We prospected a length by width in the x- and y-direction of 0.5 x 0.5, 0.5 x 1.0 or 1.0 x 1.0 m.

During our work we discovered four different kinds of results:

(1) Areas without significant differences in resistivity
(2) Areas with significant differences in resistivity,
(3) Areas with small differences in resistivity (because of nearby bedrock), and also
(4) Surprisingly a long small corridor between regions with significant differences in the centre of area I (between fields no. 8:6a and b; cf. Fig. 2) where we could hardly find any differences of resistivity.

We decided to excavate one trench in every region of typical different geoelectric results. Therefore, we opened square H 4 (area exemplary for type 1), L-M/55-56 (exemplary for type 2), AK 83-86 and AL 83-84 (exemplary for type 3), and AB 83 (exemplary for type 4), and we then drew the conclusions of our work in section 'The excavation results' (the maps of our geoelectric work will be published in Zeitschrift des Deutschen Palästina - Vereins vol. 1/ 2001).

The Excavation Results

In 1999 we excavated only in area I. The work is described from south to north.

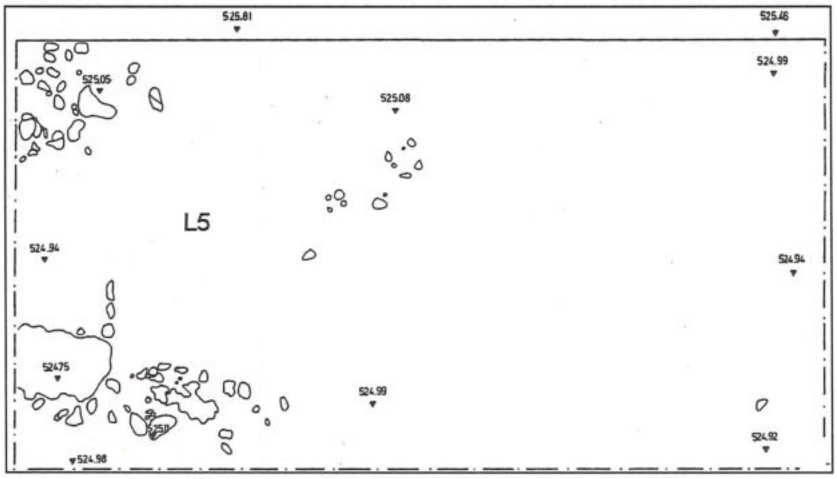
1. Square H 4, area I (see Fig. 3 and Table 2): The square is located in the southern part of area I. In general it would be of advantage to start the excavation here in the south of Khirbat al-Bayaz because of some basic considerations: 'the square is situated near the wadi, protected by a 20m high slope from the water floods and integrated within a fertile environment. This must have comprised the best living conditions in prehistoric times. In our survey,[8] as already mentioned, a lot of large stones here on the surface (some are collected and used as walls between the fields as landmarks). In addition, the sherds and the large number of basalt objects (fragments) on the surface lead to the assumption, that these formed the prehistoric stratum, now disturbed by ploughing and moved to the surface. Finally, the bedrock is found close to the surface - sometimes just visible in large areas on top of the surface.

Table 2.

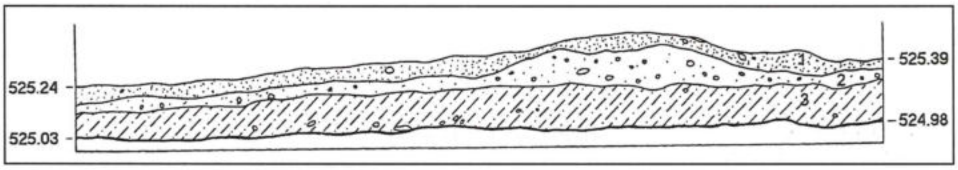
Loci	Date (9/1999)	Diagnostics	Non-Diagnostics	Culture
1	13		23	Chal/EB
		1		EB or later
		1		EB II
			3	Rom-Byz
2	13/14	8+1?		Chal
			33	Chal/mostly EB
			11	Rom-Byz
		1		Islamic
3	15	1	7	Chal/EB
4	15			?
5	16			---

Only close to the olive trees and under the pathway (used by agricultural vehicles and therefore not regularly ploughed) did our resistivity mapping provide some traces of architectural features. Otherwise, the resistivity data were not conclusive for man-made constructions probably due to agricultural work. This result was proved by fieldwork. Half of a 5 x 5 m square (2.5 m in north-south direction) was excavated. According to the excavation grid we named it H 4 (Figs. 8-10). Consistent with the results of our geoelectric work, we could not find any architectural structures. The surface layer which represents stratum 1 contained

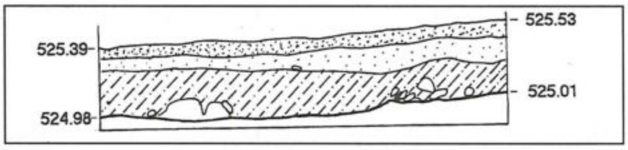
8. Cf. also the survey of Mittmann, Ibrahim and Kamlah in Kamlah 2000: 47.



8. Square H4, M 1:50.



9. Southern section (Strata 4 and 5 are virgin soil); meters above NN; scale M 1:50.



10. Western section; meters above NN; scale; M 1:50.

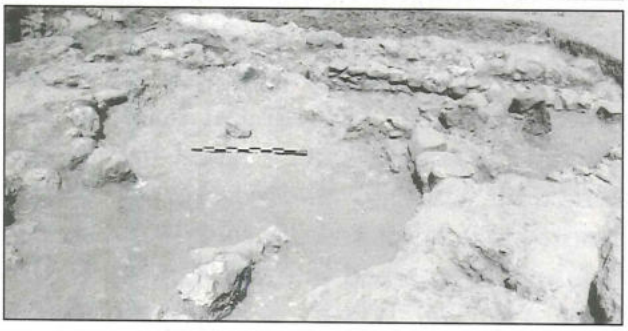
pottery sherds from different periods (from Chalcolithic to Roman/Byzantine) and some flint tools. Beneath stratum 2 we excavated only mixed layers in the square. The pottery mix was similar to the surface layer (from Chalcolithic to Islamic). Because of agricultural processes, it was nearly impossible to determine any further stratigraphy. After approximatley 16-30 cm we reached virgin soil in all parts of the square. Just above this natural layer we verified what seemed like stone pavements (L 3 and 4) in the north-west and the south-west corner of the square. Locus 3 contained only Chal or EB sherds. In locus 4, we could not find any ceramic. Probably these are the last undisturbed remains of the former cultural strata there.

2. Square L-M/55-56, Area I (see Fig. 3 and Table 3): This square (8 x 9 m) was excavated due to the results of resistivity measurements. On the screen, structures were seen that were most likely not natural. There seemed to be well preserved, perhaps undisturbed cultural layers. After the survey results, one could hope for Chalcolithic architectural remains. However, different features such as round and rectangular structures were excavated. The cultural features - especially the round ones - stood in close interaction with the nearby bedrock formations. First, we exposed a round/oval shaped house partly carved into the bedrock (L 16) (Fig. 11). This house - reminding of buildings from the Neolithic period - is connected with a kind of courtyard (L 10) and a wall built with small stones of equal size directly on the bedrock to the north-east (L 25). The installation were all carved into the bedrock, like L 19 and 20 (postholes; also L 18?), L 24 (inlet for a large vessel) and L 29 (storage pit). There are some more traces of installation around L 19 and 20 which interpret L 26 as something like a (household) working area adjacent to the dwelling. These structures are Chalcolithic because of the ceramic finds found there (see L 18, 21 and 29; no ceramic in L 16, 19, 20, 24 and 25) (Figs. 12-13).

One can distinguish between two different phases of the Chalcolithic settlement. During the older phase of settlement there was a larger area of house L 16, rebuilt or

Table. 3

Loci	Date (9/1999)	Diagnostics	Culture
5	13/14	1	Chal
		1	Chal/EB
		2(+2?)	EB
		1	Islamic
7	14	1	Chal
		1	Chal/EB
		1	EB
		1	MB/LB
		1	Iron IIC
10	20	4	Chal/EB
			EB
		1	MB/LB
		1?	Rom-Byz
12	16	1	EB
13	18/19/23	9	Chal
		9	Chal/EB
		1	EB
		2	MB/LB
		1	MB II A
		1	Rom-Byz
17	22	1	Chal
18	22	1	Chal/EB
21	23	2	Chal
29	23	6	Chal



11. Square L-M / 55-56, view (from south to north) to L16 and Wall L 14. In the background EB wall L6 and 11.

restored in further times with narrow space (see walls L 14 and 15).

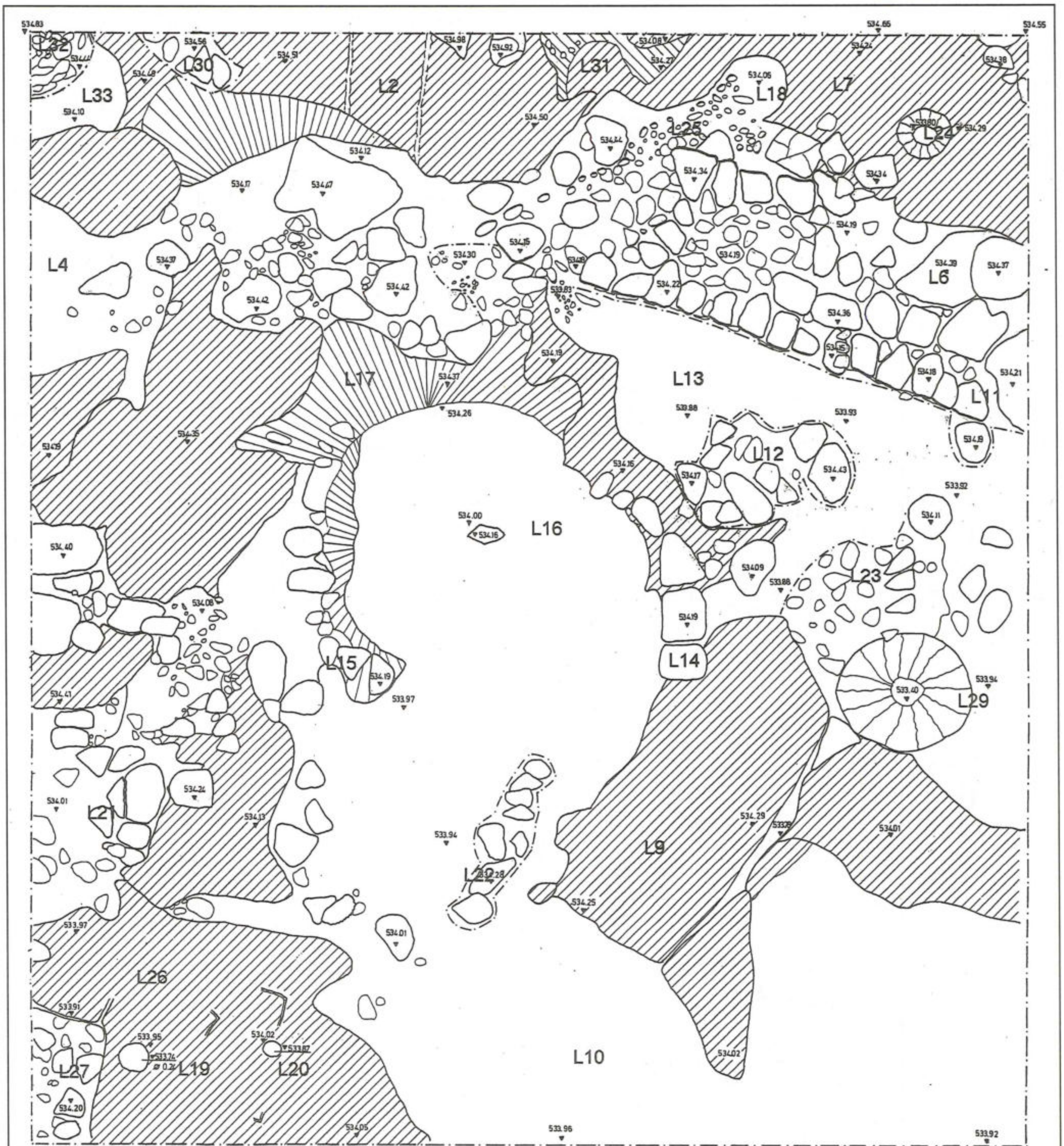
It was a surprise to expose a further stratigraphic detail: wall L 6 with a bench-like part in the south (L 11) gives us a strong support of our geoelectric reconstruction of a rectangularly formed structure. The style of architecture is similar to the nearby Khirbat as-Zayraqūn architecture and the connected large quantity of EB ceramics leads us to place this building in (a middle) EB period. Wall L 6 covers wall L 25 of the chalcolithic period.

Due to modern destruction by agriculture (up to a depth of 30-35 cm below surface) we could not find EB loci without any disturbed ceramic assemblages. For example, we found in L 17 a modern piece of glass, a modern iron clamp for water installation, a cartridge and a plastic bead of a prayer chain just on the surface of the rock. The large quantity of ceramics from all of these loci (like L 5, 7, 10, 13 and 17) contains mostly Chalcolithic and EB material, but also some MB/LB wares, in one case an Iron II rim (L 7), everywhere Roman-Byzantine material, and in L 5 a piece of Islamic pottery.

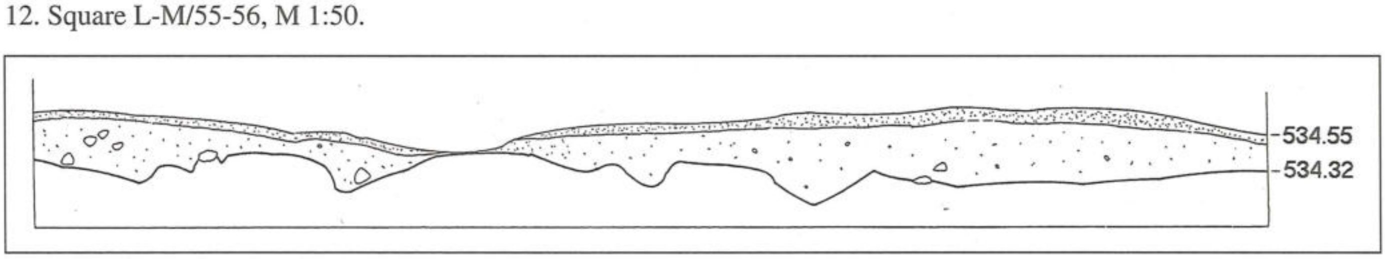
No suitable material was found to facilitate a C14 dating. However, samples of earth were collected from the self-contained loci, such as L 19, 20 and 29, for pollen, fungi and virus analyses.

3. Square AB 83, Area I (see Fig. 3 and Table 4): Square AB 83 is located in the northern part of area I. There is a large area sloping down from the modern village in the north to the southern part of Khirbat al-Bayaz al-Gharbīyyah (e.g. the vicinity of square L-M/55-56). The work in this square (4.30 x 4.50 m) started because of two reasons: there are better conditions in this place to form deposit layers due to the special shape of the slope, and, as a result of our geoelectric work, a strange phenomenon was detected. We could not see any clear difference in resistivities beneath the soil. The reason was - as we could interpret later on the basis of measurements with the Schlumberger configuration on top of the bedrock and on top of the walls - a nearly equal resistivity of all these components.

Our expectation for thicker deposit layers on top of the cultural strata was fulfilled only for the Chalcolithic layer. Underneath a small surface layer (stratum 1; alluvium = L1) with mixed pottery sherds, flint tools and plant roots (from LB to Islamic), a corner of a rectangular building (L 3 and 4) was exposed. Common with loci 2 and 6-9, these structures represent the (middle) EB architectural style (stratum 2; cf. square L-M/55-56) (Figs. 14-15).



12. Square L-M/55-56, M 1:50.



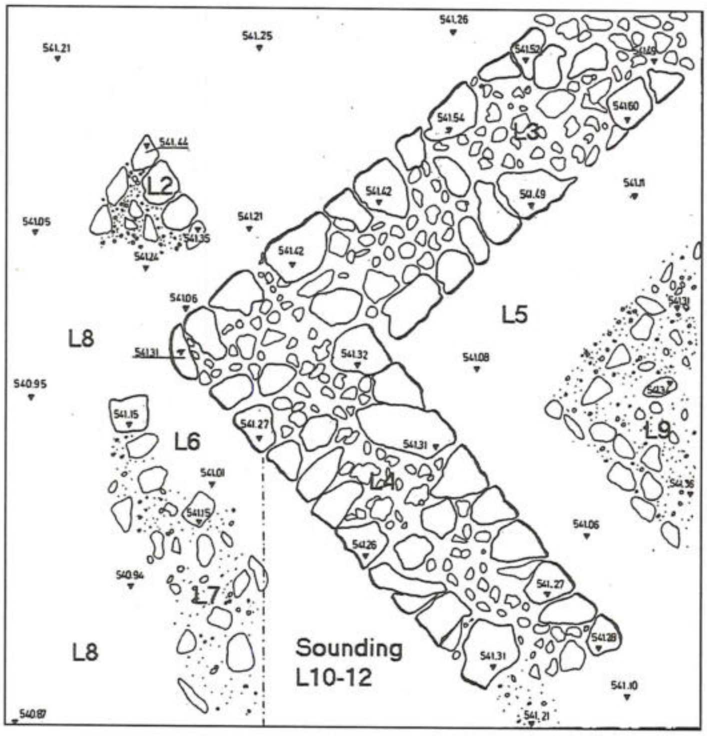
13. Northern section [strata 1 and 5, below bedrock], scale; meters above NN, M 1:50.

Table. 4.

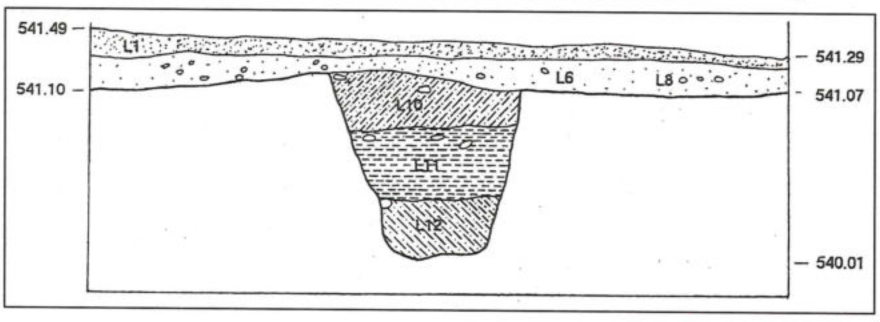
Loci	Date (9/1999)	Diagnostics	Non-Diagnostics	Culture
1	21	1		LB/Iron
		1	3	Rom-Byz
		1		Islamic?
5	23/25/27	1?	1	Chal
			7	Chal/EB
		1?	2	EB
		1		MB/LB?
		1	1	Rom-Byz
6	26		3	Chal
			26	Chal/EB
		3	6	EB
8	22/25	1		Chal
		1	8	Chal/EB
		1		EB
		1		MB
			3	Rom-Byz
		1		Islamic
10	27	5	27	Chal
11	27	6	10	Chal

Locus 3 represents a stone wall extending from the middle of the square to the northeast corner. This wall might have been formed in two steps, but the upper one was nearly completely destroyed by means of agricultural processes. The other wall (L 4) extends from the middle of the square to the southeast and ends near the southeast corner of the square. The entrance of the building could have been there. However, it appears more as a secondary destruction. Inside the house there was something like a disorderly stone pavement which did not touch the walls. The connection between both structures is unclear. Also, between L 2 - a fragment of an older wall? - and L 3 and 4 there is no genuine connection. One may interpret that L 5 and L 6 are parts of a former trench used for the construction of L 3 and 4, but unfortunately, L 5 is quite broad and while digging the sounding (L 10-12) we could not find any hint for this interpretation.

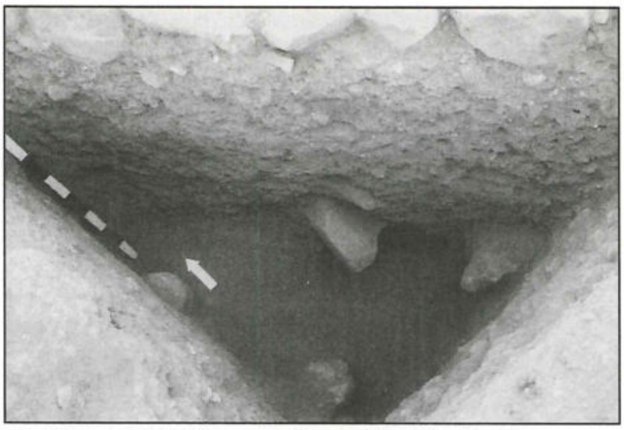
Stratum 3 represents the Chaḷcolithic period and is located deep underneath the EB layer (L 10-12) (Fig. 16). We could only



14. Square AB 83, M 1:50.



15. Southem section with sounding [meters above NN], M 1:50.



16. Square AB 83, sounding. View from above, over the chalcolithic level (L12).

reach it by a sounding, where we found - 80-95 cm underneath the EB stratum - Chalcolithic remains in good condition. This place and the adjacent area are undoubtedly favourable for further exploration of Chalcolithic culture of Sāl.

4. Squares AK 83-86 and AL 83-84, Area I (see Fig. 3 Table 5): These squares are located in the north-eastern part of area I. The whole region slopes slightly from north to south. We excavated this part mainly to prove our geoelectric results under extremely unfavourable conditions: small prehistoric walls, intense agricultural destruction, and the bedrock being located nearby, underneath the surface (in small parts already visible).

The geoelectric work in this place and in the adjacent areas has been described above.

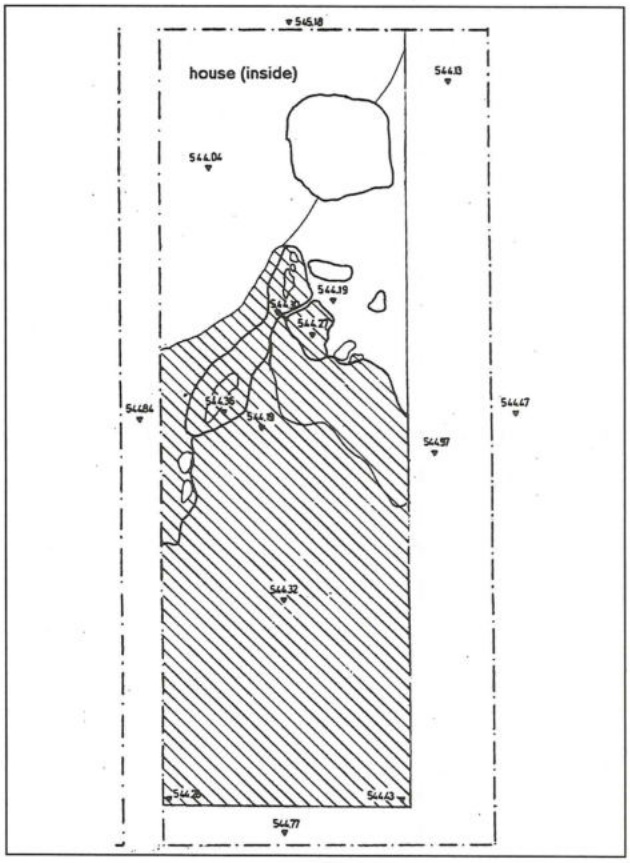
Table 5.

Squares	Date (9/1999)	Diagnostics	Non-Diagnostics	Culture
AK 83	23/25/26	1	1	Chal
		1	8	Chal/EB
		1(+1?)	1	EB
			4	Rom-Byz
		1		Islamic
AK 84	21/22	3		Chal
			11	Chal/EB
		1	5	EB
		1		MB/LB?
			1	Rom-Byz
AK 85	26/27	2	5	Chal/EB
		1		MB/LB
AK 86	27	1	15	Chal/EB
		2	2	EB
		1		MB(/LB)
AL 83	16	7(+1?)	5	Chal
		9	24	Chal/EB
		6(+1?)	2	EB
		5		MB/LB
			7	Rom-Byz
AL 84	22	1(+1?)	1	Chal
			16	(Chal/)EB

For the preliminary publication, two facts are most important. First, in AK 86 (Fig. 17) we uncovered the wall of the rectangular building that we had expected in the north. The house was carved into the bedrock like the round one in square L-M/55-56. Second, there are some small walls visible, all founded on bedrock like in AL 84 (Fig. 18). However, because of the agricultural work there are no sufficient archaeological interpretations for these fragments as for the larger structures and there are no 'closed loci' at all - all of them contained mixed pottery.

The Idols

The great majority of the 52 idols from the Golan and the Hule-valley (already published by C. Epstein) were excavated in reliable house contexts or discovered within a recognised Chalcolithic site.[9] Some of them were found in secondary use in villages located near sites subsequently identified as



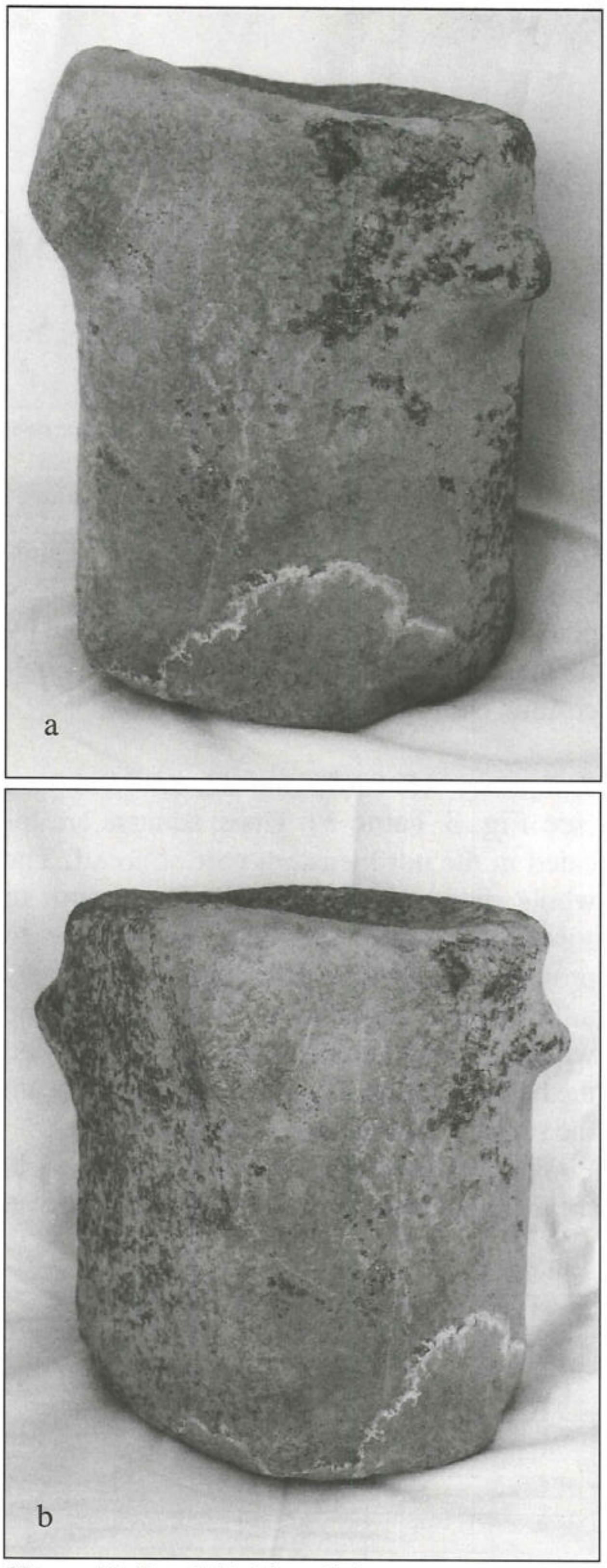
17. Square AK 86, M 1:50.

9. See for the introduction to the problem in general e.g. Epstein, 1985. 1988. 1998.

18. Square AL 84, M 1:50.

Chalcolithic, where they were mostly found on the surface. Like this second group, the two new objects from Sāl were discovered by the villagers who excavated by digging holes for the new olive trees. It is generally accepted that these objects are essentially cultic in character, since they have been originally placed in houses. There they formed part of a domestic cult intended to promote fertility. They are closely connected with the two main branches of the contemporary economy: sheep and goat rearing and agriculture.

We already know of 10 theriomorphous cultic stands from this area. They will be published with a complete description and extensive discussion by S. Mittmann (Mittmann, in print). On September 27th 1999, we found two more objects in Bushra, near Sāl. They are in possession of the family of Suleiman Jaradat and registered by the Department of Antiquities, Irbid. The larger basalt stand (Fig. 19a) is 26.6 cm high (in front; behind: 23.5 cm) and at the bottom it is 21.8 cm in diameter. Including the ears, it



19. a and b: Basalt idol from Sāl.

has a max. width of 24.5cm, and without them it is 22.2 cm. The smaller one (Fig. 19b) is partly (the nose and face) disturbed. Its height is 13.6 cm, and its width at the bottom is 11.4, at the top it is 15.4 cm, and with ears it is 17.4 cm.

A full report on these two theriomorphous cultic stands is in preparation. We have determined that these idols, found in the Hule-valley, as in the Golan and across the Yarmuk in Transjordan in the greater vicinity of Sāl, are examples of the large expansion of the Chalcolithic culture in northern Palestine. This claim is supported not only by the ceramic evidence but also by the idols, which contain a similar religious background in the mentioned areas.

The Stone Material (by Muhammed Jaradat)

During the 1999 season, some flint tools and debitage were collected dating from the fourth millennium BC. The flint assemblage consisted of 466 pieces, 236 of them are debitage and 230 pieces are classified as tools (Table 6). This collection was found in thirteen areas, nine of them represented surface collections and four excavated layers (from squares H 4, L-M/55-56, AB 83 and AK 83-86, AL 83-84).

Unfortunately, we cannot offer a complete study for the chipped stone from Sāl, due to the small amount comprising only one core and the absence of the debris that help in studying the manufacturing techniques. To date, a parallel study has been done (in small scale) which indicates that most of the tools may date from the fourth millennium BC (cf. Levy 1987 and Hanbury-Tenison 1986). Due to the absence of cores and debris it may concluded that the flint tools that were collected or excavated at the site may have been manufactured somewhere else other than at the examined area of Sāl.

Table 6. Stone material from the 1999 season.

	area	GE2 (incl. H 4)	L-M/55-56	AB 83	AK 83-86; AL 83-84	GE1	GE (R) 1	GE 3	GE (R) 3	GE (R) 4	GE 4	GE 5	GE (R) 5	GE (R) 6d	Total
	Debitage	115	16	23	15	7	6	3	-	8	26	10	-	7	236
1	Tools Retouched Flake	46	4	6	8	1	4	-	1	1	6	4	-	12	93
2	Notched Flake	-	-	-	-	-	-	-	-	-	-	-	1	-	1
3	Invers R. Flake	2	1	-	-	-	-	-	-	-	-	-	-	-	3
4	Denticulated Flake	1	-	-	-	-	-	-	-	-	-	-	-	-	1
5	Tabular R. Flake	-	-	-	1	-	-	-	-	-	-	-	-	-	1
6	Retouched Blade	16	-	2	5	2	3	5+3[22]	-	5	13	6	2	1	. 63
7	Backed Blade	4	1	1	-	-	-	1[23]	-	-	3	3	-	2	15
8	Sickle Blade	3	2	2	-	-	-	-	-	-	1	-	-	1	9
9	Notched Blade	1	1[24]	-	-	-	-	-	-	-	-	1	-	-	3
10	End-Scraper	9	1	2	1	2	-	-	-	-	2	1	1	-	19
11	Side-Scraper	-	-	-	1	-	-	-	-	-	-	-	-	-	1
12	Dent Scraper	1	-	-	-	-	-	-	-	-	-	-	-	-	1
13	Round-Scraper	1	-	-	-	-	-	-	-	-	-	1	-	-	2
14	Tabular-Scraper	1	-	-	1	-	-	-	-	-	-	-	-	-	2
15	Truncation	-	1	-	-	-	-	-	-	-	-	-	-	-	1
16	Borer	7	-	1	-	-	-	-	-	-	-	-	-	1	9
17	Chopper	1	-	-	-	-	-	-	-	-	-	-	-	-	1
18	Small Bick	1	-	-	-	-	-	-	-	-	-	-	-	1	2
19	Chissel	1	1	-	-	-	-	-	-	-	-	-	-	-	2
20	Blade Core	-	-	-	-	-	-	-	1	-	-	-	-	-	1
	Total	210	28	37	32	12	13	12	2	14	51	26	4	25	466

Tentative Conclusion

The extraordinary value of geophysical work in the archaeology of the Near East is evident, even under the difficult conditions of a partly destroyed prehistoric site. To demonstrate the advantages of this geophysical method:

- we could prospect a large area in a short time and base our archaeological strategy on these results (e.g. places of work)
- we could partially interpret prospected areas with knowledge of our excavation work
- we could leave unexcavated/undestroyed parts of antique sites for further archaeological work, especially for further generations

The Chalcolithic inhabitants of Sāl seemed to have lived in houses, partly carved into the bedrock. The prospected areas show a large area covered with houses, but not cramped or densely populated. There seemed to be enough space for courtyards, household areas, etc. Moreover, there is certainly a (middle) EB settlement outside the Tall with well built architecture of rectangular units. Unfortunately, we do not know specific facts about this society because of the large destruction found all over the site.

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The campaign was based on the recent field survey which is part of the Khirbat az-Zayragūn survey, conducted during four weeks in 1989 by Prof. Dr Siegfried Mittmann (Tübingen) and Dr Jens Kamlah (Kiel). We would also like to thank S. Mittmann and J. Kamlah for the valuable information given regarding their survey work in Sāl. The authors prepared their excavation by field inspections in Sāl during the spring of 1999. Siegfried Mittmann visited the site at that time and gave valuable advice and generous aid. The German Protestant Institute, Amman has strongly supported the excavation. We are deeply impressed by the personal engagement and the effective help of its director, Dr Hans-Dieter Bienert. Many thanks also go to Muna Zaghloul and May Shaer for their assistance in editing this article.

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