ARCHAEOLOGY AND ENVIRONMENT OF THE DEAD SEA PLAIN: PRELIMINARY RESULTS OF THE FIRST SEASON OF INVESTIGATIONS BY THE JOINT LA TROBE UNIVERSITY/ ARIZONA STATE UNIVERSITY PROJECT

Phillip C. Edwards, Steven E. Falconer, Patricia L. Fall, Ilya Berelov, Caroline Davies, John Meadows, Cathryn Meegan, Mary C. Metzger and Ghattas Sayej

Introduction

The 'Archaeology and Environment of the Dead Sea Plain' project, directed by Phillip Edwards, Steven Falconer and Patricia Fall, is a new venture that will develop new understandings of the cultural and natural history of the 'Dead Sea Plain'.[1] Our area of investigation comprises the Lisān Peninsula (اللسان), which juts into the south-eastern corner of the Dead Sea, the environs of the modern municipality of al-Mazra'a (المزرعة), and the hinterland of the municipality of adh-Dhrā' الذراع (Ẓahrat adh-Dhrā' ظهـرة الذراع), situated between al-Mazra'a to the west and the Jordan Valley margin to the east (**Fig. 1**). Excavations at two recently discovered and neighbouring sites at Ẓahrat adh-Dhrā' will be combined with geomorphological, palaeoenvironmental, and modern environmental investigations to elucidate the ways in which hu-

1. The 1999 season of La Trobe University excavations at Ẓahrat adh-Dhrā' 2 and the 1999/2000 Arizona State University excavations at Ẓahrat adh-Dhrā' 1 were made possible by the kind co-operation of Dr Fawwaz al-Khraysheh and the Department of Antiquities of Jordan. The sites were excavated under Permits No. 99/57 and No. 99/59, respectively. Operations were carried out at ZAD 2 between November 10 and December 9, and at ZAD 1 between December 18, 1999 and January 15, 2000. The 2000 sediment coring operation was conducted with the generous cooperation of the Natural Resource Authority, Hashemite Kingdom of Jordan and the Arab Potash Company. Special thanks go to NRA Director-General Main Hiyari for his support and encouragement.
The 1999 La Trobe University team consisted of Phillip Edwards (director), Rudy Frank (surveyor and photographer), Ali al-Khayyat (Department of Antiquities representative and excavation supervisor), John Meadows (archaeobotanist and excavation supervisor), Ghattas Sayej (excavation supervisor), and Abu Sami (Hassan Mahmoud Hassan, cook). Four local workmen – Salim Salim al-Hubeiri, Muhammad Salman Azazme, Ahmed Salman Azazme and Muhammad Oda – were employed in the excavation, as well as our donkey 'Umm Sabr'.
The 1999/2000 excavation staff at ZAD 1 included Steven Falconer (director), Patricia Fall (co-director and paleobotanist), Khalil Hamdan (Department of Antiquities representative), Mary Metzger (zooarchaeologist and excavation supervisor), Abu Sami (cook), Abdel Abid (assistant cook), excavation supervisors Ilya Berelov, John Czarzasty, Caroline Davies, Cynthia Keller, Cathryn Meegan, and Emily Prud'Homme, tutor Jaime Broderick, and junior excavators Sam Falconer and Will Falconer. Arizona State field school students included Shawn Barnes, Rebeccalynn Bilodeau, Mindy Coffman, Jennifer Dudek, Jeffrey Ferguson, Abigail Manus, Jennifer Norman, Jesse Rodriguez, Mary Ruiz, and Jaime Ullinger. Twenty-four members of the local Azazme bedouin served ably as excavators and site guards. Geomorphologists Philip Macumber and James Bowler contributed to our geological interpretations. Mary C. Metzger thanks Alex Wasse, Melinda Zeder and Heather Lapham for advice and assistance in the preparation of her reports.
The 2000 sediment coring staff included Patricia Fall (director), Caroline Davies, Steven Falconer, Bruce Howell, Emily Prud'Homme and Jennifer Tulloch. We extend special thanks to the Natural Resources Authority drilling staff who made the mechanized coring possible: Engineer Fawzi S. Khawawneh, Engineer Mohammad Ahmad Jawabrah, Engineer Ahmed Mahmoud al-Dabas, Driller Adnan Ahmad al-Hayajneh, Assistant Driller Hamza Ghafel Abu-Zubdah, Ibrahim Muslim Mayufeh, Abid al-Latefe Suliman Mansour, Sayir Khalife Sayir, and Mahmoud Ali al-Budour.
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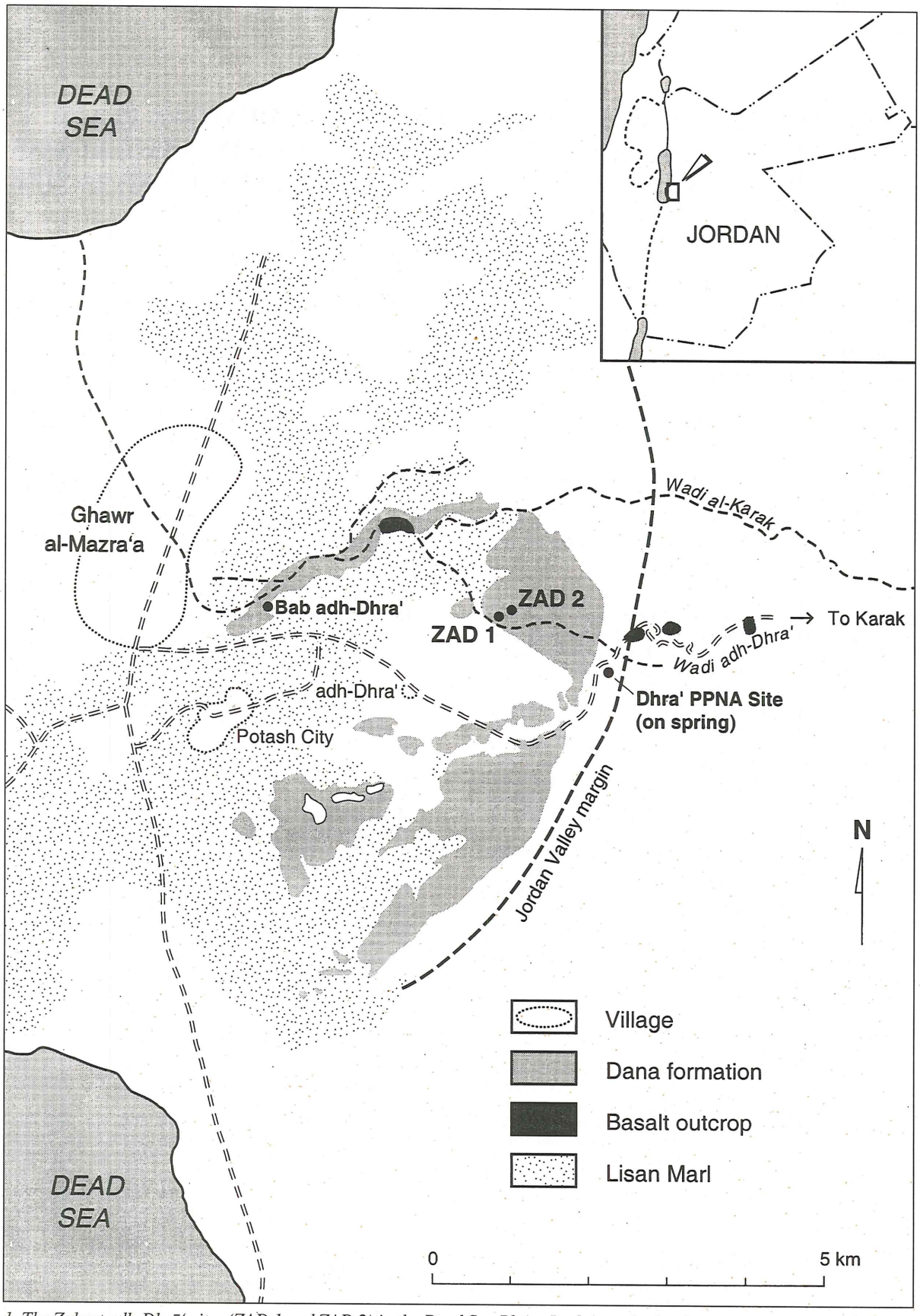
Engineer Abdullah Hamarne of the JVA at aṣ-Ṣāfī rendered to us invaluable help in providing crucial maps. Thanks are due to JVA staff member Na'il Habashne and his workforce for renovating the al-Mazra'a house before our arrival. Thanks are also due to Dino Politis for providing logistical aid to our project. Khalil Hamdan, the Department of Antiquities Inspector for the Southern Aghwār region, helped us with advice and logistical aid in many areas. We thank Khalil, Na'il and their families for their warm hospitality in making our stay at al-Mazra'a such a pleasant one.



1. The Ẓahrat adh-Dhrā' sites (ZAD 1 and ZAD 2) in the Dead Sea Plain, Jordan, and other key sites.

man settlement and agriculture have affected and been constrained by the local natural environment during the Holocene. In particular, the project will highlight evidence from two of the region's most significant eras of prehistoric agricultural intensification: the Neolithic advent of farming and the Middle Bronze Age florescence of cities. The first site, Ẓahrat adh-Dhrā' 1 (ZAD 1), is an unusual Middle Bronze Age (ca. 2,000-1,500 BC) village; the second site, Ẓahrat adh-Dhrā' 2 (ZAD 2), is a Pre-Pottery Neolithic A (PPNA) settlement (9,500 yr BP or 9,150-8,550 cal. BC) situated only 200 meters from ZAD 1.

The Dead Sea is a hypersaline inland drainage basin fed by the Jordan River (Niemi *et al.* 1997). The locality of Ẓahrat adh-Dhrā' is characterised by extremes of low elevation (the ZAD sites' median elevation is about 180 metres below sea level), high temperatures (regularly over 40°C in summer) and insignificant annual rainfall (50-100mm). Its harsh climate is mitigated only by a major spring ('Ayn adh-Dhrā' عين الذراع), which rises at the Jordan Valley margin and feeds the Wādī adh-Dhrā' that flows westward over the plain. In the past, as now, human settlement at Ẓahrat adh-Dhrā' required effective harnessing of this spring for sedentary farming and village life. Much of Ẓahrat adh-Dhrā' is presently characterised by badlands topography composed of deep wadi crevasses, steep-sided plateaus, and broad alluvial fans encumbered by large boulders. The new ZAD sites indicate, however, a more benign landscape for human settlement in the past.

The local geological landscape is dominated by the only extensive exposure in Jordan of the undated (anywhere between Miocene to Early Pleistocene) "Dana Conglomerate Formation", represented by variously tilted blocks of red and white evaporites interbedded with massive alluvial chert seams (Khalil 1992: 40-41; Powell 1988: 93). In the area underlying the ZAD sites, the Dana Formation is unconformably overlain by horizontally bedded Late Pleistocene gravels which contain Middle Palaeolithic artefacts (Edwards *et al.* 1998). The ZAD sites lie at the margin between the Dana Formation and the Lisan Marl Formation to the west. The Lisan Marl Formation, composed of the sedimentary detritus of Lake Lisan (ca. 60,000 -11,000 years BP), extends right to the Dead Sea shore, constituting the entire Lisān Peninsula and thus the largest known outcrops of the formation (Khalil 1992: 42ff). These saline and sterile geological substrates surround both sites, greatly reducing the agricultural productivity of the already poor local soils. The major attraction to settled life in the vicinity would have been the Wādī adh-Dhrā' (Raikes 1984), which flows presently at the bottom of a steep, narrow gorge some 60 metres below the surrounding plains. In antiquity this stream meandered westward over the plain at a higher elevation, approximately where the ZAD sites now lie. This situation is indicated by the presence in surficial deposits at ZAD 2 of the molluscan species *Melanopsis praemorsa,* which occupies slow-moving bodies of freshwater. Notably, another PPNA site, known as Dhrā', is situated where the spring emerges at the margin of the Jordan Valley (Kuijt and Mahasneh 1998). The environs of the ZAD sites once may have offered broad flat plains, like the modern farmlands immediately to the south and the best-known ancient settlement in the region – the Early Bronze Age site of Bāb adh-Dhrā' باب الذراع (Rast and Schaub 1981; Schaub and Rast 1989), rather than the deeply dissected badlands that characterise their immediate surroundings today.

The erosion of Wādī adh-Dhrā' through the MB site of ZAD 1 recalls the circumstances of two Early Bronze (EB) Age sites which were similarly truncated (Donahue 1985): nearby Bāb adh-Dhrā' and Numayra, 15 kilometres to the south. Donahue suggests that this incision was triggered by tectonic uplift in the area, but concedes that no traces of the uplift have been discovered. An alternative study by Frumkin and colleagues (1994) reconstructs a sequence of major rises and drops in the level of the Dead Sea during the Holocene. Intriguingly, both ZAD 1 and 2 are truncated by deep erosion gullies. Accordingly, the investigation of this geomorphological evolution will play an important part in our project. The following reports compiled by team members describe the results of the initial field seasons undertaken by La Trobe and Arizona State Universities from November 1999 to February 2000. The first section details the project's paleoenvironmental investigations. Subsequent sections describe the excavations at the PPNA site of ZAD 2 and the Middle Bronze Age site of ZAD 1.

(PCE, SEF and PLF)

Palaeoenvironmental Investigations on the Lisān Peninsula and Dead Sea Plain

An important aspect of our project involves the explanation of the sporadic history of settlement on the Dead Sea Plain and the interactions of ZAD 1 and 2 with their local environments. This area of investigation is particularly compelling in light of the present hyperarid character of Ẓahrat adh-Dhrā', and the relationships of ZAD 1 and 2 with

the Dead Sea. Interestingly, both sites are located along Pleistocene shorelines of Lake Lisan, raising the possibility that higher Dead Sea levels in the Neolithic or Bronze Age may have permitted spring waters (e.g. from 'Ayn adh-Dhrā') to emerge higher and flow across a less dissected landscape. In this particularly fragile hydrological and tectonic setting, natural environmental constraints and human environmental impacts play prominent roles in interpreting the course of human settlement and agricultural ecology.

With these circumstances in mind, geological investigations were directed by Patricia Fall to retrieve sediment cores from the Dead Sea that would provide a paleoenvironmental record for the Dead Sea Plain with special interest in the early Holocene. This work also involved description and collection of columnar samples from a stratified exposure of Lisan Marls underlying the western foot of the site of Bāb adh-Dhrā'. Sedimentilogical and palynological analyses of these cores and sections will be used for interpretation of agrarian ecology and human-environmental interaction in conjunction with excavated evidence from ZAD 1 and 2, and in comparison with evidence from sediment cores collected elsewhere along the Jordan Rift (e.g. Horowitz 1979; Baruch 1986; 1990; Baruch and Bottema 1991; Heim *et al.* 1997).

During mid-January and mid-February 2000 eight cores were recovered from four localities on the Lisān Peninsula in cooperation with the Arab Potash Company and the Natural Resources Authority, Hashemite Kingdom of Jordan. A truck-mounted mechanized rotary coring rig from the Natural Resources Authority retrieved 12.25 inch diameter cores from localities Lisan 1, 2, 3, 4, and 6 (**Fig. 2**). At Lisan 3, the mechanized corer cleared a hole through 5 metres of compacted dirt road and hard halite and carbonate layers above the water table. We continued coring Lisan 3 with a Livingstone piston hand corer to recover a 10cm diameter core of soft sediments to a depth of 12m (**Table 1**). Three additional cores, Dead Sea 1-3, also were collected with a Livingstone piston corer.

The recovered sediments represent a sequence of finely laminated marls alternating with thicker horizons of grey-green detrital sediments and salt layers. The laminae may be varved sediments made up of annual couplets, and are composed of white evaporite precipitation (summer) and dark grey laminae with detrital clasts and minerals (winter). The laminae vary in thickness from less than 1mm to several millimetres. The dark sediments are generally grey to greenish grey, but vary from

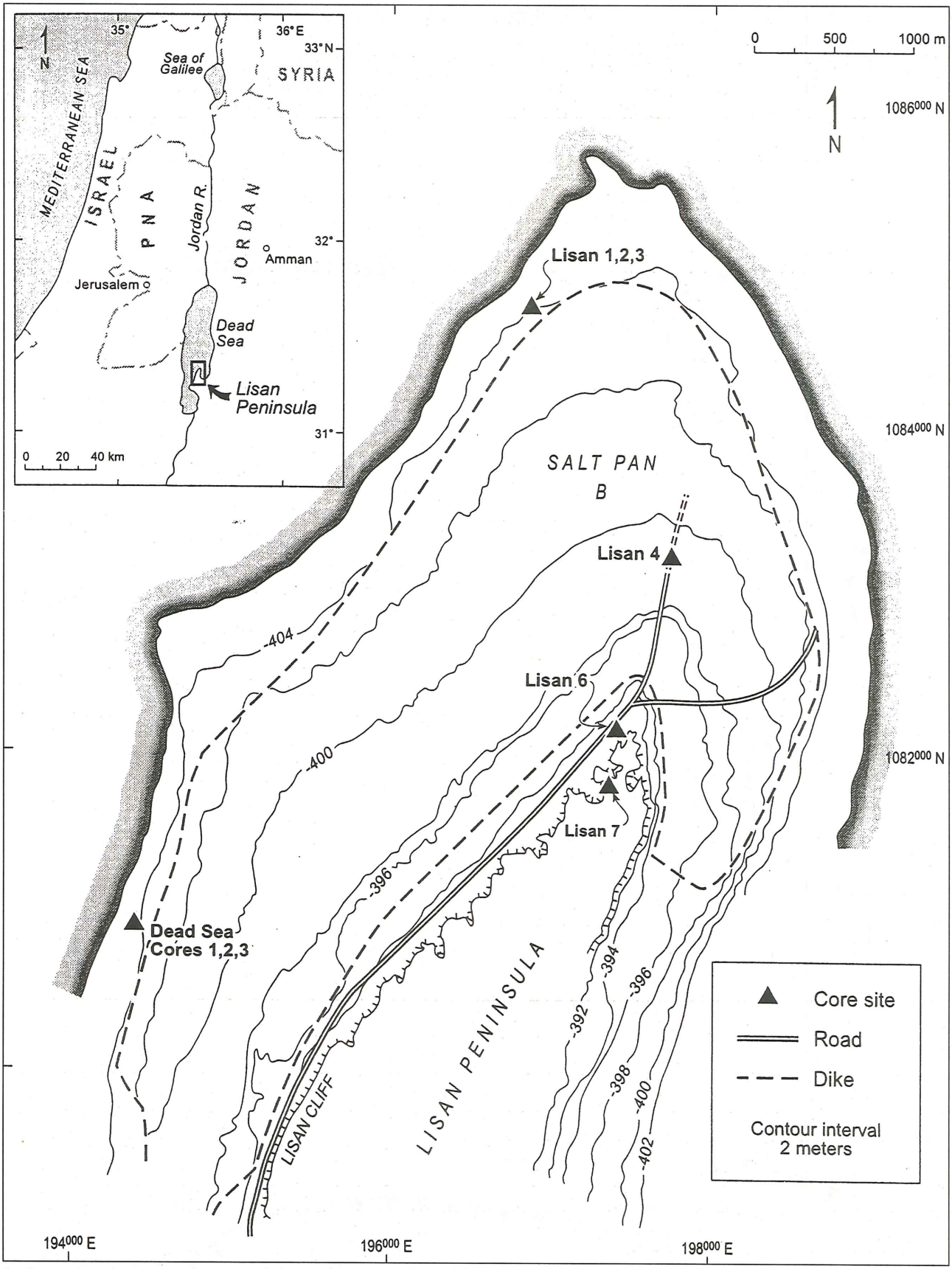
Table 1: Sediment coring methods and core depths.

Locality	Coring Method	Core Depth
Lisan 1	Mechanized, rotary	15 m
Lisan 2	Mechanized, rotary	30 m
Lisan 3	Mechanized, rotary Hand, piston corer	5 m (0-5 m) 7 m (5-12 m)
Lisan 4	Mechanized, rotary	5 m
Lisan 6	Mechanized, rotary	13.5 m
Dead Sea	Hand, piston corer	1 m
Dead Sea	Hand, piston corer	5.75 m
Dead Sea	Hand, piston corer	4 m

possibly organic black or very dark grey layers, to brown or green. The laminae probably represent sediments deposited in deeper water. There are also horizons of thick green lacustrine clay and occasional horizons of halite and gypsum that indicate fluctuations in water depth and salinity. The details of these fluctuations in depositional regime and their timing remain to be defined, but may represent significant hydrological and climatic changes.

The stratified deposits underlying the cultural deposits of Bāb adh-Dhrā', measuring 8.5m deep, are made up of massive grey clays, laminated sediments, gypsum and sand lenses. Analyses of the Bāb adh-Dhrā' section, at the edge of the Dead Sea basin, will provide comparative evidence for the interpretation of the cores collected along the modern shoreline near the basin center.

Analysis of these cores will address the age and origin of the sediments located at the present Dead Sea shoreline. Two working hypotheses are: (1) the upper (younger) nearshore sediments (presumably Holocene in age) have been eroded through regression processes, exposing older Pleistocene age deposits. These Pleistocene deposits may be equivalent in age to the basal units under the Lisan Marl cliffs exposed on the Lisān Peninsula. Lisan 6 sampled sediments at the base of the Lisan Marl cliffs. (2) The modern nearshore sediments are late Holocene in age and the sediments represent Holocene, and perhaps late Pleistocene, deposition and postdate the upper Lisan Marls at the peninsula in-



2. Coring localities on the Lisān Peninsula.

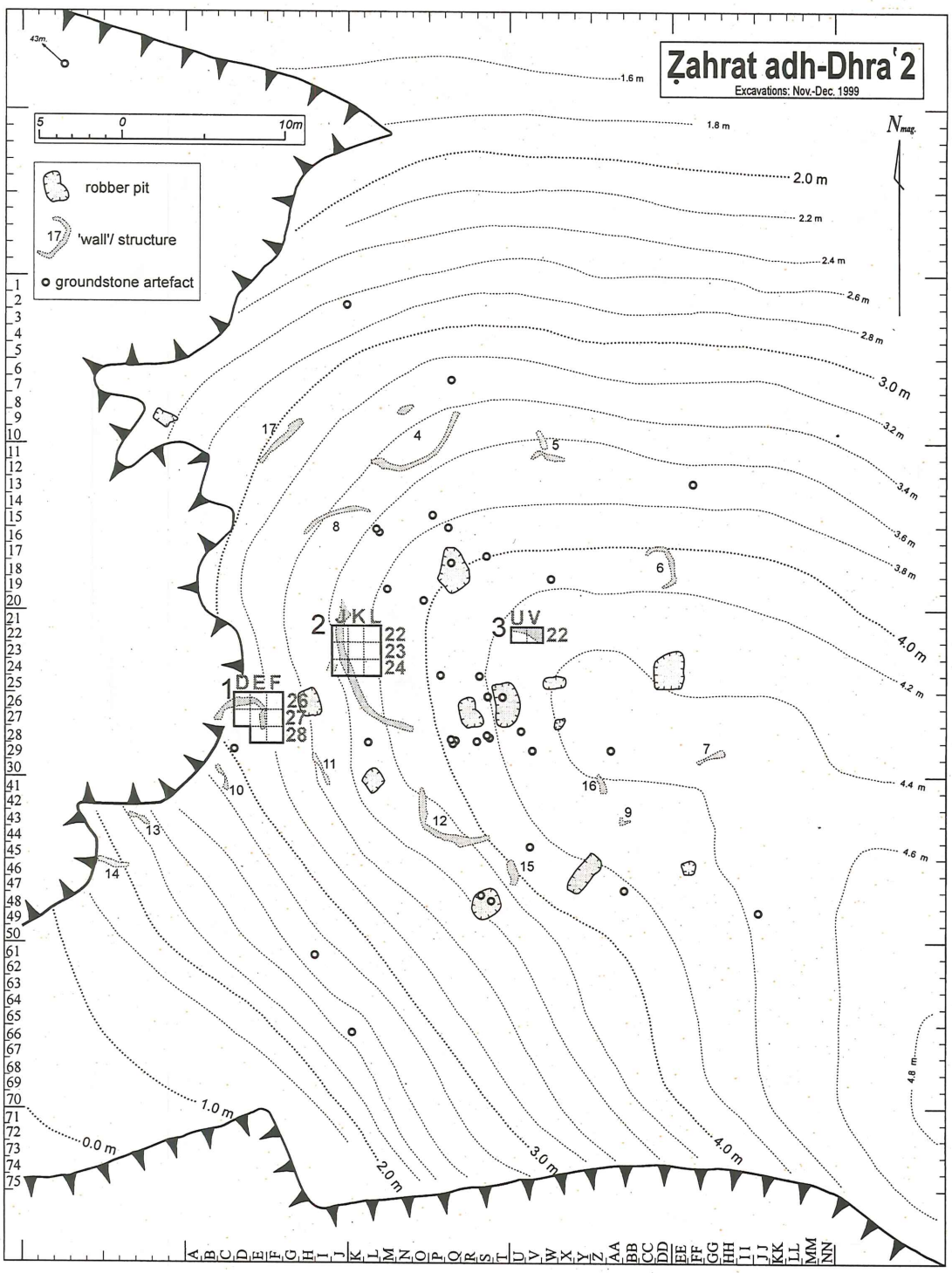
terior (e.g. above Lisan 6). Either of these hypotheses has important implications for past climate and environmental conditions within the Lisān basin. Ultimately these hypotheses will be answered to a great extent by radiometric age determinations.

(PLF and CD)

The PPNA site of Ẓahrat adh-Dhrā‘ 2 (ZAD 2)

ZAD 2: Context and Description

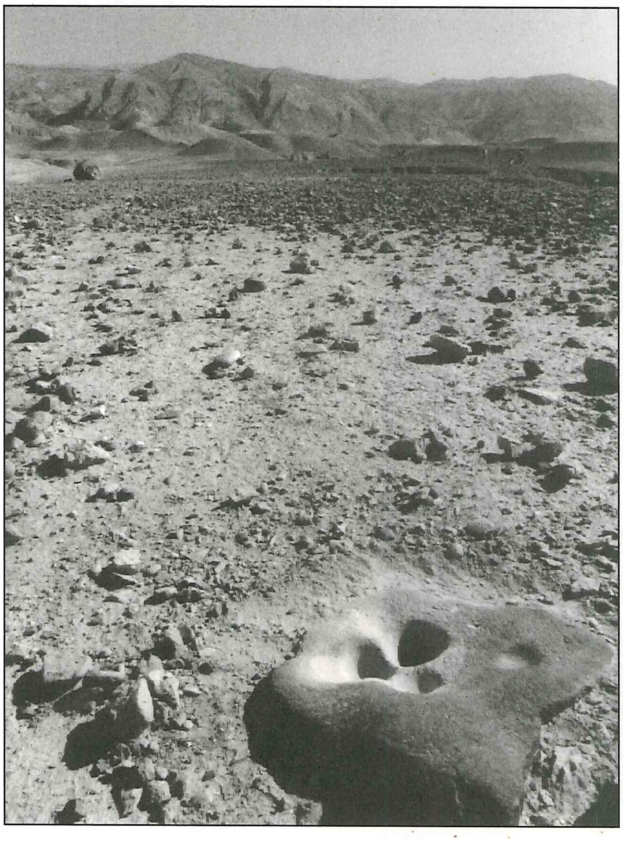
The cultural counterpart to our evidence for the natural environment of early Holocene Dhrā‘ comes in the form of the Pre-Pottery Neolithic A site of Ẓahrat adh-Dhrā‘ 2 which is situated on a



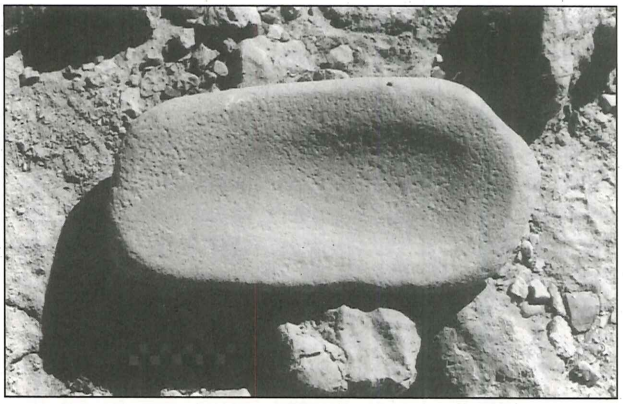
3. Site plan of ZAD 2.

promontory of land jutting southwest against a deep gully that separates ZAD 2 from ZAD 1 (**Fig. 3**). Whereas some of the site clearly has been truncated by erosion to the west, the surviving portion forms a roughly circular, low mound about two meters thick and 2,000 square metres in area. The site is littered by stone cobbles and fragments spread within a radius of about 50 metres from the central and highest part of the mound. Seventeen curvilinear wall stubs emerge clearly through topsoil, and 12 pits resulting from illegal excavations, surrounded by small hillocks of sediments, had been dug into the site. A dark organic sediment was generally observable across the pits at a level of about half a metre below the surface. A number of groundstone artefacts were concentrated in the small hillocks of sediment thrown up next to the robber pits, as if many of these had been exhumed from subsurface structures during the clandestine excavations.

Thirty-five surface groundstone artefacts, including mortars, pestles, querns, handstones and a shaft straightener were found and their locations planned. Most of these were broken. The exceptions were five cup-hole mortars, made from large blocks of basalt (**Fig. 4**), limestone and sandstone, and an intact sandstone quern (**Fig. 5**). The surface



4. Basalt cup-hole mortar on the surface at ZAD 2.



5. Sandstone quern on the surface at ZAD 2.

of ZAD 2 was also littered with the remains of an extensive flint knapping industry.

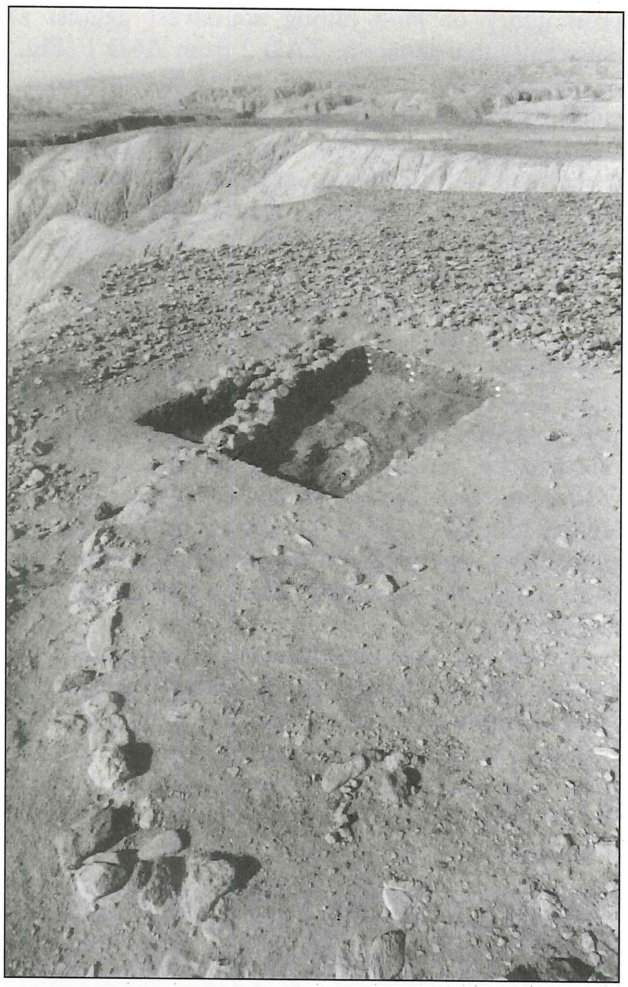
Initially, Rudy Frank established a 45m x 45m grid over the site with steel pegs located at 5m intervals. This enabled the square-metre excavation plots to be emplaced quickly and accurately. Excavation proceeded according to natural stratigraphy augmented by a series of artificial units that were usually 5-10cm thick. Horizontal control was maintained by excavating in square-metre areas. All sediments were dry-sieved at the site through 3mm mesh, then subsequently wet-sieved and washed through 3mm mesh at the excavation house at al-Mazra'a. Excavation squares were begun in three areas of the site: at Structure 1 which was visible in the cliff section on the western face of the site; at Structure 2 over a long curvilinear wall section; and at Structure 3 near the summit of the site, in order to investigate the site's thickest deposits.

Squares D26 to F28 (**Fig. 3**) were chosen at a point on the gully cliff where the remains of an oval structure could be seen cutting the surface. Here, a dark organic sediment was also visible in section, overlaying the underlying natural basal sediments. The 8-square metre excavation (Squares D26/ D27/ D28/ E26/ E27/ E28/ F26/ F27/ F28) revealed a curvilinear wall-section enclosing a semicircular dwelling. To the west of this wall the floor was stepped down about 30cm. Outside, to the east, a plastered floor formed the occupation surface at a higher level. Additionally another wall section was evident abutting F.1 and arcing away in the opposite direction. Feature 1 was a well-made wall with angular and oval stone fragments set into a mud mortar. Deeper excavations were continued in Square F27 into an underlying series of ephemeral red and dark grey surfaces. The red sediment may be derived from the underlying natural Dana Formation calcarenite, and the dark

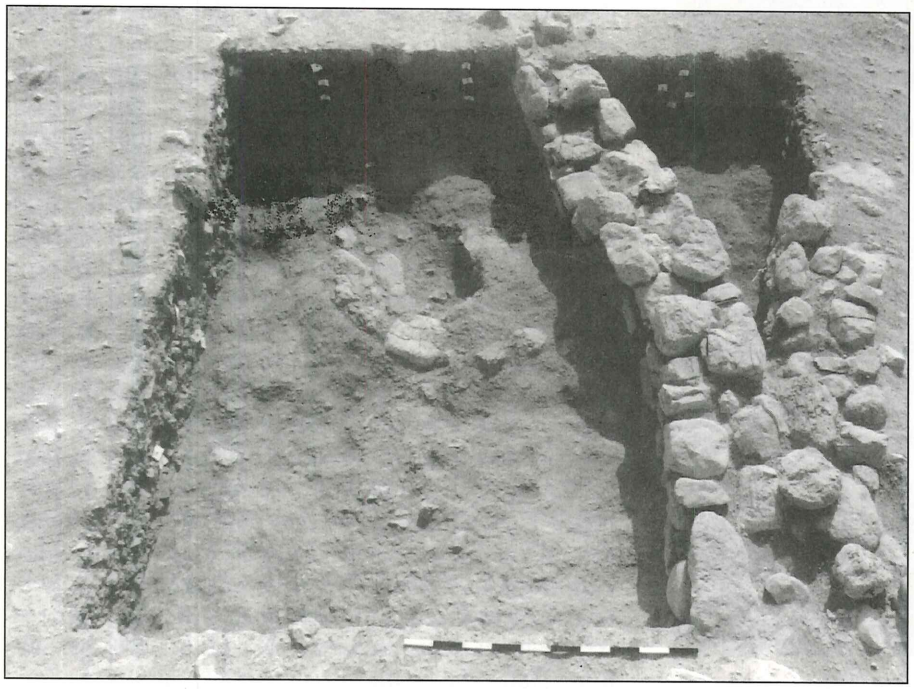
patches are clearly derived from hearths and organic waste. The deposits slope down to the west in this area, and appear to derive from refuse tipped into an exterior midden.

Structure 2 (Squares J22 - L24, **Fig. 3**), lying close to the east of Structure 1, was excavated over an area of nine square metres in order to elucidate the nature of a curvilinear wall line protruding through topsoil. The wall line extends for 6.5m, and it was anticipated that this structure would prove to be one of the site's largest and best preserved, and one of the most promising for broad-scale clearance. This indeed turned out to be the case (**Fig. 6**). The excavations yielded a walled structure (Feature 1 = F.1) with plastered floor and interior hearth (F.4) set with stones and plaster (**Fig. 7**). The wall (F.1), which curves from the northwest in Square J22 to the southeast in Square K24, was well made with three courses and two rows of stones set firmly in a hard lime mortar and it survives to a height of 40cm. A second wall (F.2) abutted F.1 in Square J22 and curved away in the opposite direction, to the southwest (**Fig. 7**). A small cairn of stones (F.3) positioned in the interstices between the two walls near the south baulk of Square J24 overlay some large fragments of a human cranium. Further excavation showed that F.3 marked the northern end of a complete human skull (and perhaps a complete human skeleton), which was evident in the baulk section.

Two squares (U22 - V22) were positioned at the summit of the mound in order to investigate the



6. View northwest over Structure 2, ZAD 2.



7. Excavations at Structure 2, ZAD 2; view south.

deepest deposits of the site. This relatively small excavation lacked the advantage of the previous ones in being positioned over a clear-cut structure. Nevertheless, one (Structure 3) was indeed found here. At Locus 2.1, about 40cm below the surface, a hearth (F.3) rich in charcoal was found associated with a floor (**Fig. 8**). This capped a lower structure which consisted of a curvilinear wall stepped down to the north, curving east to west from Square V22 to U22, with the interior floored surface sunk 25m below the exterior one.

Chronology of Ẓahrat adh-Dhrā' 2

Charcoal samples were recovered from all structures, and three of those from Structure 3 were submitted for AMS dating and have provided the basis for a radiocarbon chronology of the site. Many characteristics of the ZAD 2 groundstone and flaked stone assemblages (below) indicate that the site belongs to the Sultanian phase of the Pre-Pottery Neolithic A period (*cf.* Enoch-Shiloh and Bar-Yosef 1997). The sequence of radiocarbon dates from the two phases of occupation in Structure 3 (**Fig. 8**) confirmed this by yielding similar determinations of ca. 9,500 BP (**Table 2**).

Various Artefacts and Materials from ZAD 2

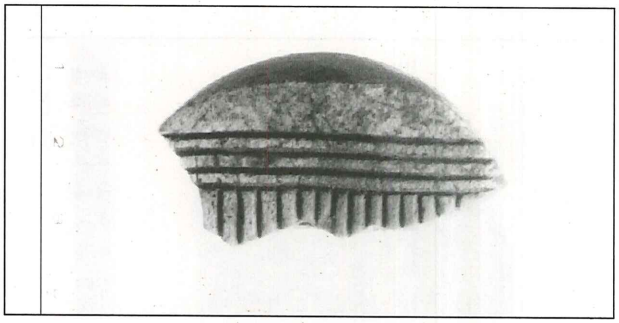
Two broken, grooved basalt shaft straighteners were found, one from an occupation surface in Structure 1 and the other from Structure 2. Short sections of two marine *Dentalium* sp. molluscs were discovered, representing exchange links to either the west (Mediterranean Sea) or the south (Red Sea). Structure 1 also produced an incised fragment of burnt limestone with seven parallel notches carved in a shaped 'rim'.

Table 2: *Radiocarbon age determinations from ZAD 2.*

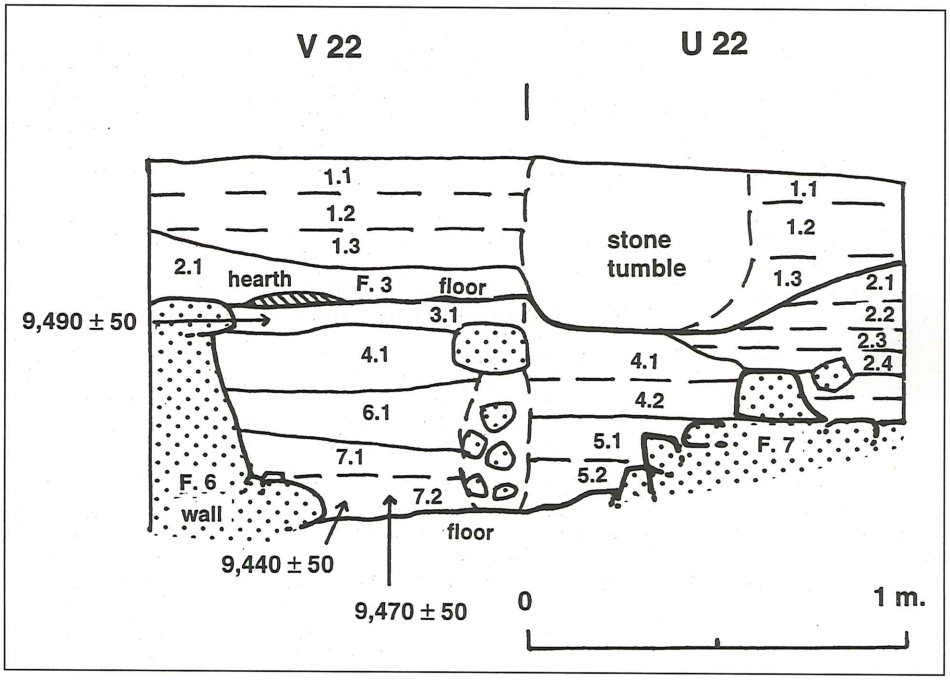
Provenance	Date (uncal. BP)	Laboratory Code	Calibrated date (95.4% probability)
Structure 3, Sq. V 22, Loc. 3.1	9,490 ± 50	OZE 605	9,150 – 8,650 BC
Structure 3, Sq. V 22, Loc. 7.2	9,440 ± 50	OZE 606	9,150 – 8,550 BC
Structure 3, Sq. V 22, Loc. 7.2	9,470 ± 50	OZE 607	9,150 – 8,600 BC

The most notable piece of *art mobilier* was a limestone plaque from Structure 2, incised with a geometric pattern of 15 vertical strokes pendant from a band of four parallel lines (**Fig. 9**). Exotic materials attesting to long-range structures were found in the excavations and on the surface of the site. These include obsidian flakes, fragments of green copper ore, fragments of a hard green mineral (turquoise?) and marine *Dentalium* shells.

(PCE)



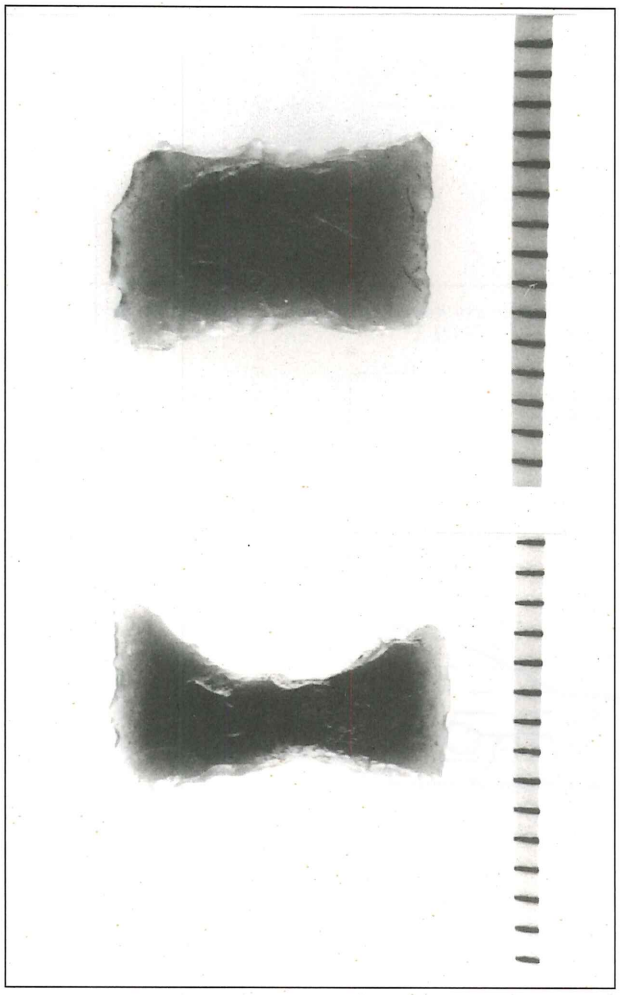
9. Incised limestone plaque from Structure 2 (Square K22, Locus 2.1) at ZAD 2.



8. Section through Structure 3 (Squares U22/ V22) at ZAD 2.

The Flaked Stone Assemblage of ZAD 2

A large quantity of lithics was recovered from the three structures excavated in the 1999 season. Structure 1 provided 27,536 pieces of debitage, debris and tools. Structure 2, the largest excavated area, supplied roughly 30,000 lithics and Structure 3 had only 5,200 pieces. These lithics were dry sieved at the site using a 3mm mesh and consequently wet-sieved though the same mesh size at the dig base. After completing the sorting process, all lithics were re-washed before classification. A small number of burnt lithics were included in this sample, which may have the two implications of either flint heat treatment during manufacturing, or (more likely) that these pieces resulted from incidental firing in hearths placed over lithic refuse. At this stage, the site produced many tool types such as sickle blades, picks, adzes, Hagdud truncations (**Fig. 10**), borers/drills, and scrapers but surprisingly few points – in particular, no complete El Khiam points have yet been recovered.



10. Hagdud Truncations from Structure 2 (above) and Structure 1 (below); scale is 4x natural size.

Massive layers of alluvial chert cobbles intersect the small arid exposure of Dana Conglomerate on which the site of ZAD 2 is located. The survey of 1994 (Edwards *et al.* 1998) demonstrated that relatively flat exposures of these flint cobbles that occur 1.5km east of the site were used through time as flint quarries. Furthermore, the pebbles, which also wash down the Wādī adh-Dhrā' system are widely dispersed over the Ẓahrat adh-Dhrā' area and certainly supplied most of the flint used at ZAD 2. The results of the 1999 season showed that a small number of flaked stone tools were not only produced from flint but also from other raw materials such as quartz, quartzite and obsidian. The source of the obsidian is most likely to be from Cappadocia in central Anatolia (e.g. Dixon *et al.* 1968: 40-43; Yellin 1997), while the origin of the quartz is still under investigation. However, the existence of obsidian on the site implies a long distance exchange of knowledge and material culture between the inhabitants of ZAD 2 and the other Neolithic sites in the Near East (e.g. Renfrew *et al.* 1966: 54).

The preliminary classifications of these lithics as well as the existence of many curvilinear structures and the availability of a tight range of radiocarbon dates indicates that this site has one period of occupation dating to the late PPNA. Such kinds of material culture makes it possible to infer that ZAD 2 will contribute strongly to an understanding of the cultural succession in the PPNA and help to elucidate the nature of its controversial Khiamian and Sultanian phases (Kuijt 1997; Nadel 1998; Ronen and Lechevallier 1999). Future comparisons will be conducted between ZAD 2 in its arid setting with the other nearby PPNA sites of Dhrā' and 'Wadi Feinan 16' and the northerly ones located in more mesic environments such as Netiv Hagdud (Nadel 1997: 71-149) and Jericho (Crowfoot-Payne 1983).

(GJS)

Archaeobotanical Remains from ZAD 2

During the 1999 field season, forty-one soil samples were processed by flotation in order to recover plant remains. Twenty-six of these samples, comprising 100 litres of sediment, came from Structure 1; three samples, representing eleven litres, were collected in Structure 2, and twelve samples, comprising 17.5 litres, came from Structure 3. All of the samples were processed by the wash-over, or bucket, method. The sample was measured into a bucket, which was then filled with clean water. The sediment was stirred by hand until the soil matrix had dissolved completely, and the excess

water was then poured over a piece of 0.5mm mesh fabric. The process was repeated twice to ensure that all buoyant plant remains had been extracted. Inevitably, some silt and snail shells were also collected in this way.

The flots, or light fractions, were fully sorted under X10-X40 magnification at La Trobe University. All plant remains, as well as snail shells and pellets of rodent or insect dung, were set aside and recorded. The plant remains were poorly preserved, making identification a rather speculative pursuit. All carbonised remains were assumed to be ancient, and non-carbonised remains were assumed to be intrusive. Most of the snails and pellets were also not charred, and are therefore probably modern. **Table 3** summarises the results. Note that it is the ubiquity of each taxon that is shown; in other words, the number of samples containing that taxon, rather than the absolute number of items of that taxon found. Because the remains were so fragmented, counts of some plant types were difficult to determine. It cannot be assumed that the ZAD 2 samples are independent of each other, so that patterns of ubiquity may also be misleading (Popper 1988).

In fact, there may not be any patterning within the assemblage that is not explained by differential sampling and preservation. For example, practically all the rare taxa were found only in samples from Structure 1, presumably because three-quarters of the sediment processed came from this structure. Larger samples (in terms of the number of identifiable plant remains) contained the greatest range of taxa; smaller samples included only part of that range. Remains from contexts more than half a metre below the modern, deflated surface of the site were clearly better preserved than those in samples from closer to the surface, and this is reflected in a greater diversity of identifiable types. Conversely, indicators of bioturbation (snails, pellets and uncharred seeds such as *Aizoon hispanicum*) were more abundant in the upper levels.

Four categories of ancient plant remains should be considered ubiquitous at ZAD 2 – cereal fragments, pulse fragments, fig nutlets and *Pistacia* shell fragments (non-diagnostic nutshell fragments occur in all but two samples). Two cereal species, barley and wheat, are apparently represented, although no complete, diagnostic grains were recovered. It was sometimes possible to assign a grain fragment to either wheat or barley. Chaff fragments of barley, and occasionally of wheat, were also identified. There were at least two pulse species, lentil and a spherical variety akin to a very small pea.

The most detailed archaeobotanical study of a PPNA site in the southern Levant is Kislev's analysis of the plant remains from Netiv Hagdud (Kislev 1997), a site in a broadly comparable environmental setting to ZAD 2. The Netiv Hagdud remains were very well preserved, permitting Kislev to identify seventy-five taxa, mostly to species level. A comparison of the two assemblages shows that the ZAD 2 species are essentially a subset of those recovered at Netiv Hagdud. Kislev argues, contrary to Hopf's (1983) interpretation of the PPNA plant remains from Jericho, that the Netiv Hagdud remains do not support the contention that domestic varieties of wheat and barley were cultivated in the PPNA. Barley rachis internodes with domestic-type disarticulation scars made up only a small minority of the total, and it was shown experimentally that a similar percentage of 'domestic' types could be obtained by harvesting a crop of wild barley. The wheat grains found at Netiv Hagdud could apparently all be assigned to the wild ancestor of emmer, *Triticum dicoccoides*.

At 'Irāq ad-Dubb, however, Colledge (1994) found what appeared to be domestic types of both wheat and barley, as well as large-seeded legumes (including lentil and fava bean), pistachio and walnut shells, fig seeds and several herbs that are potentially weeds of cultivation. The presence of straw components and domestic varieties of cereals suggested that the site depended to some degree on food production, supplemented by gathering and hunting. 'Irāq ad-Dubb is the only PPNA site in Jordan with published archaeobotanical data (Neef 1997).

The results of the first season at ZAD 2 lend some support to both views. Of the barley rachis internodes, the majority that could be determined are of the wild type, and the breakage pattern is not that typical of domesticated barley. Most of the grain fragments identified as barley are apparently of wild barley. On the other hand, some barley grain fragments are large enough to be of the domesticated variety, and one grain apex was identified as probable domestic einkorn wheat. On balance, the evidence obtained is more consistent with the interpretation of Netiv Hagdud, where it is postulated that wild varieties of cereals and pulses may have been collected or cultivated, than with the fully agricultural settlement suggested at Jericho. It remains possible, however, that further sampling at ZAD 2 will provide more evidence of plant domestication.

One whole nutlet of *Pistacia* was recovered in Structure 3. It is very small – which is presumably why it was not broken open and consumed – but it

Table 3: Ubiquity of archaeobotanical samples from ZAD 2.

Total number of samples = 41.

Taxon	# samples	% samples	structures	status
snail shells	40	98	1, 2, 3	ubiquitous
rodent/insect pellets	21	51	1, 2, 3	abundant
wood fragments	32	78	1, 2, 3	ubiquitous
wheat grain, Triticum sp.	1	2	3	rare
glume base (wheat), Triticum sp.	4	10	1, 3	occasional
wheat rachis internode, Triticum sp.	1	2	3	rare
wild-type barley grain, Hordeum sp.	8	20	1, 3	frequent
domestic-type barley grain, Hordeum sp,	1	2	1	rare
indeterminate barley grain, Hordeum sp.	5	12	1, 3	frequent
barley floret base, Hordeum sp.	19	46	1, 3	abundant
wild-type barley rachis internode, Hordeum sp.	6	15	1, 3	frequent
domestic-type barley rachis internode, Hordeum sp.	4	10	1	occasional
indeterminate barley rachis internodem Hordeum sp.	11	27	1, 3	frequent
[any barley grain]	12	29	1, 3	frequent
[any barley rachis internode]	14	34	1, 3	abundant
oat awn fragment, Avena sp.	8	20	1, 3	frequent
cereal grain fragments	25	61	1, 2, 3	ubiquitous
cereal culm node	1	2	1	rare
indeterminate floret base	2	5	1, 3	occasional
lentil, Lens sp.	6	15	1, 3	frequent
pea-type pulse, Papilionaceae (Vicieae)	8	20	1, 2	frequent
pulse fragments	31	76	1, 2, 3	ubiquitous
Pistacia sp. nutshell fragments ('diagnostic')	23	56	1, 2, 3	abundant
Ficus sp. nutlets	27	66	1, 2, 3	ubiquitous
Aizoon hispanicum seed [not carbonised]	38	93	1, 2, 3	ubiquitous
Cerastium sp. seed	1	2	1	rare
Silene sp. seed	1	2	1	rare
Heliotropium type seed	1	2	1	rare
Lithospermum type seed	3	7	1, 3	occasional
Chenopodiaceae seed	1	2	1	rare
Carex type seed	1	2	1	rare
small-seeded legume seed	1	2	1	rare
Ornithogalum type seed	2	5	1	occasional
Malva sp. seed	1	2	3	rare
Plantago sp. seed	5	12	1	frequent
non-cereal grass seeds	3	7	1, 3	occasional
grass seed fragments	10	24	1, 3	frequent

ubiquitous = >59%
abundant = >29%
frequent = >10%
occasional = >2%
rare = single record

appears to conform to *Pistacia atlantica*, with its "crater-like" hilum (Kislev 1997: 210). Most of the nutshell fragments found at ZAD 2 lack any distinguishing features, but a minority, recorded as 'diagnostic', include an angle that is consistent with the 'crater-like' hilum of *P. atlantica*. On average, there are 15-20 featureless nutshell fragments for every 'diagnostic', and sixteen samples contained small numbers of fragments (fewer than twenty) but no diagnostics. It appears that *P. atlantica* is the only nut type represented at ZAD 2, but its remains are ubiquitous. The tree probably formed a minor component of the natural vegetation of Wādī al-Karak, and perhaps of the Karak plateau, before the advent of agriculture (Kürschner 1986). Remains of *Pistacia* are widely recorded at Jordanian sites of all periods (Neef 1997).

Likewise, *Ficus* (fig) nutlets are commonly reported, from the Natufian onwards (Neef 1997). *Ficus pseudosycomorus* is native to southern Jordan, and occurs, for example, in sandstone gorges around Petra. As the same Mediterranean/Saharo-Arabian transition zone extends northwards beyond adh-Dhrā' (Kürschner 1986), it is reasonable to assume that the tree would have grown within easy access of ZAD 2. Both *Ficus* (over 400 nutlets) and *Pistacia* (nearly 3000 fragments) may be over-represented, relative to the cereals and pulses, because of the large number of nutlets in each fig and the large number of woody nutshell fragments from each nut.

The ubiquity data, however, provide a crude measure of how often each taxon was used (Popper 1988). The fact that cereal, pulse, *Ficus* and *Pistacia* remains each occur in about sixty percent of the samples suggests that all may have been equally important. In other words, whether or not the cereals and pulses were cultivated, it seems that gathered plant foods made a significant contribution to diet. In future seasons at ZAD 2, the project will aim to sample a much larger volume of sediment than in the 1999 season, with the object of collecting better-preserved specimens of the main food plants, and a wider range of species that may indicate which environmental niches were exploited.

(JM)

Faunal Remains from ZAD 2

Neolithic sites in the eastern Mediterranean are critical for understanding the processes of animal domestication. Among the factors long used by archaeologists to determine whether or not a particular animal bone signifies domestication has been size, since bones of domesticated livestock (sheep, goat, pigs, and cattle) in archaeological contexts normally reflect animals which were physically smaller than their wild ancestors. Evidence for the first domestication of ungulates is exemplified by bones of goats found at Ganj Dareh in the highland Zagros region of Iran. A recent study by Zeder and Hesse (2000) demonstrates that morphological differences such as size and changes in the shape of ovicaprid horn cores were the indirect result of human management. However, these changes occurred gradually.

While the pace of these physical developments in Near Eastern contexts has been undergoing precise definition, there is wide acceptance that goat domestication began in Iran, occurred subsequently in the Damascus Basin, and later took place in the southern Levant. During the PPNB, the faunal record indicates that human communities began to depend upon domestic goats to augment the harvesting of wild goats (*Capra ibex* and *Capra hircus aegagrus*) and gazelles (Wasse 1999). So far no evidence for domestication of ungulates has in the southern Levant has emerged for the PPNA period.

The first excavation season at ZAD 2 recovered 34 animal bones and bone fragments. These remains were found in an upper phase; consequently, they reflect heavy surface wear due to exposure. The identifiable large mammal species include *Capra ssp.* and *Bos primigenius. Capra ssp.* is represented by a first phalange and an astragalus. Both fall within the parameters of size for domestic goats, but size alone is insufficient as a distinguishing marker. *Bos primigenius* is represented by a proximal rib fragment. Two phalanges represent a carnivore, possibly badger (*Meles meles*). One crab claw (*Potamon*) was also recovered. Many larger fragments could not be distinguished definitively as either *Capra* or *Gazella*. Gazelle remains occur frequently in PPNA sites in the southern Levant so some of these bones may be from gazelles. Interestingly, however, the "Dana-Faynan-Ghuwayr Early Prehistory Project" has recovered from Site WF 16 an animal bone assemblage which features Capra but seems not to include Gazella (Finlayson *et al.* 2000). It is hoped that in the second excavation season at ZAD 2, when lower phases will be more extensively excavated, that the faunal assemblages recovered will provide data with which to further probe the relationship between human communities and indigenous fauna in the southern Levantine PPNA.

(MCM)

The Middle Bronze Age Site of Ẓahrat adh-Dhrā' 1 (ZAD 1)

ZAD 1: Context and Description

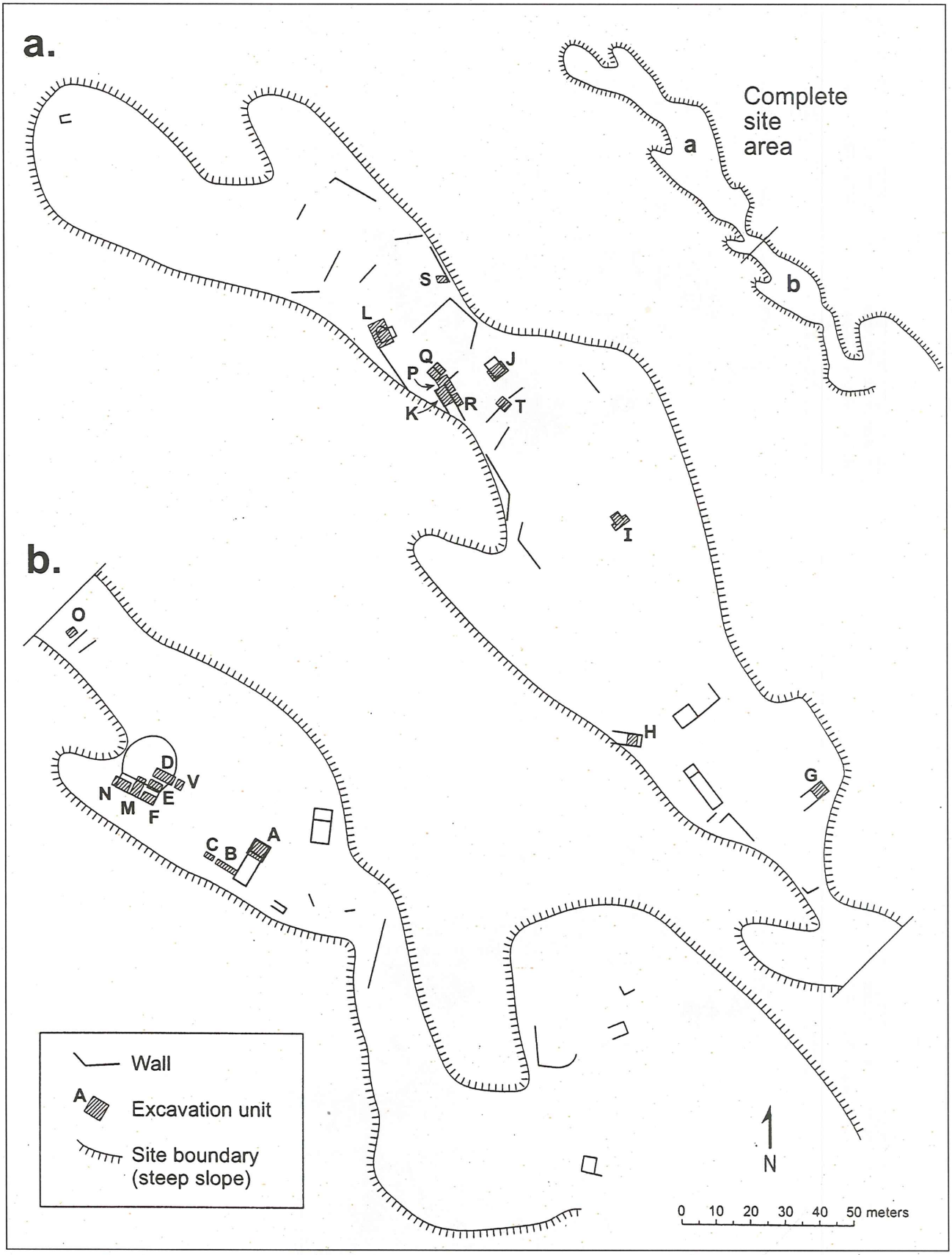
Ẓahrat adh-Dhrā' 1 was discovered in 1989 by geomorphologist Phillip Macumber and included in a 1994 archaeological survey directed by Macumber and Phillip Edwards (Edwards *et al.* 1998). The site was mapped first by George Findlater during the original reconnaissance of the area. The first step in designing the excavation of ZAD 1 was taken during the ZAD 2 field season, when Rudy Frank resurveyed the site (**Fig. 11**). The first season of excavation at ZAD 1, directed by Steven Falconer between mid-December 1999 and mid-January 2000, began with a general mapping of surface architecture.

The site is located along a northwest-southeast trending ridge bounded by two tributaries that drain into Wādī al-Karak, about one-half kilometer to the northwest: a small wadi on the north and the Wādī adh-Dhrā' on the south. Rectilinear and curvilinear stone building remains protrude through topsoil over an area of six hectares. The most common building plans show one- and two-roomed structures with courtyards. Truncated buildings along the ridge's southern face, and similar remains exposed along a neighboring ridge 200 metres across the chasm to the south, imply that ZAD 1 originally measured at least 12 hectares in area and extended over a flat plain that was incised by subsequent downcutting of the Wādī adh-Dhrā'. Roughly northeast-southwest alignments of very large limestone boulders at the eastern and western ends of the ridge may mark Pleistocene shorelines of ancient Lake Lisan.

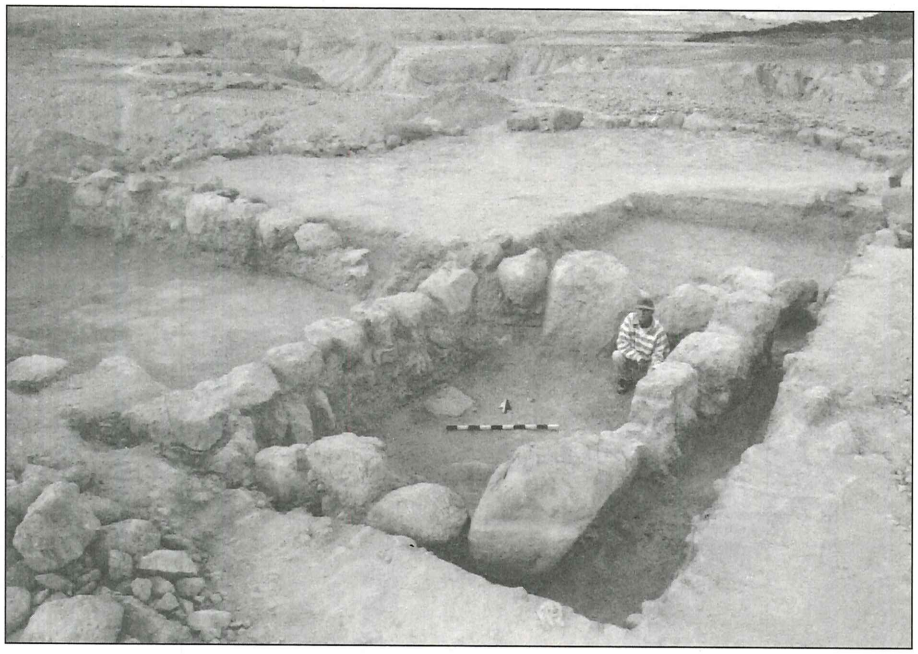
Rather than employing a traditional grid of 5x5 metre excavation squares, we used our survey results to place 23 units of varying sizes in optimal locations to explore the chronological, functional, and architectural variation within ZAD 1. Our units sampled two multi-enclosure architectural complexes, one toward the southeastern end of the site (units D, E, F, M, N and V), another toward the northwestern end (units J, K, L, P and Q). More isolated rectilinear structures were sampled by units A, G, H and I. Units B and C cross-cut the massive boulder alignment at the eastern end of the site. Unit T tested a wall apparently bounding the northwestern architectural complex. Units O, R, S and V searched for exterior midden deposits, especially in hope of producing significant floral and faunal remains. Units Y and Z sampled stratified organic deposits on a low terrace in Wādī adh-Dhrā'. Unit designation U was used briefly for the southeastern portion of Unit K, but was then subsumed as part of Unit K. Unit designations W and X were not used. All excavated sediments were dry-sieved through 5mm mesh screen.

The following section briefly summarizes the placement and general results of excavation for each unit. Each unit was assigned a letter designation in the order in which they were laid out for excavation. Although laid out early in the season, units Y and Z, were given the last letters of the alphabet in recognition of their location off the main site. Unit A was a 5x5m unit situated around the north end of a rectangular structure lying just east of the massive boulder alignment at the east end of the site. It revealed cultural deposits well below the founding levels of the walls, including an east-west cross wall, but few clear surfaces.

Units B and C were 1x8m trenches that cut across the boulder alignment at the east end of the site. They produced no cultural surfaces, almost no material culture and revealed that the boulders did not form a built alignment, but had been deposited naturally amid gravelly sediments along a possible Pleistocene shoreline of Lake Lisan. Units D, E, F, M, N and V (**Fig. 12**) investigated a multi-room rectangular structure with attached ovoid enclosure. Unit D was a 3x6m unit that cross cut the enclosure wall, revealing shallow deposits within the enclosure, but providing clear evidence of an earlier phase of an enclosure wall. Unit V was a 2x3m unit located on the northern exterior of the enclosure wall in hope of finding exterior midden deposits. This unit produced very little material below modern surface level. Units E and F were 3x4m units that exposed the southern room of the rectangular structure. Both units revealed lower wall alignments for the southwestern and southeastern walls of this room, indicating an earlier phase of construction. Both units, particularly Unit F, revealed deep deposition, including use surfaces below heavy rock wall fall, and produced abundant cooking pot and store jar sherds. Units M (2x6m) and N (3x5m) expanded the investigation of this structure's southern architecture, revealing less deposition and material culture, and no evidence of an earlier architectural phase. The results from this structure suggest three distinct functional and depositional components: 1) the small southern room of Units E and F, the best candidate for a roofed living space, with two architectural phases; 2) the larger rectangular room or courtyard of Units M and N, with moderate rock wall fall and much less abundant material culture; and 3) the curvilinear enclosure with two wall phases exposed in Unit D, which produced shallow deposits and little rock



11. Site plan of ZAD 1.

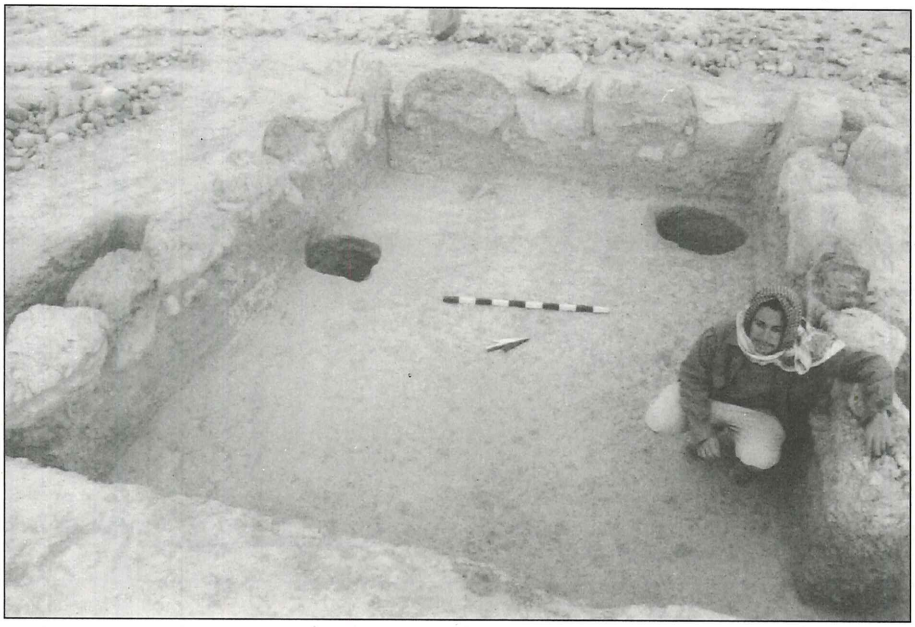


12. Units D, E, F, M, N and V at the southeastern ZAD 1, showing two-room rectangular structure in foreground, ovoid enclosure in background; view north.

fall or material evidence.

Units G, H and I each sampled isolated single rooms, rectilinear structures toward the middle of the site. Unit G was a 4x4m unit that cross cut the eastern end of a rectilinear structure on the northern edge of the site. This unit revealed very shallow deposits with little material evidence. Unit H was a 3x4m unit placed across another rectilinear structure on the southern edge of the site. Although revealing deeper deposition and rock wall fall than unit G, its material evidence was limited. Neither Unit G nor H revealed clear use surfaces. Unit I was a 2x5m unit across the middle of a former rectilinear structure (**Fig. 13**). In contrast to units G and H, it produced very clear stratigraphic evidence of interior pits, hearths and use surfaces (mostly below the founding level of its walls), and moderate amounts of material culture.

Units J, K, L, P, Q, R, S and T investigated a variety of depositional contexts related to a cluster of buildings and enclosures toward the northwestern end of the site. Unit J (**Fig. 14**) was a 3x6m unit across a long rectilinear structure similar to the structure excavated in Units E, F, M and N. Unit J revealed a cross wall with doorway that separated a small, roughly square room with interior use sur-

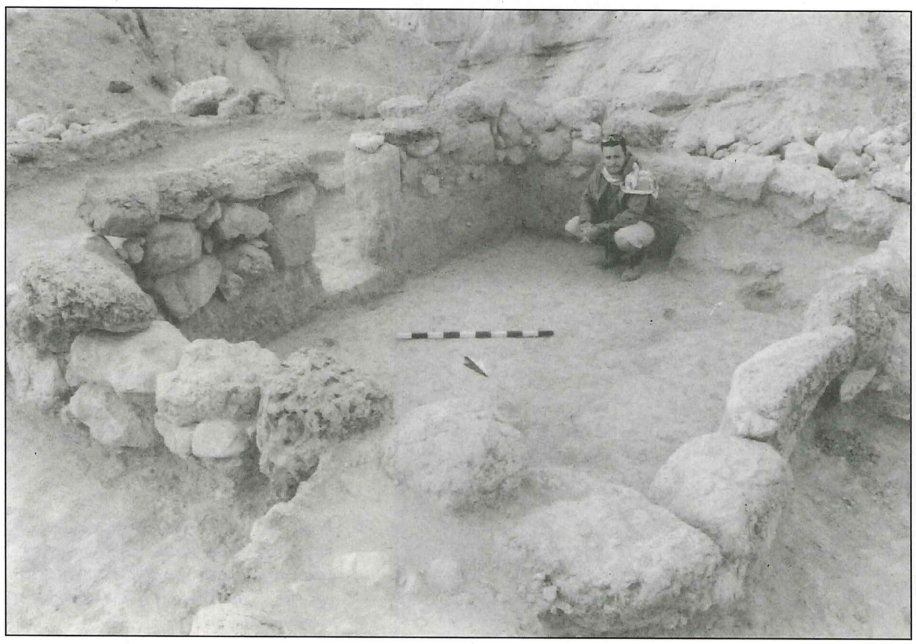


13. Unit I, central ZAD 1, showing rectangular structure with pits dug into interior surface; view northwest.

14. Unit J, northwestern ZAD 1, showing two-room rectangular structure with interior doorway; view northwest.

faces below wall founding levels. The larger enclosed space to the south of this room had higher, less well defined use surfaces. Unlike Units E and F, however, Unit J produced relatively little material culture. Unit K (**Fig. 15**) began as a 3x4m unit within a clearly defined room with multiple-course preserved walls and deep deposition. To the south of this room lies a longer, rectilinear enclosure that is poorly preserved along its western wall, which is eroding into the wadi below. This structure is again similar to those sampled by Unit J, and by Units E, F, M and N. Unit K was expanded to the south (3x5m) to include adjacent areas within the long rectilinear enclosure and to the east (2x3m) to include exterior deposits possibly bounded by low enclosure walls. Likewise, Unit R (2x4m) was situated to test these exterior deposits. The results from Unit K East and Unit R were similar to those from Units D and V. Deposits were shallow, and produced little material evidence.

The western portions of Unit K, however, revealed well-preserved architecture, deep cultural deposits and abundant material evidence. Unit K provided the clearest evidence of how interior living spaces, such as those sampled in units F and J, were created. A very clear stratigraphic profile



15. Unit K, northwestern ZAD 1, showing two-room rectangular structure with interior doorway; view southwest.

shows that exterior walls were set on the site's surface level or in a shallow foundation trench. Subsequently, interior space was excavated 50cm or more below the wall founding level for the creation of a flat use surface. In Unit K, three major stratified use surfaces are indicated by ash layers accompanied by flat-lying pottery. These surfaces are segregated by soft laminated, possibly wind-blown sediments that may indicate annual or seasonal intervals during which this room was unused or abandoned. The southern portion of Unit K is segregated by a cross wall with doorway, and has two use surfaces that are higher than Unit K's interior surfaces. The designation "Unit U" was used initially to refer to the southern portion of Unit K, but the Unit U designation was dropped immediately after starting excavation here.

Unit Q cleared a 3x4m area within a partially robbed-out square building to the north of Unit K. Unit P searched a 2x4m area for midden deposits between these buildings. Both units produced very modest amounts of material culture. Unit L (**Fig. 16**), a 4x7m unit, encompassed most of a structure with two enclosed spaces and their surrounding exterior deposits. The northern end of this building features a large stone-built bin or installation. Although interior surfaces were less well-defined than those in Unit K, Unit L produced a moderate amount of material culture, including material deposited on rough surfaces on the western exterior of this structure.

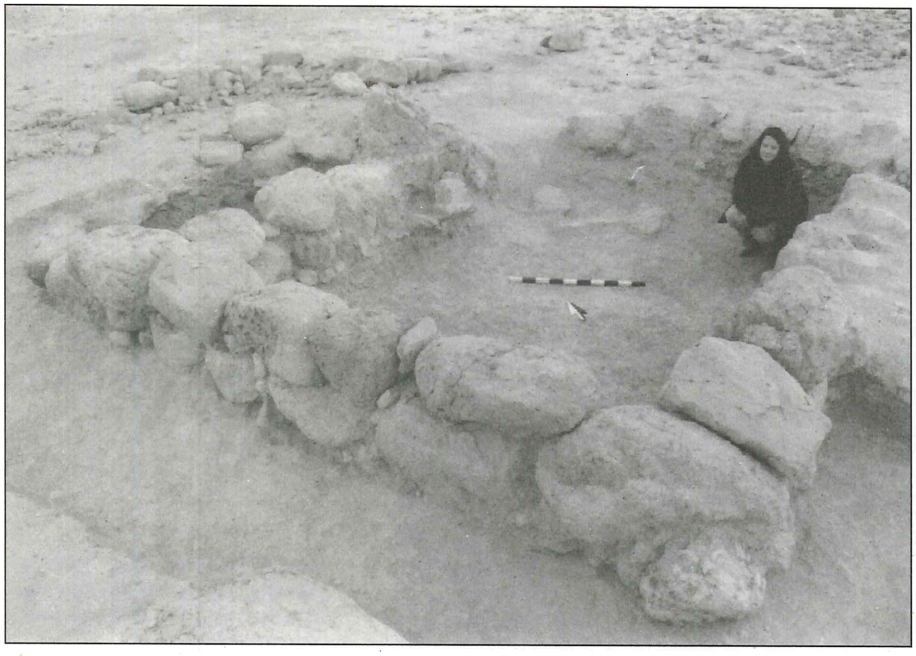
Unit O was a 2x2m unit designed to investigate a possible midden in an area of abundant surface ceramics and apparently deep exterior deposits alongside a rectilinear structure at the south end of the site. Unit S was another 2x2m unit intended to test possible midden deposits at the north end of the site. Unit T was a 2x2.5m unit in search of midden deposits along an enclosure wall south of Unit J. Below relatively abundant ceramics on the modern site surface all three units gave way very quickly to underlying Pleistocene gravel deposits (cf. Edwards *et al.* 1998) with little material culture.

Units Y and Z were 1x2m trenches on a terrace in the Wādī adh-Dhrā' approximately 2 meters above the present streambed. These units were inspired by a stratigraphic exposure along the edge of this terrace that revealed heavy organic deposits with substantial amounts of charcoal. Excavation of these units revealed multiple organic layers, probably of burned vegetation, and no archaeological evidence. This terrace appears to have aggraded after the heavy downcutting of the Wādī adh-Dhrā' and charcoals from the terrace will be of great importance for dating this erosive event.

(SEF)

The Middle Bronze Age Pottery from Ẓahrat adh-Dhrā' 1

Previous reconnaissance (Edwards *et al.* 1998) reported that ZAD 1 was littered with sherds from flat-bottomed coarse ware cooking pots that characterize Middle Bronze Age assemblages in the Jordan Valley (e.g. Smith and Potts 1992: pls. 36-37; Falconer 1995; Flanagan *et al.* 1994) and throughout the southern Levant. Clear examples of earlier



16. Unit L, northwestern ZAD 1, showing one-room rectangular structure with semi-circular bin on its northwestern exterior; view north.

or later pottery, including Roman/Byzantine wares that are nearly ubiquitous elsewhere in the region, were absent at ZAD 1. This preliminary ceramic sample suggested prior to excavation that ZAD 1 was occupied only during the Middle Bronze Age.

The ceramic assemblage excavated in 1999/2000 indeed fits within the Middle Bronze Age typological tradition common to the southern Levant. Unlike domestic assemblages found elsewhere, however, the repertoire at ZAD 1 includes a striking predominance of cooking pot sherds. Store jar sherds, which often make up the majority of other assemblages, are only modest in number when compared with other MB sites (Cole 1984; Dornemann 1990; Falconer 1995; Magness-Gardiner and Falconer 1994), and bowl/cup forms are very rare.

Cooking pot forms include hand-built, straight-sided, coarse ware vessels with appended rope molding that are consistent with Middle Bronze IIA and B examples found commonly at a wide variety of other sites (cf. Gerstenblith 1983; Cole 1984: plate 23; Falconer 1995: fig. 10a). One cooking pot sherd from Unit J shows possible potter's marks (DoA Object 99-3). Globular holemouth cooking pots, which appear throughout the Middle Bronze Age at other sites (e.g. Falconer 1995; Magness-Gardiner and Falconer 1994), are completely absent.

Storage vessels tend to have short necks, with unelaborated rims and a total absence of painted decoration. Store jar bases are flat, in keeping with early Middle Bronze Age forms (Beck 1975; 1985). The more elaborated rim profiles and elongated, slightly pointed bases that appear later in the period are absent. Decoration generally is limited to horizontal band combing, accompanied by a few examples of crosshatch combing. A partially restorable jar from the interior of Unit K features a rare zoomorphic motif: a series of incised ibex (DoA Object 99-2), paralleling a similar jar with a single incised ibex found at Bāb adh-Dhrā' (Saller 1965: fig. 13, no. 4, fig. 17). Interestingly, this assemblage is distinguished by a complete lack of jar handles. The excavated pottery includes no jar handle fragments, and no jar body sherds with handle stumps or joins. Short neck, handle-less jars characterize a very specific and unusual repertoire of storage vessels.

Among the modest collection of fine ware vessels, the form of a nearly complete dipper juglet from the upper phase of Unit E is consistent with MB IIA or possibly B (cf. Cole 1984: plate 27a-i; DoA Object 99-1). Among the few bowl forms found at ZAD 1 is an open bowl base from Unit E with a moderately high foot, consistent with MB II B forms. There are no chalice or high-footed forms that might suggest an MB II C date.

Variability in vessel form and size appears to be relatively low. The sizes of cooking vessels are fairly uniform and uncommonly large when compared with assemblages from other sites (Cole 1984; Dornemann 1990). These characteristics may be linked to the sizes of social units living at ZAD 1. The storage vessels also show more variability in rim diameter, wall thickness, and volume than the other sites. The jars at ZAD 1 are wheel-made and technologically homogeneous, suggesting local manufacture. This hypothesis will be tested through petrographic analysis. This class of vessels is fired at a higher temperature than the cooking pots and, therefore, is lighter in colour. Colour variation within vessels suggests open firing. The most common jar colours lie in the light orange (Munsell 10YR) range, as compared to the red-orange-brown (2.5YR) hues of the cooking vessels.

Intensive curation of jars, and perhaps minimal availability of pottery, is suggested by the unusually large proportion of mend holes in the jar sherds at ZAD 1. There appears to be general uniformity in ceramic deposition, with the possible exception of greater sherd densities in the larger structures. The vast majority of the ceramic material was recovered beneath interior wall collapse, probably belonging to occupational debris. Further ceramic analysis will focus on spatial and compositional patterning as they reveal patterns of refuse deposition, consumption and breakage rates, and functional differences in the architectural components of ZAD 1.

(SEF and IB)

Archaeobotanical Remains from Ẓahrat adh-Dhrā' 1

During the 1999/2000 excavations at ZAD 1 sediment samples were collected from all archaeological deposits with discernible organic content, especially those containing visible carbonized plant remains. Hearths, pits, and use surfaces were sampled most frequently, as they were expected to represent minimally mixed deposits and produce the most abundant burned material. Over the course of this field season 123 samples were collected, totaling approximately 353 liters of sediment. Sample volumes averaged 2.87 liters. Units I, K and L were sampled most abundantly, providing 54 (almost 44%) of the site's samples. Ten of the samples were collected from natural deposits in Units Y and Z on the wadi terrace below ZAD 1. As mentioned above, radiocarbon dating of this material may provide an age for the aggradation of

this terrace that post-dates the wadi down cutting at Ẓahrat adh-Dhrā'.

The sediment samples were processed via water flotation, using a five-gallon bucket apparatus from Arizona State University. Small samples, measuring less than one liter each, were processed using a one-gallon flotation bucket. Each sample was measured, then poured into the bucket. Clean water was added and the sample was stirred gently to disaggregate the sediment and allow the plant remains to float freely. Excess water carrying the plant macrofossils flowed out through a spout at the top of the bucket into a large strainer lined with fine mesh chiffon fabric. This process was continued until plant remains were no longer apparent in the flotation water. The water was then poured out and the heavy fraction, consisting primarily of small stones and sediment, was examined for plant remains. The light sample fractions captured in the chiffon fabric, and the plant remains extracted from the heavy fractions, were allowed to dry before packaging.

The plant macrofossils are being sorted under low power magnification at Arizona State University. Preliminary analysis has identified cultivated barley, wheat, legumes, grapes and figs. Wild taxa include *Chenopodium, Amaranthus,* and various grasses. This analysis also suggests significant spatial variation in botanical remains across the site.

(PLF and CM)

Faunal Remains from Ẓahrat adh-Dhrā' 1

Animal bones were recovered from ZAD 1 by dry sieving all excavated sediments through half-centimeter mesh. The 1999/2000 excavations revealed relatively sparse faunal deposition, producing a total of 323 bones and bone fragments, many highly degraded (**Table 4**). The relative paucity of faunal evidence probably results from poor preservation due to the relatively shallow and porous sedimentation at ZAD 1. The identifiable faunal taxa include 31 identifiable bones, of which 30 represent domestic sheep/ goat (*Ovis aries/ Capra hircus*), while one bone comes from domestic pig (*Sus scrofa*) (**Table 5**). A similar dominance of sheep/goat is reported for the Bronze Age faunal assemblages from Lachish (Lernau 1975) and nearby Bāb adh-Dhrā' (Rast and Schaub 1980), both of which share similar rainfall regimes.

Distinct majorities of the general faunal assemblage and of the identifiable bones were found in just three excavation units (J, K and M), all of which feature relatively deep sedimentation, while many other units produced no faunal remains at all. Bone deposition was particularly substantial in Unit M, which covered part of the multi-enclosure complex at the southeastern end of ZAD 1. Units J and K investigated two multiple room structures in the architectural complex at the northwestern end of the site. As with the botanical evidence reported above, the faunal remains suggest significant spatial variation across ZAD 1.

(MCM)

Preliminary Interpretation of ZAD 1 Architecture and Archaeological Deposition

Ẓahrat adh-Dhrā' 1 includes a variety of recti-

Table 4: *Distribution of unidentifiable bone fragments at ZAD 1.*

Unit	No. of Bone Fragments
A	6
D	9
E	8
I	1
J	45
K	65
L	4
M	154

Table 5: *Identifiable bone fragments at ZAD 1.*

Ovis/Capra		
Unit	Bone Element	Count
A	rib	1
	atlas	1
J	incisor	1
K	ribs	3
	scapula	4
	distal tibia	1
	astragalus	1
	Os malleolare	1
L	horn core	1
	lower m3 and dp2	2
M	scapula	4
	innominate	2
	lower M1	1
	lower M2	1
	ribs	6
	upper P4 and M1	2
	tibia diaphysis	1
	radius (neonate)	1
Sus		
M	occiput	1

linear structures of various sizes, commonly including a nearly square room at one end of a rectangular building. In some cases these buildings are attached to curvilinear courtyard or enclosure walls that may have defined use areas or segregated residential space. The best stratified interior deposits, from Units F, I, J and K reveal these structures to be pithouses similar to Early Bronze II examples in the Sinai (Beit Arieh 1983; 1992). The structure walls at ZAD 1 rarely stand higher than one or two courses. Unit K revealed walls standing four courses high. Substantial rock fall indicates that structure walls once stood much higher. Rock fall was generally greatest within square rooms (e.g. Units F and K), less abundant in the rectilinear rooms attached to them, and limited along apparent enclosure walls. There is no obvious indication of roofing material (e.g. roof beams), although flat rock slabs were found in the lowest deposits of Unit A. The architecture suggests various heights of construction and the possibility that perishable materials (e.g. brush or hides) may have been used for roofing material. In conjunction with the ceramic, faunal and floral evidence, the architecture and sedimentation of ZAD 1 suggests a farming and herding settlement occupied discontinuously during the Middle Bronze Age.

(SEF)

P.C. Edwards
I. Berelov
J. Meadows
G. Sayej
La Trobe University
Victoria 3086
Australia

S.E. Falconer
P.L. Fall
C. Meegan
Arizona State University
Tempe, AZ
USA

C. Davies
University of Memphis
Memphis, TN
USA

M.C. Metzger
New Jersey Institute of Technology
Newark, NJ
USA

References

Baruch, U.
1986 The Late Holocene Vegetational History of Lake Kinneret (Sea of Galilee), Israel. *Paléorient* 12(2): 37-48.
1990 Palynological Evidence of Human Impact on the Vegetation as Recorded in Late Holocene Lake Sediments in Israel. Pp. 283-293 in S. Bottema, G. Entjes-Nieborg and W. van Zeist (eds.), *Man's Role in the Shaping of the Eastern Mediterranean Landscape.* Rotterdam: Balkema.

Baruch, U. and Bottema, S.
1991 Palynological Evidence for Climate Changes in the Levant 17,000-9,000 BP. Pp. 11-20 in O. Bar-Yosef and F. Valla (eds.), *The Natufian Culture in the Levant.* Ann Arbor: International Monographs in Prehistory.

Beck, P.
1975 The Pottery of the Middle Bronze Age IIA at Tel Aphek. *Tel Aviv* 2: 45-85.
1985 The Middle Bronze Age IIA Pottery from Aphek, 1972-84: First Summary. *Tel Aviv* 12: 181-203.

Beit Arieh, I.
1983 Central-Southern Sinai in the Early Bronze Age II and its Relationship with Palestine. *Levant* 15: 39-48.
1992 Buildings and Settlements Patterns at Early Bronze Age II Sites in Southern Israel and Southern Sinai. Pp. 81-84 in A. Kempinski and R. Reich (eds.), *The Architecture of Ancient Israel.* Jerusalem: Israel Exploration Society.

Cole, D.P.
1984 *Shechem I: The Middle Bronze IIB Pottery.* Winona Lake, IN: American Schools of Oriental Research.

Colledge, S.
1994 *Plant Exploitation on Epipalaeolithic and Early Neolithic Sites in the Levant.* Unpublished PhD thesis, University of Sheffield.

Crowfoot Payne, J.
1983 The Flint Industries of Jericho. Pp. 622-757 in K.M. Kenyon and T.A. Holland (eds.), *Excavations at Jericho Volume V: The Pottery Phases of the Tell and Other Finds.* Oxford: Oxford University Press.

Dixon, J.E., Cann, J.R. and Renfrew, C.
1968 Obsidian and the Origins of Trade. *Scientific American.* 218 (3): 38-46.

Donahue, J.
1985 Hydrologic and Topographic Change during and after Early Bronze Occupation at Bab adh-Dhra' and Numeira. Pp. 131-140 in *SHAJ 2.* Amman: Department of Antiquities of Jordan, and London: Routledge & Kegan Paul.

Dornemann, R.
1990 Preliminary Comments on the Pottery Traditions at Tell Nimrin, Illustrated from the 1989 Season of Excavations. *ADAJ* 34: 153-181.

Edwards, P.C., Macumber, P.G. and Green, M.K.
1998 Investigations into the Early Prehistory of the East Jordan Valley: Results of the 1993/1994 La Trobe University Survey and Excavation Season. *ADAJ*

42: 15-40.

Enoch-Shiloh, D. and Bar-Yosef, O.
1997 Salaibiya IX. Pp. 13-40 in O. Bar-Yosef and A. Gopher (eds.), *An Early Neolithic Village in the Jordan Valley. Part I: The Archaeology of Netiv Hagdud.* School of Prehistoric Research Bulletin 43. Cambridge, Mass: Peabody Museum of Archaeology and Ethnology, Harvard University.

Falconer, S.E.
1995 Rural Responses to Early Urbanism: Bronze Age Household and Village Economy at Tell el-Hayyat, Jordan. *Journal of Field Archaeology* 22(4): 399-419.

Finlayson, B., Mithen, S., Carruthers, D., Kennedy, A., Pirie, A. and Tipping, R.
2000 Dana-Faynan-Ghuwayr Early Prehistory Project. *Levant* 32: 1-26.

Flanagan, J.W., McCreery, D.W. and Yassine, K.N.
1994 Tell Nimrin: Preliminary Report on the 1993 Season. *ADAJ* 38: 205-244.

Frumkin, A., Carmi, I., Zak, I. and Margaritz, M.
1994 Middle Holocene Environmental Change Determined from the Salt Caves of Mount Sedom, Israel. Pp. 315-332 in O. Bar-Yosef and R.S. Kra (eds.), *Late Quaternary Chronology and Paleoclimates of the Eastern Mediterranean.* Tucson: RADIOCARBON, University of Arizona.

Gerstenblith, P.
1983 *The Levant at the Beginning of the Middle Bronze Age.* ASOR Dissertation Series No. 5. Winona Lake, IN: Eisenbrauns.

Heim, C., Nowaczyk, N.R., Negendank, J.F.W., Leroy, S.A.G. and Ben-Avraham, Z.
1997 Near East Desertification: Evidence from the Dead Sea. *Naturwissenschaften* 84: 398-401.

Hopf, M.
1983 Jericho Plant Remains. Pp. 576-621 in K.M. Kenyon and T.A. Holland (eds.), *Excavations at Jericho Volume V: The Pottery Phases of the Tell and Other Finds.* Oxford: Oxford University Press.

Horowitz, A.
1979 *The Quaternary of Israel.* New York: Academic Press.

Khalil, B.
1992 *The Geology of the ar-Rabba Area. Map Sheet no. 3152 IV.* Bulletin 22, Geology Mapping Division, Geology Directorate. Amman: Ministry of Energy and Mineral Resources/ Natural Resources Authority, Hashemite Kingdom of Jordan.

Kislev, M.E.
1997 Early Agriculture and Paleoecology of Netiv Hagdud. Pp. 209-236 in O. Bar-Yosef and A. Gopher (eds.), *An Early Neolithic Village in the Jordan Valley Part I: The Archaeology of Netiv Hagdud.* School of Prehistoric Research Bulletin 43. Cambridge, Mass: Peabody Museum of Archaeology and Ethnology, Harvard University.

Kuijt, I.
1997 Interpretation, Data and the Khiamian of the South-Central Levant. *Neo-Lithics* 3: 3-6.

Kuijt, I. and Mahasneh, H.
1998 The Early Neolithic Occupation of Dhra', Jordan: Implications for the Jordan Valley as a Social, Economic and Ritual focus. *Journal of Field Archaeology* 25/2: 153-162.

Kürschner, H.
1986 A Physiognomical-Ecological Classification of the Vegetation of Southern Jordan. Pp. 45-80 in H. Kürschner (ed.), *Contributions to the Vegetation of Southwest Asia.* Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A, Nr.24. Wiesbaden: Dr Ludwig Reichert Verlag.

Lernau, H.
1975 Animal Remains. Pp. 86-102 in Y. Aharoni (ed.), *Investigations at Lachish: The Sanctuary and the Residency.* Tel Aviv: Gateway.

Magness-Gardiner, B. and Falconer, S.E.
1994 Community, Polity, and Temple in a Middle Bronze Age Levantine Village. *JMA* 7(2): 127-164.

Nadel, D.
1997 The Chipped Stone Industry of Netiv Hagdud. Pp. 71-149 in O. Bar-Yosef and A. Gopher (eds.), *An Early Neolithic Village in the Jordan Valley. Part I: The Archaeology of Netiv Hagdud.* School of Prehistoric Research Bulletin 43. Cambridge, Mass: Peabody Museum of Archaeology and Ethnology, Harvard University.
1998 A Note on PPNA Intra-site Variability. *Neo-Lithics* 1/98: 8-10.

Neef, R.
1997 Status and Perspectives of Archaeobotanical Research in Jordan. Pp. 601-609 in H.-G. Gebel, Z. Kafafi and G.O. Rollefson (eds.), *The Prehistory of Jordan II. Perspectives from 1997.* Studies in Early Near Eastern Production, Subsistence and Environment 4. Berlin: ex Oriente.

Niemi, T.M., Ben-Avraham, Z. and Gat, J.R.
1996 Dead Sea Research - An Introduction. Pp. 3-7 in T.M. Niemi, Z. Ben-Avraham and J.R. Gat (eds.), *The Dead Sea: The Lake and its Setting.* Oxford Monographs on Geology and Geophysics no. 36. Oxford: Oxford University Press.

Popper, V.S.
1988 Quantitative Methods in Paleoethnobotany. Pp. 53-71 in C.A. Hastorf and V.S. Popper (eds.), *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains.* London: University of Chicago Press.

Powell, J.H.
1988 *The Geology of the Karak Area. Map Sheet no. 3152 III.* Bulletin 8, Geological Mapping Division, Geology Directorate. Amman: Ministry of Energy and Mineral Resources/ Natural Resources Authority, Hashemite Kingdom of Jordan.

Raikes, R.
1984 *Water, Weather and Prehistory.* Wales, NJ: Humanities Press.

Rast, W.E. and Schaub, R.T.
1980 Preliminary Report of the 1979 Expedition to the Dead Sea Plain, Jordan. *BASOR* 240: 21-61.

1981 The 1977 Expedition to the Southeastern Dead Sea Plain, Jordan. Pp.1-6 in W.E. Rast and R.T. Schaub (eds.), *The Southeastern Dead Sea Plain Expedition: An Interim report of the 1977 Season.* Cambridge, M.A: American Schools of Oriental Research.

Renfrew, C., Dixon, J. and Cann, J.

1966 Obsidian and Early Cultural Contact in the Near East. *Proceedings of the Prehistoric Society* 32: 30-72.

Ronen, A. and Lechevallier, M.

1999 Save the Khiamian! *Neo-Lithics* 1/99: 6-7.

Saller, S.

1965 Bab adh-Dhra. *LA* 15: 137-219.

Schaub, R.T. and Rast, W.E.

1989 *Bab adh-Dhra': Excavations in the Cemetery Directed by Paul W. Lapp. (1965-67).* American Schools of Oriental Research. Winona Lake: Eisenbrauns.

Smith, R.H. and Potts, T.F.

1992 The Middle and Late Bronze Ages. Pp. 35-81 in A.W. McNicoll, P.C. Edwards, J. Hanbury-Tenison, J.B. Hennessy, T.F. Potts, R.H. Smith, A. Walmsley and P. Watson (eds.), *Pella in Jordan 2.* Sydney: University of Sydney.

Wasse, A.

1999 *The Development of Goat and Sheep Herding during the Levantine Neolithic.* Unpublished PhD thesis, University of London.

Yellin, J.

1997 Miscellaneous Finds: The Obsidian Artefacts from Netiv Hagdud. Pp. 193-196 in O. Bar-Yosef and A. Gopher (eds.), *An Early Neolithic Village in the Jordan Valley. Part I: The Archaeology of Netiv Hagdud.* School of Prehistoric Research Bulletin 43. Cambridge, Mass: Peabody Museum of Archaeology and Ethnology, Harvard University.

Zeder, M.A. and Hesse, B.

2000 The Initial Domestication of Goats (*Capra hircus*) in the Zagros Mountains 10,000 Years Ago. *Science* 287: 2254-2257.