PART I
Research Themes, Methods, and Background

1. The Wadi Faynan Landscape Survey: research themes and project development

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1.1 Introduction

> Desertification: land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UNEP 1992).
>
> I searched for palaeohydrological clues to determine whether processes of flooding and desertification in the past were a function of climate changes or human activity. A good example is the desertification of the cities and agricultural farms that flourished in Nabataean, Roman, and Byzantine times in the arid part of the Levant. Most contemporary archaeologists, historians, and ecologists maintain this desertification was for anthropogenic reasons. (Whilst) this investigation was progressing … the natural cause became more and more convincing (Issar 2003: xiii).

This book explores the evolution of the human and natural landscapes of the Wadi Faynan in southern Jordan, situated at the mountain front where the lowland hyper-arid deserts of the Wadi 'Arabah in southern Jordan meet the rugged and wetter Mountains of Edom (Figs 1.1, 1.3). It seeks to demonstrate how interdisciplinary landscape archaeology can provide a long-term perspective on how people in the past coped with and managed the risks of living in what is now a difficult and arid environment – the research problems emphasized in the definition and quotation above.

A common feature of a well-structured final publication of an archaeological and palaeoenvironmental field project such as the Wadi Faynan Landscape Survey is an introductory chapter that outlines the aims and objectives of the field programme. This normally begins with the general research problems that interested the project director(s) at the time the project was being planned, followed by the justification of the selection of the site (in the case of an excavation) or the study area (in the case of a survey project) as the ideal 'laboratory' where these problems could be appropriately addressed. Usually the next stage is to elaborate the methodologies used: commonly we learn that the need for a multi-disciplinary approach was recognized at the outset, and a multi-phase strategy was then devised for its effective implementation. In publishing their previous field projects, the authors of this chapter have written exactly these kinds of introductory discussions (Barker 1995; Barker *et al.* 1996a; Coccia and Mattingly 1993; Gilbertson *et al*. 1996; D. Mattingly 1992; Mattingly *et al.* 2003).

Yet all fieldworkers know that the practical reality of how a major field project actually develops on the ground is invariably rather different, a combination of vision (we hope!), strategic planning, and tactical responses to successes and failures and to new opportunities and setbacks, all shaped by other factors such as financial constraints, career changes of personnel, and the effects (especially in arduous and difficult terrain) of weather conditions, equipment failures, injury, health and safety considerations, and much more besides. But in the midst of this confusing reality, the interaction between theory and practice, between changing questions and changing data, remains the cornerstone of the fieldwork process; on it rests the intellectual framework in which the discipline is practised. In this chapter we reflect on the development of, and interaction between, the project's research goals and methodologies, as an introduction to the chapters that follow dealing with the evidence gathered by the project's field and laboratory investigations and their contribution towards those research goals.

1.2 Background and research context

The background to the project was a visit made by one of us (Graeme Barker, then at the University of Leicester) to the Wadi Faynan in early spring 1995 as a member of a review committee of the British Academy visiting BIAAH, the British Institute at Amman for Archaeology and History (later, following the review, incorporated within a new Council for British Research in the Levant). BIAAH

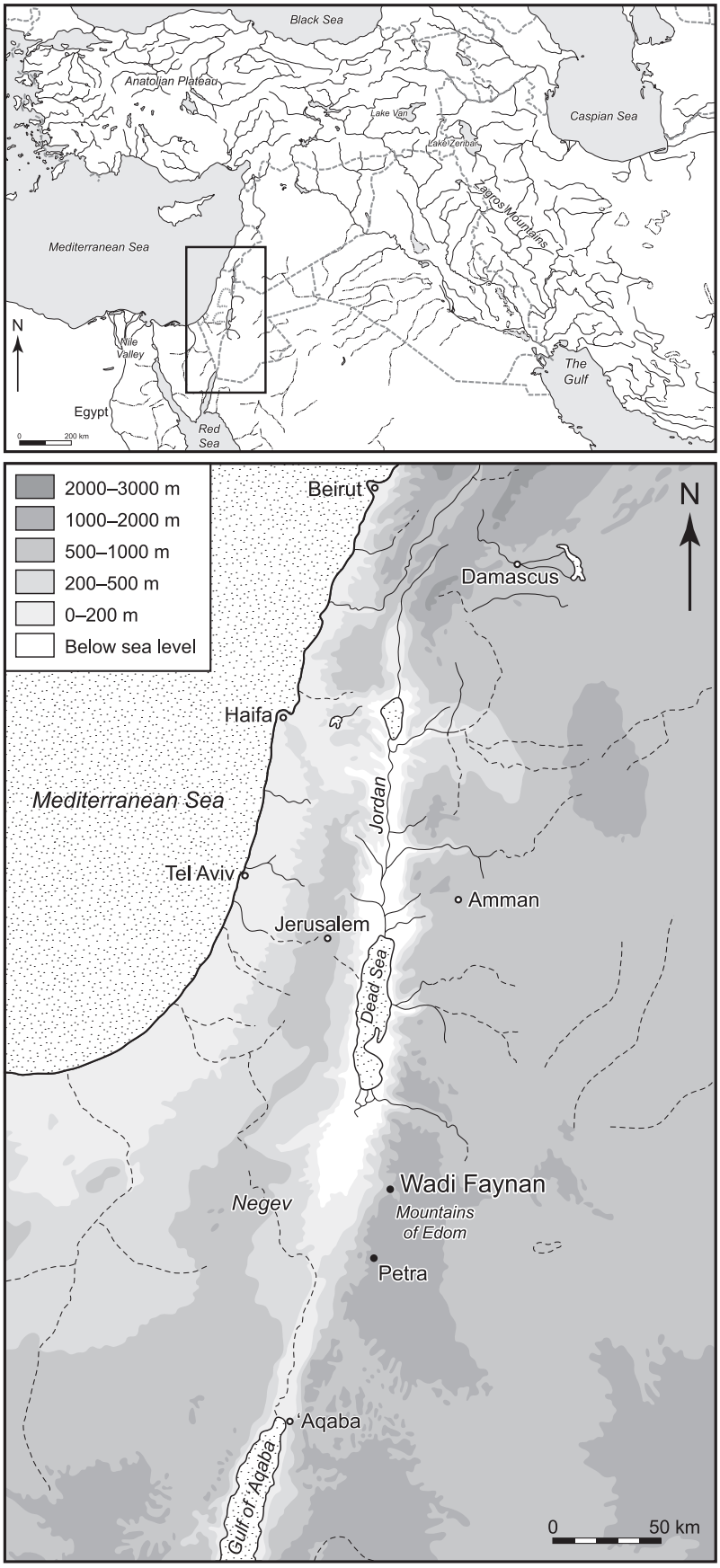

Figure 1.1 *Southern Levant, showing the location of the Wadi Faynan in its regional context. (Illustration: Dora Kemp.)*

was one of the series of overseas British Schools and Institutes that the British Academy funds to facilitate research by British scholars in the humanities. Archaeology has traditionally been a major focus of interest for these institutes, and in common with their sister institutions subject to the review, BIAAH arranged visits to areas of current archaeological fieldwork to illustrate their activities to the committee. It was within this context that the BIAAH staff took the review committee for a short tour of southern Jordan that included a few hours visiting Wadi Faynan, which is situated about 50 km south of the Dead Sea and about 50 km northwest of Petra.

The Wadi Faynan forms as three main tributary wadis (the Dana, Ghuwayr, and Shayqar) combine after they have cut through the mountain front that forms the western edge of the tablelands of the Jordanian Plateau, and to the south, the rugged Mountains of Edom (Fig. 1.2). The wide and shallow gravel floor of the braid-plain of the Wadi Faynan then passes due westwards through gently-sloping colluvial and alluvial fans for about 5 km and then, as the Wadi Fidan, swings northwest for about the same distance before debouching onto the floor of the rift valley of the Wadi 'Arabah (Fig. 1.3). The plateau above the Wadi Faynan, at *c*.1100 m above sea level, receives more than 200 mm of rainfall a year, so a Mediterranean-style rain-fed agriculture is practised by the modern inhabitants, whereas the Wadi Faynan just 4–5 hours' walk lower down has an extremely dry desertic climate that is rainless for most of the year and its sparsely-vegetated landscape is used predominantly by bedouin goat herders. (Present-day land use is described in Chapters 2 and 12.)

The richness of the archaeological remains in the Wadi Faynan has long been known to European travellers and explorers (Glueck 1935; Musil 1907). The main focus of their visits was a complex of imposing structures at the foot of the escarpment near the confluence of the three tributary wadis, dominated by a major archaeological monument called Khirbat Faynan, 'the Ruin of Faynan' (Figs 1.4, 1.5), which they dated to Nabataean, Roman, and Byzantine times (*c*.300 BC–AD 700) on the basis of its surface pottery. Amidst a dense tumble of sandstone masonry Glueck was able to discern a large central rectangular complex surrounded by subsidiary buildings, including two

Figure 1.2 *Looking westwards from the mountain front near Dana Village down the gorge of the Wadi Dana towards the lowlands of the Wadi Faynan. (Photograph: Graeme Barker.)*

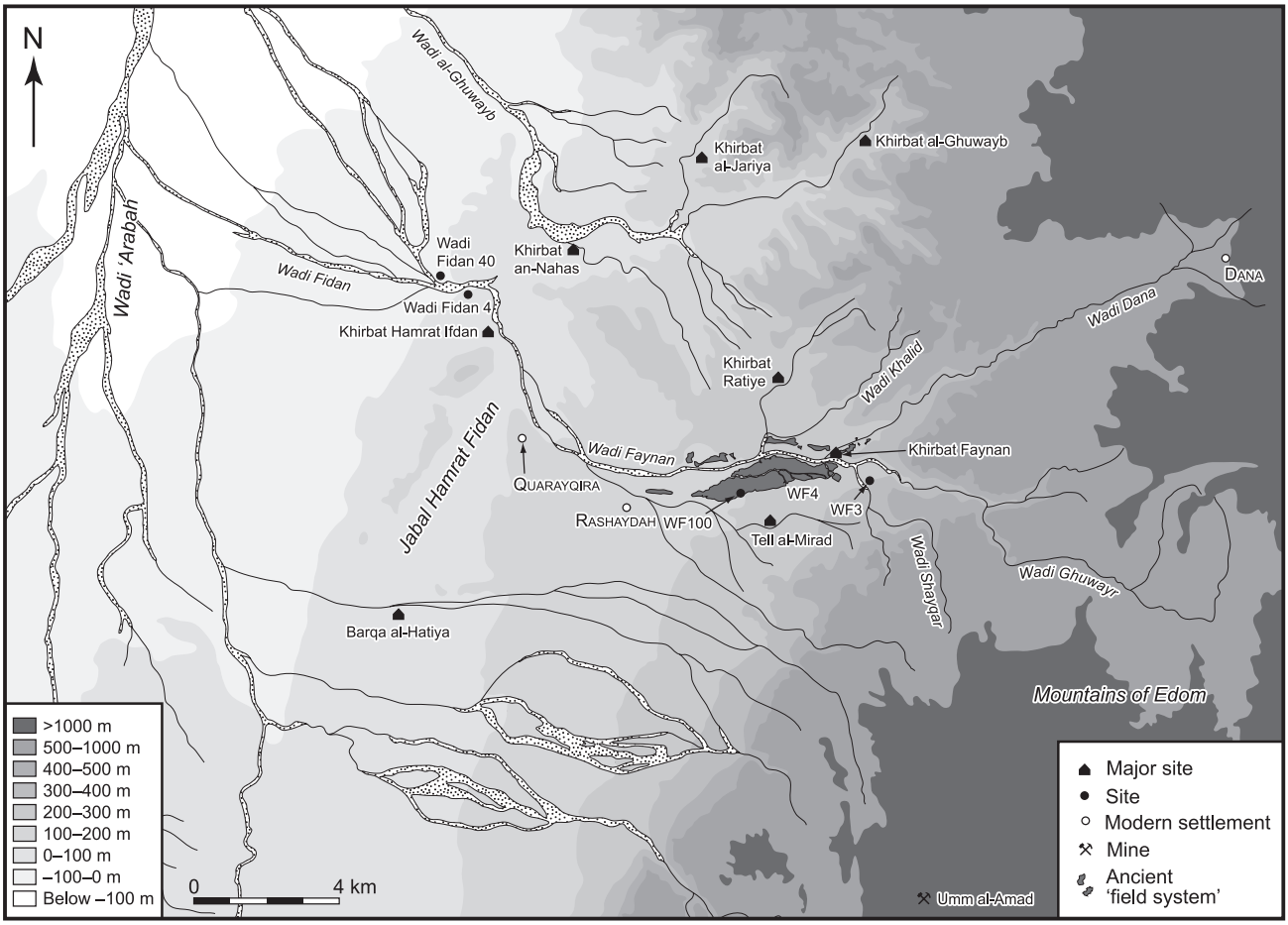

Figure 1.3 *Topography of Wadis Faynan, Fidan, Dana, Ghuwayr, al-Ghuwayb, and Shayqar in relation to the major archaeological sites and the ancient 'field system' WF4. (Illustration: Dora Kemp.)*

Figure 1.4 *Aerial photograph of the eastern section of the wide braid-plain of the Wadi Faynan, looking east, showing its confluence at Khirbat Faynan. Upstream of this confluence are the braid-plains of the Wadis Dana, Ghuwayr and Shayqar. The major ancient (Nabataean, Roman, Byzantine) settlement of Khirbat Faynan is on the promontory on the north bank of the Wadi Faynan; to the west, on the south bank, is a vast near-circular mass of black slag as a result of copper smelting. Further west is the large square reservoir and its feeder conduit, the linear feature to its east. Further east of the slag mound are the remnants of the aqueduct at the eastern margin of the Wadi Shayqar. Networks of walls – ancient fields – are visible both to the south (WF4) and north of the Wadi Faynan. (APA98/SL38.22, 20 May 1998 = Kennedy and Bewley 2004, 214, fig. 11.10A.)*

Byzantine churches. On the opposite (southern) side of the main channel were further monuments, apparently of similar antiquity, including an aqueduct, a reservoir, and a watermill. The hill-slopes around these monuments were black with slag, the residues of ancient copper smelting, and in places, the surrounding hills were honeycombed with ancient mining shafts (Fig. 1.6). It had long been recognized that Khirbat Faynan was very likely to be the ancient settlement variously named *Pinon, Punon, Phunon, Phaino* in the Bible and in Greek and Latin sources and described as the centre of a copper-mining industry (Hauptmann 2007: 39; Lagrange 1898), including references to Christians of Palestine and Egypt being transported there as slave labour in the third and fourth centuries AD. As he travelled down the Wadi Faynan after visiting Khirbat Faynan, Glueck also noticed walls made of cobbles and boulders indicating 'large stretches of formerly cultivated fields … strewn with Nabataean sherds' (1935: 35). These 'field systems' extended for several kilometres down-wadi from Khirbat Faynan, especially along the southern side of the wadi channel. (Throughout this report, the terms 'field' and 'field system' are to be read as though within inverted commas: see below, Chapter 5 for a discussion of the complex interpretational issues and potential problems with the presumption that all such walls in the landscape demarcate fields.)

The northern side of the Faynan channel forms the southern boundary of the Dana Nature Reserve managed by the Royal Society for the Conservation of Nature. In March 1995 a small team from BIAAH conducted a reconnaissance survey of the wadi's archaeology in order to assist the RSCN with the development of its management plan for the reserve (Barnes *et al*. 1995; Ruben *et al.* 1997). The survey, conducted as a series of approximately north–south transects at right angles to the west–east orientation of the main wadi channel, found widespread evidence for ancient settlement in the form of surface collections of stone tools and/or pottery, often associated with stone-built structures, both within the zone of ancient fields and in the hills on the northern side of the wadi. It also suggested, from the evidence of the surface finds, that the main field system flooring the wadi (classified as WF4 in the team's survey register) probably dated to Nabataean, Roman, and Byzantine times, like Khirbat Faynan. Another team made the first detailed ground plan of Khirbat Faynan in terms of the structures that could be discerned on the surface without excavation. In the decade before our project, the ancient mines and mining technologies of the Faynan region had also been the subject of intensive study by the Bochum Mining Museum, work that had demonstrated a rich prehistory and history of copper mining and smelting beginning in the Chalcolithic period in the fourth millennium BC and continuing with greater intensity up to and including the Byzantine period, with a brief resurgence in Islamic times (Hauptmann 1989a,b; 1990; 1992; 1997; 2000; 2007; Hauptmann *et al.* 1992). At the time of the British

Figure 1.5 *Wadi Faynan, looking east, showing the ancient settlement Khirbat Faynan in the middle distance, field systems of comparable age in front of it, and the gorge of the Wadi Dana. (Photograph: Graeme Barker.)*

Figure 1.6 *A typical ancient mine (WF1469) in Wadi Khalid, a northern tributary of the Wadi Faynan; looking northeast across the Wadi Faynan to the Mountains of Edom. (Photograph: Graeme Barker.)*

Academy's review visit, BIAAH was also coordinating a programme of rescue excavation, in collaboration with Yarmouk University, of a large cemetery of mainly Byzan-

tine date, termed the South Cemetery (WF3: Fig. 10.26), at the foot of the escarpment on the southern side of the Wadi Ghuwayr, at the request of the Department of Antiquities in response to the threat to the site from extensive grave robbing. The British Academy's review committee was brought to see Faynan's remarkable archaeological monuments, the site of the cemetery rescue excavation, and the location of the survey, because BIAAH was keen to build on the fruitful collaborations it had established in Faynan and to facilitate further involvement by British archaeological teams.

The main focus of interest for the rest of the committee members during the visit was Khirbat Faynan and its churches, and the aqueduct, reservoir, and mill nearby, but the field system, though far less prepossessing, struck a particular chord with Graeme Barker. At the time of the review he was engaged in the preparations for the final publication of an archaeological survey project he had co-directed in the Tripolitanian Pre-desert in northwest Libya, termed the UNESCO Libyan Valleys Survey, the principal focus of which were Roman-period farmsteads and their associated wall and field systems (Barker *et al.* 1996a). These remains were *prima facie* evidence that the desert margins of Libya, now inhabited by semi-nomadic pastoralists, had been characterized in Roman times by settlement and land-use systems very different from those of today. In funding the project, UNESCO gave the team the specific brief to try to understand when, how, and why the desert margins of Libya had been settled and farmed intensively in antiquity, to inform modern plans for agricultural development in the same region. The project found that the indigenous Libyan population had moved from subsistence to cash-crop farming in response to the economic opportunities of the Roman empire, but the team's environmental scientists established that there were no reasons to believe that the climate of the region in the Roman period was profoundly different from that of today, so agricultural intensification did not necessarily need to be explained in terms of a significantly wetter, more benign, climate. Instead, the project concluded that the settlement transformation had been made possible by the development of rather sophisticated systems of floodwater farming: the people built enormous numbers of dry-stone walls, many of them very substantial, to collect the floodwaters of seasonal downpours on higher ground, guide them down to the wadi floors, and trap them there in wall-enclosed fields – technology and practices that we identified could still be found in the region today.

The apparent similarities between the Tripolitanian and Faynan field systems posed obvious questions about the latter. Did they represent similar solutions by Classical farmers in Jordan to coping with a similarly arid environment? When had they been built? For how long had they been used? Did the almost 5 km of the main field system (WF4: Figs. 1.3, 1.4) represent something that had grown organically and piecemeal over a long period, or a planned system laid out and maintained more or less as an integral system, or a combination of both? What did the walls represent in terms of systems of land use? What were the social and economic contexts in which such an investment in wall-building became attractive or necessary? And when and why did the field systems go out of use and the present-day system of pastoral-dominated settlement develop? The study of such issues relates to wider debates about the past, present, and future of arid lands that formed the primary research context for the project, that is, about the processes of 'desertification' as defined by UNEP (1992) given at the beginning of this chapter.

1.3 Archaeology and desertification

In their archaeological evidence that there must once have been intensive phases of settlement in what are now dry and degraded environments, the Tripolitanian Predesert and the Wadi Faynan are typical of many dryland regions around the world (Barker and Gilbertson 2000a). Archaeologists, historians, and geographers have frequently speculated about the causes of desertification in the past, generally identifying climatic change or human agency as the primary culprit. Perhaps the longer-term climate shifted to significantly greater aridity? Or was it that people over time sowed the seeds of their own destruction through their own actions, for example by developing inefficient irrigation systems that poisoned the land by salinization, or by stripping the landscape for fuel wood, or by allowing their livestock to 'overgraze' the vegetation resulting in extreme soil erosion?

In general, the debate on desertification or land degradation in the archaeological and historical past has been characterized more by confident assertion than well-founded argument: indeed, many explanations can be seen to be mutually incompatible or irreconcilable (Barker and Gilbertson 2000b). In writing up the Tripolitanian work we had become aware that, in contrast with most archaeological literature on past desertification processes, contemporary ecological theory for drylands, that introduced ideas of disequilibrial relationships and changing landscape sensitivity to natural and human impacts, suggested that interactions between dryland environments, climate, and people are by no means simple (Beaumont 1993; Gilbertson 1996; Thomas and Allison 1993). Modern case studies demonstrated that drylands could sometimes be remarkably resilient, recovering relatively quickly from alleged 'overgrazing' or 'overexploitation', and that simple procedures by farmers could often protect against the latter (Mortimore 1998; Thomas and Middleton 1994; Tiffen *et al*. 1994).

We were also aware of similarly marked differences between past and present thinking on the nature of climatic change through the Holocene, the modern climatic era that developed after the end of the Pleistocene (the 'Ice Ages') *c*.10,000 years ago. In his influential book *Water, Weather, and Prehistory* (1967 [1984]), the engineer-hydrologist Robert Raikes, one of the pioneers of palaeoenvironmental research in the Faynan, concluded

Figure 1.7 *Ploughing within the zone of the ancient field systems, looking northwest, in 1996. (Photograph: Graeme Barker.)*

that, throughout the region (and perhaps the world), there had been no significant change of climate within the last *c*.9000 years: arguments to the contrary reflected a lack of awareness of the capacity of people to manage or change their environments, and mistook the products of one or a series of extreme meteorological-geomorphological events such as major floods or intense local droughts as evidence for a general change in climate. In contrast, more recent palaeoenvironmental research was frequently advancing evidence for abrupt and significant climatic fluctuations in the Holocene (Lamb *et al*. 1995). An archaeological-palaeoenvironmental investigation in an adjacent area of Southwest Asia, in an arid environment similar to that of Wadi Faynan, had concluded that

> one thing is nevertheless inescapable. The Holocene climate was far from stable and benign. Bad things happened to climate and Man in the Holocene long before the advent of modern polluting, high technology society (Dalfes *et al*. 1997b: v–vii).

This was the context in which the Wadi Faynan Landscape Survey was planned, to contribute to the desertification debate by applying modern interdisciplinary landscape archaeology and geoarchaeology to a regional case study, in order to provide a long-term perspective on the relationship between environmental change and human history in arid lands. How had the Faynan environment developed in physical terms, and to what extent could changes in the landscape be related to climate and/or the actions of people? How did the socio-economic and biophysical spheres interact? How had past societies responded to changing opportunities and hazards? Why did they take the choices they took? Given its abundant archaeological remains – settlements, cemeteries, field systems, and mining residues – indicating that its past had been characterized by episodes of settlement and land use very different from those of today, the Wadi Faynan seemed an ideal location for investigating the long-term 'archaeological history' of interactions between a desertic landscape and its human inhabitants. The longer time-depth of its known archaeology, compared with the Roman emphasis of desert-edge farming in Tripolitania, was a particular attraction.

1.4 Initial frameworks

Following his initial visit, Graeme Barker returned to Faynan for a three-day reconnaissance in July 1995 with two physical geographers, David Gilbertson (then at Aberystwyth, who had coordinated the palaeoenvironmental programme of the Libyan Valleys Survey) and Sue McLaren, a Leicester colleague with primary research interests in arid-zone geomorphology. The purpose of the visit was to assess the suitability of the archaeology for a landscape study in terms of the state of survival of the field system and the nature of the wider archaeological landscape, and for a programme of palaeoenvironmental investigation in terms of, for example, accessible exposures of Late Quaternary sequences and landforms.

The results on both counts were positive, but one unwelcome discovery was that the field systems, whilst generally still as well preserved as in 1970s air photographs in the BIAAH archive, were in some locations being visibly damaged by the recent and rapid expansion of market gardening (Fig. 1.7; and see Chapter 2, §2.2.5). Water was being piped in plastic tubing several kilometres down the length of the Wadi Faynan from a spring in the Wadi Ghuwayr, stored in reservoirs formed by bulldozing square earth embankments and filling the interior with plastic sheeting, and then pumped into irrigation piping feeding surrounding fields. For the most

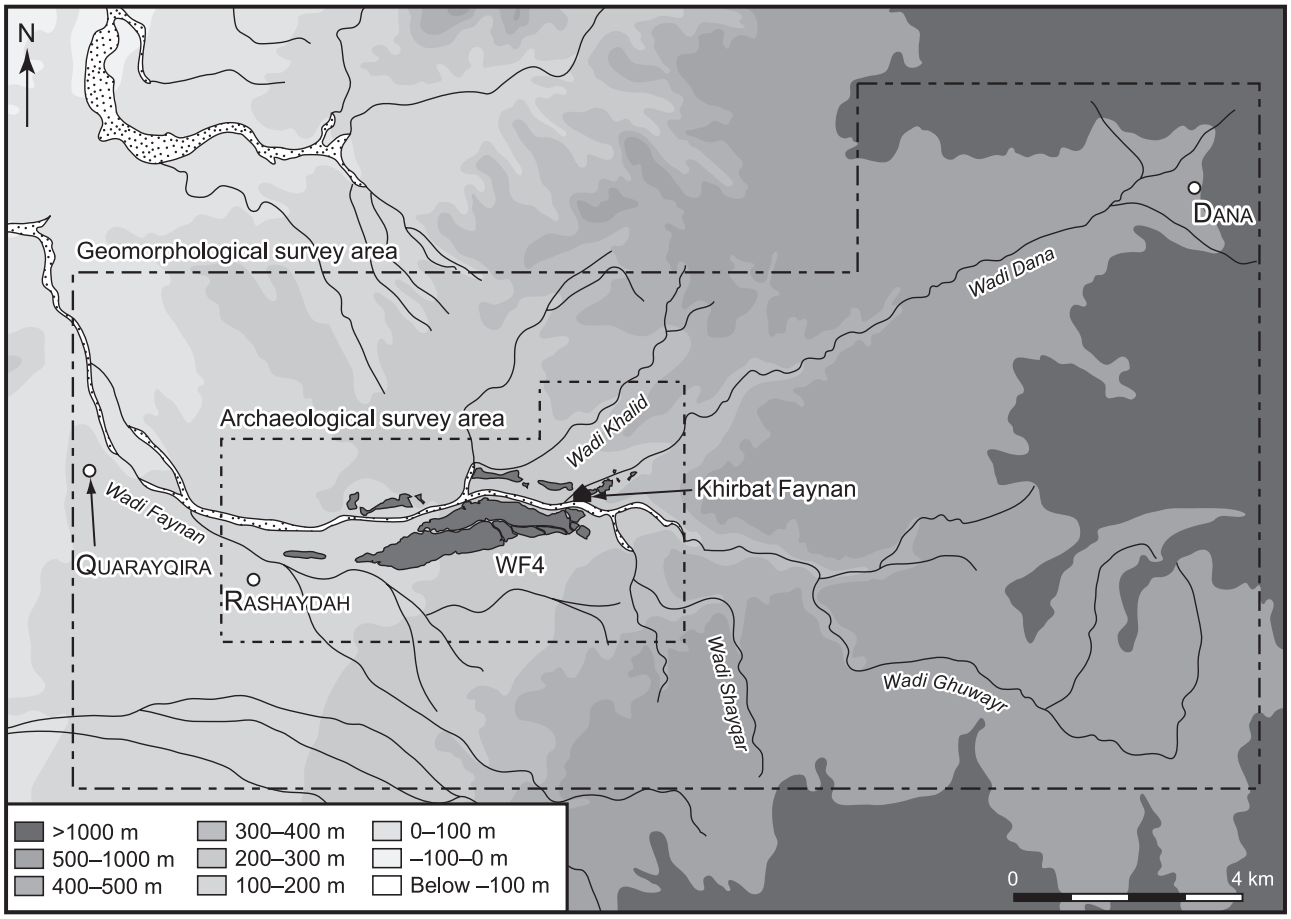

Figure 1.8 *The Wadi Faynan showing the extent of the geomorphological survey area, topography, the boundaries of the archaeological survey area, and location of the main ancient field system WF4. (Illustration: Dora Kemp.)*

part these modern fields were being established within the ancient fields for convenience, and the main ancient walls forming their boundaries were solid enough to withstand the onslaught of the tractors (they simply broke the ploughshares of the careless or foolhardy), but in many places it was evident that smaller walls were being ploughed up. The farmers were under pressure to abandon their fields and concentrate on their traditional lands in the Wadi 'Arabah on the other side of Quarayqira, but given the uncertainties it was clear that the first priority for the archaeological survey had to be the field systems rather than the archaeology on their margins or further at a distance in the surrounding hills.

From the outset we envisaged that, whilst the geomorphological fieldwork would necessarily range across the Faynan basin and its feeder channels (the Dana, Ghuwayr, and Shayqar), the archaeological fieldwork would have an initial focus on the field system WF4 and its associated systems and structures, followed by the expansion of the investigation to the archaeology of the surrounding landscape of the main Faynan basin (Fig. 1.8). The use of Geographical Information Systems (GIS) technology for the analysis of the data was envisaged from the start, and played its part in shaping the recording methodology.

The first field season was planned for the following spring, with a small team. Graeme Barker asked David Mattingly, who had collaborated with him and David Gilbertson in the Libyan Valleys Survey, to join him to head the archaeological investigation, given their common interests in arid-zone landscape archaeology but respective expertise in prehistoric and Roman archaeology. In addition to Sue McLaren, David Gilbertson brought in Chris Hunt (now at Queen's University Belfast), another member of the Libyan Valleys team, for his complementary expertise in palaeoecology, including molluscan and pollen analysis. This small team was augmented by two postgraduates, Oliver Creighton (Leicester) and David Thomas (the BIAAH computer officer).

The geomorphological team only had access to small-scale topographic maps and geological sheets concerned mainly with solid geology (Rabb'a 1994), and limited air photographic cover, as the basis for identifying locations and ancient sites capable of providing worthwhile information on past environmental changes and their possible natural and human causes. From the outset, therefore, their fieldwork in the unfamiliar and difficult terrain of the Wadi Faynan and the gorges of its feeder channels had to depend to a large degree on chance detections

Figure 1.9 *Geomorphological fieldwork at the Late Neolithic/Chalcolithic site Tell Wadi Faynan. Beneath the upright poles at the top-left of the 5–10 m high cliff – produced by erosion along the southern margin of the incised braid-plain of the Wadi Faynan – are the remains of the excavation, where a geomorphologist is kneeling whilst sampling the overlying Tell Loams at site WF5022. Further right at site WF5021, other geomorphologists are using a modern talus cone of collapsed cliff to gain access to the early–mid Holocene fluvial deposits exposed at their level by erosion. The lower 2–4 m of gravels are of Late Pleistocene age. (Photograph: Graeme Barker.)*

of natural exposures, or locations that could be cored or excavated, during ground reconnaissance conducted primarily on foot (Chapter 3). These conditions raised a host of problems familiar to all field geomorphologists but still crucial in terms of the evidence gathered and the reliability of the interpretations based on it:

- about identification and interpretation of modern and past processes and events;
- the degree of representativeness of the evidence through time;
- the extent to which interpretation could be reliably scaled up from the find-site to the wadi to the region;
- the magnitude and frequency of the inferred processes and events through time;
- the degrees of precision and accuracy that might be inferred;
- the exact age and longevity of the features or events;
- the response-times and 'time-lag effects' as well as the likely changing 'sensitivity' of the landscape over time;
- the relationships between past causes and effects in an arid landscape whose modern properties and functional systems were poorly known.

These difficulties were challenging, and much time was spent in successive seasons re-checking exposures and interrogating team members' previous interpretations as understanding developed, in particular as frameworks of relative and absolute dating strengthened.

Despite these difficulties, the 1996 reconnaissance succeeded in establishing a preliminary outline of the Quaternary and hence the palaeoclimatic sequence. In the feeder channels and the upper Wadi Faynan, this sequence included: gorge erosion; the development of large alluvial fans, and of colluvial, aeolian, and fluvial deposits; and distinct episodes of downcutting. Some of the sediments were found to contain prehistoric lithics (stone artefacts) including Lower Palaeolithic forms implying ages beyond 150 kya (thousands of years ago) (see Chapter 6). Geomorphological mapping in the lower part of the Wadi Faynan showed that the WF4 field system was in part built upon fluvial and aeolian deposits that were named the Faynan Member and the Tell Loam Member. There were distinctive traces of more recent fluvial-aeolian deposits on the floor of the main wadi that were termed the Upper and Lower Dana Wadi Members. An important indicator of the antiquity of the Faynan Member was the presence in an exposure in the wadi-cliff at Tell Wadi Faynan of cultural material that had been investigated in trial excavations by a Jordanian team, identified as of Pottery (Late) Neolithic/Chalcolithic type, and radiocarbon-dated from charcoal to

Figure 1.10 *Coring a sediment trap within Roman-period smelting deposits, to locate pollen-rich sediments. (Photograph: Graeme Barker.)*

the sixth/fifth millennia BC (al-Najjar *et al.* 1990; Fig. 1.9): the archaeological layers could be seen to be associated with the fluvial deposits of a perennial stream ascribed to the Faynan Member. The geomorphology and palaeoecology of the fluvial sediments associated with the site contained indicators of active biological conditions implying an early Holocene climate substantially wetter than that of today, very different from Raikes's (1967 [1984]) model. A first impression of the emerging geomorphological sequence was published in the report on the first field season (Barker *et al.* 1997: fig. 5). Various natural and archaeological sediment traps were cored by Chris Hunt to establish whether or not pollen survived (Fig. 1.10).

The main focus of the archaeological fieldwork in the first season was the trialling of a series of methodologies for the investigation of the 250-hectare field system WF4, which was calculated to contain about 1000 fields (Chapter 5). The first of these was the task of mapping the entire system using surface examination to check or 'ground truth' a map prepared in the UK before the field season from vertical air photographs (Fig. 1.11, upper). The second approach envisaged was detailed surveying of selected areas using a 'Total Station' (an electronic laser-based theodolite), but we needed to establish the utility of the data that might be collected by this means in selected zones (as realistically we could probably only expect to plan selected zones by this means) compared with the faster but more schematic mapping of the entire field system. The other approaches we needed to trial included the collection of surface artefacts, the recording of archaeological sites within and adjacent to the fields, the recording and classifying of wall types, and the identification and mapping of any structures within the field system indicative of ancient systems of water control, such as the stone sluices and baffles used by the floodwater farmers of Roman Tripolitania. Within the first few days of fieldwork it became clear that the field system had undergone considerable change since the air photographs were taken, and also that there was considerable variability in wall building, field layout, and surface pottery. If we were to understand its history, it was clearly going to be necessary to map the WF4 field system in detail. To facilitate this, David Mattingly subdivided it into twenty sub-units defined according to major constructional features, significant breaks in topography, and natural features such as wadi channels. These were numbered as Units WF4.1 to WF4.20, and each field within each unit was also numbered separately, such as WF4.1.5, WF4.13.20, and so on (Fig. 1.11, lower).

The finds on the surface of many of the fields were extraordinarily dense, so rather than having all field walkers pick up all visible material, a system was devised whereby all material on a metre-wide corridor was collected from one in every three transects, the latter being 10 m apart (Fig. 1.12). The material in the intervening transects was recorded using clicker counters, to give an assessment of density of pottery and lithics to compare with the counts of the collected material. Unit WF4.13 encompassed a major settlement of Early Bronze Age date (*c*.3600–2200 BC) mapped in the 1995 BIAAH survey as site WF100, and during our first field season Dr Karen Wright (University

Figure 1.11 *(upper) Initial mapping of the Wadi Faynan 'field systems', drawn up from vertical air photographs; (lower) map of the 'field system' WF4, showing the sub-divisions devised for its recording and analysis. (After Barker* et al. *1997: figs 7 and 8.)*

Figure 1.12 *Collecting surface artefacts within the WF4 'field system', and mapping the field walls; photograph looking west down the Wadi Faynan to the Wadi Fidan. (Photograph: Graeme Barker.)*

College London) was carrying out a reconnaissance season on the site in preparation for excavating it the next year, when she was also planning a detailed surface pick-up. It was therefore agreed with her that our project would trial its artefact collection system in Unit WF4.13, which would ensure that we had data collected from it using the standard methodology we wished to apply to the rest of the field system. In addition to the development of the artefact collection systems, a segment of terrain around Tell Wadi Faynan, measuring some 500 by 150 m, was mapped with the Total Station, and a preliminary classification was established of wall types and other archaeological structures in walls or in fields such as cairns, terraces, and sluices.

The immediate realization from this initial archaeological fieldwork was that we were not looking at a repetition of Roman-period floodwater farming systems in Tripolitania. Most obviously, there seemed to be very few water-harvesting catchment walls on the slopes outside the field system to collect and divert water into wadi-floor fields. In parts of the southern portion of the system (in Units 4.4 and 4.5, for example), where the ground sloped quite sharply, there were substantial terrace walls unlike anything we had observed in Libya, where most of the wall-building concentrated on the floors of long narrow wadis. Yet large parts of the field system (Units 4.2, 4.3, 4.6, 4.7, 4.9, 4.10, 4.15–4.20) were on gently undulating or virtually flat terrain. The one thing that was clear was that the ancient fields were not being irrigated, like the modern fields, by water brought down from the Wadi Ghuwayr spring: the system looked as if it must be rainfed, but exactly how remained unclear, though a series of parallel walls inside the field system seemed likely to be an important clue.

The second main conclusion from the 1996 season was that WF4 was likely to represent a palimpsest of wall-building and land-use systems. Most of the pottery on the surface of the fields was clearly Nabataean, Roman, and Byzantine, but there was certainly prehistoric pottery at several locations, not just in Unit 4.13, and a series of circular silt-filled enclosures with such pottery found in and just outside the southeast corner of Unit 4.12 suggested some kind of water-management strategy. Neolithic agriculture, by contrast, appeared to have operated in a wetter climate and more vegetated landscape, and to have focused on stream-side locations. This was true not just of Tell Wadi Faynan but also of an earlier Neolithic settlement termed Ghwair I being excavated by an American-Jordanian team (Simmons and al-Najjar 1996; Simmons and Najjar 2006), which was situated immediately by the Wadi Ghuwayr spring at the mountain edge. This site had been identified from its material culture as belonging to the Pre-Pottery Neolithic B (PPNB) period (*c.*8500–7000 BC), the period when agricultural villages sustained by the cultivation of wheat, barley, and legumes and the herding of sheep and goats were first established throughout Southwest Asia.

Alongside the field system survey, we undertook limited reconnaissance survey on the upper slopes south of the field system. This found a suite of archaeological remains including terrace walls, lithic scatters, domestic structures, graves, boulders decorated with pictographs (incised pictures or motifs), and what looked like recently-abandoned bedouin campsites, implying that the hinterland around the field system was likely to contain an equally rich, if different, archaeology, both prehistoric and historic. As we concluded in the first report,

> dating this archaeology is likely to be extremely difficult, but the potential clearly exists in the archaeological record outside the field system, as within it, to document changing patterns of arable and pastoral activity, and the extent to which they were integrated or separated in terms of social organization, from the time of the first agricultural settlement in the Wadi Ghuwayr to the present day (Barker *et al.* 1997: 38).

For the second season, the environmental team was strengthened by the addition of John Grattan (Aberystwyth) and Hwedi el-Rishi Mohamed, a Libyan PhD student working on the Faynan with Chris Hunt. Their geomorphological field studies concentrated on the tributary wadis above the area of study for the archaeological survey, as these were more likely to contain a record of deep-time alluvial activity than the flatter topography of the lower valley, where recent sedimentation predominated. The complicating effects of tectonic activity became apparent, but the fieldwork was able to yield a refined geomorphological map for the confluence area, with different episodes of fluvial activity recognized within the Ghuwayr and Shayqar Beds (Barker *et al.* 1998: fig. 1). The team now included a lithics specialist, Tim Reynolds (Birkbeck, London), and lithic/sediment associations confirmed the late Pleistocene age suspected for these beds.

Another critical advance came with the successful extraction of pollen from one of the 1996 cores, taken from the sediments built up against a prominent barrage wall constructed at the foot of Khirbat Faynan (Fig. 1.13). The assumption was that the barrage was built by the Khirbat Faynan community, presumably in Nabataean, Roman, or Byzantine times, so though this still meant anywhere within a thousand years (*c.*300 BC–AD 700), the hope was that the pollen diagram would give us a first indicator of vegetation change from the Classical period (loosely defined) to the present day. The initial analysis (Hunt and Mohamed 1998) suggested two distinct vegetational phases: a steppic landscape in which cereal and olive cultivation was practised developed at some stage into an extremely degraded landscape. The transformation suggested climatic aridification, or humanly-induced degradation (from, for example, overgrazing), or a combination of both. When the second fieldwork report was in press, a radiocarbon date of *c.*2500 BP for the basal sediments indicated that the sequence probably began in Nabataean times; later we were to revise this interpretation (Chapters 3 and 10).

The archaeological fieldwork in 1997 was unexpectedly complicated by a back injury to David Mattingly

Figure 1.13 *The ancient barrage below Khirbat Faynan, that created a sediment trap that proved a source of invaluable information about the development of climate, environment, and industrial history over the past 2000 years. Photograph looking northeast, across large areas of slag and polluted sediments, up the Wadi Dana. A scale is provided by the person sitting on the far end of the barrage. (Photograph: Graeme Barker.)*

shortly before the field season. The original intention was that Graeme Barker and David Mattingly would share the fieldwork, one running the team for the first part of the 1997 season and the other the second half, but the injury meant last-minute changes of plans, one result of which was Oliver Creighton finding himself running the project on his own for ten days in the middle. The unexpected benefit was that his research interests shifted dramatically from his PhD in medieval English landscapes to include landscape methodologies more generally, the result being his increasing role in the team in the ensuing seasons in developing the project's survey methodologies and classification systems (Chapter 4).

The main focus of the archaeological fieldwork was the application of the wall recording and surface pick-up methods trialled the previous year in WF4.13 to other parts of the field system. Recording forms had been designed in the light of the experience of the first season to streamline the recording of the field system walls and for logging the count and weight data from the field collections. By the end of the 1997 season, some two-thirds of the system had been surveyed. The survey was facilitated by an improved photogrammetric map produced for BIAAH by Leoni Blank (University College London), enabling rapid ground-truthing by the wall-recording teams to produce detailed maps of each of the WF4 sub-units (Fig. 1.14). These maps included increasingly confident identifications of structures related to water control: a typology of sluices, baffles, spillways, and channels began to be developed. Indeed, a vital component of the field system recording was the identification and examination of all associated structures, including numerous cairns, enclosures, and small buildings as well as hydraulic features. The upper slopes of the part of the field system nearest Khirbat Faynan (in WF4.1–WF4.3 and WF4.5) were studied in particular detail, and an interpretation was suggested in the second report that they represented small-scale diversion systems: floodwaters were blocked by small barrages in the wadi channels as they arrived at the field system, guided along the contours by diversion walls, and then allowed to flow through sluice gaps downslope over terraced fields, to return to the wadi channels lower down. Systems of parallel walls seemed to be the key to how water was diverted from wadi channels to fields at lower elevations. The preliminary study of the ceramics from these units by Russ Adams, a prehistoric pottery specialist then at Sheffield who joined the team in 1997, indicated that, along with much Nabataean material, the upper slopes had significant quantities of Iron Age pottery of the seventh–sixth centuries BC. Also, a Roman sherd was found in the make-up of a wall of a parallel-wall system.

Hence at the end of the second season we had better understanding of Pleistocene environmental history, at one end of the sequence, and at the other, indications of an Iron Age–Nabataean–Roman constructional history for the field system, with indications of functional differentiation relating to that sequence. We also had palynological

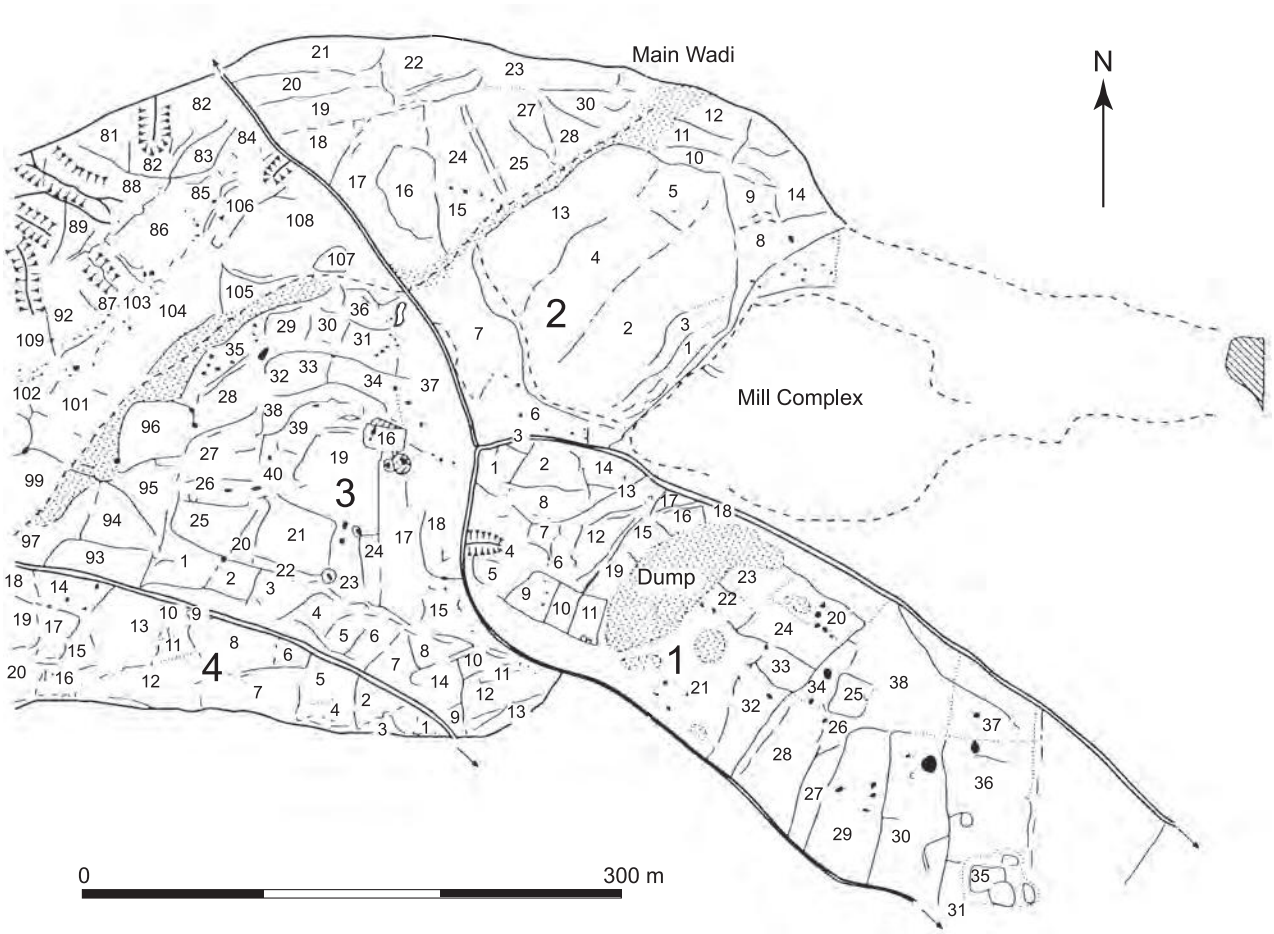

Figure 1.14 *Field map of part of the WF4 'field system', after ground verification of the photogrammetric map in the 1997 field season. (After Barker* et al. *1998, fig. 4.)*

evidence for a poorly vegetated degraded landscape – that we initially wrongly attributed to Nabataean rather than the Roman-Classical period – that developed some time later into desert, before reverting over the last one hundred years or so to the modern steppe vegetation. As we concluded at the end of the second report,

> one important goal for our future fieldwork must be to investigate whether the eventual abandonment of the field system coincided with the significant landscape changes that can be inferred from the pollen diagram and if so, the extent to which this process of desertification was climatically- and/or humanly-induced (Barker *et al.* 1998: 25).

The field system survey was producing many sporadic prehistoric lithic artefacts, but it was clear from reconnaissance that the densest spreads of lithic material were on the surrounding hills. For the middle part of the sequence, Karen Wright's excavations of WF100 concurrent with our own fieldwork had yielded excellent information on the character of a major Early Bronze Age settlement (Wright *et al.* 1998). Trial excavations later that year by Bill Finlayson and Steve Mithen at site WF16 a few hundred metres west of the Ghwair I PPNB settlement (Finlayson and Mithen 1998) revealed it to be an even earlier Neolithic settlement of the Pre-Pottery Neolithic A period, the first thousand years of the Holocene (*c*.9500–8500 BC), when indicators of cultivation and herding first become widespread in Southwest Asia but when hunting, fishing, and gathering remained the mainstays of subsistence for most communities.

1.5 New perspectives, new questions

The specialist personnel in the team increased further in the third season, as team members suggested areas where further input would help (Barker *et al.* 1999). Darren Crook applied the insights he had gained in his PhD fieldwork on irrigation systems on dry Swiss mountains to Roman irrigation technology in Faynan as represented by the aqueduct system (Crook 1999). The finds team was augmented by Roberta Tomber (then at the Museum of London), to take on the challenging task of analysing the mass of Classical and later pottery. Paul Newson, who had participated as a student in the second season, embarked on a NERC-funded PhD at Leicester on Roman-period water-management systems in the Levant, a core component of which was planned to be a GIS analysis of the WF4 field

system. A chronology of the Quaternary sequence started to emerge through AMS dating and more specifically through Optically-stimulated Luminescence dating undertaken by Geoff Duller at the Aberystwyth OSL laboratory, though unfortunately the sediment samples were found to be so naturally-radioactive that it was very difficult to date deposits beyond *c*.170–220 kya.

John Grattan, in addition to his work on the Quaternary sequence, was developing new research interests in the use of geochemistry to measure environmental pollution histories using the Inductively Coupled Mass Spectroscopy (ICP-MS) facilities at Aberystwyth and Energy Dispersive X-ray Micro-Analysis (EDMA) facilities at Nottingham Trent. He, along with Brian Pyatt and David Gilbertson, realized that the techniques had the potential to link the metallurgical history of Wadi Faynan, as proposed by the Bochum team, with our developing understanding of climatic, environmental, and land-use history, because sediment samples from geomorphological and archaeological exposures could be analysed by ICPMS and EDMA to measure the changing concentrations of metal pollution caused by past mining and smelting activities. The techniques thus had the potential to measure changing scales of industrial activity independent of the Bochum team's arguments based on their studies of the mining and smelting sites. The team was augmented in the field by Brian Pyatt (Nottingham Trent), an environmental biologist with interests not just in past people–environment interactions but also present-day ecology and health. The final addition to the team was Carol Palmer, an archaeobotanist (then at Bradford) who had conducted ethnoarchaeological research on a north Jordanian farming community for her PhD (Palmer 1998) but who had developing research interests in bedouin pastoralism and its interactions with farming. The project directors were becoming increasingly aware that understanding the landscape history of Faynan had to include its contemporary and recent inhabitants, and our needs and Brian Pyatt's and Carol Palmer's research interests neatly coincided.

The geomorphological fieldwork continued to refine understanding of the Quaternary sequence in the tributary wadis, their inter-relationships, and through the application of OSL dating, their approximate date ranges, confirming the estimates based on associations with archaeological artefacts. The latter included a handsome Acheulean (Lower Palaeolithic) handaxe found by the geomorphologists in a fluvial terrace 40–50 m above the modern floor in the gorge of the Wadi Dana (Fig. 6.14). The Dana fieldwork also located early Holocene sediments with molluscan and plant remains confirming the Tell Wadi Faynan evidence for significantly wetter environments. Another important piece in the jigsaw was the extraction of pollen from three geomorphological sequences, one of definite and two of probable Early Bronze Age date, which indicated relatively diverse steppic landscapes, drier and more open than those of the Neolithic but more vegetated than the degraded steppe of the Nabataean period and the succeeding extremely degraded desertic environments. Evidence for the latter had been strengthened

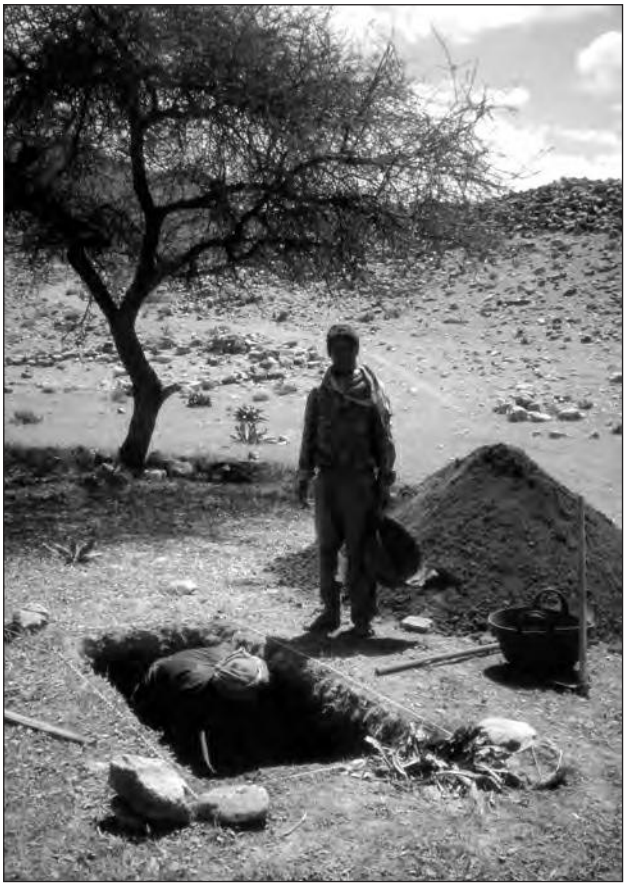

Figure 1.15 *Excavating the sediments at site WF5012 immediately up-wadi of the Khirbat Faynan barrage for palynological and geochemical research. Looking south across a small catchment to the intermediate skyline and the watershed-boundary provided by the rubble of the Khirbat Faynan, to the distant Mountains of Edom which are partially obscured behind the Acacia. (Photograph: Graeme Barker.)*

by detailed sampling of a trench excavated in the infill sediments behind the Khirbat Faynan barrage (Fig. 1.15), to add to the data obtained by the earlier coring. During the 1998 season the archaeological teams completed the survey of the main field system, and of the outlying field systems on the northern margins of the wadi. From these studies it was becoming possible to propose a provisional sequence of wall technologies indicating how systems of 'floodwater farming' had developed from the Bronze Age to (at least) the Byzantine period.

The ICPMS and EDMA studies of sediments at Tell Wadi Faynan and in the barrage sequence added new and remarkable insights into this emerging story of landscape development. The Tell Wadi Faynan archaeological and aeolian sequence, representing accumulation between the Late Neolithic settlement and the Roman/Byzantine field system on the present-day surface, showed small-scale episodes of intense metalliferous pollution caused by smelting. There was a reverse sequence in the barrage sediments: extremely high levels of metal pollution at the base, and

lower levels high up, though with minor peaks in between. The implication was that Roman/Byzantine industrial activities severely polluted the contemporary landscape. Furthermore, significant levels of pollution were found in the modern plants and animals in the area, and it was also found that biomass and cover values increased in barley plants with distance from the contamination 'hot spots'. The obvious conclusion was that modern pollution has its origins in the activities of ancient miners, particularly those of Roman and Byzantine times. Not only had they helped sustain a desert but, it seemed, they had created a legacy of metalliferous pollution for future generations into the bargain.

1.6 Developing research themes

As we began to discern some of the principal characteristics of the environmental and settlement histories of Wadi Faynan, we began to break down the overarching research interest of the project in desertification into four subsidiary but inter-related research themes.

Within the first theme, of *understanding aridification*, we first needed to establish in as much detail the evidence for developments in climate and environment. We then needed to relate those histories to the human history, of how people had lived in the study area, a history in which the interaction of sedentary and mobile lifestyles over time was clearly going to be one of the critical threads. How had people farmed at different times in the past? How, in certain periods, had they practised what appeared to be, on the evidence of the wall building, labour-intensive sedentary systems, and in what environments and with what environmental impacts? Had phases of intensive sedentary agriculture alternated with phases of less-intensive land use, such as mobile pastoralism? If pastoralism was practised alongside agriculture in particular periods, was it closely integrated or practised by more or less independent and socially-separate groups?

That kind of question introduces the second major theme, of *marginality*, of the social, economic, and political relations between the settlement histories of arid regions and those of adjacent better-watered more densely-settled regions, between 'the desert' and 'the sown' in one striking phrase. This relationship is an example of the more general phenomenon of core/periphery relations that archaeologists, geographers and historians study, of the linkages between regions regarded as economically and politically 'core' in a particular period and surrounding regions regarded as 'peripheral' to that core. Obvious examples of the latter are subject territories controlled by imperial powers, or client states beyond the imperial frontier (like the Late Iron Age petty kingdoms of southeast England prior to the Roman conquest), but core/periphery networks frequently involve economic rather than political hegemonies (Wallerstein 1974). It is generally accepted that most mobile pastoralists living in arid lands today and in the past are not relics of some kind of natural 'free-living' mode of self-sufficiency but have close economic relations with settled peoples in adjacent better-watered regions. The history of Wadi Faynan had to be understood in terms not just of the prevailing climate and local environment, and of people's relationships with them, but also of relations with the world beyond. The interactions between the various bedouin tribes using the Wadi Faynan today in part relate to the regional politics and global economic forces of the late twentieth century (Chapter 2). In particular, the expectation had to be that throughout history powerful but metal-poor states in the wider region would have had a significant interest in an environmentally-marginal but metal-rich zone such as the Wadi Faynan, whether considering the rise of the first significant (and metal-using) elites of the Levant in the Chalcolithic (*c*.5000–3600 BC) and Early Bronze Age (*c*.3600–2200 BC), or the Biblical Iron Age states, or the Roman imperial economy, or the various Islamic states. Whilst the Wadi Faynan was likely to be on the 'periphery' side of core-periphery networks, the location, scale, and nature of the core or core regions to which it related, and the nature of those relationships, could of course be expected to differ substantially.

The third theme was the history of *degradation and well-being* of the habitats and peoples of arid lands, stimulated in particular by the geochemical studies of pollution signatures that caused us to extend the focus of our interest from the arable and pastoral archaeologies of field systems and sites to the smelting sites and mines. An important underlying focus of interest, though, was the boom-and-bust character of the settlement histories of most drylands, something we were reminded forcefully of in the Wadi Faynan as the evidence of its dramatically changing settlement history began to accumulate over the first seasons of fieldwork, with periods of more or less intense occupation apparently alternating with periods of far less intensive settlement, or even abandonment. From the outset it became clear that we were not dealing with a neo-evolutionary story of increasingly sophisticated irrigation systems, for example, linking each major cultural phase inexorably to its successor, but a complex and cyclical story of expansions and contractions. Similarly complex histories could be expected in the case of the pastoral and industrial sectors, and in the inter-relationships between arable, pastoral, and industrial over the millennia and centuries. Any holistic model of desertification could be expected to build on and integrate such histories along with changing histories of aridification and changing notions and relations of marginality.

At the same time, all these sub-themes in turn interlinked with the fourth theme, of *methodologies* in arid-zone landscape archaeology. One of the major challenges confronting any archaeological investigation of diachronic settlement trends is distinguishing an absence of evidence for occupation in any particular period from evidence of absence of occupation. In arid zones this problem is particularly acute in relation to the archaeology of pastoralism: does pastoralism, especially as practised by mobile shepherds and herders, create an ephemeral archaeology of organic materials (tents, thorn-bush corrals, artefacts of skin and

hide, and so on) that does not survive in the archaeological record; or do arid-zone pastoralists use an archaeology of vestigial stone structures that, whilst much less substantial than the archaeology of settled farmers, can nevertheless be recognized? This problem had been the focus of lively debate in the southern Levant, with survey work in the Negev in particular indicating that pastoralists *could* be recognized by archaeologists, the implication being that periods with no apparent archaeology were genuinely periods of abandonment, rather than periods of less intensive settlement forms such as seasonal pastoralism (Finkelstein 1995; Finkelstein and Gophna 1993; Finkelstein and Perevolotsky 1990; Rosen 1994; Rosen and Avni 1993).

Recognizing pastoralists, however, depends in part on their building stone structures (such as tent footings) that can be recognized by archaeological surveyors, but also on their using non-organic materials that can be dated, notably pottery – otherwise a collection of stones from a tent placement might equally well be prehistoric or twentieth century. One of the striking reminders of the problems of dating evidence was the discovery of wooden vessels in Iron Age burials in Wadi Fidan (Levy *et al*. 1999a; Chapter 9), interpreted as evidence of the presence of aceramic (non-pottery using) pastoralists in a period hitherto assumed to be one of abandonment. In our own survey, one of our most critical challenges was producing convincing evidence to demonstrate that periods of 'bust' in apparent boom-and-bust cycles were either periods of genuine abandonment or periods when different lifestyles and technologies created different archaeological signatures in the landscape from periods of 'boom'. Separating absence of evidence from evidence of absence was clearly going to be critical for any theories arising from the project regarding aridification, marginality, and landscape degradation and well-being. We could employ a range of signatures of changing intensities and modes of settlement, including the archaeological remains in the landscape, indicators of land use in the palynological and geochemical records, and ethnoarchaeological studies of the people using the Wadi Faynan today and in the recent past.

1.7 Integration

One insight from the initial ethnographic studies and interviews with the present-day inhabitants of Wadi Faynan was that land-use patterns and technologies had altered profoundly in recent years in response to particular social and economic constraints or opportunities, suggesting at least the possibility of complex interactions between arable, pastoral, and industrial activities in the past as well (Palmer 1999; and see Chapters 2 and 12). It was in this context that the next stage of the archaeological survey was designed in the fourth field season (1999) to investigate the archaeology outside the field system (Barker *et al*. 2000; and see Chapter 4).

At this stage, the convergence of the data we had gathered so far on the agricultural system (the field system evidence, and the palynology) and on the environmental impacts of ancient mining (the geochemistry) was highlighting the Roman period as of potentially greater importance in the Faynan story than had been recognized hitherto – the work of the Bochum team had focused primarily on the early technology and history of metallurgy in Faynan, in the Bronze and Iron Ages especially (Hauptmann 2000; 2007). A whole new set of questions now opened up relating to the operation of Roman imperialism on the ground and the way in which the Faynan landscape increasingly became one of power and exploitation. In order to examine these aspects, and to have an understanding of how they differed from earlier phases of exploitation, it was necessary to ensure that our archaeological survey also included the mining archaeology as well as all the other archaeology beyond the field systems, even though at the beginning of the project we had planned to focus on the main field system and the archaeological sites of the surrounding hills, rather than engage with the mining evidence further afield that had been studied so thoroughly by the Bochum team.

Until this point, the external boundaries of the project had never been formally defined. As already mentioned, the environmental scientists needed information from the upper tributary wadis (the Dana, Ghuwayr, and Shayqar) to identify sequences of fluvial activity and their implications for climatic and tectonic history, but the steeply dissected landscape above those tributaries was only really amenable to reconnaissance archaeological survey rather than systematic coverage. The boundaries of the photogrammetric map we were using for the pedestrian survey work were generally at the foot of steep mountains (Fig. 1.16), so they encompassed much of the main catchment of the Faynan that the archaeologists needed to survey to understand landscape use beyond the field system as well as within it. One difficulty with defining where exactly we would place the boundaries of the survey was the lack of detailed cartography, so it was difficult to reconcile the photogrammetric and normal topographic maps within the area covered by the former, and still more difficult to map the landscape beyond at a scale appropriate for the archaeological enquiry.

However, the introduction of hand-held GPS technology at this time gave us the means at this stage in the project to develop a methodology for systematic survey of the hinterland beyond the field system, whether or not the terrain was within the photogrammetric map. The irregular outline of the photogrammetric map was set within a rectangular frame measuring 8 km west–east by 3.5 km north–south with the field system at its centre, aligned with the UTM (Universal Transverse Mercator) grid (Fig. 1.17). An additional 1 × 2.5 km was added at the northeast corner of the rectangle to incorporate the major zone of ancient mines explored by the Bochum team.

The initial investigation of the survey zone outside the field system comprised two separate stages. The densities of the surface archaeology beyond the field system were first established by collecting artefacts on 17 north–south transects corresponding to the edges of 500 × 500 m squares

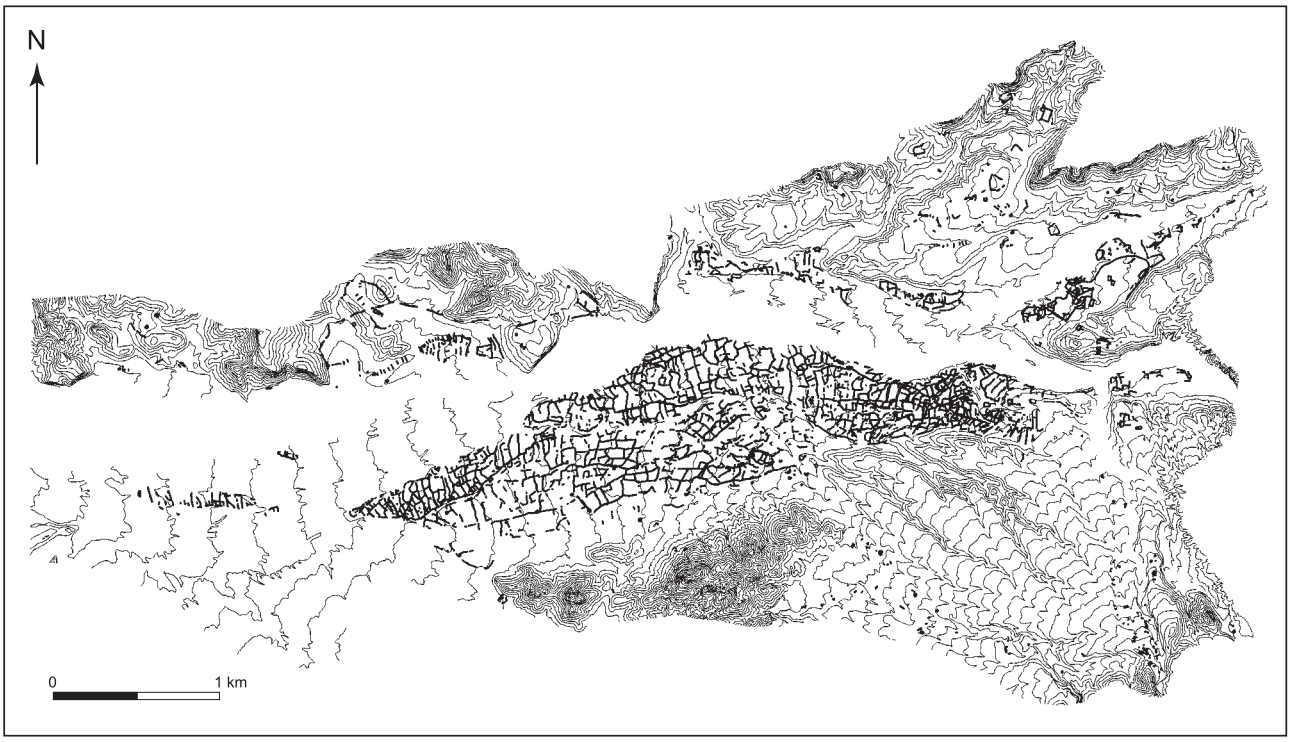

Figure 1.16 *The photogrammetric map that formed the primary base map for the survey, limiting the fieldwork until the availability of hand-held GPS technology (for altitudes, see Fig. 1.3).*

defined by the UTM grid (Fig. 1.17). The total length of these north–south transects was 65.5 km across arduous terrain in places, covering 13.1 ha (allowing for a 2 m wide visibility and collection corridor). This allowed us to compare artefact densities inside and outside the field system and to get a preview of the sort of archaeology to be encountered. The overall densities of surface artefacts were much lower than within the field system WF4, except in a few places where our transect lines crossed major sites (cf. Table 5.6 and Fig 5.43).

The archaeology was then mapped and recorded in detail within each 500 × 500 m square defined according to the UTM grid. Each square was systematically and intensively criss-crossed by a team using GPS units to define the margins of the square and to position accurately all archaeological features encountered. Some 1000 'sites' were recorded, of many different forms and of all periods of antiquity (Fig. 1.17). These included: lithic scatters; domestic structures and enclosures of dry-stone construction; field walls; graves and cemeteries; pictographs and inscriptions; mining- and smelting-related features; and recent bedouin encampments.

The ethnographic programme of fieldwork was expanded at the same time to help develop interpretative models for understanding the survey record. Graeme Barker had heard Helen Smith (Bournemouth) give a conference paper on the results of her ethnoarchaeological research on a series of Norse longhouses in the Outer Hebrides of Scotland. Intensive sampling of floor sediments for bioarchaeological remains enabled her to gain insights into the use of domestic space and the functions of the buildings, and the hypotheses were tested on sediments from a recently-abandoned croft whose former inhabitants were still alive and so could describe how the structure had been used. The implications of this approach for Faynan were obvious: if we could understand the use of space in recently-abandoned campsites from their inhabitants, and recognize 'archaeological signatures' for such activities in terms of differences in floor sediments and cultural residues, we could look for similar archaeological signatures in the archaeological sites being recorded by the survey as an aid to their interpretation. Mapping recently-abandoned bedouin campsites in 1999 and 2000, together with detailed interviews with local people, enabled Carol Palmer and Helen Smith to discern patterning in seasonal behaviour reflected in different camp architectures, and to model rates of destruction of different classes of material culture; the work was then extended by Carol Palmer to the present-day settlements of farmers and shepherds (including some of the Faynan transhumant shepherds) on the plateau edge above Faynan (see Chapters 2 and 12). Sediment samples were taken from a series of modern sites known to be of primarily arable, or primarily pastoral, use, and from various prehistoric, Nabataean, and Roman sites for comparison.

The primary emphasis of the final seasons of the palaeoenvironmental fieldwork was on refining knowledge of Quaternary environmental change and collecting samples for further AMS dating. The final phase of the programme also involved increasing integration between the environmental and archaeological fieldwork, with sediments from

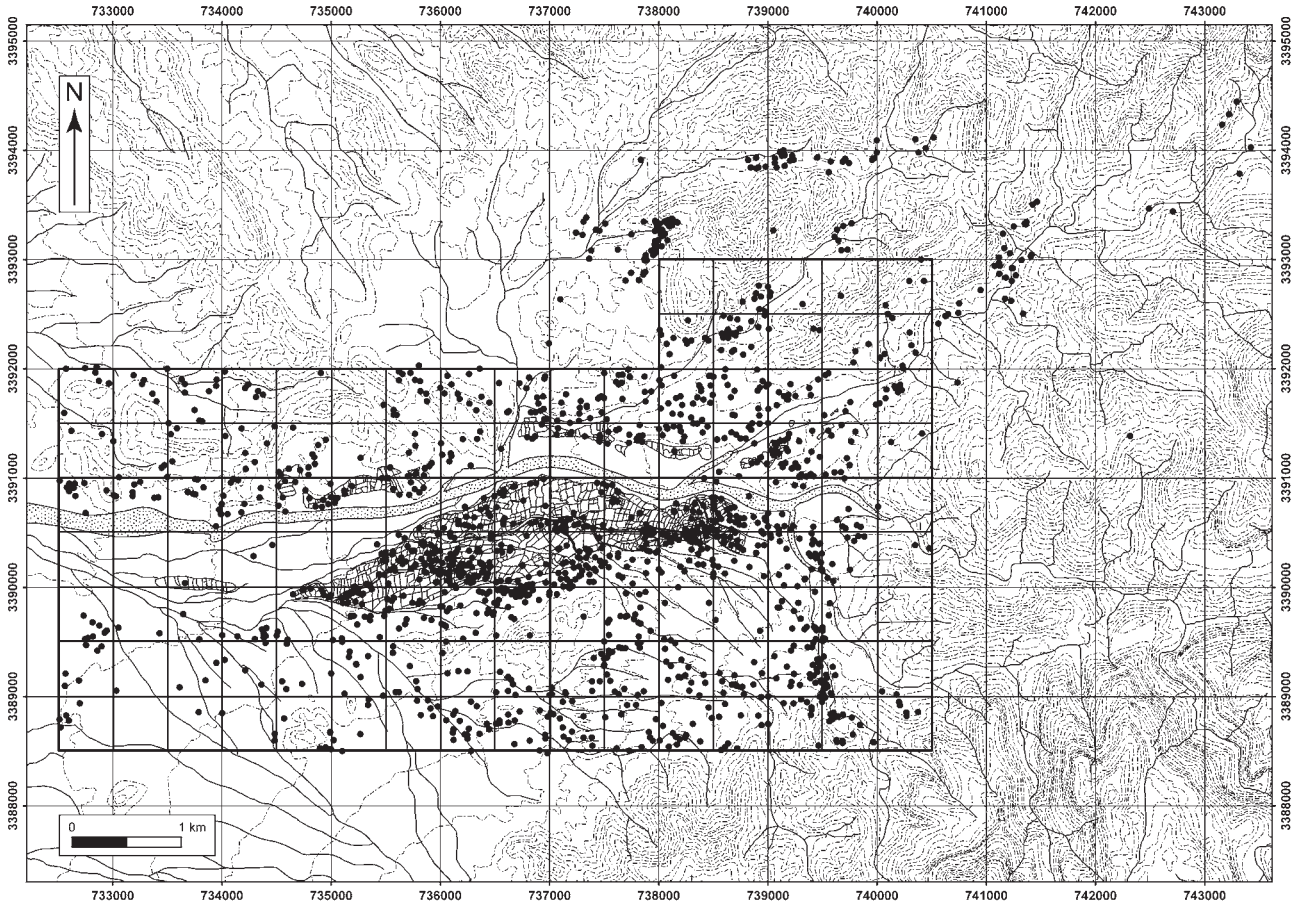

Figure 1.17 *The area of the Wadi Faynan Landscape Survey as ultimately defined, showing the 'field system' WF4, the grid used for the survey outside it, and the recorded archaeological sites. (Illustration: Paul Newson.)*

archaeologically-secure contexts and modern bedouin camps sampled for ICPMS analysis and palaeoecological indicators. One important focus of study was a series of parallel-wall systems thought to be water conduits of Roman date: trenches cut across a selection of these confirmed their date and their use for water channelling, and column samples were taken for detailed analysis of sediment sequences and associated indicators of the contemporary environments in which the hydraulic systems operated (Chapter 10). The geochemical programme concentrated on establishing the scale and extent of modern ground pollution beyond the 'hotspots' of the ancient smelting sites.

The main task of the final season of archaeological fieldwork was to elucidate information on site morphology, development, and function through a survey of a representative sample of sites located during the 1999 field season. Over 100 detailed plans were made of selected structures and landscapes at a variety of scales from 1:100 to 1:2000, differences in architecture and material culture suggesting a variety of arable, pastoral, and industrial (metallurgical) activities from Early Bronze Age to Byzantine times that it was hoped would yield specific sediment 'signatures' that might be informed by inferences from the ethnoarchaeological work. A representative group of 'petroglyphs' or 'pictographs' of prehistoric date was also planned in detail, and a tentative sequence developed from overlays of motifs, differences in patination, and the location of some pictographs in prehistoric settlement sites. Re-walking of the entire WF4 field system by Paul Newson and Patrick Daly, integrating the records from the twenty artificial units we had used for the earlier recording, indicated that it might be possible to use the comprehensive GIS to discern territorial (estate) boundaries of the Nabataean and/or Roman/Byzantine periods as well as wall layouts relating to land use and floodwater control (Chapters 9 and 10). Our explorations of the mining landscape confirmed the evidence of the geochemical studies that the Roman period marked a particularly significant phase of copper exploitation in the valley, with striking synchronicity apparent in the subsequent abandonment of the mines, the abandonment of the field system, the palynological evidence for an empty degraded landscape, and the geochemical evidence for a grossly polluted landscape.

The methodologies used in the different phases of the archaeological survey are summarized in Table 1.1. The variations in sampling strategy were designed to be fit for purpose in relation to the goals of each phase of the work. For example, the focus in the early seasons was to have close spatial and quantifiable control of the material

	Spacing of transects/walkers	Width of corridor	Collection method	Units of collection
Phase 1 Within WF4	10 m	1 m	1 in 3 transects collected, rest clicker-counted with judgemental 'grab' sample of diagnostics; all collected material counted and weighed	Systematic and grab samples from field units; some grab collections from identified sites/structures
Phase 2 Transects outside WF4	500 m between north–south lines walked	2 m	All artefacts encountered collected; all collected material counted and weighed	250 m stints along the north–south transect lines (following GPS-determined UTM grid lines), but no pick up within field-system zones crossed by transect lines
Phase 3 UTM 500 × 500 m squares	10–20 m depending on terrain and visibility; squares covered in a series of parallel sweeps	5 m	Artefacts only collected in association with sites (though pot and lithic scatters were recognized categories)	Mainly judgemental collections from identified sites, to provide a representative sample of artefacts, not simply diagnostics
Phase 4 Further recording and planning of sites	n/a	n/a	Grab only	Mainly diagnostics
Phase 5 Sites beyond the core survey area (e.g. mines and mountain sites)	Reconnaissance survey using GPS to record location of visible sites and mine workings in mountain valleys	n/a	Artefacts only collected in association with sites	Mainly judgemental collections from identified sites, to provide a representative sample of artefacts, not simply diagnostics

Table 1.1 *Summary of field survey recording methods used in the different phases and operations of the Wadi Faynan Landscape Survey.*

within the field system. Similar methods were applied to the long north–south transects across the landscape in the second phase of the survey, so that we could understand the relative densities of material within the WF4 field system and in the wider landscape. Artefact distributions on many sites located in the third and fourth phases were spatially discrete (in relation to ancient middens at settlements or to robbed graves within a cemetery). Arbitrary transects could easily have missed the main focus of artefacts, so the emphasis was primarily on the recovery of a representative 'grab' sample of artefacts. This involved at least one member of the team methodically searching the site for artefacts, taking as much time as was required to make a thorough search of its overall extent.

1.8 Conclusion and structure of this book

As this review of the development of the Wadi Faynan Landscape Survey fieldwork has described, the overarching interest of the project in contributing a long-term case study in landscape archaeology to the desertification debate stayed the same from its inception to the completion of the fieldwork, but the focus shifted significantly in the different phases of the research. There was always a clear sense amongst the project leaders of where the project should end up, but not all the methodologies had been worked out in detail, and they were re-evaluated as the project developed. The first phase concentrated on establishing what was likely to be possible, and what was most urgent to do in the face of modern development. In the second phase the emphases of the environmental and archaeological research separated somewhat – literally, in fact, as the geographers refined the Quaternary and geoarchaeological sequences in the tributary wadis especially, and the archaeologists established the main characteristics of the field systems in the main Faynan basin – as the two groups started to establish key landscape histories by building on the foundations they had laid in the first season. In the later seasons the process of integration and feedback accelerated: the archaeological survey put the field system evidence into the context of its surrounding landscape; the geomorphological survey moved from the surrounding landscape into the detailed laboratory investigations of geoarchaeological materials obtained from barrages, mines, smelting sites, water catchments, and field systems; the ethnographic and ethnoarchaeological studies helped to link past and present societies and the archaeologies they created; and the geochemical studies provided a further critical link between the landscape models of the present project with those of the Bochum team on mining history.

The major strengths of a landscape archaeology study such as the Wadi Faynan Landscape Survey are the spatial and chronological scales of the data accumulated, and their multi-disciplinary nature, in our case integrating especially the approaches of archaeology, ethnoarchaeology, geochemistry, geomorphology, and palaeoecology. The major weakness of such a project is the lack of detailed and tightly-dated information that only major excavations can provide, about particular activities at particular locations at particular moments in the past, and of circumscribed contexts where particular sets of archaeological and palaeoenvironmental information can be investigated in detail and their potential relationships established with reasonable confidence levels. Any holistic study of landscape development of course needs both approaches.

Our project has been extremely fortunate, though, in that we have been able to compare our data with, and relate our results to, the significant amount of excavation work undertaken and being undertaken by other teams in the Wadis Faynan and Fidan of sites relating to most of the major periods of settlement in the past. Critical information

about settlement forms and activities in the Wadi Faynan in the early and mid Holocene has been provided by the major excavations at the Pre-Pottery Neolithic A settlement at WF16 (Finlayson and Mithen 2007) and at the adjacent Pre-Pottery Neolithic B settlement Ghwair I (Simmons and al-Najjar 1996; Simmons and Najjar 2006), and smaller excavations at the Pottery Neolithic/Chalcolithic settlement of Tell Wadi Faynan (al-Najjar *et al*. 1990) and the Early Bronze Age settlement WF100 (Wright *et al*. 1998). Our understanding of the local prehistory has been enormously enhanced by the survey and settlement and cemetery excavations of the Wadi Fidan (Jabal Hamrat Fidan) Project led by Professor Tom Levy of the University of California, San Diego, and Dr Mohammed al-Najjar of the Department of Antiquities of Jordan. This project developed more or less in tandem with our own work but with a particular focus on the social implications of ancient mining and metallurgy; subsequently Levy's team have extended survey and excavation into the Wadi al-Jariya and Wadi al-Ghuwayb, immediately north of the Faynan catchment (Adams 2000; Adams and Genz 1995; Levy 2004; 2006; Levy and Higham 2005; Levy *et al*. 1999a,b; 2001a,b; 2003; 2004a,b; 2005a; Muniz 2006; Weisgerber 2003; 2006). This work has complemented the technologically-focused studies of the Bochum Mining Museum, brought together in particular by Hauptmann (2000; 2007).

The result is that, as described in the later chapters of this book, we can establish the principal components of the landscape history of the Wadi Faynan. Changing and complex interactions can be discerned between herders, farmers, and miners from the early Holocene to the present day. In partnership with the other projects working in the study area, the project provides a long-term perspective on the strategies by which the ancient inhabitants of Wadi Faynan managed their challenging environment, the solutions they developed, their successes and failures, and their short- and long-term environmental impacts, a perspective that we believe provides eloquent testimony of the power of landscape archaeology to contribute significantly to the desertification debate. The book is divided into two main sections. Part I is concerned with the research themes, methods and background. Chapter 2 presents an overview of the present-day Faynan region, summarizing the landforms, environment, climate, geology, and recent history and economy of the main human groups living in or exploiting the zone. In Chapter 3, the methodologies and approaches of the geoarchaeological specialists are presented in further detail, with particular attention on chronostratigraphies, palynology, geochemical and pollution studies, and the investigation of radon gas and other health risks afflicting mining communities. The two following chapters focus on the archaeological survey and the descriptive typologies of sites (Chapter 4), and the investigation of the field systems (Chapter 5). The latter in particular is as much concerned with the methodologies of fieldwork and GIS analysis of complex, multi-period field and wall systems, as it is with explaining our overall interpretation. We believe strongly that the Faynan represents an interesting methodological exemplar of how such work may be undertaken. The diachronic evolution of the field system as we understand it is presented in the relevant chapters in the second half of the book.

Part II presents our chronological syntheses of the various periods of human activity in the Faynan region, combining the archaeological and environmental story in each case. Chapter 6 focuses on the Pleistocene and the activity of hominins (early humans) against a backdrop of major changes in climate and landforms in the period 450,000–9500 BC. The early Holocene environment and the transitions to farming 9500–5000 BC are the subjects of Chapter 7. The Chalcolithic and Bronze Age phases (5000–1200 BC) saw the initiation of mining and metallurgy and more intensive patterns of settlement in a changing environment (Chapter 8). The Iron Age and Nabataean periods (1200 BC–AD 106) represent successive phases of exploitation of the region by early states, with particularly large-scale metallurgy in the Iron II period (Chapter 9). Chapter 10 presents the evidence for a landscape of imperial exploitation in the Roman and Byzantine ages, AD 106–636. The evidence for the degradation of the landscape and the human consequences of pollution linked to the metallurgy are especially notable in this phase. The following Islamic–Ottoman periods (AD 636–1918) stand in stark contrast as human activity returned to a level and intensity that is much harder to identify and evaluate (Chapter 11). The final chronological study (Chapter 12) concerns the ethnoarchaeological study of the modern bedouin, providing improved understanding of their elusive material traces, with significant implications for future investigations of pastoral groups in earlier periods of activity.

The final chapter provides a set of conclusions and responses to the questions laid out in this introduction. Many field survey projects focus above all on reconstructing settlement patterns or changing demographic profiles across time and we would emphasize at the outset that this was not the prime objective of our project (though we do of course have much to say on these issues at the appropriate places). We hope that the results of the Wadi Faynan Landscape Survey will be consulted as much for our insights concerning the methodologies and approaches of interdisciplinary research relating to a series of broad questions about the interactions of people and environment implicated in processes of desertification.