GEOARCHAEOLOGICAL SURVEY IN WĀDĪ ZIQLĀB, JORDAN

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The Wādī Ziqlāb Project conducted geomorphological and archaeological survey of wadi terraces in Wādī Ziqlāb (وادي زقلاب) from 28 May to 28 June 2000. The goals of the season involved reconstructing late Pleistocene and early Holocene palaeoenvironment and valley changes over time, and relating these changes to the distributions of sites, especially those of the Epipalaeolithic, Neolithic and Chalcolithic periods. The survey discovered 18 previously undocumented sites, including ones with probable Geometric Kebaran, Pre-Pottery Neolithic B and Late Neolithic material, and found that the extent of Neolithic and Early Bronze occupation at Tall Rakān تل ركـان (WZ 120) was greater than previously believed. It also documented the alluvial and colluvial histories of several places in the wadi that are key to reconstructing the prehistoric topographies associated with these sites.

Background of the Project

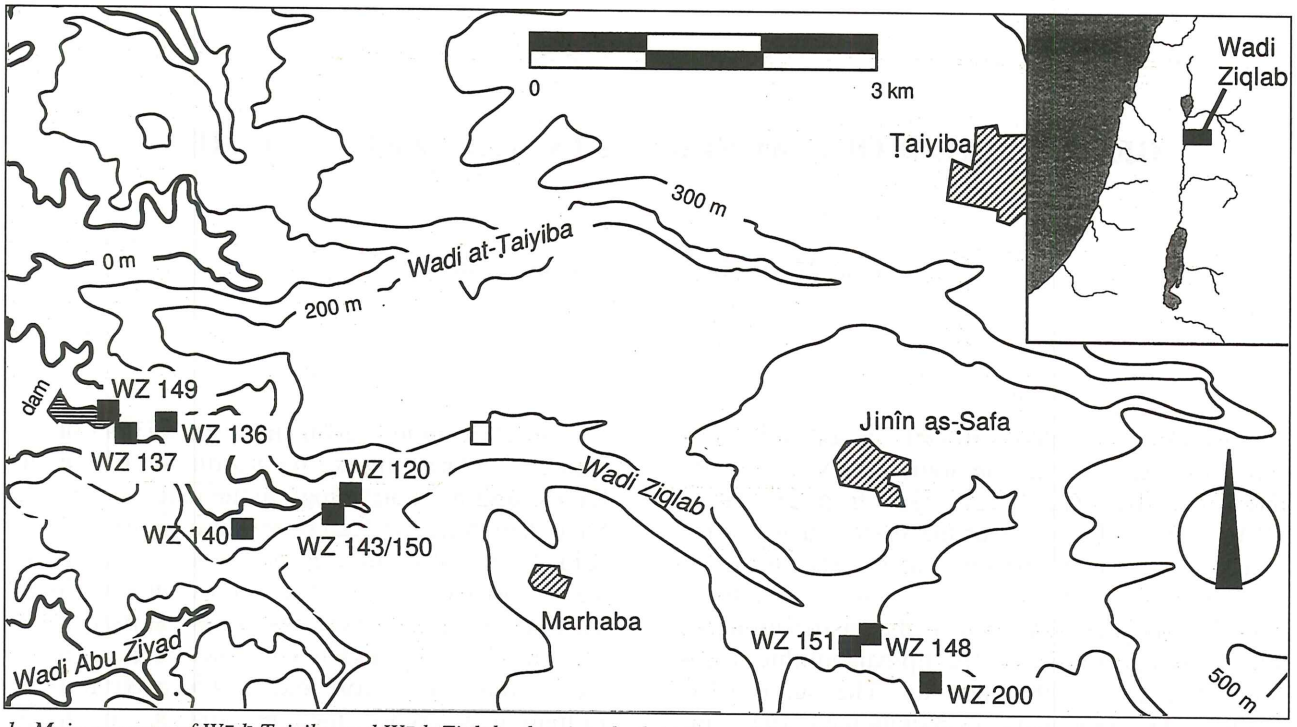
The Wādī Ziqlāb Project is an ongoing regional examination of settlement and land use of Wādī Ziqlāb's drainage basin from Epipalaeolithic to recent times. An important goal of the project continues to be the association of site locations with environmental variables used to infer changes in economic strategies over time, to understand these changes, and to identify the stresses that may have accompanied the shift from dispersed hunting-foraging camps to established agricultural villages. This requires accurate knowledge of the size, nature and distribution of settlements and other kinds of sites with respect to geological and geographical factors, as well as understanding the valley's form at different points in time. Except for the most recent sites, the modern environment can be very misleading in its associations with site distributions because downcutting has stranded portions of the valley floor well above the current wadi channel, while other parts have accumulated many metres of colluvium.

The 2000 field season involved a short survey explicitly addressing the reconstruction of the valley's changing morphology in the area between the Sadd Ziqlāb (سـدّ زقـلاب) reservoir and site WZ 200 (**Fig. 1**). It was conducted principally by examination of ancient river terraces and colluvial slopes, their stratification where visible in exposed cross-sections, and the artifacts contained both in and on them. Other geological and geomorphological information examined includes changes in watercourse, location of springs, tectonics, sediment transport and deposition. The survey team also collected samples for bulk sediment analysis, thin-section analysis of natural sedimentary deposits and stratigraphy of archaeological sites, and samples for micro-artifacts and phytoliths. We know that the wadi has changed dramatically over time through the interplay of natural factors (climate, channel course, vegetation) and human use (deforestation, agriculture, irrigation, settlement). Ultimately, the palaeoenvironmental reconstruction allows us to examine human land-use patterns and to predict the location of archaeological sites in less intensively surveyed areas in the region.

Methods

Survey mainly involved ground walking, with routes planned to examine a series of terraces previously identified in aerial photographs, rather than following arbitrary transects. At each terrace, a team of six spread out and intensively examined the modern surface, which was often plowed. In addition, the team paid close attention to any sections exposed by road cuts, erosion gullies or the wadi channel, and to terrace margins where erosion may have exposed buried material. Initial inspection of these terraces took place during the first two weeks of the survey, and was followed by subsurface and column sampling.

Subsurface sampling of selected terraces involved several different approaches, depending on the situation. Terraces on which prehistoric settle-



1. Main canyons of Wādī Ṭaiyiba and Wādī Ziqlāb, showing the locations of some Epipalaeolithic and other sites mentioned in the text. Modern villages are shown with diagonal hatching. The Ziqlāb reservoir has horizontal hatching.

ment was likely were sampled by small test trenches (1m x 1.5m). On terraces where the goal was to obtain a stratified column of bulk sediment samples and possible micro-artifacts, we extracted column samples from the sides of exposed sections or, where no section was available, took them by auger. We paid particular attention to sections containing a $CaCO_3$-rich red soil of suspected Geometric Kebaran age, first identified at Ṭabaqat al-Būma طبقة البومة (Field 1994). We traced this distinctive soil throughout the wadi, and sampled it at each location for further geomorphological and thin-section analysis. At sections containing this red soil exposed by wadi downcutting or road cuts, pick and trowel was used to clean the section. Then we removed samples for thin-section analysis either by cutting out blocks of sediment or, where possible, by pushing Kubiena boxes into the sediment.

Archaeological Results

Palaeolithic Sites

A number of remnant terraces show evidence of Palaeolithic, and sometimes specifically Middle Palaeolithic, use. These will help us determine the location of the wadi floor at some point prior to about 50,000 years ago.

Levallois points and large flakes with similar white patina occurred on terraces WZ 145, WZ 146, WZ 147 (al-Qaṣ'a القصيعة and Qilā' aṣ Ṣawāfī قلاع الصوافي, on the eastern tip of Sadd Ziqlāb), and WZ 131, WZ 132, WZ 133 (ad-Daḥādīl الدحاديل, west of Tall Abū al-Fukhār تل ابو الفخار) . Other lithics with a high probability of belonging to the Middle Palaeolithic occurred at WZ 134 and WZ 135, terraces on the south side of the wadi, opposite Tall Abū al-Fukhār and ad-Daḥādīl. The terraces on both sides of the ad-Daḥādīl and Tall Abū al-Fukhār areas have similar slope angles and are at closely similar elevations (15m a.s.l.). This is an indication that they probably represent the margins of the valley floor at the time the lithics were deposited. WZ 145, WZ 146, and WZ 147 are further west, downstream of a waterfall, where more intensive downcutting may account for their significantly lower elevations.

WZ 136 and WZ 138 are two parts of a remnant terrace, about 100m a.s.l., separated by a small gully near the eastern end of the Sadd Ziqlāb reservoir, in an area now know as al-Qaṣ'a. The exposed section of each terrace clearly shows deposits of alluvial gravel and tufa overlain by recent colluvial material (see below). Here lithic material eroding out of the side of the terrace includes flakes, blades, and bladelets, and core fragments that probably belong to the Upper Palaeolithic or Epipalaeolithic, or both. Future work may discover more diagnostic material that allows us to date this terrace more closely.

Epipalaeolithic Sites

The survey discovered one definite Geometric Kebaran site, which, in combination with previously excavated material from Ṭabaqat al-Būma (WZ 200: Banning *et al.* 1992; 1996), brings the inventory of confirmed Epipalaeolithic sites in Wādī Ziqlāb to two. Both these sites belong to the Geometric Kebaran (ca. 14,500 to 12,500 BP) on the basis of high frequencies of backed bladelets modified at both ends, often to make rectangular or trapezoidal microliths (Maher *et al.*, n.d.).

Site WZ 148 occurs in a remnant terrace cut by the road to Tubna (تبنه). It is only some 200m northwest of site WZ 310, where we excavated Early Bronze and Late Neolithic material in 1990 and 1992 (Banning 1996; Banning *et al.* 1992; 1996), and 800m from Ṭabaqat al-Būma. It is also within 300m of the modern spring at 'Uyūn al-Ḥammām (عيون الحمّام). Artifacts appear in the exposed road cut, in the colluvium at its base, on the surface across the road from the cut, and in the exposed section left by wadi downcutting. We excavated two 1m x 1.5m soundings into the terrace cut to obtain a sample of stratified artifacts, faunal remains, and sediments.

All the artifacts from the surface collections and soundings are typologically Geometric Kebaran (**Fig. 2**). Notable are the relatively high proportion of rectangles, trapezes, and backed bladelets and the presence of small scrapers. Three pieces of finely ground basalt were found eroding out of the section, including a complete pestle.

Less certain Epipalaeolithic material was found at WZ 138 and WZ 120, consisting of bladelets or fragments of bladelet cores.

Pre-Pottery Neolithic

Some artifacts found on various terraces, such as long, slender blades, represent possible occupation or use during the Pre-Pottery Neolithic B (PPNB). However, most of our new evidence for the PPNB stems from the discovery that the Neolithic settlement at Tall Rakān (WZ 120) is larger than previously suspected (Banning and Najjar 1999). The site contains high artifact densities continuing onto neighbouring slopes and terraces. We found no clear evidence for PPNA occupation during the survey.

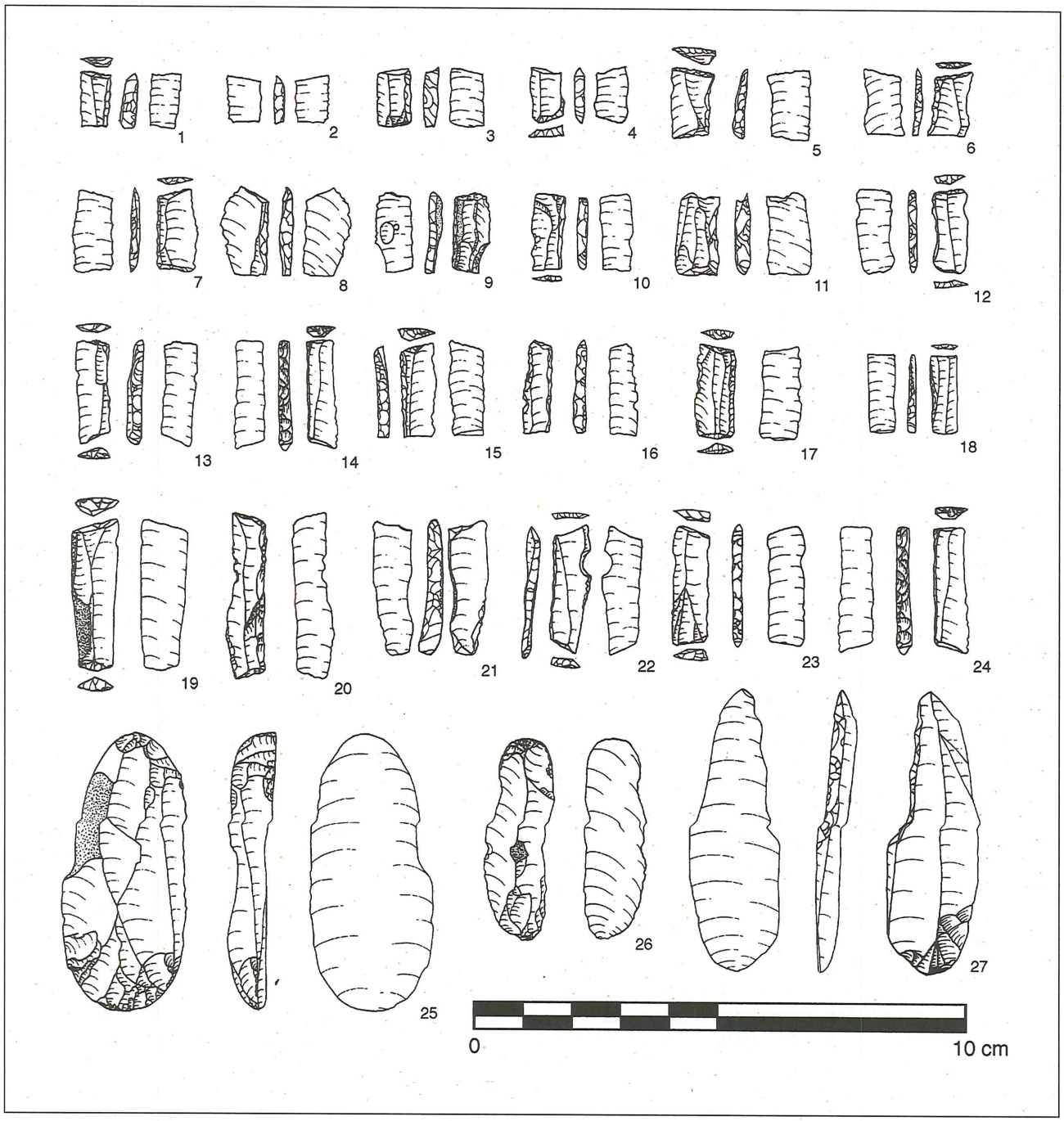
Survey of terrace WZ 143, on the other side of the tributary Wādī 'Antar (وادي عنتر) and a little southwest of Tall Rakān, shows fairly abundant lithics and ground stone that most likely belong to the PPNB. These include an unfinished adze, blades, scrapers, and blade cores. It is possible that this represents fairly intensive use of this terrace for agriculture in PPNB times, but the fairly high artifact densities in some parts of the terrace suggest that at least some Neolithic houses were probably sited here. Today the terrace has a small olive grove on it.

The terrace a short distance west of the concrete fishponds at Tall Rakān was impossible to survey in 1999 because of the jungle-like cover of reeds and the many snakes it hosted. Since then, however, this area has been cleared, bulldozed, plowed and planted with vegetables, giving us the opportunity to sample it by walking parallel transects about 5m apart. As it turned out, this new field contained extremely abundant PPNB material, including a large limestone saddle quern, many blades, and a small biface. Although we had expected this terrace to have served as an agricultural field for the PPNB occupants of Tall Rakān, it now seems very likely that PPNB houses occurred here. Unfortunately, the bulldozing (to depths of 1.5m, according to the landowner) has presumably removed most traces of architecture and all stratigraphic contexts for these artifacts. Although this is presumably an extension of Tall Rakān, for convenience we gave this terrace its own site number, WZ 144. We would now estimate the extent of PPNB occupation at Tall Rakān as approximately 2ha.

Late Neolithic

Lithic assemblages of the Late Neolithic tend not to be particularly distinctive, consisting mainly of flakes and various by-products of "expedient" core reduction. This makes them more difficult to identify and distinguish from Chalcolithic and Bronze Age assemblages. However, we can tentatively attribute a number of the new surface scatters to the Late Neolithic on the basis of the high proportions of "amorphous" multi-directional cores and the presence of some types of sickle elements. One site is more definitely Late Neolithic. The sickle elements are consistent with the later Late Neolithic, showing relatively fine denticulation similar to those on sickles of the 'Wadi Rabah' facies, and being quite unlike the relatively coarsely toothed sickles common in Yarmoukian assemblages. No pottery that we could attribute to the Neolithic with reasonable certainty occurred in our surface collections, but that is fairly typical of the Late Neolithic; Neolithic sherds tend to be too fragile to survive exposure on the modern surface. However, probable Neolithic pottery was found below the surface at WZ 140.

Site WZ 140 occurs on a slope leading up to the terrace WZ 141, on the south side of Wādī Ziqlāb,



2. *A selection of Middle Epipalaeolithic tools from WZ 148: Trapeze/rectangles with one end incomplete (1, 4, 6, 8-11, 16, 18, 24); complete Trapeze/rectangles (5, 7, 12-15, 17, 19-23); Trapeze/rectangles incomplete on both ends (2, 3); double end scraper on blade (25); double end scraper on bladelet (26); and an end scraper on a partially retouched blade (27) (drawings by N. Tatarnik).*

opposite Tall Abū al-Fukhār. Here the assemblage from the plowed surface of an olive grove includes perforators made on blades, sickle elements with heavy sickle sheen, and various blades and cores. This assemblage encouraged us to excavate two 1m x 1m test pits, both to recover sediment samples from their sections and to see if there were any primary deposits of Late Neolithic material below the surface.

Excavations of the two test pits in Areas G12 and G13 of this site, beginning on 12 June, produced some probable Neolithic sickle elements and Neolithic pottery from a colluvium (locus 002) below the plow zone. This pottery occurred about 30cm below the surface in association with abundant faunal remains and potentially Neolithic lithics.

It is possible that, like WZ 200, site WZ 140 is the remains of a farmstead or small hamlet dating to about 6500 BP (ca. 5500 cal BC). Broader excavations might reveal some architecture and other evidence with which to determine whether this is the case.

Early Bronze Age

Definite evidence for the Early Bronze Age comes from a fairly high terrace, WZ 150, above and east of WZ 143 and across a small wadi from Tall Rakān. Elsewhere occasional small body sherds with gritty fabric probably belong to the Early Bronze Age, but attributing these more certainly will require more detailed laboratory examination and comparison of fabrics with sherds from Tall Rakān.

Terrace WZ 150 received only cursory examination during the survey. The two diagnostic Early Bronze sherds came from the slope immediately below and presumably derived from it. Very few lithics were seen on the terrace itself while the survey team was walking to nearby terrace WZ 143. However, it seems likely that this terrace, like site WZ 130 on the spur above Tall Rakan I, was an extension of that settlement during the Early Bronze Age or at least was an agricultural field used by its inhabitants.

Iron Age

The main collection of Iron Age material during the survey occurred at a robbed cemetery, WZ 149. This cemetery occupies a knoll on the north shore of the modern water reservoir behind Sadd Ziqlāb. Tomb robbing appears to have begun there during the year prior to our survey and has proceeded at a rather rapid pace. Smashed Late Iron II pottery occurs around the pits dug to access the tomb shafts. This site should be a high priority for fieldwork by a team of Iron Age archaeologists and physical anthropologists while some of it survives.

Geological Results

As stated above, the goals of the 2000 field season include geoarchaeological investigation of the wadi channel and its changes over time. We aim to integrate understanding of the geomorphological changes that have occurred in the wadi with changing land-use and settlement patterns, especially from Epipalaeolithic to Late Neolithic times. This season involved assessment of recent (Pleistocene-Holocene) geomorphological activity throughout the main canyon of Wādī Ziqlāb, both on- and off-site, by field observation and sediment sampling of deposits exposed either in section or by test excavations. The results reported here involve our preliminary field observations of these deposits.

Our sampling strategy has been to pursue certain lines of evidence that will help us fulfill our objectives. These lines of evidence allow us to relate archaeological site locations to geomorphological activity. First, bulk sampling of deposits for standard sediment analysis, including textural and chemical analysis, which we conducted throughout the wadi, will yield information about the origin and age of the soil and degree of soil development. Phytolith samples that we collected will help us estimate the ubiquity and abundance of various plant taxa and thus contribute to palaeoclimatic reconstruction in the late Pleistocene and early Holocene. Micro- and macro-artifact sampling, furthermore, provides age controls for many of the surface and subsurface deposits.

A distinctive red paleosol that we traced and sampled through much of the wadi appears to be Geometric Kebaran in age (ca. 14,000 BP). This paleosol may serve as a useful marker of late Pleistocene and subsequent geomorphic activity and help us identify the probable locations of Epipalaeolithic and Neolithic sites. The carbonate- and clay-rich, red soil is currently under analysis at the Geomorphology Laboratory at York University in Toronto. Thin-section and other samples that we collected at archaeological sites and other outcrops of the red paleosol will allow us to characterize it and identify contemporaneous occupational surfaces.

A key aspect of the above-mentioned evidence is the possibility that the red paleosol will serve as a reliable indicator of age and surface stability. One of our primary considerations, consequently, was identification of the distinctive red soil first identified at WZ 200 as Unit 3 (Field 1994). Unit 3 contains artifacts of Geometric Kebaran type and has yielded radiocarbon dates of 14,850 ± 160, 13,110 ±130 BP, 12,810 ± 480 BP, 12,660 ± 430 BP, and 11,170 ± 100 BP. We have located, mapped, and sampled this soil everywhere it appears in the wadi. Based upon field observations of the soil, it can be characterized by its distinctive red colour and moderate subangular blocky structure, as well as extensive carbonate encrustation on peds. If this soil can indeed be reliably traced throughout the wadi, it can also be used to determine whether deposition of overlying sediments was local (i.e. the result of landslides) or regional and climatically induced. So far, WZ 120 is the farthest west this soil has been securely identified and WZ 200 is the farthest east.

A second consideration of our geomorphological survey involved identifying the locations of landslides and assessing their impact on changing the course of the wadi and affecting spring locations. We observed many areas in the wadi where ancient landslides had blocked the main wadi channel for an unknown period of time. We also observed many areas of recent landslide activity, indicating that this concern remains important for environmental reconstruction to this day (Field and Banning 1998).

On the smaller scale, it was clear in many sections we examined that almost all alluvial fans or channel deposits were capped by at least 1m of either successive debris flows or colluvial slope wash. Alternating periods of alluvial and colluvial activity tended to characterize each section, supporting previous indications that landslides and hillslope activity have very important implications for the burial or exposure of archaeological sites from all time periods (Field and Banning 1998).

A final consideration of survey was the identification of ancient water-lain deposits. This includes the location of alluvial channel and fan deposits in section and observing how they relate to previous and subsequent geomorphic activity. It also includes examining the locations of tufa or travertine deposits as indicators of ancient shallow water or spring locations. Tufa deposits were exposed at many sections, especially between WZ 120 and Sadd Ziqlāb. This area presently has the wadi's densest vegetation and several perennial springs and streams. Most likely, it has been much like this since at least the beginning of the Holocene. Thus, one of our primary objectives, in addition to mapping and sampling paleosols and hillslope activity, has been to map the locations of spring deposits and collect samples from them for palaeoclimatic analysis. This includes geochemical composition, carbonate development, organic remains, or oxygen isotope ratios, as well as evidence for the association of sites with past and present springs.

Late Pleistocene Sites and Sections

The survey team identified several sections cut by stream incision or bulldozing in which to document the sequence of paleosols, colluviation (including massive landslides), alluviation, and downcutting. These include ones associated with archaeological sites, such as WZ148 and WZ 120, and ones with no visible archaeological remains, but containing valuable geological information.

Site WZ 138 consist of an ancient river terrace that clearly demonstrates the effects of landslides and colluviation on soil development and site stability. WZ 138 is actually the central of three adjacent terraces, separated by to small gullies. In sections exposed at the toe by recent channel erosion individual deposits can easily be traced across all three terraces. However, only WZ 138 and, to a lesser extent, WZ 136 to its west were accessible. WZ 136 yielded significant amounts of Upper Palaeolithic material, while WZ 138 yielded fewer lithics, possibly of Epipalaeolithic age. The corresponding deposits at both terraces show three sequences of alternating tufa, alluvial, and colluvial deposits. The assemblages are eroding out of the sections at both terraces from the same two deposits, a heavily concreted tufa overlain by a red paleosol.

Immediately east of these terraces is a steep-sided section of the wadi where large blocks of chalky limestone bedrock overlay alluvial, colluvial, and travertine deposits at approximately the same elevation as these terraces. It is believed that this landslide block may have blocked off this section of the wadi. Additionally, renewed downcutting has significantly incised the main channel so that the terraces are now well above the present valley floor. We consider it important to determine when the landslide occurred and identify its impact on the terraces, as well as the area to the west. For example, did the landslide occur before occupation of the terraces, affecting drainage, and thus contribute to conditions that attracted humans to the terraces? Alternatively, were the terraces created and occupied before the landslide, in association with a spring or smaller tributary that would account for the tufas, so that increased stream velocity following the landslide eroded through them at some later date? We hope that further examination of the stratigraphy around the landslide area will provide clues to landslide chronology in the wadi.

Epipalaeolithic Sites and Sections

In the soil profile for the WZ 148 section the upper three horizons, designated as C horizons, represent disturbed terrace material bulldozed over the existing surface to flatten and compact it during road construction. The remaining profile represents soil development on top of colluvium and alluvial gravel marking the ancient wadi floor.

Preliminary inspection might lead one to believe that the structure is more mature down through the profile, indicating increased age with depth. However, the fact that all horizons exhibit granular peds (the youngest type of structure), except the 2Bk horizon, indicates that the whole profile is relatively recent in terms of soil formation (a

few thousands of years). The subangular structure of the 2Bk horizon most likely results from the leaching in of carbonate, which precipitates first on and around pebbles and existing peds.

Soil texture can also serve as a relative indicator of age, older profiles generally showing a 'clay bulge' in the B horizon (Birkeland 1984). In laboratory particle size distributions from 23 samples of material collected over 281cm of exposed section at site WZ 148, results show a general trend beginning in the sand fraction of a shallow, smooth, continuous increase in cumulative percentage. Silt dominates the particle size determinations, consistently averaging 40-50%. Clay content for most WZ 148 samples ranges between 15.7-40%, and seems to decrease slightly with depth. The sand content increases slightly with depth until the alluvial sand at the base of the profile. The clay fraction shows the highest degree of variation down the profile. The wide range in clay content between samples may result from either the depth of leaching or the age of the profile. Mature soils generally display the highest amount of clay in the B horizon. However, the amount of precipitation and leaching determines how far the clay travels through the profile. Even when the colluvial material deposited on top of the paleosol are omitted, the WZ 148 section shows a decrease in clay content with depth, perhaps indicating a younger soil.

Short-lived INAA on nine samples of colluvial, artifact-bearing material, two samples of alluvium, and two samples of local limestone bedrock illustrate the internal consistency of the artifact-bearing material. These analyses indicate that all samples are very similar in elemental composition but distinguish the cultural levels strongly from the alluvium and bedrock. All samples are highly calcareous, as we would expect from limestone-derived sediments and soils, and indicate that limestone influx has continued during soil formation.

Closer examination of both the exposed section by the concrete fish tanks and the local setting of Tall Rakān (WZ 120; Banning and Najjar 1999) contributed to a better understanding of the context of this site. In one small area at the very base of the exposed section, we discovered a red paleosol very similar to the Geometric Kebaran Unit 3 of WZ 200. This contained some small bladelets, which would also be consistent with an Epipalaeolithic age. Here we collected samples for clay mineralogy, textural and chemical analysis, and micromorphology. Additionally, we collected samples of mud brick and plaster from the section for thin section characterization, and surveyed around the site for evidence of ancient spring sources. Approximately 20m below the terrace surface a thick tufa deposit was found. It is well below the red soil, and this may be older than Geometric Kebaran. There is presently a large spring just east of the site that may have been associated with this tufa in the past. We hope that samples from the buried tufa and from the present spring may clear up this issue.

In summary, the 'red soil' shows more pronounced structure, a carbonate-rich horizon, clay cutans, and high densities of Epipalaeolithic lithics and fauna, indicating formation under conditions different from today. Conditions were likely wetter, allowing leaching to form the carbonate horizon at substantial depth in the profile. The last time conditions were wet and warm enough to form carbonate horizons at depth was during the Terminal Pleistocene (Baruch and Bottema 1991) and this may indicate that the WZ 148 soil is only a few thousands of years old, consistent with the Geometric Kebaran. The overlying light-coloured colluvium is much more recent, likely marking the Holocene (Field and Banning 1998).

Neolithic Sites and Sections

WZ 140 is presently an olive orchard on a steep colluvial slope. It contains no exposed sections, but the test excavations yielded much information on subsurface deposits. Two 11m units went down to a depth of about 120cm, through five stratigraphic layers. The plow zone, 20cm thick, is heavily disturbed and contains both Neolithic material and Byzantine sherds. Below the plow zone, however, undisturbed Neolithic pottery and lithics are common, along with significant amounts of faunal material (see above). In profile, the stratification of each unit displays abrupt layers of colluvium, which vary only in colour and the density of larger cobbles. Below the plow zone this colluvium contains Neolithic material exclusively. Additionally, while separated only by a 1m baulk, the unit upslope (G13) was rich in material, while the down slope unit (G12) contained virtually no pottery or fauna and few lithics.

WZ 140 is actually the lower portion of a larger terrace divided into two by a bulldozed road. Thus, the layered colluvial material seen in profile may represent slope wash from the upper portion of the terrace, designated WZ 135, subsequent to the Neolithic period. Alternatively, terrace WZ 140 may be *in situ*, but the test excavations were too small or ill placed to detect any architectural traces or features. Samples for bulk sediment, phytoliths, and microartifacts collected from each locus and

further excavations that we hope to carry out in 2002 may clarify this issue.

Off-Site

WZ 400 is a section exposing 9m of wadi downcutting at a meander in Wādī Ziqlāb located between WZ 120 and WZ 148 (**Fig. 1**). This section is actually the remainder of an alluvial fan that has been eroded back to its base by the alternating action of the present wadi channel and the large hillslope gully that originally laid it down. The gully is now depositing a new, smaller fan at the bottom of the eroded section. Additionally, other intact alluvial fans occur in this portion of the wadi, which is curiously devoid of ancient cultural remains. The sections clearly show three distinct red soils with abrupt upper and lower boundaries, separated either by alluvial gravel or colluvial soils. This tall, complicated section most likely represents successive slope-wash events of varying size and proportion that deposited soils and colluvium from upslope, interlain by alluvial gravel deposited by the meandering main channel. Thus, we suspect that the red soils are reworked. Here, as in much of Wādī Ziqlāb, the depositional sequence of alluvial and colluvial material often indicates a constant battle between wadi channel and hillslope activity. Concurrently, the deposition and erosion of material is also a constant battle between a local gully cutting the hillslope and the meandering main wadi channel cutting into the gully fans.

We suspect that the area between WZ 120 and WZ 148 represents an area of intensive erosion in the past, and only recent deposition. The area contains steep colluvial slopes, eroded alluvial fans, and relatively recent, low, flat terraces. Downstream, large boulders from a past landslide bound the area that blocked the wadi channel for some time, until stream incision cut through it. It is possible that this section of the wadi once held a much larger body of water that eroded out this narrow, deeply incised section of the wadi system. This area has no substantial tributaries to carry in sediment for deposition, so any sediment and archaeological material present was probably continually transported away. At some point in time, perhaps even as recent as the diversion of the springs upstream, the wadi channel became substantially smaller. It again began to meander across the valley floor, creating the existing low terraces that all display the same pattern in section of coarse alluvial gravel overlain by colluvium.

Discussion

A complete reconstruction of the landscape changes in Wādī Ziqlāb awaits future fieldwork planned over the next few years. However, based upon our recent work, a number of general observations can be made. First, during the Middle and Upper Palaeolithic the wadi was much less deeply incised than today. The occurrence of Middle Palaeolithic lithics exclusively on the highest terraces with the most deeply exposed sections is evidence of this. Furthermore, one can identify lithics from the same period on terraces of roughly equal elevation on both sides of the wadi. Thus, the wadi would have been at a higher elevation, and wider and straighter, becoming incised and meandering both with time and with distance downstream as recently as 20,000 BP.

Additionally, during the transition from Upper Palaeolithic to Epipalaeolithic, Lake Lisan was at a maximum and occupied a large portion of the Jordan Valley (Macumber and Head 1991), certainly extending into the current mouth of Wādī Ziqlāb to some extent. Although no Lisan deposits have been identified in the wadi to date, the presence of this lake surely would have affected prehistoric activity and occupation of the western half of the Ziqlāb drainage system, generally, and in the neighbourhood of WZ 138 in particular.

Over time, more recent sites seem to be located at successively lower elevations as wadi incision continues. WZ 148 is very similar to other Geometric Kebaran A sites in the Mediterranean zone, such as Neve David (Kaufman 1989). Large in size, the site likely extends over 100m^2 on a low, gently sloping terrace about 5m above the modern wadi floor. It contains extremely high densities of lithics and fauna within a thick red, carbonate-rich deposit. This same deposit can be traced upstream to WZ 200, where another Middle Epipalaeolithic component occurs.

Preliminary field and laboratory analyses of soil development at WZ 148 indicate the relatively recent age of the profile, somewhere after to 20,000 BP. Geochemical analysis of the soil indicates its highly calcareous nature, derived from local limestone-based colluvial parent material. Particle-size analysis of the soil confirms the colluvial nature of its parent material, as well as its relatively young age. There is a decrease in clay content with depth, indicative of a relatively short time since the beginning of development or a climate lacking in significant precipitation. The profile is dominated by silts, which account for some 40% of the size distribution in every sample. Most importantly for understanding climatic conditions at WZ 148, the Middle Epipalaeolithic artifacts are found above, below, and within a 50cm-thick, carbonate-

concreted horizon. The development of a carbonate horizon depends on parent material and leaching (Birkeland 1984). The presence of this horizon at depth indicates that during or immediately after soil formation conditions were sufficiently wet to promote leaching.

WZ 200 and WZ 148 are both located on low, flat terraces where alluvial deposits are overlain by colluvium exhibiting subsequent soil development. This sequence has been documented at many other non-artifact-bearing locations in the wadi. The presence of this deposit and its extension throughout most of the wadi indicates a period of relative surface and landscape stability during the Epipalaeolithic.

There is also evidence for the preferential selection of ancient stream terraces as residential in particular periods. Previous survey in Wādī Ziqlāb (Banning and Fawcett 1983; Banning *et al.* 1989; 1996) has demonstrated this preference for the Neolithic. The present survey used this *a priori* information to locate sites, focusing inspection on lower terraces likely to contain Epipalaeolithic and Neolithic sites. Two important sites were found this way (WZ 140 and WZ 148), substantially increasing our knowledge about settlement location in Wādī Ziqlāb during these periods.

In the Neolithic, the PPNB site of WZ 120, as well as the Late Neolithic sites of WZ 200 and WZ 140, are all located on large, gently sloping, low-lying terraces. Additionally, these terraces also contain artifacts from recent periods (Byzantine, Mamluk, and Ottoman) indicating their continued attraction as site locations, under at least some circumstances. Furthermore, these sites are also all located within 500m of a major spring. Indeed, WZ 140 is located directly adjacent to a large waterfall.

Preliminary Conclusions

The 2000 field season of the Wādī Ziqlāb Project was the first planned specifically to integrate geological and geomorphological activity in the wadi system with settlement patterns and land-use changes during Epipalaeolithic and Neolithic, periods of rapid cultural and economic change. We hope that the detailed analysis of a local landscape will contribute information on and help us understand the causes of these changes and their impact on prehistoric inhabitants of the area. Only by realizing the mutual relationship between the landscape and its inhabitants can we gain insight into these changes.

This season's fieldwork allows us to begin to examine the relationship between environmental and cultural changes in Wādī Ziqlāb. We discovered many new sites and examined them specifically within their geomorphological setting. We exploited key off-site areas as sources of evidence for paleolandscape reconstruction. Finally, we re-examined previously documented sites to relate them to other sites and local geomorphic processes in the wadi. At this stage of research, we have moved towards the project goals of identifying and understanding regional settlement and land-use patterns in Wādī Ziqlāb's drainage basin. Integrating a geomorphological approach with archaeology (including clay mineralogy, textural, chemical, thin-section, phytolith and micro-/macro-artifact analysis) presents a clearer picture of changes in the landscape from Epipalaeolithic to Neolithic times, including how people where using, modifying, and being affected by this environment.

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References Cited

Banning, E.B.
1985 *Pastoral and Agricultural Land Use in the Wadi Ziqlab, Jordan: An Archaeological and Ecological Survey.* Unpublished Ph.D diss. University of Toronto.
1996 Highlands and Lowlands: Problems and Survey Frameworks for Rural Archaeology in the Near East. *BASOR* 301: 25-45.

Banning, E.B. and Fawcett, C.
1983 Man-Land Relationships in the Ancient Wadi Ziqlab: Report of the 1981 Survey. *ADAJ* 27: 291-309.

Banning, E.B., Dods, R.R., Field, J., Maltby, S., McCorriston, J., Monckton, S., Rubenstein, R. and Sheppard, P.
1989 Wadi Ziqlab Project 1987: A Preliminary Report. *ADAJ* 33: 43-58.

Banning, E.B., Dods, R., Field, J., Kuijt, I., McCorriston, J., Siggers, J., Taani, H. and Triggs, J.
1992 Tabaqat al-Bûma: 1990 Excavations at a Kebaran and Late Neolithic Site in Wadi Ziqlab. *ADAJ* 36: 43-69.

Banning, E.B. and Najjar, M.
1999 Excavations at Tell Rakan I, a Neolithic Site in Wadi Ziqlab, Jordan. *Neo-Lithics* 2/99: 1-3.

Banning, E.B., Rahimi, D. and Siggers, J.
1994 The Late Neolithic of the Southern Levant: Hiatus, Settlement Shift or Observer Bias? The Perspective from Wadi Ziqlab. *Paléorient* 20(2): 151-164.

Banning, E.B., Rahimi, D., Siggers, J. and Ta'ani, H.
1996 1992 Season of Excavations in Wadi Ziqlab, Jordan. *ADAJ* 40: 29-49.

Bar-Yosef, O.
1970 *The Epi-Palaeolithic Cultures of Palestine.* Unpublished Ph.D diss. Hebrew University of Jerusalem.

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

Birkeland, P.
1984 *Soils and Geomorphology.* New York: Oxford University Press.

Field, J.
1994 Rainfall Patterns and Landscape Changes in Wadi Ziqlab, Jordan. *Archaeology and the Environment: A Fragile Coexistence.* Proceedings of the 24th Annual Chacmool Conference. Calgary: Department of Archaeology, University of Calgary.

Field, J. and Banning, E.B.
1998 Hillslope processes and archaeology in Wadi Ziqlab, Jordan. *Geoarchaeology* 13(6): 595-616.

Kaufman, D.
1989 Observations on the Geometric Kebaran: A View from Neve David. Pp. 275-284 in O. Bar-Yosef and B. Vandermeersch (eds.), *Investigations in South Levantine Prehistory.* Oxford: BAR.

Maher, L., Lohr, M., Betts, M., Parslow, C. and Banning, E.B.
n.d. Middle Epipalaeolithic Sites in Wadi Ziqlab, Northern Jordan. Submitted to *Paléorient.*

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