middle palaeolithic type were found within it, and artefacts of middle and upper palaeolithic type were found on its surfaces. The indications are that the Ghuwayr Beds are talus fan and braid-plain deposits laid down in an episode characterized by abundant sediment supply, probably some time during the period 150,000–50,000 years ago.

We have also sub-divided the superficial deposits designated Plf (Pleistocene alluvial fan) and A1 (Holocene wadi floor alluvium) by Rabb'a (1994), in the area down-wadi of the confluence and Khirbat Faynan. The Shayqar Beds are part of Rabb'a's Plf group and are probably of Pleistocene age, and mainly fluvial in origin. Where exposed, they are up to twelve metres thick and consist of red/yellow trough cross-bedded sands and gravels, with some loams, and frequent calcium carbonate induration. A group of middle palaeolithic artefacts was found on the surface of the Shayqar Beds, together with isolated artefacts likely to be younger in age, whilst ancient fields and structures occur on surfaces and soils developed on this unit. On present evidence, the Shayqar Beds seem likely to have been laid down sometime in the period 150,000–50,000 years ago, but probably (on toposequence evidence) at a considerably later date than the Ghuwayr Beds.

Of greater immediate archaeological importance are the bodies of gravel mapped in Figure 5 as the Faynan Beds (Upper and Lower) and the younger Dana Beds, within the deposits mapped as Holocene Alluvium (A1) by Rabb'a (1994). The Lower Faynan Beds are 3–5 metres thick and consist of yellow-brown trough cross-bedded sandy gravels, which accumulated in a fluvial wadi floor environment not too dissimilar from that which occurs today on the floor of the Wadi Faynan. They were deposited, at least in part, in the early Holocene, though to date no significant archaeological remains have been detected within them.

This is in contrast with the Upper Faynan Beds, however. These deposits, which are 0 to 1·5 metres thick, are associated with and crop out some 4–8 metres above the present wadi floor at Tell Wadi Faynan, an excavated later neolithic and chalcolithic settlement with calibrated radiocarbon dates from the later sixth to the later fifth millennia B.C. (Najjar *et al.* 1990; Fig. 6). The Upper Faynan Beds at this location consist of a complex set of fine-grained silts,

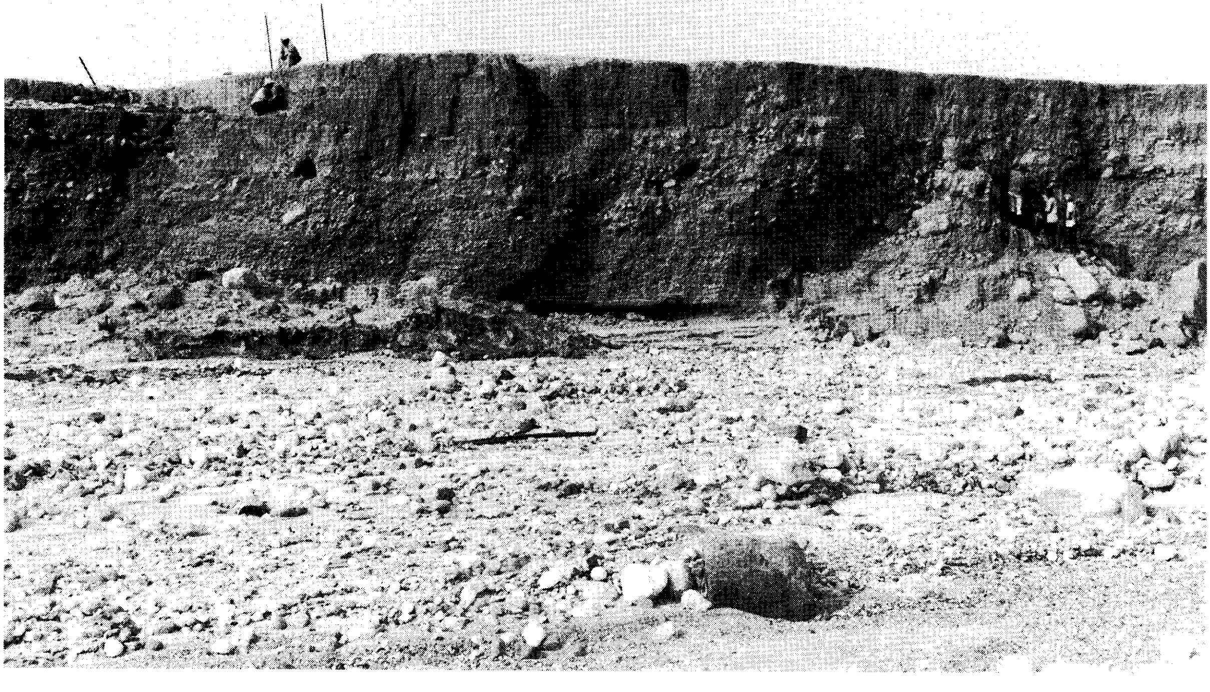

Figure 6. *Geomorphological recording of the section exposed in the Wadi Faynan at Tell Wadi Faynan, a later neolithic and chalcolithic settlement (at the top of the section) situated within the Upper Faynan Beds. (Photograph: G. Barker).*

biological remains, discarded ash and neolithic midden materials including fragments of animal bone and charcoal. The midden materials accumulated in the quiet waters of a pond or stream measuring perhaps 5–10 metres across, whose longevity must probably be measured in years rather than months. These deposits are particularly important because they point to environmental conditions on the floodplain at the time of the neolithic and chalcolithic settlement being substantially different from those which prevail today: there was relative stability, quiet and perennial water, and notable biological production, in stark contrast with the mixture of drought and flooding in the wadi today.

Much of the ancient field system was constructed on surfaces developed on the Lower and Upper Faynan Beds (Fig. 13), and at a number of locations in the study area the upper parts of the Upper Faynan Beds appear to contain post-palaeolithic artefacts and structures.

The Dana Beds are fluvial deposits essentially similar to those accumulating on the modern wadi floor. They rest unconformably against the Lower Faynan Beds and are separated from the modern wadi floor by an erosional scarp 0·5–1·5 metres high. Their equivalents up-wadi appear to have been affected by natural events such as earthquake shock, and by human activites, in particular the introduction of mineral wastes from metalliferous mining. The Roman aqueduct spanning the bottom of the Wadi Shayqar was built with a sand facies of this unit, though immediately downstream of Khirbat Faynan the Dana Beds are clearly much younger than, and visibly separate from, ancient field systems on the terrace surfaces. The geomorphological and archaeological relationships for all the Dana Beds and the Faynan Beds remain uncertain, though they were probably complex.

Finally, the most visible and obvious deposits in the area are the black metalliferous mining wastes which mantle much of the area around Khirbat Faynan and its associated archaeological sites.

Survey of the field system (DJM, with GWB, OHC and DCT)

The 250-hectare area of fields to the west of Khirbat Faynan, running for some eight kilometres along the southern side of the Wadi Faynan and termed site WF4 in the BIAAH 1995 survey, was a prime focus of the archaeological fieldwork. The dating of the walls at the beginning of our fieldwork was entirely uncertain, apart from the observation from the trial field-walking by the BIAAH team in March 1995 that the surface pottery was predominantly Nabataean, Roman and Byzantine.

It was therefore decided to explore the potential for an intensive survey of the entire field system. There were six main approaches adopted for this preliminary investigation: (1) mapping the entire system from air-photographs, combined with surface examination ('ground-truthing'); (2) detailed planning of selected areas of the field systems, using Total Station or EDM survey, to produce computer-generated maps; (3) the collection and counting of artefacts in selected areas, trialing new methods to be employed for the recording of the entire field system in future seasons; (4) the assessment of the visibility, preservation and typology of archaeological sites and features of all periods from the palaeolithic to the present within and adjacent to the field system; (5) the structural analysis of the walls to produce a preliminary classification of their type, construction and functional attributes, as a basis again for a fuller record of the system in future seasons; and (6), an initial assessment of the implications of the wall systems for the nature of the hydraulic farming regime or regimes practised in antiquity. The last two approaches build on the methodologies we have recently applied to ancient wall systems in the UNESCO Libyan Valleys Survey in the Tripolitanian pre-desert in north-west Libya (Gilbertson and Hunt 1996). A further goal was to assess the impact on the archaeological landscape in general, and the field system in particular, of the modern irrigation systems.

Mapping

A preliminary plot of the vertical air photographs covering the study area was produced in the UK before the field season (Fig. 7) and the first days of fieldwork were spent checking details on this. With better-quality versions of the air-photographs available in Jordan, we were able to enhance the quality of the map, and ground observation clarified many features and added new details. From this examination, it also became clear that the nature of both the surface material within the field system and the structural detail of the field walls and associated features varied considerably. After consideration of these structural differences and visible topographic variability, it was decided to subdivide the field system for the purposes of recording into the twenty sub-units (WF4.1 to WF4.20) shown in Figure 8.

Total Station survey

Two areas within the field system were selected for detailed survey. The first was WF4.13, equivalent to

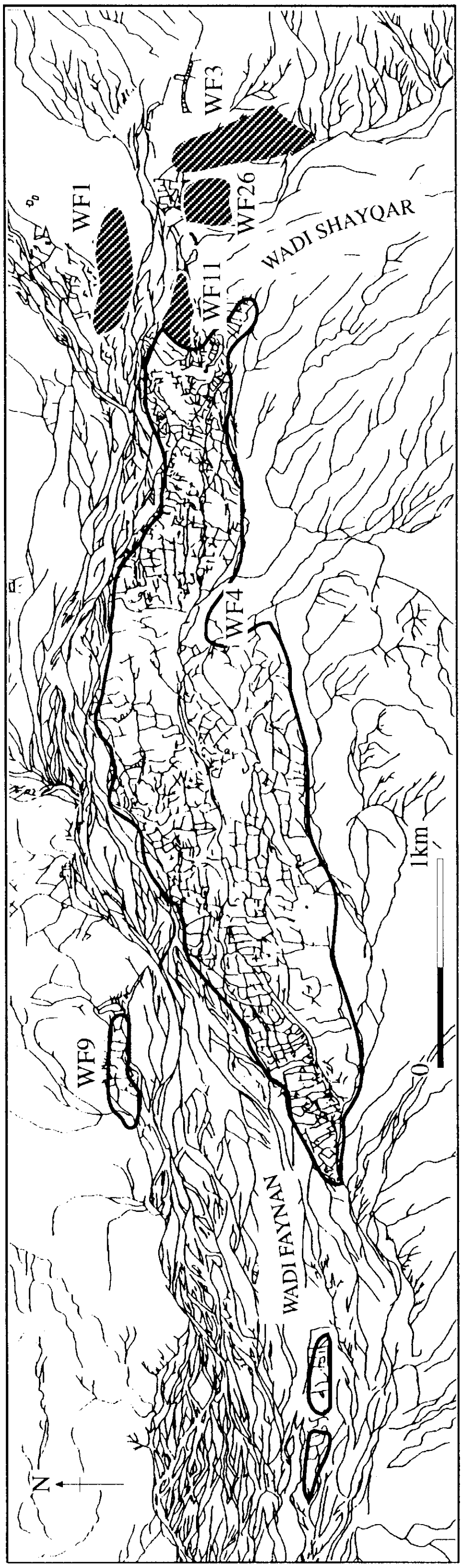

Figure 7. *Initial mapping of field system WF4 in the Wadi Faynan, drawn up from vertical air photographs.*

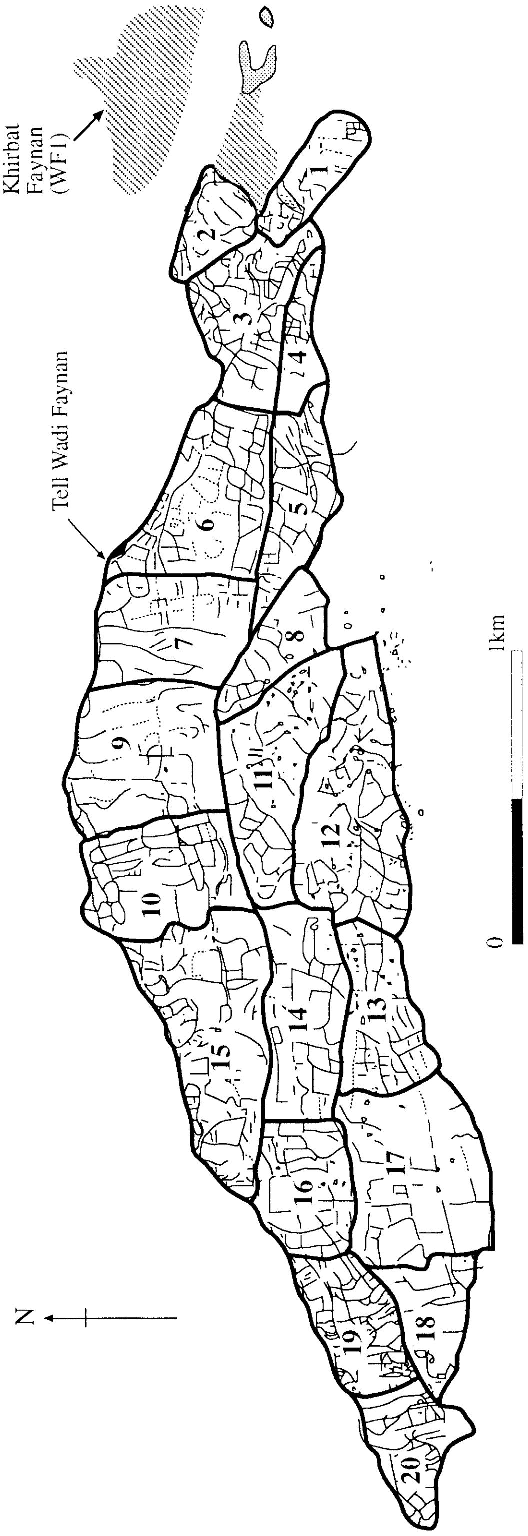

Figure 8. *Revised map of the Wadi Faynan field system, showing the proposed sub-divisions for its recording and analysis.*

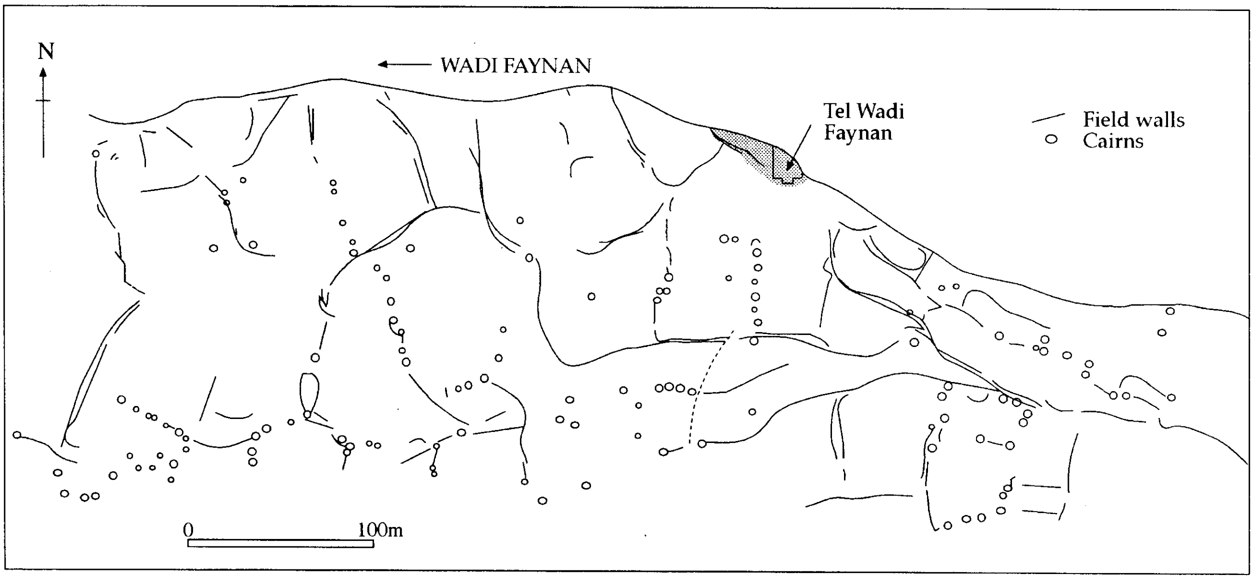

Figure 9. *Detailed map of part of the Wadi Faynan field system (in WF4.6 and WF4.7) produced by Total Station survey, showing topography, walls and structures (cairns).*

the area identified by Dr Wright and her team as enclosing the primary occupation area of the early bronze age site WF100. This survey was carried out by Dr Wright and her team and is not described in detail in this report, though a few comments on its possible implications for diachronic patterns of settlement in the study area are made in the final section. The second area comprised about half of area WF4.6 and a third of area WF4.7, centred on the known late neolithic/chalcolithic site of Tell Wadi Faynan (now numbered WF25 in the survey record). The preservation of ancient field walls in this part of the system is very good at present, though the area is now entirely surrounded by irrigated fields, which threaten to obliterate some features in the near future. The resulting plan of this area, produced by Oliver Creighton and David Thomas (Fig. 9), shows fields defined by both walls and cairn lines, here probably used as clearance features, as well as a number of channels, which probably had a hydrological function at a very localized level. There is no evidence at present for these forming part of a unified system for efficiently leading run-off water from large external catchments into the field system (see Discussion and Conclusion).

Field collection

There are about a thousand separate fields within the field system, many with a very high density of surface artefacts within them. Casual observation during the initial fieldwork suggested that there were significant differences in sherd density and assemblage composition from one part of the field system to another. For instance, the area of Dr Wright's site (WF4.13 = WF100) is notable for the remarkable concentration of chalcolithic and early bronze age sherds and lithics and for the paucity of Nabataean, Roman and Byzantine sherds. By way of contrast, the area of WF4.6–7 mapped as Figure 9 contained a dense carpet of Nabataean to Byzantine sherds, glass and slag, as well as numerous lithic implements. The problem confronting us was how to record this diversity at an appropriate level of detail without swamping any finds-processing system.

The proposed methodology, tested with some success on areas WF4.13 (again with the participation of Dr Wright's team) and WF4.6–7, aims to record the varying density of material, whilst limiting the actual collection to a minimum level. Each sub-area of the site was divided into a series of collection units, normally based on the actual ancient field boundaries (WF4.13 was subdivided into 30 fields, numbered WF4.13.1, 4.13.2 and so on). Field-walkers traversed the fields in a systematic manner, spaced 10 metres apart from each other, scanning a metre-wide corridor of the ground in front of them – in effect this provides a 10 per cent coverage of the fields. To limit the amount of material collected, clicker counters were used by all but one of the field-walking team, registering continuous counts of flint and pottery sherds within each individual field of the field system. The remaining team member collected a control sample of all the archaeological material in his or her transect across the field (pottery in one bag, lithics, slag, glass, special finds in another). This material was counted and weighed and the data added to that recorded by the clickers.

To give an idea of the variance in the density and character of the surface assemblages, only about half the fields in WF4.13 yielded slag, whilst almost every field in WF4.6–7 had plentiful copper slag. Similarly, the large size of the prehistoric sherds dominating WF4.13 is reflected in the relationship between sherd numbers and weights: WF4.13.6 produced 27 collected sherds weighing 850 grams, whereas WF4.6.14 yielded 192 sherds, of mainly Nabataean, Roman and Byzantine fabrics, weighing 450 grams!

The character of the slag collected may be diagnostic as to its date. For instance, it was observed that much of the material in area WF14.6 comprised very small, broken-up fragments, rather than the larger plate-like tap slags of Roman furnaces. Earlier work in the Wadi Araba has suggested that bronze age copper working involved primitive bowl hearths, with copper droplets being separated from the slag by breaking up the slag into small fragments such as were found in WF4.6 (Rothenberg 1972, 235–6). The record of numbers of fragments of slag and the weight of the samples collected may thus allow some degree of mapping of the early metallurgy in the wadi, whilst clearly distinguishing it from the later tap slags of the Nabataean/Roman/Byzantine periods. (On the distinctiveness of Roman copper production on the western side of the Araba, see Rothenberg 1972, 208–23.)

All the data on artefact distributions and assemblages will be entered into a computer database and used in conjunction with a GIS (Geographical Information System) for analysis and display.

Wall classification

The initial examination of walls and terraces, adapting the preliminary descriptive typologies used in the UNESCO Libyan Valleys Survey, suggested a list of sixteen different typological variants and eight distinct associated features (Table 1). Trial use of the list in the record of fields in WF4.13 and WF4.6–7 showed the system to be somewhat more complicated, many walls comprising work in more than one style or type of construction. It has been decided to design a structural record sheet for future seasons which will allow rapid visual identification of different styles of masonry and types of construction. Data from the structural survey will also be entered into the GIS and will allow identification of component groups of fields executed in similar methods of construction.

Table 1. *The Wadi Faynan field system: initial classification of wall types and features*

Wall types
1. cairn lines
2. terrace (wall unclear)
3. terrace wall (single face)
4. terrace wall (double face)
5. wide terrace or barrage (single face)
6. wide terrace or barrage (double face)
7. random linear stone line
8. rough-coursed linear feature (single face)
9. rough-coursed linear feature (double face)
10. coursed linear feature (single face)
11. coursed linear feature (double face)
12. double walls (channels? tracks?)
13. large boulder lines (laid flat)
14. large boulder lines (orthostatic)
15. large boulder lines, with smaller rough courses above
16. other (describe)

Wall features
1. corner cairn
2. T-shaped cairn junction
3. integral cairn
4. narrow built gap (probable sluice)
5. narrow built gap with adajacent down-wadi wall (probable sluice with baffle)
6. stepped feature (probable spillway)
7. angled construction of terrace
8. attached line structure

Site recognition

Although the Nabataean, Roman and Byzantine settlement hierarchy was in all probability dominated by the huge centre of Khirbat Faynan, it is abundantly clear as a result of the initial work of the Wadi Faynan Project that many smaller sites and structures of these and other periods exist in and around the field system. In particular, there is an almost continuous zone of cemeteries of all periods along the southern fringes of the fields, and in places within them too. Some sites are visible as physical structures, such as small enclosures, stone settings for graves, and deliberately constructed gaps or stepped features in the wall system that can be confidently recognized, respectively, as sluices and spillways (Fig. 10). Other sites will only be revealed by the systematic field-walking, especially those of prehistoric date, like a concentration of possibly chalcolithic pottery and flint noted in zone WF4.16 in the 1996 wall survey. In this initial phase of our work, we concentrated on the area of the field system, within which the archaeological features

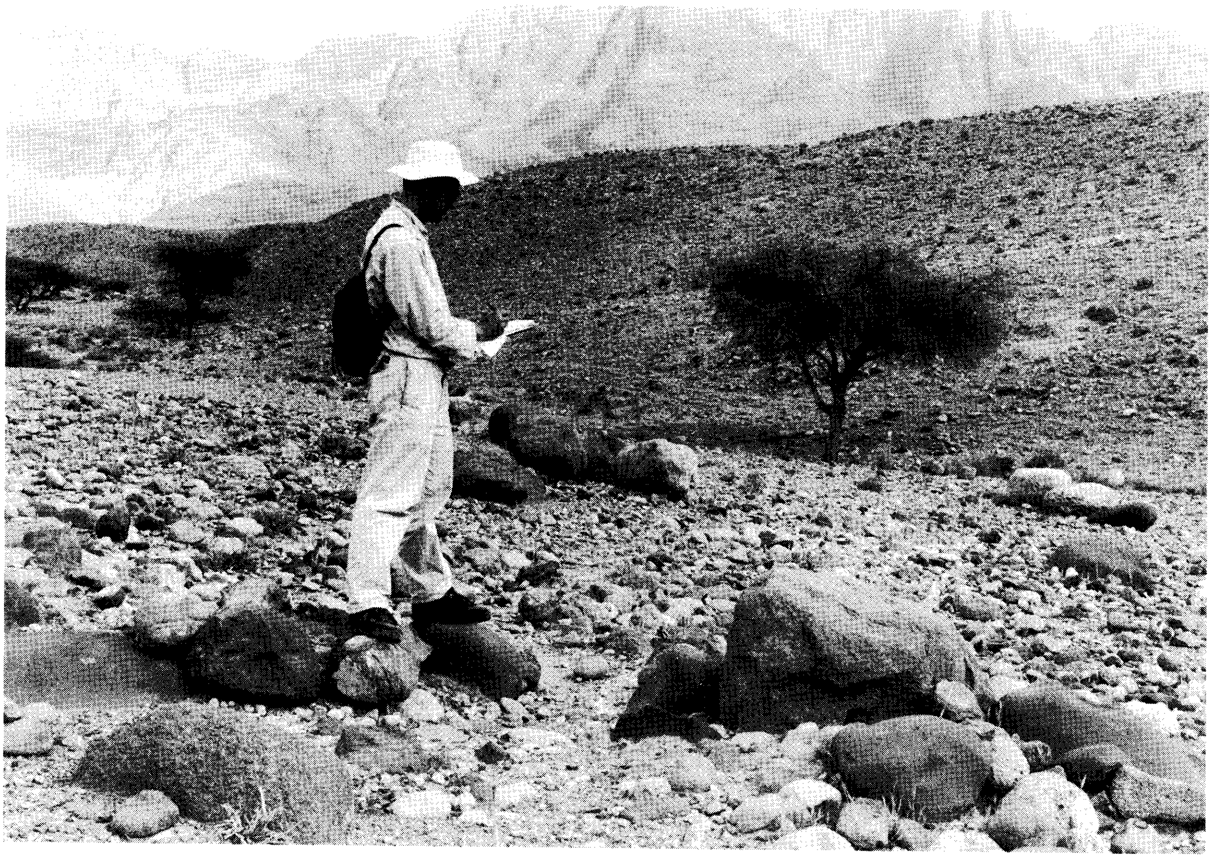

Figure 10. *A typical sluice in the Wadi Faynan field system. (Photograph: G. Barker).*

include a wide variety of domestic and funerary sites of different periods, but it is also clear from a few days' reconnaissance survey on the adjacent hill slopes that the entire study area bears the traces of a very long antiquity of complex domestic and ritual landscapes that remain to be mapped and analyzed.

Land use implications

The first point to make about the ancient farming of the area – as represented by the field system – is that it does not appear to have been dependent on irrigation using perennial stream sources, whether delivered by aqueduct or other means, along the lines of the modern irrigation systems.

However, neither do the wall systems of the terrace area appear to represent, as we had tended to assume at the outset of the fieldwork following our work on the ancient floodwater farming systems of Tripolitania (Barker *et al.* 1996), a systematic attempt to develop an effective means of trapping and delivering rainwater to farmed areas on the terrace surface. Whilst it certainly is the case that such floodwater farming did occur in the area, as in the Negev, this intention does not appear to have dominated the ideas of the builders of the walls in this area. The prime difference is the absence of appropriate catchments and water-harvesting catchment walls which were capable of entraining water from outside the farmed area. Neither did the ancient topography of the terrace help: the undulating terrain prevented the ready transfer of rainwater from areas of natural abundance, such as the fan deposits at the edge of the terrace, to the main areas of enclosed land further north.

Nevertheless, at a very localized level, a hydraulic function of some walls can be discerned. For example, two sets of walls were reliably identified as water distribution systems, one in WF4.6 (Fig. 9) and the other traversing WF.10 and WF4.15 (Fig. 8). Both systems took water from one of the four minor gullies that run down the long slope of the terrace and redistributed it through a series of walled channels (Fig. 11) to areas significantly downstream of the water intake. Another kind of system was found in WF4.3, at the south-eastern margins of the field

Figure 11. *Part of the channel system traversing WF4.10 and WF4.15. (Photograph: G. Barker).*

system, where walls running obliquely in a herring-bone pattern down the mountain sides trapped both overland flow and gully flow and led this water into the fields below (Fig. 12).

These are very preliminary observations, and on the experience of the Tripolitanian study of wadi walls and ancient floodwater farming, the analysis of the Wadi Faynan field system is going to require from the team a substantial accumulation of detailed topographic awareness and appreciation of wall technologies, typologies and associations, as well as input from the field-walking programme, if we are to understand how the system developed and functioned.

Impact of modern activity on the field system

The considerable impact of the current farming regime and grave-robbing on the extant archaeological remains poses a clear and urgent threat to the long-term survival of the remarkable archaeological landscapes of the Wadi Faynan. Further evidence for the gathering pace of damage was recorded (see below).

Discussion and conclusion (GWB, with DDG and DJM)

The initial campaign of geoarchaeological fieldwork has proved extremely successful in providing a first framework for the landscape history of the study area and in establishing methodologies for systematic and detailed investigation in future seasons.

The provisional geomorphological event sequence we have been able to construct indicates that the present landscape of the Wadi Faynan is the result of complex interactions between natural and human processes including climatic fluctuations, tectonic activity, agriculture and mining. Whilst unfortunately we do not, as yet, have adequate evidence to set out more precisely their geomorphic significance, laboratory analyses of the samples taken in the fieldwork should help resolve these problems. Perhaps