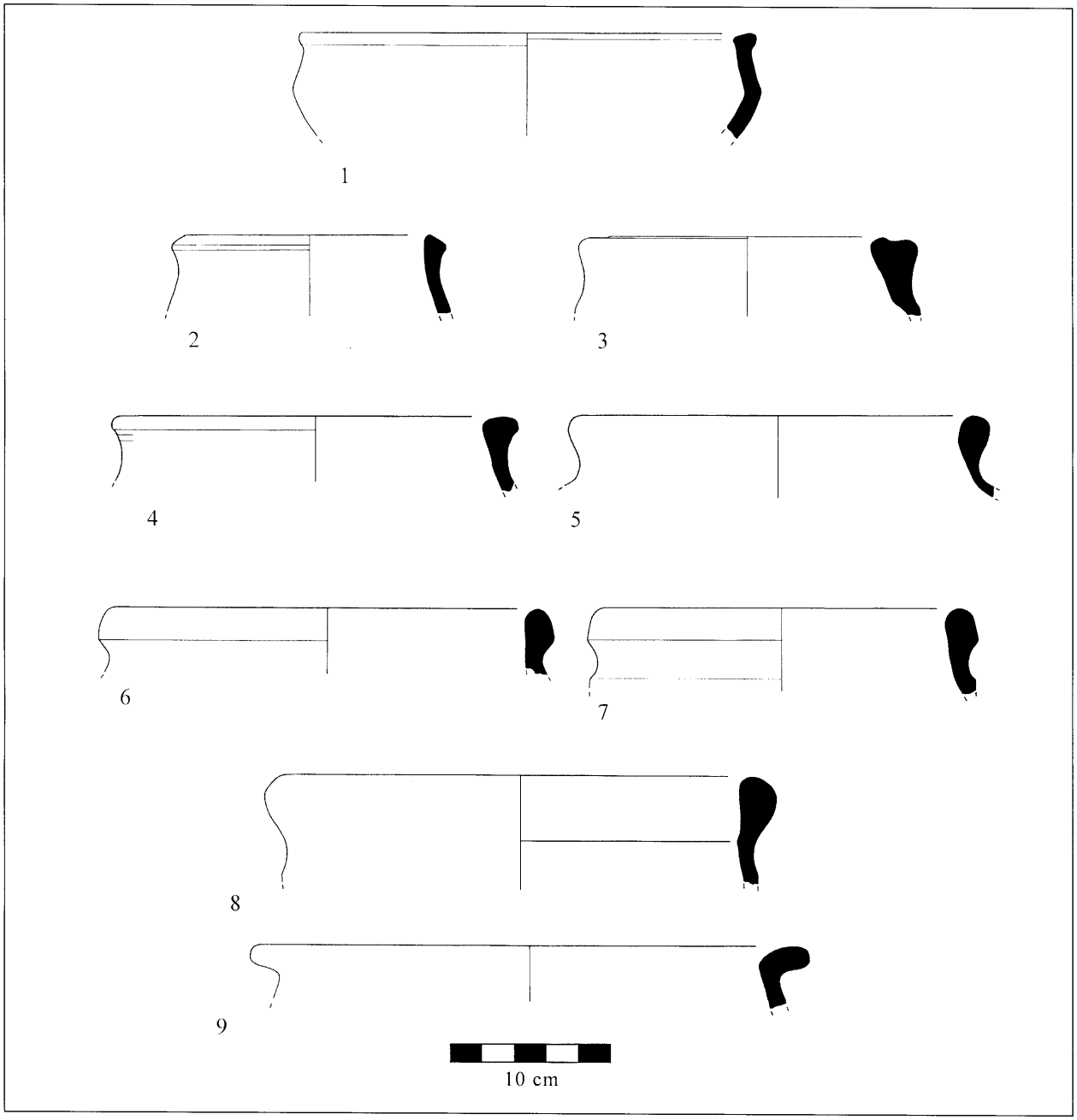

Figure 27. *Iron age pottery from WF424. (Drawn by Larrisa Najjar).*

Of these known types, fine wares are most common, although these represented <1 per cent of the total assemblage. In contrast, imported amphorae are virtually absent. This picture, with fine wares more common than amphorae, is somewhat surprising and will be systematically investigated for the assemblage as a whole.

Although never represented by more than a handful of sherds, imported amphorae comprise Late Roman Amphora 1 from Cilicia and Late Roman Amphora 4 from Gaza, as well as North African (Tunisian) Cylindrical amphorae. A final amphora, which appears to be present in similar numbers, has a known distribution around the Red Sea and on its

fringes, from Ayla to Aksum (Hayes 1996). Its production is known from kilns at Aqaba, during both the fifth (S.T. Parker pers. comm.) and seventh centuries (Melkawi *et al.* 1994; see also Sedov 1996 for a better example of form). Apart from a single North African rim, which may be Roman in date, these named amphora types are exclusively late Roman or Byzantine. Sourced Hellenistic and early Roman types are absent from the sampled units.

Of the fine wares, the earliest classical material is Nabatean thin-walled ware, some of which belongs to the elaborate painted forms. These wares, whose production is known from the region of Petra ('Amr 1987), form the largest group of finewares with, as expected, imported vessels much less common for both this period and later. During the early period, imports are restricted to several sherds of Eastern Sigillata A, from northern Syria. Later fine wares are more common, with North African (Tunisian) and Phocaean Red-slipped wares, in forms defined by Hayes (1972), best represented. North African vessels that recur date from the third to early fifth centuries and include forms 50, 59, 61A and stamp style A. Later, from the mid-fifth to mid-sixth centuries, African vessels are absent, replaced by the mass-produced Phocaean Red-slip form 3, which flooded the eastern market at this time and, in absolute numbers, is the most common red-slip form seen in Wadi Faynan. The only seventh-century vessel type securely identified as yet is again North African, belonging to form 107. Rare sherds of Cypriot Red slip form 2, dating from the late fourth to fifth century, are also present. Thus, the pattern emerging from these vessels is essentially local or eastern in origin, with Tunisia the most westerly source presented.

Ethnoarchaeological studies of present-day agriculture and pastoralism (CP)

During the 1998 survey season, ethnoarchaeological fieldwork began in the Wadi Faynan and its hinterland, in particular the Wadi Dana and the adjacent plateau-edge communities, to investigate the nature of, and relationships between, pastoralism and agriculture. Both bedouin and villagers (*fellaheen*) manage herds and cultivate crops. The social and economic importance placed on each differs considerably, however, and there exists a diverse range and mix of activities along a continuum from bedouin who primarily herd flocks to villagers chiefly concerned with agriculture. Waged employment is increasingly vital for supporting and enhancing local livelihoods, as in other parts of Jordan (Mundy and Smith 1990), and herding and farming are often supplementary to, rather than the basis of, household income. Not all groups, however, are at the same stage of economic development. Many people who were formally more mobile have settled in recent years.

The study area lies within the Dana Nature Reserve which is managed by the Royal Society for the Conservation of Nature (RSCN). The area is a focus for ecological research and a growing centre for eco-tourism. As part of the wildlife conservation strategy of the RSCN, grazing is restricted within the Nature Reserve. Grazing restrictions are very unpopular policy with the locals, as grazing is considered to be a fundamental right. Stronger grazing restrictions are active in the higher altitudes of the Nature Reserve than in the lower areas, such as in lower Wadi Dana and Wadi Faynan, but the locals are aware that further restrictions will be imposed. Socio-economic schemes are underway to offset the effects of the loss of grazing and provide alternative sources of income. As part of this, two main socio-economic surveys (Lancaster and Lancaster 1993; Swenne 1995) have been conducted. The RSCN is already an important employer within the area, and the socio-economic development plans will further integrate the Nature Reserve into the lives of the people living there. These plans include, for example, the development of the irrigated orchards at Dana and a goat-fattening scheme which uses alternative sources of animal feed. In the Wadi Faynan, archaeology is a good source of income and people are always eager to know if a new team will bring work. There is a cluster of tent compounds in the vicinity of the RSCN/CBRL camp at the bottom of the Wadi Dana, attracted by the good water supply, the school (current premises erected six years ago) and employment possibilities.

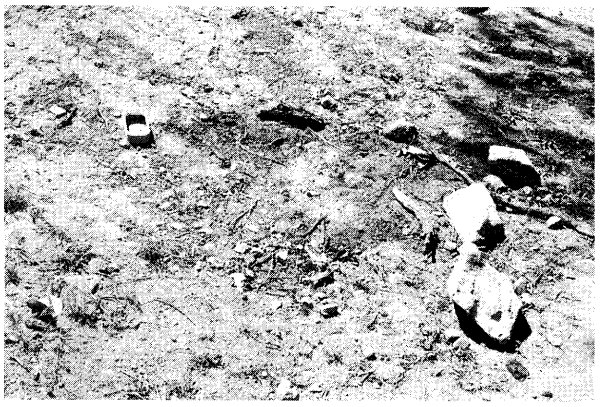

Figure 28. *A typical shepherd's lunch site in the Wadi Dana: note the discoloration of the ground from the fire, the three larger stones on which the tea kettle was perched to the right, and the empty sardine tin and lid to the left. (Photograph: C. Palmer).*

A basic aim of the ethnoarchaeological work is to understand land use in the terms of the people using the land today and in the recent past. In this preliminary season of fieldwork, informal visits were made to a number of households from four of the groups living in the Wadi Faynan/Dana area. I also participated in some household activities including spending a day grazing goats with a local shepherdess.

In the area of the Wadi Faynan and its tributaries, herding is the dominant activity. The modern irrigation farming (see Barker *et al.* 1997) has been abandoned. Black goats are the most important herd animals. A few households keep sheep, which have a higher market value, but their feet are not suited to the rocky terrain and they are considered 'old' after two to three years. Goats, on the other hand, can live for up to 15 years. This year, the winter rains were good and grazing cover was much better than in the previous two springs (1996 and 1997). In order to find sufficient grazing, however, the herds daily range over large distances. These have not yet been quantified, and in any case vary according to grazing availability, but the goats and sheep are taken from the encampments shortly after the dawn milking and return just before the second milking at sunset, the shepherds keeping them moving throughout the day except for occasional short resting periods. Very young, sick or heavily pregnant animals are kept at the encampments. The landscape is frequently spotted with the remains of bedouin tea breaks: an ash hearth, with three partially-burnt stones on which the kettle rested (Fig. 28).

Labour to herd goats is provided by younger family members. Girls leave school early to assist with household chores and to work as herders. Young men also graze flocks, as do schoolboys during their holidays. During April, kidding and lambing are over and the women continue to be busy processing milk into *saman* (purified fermented butter) and *jamid* (defatted, dehydrated yoghurt) until the summer. Kidding and lambing are spread over the winter and early spring in order to prolong the milking period. Animals can be penned overnight in outside stalls or in one half of the bedouin tent. Dung which collects from stalling animals can be dried and used as an alternative to firewood for cooking, but it is considered a poor second-best. Milk products are for home use (Lancaster and Lancaster 1993; Swenne 1995). Income is obtained by selling animals for meat or as breeding females. Except during feasts, meat is not a regular or large part of the local diet. All households visited kept chickens for eggs. Every household also owns at least one donkey.

Sheep and goat herd sizes range between approximately 30 and 200–300 animals (Swenne 1995). Herd size does not necessarily increase with the economic status of the owner – in fact, the tribal grouping with the largest herds is locally considered to be the poorest. Members of this tribe have few alternative sources of income and, consequently, are the most dependent upon livestock for subsistence. They view the herd as security and, even in times of hardship, such as exist at the moment with the lifting of the subsidy on animal feed, are the most reluctant to sell their animals (Alan Rowe, pers. comm.). This group was originally based in Beersheba and came to live permanently in the area after 1948. Although now largely animal-dependent, agriculture was a greater part of their economy in Beersheba. Lancaster and Lancaster (1993) note that another, smaller, group, who also came as refugees, are in a better economic situation because they were able to exploit tribal ties. This emphasizes the importance of social alliances for the prosperity of the group.

In general, households which have alternative sources of income tend to keep fewer animals. Animals are kept to provide milk products for the family and to fulfil important hospitality requirements. Members from tribal groups who state a longer-term association with the area reported that they and their herds move to stay with relatives living on the plateau during the summer months (usually June-September). Not all of the household may move, however, due to employment obligations and schooling. Migration to the plateau may provide cooler conditions, but one informant commented that water is a greater problem there. Although households may keep small herds, numbers can be built up rapidly (Cribb 1991). In times of employment insecurity, for example, households may choose to invest in livestock (cf. Marx 1980); indeed, this appears to be the strategy of the tribal group from Beersheba discussed above. Therefore, the maintenance of a small herd is a form of insurance.

In the past, cultivation based on water harvesting was practised in local wadis. The scale and nature of this practice remain to be established. Some localized cultivation did take place fifty years ago inside the ancient field system in the vicinity of the Roman-period mill. Cultivation is now prohibited within the Nature Reserve. Malaria was formerly a problem which affected summer living conditions. The presence of perennial water supplies, therefore, had serious negative implications.

There is a concentration of tent compounds along the lower reaches of the track that runs up the Wadi Dana, all of which are situated close to natural springs. Without this assured water supply, the encampments quickly fade away, and the next

settled area encountered along the track up the Wadi Dana is the village of Dana itself on the rim of the plateau. Dana's irrigated orchards, its 'gardens', are encountered first, and then the traditional architecture of the village itself. The villagers practise both dryland and irrigated agriculture, as well as maintaining small herds of sheep and goats. The gardens are spring-watered, and there are no regulations affecting how water is distributed. Lancaster and Lancaster (1993) also report that the water freely flows into the gardens and people open and close the channels as they require. This contrasts with practices observed in the north of Jordan (Palmer 1993) and also reported to the author from Tafila. High-value tree crops dominate the gardens and include olives, pomegranates, fig, and walnuts. The gardens are currently being developed for herb production and to grow a greater range of fruits, in part for jam-making. Dryland arable agriculture takes place on the plateau above the village, where wheat and barley are the principal crops. Both in Wadi Faynan and at Dana, older inhabitants commented that large numbers of cattle were once maintained. This meant that the fodder crop bitter vetch was once part of the local crop rotation system. The maintenance of cattle must have affected grazing and transhumant patterns in the area. Cattle are no longer required to till agricultural lands, which are tractor-ploughed, and local people reported that grazing for cattle is no longer freely available, though the reasons for this (if true) still have to be established. Many former inhabitants of Dana have moved to the new town of Qadisiyya where there are more public services and greater opportunities for paid employment.

Land which is cultivated is privately held, but land receiving less than 200 mm. of rainfall is legally open for grazing. Some tribal groups do claim ancestral rights over grazing land, but such claims appear to be heavily contested. As a consequence of the link between cultivation and ownership, a link which is well established in Ottoman land law, breaking new ground for agriculture can result in conflict. The establishment of cultivated areas is controlled by official state-related bodies, as in the example of the foundation of the modern village of Grigora in the Wadi Araba and its associated irrigation scheme approximately 20 years ago (Swenne 1995).

Transhumant patterns used today and in the recent past remain to be explored. Of the groups who do move, different patterns appear to exist and patterns have fundamentally changed in recent history, with the imposition of national borders and the arrival, for example, of new technology such as the pick-up truck.

Ethnoarchaeology may provide possible analogues to understand the 'archaeological history' of the area in response to changing social and economic factors through time. It also provides access to the motivations for change among the inhabitants of the region recently. The first season of work has already produced evidence suggesting the fluidity with which people may respond to social and economic constraints and alter their subsistence base accordingly.

Discussion and conclusion (GWB)

The 1998 season of fieldwork has added significantly to our understanding of the landscape history of the Wadi Faynan, in terms of the nature and chronology of environmental change, the sequence of agricultural and industrial activities, and the impact of the ancient farmers and miners on their landscape.

The geomorphological sequence of landform changes and climatic fluctuations established in previous years has been confirmed in its essential characteristics. The preliminary OSL and ^{14}C dates, in combination with archaeological artefacts associated with particular sedimentary facies, such as the handaxe from the Fass Yad terrace (Fig. 1), have allowed us to construct a first approximation of the chronology of environmental change over the past *c.* 200,000 years. There are indications of parallel sequences of Pleistocene terrace formation in the principal feeder wadis of the Wadi Faynan, and it seems likely that these may be correlated with the sequence already established of alluvial fan development. There is strong and widespread evidence for a significantly wetter environment in the early Holocene, probably lasting until *c.* 6000 years ago, and although secure dating is still required, there is evidence that it was followed by a diverse steppic landscape by the Bronze Age. There has been significant soil erosion subsequently, with our preliminary findings pointing to environmental degradation between the Early Bronze Age and classical times, probably reflecting aridification more than human activity. This bronze age landscape (if we are able to confirm the bronze age date) certainly contrasts strikingly with the degraded steppeland of Nabatean times, and the even more degraded desertic environment that succeeded it, when there is abundant evidence for human activity having a profound impact.

The completion of the recording of the WF4 field system along its 4-km. length on the southern side of the Wadi Faynan, the recording of major outlying units on the northern side, and the study of the asso-

ciated artefacts, have confirmed and amplified our understanding of land use history. It seems clear from our own survey work in the Wadi Dana and other surveys and excavations in the Wadi Ghuwayr (Finlayson and Mithen 1998; Simmons and al-Najjar 1996) that the preferred locations for the settlements of the first neolithic farmers were by springs in the well-watered hills at the eastern end of the wadi. However, the lithic material studied in 1997 and 1998 from the Wadi Faynan field systems also indicates small-scale neolithic activity throughout the main wadi, presumably hunting and pastoralism, and neolithic sites are also known in the Wadi Fidan. By the Late Neolithic, the people living at Tell Wadi Faynan were probably exploiting the seasonal floodwaters of the main wadi for their crops, without practising floodwater diversion systems. The nature of chalcolithic settlement and land use remains elusive, but by the Early Bronze Age there was an extensive zone of settlement on the southern side of the main wadi, both in the zone of WF4.13 (site WF100 being investigated by Dr. Karen Wright's team) and on the interfluves to the north. The boulder walls mapped in WF4.13 (Fig. 16, above), which we believe to be of bronze age date, seem to be vestiges of both structures and field boundaries, and are associated with water storage structures. The series of terrace walls or check dams built across the shallow floor of a small tributary wadi flowing into the northern side of Wadi Faynan (WF406: Figs 13 and 14) is also likely to be bronze age. Whilst dating remains problematic, the indications are that bronze age farmers had developed simple techniques of floodwater farming.

By the early first millennium BC, the Iron Age, we now know that the landscape was dominated by a substantial settlement (WF424: Fig. 16), built like its successor Khirbat Faynan at the strategic centre of the Faynan region, the point where the three major tributary wadis (the Dana, Ghuwayr and Shayqar) come together to form the Faynan. The settlement was associated with a field system of boulder-built walls, often set orthostatically. Substantial boundary walls were built upstream of these fields, which collected water from the surrounding slopes to direct maximum water flow down the central part of the field system. Similar boundary walls enclosed field systems at WF408 and WF406 (Figs 13 and 14), and in part at least they had a water-diversion function. We cannot be sure of the dating of these boundary walls because it is clear that the boulder-built field walls in both the WF424 and WF406–408 systems are overlain by later field walls of the classical period. However, the fact that we have only found these boundary walls enclosing field systems with significant iron age material, and the constructional similarities between the walls and the fields they enclose, suggest an iron age date is the most reasonable hypothesis on the present evidence. If correct, it would mean that, whereas bronze age farmers built terrace walls at right angles across wadi beds to spread floodwater over surrounding fields, and small catchments to collect water in cisterns, iron age farmers in Faynan had learned to construct substantial and rather sophisticated walls to divert the flow of floodwaters sometimes hundreds of metres from their natural line, so that far greater quantities of water could be collected and sent down a field system than was possible with bronze age technology.

As discussed in the 1997 report, the technology of floodwater farming was further refined by Nabatean farmers, the focus of their wall-building activities moving especially to the small tributary wadis that run parallel to the main wadi along its southern side. Water was dammed as it issued from the adjacent hills, diverted westwards by boulder walls along the contour of the slope, and then through simple sluices (gaps) and spillways (stepped structures) onto terraced fields below. Nabatean technology on the southern slopes may also have included channels formed by parallel walls that fed water directly into the fields on either side through sluice gaps.

It seems increasingly likely from the studies of field layout and construction and of the surface material that the entire agricultural landscape was managed as a more or less integral system in the Roman and Byzantine periods. Systems of long parallel walls were built to divert water from the main wadi into adjacent fields on low-elevation terrain, and from the southern tributary wadis. Similar channels were built at *c.* 45° to water flow further down the tributary wadis to collect any water that had by-passed the higher diversion walls or that had drained back into the wadis from the higher terraced fields and force it once more onto adjacent cultivable land. The effectiveness of the system is in part explained by the uniformly low levels of infiltration we found at sample sites from the upper slopes to the lowest fields (see 'Palaeohydrology' above). However, organi-sational factors were also important. The field evidence supports the hypothesis of cooperation between areas of the field system fed by the parallel channels: rather than certain areas of the system having exclusive access to particular wadis at the expense of other areas, the internal linkages between the system imply that water resources were shared. The construction of the major parallel channels to feed the main body of the field system demonstrates the same engineer-

ing skills in moving water relatively long distances over gentle gradients as the Roman aqueduct east of the WF4 field system and its rock-cut feeder channel from the Wadi Ghuwayr spring.

Although the principal focus of the field system study so far has been on chronology and function, we are also beginning to discern a rich social archaeology as well. In addition to the evidence for a series of bronze age settlement zones, there are indications of extensive iron age settlement along the southern margins of the field system within and just outside WF12. The excavations by Wright *et al.* (1998) found small buildings of Nabatean and Roman date on the northern side of WF4.13, and we have noted a variety of structures with similar pottery elsewhere within the field system. The systematic recording and analysis of the archaeology outside the WF4 field system begins in 1999, but we know of a series of larger farmsteads of broadly Nabatean date on the southern slopes overlooking the fields. The model that is beginning to emerge as a result of the 1998 fieldwork is that iron age settlement consisted of a few large and discrete settlement/field units, the Nabatean landscape consisted of a series of adjacent farm units, and that the entire WF4 field system was then managed as a single agricultural unit or estate in Roman/Byzantine times.

Another important component of the landscape are cairns, and a major focus of our fieldwork in the future has to focus on their significance. Cairn-building has been a feature of most periods of past settlement, sometimes for burial, sometimes for field-clearance, the two activities frequently happening at the same location at different times, so the task of disentangling this archaeology is going to be extremely complex. However, in the 1998 fieldwork we noted distinct zones of cairns within the field system that are avoided by field walls, and also occurrences of carefully-constructed cairns within the parallel channels, often at key junction points, suggesting complex relationships between agricultural and ritual landscapes. We are currently developing a GIS to explore the potentially complex interplay between technological, socio-economic and ritual factors in the development of the WF4 field system.

Another very promising outcome of the project so far is the exciting geochemical evidence from sediments sampled near Tell Wadi Faynan and Khirbat Faynan that environmental pollution from copper smelting was small-scale in later prehistory, significantly greater in iron age and Nabatean times, and enormous in Roman/Byzantine times, with further smaller impacts later (Figs 4–7). As further evidence for the pervasiveness of environmental pollution from smelting, a sherd of locally-made iron age pottery from WF4.3 contained quantities of copper and iron many times higher than a sherd of imported Roman fine ware from the same locality (B. Pyatt, pers. comm.). The geochemical evidence for changing scales of environmental pollution gives added significance to the sequence of mining and smelting technology established by the Bochum Mining Museum. The evidence for large-scale and highly organized (state organized?) mining and mineral processing in Roman times around the Wadi Faynan is obviously in parallel with the field-system evidence for large-scale and highly organized floodwater farming along the wadi floor in the same period; presumably the latter supported the former. Yet the implication of the severe air-borne and terrestrial pollution registered in the Khirbat Faynan barrage sediments is surely that the large-scale industrial activity registered nearby at WF424 must have had a very considerable impact on the continued usage of the land for farming. The initial study of the pollen core taken from the Khirbat Faynan barrage sediments (Hunt and Mohammed 1998) provided indications of a degraded classical landscape with cereals and olives, followed by large-scale desertification. As described earlier, following these promising results the same sediments have now been sampled on a much larger scale to enable a detailed investigation of vegetation history over the past 2500 years. It seems likely that the transition from the intensive farming and industrial processing of Roman and Byzantine times to systems of settlement and land use more akin to those of the present-day will turn out to reflect a complex interplay between climate change, humanly-induced environmental degradation, and economic relations between Faynan and the wider world.

In the remaining two seasons of fieldwork proposed for this project, we intend to continue detailed analysis of the field systems and also to extend the focus of our survey to the abundant multi-period archaeology outside it. In this, the ethnoarchaeological study begun in 1998 will be vital not just for informing on the potential complexity of farmer-pastoralist relations in the study area but also for providing archaeological signatures to aid us in the interpretation of the surface archaeology. The 1998 fieldwork emphasizes still more the extraordinary potential of the Wadi Faynan to provide a remarkable case study in arid-zone landscape archaeology, allowing us to understand both when, how and why the present-day landscape has developed as it has, with the lives of its past inhabitants still impacting on the people who depend on it for their livelihood today.

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