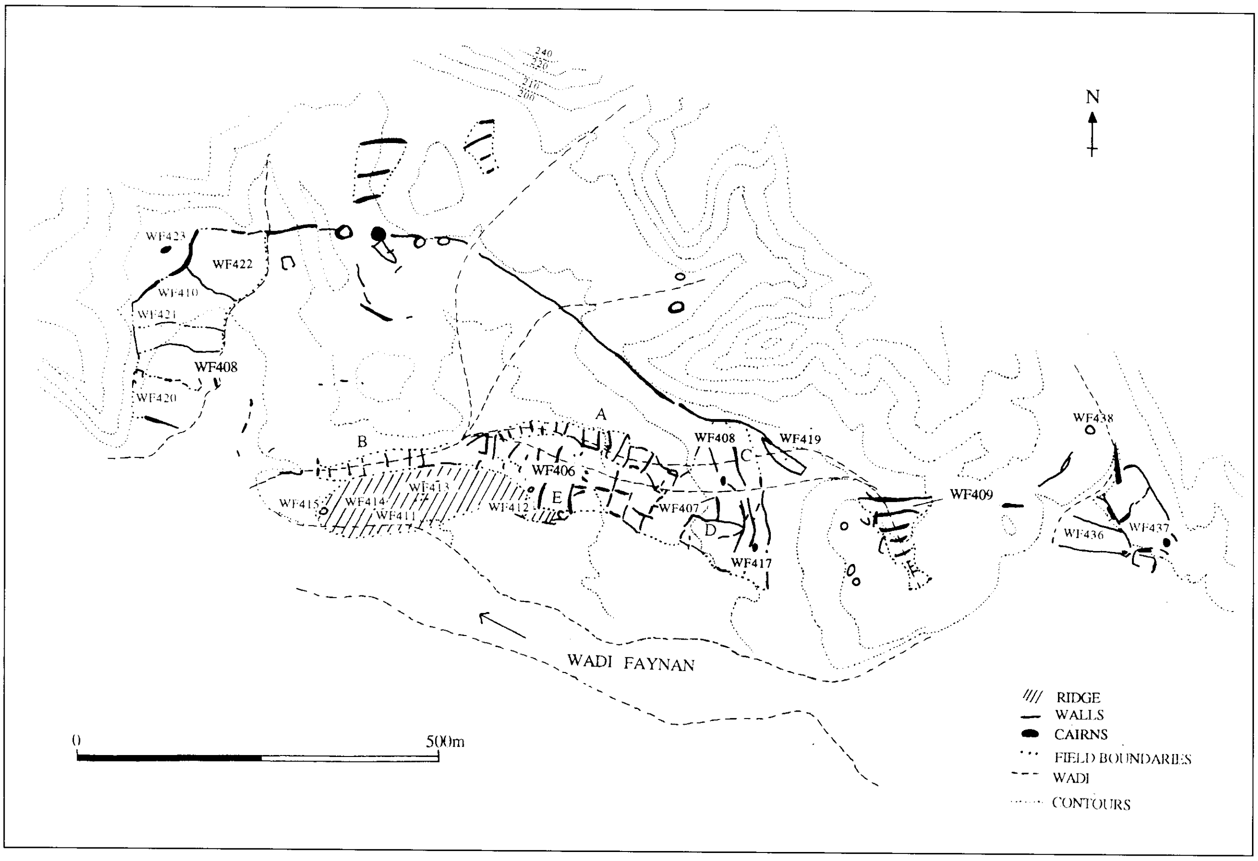

Figure 13. *Survey units WF408 (left), WF406 (centre) and WF409 (right) on the northern side of Wadi Faynan. Contours in metres.*

earlier (HAM, COH). Since some of the marks were also found on stones reused in the extant field walls, it would appear that the 'Nabatean' field system had itself evolved and changed over time, or that there was cultivation in progress even before the construction of the Nabatean system.

Another notable feature of the archaeology of this unit is the presence of a large number of cairns, some within the fields, others incorporated in their boundary walls. Some of these cairns may overlie burials or other monuments of bronze age (or pre-Nabatean) date, but almost all showed signs of having been enhanced in the Nabatean and Roman periods, with the dumping of additional stone (often retained by kerb walls). In a few cases, it was clear that the cairn had originated as a clearance dump, constructed over some substantial feature of earlier date. Without further excavation, it is impossible to verify the number and nature of pre-Nabatean structures below the visible cairns. Most of the cairns did produce sherds of Nabatean or Roman pottery as well as bronze age wares and lithics when sherded.

The surface evidence from unit WF4.13 suggests that there was a very substantial settlement of early bronze age date here. The material is mainly concentrated on the terrace on which sits the later field system, but large middens of early bronze age date have been identified extending beyond both the eastern and western limits of the unit. There are several areas of dense boulder walls surviving, notably in the north-eastern and south-eastern sectors of the unit and in the north-western area behind the major terrace wall. The south-western sector is less well-preserved because of recent agriculture, which has undoubtedly damaged some structures here. Figure 10 (upper map) shows the main evidence recorded in the 1998 season. Not all the boulder walls indicated can be guaranteed of early bronze age date, of course, especially as some of the reused boulders were laid in rough courses in Nabatean walls, but both where they appear as built lines or as individual stones incorporated into later walls, it is likely that they derive from boulder-built walls which were originally very close by.

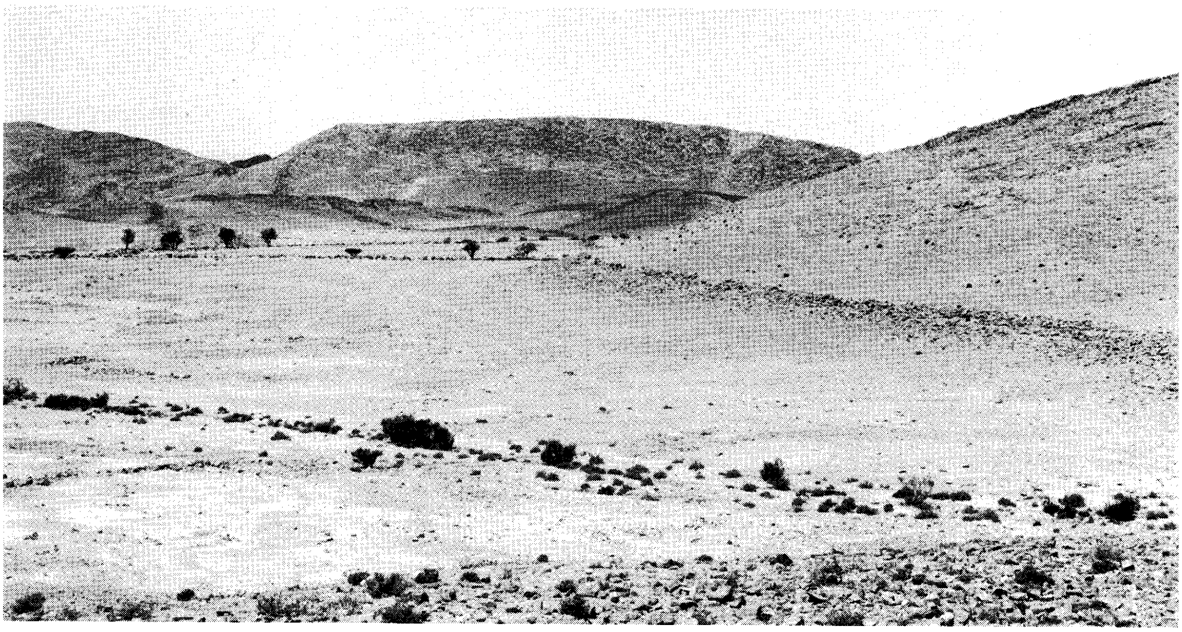

Figure 14. *View westwards across WF406; the diversion boulder walls are visible along the base of the hills on the right and in the centre distance; slight terrace walls thought to be of bronze age date lie in the centre of the picture between the wadi marked by the line of bushes in the centre foreground and the right-hand boulder wall; more substantial walls of later date lie to the left of the wadi in the left foreground. (Photograph: G. Barker).*

Figure 15. *Wall WF407, one of the WF406 walls assumed to be of iron age and Roman date on the basis of surface pottery, where a large sherd of chalcolithic/bronze age pottery was found a metre below the wall, by the 50 cm. scale on the right. The location of wall WF407 is shown on Figure 13. (Photograph: G. Barker).*

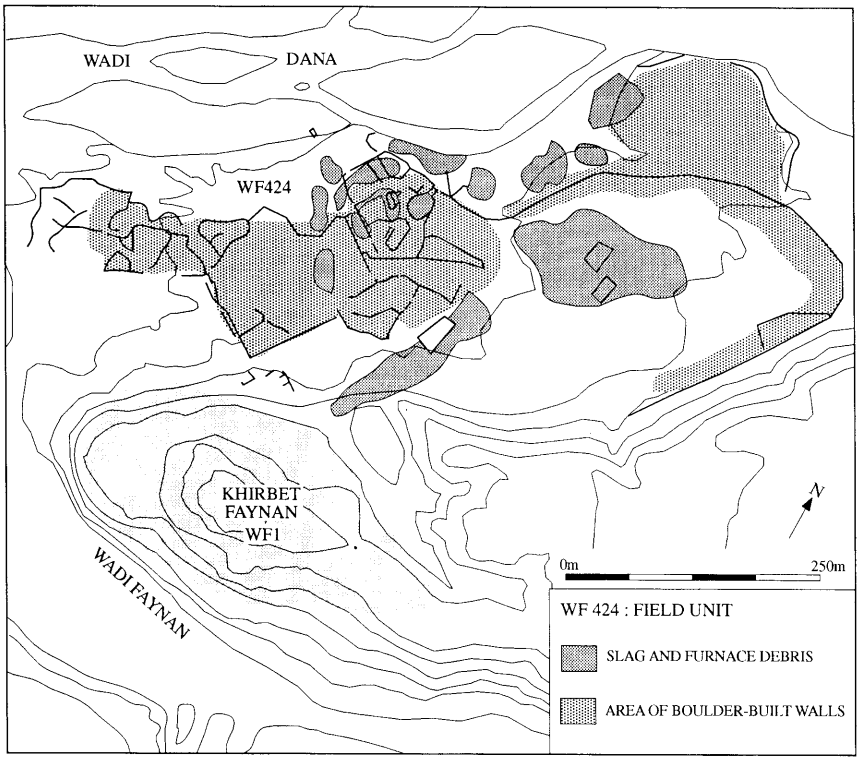

Figure 16. *Field unit WF424, showing major walls (black lines) as marked on the photogrammetric map, areas of other boulder-built walls (presumed mainly iron age in date) and main slag and furnace debris concentrations (mainly Roman in date).*

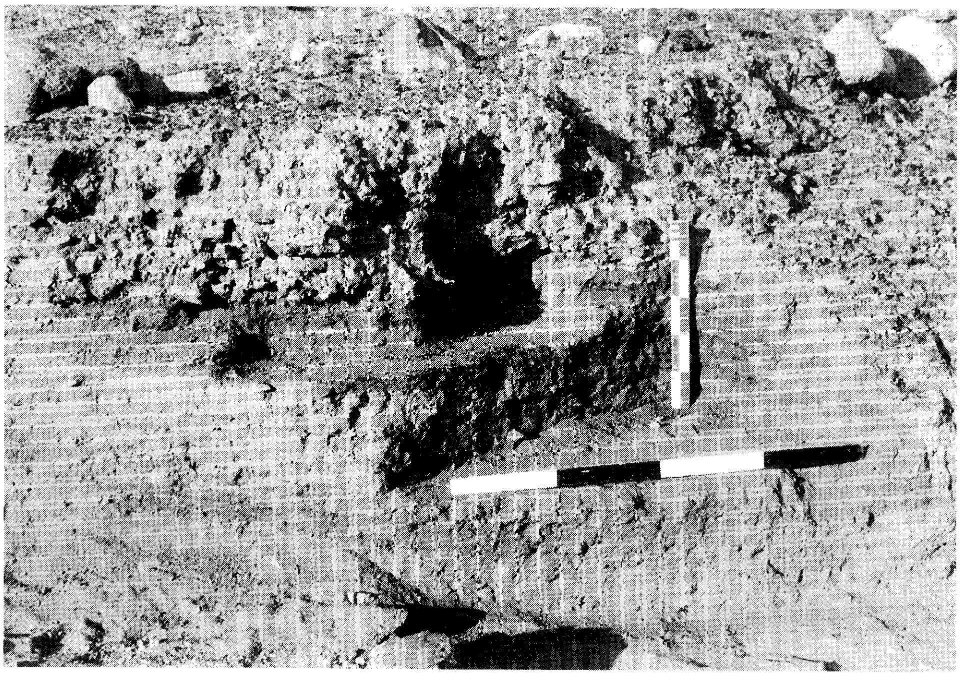

Figure 17. *WF424, showing Roman slag and furnace deposits overlying iron age occupation deposits with metal-working debris. Scales: vertical 50 cm., horizontal 80 cm. (Photograph: D. Mattingly).*

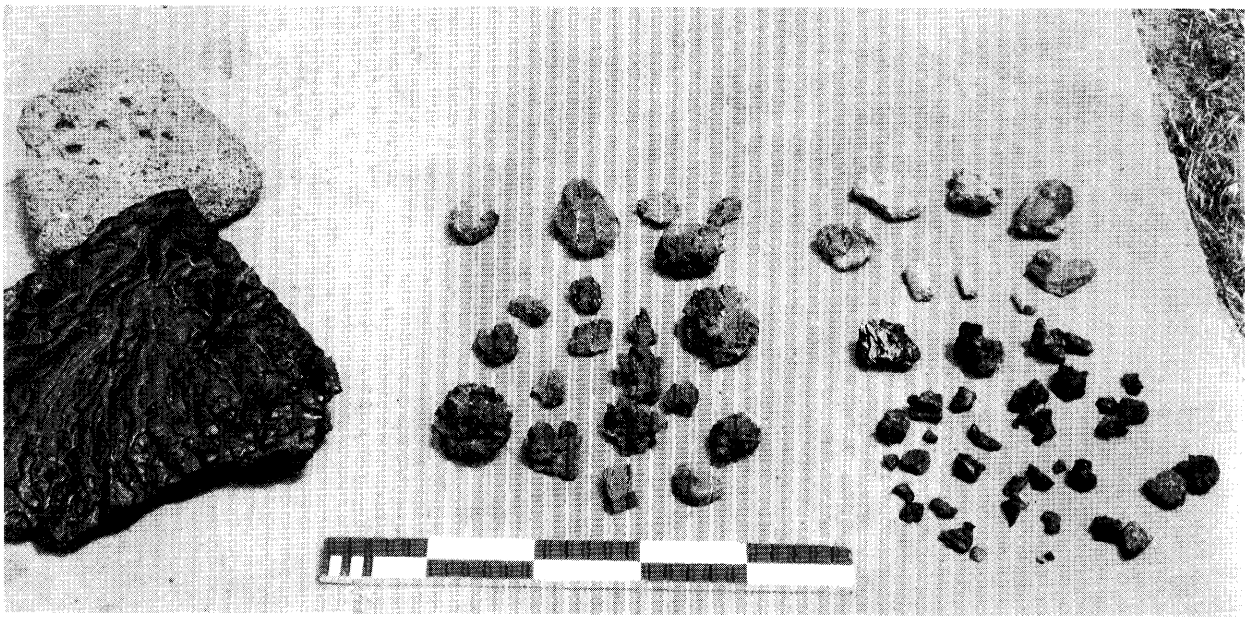

Figure 18. *Roman (left), iron age (centre) and bronze age (right) slag and furnace-wall fragments from WF424. Scale: 50 cm. (Photograph: D. Mattingly).*

Field systems north of WF4 (GWB)

To the north of WF4, we surveyed a complex arrangement of separate but probably linked systems based on harnessing the water flow of two minor tributary wadis. The small wadis occupy two small valleys that open up into wide flat areas beside the main wadi, one wadi cutting through to the western valley from the eastern one. The systems were recorded as (from west to east) WF408, WF406 (the principal complex), and WF409 (Figs. 13 and 14). A notable feature of the system is the large boulder walls surrounding it, which our preliminary survey indicates were mostly built to capture floodwaters moving downslope and concentrate their flow so that most of the floodwater entered the valley floor at the eastern end or head of the WF406 system before moving westwards across WF406 to the main Wadi Faynan. A few segments of these walls, however, do not seem to have floodwater-control functions, and it is likely that land division and demarcation were additional functions of the system. The distribution of surface pottery suggests that the simple cross-wadi walls in the northern part of WF406 (marked A and B in Figure 13) are most likely to be bronze age in date, whereas the larger more complex walls (C, D, E) are later, probably iron age with reuse in classical (and later) times. Though the dating remains very speculative, a large sherd of chalcolithic or early bronze age pottery found in silt one metre below one of the latter walls (Fig. 15) is an indicator of the time depth that is probably represented by this system.

The iron age landscape of WF424 (DJM)

The examination of the unusual field unit WF424, situated in the Wadi Dana east of its confluence with the Wadi Faynan immediately by Khirbat Faynan, produced some highly significant archaeological data: we have discovered a major iron age site lying immediately north and north-west of Khirbat Faynan (WF1), with associated metallurgical workings and probable field systems (Fig. 16). The morphology of the field unit was quite distinctive and rather different from most of the obvious hydrological systems examined in the other field systems. Just as with unit WF4.13 (see above), this is another case where close examination of the visible archaeology suggested two distinctive constructional phases. Once again, the earlier phase comprised numerous walls founded on lines of boulders, often set orthostatically. In this case the bulk of the surface material is iron age in date, and although analysis of the pottery (and indeed of the field unit) is far from complete, a few tentative comments can be offered.

The boulder-built walls can be traced over a very considerable area (*c.* 500 m. east to west); while some of these appear to be field or enclosure walls, others have more the appearance of structures. The

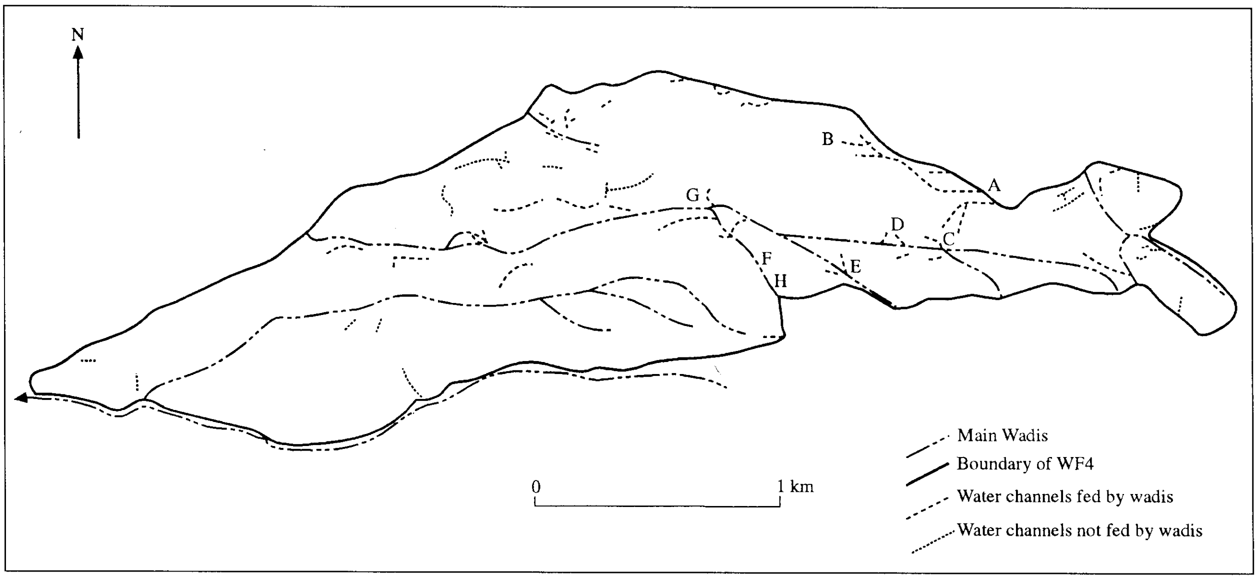

Figure 19. *Field system WF4, showing the principal surviving parallel-wall channels associated with water management and floodwater farming, probably mainly Roman/Byzantine in date.*

density of the iron age material suggests that we have a substantial occupation site here along with its associated field systems, which was later overbuilt by an extended field system, encapsulating many elements of the earlier structures into its rather haphazard layout. The dating of this second phase is not certain at present, but may well be Nabatean to judge from the surface sherds.

In addition to the two main constructional phases suggested by analysis of the wall systems, it is clear that the area has also witnessed a significant level of copper smelting and other industrial activity. There are numerous mounds of tap slag and furnace debris, evidently of Roman date to judge from comparative material, which extend over a substantial area of the eastern part of field system WF424. It is hard to reconcile this material with the interpretation of the final function of the wall system here as related to farming activity: the air-borne and terrestrial pollution of such large-scale industrial activity – evidenced nearby (*c.* 150 m.) in the sediments from behind the Khirbat Faynan barrage (Figs. 6 and 7) – must have had a very considerable impact on the continued usage of this part of the field system for farming. Furthermore, during our examination of these Roman metal-working areas we discovered, in a gully of recent formation cutting through some of the Roman slag and furnace deposits, a lower level of metal-working debris (Fig. 17). This contained furnace debris of a fabric that is very distinctive in comparison with the slag-tempered Roman furnace walls, together with slags of radically different visual appearance to the Roman tap slag (Fig. 18). The association of iron age pottery would seem to indicate an iron age date for this metallurgy. Further work will be carried out in 1999 to confirm and amplify these important findings.

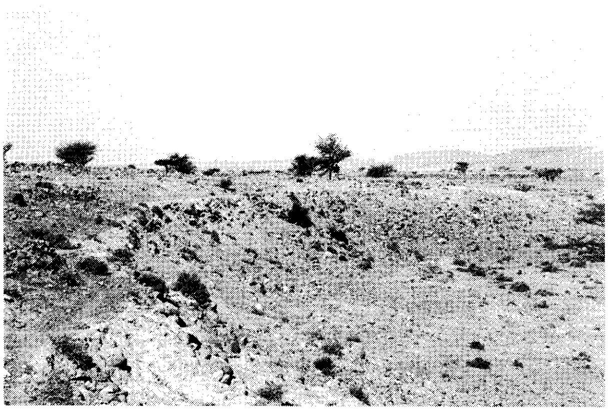

Figure 20. *A parallel-wall channel designed to divert water from the main Wadi Faynan into the WF4 field system; the channel is visible lower left, and curves round to the figure standing by the tree in the centre, middle-distance (Figure 13: A–B). (Photograph: G. Barker).*

Water management practices in the WF4 field system (OC, PN)

Following completion of artefact pickup and structural survey, an additional phase of extensive survey

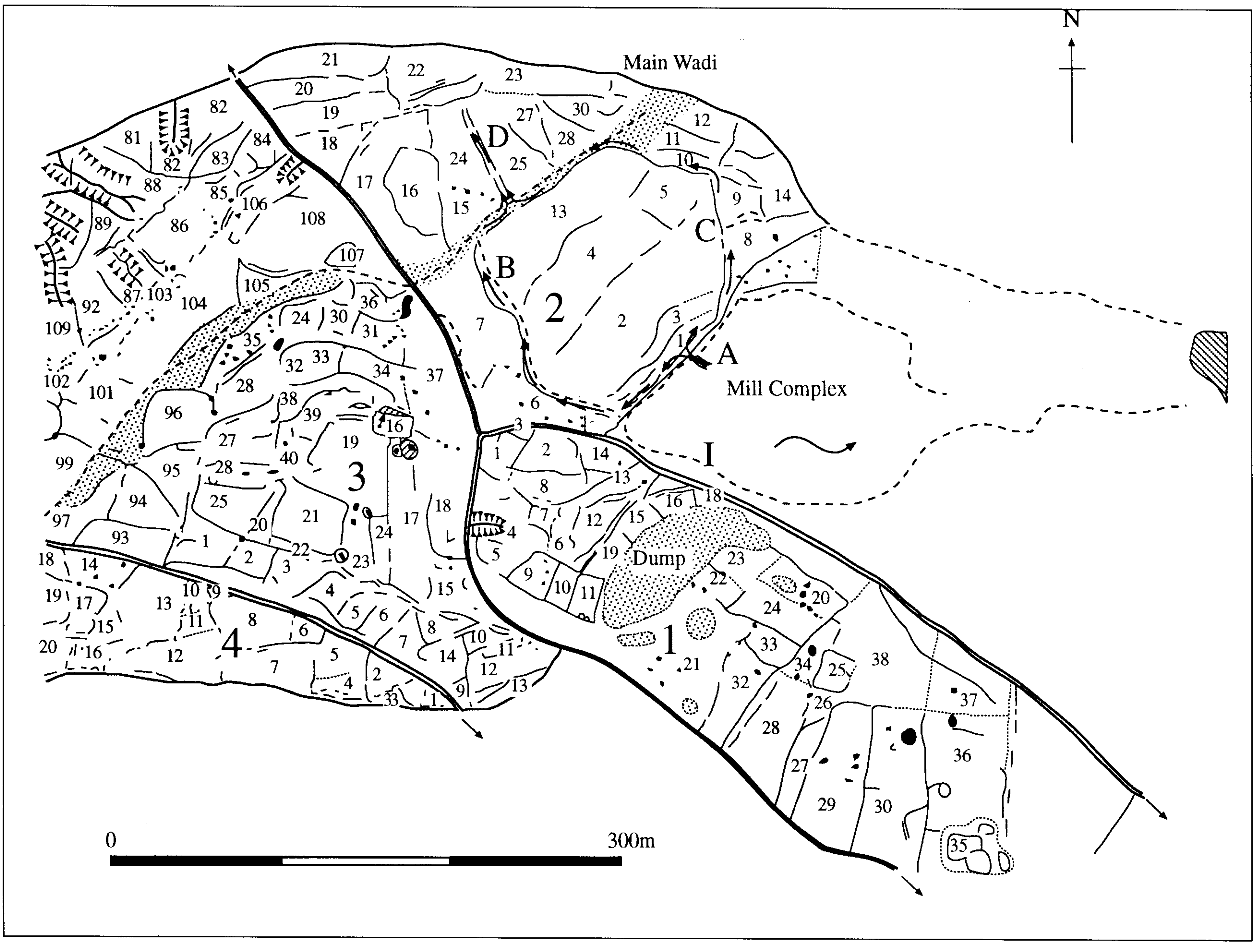

Figure 21. *Field system WF4.1–WF4.4, showing the mill complex and its associated evacuation channels through WF4.2 into the main wadi.*

within the WF4 field system aimed to enhance our understanding of water management practices. A principal focus was on the nature, function and possible dating of parallel walls forming channels, two of which we illustrated in our 1997 report (Barker *et al.* 1998: figs 5 and 6 [WF243 in WF4.3] and figs 10 and 11 [WF288 in WF4.5]). The 1998 fieldwork indicates that they can be divided into two principal types: those exploiting water from wadis through damming and diversion, and those re-directing overland flow (Fig. 19). Initial indications are that channels associated with the direct tapping of wadis tend to be wider (*c.* 2–2.5 m.), and formed by parallel free-standing walls, whilst those capturing and re-distributing overland flow are predominantly formed by a dwarf wall at the foot of a faced terrace.

Field observation demonstrates clearly the tapping of the main Wadi Faynan (even though down-cutting since Roman times has moved the floor of the wadi some five metres below the present level of the fields) to irrigate a narrow strip of fields along the northern fringes of the system, a good example being a sinuous alignment of parallel walls defining a low terrace alongside the main wadi in unit WF 4.6 (Fig. 19: A–B; Fig. 20). Most channels directly tapping the main wadi appear to deviate to the south before continuing west, presumably to use the velocity of the floodwaters to spread the flooding as far as possible into the main body of the field system before allowing it to flow westwards out of the system. Elsewhere, the minor wadis entering the system from the south are tapped, with a particular concentration at the confluence of wadi channels so as to exploit maximum volumes of water: at such places, parallel channels were often built in a herringbone pattern at an angle of roughly 45° to the channel to divert floodwaters onto the fields on either side (Fig. 19: C–G). In all these instances the wadis have

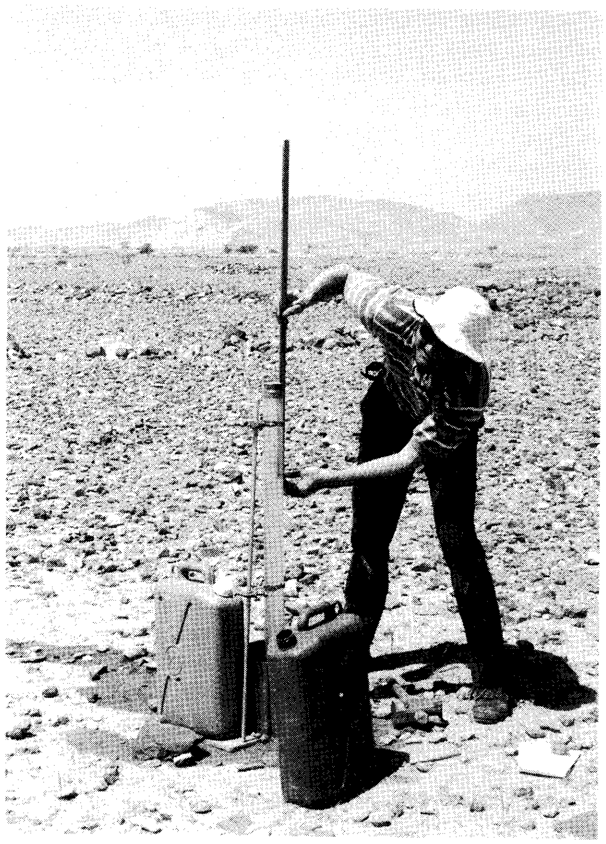

Figure 22. *Measuring water infiltration rates in the WF4 field system. (Photograph: G. Barker).*

downcut considerably since the construction of these diversion walls: in one instance a revetment wall constructed at the level of the original wadi bed (Fig. 19: H) is presently *c.* 2.5 m. above the wadi base.

A more atypical instance of water management was demonstrated in unit WF4.2 (Fig. 21). Water from the tail race of the Roman mill (Fig. 21: A) was diverted via a perimeter wall around fields WF 4. 1, 2, 3, 4, 5 and 13 (B, C), before discharging into the main wadi via an artificial channel (D). The mill was fed by water from a large stone-lined reservoir 100 m. further east, which collected water channelled from the Wadi Ghuwayr springs some 2 km. to the east by means of a rock-cut channel and (across the Wadi Shayqar) a substantial aqueduct (see below, Palaeohydrology). A likely explanation is that the mill was used primarily for ore crushing, and that the water discharging from it was sufficiently polluted to be unsuitable for agricultural usage. An additional implication of this hypothesis is that the arrangement of fields north-west of the mill complex in WF4.2 may pre-date the construction and use of the mill.

The distribution of the parallel-wall systems within the WF4 field system is also instructive. Water management is clearly intricately related to physical topography: parallel channels are a key feature of the field system only in the predominantly flat zone forming the northern half of WF4. Elsewhere, other modes of water management predominate. For example, on the higher ground on the southern side of the system, as discussed in our previous report regarding WF4.3 and WF4.4 (Fig. 21),

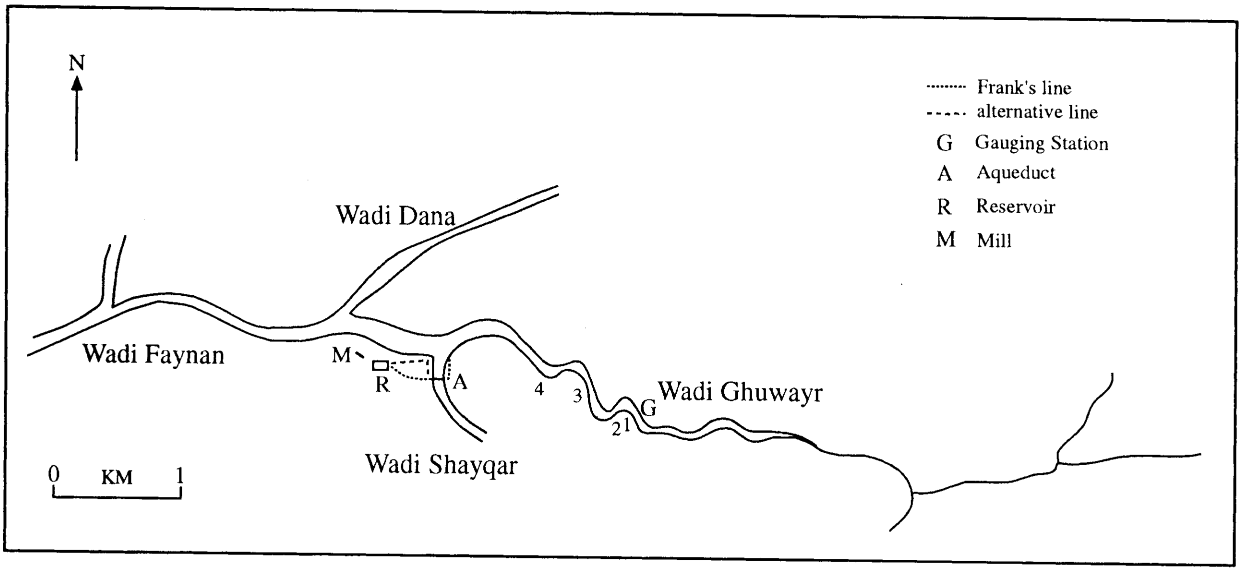

Figure 23. *Plan of the remnants of the Roman/Byzantine aqueduct conduit system.*