Fuad Hourani
Laboratoire de sciences des sols et d'hydrologie
INA PG
78850 Thiverval Grignon
France

Fuad Hourani

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

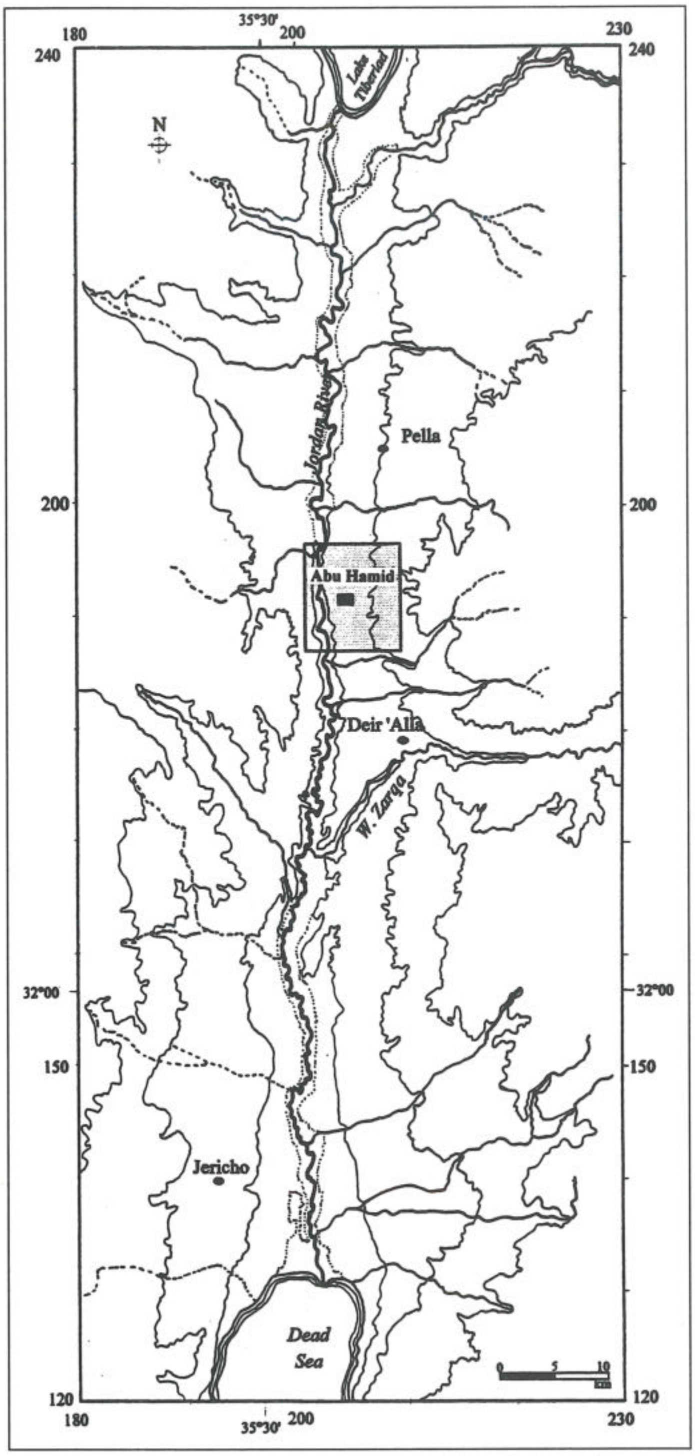
Located in the middle of the Jordan valley, at an equal distance between the Dead Sea and Lake Tiberias (FIGS. 1and 2), Abū Ḥāmid at -240m bsl was established close to the Jordan River on a red clayey colluvial soil that covers the marl deposits of the Late Pleistocene al-Lisān Lake. The region of Abū 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.

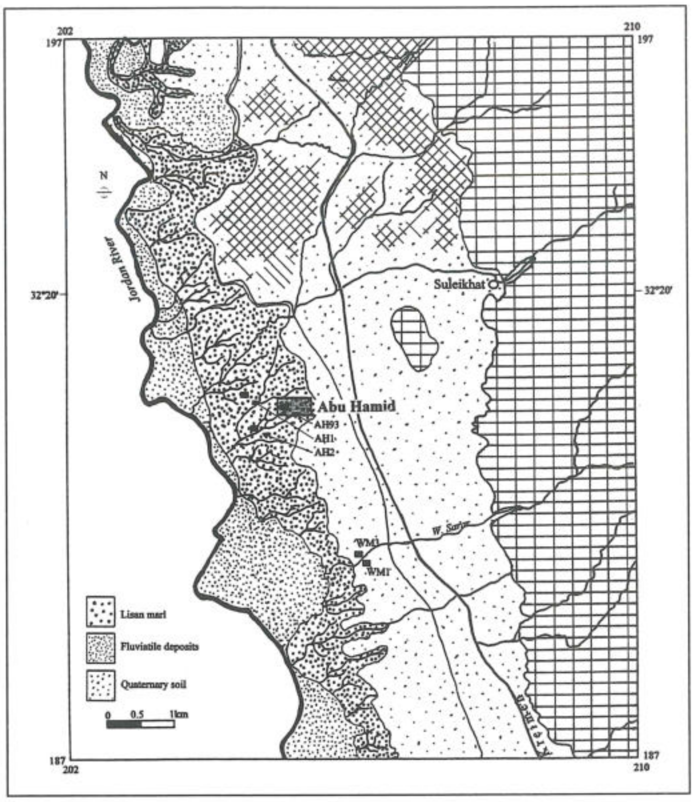
Excavations revealed three main phases of occupation (Dollfus and Kafafi 1993):

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

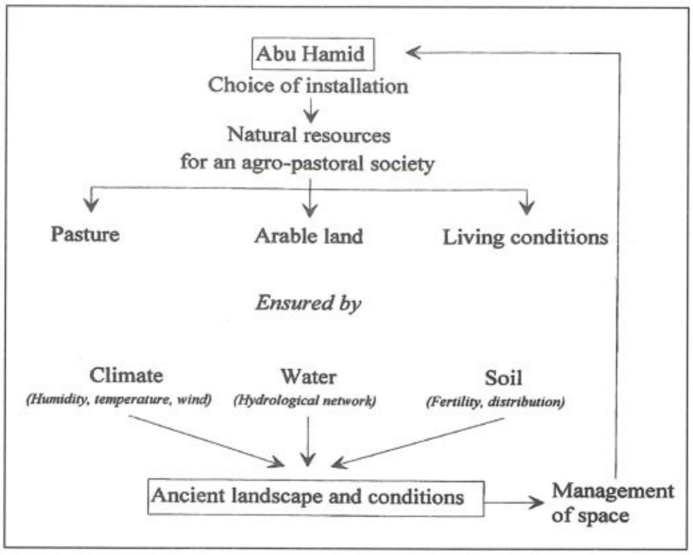
3. Alternate sequence and wall of the dwelling A2.

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.

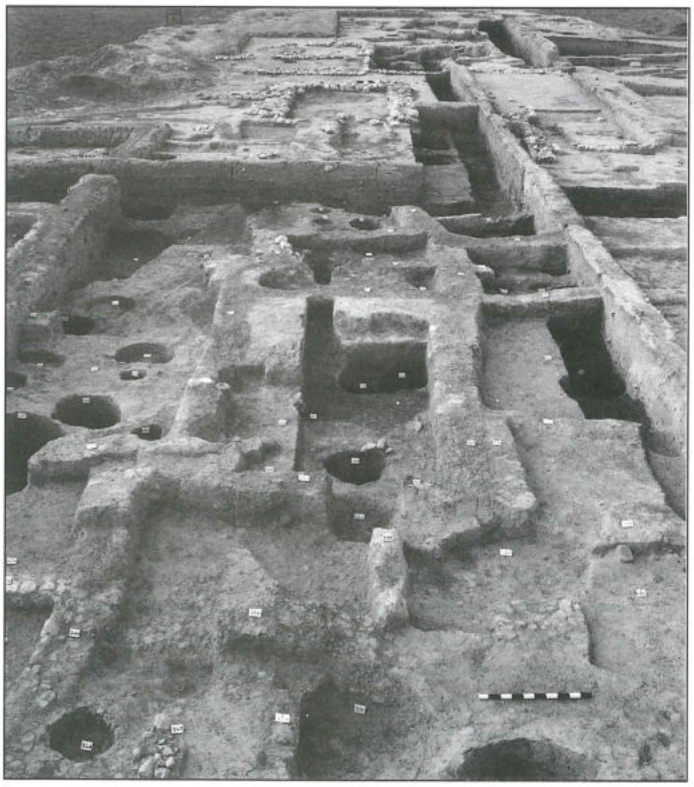
In respect of the archaeological questions specific to the site of Abū Ḥāmid, this study is geared towards two directions: first, the study of the surrounding formations in order to reconstruct the landscape evolution around the site and, second, the study of the archaeological deposits within the site 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.

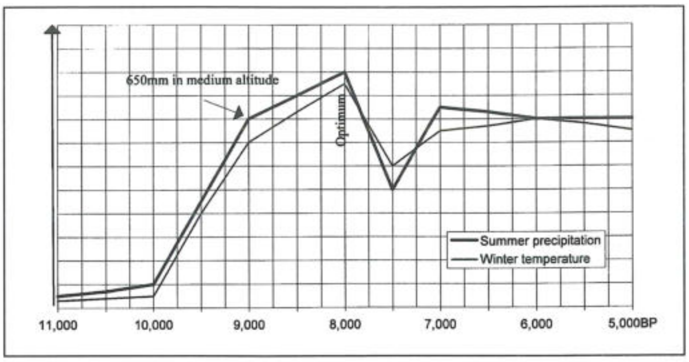
Recent work on the palaeoclimate of the eastern Mediterranean Basin (Van Zeist and Bottema 1982; Cheddadi *et al.* 1991; Rossignol-Strick 1993), based on marine and land records provided by palynology of long cores, proposes climatic information for the Late Quaternary. The recent Rossignol-Strick (1993) 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



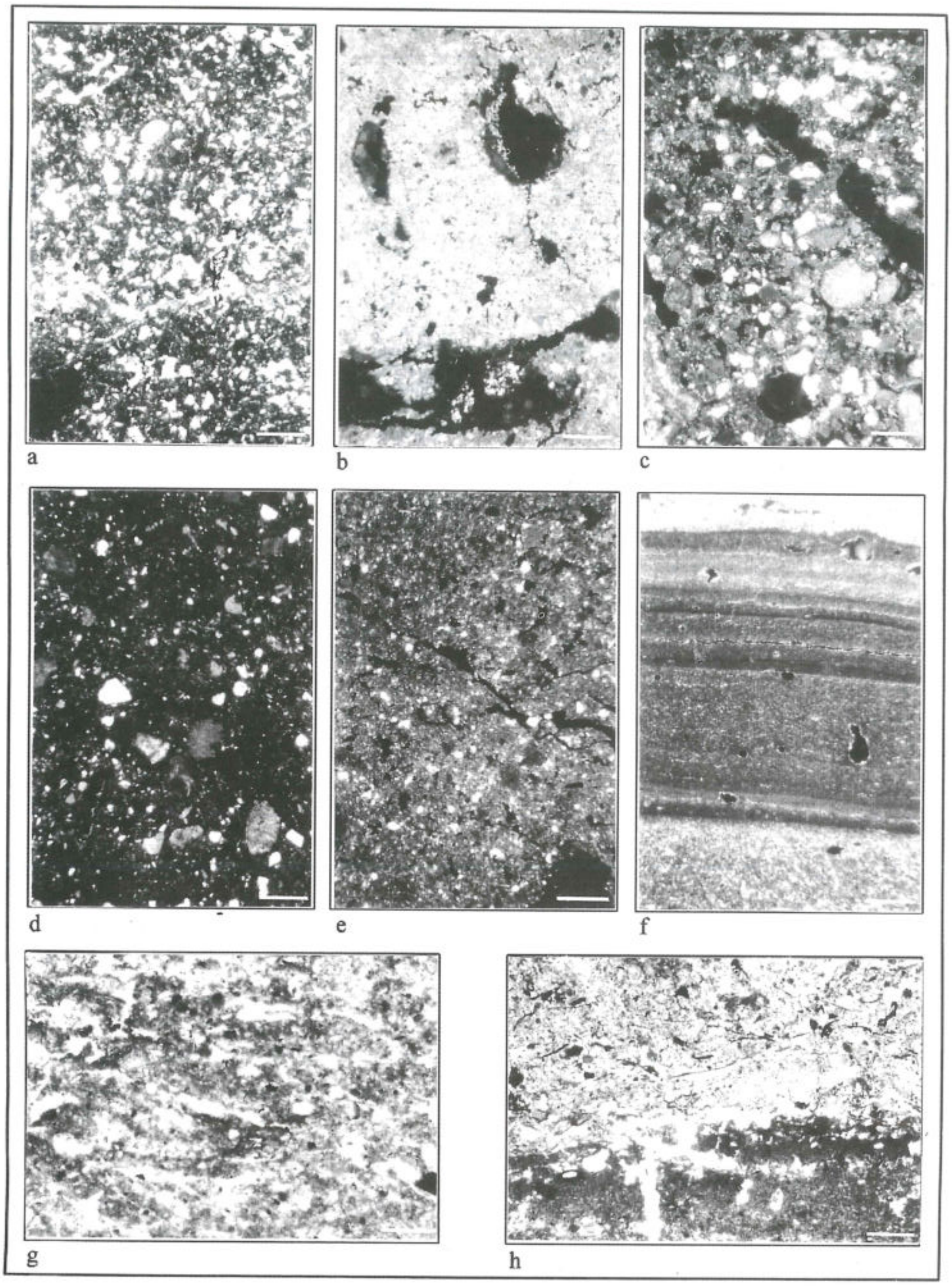
5. Synthetic curve of the Late Quaternary climatic evolution (after Rossignol- Strick correlations and re-evaluation, 1994).

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.

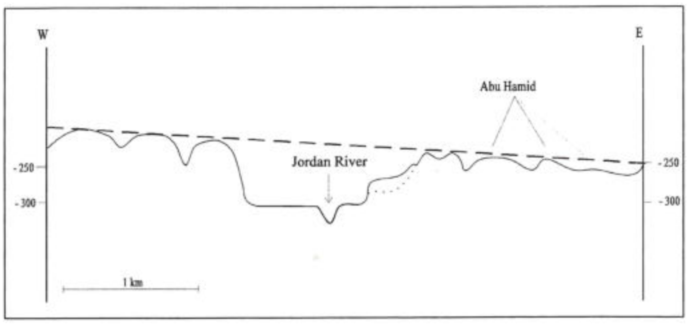
(a) Photomicrograph of red brown clayey loam presenting an example of vesicular and vughy voids [in (e) they are associated with massive microstructure] characteristic of the water saturation of sediment. Dwelling A2, upper part of sample 5. PPL. (Bar=600um).
(b) Dark ferruginous coating around large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

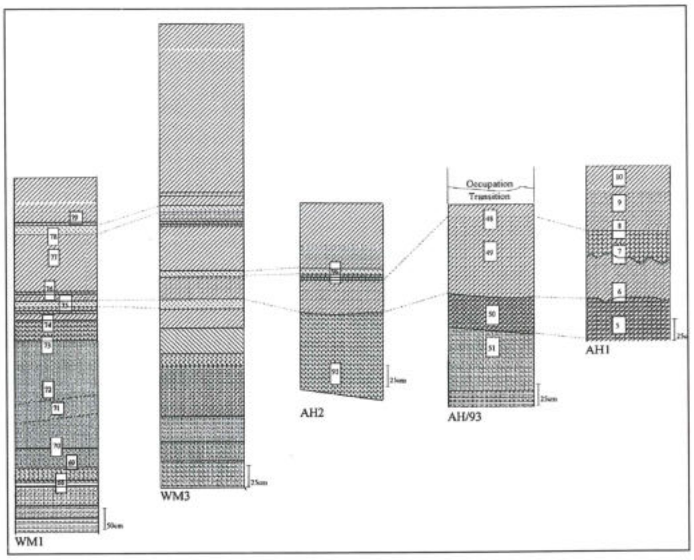
As for its distribution, at the present time the only remnants of this red soil are represented on summits of hillocks adjacent to the site. Its spatial distribution over time depends on the landscape's evolution. Correlation between sections opened in various locations of the Holocene formations in 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

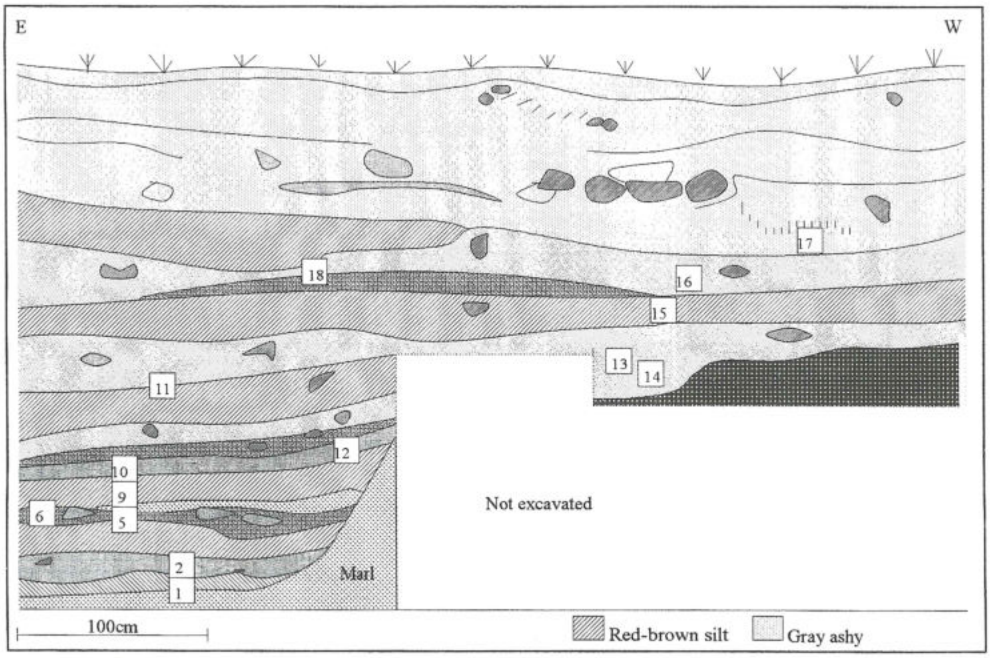
The study of thin sections made from undisturbed soil samples collected systematically from the pit deposits allow us to distinguish, for each pit, a succession of various sedimentary units of different characters. Characteristics of each sedimentary unit help to discriminate the sedimentary processes 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:

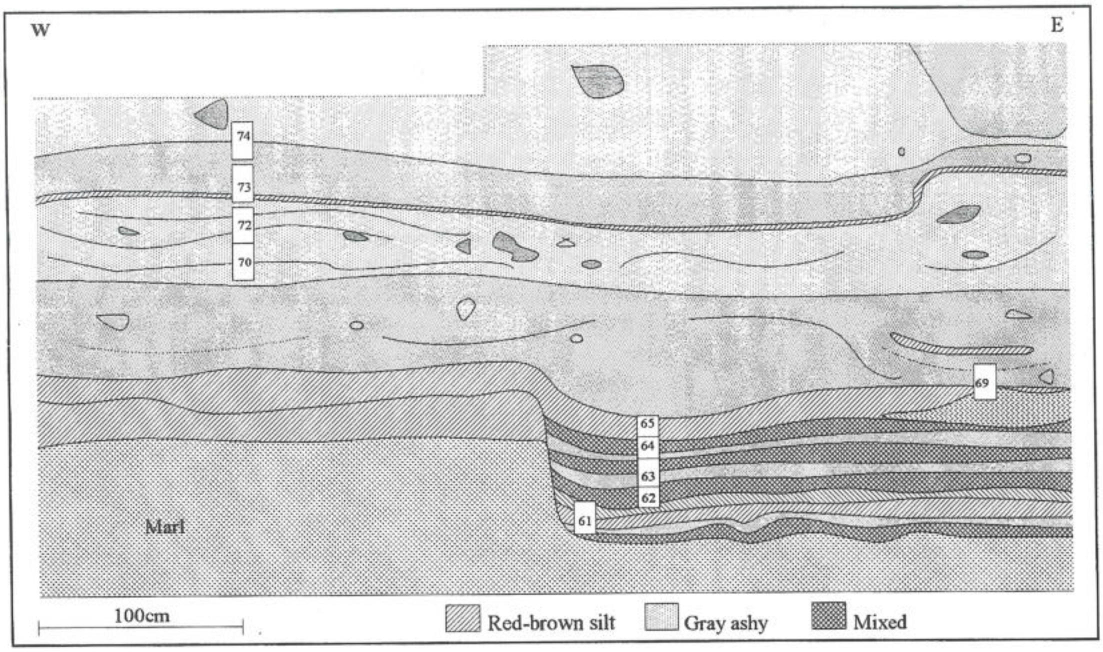
- surfaces where the sediment is homogenised by trampling. In the A2 pit, sample no. 2 (FIG. 9) includes the transition between a layer of red brown soil, covering the bottom of the pit, and an ashy occupational one. The uppermost part of the former displays well homogenised micro-aggregated fabrics 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.

Acknowledgements

This work is supported by the Franco-Jordanian joint project (CNRS and Ministry of Foreign Affairs - France, and the Institute of Archaeology and Anthropology-Yarmuk University). I wish to express my sincerest gratitude to Dr G. Dollfus and Prof. Z. Kafafi, co-directors of the project, for helping me in accessing their site and their documentation; to Dr M.-A. Courty and Dr J. Rewersky for useful discussions on the field and in the laboratory; to the French Ministry of Foreign Affairs who has awarded me a doctoral grant, and to the INA-PG for offering me all laboratory facilities in order to accomplish this research. I am very thankful to Mrs L. Copeland for her help in correcting my English.

Bibliography

Cheddadi, R., Rossignol-Strick, M. and Fontugne, M. 1991. Eastern Mediterranean palaeoclimates from 26 to 5 K yr B.P. documented by pollen and isotopic analysis of a core in the anoxic Bannock basin. *Marine Geo*. 100: 53-66.

Courty, M.-A. 1994. Le cadre paléogéographique des occupations humaines dans le bassin du Haut-Khabur (Syrie du nord-est). Premiers résultats. *Paléorient* 20/1: 21-59.

Courty, M.-A., Goldberg, P. and Macphail, R. 1989. *Soils and micromorphology in archaeology*. Cambridge: Cambridge University Press.

Dollfus, G., Kafafi, Z., Rewersdi, J., Vaillant, N., Coqueugniot, J. and Neef, R. 1988. Abu Hamid, an early fourth millennium site in the Jordan Valley. Pp. 567-601 in A. N. Garrard, and H.G. Gebel (eds), *The Prehistory of Jordan: The State of Research in 1986*. Oxford: BAR Int. Ser. 396 (ii).

Dollfus, G. and Kafafi, Z. 1993. Recent Researches at Abu Hamid. *ADAJ* 37: 241-262.

Dothman, M. 1959. Excavations at Horvat Beter (Beersheba). *Atiqot* 2: 1-42.

Field, J.J. 1991. Rainfall patterns and landscape changes in the Wadi Ziqlab, Jordan. Paper presented at the 24th annual Chacmool conference, University of Calgary, November 7-10.

Freund, R. and Garfunkel, Z. (eds), 1981. *The Dead Sea Rift. Tectonophysics* 80.

Gilead, I. 1992. Farmers and Herders in Southern Israel During the Chalcolithic Period. Pp.29-44 in Bar-Yosef, O. and Khazanov, A. (eds), *Pastoralism in the Levant. Archaeological Materials in Anthropological Perspectives.* Madison, Wisc. *WA* 10.

Goldberg, P. and Bar-Yosef, O. 1982. Environmental and Archaeological evidence for climate change in the southern Levant. Pp. 339-414 in J. L.Bintliff and W. Van Zeist (eds), *Paleoenvironments and Human Communities in the Eastern Mediterranean Region in Later Prehistory.* Oxford: BAR Int. Ser 133.

Ibrahim, M., Sauer, J. and Yassine, K.H. 1976. The East Jordan Valley Survey. *BASOR* 222: 41-66.

Mabry, J. B. 1992. Alluvial Cycles and Early Agricultural Settlement Phases in the Jordan Valley. Unpublished dissertation. The University of Arizona.

Macumber, P. G. and Head, M. J. 1991. Implications of the Wadi al-Hammeh Sequences for the Terminal Drying of Lake Lisan, Jordan. *Paleogeog. Paleoclim. Palaeoecol.* 84: 163-173.

Perrot, J. 1984. Structures d'habitat, mode de vie et environnement: les villages souterrains des pasteurs de Beershéva dans le sud d'Israël, au IVe millénaire avant l'ère chrétienne. *Paléorient* 10/1: 75-92.

Rossignol-Strick, M. 1993. Late Quaternary Climate in the Eastern Mediterranean Region. *Paléorient* 19/1: 135-152.

Van Zeist, W. and Bottema, S. 1982. Vegetal history of the Eastern Medditerranean and the Near East during the last 20,000 years. Pp. 277-321 in J. L. Bintliff and W. Van Zeist (eds), *Palaeoenvironments and Human Communities in the Eastern Mediterranean Region in Later Prehistory*. Oxford: BAR Int. Ser. 133.