

Industry and Empire: Administration of the Roman and Byzantine Faynan

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Abstract

Industry and Empire: Administration of the Roman and Byzantine Faynan School of Archaeology and Ancient History, University of Leicester

The aim of this thesis is to gain a greater understanding of *metalla*, the imperially owned mining and quarrying districts of the Roman and Byzantine Empires. These extraction industries, and their products, were vital for the State to supply the army and to provide metals for coinage and marble for imperial building projects. To meet the large-scale production needs of the State, the administration of these regions had to manage, supply and organise the industry. This thesis argues that the administration of *metalla* profoundly impacted the regional landscape and studying these landscapes can reveal the management strategies employed.

To explore these issues the Faynan, a copper mining district located in southern Jordan, is used as a case study. This region has been the focus of intensive survey and presents an exceptional opportunity for studying an industrial landscape. By examining the landscape, and comparing the Faynan case study to other *metalla*, the specific mechanisms of management used by the administration are revealed. Some methods involved the creation of infrastructure (roads, aqueducts and administrative buildings) to facilitate production. Certain activities and resources were centralised to allow for greater control. Using GIS, it is demonstrated that the administration employed complex understanding of the ability to exert control through surveillance in its placement of structures in the landscape. It is shown that the Faynan and other *metalla* used multiple strategies to accomplish production. By comparing *metalla* from a number of regions common patterns emerge and the importance of decorative stone and metal to the imperial State is confirmed. The archaeological record reflects in general and specific ways that landscapes were managed and organised by the mining and quarrying authorities.

Key words- *Metalla*, Roman, Byzantine, Faynan, copper mines

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Chapter 1 – Introducing the Research Question

1.1 Introduction

... in the neighbourhood of the copper mines in Palestine no small number of confessors was gathered together, who used great boldness, so as even to build houses for church assemblies. But the ruler of the province...having come to stay there and learning the manner of their life, communicated everything he thought fit to the emperor in a letter that was meant to slander. Next came on the scene the superintendent of the mines, and acting, apparently on the emperor's orders he divided the body of the confessors, assigning to some a place of abode in Cyprus, to others in Lebanon, scattering some here and some there in the districts of Palestine; and ordered that they all should be oppressed with various kinds of labour. After that he picked out those four who seemed most like their leaders and sent them to the officer in charge of the armies in that quarter.

Eusebius *MP* 13.1-4

This citation chronicles events that occurred in the Faynan (AD 310), a copper mining district located in Southern Jordan that was exploited during the Roman and Byzantine period. It is a text of the early church father Eusebius (c. AD 239-339), describing Christian convicts being punished for practicing their religion. However, the underlying theme running throughout the passage is the complex and dynamic interaction of officials in the operation of imperial mines. It is this aspect of the text that touches directly on the central discussions of this thesis.

While there is evidence that the Faynan was an imperial *metallum*, a mining district owned by the Roman and Byzantine State, much of the support for this designation is derived from textual sources like the passage of Eusebius above (for full definition of *metallum* see Chapter 1.3; for discussion of evidence of imperial ownership of the Faynan see Chapter 2). This thesis focuses on the archaeological evidence,

especially the landscape and features within it, to test whether there is physical evidence to corroborate this imperial status. I argue that studying the Faynan landscape will provide deeper insights into the actions of the local mining administration and the means by which they, with external imperial and provincial support, successfully managed the region and the copper industry. This evidence, when combined with that from other *metalla*, will contribute to greater understanding of these vital State industries across the entire empire (Fig. 1.1).

1.2 The Approach of Landscape Archaeology

Landscape archaeology is a set of methods and theories that focus on archaeological evidence on a regional level and holds as a tenet the hypothesis that human behaviour, either conscious or unconscious, shapes its surrounding natural, human made, and social environment (see Chapman 2006; Tilley 1994; Barker, *et al.* 1995). It is an approach primarily pursued through archaeological survey, but also can encompass information from a range of sources such as textual, environmental, and excavation evidence.

A study of landscape and the way it was used and modified, as well as the structures built on it, is not just a fruitful avenue of research for studying the effects of humans and communities, *but governments as well* (Given 2004, 47). Imperial ownership enacted through a local administration changed the character of the landscape profoundly for the State's benefit, leaving traces in the archaeological record. This is discussed at length in Given's (2004) book *The Archaeology of the Colonized*. He argues that after conquest the majority of the ruling power's efforts are directed towards exploitation and

taxation (Given 2004, 51). Colonial or imperial powers create military and administrative facilities that affect the landscape in order to exploit and collect resources. Roads and infrastructure are built to facilitate the collection and organisation of goods. Given terms this system and its structures ‘settlement of empire,’ since they were created to further the causes of the State (2004, 5).

Given discusses these ideas mainly in relation to taxation and changes to agricultural landscape. However the principle, that an imperial State leaves evidence of its ownership and policies in the landscape, can be applied to other situations. *Metalla* were regions developed for imperial benefit; for the Roman or Byzantine State’s political and economic desires for metal and stone. This thesis argues that in a similar fashion to agricultural areas, exploitation by an imperial power should leave visible traces in the landscape of a *metallum*. The Faynan will be examined for the features of ‘settlement of empire,’ including study of the spatial organisation of the region and of the structures within it.

A field survey, collecting information about large portions of the landscape, is ideal for this type of spatially based approach. By examining the archaeological remains of a region at a scale that encompasses the *metallum* and its surrounding support and management structures, the evidence of administration and State support or exploitation can be investigated.

Field surveys have been used to explore several *metalla* of the Roman and Byzantine periods, providing considerable information about techniques, site location and intensity of production (e.g. Given and Knapp 2003; Maxfield and Peacock 2001a;

Sánchez-Palencia 2000). These projects specifically addressed a perceived problem in the field, that most studies of ancient industry started from a framework of archaeo-metallurgy and were largely concerned with recording technological and industrial aspects of the landscape, rather than the social, structural and cultural components (for discussion see Knapp 1998, 2). These studies concentrated on individual *metalla*. A number of more comprehensive studies of groups of *metalla* using field surveys have also been completed, mostly relating to the European provinces (Domergue 1990; Orejas and Sánchez-Palencia 2002; Orejas 2001, 2003). These studies address issues of organisation and spatial patterning over an entire province but rarely make use of advanced spatial techniques of analysis. Nor have the techniques they have applied been used to examine other parts of the empire.

The Faynan is an example of a *metallum* where detailed landscape archaeology has been carried out (Barker *et al.* 1998, 1999, 2000, 2007; Levy *et al.* 2001a, 2003; Witten *et al.* 2000; Hauptmann 2000, 2007) and is thus a suitable case study to employ for this thesis. Landscape archaeology will be used to identify the effects of the local administration and its management techniques through their impact on spatial organisation of the region. This thesis will provide a detailed analysis of the Faynan using the newer techniques of spatial analysis available through Geographic Information Systems (GIS).

This thesis uses the archaeological landscape to study *metalla* and gain a different perspective on their workings and organisation, supported where possible by textual and archaeological evidence. The information gathered from the Faynan will not be considered in isolation but will be combined with other case studies to properly

contextualise the Faynan as well as gain a broader understanding of *metalla* in general. This thesis intends to provide a systematic review and collation of the features of the landscapes of *metalla* in order to construct a general context.

1.3 Definition of an Imperial *Metallum*

Before examining the Faynan region more specifically, it is necessary to discuss the term *metallum*, an extractive region or regions that contained a group of mines or quarries. A further distinction exists, with some extraction regions being designated as imperial *metalla* rather than private holdings. The Roman author Suetonius wrote in AD 17 that Emperor Tiberius made many of the large *metalla* in the provinces subject to imperial jurisdiction (*Tib.* 49.2). This means that they were placed under the direction of imperial officials or members of the military and they generated revenue for the State. It is unlikely that all *metalla* were co-opted in this manner, many may have continued as private holdings. However, Suetonius' point is that the ones that generated the most wealth, or were of particular interest, were confiscated. While the magnitude of this imperial confiscation is arguable (for discussion see Hirt 2004, 63-72), the implications are profound. Metal and stone might have been valuable products for individuals in the Roman and Byzantine empires, but they were vital products for the State. Metal was used for coinage for payment of the army, and for weapons – the means to unite an empire. Stone was used for public building projects to promote imperial ideology (see Fant 1993, Jones 1980). Most scholars accept that during the Late Roman Empire large *metalla* belonged to the imperial State (Hirt 2004, 80; Marc 1995, 34) and imperial control continued through the Byzantine period (Edmonson 1989, 98; Meyer *et al.* 2000, 43;

Matschke 2007, 116-117).

1.4 Administration of *Metalla*

It is crucial to understand the respective roles and interactions of the imperial government and the local administrations of *metalla* in order to determine any effects they might have had on the landscape. While they were under imperial jurisdiction, Emperors did not personally oversee *metalla*, although from time to time they are recorded as taking interest in them (Hirt 2004, 302). For example, Augustus is said to have forced the Asturians to resettle in a gold producing region in order to encourage exploitation of the resource (Florus *Epit.* 2.35.60) (see Chapter 8.7). Emperors mainly were concerned with the profits or materials that these areas could provide. After confiscation the organisation and operation of *metalla* was handled by lower officials.

One common stratagem throughout the Roman Empire was that a *procurator*, an imperial freedman or an equestrian, was assigned to the district. Working under the provincial government and sometimes with military authorities, he would have been assigned a territory that might consist of a single cluster of mines or multiple mining zones (Davis 1979, 11; Hirt 2004, 37). Two examples of this management are provided by the quarries of the Eastern Egyptian desert, Mons Claudianus and Mons Porphyrites, and the Vipasca tablets from modern Aljustrel in Portugal.

At Mons Claudianus, evidence from ostraca and epigraphy details the actual officials involved and who controlled which aspects of production (Peacock and Maxfield 1997, 2001a). During the Trajanic/Hadrianic periods a *procurator metallorum*,

an equestrian prefect and imperial official, was in charge of all the quarries in the Eastern Desert. He was responsible for logistical support, acquiring animals for transport and grain supply (Maxfield 2001, 143). The individual *metallum* seem to have been run by a legionary *centurion*. There was a military detachment on-site; commanded by a *praepositus*- likely a *centurion* or *decurion* (Maxfield 2001, 151). The soldiers' duties included administrative tasks, organisation of supplies and protection of the quarry and its product. Finally the quarried stone was registered and marked by the *procurator caesaris*, providing further evidence of the close control by the imperial State (Peacock and Maxfield 1997, 334).

The most detailed source of information on the administration of mining districts is the Vipasca tablets found near Aljustrel in modern south-west Portugal. The *Lex Metalli Vipascensis*; found in 1906, listed laws regulating the mining industry from the Hadrianic era (Alarcão 1988, 178). The laws were publicly posted by a *procurator* and give valuable insights into the management of this *metallum* during the Hadrianic era. Vipasca was an imperially-owned mining district where leases for workings and mining rights were granted to private individuals or companies (*FRIA* 104 22). This is not to suggest that the State did not still control the mines; 'ownership' was still the prerogative of the State and the default owner in all situations was the State (Hirt 2004, 256). The tablets clearly show that the *procurator* and the state were in charge of the mining effort with the main concerns being taxation and supporting the community supplying the revenue.

In the Roman period imperial *metalla* were operated individually or as part of a provincial group, and it is suggested that a decentralised control existed at the State level,

as no evidence has been found for a centralised office or of individuals formally assigned to a central office (Hirt 2004, 311).

This situation changed in the Early Byzantine period. While there are fewer sources of textual or epigraphic evidence to reconstruct details of administration, what is apparent is that the system of rule was codified and became centralised. The loose, decentralised control under which many parts of the government had operated during the Roman Empire became firm control and a far-reaching bureaucracy took shape (Kelly 2004, 1). It is often claimed that in the Byzantine period the number of *metalla* decreased from that of the Early Imperial period, as did their scale of operations (see discussion Vryonis 1962; Edmondson 1989). This does seem to be the case; however, it is also becoming more apparent that the direct operation of large-scale *metalla* by imperial officials, similar to the organisation at Mons Claudianus, continued throughout the 5th and 6th centuries (for general discussion see Matschke 2002, 115). The best evidence comes from legal codes, especially the *Codex Theodosianus*. The system of mines and quarries was overseen by a central office, run by the *Comes Sacrarum Largitionum* (CSL), one of the two most powerful financial officers in charge of State industries and factories (Kelly 2004, 29). Under him were other *comites metallorum* in charge of regions; for instance, the *Notitia Dignitatum* records a *comes metallorum Illyricum* (Or. 13.11). Regional officials were also responsible for *metalla*. The empire was divided into four regions officiated by Praetorian Prefects, then further sub-divided into dioceses which were formed from provinces (Salway 2001, 245). Thus laws were given to the Prefects to be enforced in their region, and so on down. There is no evidence to suggest that these larger bureaucratic changes radically changed the role of the *procurator*.

Although now assigned by the Prefects or even local councils, he was still the main individual in charge of a mining region. What is evident from *CTh* 1.32.3 is that every detail of the operation, its expenditure and profit, had to be quickly and accurately reported.

The laws directed at the CSL and Prefects are very specific and do not offer an overview of *metalla* across the empire; but even so, three general themes emerge. The first theme regards the restriction of miners and their movements to prevent gold rushes or shortages of miners in critical areas (*CTh* 10.19.7, 15). Second, the laws regarding leasing of State *metalla* were meticulously detailed (*CTh* 10.19.2, 3, 4, 12). Despite the involvement of private companies, Byzantine *metalla* were still regions with heavy imperial involvement. Third, of paramount importance, was the collection of taxes and the State's portions of profit (*CTh* 10.19.3, 4, 10, 11).

The main task after acquiring a territory, as identified by Given (2004), was the implementation of a governing system and structures that could successfully exploit a region and bring economic resources for the State. Reviewing the history and administrative methods of *metalla* documented in textual sources, it is clear that actions taken regarding these regions can be attributed directly to imperial policies or to the procurators working on behalf of the State.

1.5 Industry in the Ancient World

With textual definition of what constituted imperial *metalla* and how they were administered in hand, we turn to efforts to identify the physical and spatial characteristics

of these *metalla*. Other scholars have identified features that indicate imperial jurisdiction. Rothenburg and Blanco-Freijeiro studying Rio Tinto, remarked that imperial ownership was revealed in the scale of production, especially in such an environmentally and topographically challenging location (1981, 174). Such a vast investment, greater than that possible from an individual or group, was confirmation of the participation of the State. Can imperial *metalla* be recognised and described as large-scale industrial endeavours?

Industry can be defined as the continued manufacturing of products from large amounts of raw materials with considerable investment of resources and supplies; usage of this term in a pre-industrial context is a contested issue. Its existence in the Roman and Byzantine empires is part of a larger discussion about the economies operating in the Classical periods. This debate has swung from models that equate the past to modern markets, such as that of Rostovtzeff (1957), to models of a stagnant, agriculturally based economy, as envisaged by Finley (1999 [1975]). Finley's primitivist model dominated the discussion of the Roman economy for many years and still deeply influences the way it is viewed; as underdeveloped, embedded, and without growth or large-scale production (Morris 1999, xviii; discussion in Hitchner 1993, 506). This view has been challenged over the past two decades and a more dynamic understanding of the Roman world has been promoted by some scholars, especially archaeologists (see Mattingly and Salmon 2001; Harris 1993; Greene 1986).

The modern idea of large-scale industry is not appropriate to either the primitive or dynamic models of the ancient economy and it would be incorrect to state that anything in the ancient world was similar to the industrial revolution of the eighteenth

century (Peacock 1982, 10). While it is true that modern connotations of factories and mass production are not applicable to the ancient world, manufacturing activities did occur on a cumulative scale that today would be considered industrial (Rihll 2001, 134). Peacock, when describing Roman pottery production, states that the archaeological difference between types of manufacturing can be determined by the scale of the project (1982, 9). The archetypal activity often presented by scholars to refute claims of a primitive agricultural economy and to argue for the presence of industry is that of the imperial *metalla*.

Imperial *metalla* were organisationally far beyond the scale of nucleated workshops or manufactories (see Peacock 1982, 8-10). These were massive projects, highly organised endeavours, for which a large labour force was required. For example, at Las Médulas, a Roman gold mine in north-west Spain, an estimated 93.55 million m³ of alluvium were sifted to produce 4,677,500kg of gold (Sánchez-Palencia 2000, 157) (Fig. 1.1). Sixteen leats brought water into the site, the longest from a distance of 100km away (Pérez-García *et al.* 2000, 235; Lewis and Jones 1970, 175; Bird 1972, 59). The tailings from the mine in some places are 2km long, enough to block the drainage of a valley and create a small lake (Pérez-García *et al.* 2000, 235) (Fig. 1.2). The cumulative impact of these industries was profound, as ice core samples taken from Greenland show. Atmospheric pollution was produced in the Classical world to a degree that was not matched until the industrial revolution of the 18th century (Hong *et al.* 1996). The Roman and Byzantine empires were contributors to these global effects.

Thus I argue that the term industry can be used when discussing some aspects of the ancient economy, especially the subject of this thesis, imperial *metalla*. The textual

evidence indicates that the Faynan was an imperial *metallum*; if it is like these other examples, it should show characteristics of an industrial scale, highly complex endeavour with a large labour force.

1.6 Use of Comparative Sites

Rothenburg and Blanco-Freijeiro believe that *metalla* were extraction districts with what can be termed industrial production. However, scholars have also suggested other attributes of imperial ownership. For Hirt, the evidence of State ownership lies in the use of State institutions such as the military and the presence of convicts, the *damnati in metallum* (2004, 79). Maxfield believed imperial involvement could be seen in the administration of the *metallum* itself, a central management that was powerful enough to direct inter-regional industry, as well as transportation of supplies and product (2001, 166).

But if these attributes are present, how do they manifest themselves in the landscape or in the archaeological record? An examination of known imperial *metalla* should assist in identifying some of the characteristics that are the markers of empire or, as Given termed it, ‘settlement of empire’ (2004, 4). Mons Claudianus, Mons Porphyrites, Simitthus and Las Médulas are presented here and examined for what each has to offer in terms of indicators of imperial ownership.

1.6.1 Quarries of the Egyptian Desert

The term *metalla* was used by the Romans for mines and quarries, though the latter are different in terms of product and extractive techniques. Yet both types were still

extraction sites requiring a high level of technical skill and both produced vital state products used for imperial projects. Given that mines and quarries were similar in technical complexity and importance to the State, it is advantageous to compare them. Two quarries that lend themselves readily for comparison with the Faynan are Mons Claudianus and Mons Porphyrites (Fig. 1.3). Located in the Eastern Desert of Egypt, they were similar to the Faynan in arid environment and dramatic topography, and were very remote sites, located over 120km away from the Nile and over 80km from the Red Sea (see Chapter 2.2 discussion of Faynan environment).

The Eastern Egyptian desert was a military controlled zone and no travel could take place without permit (Maxfield 2001, 160). The quarries were surrounded by a dense network of military garrisons, *praesidia* that lined the roads leading to the Red Sea and the Nile. Accompanying watering stations, *hydreumata*, were placed at intervals along the route; these provided the water and overnight secure accommodation (Maxfield 2001, 160).

Estimates based on archaeology and the *ostraca*, documentary records written on potsherds, suggest a population of about 900 for Mons Claudianus, 60-100 being soldiers who lived within the quarry community. This population had to be provided for and because of the arid environment large-scale agriculture was not possible; although some small garden plots may have existed, the majority of food was imported (van der Veen 1996, 137). Also, large numbers of animals had to be requisitioned to transport the stone products; a column found in situ at Mons Claudianus is 60ft in length and estimated to weigh 207t (Maxfield 2001, 158). Adams (2001) made estimations for the cost of needed supplies for Mons Claudianus.

Table 1.1 Costs per year at Mons Claudianus, (adapted from Adams 2001, 187).

	Persons or animals supplied	Grain/ Barley required in <i>artabas</i> per year	Cost in drachmas
Population of Mons Claudianus	c. 900	10,800	86,400
Animals to transport grain	c. 150	5,400	42,300
Animals to transport stone	c. 100	3,600	28,800

Mons Porphyrites would have had similar needs; these quarries were massive logistical operations where the required food and water needed to be supplied, animals and transport for the stone products needed to be requisitioned, and protection for the transport route needed to be provided. These needs required resources from across the province of Egypt. As Adams states, the quarries were not economically rational operations, but instead created to meet a need of the emperors (2001, 188). It becomes apparent that even without the epigraphic evidence of the quarries being under imperial jurisdiction, the scale of extraction and transport strongly indicates imperial involvement (Maxfield 2001, 166). But what did this production do to the landscape, what evidence for the administration and the ‘settlement of empire’ exists on the ground?

1.6.2 Mons Porphyrites

Quarries at Mons Porphyrites were in operation from the 1st to the early 5th centuries (Fig. 1.4). Its red-purple porphyry was highly prized, purple being the royal colour, and often took on ceremonial significance for emperors (Dodge 1991, 30). It was used in many buildings including the Baths of Caracalla, Hagia Sofia and Great Palace of Byzantium (Maxfield and Peacock 2001b, 320; Peacock and Maxfield 2007, 420).

The main area of settlement and the heart of the *metallum* was the Wadi Abu Ma'amel (Fig. 1.4, Fig. 1.6) (A). It had a fortified complex at its centre which seems to have housed the garrison and administrative officials (Maxfield and Peacock 2001b, 12). For convenience it is referred to in the literature as the Porphyrites Fort although its topology is very different from other forts of the Levant. It has 1m thick walls and a tower in the south-east corner (Fig. 1.5). To the south of the fort, another building, described originally as a bath house due to its hypocaust system, was likely a high status dwelling of the official in charge of the district (Fig. 1.6) (Maxfield and Peacock 2001b, 23).

Accompanying these more official buildings was a workers' village (Fig. 1.6). Completing the community was a necropolis located to the north of the fort and three temples dedicated to Serapis, Isis and Isis Myrionomos (Maxfield and Peacock 2001b, 12). A well, vital in this arid climate, was located near the fort (Maxfield 2001, 42).

Structures also existed to connect this centre visually with the quarries. Two *skopeloi*, small observation posts of rough construction, are located at the southern end of Wadi Abu Ma'amel (Fig. 1.7). They provided views of the central complex, the South-west village, the Rammius quarries in the surrounding mountains and the foot pass (Maxfield and Peacock 2001b, 196).

There are two side settlements in the surrounding wadis, Umm Sidri (C) and Badia (B) (Fig. 1.4). Umm Sidri had animal lines and likely housed the animals who were transporting the porphyry. Furthering this theory, a nearby loading ramp suggests that the porphyry would be transferred to carts before heading to Badia and the Nile (Maxfield

2001, 213). Badia was a second facility located to the south of the main community on the road leading into the region. A fort was located at this important road junction (Maxfield 2001, 219) (Fig. 1.4). Projecting towers were added to each of its corners and at the midpoint of each wall, providing views of the main approaches into the region. Next to the fort is a set of animal lines, a huge construction, measuring 0.22ha, larger in size than the fort. It was rectangular with six interior lines of watering or feeding troughs (Maxfield and Peacock 2001b, 226). This facility is located at a critical junction between the last stop of the region and the road that runs to the Nile. Finally the Wadi Abu Ma'amel is accessible through a pass in the south and the footpath station, a small fort (D), was placed here (Maxfield and Peacock 2001b, 200).

The quarries are located in the Gebel Dokhan Mountains (E) to the west of the Wadi Abu Ma'amel (Fig. 1.4, Fig. 1.7). There were also subsidiary quarries to the north and east of the Porphyrites' fort and further workers' villages were in the mountains. Some villages are small hamlets like Bradford village, which was comprised of only 7 huts (Maxfield and Peacock 2001b, 58). Others like the North-west and South-west villages were substantial settlements with large buildings. These sites have a mix of housing, simple structures or barrack style buildings, sometimes accompanied by an upper status house, likely for an official.

1.6.3 Mons Claudianus

Mons Claudianus was a quarry producing granodiorite and it was in use from the 1st to the 3rd centuries (Peacock and Maxfield 1997, 2001a, 2006). The main use of the stone was in imperial public works in Rome, the most famous being Trajan's Basilica

Ulpia and Hadrian's Pantheon. Mons Claudianus is an especially informative *metallum* to study due to the substantial numbers of *ostraca*. These offer a surviving record of administrative, military and civilian matters that greatly adds to knowledge of the site (Bingen *et al.* 1992, 1997; Cuvigny 2000).

Mons Claudianus consists of three main areas (Fig. 1.8, areas A, B, C). In Wadi Umm Hussein were the main complexes of the region (A). The largest structure, evidently a fort, seems to have been occupied by both military and civilian inhabitants (Peacock and Maxfield 2001a, 75) (Fig. 1.9). Attached to this was an annex that expanded the living quarters. Its regular barracks and lack of residential buildings suggest it may have been a separate area for soldiers. Within the walls of the fort is a separate structure, likely a dwelling used by someone of high status (Peacock and Maxfield 1997, 85). The fort has walls surrounding it with three towers on the north, south and east sides (Peacock and Maxfield 1997, 39).

Animal lines are to the south-west of the fort, and as at Mons Porphyrites these offer large watering and feeding facilities (Peacock and Maxfield 1997, 86) (Fig. 1.9). Part of this complex was a granary or store building to supply the large community (Peacock and Maxfield 1997, 94). A well was also located here (Peacock and Maxfield 1997, 99). Nearby was a bathhouse and residential complex. It likely was accommodation for officials or visitors (Peacock and Maxfield 1997, 134) (Fig. 1.9). To the north of the fort was a temple to Serapis with inscriptions referencing Emperors Trajan and Hadrian and the XV *Apollinaris* legion (Fig. 1.9). Finally to the west of these structures was a necropolis (Peacock and Maxfield 1997, 137).

The quarries were located to the north of Wadi Umm Hussein (B) (Fig. 1.9). There were some huts and small structures, but in most cases these were isolated single buildings and may have been forges for tool repair rather than settlements like those of Mons Porphyrites (Peacock and Maxfield 1997, 233). Interspersed around the region were *skopeloi*, in view of each other and the quarries, placed at a maximum of 650m apart, which allowed for voice or signal communication (Peacock and Maxfield 1997, 254).

About a kilometre away was Hydreumata (C) (Fig. 1.9), a village with a small fortlet and a collection of irregular buildings- possibly workers' accommodation (Fig. 1.10) (Peacock and Maxfield 1997, 141). A large domestic structure, perhaps belonging to an administrative official, was also located here (Peacock and Maxfield 1997, 141).

1.6.4 Simitthus

Another well studied *metallum* is the Tunisian quarrying site of Simitthus that produced a yellow marble (Rakob 1993, 1994; Mackensen 2005) (Fig. 1.11). Simitthus had a town next to the workings, classically Greco-Roman in form with a forum, marketplace and bath (Mackensen 2005, 119). The quarries were worked from the 1st century until the end of the 3rd AD (Mackensen 2005, 121). The city was located along the Mejerda River that flows into the Mediterranean Sea, the only perennial river in Tunisia. Today it is a major source of water for Tunisia's cereal cultivation and it is likely that the same importance was afforded it in Roman times; indeed, at Simitthus the remains of water-powered grain mills have been found (Wilson 2002, 14).

Simitthus was not as isolated as the Egyptian quarries. The adjacent civilian town

presents a different situation than the remote Eastern desert. However, the urban centre was a distinct entity, separated by a wall (A) from the imperial quarry (Fig. 1.11). The land was demarcated, separating civilians from imperial property physically and psychologically. In fact the town itself did not use much of the marble from the quarries for its public buildings, further suggesting the lack of interaction between civilian and industrial sectors (Hirt 2004, 25). The town had monumental structures such as the amphitheatre and the forum that were unrelated to the quarry and show evidence of a civilian government operating alongside the industrial administration.

The most remarkable buildings of the quarry are located to the north-east of the quarries (B) (Fig. 1.11). This complex was larger than any other in the area, industrial or civilian, measuring 114.9m by 229.2m (Mackensen 2005, 4). It is a tripartite construction with three separate areas (B1, B2, B3 on Fig. 1.12), surrounded by walls. Originally the complex was interpreted to have been a single phase construction, the western part serving as an administrative/military compound (B1), the centre as a prison for convicts (B2), and the eastern as a barracks (B3) (Mackensen 2005, 119). It now appears there were several phases of construction. Interpretation of the western building is ongoing; it may have functioned as the administrative centre (B1) (Mackensen 2005, 122). The administrators may have been military officials, as legionary inscriptions were excavated here. However, no military equipment was found during excavation. While soldiers may have built parts of the complex their continued occupation after that event is not proven.

The large central building was divided into six north-south aisles (B2). The suggestion that this functioned as a prison was based on the deep foundations and gates with each room having only one point of access. However, the building had no outer lock

and to have operated as an effective prison a guard would have had to be placed at each door (Mackensen 2005, 119). Mackensen suggests that it instead functioned as a *fabrica*, a marble workshop (see Chapter 8.2.4). During a second phase of use this is very likely, as the finds include marble polishing benches (Mackensen 2005, 122). Under either interpretation it is a massive building comprising six elongated rooms, each c. 80m long. Its location in the quarry area makes it clearly a building associated with the extractive industry.

The eastern compound (B3) was erected later than the other buildings, in the mid-3rd century, and was only occupied for a short time, ending by the 4th century (Mackensen 2005, 121). Contrary to earlier interpretations there is no material evidence to suggest it functioned as a barrack and the interior layout is unlike other regional military structures. However, partially finished marble bowls and polishing benches suggest it was a marble *fabrica* and several narrow rectangular rooms could have functioned as a storage area.

In sum, at Simitthus part of the infrastructure for the industry was a monumental complex, a building larger than any of those found in the civilian town, for example the baths (Fig. 1.11) (D). The structure, though uncertain as to phases, does show itself to be a multipurpose building used for manufacturing. The amount invested in its construction certainly reflects the importance placed on production of marble pieces.

1.6.5 Las Médulas

Las Médulas was a gold mining district in north-western Spain (Sánchez-Palencia *et al.* 1999, 2000). Arguably it was one of the most significant mines in the Roman Empire due to its unusually large size. The gold produced had wide reaching effects, for

example Emperor Augustus reformed the monetary system based on gold *aureus* coins using the metal from this region (Sánchez-Palencia *et al.* 1999, 116). The mining operation ran from the 1st to the 3rd AD century when it ended. North-west Spain was an area that fiercely resisted colonisation, thus the Roman military was a constant presence to prevent revolts (see Jones 1976). Within the Las Médulas region a road network linked the provincial capital, surrounding military forts and the important population centres to the *metallum* (Sánchez-Palencia 2000, 293) (Fig. 1.12).

The region encompasses multiple mines including several smaller gold and iron mines (Fig. 1.13). However the main opencast mining pit, now named Las Médulas, was the focus of industry in the region. Las Médulas was mined using a mix of complicated hydraulic systems. The first method was hushing, the controlled application of bursts of water to remove rock that had already been destabilised by the miners (Lewis and Jones 1970, 177). The other technique, used more frequently, was hydralulicing whereby a continual flow of water eroded soft beds, loosening the alluvium (Jones and Lewis 1971, 17). As both were gravity based systems, the first requirement was to provide water above the area to be mined (see Chapter 1.3). Aqueducts would supply the water to a series of tanks high up in the mountains. From these, channels directed the water. After the alluvium was washed loose it would travel through a series of washing tables. At each stage more of the waste materials would be removed until most of the gold was separated (Pliny *NH* 33.76).

The progression of a landscape of industry is well understood at Las Médulas. The pre-Roman settlement was characterised by *castros*, fortified hilltop settlements. Although culturally connected, each settlement was separated and self sufficient. Each

castro had its own set of farmers, pastoralists, and metalworkers (Sánchez-Palencia 2000, 108). The new landscape that emerged after the conquest was markedly different. It involved the reorganisation of the landscape; more settlements with denser populations located closer to the mines (Fig. 1.14). These new settlements were not *castros* but open plan communities (Orejas and Sánchez-Palencia 2002, 591). This formation had a profound effect on settlement within the region and differed markedly from pre-Roman spatial patterns.

Over 40 sites have been found dating to the Roman period. It is difficult to estimate the population as smaller sites may have been inhabited for short periods, but anywhere from 1,700-4,800 people inhabited the region at this time (Sánchez-Palencia *et al.* 2001, III.3.A). Some sites have been excavated; one, Las Pedreiras, was very different from the others. It had very “Romanised” building styles, with materials and layout being classically Greco-Roman, to a degree not found in any other sites of the region (Sánchez-Palencia 2000, 291). It is likely that this high status site was for a supervisor of the region or perhaps the *procurator* of mining. Castro Orellán was another site excavated that was heavily involved in iron smelting. Its multiple slag heaps indicate the large-scale of production and it may have served as a smithy, providing tools for use in the rest of the area (Fig. 1.14) (Sánchez-Palencia *et al.* 2001, III 5A).

1.7 Hallmarks of Imperial *Metalla*

Some hallmarks of *metalla* already suggested by other scholars were: an industrial scale of production, a strong administration directing intra- and extra-regional trade and supply, the presence of the military, a large investment of resources and the overcoming

of environmental challenges (Chapter 1.4). As can be seen from these case studies, these overarching indicators were present and were implemented in a locally responsive fashion in each individual *metallum*, with adaptations based on numerous factors including location, environment, industry and available infrastructure. Each of these factors radically changed the form the *metallum* took, but in each, evidence for the hallmarks was present.

In each case the presence of the army was attested in the creation of forts, fortified buildings or a network of military sites. Also observable in the archaeological record are the effects of colonialism and what Given termed ‘settlement of empire.’ Infrastructure was created at all the *metalla* to facilitate and control production on an industrial scale and observational structures were created to oversee the process. Landscapes such as that of Las Médulas were reorganised after conquest to best suit the needs of the imperial State. At the Egyptian quarries, production was beyond that which the local environment could support and this required a continuous source of supplies orchestrated by the administration; structures such as roads or watering stations were present to increase the volume of transportation.

If the Faynan shows similarities to the imperial *metalla* examined in this chapter, it will have analogous hallmarks of State ownership. Indicators to search for in the archaeological record would include those related to the military- fortified structures. These might be located at exits and entrances to the region suggesting that there was restricted access to the imperial district. *Skopeloi* or watchtowers might be located in the landscape in order to facilitate communication or to monitor approaches to the site, as were found at the Quarries. Infrastructure for the extraction, smelting and transport of the

product would be present. This infrastructure might take the form of monumental buildings, loading ramps and road networks. Evidence might be found of efforts to supply large quantities of food and other supplies. This thesis will present a detailed examination of the Faynan region, searching for these and other archaeological evidences of an imperial *metallum* and its characteristic structures or spatial patterns.

1.8 The Faynan

The Faynan has been the focus of many studies; the two main ones used for this study are the Wadi Faynan Landscape Survey (WFLS) and the Jabal Hamrat Fidan Survey (JHF). Recently this research has culminated in the publication of several books. Finlayson and Mithen (2007) have written *The Early Prehistory of Wadi Faynan, Southern Jordan: Archaeological Survey of Wadis Faynan, Ghuwayr and Al Bustan and Evaluation of the Pre-Pottery Neolithic A Site of WF16*. More pertinent to this thesis is a complete collection of the Wadi Faynan Landscape Survey (WFLS), *Archaeology and Desertification, The Wadi Faynan Landscape Survey, Southern Jordan* (Barker *et al.* 2007). This work covers all the data collected by that survey from the Palaeolithic period to studies of the modern Bedouin. Given the scope of time covered by Barker *et al.* (2007), the space allotted to the Roman and Byzantine periods did not allow for discussion of those eras in detail. *Metalla* played a vital role in the imperial State; a separate, more detailed study will advance understanding of the extractive industries. The medium of a thesis provides the needed space to analyse this *metallum* thoroughly. Though excellent surveys have been conducted, each examined different parts of the Faynan region (for metallurgy see Hauptmann 2000, 2007; for Iron Age and Wadis

Fidan, al-Ghuwayb and al-Jariya see Levy *et al.* 2001a, 2003; for Wadi Faynan see Barker *et al.* 1997, 1998, 1999, 2000, 2007). I would argue that a regional view encompassing the entire landscape, rather than a single wadi catchment, is necessary to understand the industry and administration of the Roman and Byzantine Faynan. Combined, these surveys provide a holistic view of the region that was previously unattainable (see Chapter 4), and form the database for this thesis.

The Faynan region is of particular archaeological interest because of its exceptional state of preservation. Faynan's copper industry was never revived on a large-scale after the Roman/Byzantine periods (Hauptmann 2007, 156). The industry during the medieval period was based approximately 6km north-west of the centre of the Roman/Byzantine operations (Kind *et al.* 2005, 188). Aside from a few prospection tunnels by the Natural Resources Authority of Jordan there has been no modern mining in the region. Modern extraction is particularly destructive and the modern apparatus that supports the mining industry, roads, towns and power plants, can change the landscape dramatically, destroying archaeological remains. Even settlement in the Faynan has been sparse since the Roman/Byzantine Periods, leaving large areas of the land undeveloped, although construction has accelerated rapidly in recent years (Barker *et al.* 1997, 21). The domestic and agricultural structures as well as the remains of the industry are largely undisturbed and well preserved in the Faynan's arid climate. The *metalla* of other regions, such as Spain and Cyprus, are not as well preserved due to extensive civilian settlements and continued mining operations (Jones 1980; Given and Knapp 2003, 45). This means the Faynan is an excellent case study as it can provide more information than other regions.

1.9 Conclusion

This thesis will explore the subject of industry, imperial ownership and support, and spatial relationships in the following manner. In Chapter 2 the Faynan case study will be introduced, its environment, topography and scale of industry will be examined. Chapter 3 discusses the survey data available for the Faynan region. Methodological issues surrounding the use of field surveys and the specific surveys used in this study are discussed. Chapter 4 engages with the data and the digital aspects of this research starting with the methodology used during the creation of the database. Also in this chapter is a discussion of GIS; the history of its use and methodological concerns. Chapter 5 lays out the structural archaeology across the landscape. The combination of the surveys allows for a new and unique broader view of the landscape that clearly demonstrates the presence of the archaeology of imperial ownership. Based on these findings, Chapter 6 engages in a broader discussion of the Faynan, both its archaeology and landscape, and how it demonstrates the hallmarks of an imperial mining operation. Key aspects of the mining industry and imperial management in the Faynan region are identified. Chapter 7 looks at one particular aspect of this imperial impact on the Faynan, the creation of a surveillance system. This observational system shows a deep understanding of the principles of surveillance and observation. Chapter 8 integrates knowledge gained about the Faynan with other *metalla*; similarities and differences as well as a theory of spatial patterning are discussed. Information from the case study *metalla*, many of which have been excavated, will be used to suggest future avenues of research in the Faynan. Chapter 9 will include the summary and conclusion, highlighting what has been learned as well as discussing what areas of knowledge are as yet incomplete.

Chapter 2 – The Faynan Case Study

2.1 Introduction

An introduction to the Faynan region is essential before further discussion can take place (Fig. 2.1). This chapter will cover a number of aspects of the Faynan including its physical geography and climate. A review of the already established scholarship and archaeological data pertaining to the region is also presented. Most essential to this project, the current state of the evidence supporting the status of the Faynan as an imperial *metallum* is laid out and discussed in depth. A variety of data, both textual and archaeological, are used to create a model of the Faynan throughout the imperial era.

2.2 The Faynan's Topography and Environment

‘Wadi’ is the Arabic term for seasonal drainages or dry riverbeds. The heart of the Faynan is a wadi system, a grouping of main wadis and their tributaries. The region derives its name from the chief wadi, the Wadi Faynan. Although the region is named for the major wadi, the true unifying resource for the region is copper, both the mineral deposits and the sites of copper industry. This is a rugged mountainous landscape with a challenging climate that has the effect of restricting human behaviour within it (Fig. 2.2). Although no landscape can completely determine the actions of human beings, it can limit options and the choices available (Baly 1985, 20). Thus it is valuable to consider the surrounding environment of the Faynan when attempting to understand human choices made within it. Even today the topographical features of this area profoundly influence

the settlement and exploitation of the land.

Examining the region from east to west it becomes clear the Faynan landscape comprises a vast array of landforms with dramatically varied elevations (Fig. 2.3). The Jordanian Plateau borders the region to the east. It is a large formation running north-south and rising at points to 1100m above sea level (Barker *et al.* 1997, 21). The western edge of this edifice has sharp slopes and would be extremely difficult to traverse if not for the series of steeply incised valleys such as the Wadi Dana, which act as a natural route between the plateau and the land below (Fig. 2.3).

The Wadi Faynan itself is created by the confluence of three tributary wadis, Wadi Dana, Wadi Ghuwayr and Wadi Shaygar, running down from the rocky east (Barker *et al.* 1997, 20). The Wadi Faynan opens up shortly after its beginning, creating a wide flood plain some 8km in length and 3km wide at its greatest extent (Fig. 2.3). This flood plain is the largest in the region and lends itself naturally to agriculture. A further tributary is the Wadi Ratiye, the location of many of the copper mines of the region (Hauptmann and Weisgerber 1987, 421). About 12km further west, the Wadi Faynan plain narrows, and on reaching the mountain ridge Jabal Hamrat Fidan, becomes the Wadi Fidan. The Wadi Fidan cuts north-west, narrowing further as it carves through the ridge that rises some 150m above the wadi bottom (Levy *et al.* 2001a, 165). To the north of Wadi Fidan the line of the Jabal Hamrat Fidan is continued, and both of these ridges flank the Wadi Fidan completely. Having broken through the mountain front, the wadi fans out and becomes a part of the larger Wadi 'Arabah. The two mountains run 12km along the Wadi 'Arabah and the Wadi Fidan is the only entrance through them (Fig. 2.3).

Wadis al-Jariya and al-Ghuwayb, although they are not tributaries to this main geological formation, are included in the boundaries of the Faynan region because they are adjacent to the copper mines, the unifying factor in forming a coherent region. Wadi al-Ghuwayb lies to the north of the main Faynan-Fidan geological system. It winds for about 14 km (Fig. 2.3) (Levy *et al.* 2003, 249). Wadi al-Jariya is about 5km to the north of the main wadi system (Levy *et al.* 2003, 259). Running south-west, it is narrow, has steep embankments and is the location of another dense concentration of mines (Hauptmann and Weisgerber 1987, 421).

In places these wadis form deep gorges that carve the land, inhibiting travel outside of them; but if they are followed, they form a system of corridors (Fig. 2.2). Travel within the Faynan is more feasible east and west, as the mountains limit movement to the north and south. The most significant result of this geological formation is that this wadi system creates a traversable passage between the Wadi ‘Arabah rift valley and the Jordanian plateau, the wadi bottoms being low and relatively flat where the rest of the terrain is a steep, rocky, mountainous area. This landscape is a closed system with very few openings. A bounded space is created.

The Faynan region is part of the larger Wadi ‘Arabah system, a semi-arid zone that experiences little precipitation (Bienkowski 2006, 9). Today, the average yearly rainfall in the Faynan is variable and changes depending on how close to the Jordanian plateau the measurement is taken. An average of 34mm of rain annually has been recorded at Wadi Faynan, 70mm in the Wadi Fidan and 90mm on the Wadi al-Ghuwayb (Barker *et al.* 1997, 21; Levy *et al.* 2003, 249; Levy *et al.* 2001a, 165). The rainfall, which occurs during the winter months, is uneven and, aside from a few deluges, sparse

(Raikes 1985, 96). Lack of rain during the rest of the year and the nearby plateau create the conditions for flash flooding.

The Faynan possesses a critical environmental resource, rare to the Wadi ‘Arabah, it has natural perennial springs. There are five springs: three are located in the tributaries to the Faynan in the Wadi Ghuwayr, Wadi Dana, and the Wadi Shayqar; a fourth spring can be found in the Jabal Hamrat Fidan (Raikes 1980, 40). The fifth is located in the Wadi al-Ghuwayb Rawani (Levy *et al.* 2003, 249). These springs provide water throughout the year.

Research indicates that the climate of the southern Levant has remained relatively unchanged, being mostly arid, since the Early Bronze Age, 3000-2400 BC (Barker *et al.* 2007, 335). However there is evidence to suggest that during the Classical period, from the 1st century BC to the 3rd century AD, there was an increase in precipitation. This can be inferred from different sources of evidence, such as the changing shoreline of the Dead Sea (Shehdeh 1985, 27; Bruins 2006, 32). Hunt *et al.* (2007) examined the paleoenvironment of the Faynan region to document changes over time. For the Roman and Byzantine period sedimentological and algal microfossils taken from the barrage WF441 (see Chapter 2.5.3) indicate a wetter environment than currently present, with the barrage actually containing standing water for long periods (Hunt *et al.* 2007, 1321). Unlike the present day desert conditions, it was a steppe environment with 100-150mm of rainfall annually (Hunt *et al.* 2007, 1332). Roman industrial activity in the valley may have benefited from the increased precipitation making settlement easier, but rainfall was never plentiful throughout the year. Moreover, habitation in the region continued into the Late Byzantine era despite the end of this wetter period. Thus, increased precipitation

was not the only determining factor in studying human settlement patterns in this region; social, political and cultural factors must be considered as well (Bruins 2006, 32).

2.3 Previous Research in the Faynan

The Wadi ‘Arabah has been a region of western scientific exploration for over a century (Bienkowski 2006, 9). Reports generated from initial forays in the nineteenth century were more travel logs than published systematic surveys. Alois Musil (1907), Fritz Frank (1934) and Nelson Glueck (1935) provided archaeologists with the first view of many of the sites of southern Jordan, including those of the Faynan region. Hans-Dieter Kind (1965), while investigating the geology of Jordan, published on the Faynan and its copper resources. Thomas Raikes (1980) is the modern surveyor who is often credited with reassessing and redrawing attention to the important archaeological sites in the southern Wadi ‘Arabah. In 1983 a project was started by Andreas Hauptmann and the Deutsches Bergbau-Museum Bochum (DBM), in co-operation with the Jordanian Department of Antiquities, to study the archaeometallurgical remains in the region (Hauptmann 2007, v). Finally, Burton MacDonald (1992) conducted the Southern Ghors and Northeast ‘Arabah Survey, the southern limits of which covered parts of the Faynan.

The primary data sets used in this thesis are the systematic surveys performed by the Wadi Faynan Landscape Survey (WFLS) and Jabal Hamrat Fidan project (JHF) (Levy *et al.* 2001a, 2003; Barker *et al.* 1997, 1998, 1999, 2000, 2007). These surveys are supplemented by other works to add further details when possible, especially when discussing the metallurgical sites (Hauptmann 2000, 2007), and MacDonald, whose Southern Ghors and Northeast ‘Arabah Survey (SIGNAS, 1992), overlapped slightly with

the JHF.

2.4 History of the Roman Province of Arabia

Although it is not the purpose of this research to give a detailed historical account, it is necessary to understand Roman Faynan within a larger historical context (Appendix 1). The Faynan had a long history of settlement and exploitation of its mineral resources; evidence from the Neolithic, Chalcolithic, Bronze Age, Iron Age and Nabataean eras has been found (Najar *et al.* 1990; Levy *et al.* 2001a; Barker *et al.* 2007; Finlayson and Mithen 2007). The first historical reference to Faynan was c. 1219-1213 BC during the reign of Pharaoh Ramses II, when it was recorded in geographical lists as *Pwnw* (Kind *et al.* 2005, 169). It is also mentioned in the Bible as Punon (Num 33:42).

2.4.1 History Pre-conquest (100 BC - AD 106)

Augustus (27 BC-AD 14) and the Julio-Claudian emperors (AD 14-68) consolidated control over Judea and Egypt. Through these incursions in the Levant the Romans came in contact with different tribal groups and kingdoms. One was Nabataea, which became an ally and client kingdom (Millar 1993, 353). The Kingdom of Nabataea, in its most prosperous period from 63 BC to AD 106, encompassed the Sinai and Negev deserts, the Hauran and Transjordan, including the Faynan (Bowerstock 1983, 2). The Nabataean Kingdom had a number of cosmopolitan cities, the capital Petra, as well as 'Aqaba and Bostra. The Kingdom based much of its economy on trade; overland caravan routes from the East had to cross the Nabataean territory on the way to the Mediterranean (Millar 1993, 387).

Pottery and coins (see Chapter 2.6 below) have been found documenting that the Faynan was inhabited during the Nabataean Period. Khirbet Faynan was the central settlement and agriculture was practiced on the floodplain (Barker *et al.* 2007, 293). Whether the activities practiced in these settlements included mining and metallurgy is under debate. There is a growing body of evidence that the Nabataeans exploited the copper resources in the Faynan region in a limited fashion. This has implications for determining how early Roman industry began. If Nabataean workings were established, they might have made it easier for the industry to expand to the scale reached in the Late Roman Period, as the region would have had some limited current mining infrastructure.

The Deutsches Bergbau-Museum Bochum (DMB) has acknowledged that the main smelting site of the Classical period shows evidence for pre-Roman activities starting in the 2nd century BC (Hauptmann 2007, 94). However, Hauptmann and the DBM posit that Nabataeans in the region were not engaged in extraction or smelting; instead this may be evidence of non-industrial activities (Hauptmann 2007, 155). Weisgerber states that no mining or smelting can be linked to the Nabataeans (Weisgerber 2006, 17).

Contrary to this, it can be argued that there is clear evidence for pre-Roman extraction and possessing of ore, but by whom, whether visiting Romans or Nabataeans, is unclear. There are two mine workings that are believed to date to the pre-conquest period. One is WAG 57, a mine containing pottery associated with the Nabataean/Early Roman Period (Levy *et al.* forthcoming b). The other is a mine prospection tunnel found in the Wadi Khalid with a coin recovered by its entrance that was minted during Vespasian's reign (Hauptmann 2007, 121; Kind *et al.* 2005, 191). Evidence of metallurgy

during the Nabataean/Early Roman period has been found in 'Aqaba where ore, slag and several hundred copper and bronze objects have been found (Fig. 2.1). Although the Nabataeans had extensive trade networks to procure metal, the presence of ore rather than just metal is what suggests a local source. Parker believes the likely source of this copper ore was the Faynan (Parker 2006, 228). Within Wadi Faynan itself, calibrated radiocarbon dates of charcoal found at slag heap 1 are 2031 ± 50 (171 BC-AD 68) and 1991 ± 72 (194 BC-AD 209) (Hunt *et al.* 2007, 1334). These dates strongly suggest that smelting occurred in this location in the Nabataean period.

This evidence indicates that a re-examination of Nabataean sites in the Faynan must take place; the extent and timing of Nabataean period extraction may be in question but, contrary to the position of DBM, there is evidence of its existence. Further sampling of slag piles should be done to determine the extent of Nabataean copper production in the Faynan.

2.4.2 Conquest and Initial Exploitation of the Faynan

Although there were earlier interactions with Nabataea, the Roman Period (AD 106-324) began upon annexation of the Kingdom. The reasons for annexation are still debated; what is known is that it involved the death or curtailed power of King Rabell II. Scholars debate whether formal incorporation into the Empire in AD 106 was the inevitable progression of Roman provincial policy or precipitated by revolt (see Freeman 1996; Bowerstock 1983; Millar 1993).

It is presently unknown exactly when Faynan itself came under imperial jurisdiction. It can be argued that the declaration of confiscation by Tiberius would have

meant significant mineral resources became imperial property upon annexation (see Chapter 1.2). Given the renown of the mineral belt of Timna and Faynan, “King Solomon’s Mines,” it is likely that the existence of substantial copper reserves was known to the Roman Empire. It is even plausible that this knowledge figured in the decision to make Nabataea a province (Barker *et al.* 2007, 305). Even if this were not the case, upon creation of the province in AD 106, the Faynan would have been recognised as a valuable resource and most likely earmarked as an imperial holding.

Although the Faynan region may have immediately been claimed as an imperial *metallum*, the actual start of a State run copper industry is difficult to pinpoint. The imperial accomplishment of the Early Roman period with the most impact on the Faynan was the construction of the *Via Nova Traiana*. The Wadi Dana provides a moderate ascent to the Jordanian Plateau and the journey from Khirbet Faynan to the *Via Nova* is about 14km (Rollin and Streetly 1998, 203) (Fig. 6.9). An infrastructure was being created for the province that facilitated the eventual large-scale copper production at Faynan.

2.5 The Imperial Copper Industry at its Height (AD 150-400)

In Chapter 1, I established the concept that it was the scale of production that indicated whether the term industry could be applied to ancient extraction industries. It was also posited that one of the identifiers of imperial *metalla* was production beyond that of small manufactories into the scale of industrial production. Rothenburg and Blanco-Freijeiro (1981, 174), when describing Huelva, Spain, declared, “The scale of the operation and the layout of the actual working schemes are evidence of minute overall

planning...that could only have been made possible by the active involvement of the governing political and military establishment.” One of the first questions to ask is what was the scale of production across the Faynan landscape? A second is what is the model of development of Classical period settlement and industry?

The best evidence for industry in the Faynan occurs during the Late Roman Empire and the scale of production may have been spurred on by provincial changes. The main smelting site of the region shows ample evidence of industrial activity from the 2nd and 3rd centuries (Hauptmann 2007, 94). When Emperor Diocletian (AD 285-305) reorganised the entire system of government across the empire, the main effect on the Levant was to further improve the military defences (Bowerstock 1983, 143). As the number of soldiers surrounding the Faynan increased, so did the need for metal in the region. Faynan was connected not only to the *Via Nova* but to the Mediterranean as well (Barker 2002, 496). A section of road has been found nearby between Mampsis and H. Zafir that, if extended, would connect the Faynan to Gaza, the nearest Mediterranean port (Isaac 2006, 217).

The other empire-wide event that affected the Faynan during this period was the persecution of Christianity. The largest purges started in AD 303-311 when considerable numbers of Christians were tried and condemned to labour in the mines (McManners 2001, 42). It is in reference to this historical event that the best textual evidence of events in the Faynan, or *Phaeno* as it was then called, is provided. Eusebius (AD 263-339), in his works *Ecclesiastical History* and *The Martyrs of Palestine*, describes *Phaeno*, the copper mines of Palestine. Recording the history of the persecution, he provides important evidence about administration and organisation (see Chapter 2.5.1 and 6.6).

There are four already established lines of evidence that the Faynan region operated as an imperial *metallum* of industrial scale during the Roman and Byzantine periods; the textual evidence of Eusebius and other ancient sources, radiocarbon dates, pollution signature evidence from the barrage at Khirbet Faynan and the archaeo-osteological evidence of industrial labour and pollution.

2.5.1 The Textual Evidence

Eusebius described the specific punishment of *damnati ad metalla* in his texts; this confirms the presence of convict labour in the Faynan (Appendix 2, *MP* 7.2, 8.1). Many authors believe the presence of convicts condemned to the mines indicates imperial jurisdiction (Hirt 2004, 74; Millar 1985, 142). Condemnation to the mines was a special, reserved form of punishment in Roman society. Some aspects of it changed throughout the imperial period but it never lost its legal ramifications or was considered a less severe form of punishment. Persons of all social ranks including slaves could receive this punishment; it was therefore a status below that of slavery (Millar 1985, 138). Punishment by being sent to the mines meant that legally the individuals lost their freedom and rights of inheritance and all property was confiscated. Being sentenced to the *metalla* also meant the individuals were not punished locally as was common for other crimes. Instead they were often transported great distances, even to other provinces. No evidence exists for these convicts being used privately; most references relate to condemnation to imperial *metalla* where these convicts were used as State property to further its economic interests (Millar 1985, 143-144).

There are three instances where Eusebius refers to the Faynan mines specifically,

as he chronicles the trials and sentencing of Christians who were condemned by provincial governors (*MP* 7.2; 8.1; 8.13). These men, women and children came from the cities of Gaza and Caesarea, in the Palestinian Province, and were sent as convicts to Faynan (Appendix 2). However he also relates that individuals from other provinces, Egyptians most notably, were tried and sent to Faynan for punishment (*MP* 8.13). When describing one group of Egyptian convicts he states that some were sent to *metalla* in Palestine and some to Cilicia (*MP* 8.13). He also emphasises the diversity of convict origins; the workforce at Faynan was supplied from multiple provinces. This widespread assignment of condemned prisoners to the *metalla* suggests coordination between the provincial governors, a benefit of which was a supply of labour for the extractive industries.

Of even greater help is Eusebius' discussion of an incident in the Faynan itself. Both the administration of Faynan's *metallum* and the military are mentioned (*MP* 13.1-4) (Appendix 2). *Phaeno* was supposed to be a punishment and an example to suppress the spread of Christianity. However, Eusebius writes that in AD 310, during the seventh year of the persecution, Christian slaves working at the mines gathered to practice their religion. They formed a ministering community that, in defiance of the Roman laws, worshiped and proselytised. This community continued these practices until the provincial governor came to visit *Phaeno*. Eusebius claims the governor wrote a letter to the Emperor to inform him of the situation. The military commander of the region was contacted and he and the *procurator* of the mines regained control over the population (*MP* 13.4) (Appendix 2). They divided the community and sent them to other *metalla* for further punishment. The ringleaders were given over to the military and executed.

The ultimate authority of the State over the mine is not questioned, but it is implied that the administration was operating independently until a crisis developed. Only then was a direct interest taken in the management of the region by provincial governors, military officers and perhaps the emperor (Millar 2004, 202). The role of the provincial governor was to oversee the *metallum* as part of the province; he did not concern himself with its management until lack of control of the situation was demonstrated. The involvement of soldiers indicates that the army was used to support the administration of the mines when necessary. The Eusebius narrative substantiates the concept that imperial and provincial forces were involved in the administration of this *metallum* and their resources were available to support the industry.

Eusebius's account is corroborated by other sources in the later 4th century, including Athanasius (AD 293-373) who writes:

They seized the subdeacon Eutychius, a man who had served the church well, and, beating him nearly to death with a whip, they deemed him worthy to be sent to a *metallum*, and not simply to any *metallum*, but to the one in Phaeno, where even a condemned murderer is scarcely able to live a few days. (*HE* 60)

This suggests that not only was the *Phaeno metallum* active in that period, it was also infamous.

Epiphanius of Salamis (c. AD 310/320-403) also mentions the Faynan when describing events of this period (*Haer.* 68.3.6) as does Theodoret (AD 393-457) (*HE* 4.22.26). Furthering the theory that the imperial government was closely involved is an order from Diocletian that the followers of Manichaeism, a Persian sect of Christianity, have their property added to the treasury and be sent to *Phaeno* or Proconnesus “...*phaenensibus vel proconnensibus metallis dari...*” regardless of social standing

(*Col. Leg. Mos. et Rom.* 15.3.7). Because of these references we can be certain that the Faynan was an imperial *metallum* throughout the late 3rd and 4th centuries. The practice of condemning convicts to the *metalla* continued throughout the 5th century (Gustafson 1994, 429) but we have no more references to the Faynan specifically.

Although most textual accounts of the Faynan are in relation to convict labour, this is not to suggest that the sole reason for the Faynan was as a punishment post. Convicts, while a useful source of labour, were complemented by free workers, both groups together producing copper for the imperial State (see Chapter 8.7). The evidence below clearly indicates that the Faynan was operating copper mines on a scale beyond that of a mere penal system.

2.5.2 Evidence for Industrial Scale Copper Production

In the Faynan, evidence amassed over 400+ years of Classical period extraction and production is complex but it clearly indicates a sizable scale of production. An initial indicator is the extraction process, the number of mines and their construction. Hauptmann and the Bochum team have made comprehensive studies of the mining and archaeometallurgy of the region and have estimated that 120 mines were in use during this period (Hauptmann 2007, 155). Some of these were quite extensive, for example Umm al-Amad, which has the largest preserved mine gallery in the Roman Empire at c. 4000m³ (Meshel 2006, 231; Hauptmann 2007, 144). A 7km paved road that connected this mine to the main settlement, Khirbet Faynan, is evidence of the scale of infrastructure facilitating transport (see Chapter 5.4).

Another way of judging scale of industry is to examine copper processing.

Estimations about copper production can be made from the volume of the by-product of smelting, blackened slag. The DBM believes that slag attributable to the Roman and Byzantine period can be found in one pile- an estimated 45,000-70,000t worth (Hauptmann 2007, 94-96) (Fig. 2.4). From this they speculate that 2500-7000t of copper were produced (Hauptmann 2007, 147). This means that an average of 6.25-17.5t of copper would have been produced annually over a 400 year period (Barker *et al.* 2007, 346).

The existence of other Classical period metallurgy sites surrounding Khirbet Faynan is under debate. Hauptmann believes that based on the radiocarbon samples, slag types and furnace remains, none of the other slag heaps were the product of Classical industry (Hauptmann 2007, 94-96). The WFLS speculates that the Bochum team may very well be underestimating and that more slag and, by extension copper production, is attributable to the Classical period (Barker *et al.* 2007, 346). They base this statement on the geochemical analysis they performed on soil samples taken from the barrage (WF441) (Fig. 2.5).

2.5.3 Evidence from the Barrage WF441

A barrage is located north of Khirbet Faynan, labelled WF441; a massive water catchment. It is a double faced wall constructed of stone blocks and boulders, 2m wide and 65m in length. It is estimated to have impounded up to 5,000m² of water at a depth of perhaps 1m (Barker *et al.* 2007, 163). It is unlikely that it contained water for human and animal consumption; a much simpler construction blocking a larger wadi flow would have been sufficient and more effective. Instead it is believed to be industrial in purpose

(Barker *et al.* 2007, 163) (see Chapters 5.5.3 and 6.6).

The inflow of water and natural erosion deposited sediment layers up to 2.5m in depth (Barker *et al.* 2007, 127). An excavation of these layers was performed and borehole samples were collected to study the deposition of sediment and perform chemical tests. Six Lithofacies, stratigraphic units, were identified (Fig. 2.5). Dating was provided by excavation, pollen biostratigraphy and radiocarbon dates of wood and charcoal (Barker *et al.* 2007, 67). Lithofacies 6 and part of 5 (225cm depth) are dated to before the barrage was built; i.e. pre-Roman times. Parts of Lithofacies 5 and Lithofacies 4 (225cm depth to 165cm) were formed after construction of the barrage in the Roman/Byzantine period. Lithofacies 3 is a distinctive flood event taking place after AD 650. Lithofacies 2 is further deposits of sediment from storm wash and wind. Finally, Lithofacies 1 is believed to date to the last 100 years.

Samples of the Lithofacies were tested with inductively coupled plasma mass spectroscopy (ICP-MS) (Grattan *et al.* 2007; Barker *et al.* 2007, 340). This technique can measure the concentrations of metals in a soil sample, in this case copper, lead, strontium and thallium. Examinations of the sediment layers suggest that little movement of metals took place post-deposition and that the concentrations recorded reflect original amounts (Barker *et al.* 2007, 81). Chemzone 4 and parts of Chemzone 3 (corresponding with Lithofacies 6 and part of 5) had pollution “spikes” of lead ranging from 2400-7825 parts per million (ppm) and thallium 9-33ppm (Fig. 2.5). Copper concentrations were between 1000-2230ppm. The higher amounts of lead and thallium pollution reflect smelting of DLS ores that contain these metals and were worked in the pre-Roman periods (for ore discussion see Chapter 5.8). Given the copper to lead ratio (Cu/Pb) it appears that these

were the result of ore processing and smelting rather than natural processes (Grattan *et al.* 2007, 97). The top of Chemzone 3 and 2 (Lithofacies 5 and 4) do not have these metals in such abundance. Copper concentrations start at 450ppm and rise to 4,500ppm, but thallium levels drop to an average <3.5ppm and lead to 500ppm (Barker *et al.* 2007, 342). It is likely that these measurements reflect the smelting of MBS ores and perhaps different smelting techniques. MBS ores were extracted in the Roman and Byzantine period (Barker *et al.* 2007, 342). Ash, charcoal, copper ore and slag were also found within Lithofacies 5 and 4. The concentrations of metals found indicate that there were active industry sites near the barrage. The ash and high metal concentrations suggest that intensive smelting occurred nearby (Barker *et al.* 2007, 69). Moreover the proportions of lead to copper indicate that copper levels increased dramatically. The Cu/Pb ratio also indicates that the production levels may have fluctuated with two peaks of pollution, likely corresponding with two distinct periods of copper production (Grattan *et al.* 2007, 99).

These chemical signatures in the barrage indicate that the figures calculated by the DBM from the single slag pile of WF11 (45,000-70,000t of slag and 2500-7000t of copper metal produced) are underestimates. Some of the slag to the north of the Khirbet should date to the Roman/Byzantine period, contrary to the Bochum team's interpretation that slag in this location was all attributable to Early Bronze Age and Iron Age smelting (Fig. 2.4).

One can then ask what other slag piles can be dated to the Roman/Byzantine period. The nearest slag heap, designated Faynan 7 by the DBM, is heavily eroded but presently is estimated to be 5,000t in volume (Hauptmann 2007, 103) (Fig. 2.4). This slag

heap was initially dated based on furnaces and slag typology, both of which are similar to finds at Khirbet an-Nahas and are Iron Age in type. Further excavations by the WFLS support this theory; the slag heap was part of an Iron Age village designated WF424 (Barker *et al.* 2007, 279). Some of the smaller slag piles around the north of the dam have not been examined in detail, most are also dated by the slag typology and furnace finds to the Bronze Age and Iron Age (Hauptmann 2007, 105). Further study may reveal more Roman/Byzantine smelting sites surrounding the Khirbet.

The pollution evidence found in the barrage helps clarify understanding of when the Roman copper industry was active in the Faynan. The calibrated radiocarbon dates of AD 92-339 at 2.24m depth, AD 60-238 at 2.04m depth and AD 349-547 at 1.74m depth reveal the presence of copper smelting from the 2nd to the 4th century (Grattan *et al.* 2007, 94). If taken to their greatest extent, these date ranges also include the 1st century. When combined with the calibrated radiocarbon dates found at slag heap 1, (171 BC-AD 68 and 194 BC-AD 209), it is clear that Nabataean, Roman and Byzantine periods are represented in the radiocarbon date record. The pollution evidence for large-scale smelting ends c. AD 500 (Fig. 2.5). The barrage sample at 1.74m depth also suggests that there was smelting in the 5th century; this will be discussed below (see Chapter 2.6).

The study by Hunt *et al.* (2007) further supports this interpretation. The sedimentological and algal evidence indicate that the Roman and Byzantine Faynan experienced wetter conditions than those of the present day, enough so that there was standing water in the Barrage (1330). It could be expected that the improved climate would have positively affected the vegetation in the region (see Chapter 2.2). In the pollen assemblage there are taxa associated with water, such as *Tamarix* and *Nerium* and

algae spores (Hunt *et al.* 2007, 1325). However, the palynology also indicates a degraded landscape similar to that which is presently observable in the Wadi Faynan (Hunt *et al.* 2007, 1330). Desert flora species, such as *Chenopodiaceae*, and those that indicate soil erosion such as *Lactuceae*, dominate the assemblage. The cause of the discrepancy observed between environment and vegetation can be attributed to human behaviour rather than climatic conditions. The creation of an “...open, treeless, biologically unproductive region....” was due to the large-scale collection of fuel for the copper smelting (Hunt *et al.* 2007, 1331). Hundreds of tonnes of fuel were collected locally to meet the needs of the copper industry and the surroundings were continually stripped of vegetation. The requirements of fuel supply for a mining operation are further examined in Chapter 6.5.

2.5.4 Skeletal Evidence

A final piece of evidence that sheds light on the industry is the skeletons from the cemetery located across from Khirbet Faynan (WF3) (see Chapter 5.5). An osteologist, Karaki, performed studies on 52 skeletons: 23 males, 19 females and 10 sub-adults/children (Karaki 2000, 46). She found evidence of vertebral osteoarthritis, a degenerative joint disease of the spine, and osteoarthritis present in the ribs, sternums and tibias (Karaki 2000, 54). She also found Schmorl's Nodes, evidence of vertebral disk pressure that can be caused by physical stress or severe trauma during the second and third decades of life. Osteophytes, again indications of degeneration of the spine, were present.

Degrees of spinal damage and arthritis are commonly found in elderly skeletons;

however, 51.9% of the skeletons studied were from persons who died between ages 20-35, and the upper limit of ages studied was 35-50 year olds (28.8 percent). In a young population these conditions indicate long-term physical stress or trauma. The majority of the skeletons studied belonged to individuals whose daily labour must have involved lifting heavy loads (Karaki 2000, 82).

A further indication of general poor health was the presence of *hyperostosis porotica*. This condition is due to the leaching of iron from the bones, indicating that the individual suffered from anaemia due to poor diet or a pathogen-filled environment. This condition was present in 3 out of the 7 children and 14 out of the 45 sub-adults/adults (Karaki 2000, 83). This was not a middle class, healthy population, but a working population engaged in manual labour.

Another study conducted by Grattan *et al.* (2002) examined 36 of these skeletons. Chemical analyses were performed to discover the concentrations of copper and lead absorbed by the individual's bones. Post-mortem contamination from the soil and surrounding environment was not considered to affect the values significantly, given the lack of metabolic activity after death and the lower levels of metals in the soil than the bones (Pyatt *et al.* 2005, 299; Grattan *et al.* 2005, 663). These studies suggest that the values measured in these skeletons closely represent the concentrations of metals the living individuals absorbed into their bodies. The distribution of values was wide; some individuals showed little evidence of exposure, for example, 5µg/g of copper and 1µg/g of lead were recorded from grave 5. Others bones, like the samples from grave 67, registered 181µg/g of copper and 289.2µg/g of lead. The mean values in Faynan were 52.57µg/g of copper and 42.49µg/g for lead. These measurements are significantly higher

than lead and copper concentrations in skeletons from other geographic regions.

To provide a reference sample, Grattan compared the levels from the Faynan to three other populations. A group from the prehistoric Canary Islands represented pre-modern populations with no industrial exposure (González-Reimers *et al.* 2001, 218; 2003, 99). A reference group of non-industrial, ‘middle class’ skeletons from the Roman period represented a contemporary populace (Nriagu *et al.* cited in Grattan *et al.* 2002). Finally, a comparison was provided to a population living in a severely polluted zone without a current active industry, Silesia, Poland (Baranowska *et al.* 1995). These individuals absorbed metals from contact with the environment and bioaccumulation.

Table 2.1 Evidence for the presence of lead and copper in skeletal remains from Faynan and 3 reference populations (after Grattan et al. 2002, 301 and 303).

Sample	Copper mean value (µg/g)	Copper minimum value (µg/g)	Copper maximum value (µg/g)
Faynan	52.57	2.18	296.2
Canary Islands	10.5	n/a	n/a
Roman	n/a	n/a	n/a
Silesia	0.59	0.18	5.17

Sample	Lead mean value µg/g	Lead minimum value µg/g	Lead maximum value µg/g
Faynan	42.49	1.0	289.2
Canary Islands	4.06	n/a	n/a
Roman	21	0.87	86
Silesia	57.55	2.9	204.53

The mean lead concentration for the Faynan skeletons is similar to that from Silesia, what the authors describe as an ecological/toxicological disaster zone

(Baranowska *et al.* 1995, 156). For copper values, the Faynan's mean is significantly higher than all the reference samples. A caveat for this evidence is that different bones absorb metal at higher rates and which bones were chosen for study varied between these studies. The Silesian bones chosen for study were sternum bones (Baranowska *et al.* 1995, 156). Tibia bones were studied by González-Reimers (2003, 98). Different bones take up metals at different rates; for example, the body partitions copper to the humerus (Grattan *et al.* 2005, 664). Given that no standardisation was practiced, the study can not be used for absolute comparisons. However, it clearly demonstrates the exposure of the Faynan population to high levels of metal pollution.

Forty-four percent of the skeletons show indications of long term absorption of heavy metals in unusually high amounts (Grattan *et al.* 2002, 304). The highest amounts recorded are enough to suggest that the absorption was from more than passive interaction with industrial remains of an inactive industry (Grattan *et al.* 2002, 304). The 56 percent that did not have high levels may represent members of the population who either were not physically involved in the industry (overseers or administrators), or individuals who died soon after arriving in the Faynan, such as new workers, traders or pilgrims. Both the hard labour and the metal poisoning may have compounded each other. Other side effects of metal poisoning are osteoporosis and anaemia that damages bones (Grattan *et al.* 2002, 304).

Taken together this evidence suggests that some individuals were very physically active in copper production and exposed to large amounts of pollution during the Byzantine period. These findings suggest that in looking for signs of an imperial *metallum* one of the sources of evidence to examine is the bodies of the workers

themselves.

2.6 The Late Byzantine Period in Faynan

Hauptmann and the DBM suggest that the zenith of Roman copper production started in the 2nd century and that the industry rapidly declined after the second half of the 4th century, ending by the 5th (Hauptmann 2007, 155; Kind *et al.* 2005, 192). This interpretation is based on a number of lines of evidence. Jerome stated, in the revised edition of the *Onomasticon* (114) (c. AD 390) “...the copper mines of *Phaeno* collapsed in our time....” Earthquakes did shake the Province in 363 and 419 and these may have affected the stability of the Faynan mines, for example mine 7 in Wadi Khalid was partially collapsed (Kind *et al.* 2005, 192; Hauptmann 2007, 116). Additional earthquakes and the outbreak of Justinian’s Plague in 540 would have put further strains on the region. There is an inscription recording an exceptionally deadly event in the region, “...a third of the population dying...” dating to c. AD 455. What particular event this refers to is not clear (Sartre 1993, 143).

Another piece of evidence offered for the decline of the copper industry after AD 350 is based on a coin collection. To further understanding of the region, Kind *et al.* (2005) collected and studied a coin assemblage from the Faynan. A total of 1013 identifiable coins were gathered during surveys and the majority were bought from the local Bedouin villagers (Kind *et al.* 2005, 170). This collection is cited as part of the DBM argument that copper production reached its zenith in the 4th century and ceased shortly after.

Table 2.2 Mint Dates of Identifiable Coins in the coin assemblage (after Kind et al. 2005, 171-177).

Date AD	Number of coins	Comments
15-294	20	
294-311	5	
312-324	68	52 western minted, 16 eastern minted
325-420	532	Predominantly eastern minted
420-650	47	

The coin collection shows a distinct pattern with a steep increase in the number of coins found dating to the 4th century. There are 25 coins dating from AD 15-311 covering the pre-conquest and Roman periods. The majority of the collection dates to AD 312-420-- c. 600 coins. They posit that the increase in number of coins minted after AD 312 is due to the presence of a monetary economy spurred by the army, that organised copper production (Kind *et al.* 2005, 192). They believe a garrison was established c. 312 that was financed by money minted in the western empire and that this is why the period from AD 312-324 is represented by 52 western minted coins verses 16 eastern minted coins (Kind *et al.* 2005, 186-187). After this decade the pattern is reversed with eastern minted coins predominant. There are only 47 coins from AD 420-650. The decline in the number of coins collected is interpreted as indicating the withdrawal of the military and the end of the industry, resulting in the collapse of a monetary economy.

These assertions need to be tested against the rest of the archaeological record of the Roman occupation of the Faynan. There are no epigraphic or textual sources of a garrison at Faynan; for example, none is mentioned in the *Notitia Dignitatum* (ND Or.

34). The DBM believes that the garrison is not listed because it only existed for a short time and that soldiers were removed in the 360s to participate in Emperor Julian's campaigns in Persia (Kind *et al.* 2005, 192).

Taken together, the textual records and the coin collection have been used to form the argument that in the 5th century the Faynan ceased to be an imperial *metallum* and became oriented towards religion and agriculture (Kind *et al.* 2005, 188). Indeed religion was an important activity; the Faynan is listed as a Bishopric and a representative from *Phaeno* attended the Council of 431 at Ephesus and 451 at Chalcedon (Sartre 1993, 143). There are also remains of five churches at Khirbet Faynan and the surrounding area (see Chapter 5.6).

Although the region did experience growth as a religious centre in late antiquity, there are multiple lines of evidence indicating that a significant portion of the population was employed in the copper industry after AD 420. The quote by Jerome likely chronicles a disaster at Faynan and it is known that the earthquake of 363 was devastating. Many buildings in the province needed rebuilding, such as the legionary fort in Lejjun (Parker *et al.* 2006, 157). However I do not believe that this was a crushing blow to the Faynan; many of the mines are still intact and can be entered in the present day, standing after multiple earthquakes. It is unlikely that the stability of all 120 mines that Hauptmann estimates were open was affected.

Interpretations based on the coin collection require careful assessment; as with all numismatic collections, the cultural factors affecting coin survival rates must be considered as well as economic factors (Casey 1986, 68-69). It is impossible to study

such as small sample of coins and draw definite conclusions, especially since their origin is unknown (see Casey 1986, 144.). The Faynan is close to Petra where a thriving market for ancient coins exists because of the tourist industry. Bedouin often travel back and forth between the regions looking for work. The reality is that it is impossible to be certain that all the coins came from the Faynan; any interpretations made from the collection must mention this caveat. There are a number of other problems with the DBM's interpretation of the coin evidence. The fluctuations in the number of coins over time could be linked to inflation; as coins become more devalued their numbers increase in the archaeological record (Casey 1974, 43-47). The 4th century was a period of rising inflation and the coin record may be reflecting not the number of coins in circulation in the local economy, but their relative values.

However, if the coin counts are taken at face value, they still do not support the argument made by the DBM. The lack of coins minted in the late 3rd to early 4th century (AD 275-324) does not correspond with the known history of the Faynan. Kind *et al.* concede that the small number, only 5 coins dating to AD 294-311, is curious, as it is known from Eusebius and other authors that Faynan was a favourite place to send convicts during this period (2005, 185). If coins are to be used as a proxy to represent the size of the industry, then an increase in coins minted before AD 312 would be expected. This is especially true as payment would likely not be in newly minted coinage. Most coins would be in circulation for a while before they become part of the archaeological record. Moreover, most of the coins in the collection are bronze and in the 3rd and 4th centuries inflation lessened their value. Empire-wide, there is a trend in the 4th century of casual coin loss, reflecting the relative unimportance of the devalued coinage (Harl 1996,

18, 166).

Finally the DBM argues that the increase in coins is due to the establishment of a military garrison financed with western monies. The authors are correct in that the pattern of coins from eastern/western mints is curious; it is seen throughout the Levant region (Kind *et al.* 2006, 187). However, if an influx of money from the west did occur, it is not fully explained why this denotes the establishment of a garrison, instead of funds being sent to industrial or provincial officials. The implication that without this garrison the industry declined and then ceased is also problematic. Although the presence of the military is a good indication of imperial *metalla*, a garrison is not a requirement (for further discussion of the scale of military presence needed for the Faynan *metallum*, see Chapter 6.6). Finally, even if a military force had left the region, the Faynan's increasing importance as a Bishopric in the late 4th and 5th centuries should also be reflected in the coin record, rather than associated with a dramatic decrease in coinage.

An alternate explanation exists, that the increased presence of coins minted in the 4th century indicates modern looting practices rather than the presence of the military during that period. The majority of the coins in the collection were bought from local villagers (Kind *et al.* 2005, 170). Other surveys in Jordan that did not buy coins had smaller collections from that time period. For example, the Limes Arabicus Survey (1,680 km² an area larger than the Faynan region) amassed 785 coins in total, of which most were from excavations of the Lejjun fortress, including a coin horde of 249 Early Byzantine coins (Parker 2006c, 293). Within the Faynan region the WFLS survey only collected 42 coins (Barker *et al.* 2007, 332). The relative paucity of coins from survey collection alone indicates the likelihood that the Kind *et al.* coin collection is composed

of mostly looted material. If the coins are from the Faynan, then a likely source is the thoroughly looted cemeteries surrounding the Khirbet (Fig. 5.7). The early Christian cemetery dates from the 4th century when coins may have been included in grave goods (Barker *et al.* 2007, 133).

2.6.1 Evidence for Late Byzantine Copper Production

From these lines of evidence, it seems likely that the DBM model of industrial development and decline in the Faynan is not entirely correct. I believe that the evidence indicates the presence of an Imperial mining industry established in the 2nd century (developed from the Nabataean/Early Roman extraction works), with a zenith in the late 3rd and 4th and a slow decline into the 5th. There is also evidence that there may have been some copper production in the 6th century, as discussed below.

The ability of the Byzantine imperial government to directly run *metalla* has often been questioned and suggestions have been made that instead, mines were leased from the State and run by private companies in the 5th and 6th centuries (for discussion see Vryonis 1962, 3; Edmonson 1989, 85). If this were the case, leases would have been let with the clear understanding that a certain level of production would be met (*CTh* 10.19.13). Yet, beyond empire-wide concerns about rising governmental costs and political instability, by this date the Faynan may not have been conducive to leased private mining. The rich ores were depleted, so larger amounts of poor grade ore were yielding declining amounts of metal. The only way for this low yield to be profitable was if a single group were capable of collecting a massive amount of ore. The supplies needed to smelt all this ore were also an issue; the landscape was continually degrading over this

period. By the Byzantine period, local supplies of fuel would have been non-existent (see Chapter 6.3.2). The difficulties surrounding extraction and smelting, supplies and trade all seem to require a single, wide-reaching administration and can support the argument that the imperial State was still directly in charge of the Faynan. The pollution record of barrage WF441 indicates that industry continued until c. AD 500. A calibrated radiocarbon date of AD 349-547 was taken from a depth of 1.74-1.76m at the barrage. The sediment above this level has no radiocarbon date but continues to be heavily polluted up to a depth of 1.65m, indicating that industry continued for longer than the last measured date of AD 349-547 (Grattan *et al.* 2007, 97). This suggests that smelting on an industrial scale and direct imperial management continued in the 6th century.

There are also four mines, WF1420, WF1461, WF1478 and WF1511, with associated pottery of the Late Byzantine period, suggesting extraction continued (Barker *et al.* 2007, 714, 722, 724, 729). Skeletons excavated from the Byzantine period (4th-6th century) cemeteries surrounding Khirbet Faynan also indicate that individuals were still involved in an active industry. I argue that there is evidence that the Faynan was an imperial holding and had an active industry through the 5th century into the Late Byzantine period, although likely at a reduced scale from its heyday in the 3rd and 4th centuries.

It is unclear exactly when the Faynan ceased functioning as a *metallum*. The region as a whole declined in the late 6th century and evidence for organised burials in the cemeteries surrounding the Khirbet ended (Findlater *et al.* 1998, 82). The latest burials may represent a religious community rather than an industrial one. Certainly this region was no longer part of the Byzantine Empire after the invasions of the Umayyad armies c.

AD 640.

2.7 The Importance of the *Metalla* and the Faynan

The need for copper in the Roman and Byzantine world is not to be underestimated, it was essential in the daily life of the empire. Small consumers had multiple uses for copper, including jewellery, bronze statuary, medical instruments and household items. Local needs in the Levant would have been considerable. Excavations in 'Aqaba during the 1994 season of the Roman 'Aqaba Project produced over 500 objects of copper or copper alloys (Parker 1997, 40).

The State would require bulk supplies of copper for its own needs, a motive for the Faynan being an imperial *metallum*. A major concern of the State was the supply of metal to the military. In the Levant military units were stationed along the eastern border and major roads. The need for metal supplies in these landlocked locations would have been best met from local sources. The exact numbers of soldiers stationed in Arabia after annexation is unknown; some estimates place the number of legionaries and auxiliaries at around 10,000 men (Kennedy and Riley 1990, 44). Six legions, *XVI Flavia* at Samosata, *IV Scythica* at Zeugma, *III Galica* at Raphanea, the *X Frentensis* at Aelia Capitolina, the *VI Ferrata* at Caparocotna and the *III Cyrenaica* at Bostra, were assigned to the provinces of Arabia, Palestine and Syria (Butcher 2003, 413). Ten legions were placed into the Levant under Diocletian's reforms, which included one full legion assigned to the south of Arabia (Kennedy and Riley, 1990, 43). The *X Fretensis* legion is mentioned in Eusebius's *Onomasticon* as being stationed in 'Aqaba itself in the early 4th century (*Om.* 8). Although these numbers would fluctuate over the entire span of the Roman and

Byzantine periods, thousands of soldiers were consistently present and would have been significant consumers of metal. Iron was commonly used for weapons and armour, but objects of copper alloy regularly appear during excavations- bronze mail for example (Goldsworthy 2003, 126). Buckles and fittings and horse harnesses were commonly made from copper alloys. Metal was required for more than martial reasons. Soldiers would require bronze domestic items, cookware and tools (Le Bohec 2000, 218). Other inhabitants of the forts, wives, children and slaves, would also be metal consumers for similar purposes. In the Roman period, fortresses had *fabricae*- blacksmith workshops (see MacMullen 1960; Sim and Ridge 2002, 73-76). They would receive a supply of metal to be used for various purposes around the military community (Goldsworthy 2003, 149). These included domestic objects and weapons or armour, the price of which was deducted from the soldiers' pay. The closest legionary fortress to Faynan was Udrh, c.30km away; others nearby were Lejjun to the north, and Humayna to the south (see Chapter 6.6). These large communities were bulk consumers of many materials, copper included. A network of smaller forts and bases was also established throughout the Levant, the nearest in the Wadi 'Arabah. These smaller garrisons would also have been supplied with equipment from the fortress *fabricae*.

Increasingly, from the 4th century onwards the arms industry became a State owned monopoly. In the Eastern Empire fifteen such *fabricae* are known from sources like the *Notitia Digitatum*, and they produced the weapons and armour for the armies (James 1988, 257). While it is not known which Imperial department these *fabricae* originally reported to, by the reign of Constantine in the 4th century they belonged to a *magister officiorum*, Master of the Offices. Three senior officials, *subadiuvae*

fabricarum, were in charge of the Eastern Empire's State arms factories (James 1988, 273). The increasing bureaucracy and high rank of the officials involved highlights the importance the Imperial government placed on the regulation and supply of arms. In order to meet the demands of equipping multiple legions with all manner of military paraphernalia, metal would be required by these factories in bulk. Copper from the Faynan was likely used to meet this military demand, a constant need throughout the Roman/Byzantine Period (Fig. 6.9).

Copper was also an imperial interest when organising mints and coin supply. Despite earlier arguments made by Finley, the Roman and Byzantine economy had a monetary rather than barter economy (Harl 1996, 251). As John Chrysostom put it at the end of the 4th century "...the use of coins welds together our whole life, and is the basis of all our transactions. Whenever anything is to be bought or sold we do it all through coins (translation in Harl 1996, 250)." While bullion was the foundation of the monetary standard, most transactions were conducted using lower denominations of copper alloys. These coins of lesser value were produced in great quantities and used to make change and pay for everyday small purchases (Greene 1986, 60).

The Late Roman Empire had a network of imperial mints responsible for creating standard coinage for the entire empire (Harl 1996, 146). The eastern cities of Antioch, Cyzicus, Alexandria and Constantinople were responsible for producing coins to be used in the Late Roman Levant (Butcher 2003, 220). When Diocletian introduced monetary reforms in AD 293, he ordered the largest single coinage issuance prior to the modern age. Millions of coins were minted, replacing the remnants of the Augustan system for an estimated 60 million inhabitants of the empire and relieving acute shortages in some

regions (Harl 1996, 152). Central to this reform was the *nummus*, a bronze coin with a silver coating (Harl 1996, 148). Further debasements of coinage followed throughout the 4th and 5th centuries and increasingly larger numbers of smaller coins were produced, with thousands of *nummi* required to make purchases. By AD 498, Emperor Anastasius was forced to introduce another wide set of reforms when the exchange rate in Constantinople reached as high as 16,800 bronze *nummi* for one gold *solidus*. While it was cumbersome to deal with this many coins, they were a vital part of the State's finances; for example, 60% of taxes paid in AD 435 in Hermopolite were in bronze coinage (Harl 1996, 179). While the State met some of this increasing need by re-minting old coins, to combat inflation new sources of copper were required.

Two staples of an empire are a monetary economy and an army. With these tools the Roman and Byzantine empires were able to govern disparate provinces. In order to continue functioning in this manner a variety of resources were required, one of which was copper. In the southern Levant the Faynan was a supplier generating tonnes of metal to meet these State needs. When the Faynan's industry was most active in the 3rd to 5th centuries, there were empire-wide demands for copper.

2.8 Conclusions

From the combined skeletal, metallurgical, and extractive evidence, the scale of copper production in the Faynan can be described as industrial. This industry was sustained for hundreds of years, extraction was carried out at multiple mines and Roman and Byzantine metallurgy produced tonnes of slag. The impact on human workers was profound; their skeletons show damage from manual labour, made worse by interaction

with a heavily polluted environment. The negative aspects of the industry are further demonstrated by the impact on the vegetative record, which indicates human activities profoundly altered the type of species present. From the scale of metallurgical remains it can be inferred that the quantities of supplies, such as fuel, needed to successfully run the industry were great and this aspect of production is discussed further in Chapter 6.5. The evidence of Eusebius and other textual sources indicates that during the 4th century the Faynan was imperially owned; a situation that appears to match the extraordinary state of the pollution evidence, which indicates that the 3-4th centuries saw a zenith in production. The pollution signatures support the presence of the mining industry into the early 6th century and there is some suggestion from cemetery data and mining remains that some extraction continued past the 6th century into the Late Byzantine period. Certainly State need for metal had not diminished by this point.

The main activity of the Faynan region during the Roman and Early Byzantine periods was the production of vast amounts of copper, tonnes per annum. This intensive extraction industry can be interpreted as a response to the needs of the imperial State for metal. Moreover, the Faynan was developed and operating when there was a shift away from the exploitation of previously vital *metalla*, most noticeably the substantial decline in Iberian mining after the 2nd century (Domergue 1990, 219-223). Other *metalla* of the Empire also appear to have been developed in response the vacuum left behind. Many of the new mining regions were in the eastern empire, likely because of the continuing conflict in (and eventual loss of) the western empire. The Balkans and Armenia were two such areas where intensive mining was developed during this period. The investment in the Faynan during the 3rd century can be seen as a similar response to continued demand

coupled with a shift away from western sources of metal (for discussion of Byzantine mines see Matschke 2002). It could be postulated that the delay from the conquest of Arabia to the start of imperial mining operations at Faynan may be in part have been due to the production of copper in other provinces during the 2nd century. If this were the case, then the Faynan was closely tied to the fluctuations of the entire Empire and its development reflects both the needs of the State and the shift to develop new regional sources of copper in the Late Roman period.

This chapter has provided a general overview of the Faynan and of the evidence from texts and a wide range of studies that bear on the imperial nature of the Faynan and its mining operations from 100-550 AD. What has not yet been illuminated is the specific means by which the imperial *metallum* functioned. A number of questions arise, such as how the administration met the goals of copper production and what evidence exists for their policies? The next chapter engages with the survey evidence that is the basis for investigation of these issues and provides the methodology that will allow us to address the question how the Faynan region functioned as an imperial *metalla*.

Chapter 3 – Field Surveys of the Faynan Region

3.1 Introduction

The approach of this thesis was to study the Faynan on a regional scale, one that encompassed multiple elements of the landscape, including the industry and administration (see Chapter 1.5). It was determined that survey data were particularly suited for this spatially based approach. However, before the data sets of the surveys used in this thesis are presented, a more general discussion of surveys must take place to properly understand how to best use this type of data.

Field surveys are not appropriate for examining short-term changes or single events, but are a useful resource for studying the *longue durée*, the extended history of an area (Given and Knapp 2003, 59). This expanded view can illuminate changes in demographics, settlement patterns and land use. Such surveys also provide information about a wide range of human behaviour rather than just one social class or type of activity (Alcock 1993, 34). This perspective affords a more holistic view of the societies under study than sites in isolation (Cherry *et al.* 1988, 159). There are, however, some limitations to the amount of information a survey can supply. One concern is that what is visible on the surface in the modern world does not embody the actuality of the sites in form or usage as they were in the past. Without excavation, it is difficult to test how much a surface represents the archaeology underneath (Lloyd 1991, 234). Remote sensing and geophysics can shed light on the situation but will not provide the same richness of information as excavation can. This limitation must be acknowledged but

does not undermine the usefulness of the survey to examine archaeological landscapes. As long as the survey is used properly, with the appropriate caveats, it can be a powerful tool in studying patterns and trends through time (Alcock and Cherry 2004, 8).

Since this study combines data from two different surveys of the Faynan, before an in-depth analysis can take place, an examination of each separate data set is necessary to explore the strengths or biases that may be present in each. A clear understanding of each survey's meta-data can help bridge differences in technique used in different projects. As long as these relative strengths and weaknesses are well understood, a controlled synthesis can take place (Alcock and Cherry 2004, 6).

Survey data from two previous studies of this area formed the basis for the present study (Fig. 3.1). The primary goal of the Jabal Hamrat Fidan Project (JHF) was to study the role of metallurgy on social development and evolution of societies from the Neolithic to the Iron Ages (Levy *et al.* 2003, 247). The primary goal of the Wadi Faynan Landscape Survey (WFLS) was to document the archaeology of the landscape from the prehistoric to modern periods, focusing especially on aspects of metallurgy (Barker *et al.* 2000, 27). The data they produced can be adapted, as both project teams were conscientious about collecting information on all sites encountered, even if that information was not applicable to their specific needs. This thesis concentrates on the Faynan region to identify aspects of imperial ownership and the copper industry during the Roman and Byzantine eras. Because both surveys documented all finds regardless of historical era, the information required for this study is contained within the data sets of these two surveys.

Large portions of the data for this study had already been collected by others prior to the commencement of this PhD research. Although expedient, this fact did mandate that the collected data be re-examined and re-interpreted. When examining surveys that have already been completed, certain questions need to be asked as to the reliability and completeness of the data. All surveys contain an element of bias; even careful researchers will miss some information. There are ways to limit the extent of bias by addressing such concerns directly from the start of the project or while analysing the data. When using data from a survey one needs to determine what adjustments have been applied and whether they were successful (Alcock and Cherry 2004, 5).

Research design is one of the most valuable ways of limiting bias when conducting surveys. Early identification of potential bias before the survey starts can eliminate future complications. Researchers can design a survey that best takes into account the factors that could preclude survey sites from generating high quality data. If earlier surveys have similar goals and outlooks as well as a clear and well-defined project, this will facilitate later efforts to integrate the surveys, as will definition of expected bias and attempts made to limit it. Also, definitions such as chronology, pottery typologies, and site types must be similar between the surveys (Alcock and Cherry 2004, 5); or the terminology needs to be clearly defined to allow translation. The correct identification of time periods, site size and function are subject to the investigator's definitions and these definitions need to be clearly stated so that they are understood. However, if surveys are found to be compatible, then synthesis can take place between them, creating larger but still high quality databases. In this way, more insight into the region as a whole can be gained than would be possible from a single study.

3.2 The Wadi Faynan Landscape Survey (WFLS)

The Wadi Faynan Project was a multidisciplinary study of the landscape, environment and history of the Faynan region. Information was collected about changes in the geology and climate from the period of the Pleistocene to the present era (Barker *et al.* 2000, 28). The project included archaeologists, archaeobotanists, geomorphologists, pollution specialists, and ethno-archaeologists. This larger investigation contained many different parts, each focusing on a different aspect of the region; for example, the Wadi Faynan 4th/3rd Millennium Project (Wright *et al.* 1998) explored the Early Bronze Age, whereas the Wadi Faynan-Wadi Ghuwayr Early Prehistory Project studied the prehistoric periods (Finlayson and Mithen 2007). The project most relevant to this PhD thesis was the Wadi Faynan Landscape Survey. This was a multiphase survey. The first phase established an understanding of the geomorphology and hydrology of the region. The second stage was an intensive survey of Wadi Faynan 4 (WF4), the main field system for the area (Fig. 3.2). The third phase covered the surrounding areas along the Wadi Faynan and Wadi Dana (Fig. 3.3). The surveys were conducted over five seasons ranging from 1996 to 2000 (Barker *et al.* 2000, 28).

The recording of WF4 was intensive and very detailed. This site occupies the largest stretch of arable land in the Wadi and evidence has been found for use from the Early Bronze Age, with heavy utilisation during the Classical periods. WF4 was divided into 20 topographic sub-sections enclosing a number of individual fields. Fields were listed by both the sub-section, and the specific field numbers. For example WF4.12.2 meant site WF4, sub-section 12, field 2 (Barker *et al.* 1998, 6) (Fig. 3.4). All 20 sections

were surveyed by making a record of structures and surface artefacts sampled. Because of the large area to be covered and the concentration of artefacts found, a method was devised for recording artefact density (Barker *et al.* 1997, 29). A survey team systematically crossed each field, with members spaced 10m apart, each individual scanning the surface in a strip 1m wide. At least one person collected all artefacts found within their 1m strip to accumulate a representative sample for chronological and typological study. The other field-walkers kept a running tally by clicker count of artefacts they observed, to gauge artefact density. Other members of the team also gathered any artefacts that were particularly diagnostic, but these were kept separate from the density counts. As well as collecting artefacts, structures within the fields, hydraulic, occupational or burial, were also recorded. Other smaller field systems found in the north of the Wadi, WF406 and WF410, were mapped with a similar technique (Barker *et al.* 2000, 28). Some micro-topographical mapping of structures inside the confines of WF4 was also carried out using a Topcon GTS 303 Total Station (Barker *et al.* 1998, 10). Fields in 4.3, for example, were mapped for micro-topological variation at a 25cm level to study the flow of water over the field (Barker *et al.* 1998, 10).

The second phase of the survey took place outside WF4. First the study area was defined with boundaries around the Wadi Faynan delineating a 3.5x8km box. In the east, an extra 1x2.5km area was included (Barker *et al.* 2000, 29). To record the density of pottery in the landscape outside of the field systems, sixteen transects were walked north/south, spaced 500m apart. These were navigated using GPS and a compass. All artefacts encountered within a 2m wide strip were collected. If these lines crossed any field systems, no material was collected so that a determination of the density of pottery

outside of agricultural land could be established (Barker *et al.* 2000, 31). The area was then divided into 500x500m squares and each square surveyed. If possible the square was walked in its entirety; however, with the nature of the terrain this was not always feasible. When necessary, for example in challenging areas such as cliffs and mountains, the most attention was paid to lower slopes or relatively flat ridges and areas that were more likely to have been utilised (see Chapter 5.2). The surveyors used random line walks to sample the higher elevations. The terrain could be re-checked for missed sites during these higher altitude forays. The team aimed for 100 percent coverage in this stage. Sites identified were subsequently recorded in detail.

A potential problem with the Wadi Faynan Survey data outside of the field system is the equipment employed to record sites. GPS Garmin 12 hand-helds were used and these can have a 30m error range (Barker *et al.* 2000, 29). When used properly by holding the point until the calibration with multiple satellites is complete, the error rate can fall to an average of 10m. As this project is a large landscape study, this margin of error will not have a significant effect. However, this error must be taken into account when conducting geo-spatial calculations. Even with this geo-spatial inaccuracy the data produced were of a high quality, recording in detail site attributes, pottery counts and detailed site plans.

3.3 The Jabal Hamrat Fidan Project (JHF)

The JHF team have conducted a number of surveys in the Faynan region, all with the intention of studying the effect that the copper resource had on social evolution of the region and the Levant (Fig. 3.1). The project is multidisciplinary, incorporating

excavation as well as archaeo-metallurgic, geomorpologic, archaeozoologic and environmental studies. In 1998, survey of the western part of the Wadi Fidan was completed. An area of 240km² was examined using survey backed up by excavation (Levy *et al.* 2001a, 159). The JHF team admits to having had limited time to finish this survey. To keep the quality of data consistent, the study area was divided in half and the eastern part of the Wadi Fidan was surveyed later in 2004, largely using the same methods (Anderson *et al.* 2004a, 1) (Fig. 3.5). An area along the Wadi Fidan was examined for 250m on each side of the wadi's banks in 1998, and 350m in 2004. In practice however, this distance would expand in some places to 400m to include likely areas such as Pleistocene Terraces (Levy *et al.* 2001a, 159; Anderson *et al.* 2004a, 1). A pedestrian survey was conducted on foot with an attempt at 100% coverage. Teams were created, usually consisting of nine surveyors, seven of whom would be field walkers and two surveyors recording the sites with an Electronic Distance Measurer (EDM) (Levy *et al.* 2001a, 174). Each walker covered a 50m transect and combed the landscape until they reached a distance of 500m. When sites or find spots were discovered, the entire team would record the archaeology in a number of ways. First a relative position was recorded on an aerial map by hand; second, the team marked the centre of the site with flagging tape. A systematic sweep of the site would be made to collect datable material and artefacts (Levy *et al.* 2001a, 174). The next day a team of two EDM surveyors guided by the aerial photo information and a member of the previous day's field-walking group would digitally record the site (Levy *et al.* 2001a, 174).

The recording techniques involved use of a Leica TC600 Total Station and a 'loop' of benchmarks, or a closed survey transverse, established by the JHF team (Levy

et al. 2001a, 177). Benchmarks were set up along the 1.5km survey grid. An initial point, later calibrated to Universal Transverse Mercator (UTM) coordinates, was entered as the BM1 (bench mark one) and then a second point BM2 was measured to it using a compass bearing for back sight. These benchmarks went around the Wadi in a circle, always with clear line of sight between them and eventually terminating at the original BM1. The error between the first measurement of BM1 and the last measurement was calculated. The amount of error was divided and assigned among the benchmarks (Levy *et al.* 2001a, 177). The estimated error at each benchmark of the loop was 0.002m. The benchmarks were then converted over to UTM WGS84 coordinates. Using this as a basis, sites were then placed within this loop and features could be recorded. Polygons of the outline of the sites as well as pertinent archaeological features like walls or cairns were recorded (Levy *et al.* 2001a, 177). In addition to these surveys, geophysical ground surveys were conducted over Khirbet Hamrat Ifdan and Wadi Fidan 4 (Levy *et al.* 2001a, 171). Finally, in conjunction with this survey excavations were carried out. One was a Neolithic site, Fidan 1, and the other was Fidan 120, Khirbet Hamrat Ifdan (Levy *et al.* 2001b, 2004b).

In 2002, Wadi al-Ghuwayb and Wadi al-Jariya were surveyed. The survey was similar to the 1998 survey in the Wadi Fidan (Levy *et al.* 2003, 260). Again, in order to record sites in detail the survey of the wadi was separated into two sections. The region east of Khirbet an-Nahas was surveyed with the region to the west left for future research (Levy *et al.* 2003, 249) (Fig. 3.6). Teams on foot inspected a 250m area on either side of the wadis. Because the topography of these wadis was steeper than that of Wadi Fidan, two survey groups conducted the survey, a high and a low altitude group. The high altitude group dealt with the steeper slopes and recorded finds and sites encountered. The

low altitude group walked both banks of the wadi at 10m intervals; the high altitude group proceeded in a similar fashion, but following a less regulated pattern due to ground conditions. Using EDM total stations and a benchmark loop system, site maps and plans were made for each site and digital photographs were taken (Levy *et al.* 2003, 260). Artefacts such as pottery, industrial waste and lithics were collected, but only what was considered as forming a representative sample. The survey team in the field at the time made the sampling decisions. No density figures were recorded and the artefacts, especially pottery, were mainly used for potential dating of the sites (Levy *et al.* 2003, 261). However, architectural features or lithics were also used (Levy *et al.* 2003, 262).

3.4 General Discussion

The research teams had similar goals, to record all the archaeological activity occurring within the Faynan. To this end WFLS and JHF both completed gazetteers with coordinates and descriptions of the archaeology found. Although the JHF research goal was focused on the Iron Age, all sites that they found were recorded regardless of their historical period.

Survey comprehensiveness is able to limit any bias that exists in the types of sites that are detected. In surveys, larger or higher status sites are more likely to be found, putting an emphasis on large institutions and certain social classes. Such selection bias favours sites constructed of enduring materials over those that may be seasonal or temporary and far more ephemeral. However, there is evidence to suggest that dedicated, intensive surveys can find a high proportion of the small sites. In the Mediterranean, intensive surveys have recorded some very small sites, indeed those are the most

common found (Alcock 1993, 53). In the Levant this is a significant consideration because of the long history of pastoral nomads. Seasonal transhumance leaves very ephemeral traces in the landscape and its presence is often missed unless an intensive strategy is used (Wilkinson 2000, 251). If such an intensive survey is conducted, then this important evidence is not ignored and a potential bias generated in data gathering is avoided.

To further comprehensiveness, researchers on both of these projects also included studies of modern Bedouin communities to gain knowledge about pastoralist social life (Levy *et al.* 2004b, 68; Barker *et al.* 2007, 370). Data were collected with an understanding of pastoralists and the surveys were conducted using the methods best able to find small sites.

3.5 Survey Compatibility

To understand and integrate the two surveys used to build the comprehensive database for this thesis, the first issue to address was sampling strategy. The area being surveyed needs to be studied to determine the best technique to be used (Barker 1991, 4). To eliminate sampling bias, a systematically intensive design should be created, investigating a representative proportion of the landscape (Barker 1991, 3). If one area was covered more intensely or had better conditions for site recovery, it is likely to have been overemphasised in the data set and this may yield an uneven or incomplete picture of the region. One of the central requirements for successful combination of data from different surveys is the intensity of the surveys; they must be similar or complex interpretation is impossible. A survey utilizing motorised vehicles and searching for a

certain type of site will not have similar results to walked systematic surveys with random samples or total coverage. The percentage of total sites recorded in a landscape is directly proportional to the intensity and thoroughness with which the survey is conducted (Cherry 1983, 378). In the Mediterranean, when survey areas have been re-walked, more sites have been found. However if a survey is designed to be intensive from the beginning and is conscientious in application, then the likelihood of most sites being found is high (Terrenato 2004, 44).

Both of the surveys being considered used field walking as their main technique, with individuals placed at regulated intervals. However there was a difference in sampling strategy design. JHF used a non-systematic form of ground walking, employing the natural boundaries of the wadi to create the survey's limits. WFLS created grids and systematically surveyed them. One of the reasons for this difference is the topography of the wadis. Wadi Fidan is very narrow and escarpments are steep. Although a non-systematic survey is not the way field surveys are normally conducted in the Mediterranean, agreement is increasing about the effectiveness of this survey technique in the Levant (Wilkinson *et al.* 2004, 196; Banning 1996, 33). On the other hand, Wadi Faynan opens up and presents more surfaces likely for habitation, requiring a more standardised approach. Therefore both surveys attempted total coverage within the limits of the respective wadis' topography, although the strategies were different. This feature allows them to be easily combined into one database, as they are of similar intensity.

The fact that the research areas were both within the Faynan region eliminated the problems that arise from combining field surveys of very different environments. However, environmental and geomorphologic aspects must still be considered. The

region's geology must be examined in order to understand processes of erosion that could be exposing some sites and covering others (Barker 1991, 4). In the Levant there are a number of topologies that affect archaeological remains differently; for example, the behaviour of wadi beds, the manner in which they erode and the formation of soil fill that can destroy or cover sites. Both teams studied the Faynan's geology to understand the formation and behaviour of the wadi beds. The surveys were therefore designed with a sound grasp of geomorphology and its effects. This understanding prevented the surveyors from making the assumption that areas that did not yield artefacts or sites were uninhabited or not utilised.

Weather conditions can also change the recovery rate during a survey, some features being easier to see in different conditions. Desert regions like Faynan have arid conditions that prohibit heavy foliage but the bright sun can make it difficult for surveyors to differentiate soil changes. Both teams benefited from the lack of vegetation which obscures site remains, making it hard to see features and distinguish objects (Barker 1991, 4).

The number of sites found during a field survey can change dramatically depending on the crew's health, experience and ability to overcome problems created by the weather (Barker 1991, 4). The ability to create as complete a survey as possible can be dependent on survey leadership and training. Trained individuals will also find and correctly identify more sites and be able to pick up on nuances and complex features, helping to eliminate bias (Terrenato 2004, 45). Both research teams had experienced surveyors on their teams who had worked in semi-arid environments before and could adapt to the effects, thus potentially lessening error. Discerning different periods at sites

that were re-used or continuously occupied is often not an easy task or readily apparent at first glance. Earlier occupation layers may be masked by later human activity that is closer to the surface and more apparent to the surveyor. This sometimes leads to more emphasis being placed on later periods, simply because this is the material that is readily seen and recorded. The usage of the site may be different during separate occupations, with the secondary usage markedly dissimilar to the first. Put simply, discerning the period and nature of site occupation requires careful scrutiny. These variables can affect both site recovery and the analysis of those sites. Regardless, experienced survey teams can lessen the impact of these issues and both these projects utilised skilled crews.

Both projects also decided that GIS analysis would be a large part of future research and both designed the projects with an eye to facilitating the collection of spatial data. Both used satellite data and aerial photography to map the landscape, creating geo-spatial databases. These databases make the data particularly easy to interpret using GIS (see Chapter 4.6).

3.6 Mechanics of Combining the Surveys

The basic structure of the surveys has been analysed, as well as the factors that could lead to errors in the data, and the measures employed by each survey to control for such potential error. However there are some factors that cannot be compensated for without adaptation.

The main incompatibility between the two surveys concerns differences in collection and recording of artefact densities. The WFLS collected a larger representative

sample of pottery, and with a large body of material to analyse, the dating of their sites may be more refined. The JHF did not collect systematic proportional samples and no methodology was created to ensure a representative sample was collected. This means that it is only possible to draw preliminary conclusions about pottery concentrations throughout the Faynan region. Also pottery from the JHF project of 1998 was recorded without separating the Nabataean, Roman or Byzantine pottery into discrete categories. When possible the pottery information from other surveys (Hauptmann 2007, MacDonald 1992) was included, but survey overlap did not occur frequently. Nor was it possible to review the pottery collection, as it is located in Jordan and was inaccessible at the time of writing. This thesis must therefore make use of the data provided by the JHF surveys to draw conclusions. However the pottery collected by both teams can be used as an indicator of occupation dates. A future avenue of research would be to refine the dating of sites; while such information would be welcome, it is not vital for the purposes of this study.

Another issue is the technology used to record the spatial data. JHF used total stations with a high degree of accuracy. The WFLS team used GPS hand-helds, which are not as precise. However accuracy was still within ten metres, which overall produced a spatial database of sufficient quality. Within the scale of the large landscape being analysed, the variation in accuracy of the two surveys is not a significant factor. In Chapter 7, accuracy of survey measurements is discussed further as part of more detailed analyses.

Neither of these surveys could wholly eliminate human error. The semi-arid environment of the Faynan can be a challenging one, both physically and mentally.

Difficulties of running archaeological projects abound and are compounded by the remoteness of the Faynan area. These factors limit the energy and health of human agents in this environment. Mistakes become more frequent and data are more likely to be mis-recorded (Given and Knapp. 2003, 4). To counter this limitation both project teams re-checked areas, both in the field and through aerial photography and accounts from past surveys.

All of the particular features of the two surveys have been described. Both projects were conscientious; they produced quality data and also highlighted methodological and data limitations in a clear manner. I have concluded that these data sets can be combined with minimal adjustment, since when examining the JHF and WFLS surveys, one finds similarities in survey intensity, project goals and type of project. Ways of accomplishing this adjustment are discussed here and in Chapter 4.

3.7 New Survey 2005

The key difference between the two surveys was in their definition and use of terminology. Though this could be partially rectified by studying the detailed evidence both groups produced, some sites and data required reinterpretation; site typology and the terms used in the surveys needed to be homogenised. In this regard, some site type definitions had to be created anew, while others could be adapted or converted. A necessary step to properly combine the survey data of these two large projects was a further comparative survey whose main purpose was the elimination of areas of omission or disparity in the two datasets. This focused re-survey was designed to help rectify the problems of ambiguity and missing site plans.

This survey was conducted by the author from 13th-18th of October 2005 in the Wadi Faynan, with the assistance of Dr. Adolfo Muniz from the University of California San Diego, and two local villagers Mr. ‘Aly Zanoon and Mr. Sayadin. The survey was designed to accomplish two functions. The first was a review of sites that had already been recorded in either the WFLS project or the JHF project. The purpose of this review was to examine sites that were described ambiguously and to clarify each prior survey’s exact definition of site terminology; for example, to determine the parameters of the word ‘hamlet’ as it was used in the 1998 JHF survey. In this example, ‘hamlet’ meant a small group of structures, usually domestic in purpose, smaller than a village/settlement. This definition also included structures that may have been part of a larger settlement that is no longer discernible; or where structures had been washed away before the survey took place. For example a Chalcolithic site, Fidan 51, has dense quantities of pottery with wall lines and standing stones. In the wadi section, structures can be seen as well as bone fragments and ash lenses. In association is Fidan 51a, an artefact scatter on a terrace fragment 50m from the main site. Fidan 51 was labelled a hamlet, reflecting the present remains, even though it was likely larger in the past.

Visiting the sites also allowed them to be placed within the landscape, as this is not always clear from survey descriptions or site plans. This can further ideas of relationships between sites or can indicate site purpose. Most importantly for this thesis, the views from key sites were recorded for later use in the study of visibility and surveillance in the Classical period (see Chapter 7). As a central argument in this thesis concerns the role of visibility and surveillance in identifying imperial interest in these mines, this step was essential.

3.8 2005 Survey- Secondary Purpose

A second key aim of the 2005 survey was to examine the wadi system as a whole in order to understand human behaviour across it rather than in discrete areas. In order to do this, a more complete picture of the region was needed. In between the two surveys there was a 'Gap' in the landscape of approximately 3.4x1.2km that had not been included in either survey (Fig. 3.7). Unlike the other areas of the Faynan, the missing area had a notably different aspect and slope, the wadi beds running in a north-south direction with the mountains further back, not providing shelter as they do in the Fidan and Jariya Wadis. The unique wind patterns this configuration creates are visible in the changes found in the landscape. For example, the rest of the Faynan is comprised of rocky stone terrain with sizable sand dunes that are located on the outskirts of the modern village. Topographically the missing area is more level than the land surrounding the Wadi Fidan or Ghuwayb, yet less open than areas of the Wadi Faynan. The unique nature of the Gap area meant it was not possible to produce predictive models of past habitation with great accuracy; as a result it had to be surveyed in person. There are a number of reasons for the lack of overlap, not least of which is the existence of the modern village of Quarayqira and its growth in recent years (Fig. 3.8). Also the prior research teams allowed space between their territories so as to comply with permits issued by the Jordanian government to ensure no overlap between their surveys.

The pace of development in the region has speeded up dramatically in the past few decades. As paved roads have been made and military control lessened, economic and social developments have flourished (MacDonald 1992, 4). These developments have

reached the municipality of Faynan as well. The history of the village is complex - development in the 1970s, when a hydraulic infrastructure was put into place, was financed by the entrepreneur Sharif Hussein Nasar. Despite the invested capital, the area did not experience significant development at this time. This led to his eventual withdrawal from the region, which further stifled the village's growth (Lancaster and Lancaster 1999, 154). Only in the past ten years has the area undergone significant expansion. Quarayqira has tripled in size in the past seven years and large fields now cover the surrounding areas. The roads leading into the village are now paved and power lines have eliminated the continuous drone of petrol-powered generators. The Rashaydah tribe have also created a separate settlement, al-Rashaydah, outside of Quarayqira. Four new roads were paved during our 2005 visit, demarking areas where houses have yet to be built. Unfortunately this means that the area around Quarayqira has largely been developed and archaeological traces, if present, are now covered with modern habitation and fields. This development also removed the possibility of true random sampling, as respect for the local villagers' property prevented close examination.

3.9 2005 Survey Methodology

The aim of the 2005 survey was to explore the area and study sites located in this gap between prior surveys, enabling this area to be incorporated into the surveys of the larger Faynan region. This was a two stage process; the first was to understand settlement patterns in general and if possible, those specifically of the classical periods. The second stage was to determine where sites were located in the landscape and to attempt to discern the reason for their placemen; in other words whether topology, land forms, or

cultural factors influenced settlement patterns. A final key consideration was to satisfy myself that no sites that would have significant implications for the overall interpretation of the region were located here.

To accomplish this, a limited pedestrian survey was carried out. Its primary purpose was to study ancient archaeology and it was not intended to be a comprehensive survey. The desert nature of the area has its advantages, as this means a high probability of preservation (Wilkinson *et al.* 2004, 191). Similar to the Wadi Faynan and JHF projects, the degree of preservation meant that small sites such as graves were still visible. This richness of the data meant that sites were plentiful, but also created difficulties in time management, given the limited window available for the survey. The survey approach I chose was a mix of systematic sampling with compromises for topography and modern settlement.

To limit the search we stayed along the wadi shelf and the mountains next to it. We walked the wadi terraces and some of the highlands. The highlands were especially useful as they allowed for visual review of areas that had just been sampled but not fully explored. If necessary, back-tracking to a missed site would have been possible, although we never had an occasion where this was required. The two transects were 30m in length with each surveyor covering ten metres, and they cut across the wadi north-south. As this proved too time consuming, the area covered by each individual was eventually widened further. Given the degree of presentation and the clear visibility of sites, an expanded survey transect coupled with visual review worked well.

As time was limited, all sites that were obviously modern were not recorded

unless they were next to, or on top of, ancient sites. As this was not an ethno-archaeological project, this information was deemed unnecessary. The age of the site was determined by the material culture, the amount of erosion and silt build-up. Some sites could be identified as modern ethnographically by Mr. 'Ala Zanoon and Mr. Sayadin. Their memory of seasonal movement by Bedouin families and their likely dwelling spots was crucial to this process. As a result recording was limited to sites with remains pre-dating the 1900s. Isolated finds of pottery and lithics were not recorded. If pottery was found in conjunction with recorded sites, it was photographed along with the structures, as the survey had no permit for artefact collection.

The survey area can be divided up into four sections (Fig. 3.7). The first is the wadi bed, the river channel itself. We performed two transects of the wadi bottom but, as expected, powerful seasonal flooding had washed away all surviving traces of archaeology. Nor were we able to see any sectioned remains in the sides of the wadi beds. The second section was on the west side of the wadi, where Quarayqira is located. As stated before, no survey was conducted here to respect villagers' property.

The other land type of note is the sand dunes to the south of the modern village (Fig. 3.9). The dunes to the south-west are still outside the zone of modern development but recent growth has brought farmed fields right to the edge of the sand dune. No visible archaeological structures were found within the dunes. Some material culture such as flint and pottery was discovered, suggesting that the dunes might be a potential area for further study. This suggestion is strengthened by the evidence of settlement at the south-eastern edge of the sand dunes found by the WFLS project. However, my survey did not find any archaeological structures. The remaining archaeological finds were on the east

bank of the Wadi Fidan, the fourth area. It was in this area we concentrated our efforts.

3.10 2005 Survey Findings

The geo-spatial data were recorded on GPS handhelds that unfortunately did not provide the highly accurate readings anticipated. With this information sites would have been placed on a satellite image, perhaps furthering interpretation. However, as stated above this was a reconnaissance survey. Though accurate spatial data would have been useful, it is still possible to draw some conclusions without them (Fig. 3.10). The goals of the survey were to gain an understanding of the Gap, identify pertinent sites and determine factors influencing spatial patterns. In this it was successful.

On the eastern wadi bed we found a number of sites (see Appendix 6 for survey database). This side could be divided into two areas. The first area was to the south in the lee of the mountains. The second began as the mountains receded further back and the area became more exposed. The southern area had two field systems, the larger 263x172m in extent. The field lines are still visible but are severely eroded, more so than those of the Classical field systems of the Wadi Faynan, which may indicate that these fields are older.

Most of the sites found were cairns or graves; some relatively modern, relating to Bedouin activity. A few enclosures, possibly animal pens, were also found. Aside from these and the field systems, the main site types found were funerary or defensive in nature. Many graves were located, usually two or three in small clusters, some robbed. One larger group was found at Site 16 that had 17 related graves. Lone cairns were found

that were most likely graves but could also have been markers or shrines. These sites had hand-made pottery and flint found in conjunction with them. Structures also were commonly found on top of foothills. These hilltop locations offered clear views of the surrounding wadis. Four of these structures were roughly oval in shape (10x10m), of collapsed, un-worked stone, often cut into by modern cairns or graves. One exception is of particular interest; a rectangular stone platform of cut stone about 6x5m, badly collapsed (Fig. 3.11, Fig. 3.12). The stone collapse had been reused and an oval structure, likely an intrusive grave, had been built next to the platform.

Like the others, this site has a commanding view for a great distance down and across the Wadi Fidan. No pottery or worked flint was found nearby; however there was a chunk of limestone that had an inscribed cross upon it, perhaps indicating the site had a Byzantine date (Fig. 3.13). The presence of a cross may indicate a burial, if so this is an impressive tomb. However, there is evidence of more than one intrusive burial. The cross may be unrelated to the platform structure.

A more thorough investigation would undoubtedly return more finds and sites. In terms of the aims of the thesis this survey cannot be considered as detailed or accurate as the others; nor can its data be integrated in to the larger database directly. However for the purpose of this investigation, what was needed was a general idea of this Gap area in order to form a holistic view of the wadi system and human habitation within it. This goal was accomplished. With the knowledge gained, modelling of the rest of the landscape could continue and be considered relatively complete, even with portions of the wadi system having been less intensively surveyed.

The picture gained from my exploratory survey is that the Gap is an area that had very little intensive settlement, especially in terms of activity relating to the Classical period. Lithics or hand-made pottery were found in conjunction with most sites. The southern part of the east bank was in the lee of the mountains, protected from the elements by the mountains (Fig. 3.14). This may explain why this bank had the highest concentration of sites, including field systems. Beyond this there were few sites found. This observation is the same as that of the JHF team. They worked to the southernmost limits of the Jabal Hamrat Fidan Mountains but little further, as the paucity of sites rendered further survey non-productive (Anderson pers. comm.). The fact that the northern end of the Gap area is not in the lee of the mountains and is unprotected from the elements may explain the lack of evidence of large-scale human activity. Simply put, this area would have been less attractive for settlement. The western sector of the Faynan experiences fierce sand storms and this Gap area is particularly hard hit. As the northern end of the east bank became more exposed, fewer and fewer sites were found. Finally, there are no obvious springs in this area, 'Ain Fidan is on the west side of the wadi, making human occupation less attractive on the east. The key outcome of the survey was that there appear to be no major settlement sites missed in the uncharted area between the JHF and WFLS surveys.

From the present evidence it appears that this area was sparsely populated during the Classical periods. It is not surprising that the survey indicated little evidence of habitation. The main hub of classical activity in the Faynan was to the east at the beginnings of the Wadi Faynan itself. The Roman/Byzantine town *Phaeno*, now known as Khirbet Faynan, is located here. This finding has implications for understanding

Roman and Byzantine settlement. For the purposes of this thesis one pertinent fact is that the Gap area was agricultural and pastoral in nature rather than industrial. No furnaces or slag piles indicating copper production were found. Also of note, excepting what may be observational structures, no buildings related to the administration or infrastructures of *metalla* were found. The smaller surveillance posts perhaps functioned like the *skopeloi* found at the Egyptian Quarries, but Site 6 is unlike these in form. It may have been a more official observation station, perhaps created by the administration, indicating that this area was under surveillance (see Chapter 7.5.2). Or it could have been an elaborate grave attesting to the presence of a high status individual. If so its position away from Khirbet Faynan is curious. Further implications of the Gap survey will be discussed in Chapter 5.6, when it is placed in relation to the other regions of the Faynan.

3.11 Conclusion

Methodological and theoretical issues of surveys have been discussed. The qualities that make a sound survey have been identified. Bias could be reduced if a survey had a rigorous research design, was comprehensive, and took into account the numerous factors that preclude site recovery. A complete research design, taking into account a number of potential biases, human, environmental, and geomorphological, is essential. The data sets of WFLS and JHF have been described and found to have these features and therefore can be considered to be high quality surveys. It has also been determined that they have enough similarities that they can be integrated. Despite this, potential problems with recording styles and terminology have been identified and a further pedestrian survey was performed to address some of these issues by reviewing sites and providing information

to facilitate combination of the two data sets. The mechanics of the database will be discussed in Chapter 4, where the identified potential problems are addressed.

Chapter 4 – Creating the Database and Tools for Exploring It

4.1 Introduction

The two systematic surveys of the Wadi Faynan region, the Jabal Hamrat Fidan Project (JHF) and the Wadi Faynan Landscape Project (WFLS) were presented in Chapter 3. Each project was conscientious about recording information, providing a wealth of data about each site. Potential problems that have been identified included differences in terminology, recording of information and use of databases. Neither database could be easily adapted to include the data of the other. However, because of the detailed documentation by both projects, it was possible to combine the data in a new, high quality database using the program Filemaker. A new database, employing a single terminology scheme was created. The mechanics of this construction and the theoretical issues that underlie data combination are discussed in this chapter.

A number of factors were considered in the construction of this project's database. The most significant was to create a final product that could be used in a GIS environment, one that could lend itself readily to geospatial analysis. Furthermore, the database had to include the appropriate amount of information without extraneous details or repetition. It also had to be flexible, with general categories that contained streamlined information but did not limit or categorise the data, allowing for more thorough interpretation (Massagrande 1995, 56).

4.2 Forming the Database

The most relevant information for use in the new database included site identification, with its spatial and relative location, material culture found, and description of various aspects of the site. The database was designed so each site had its own data entry form that included the information in Fig. 4.1. All sites with pottery or material finds for the Classical period were included.

Each site was assigned an identifying code; in each case a variation of the original survey's identifier. Sites from the Wadi Faynan Project were identified with a WF and then the site number, for example WF4. The Jabal Hamrat Fidan Project identified sites according to the wadi in which they were located; in this case, WAJ would be Wadi al-Jariya, WAG the Wadi al-Ghuwayb, and Fidan the Wadi Fidan. An example would be WAG3, meaning site number 3 in Wadi al-Ghuwayb.

Both surveys had originally recorded site coordinates in the UTM WGS84 projection and locations were easily combined. This meant neither data set had to be converted into another projection.

This database also included a long description category where the original field notes, final gazetteer entries and any other information were entered. If published work from other projects was able to provide additional information about a specific site, it was included and cited in this field. This category would include information about position relative to other sites and the current state of preservation.

4.3 The Site Types

For the purposes of this study the category ‘site types’ was modelled on the WFLS survey with further modifications; broad categories were chosen to describe the type and purpose of sites. This basic scheme was combined with some of the classificatory schemes of the JHF survey, such as the term ‘hamlet.’ It was felt that this category was a useful descriptor not used in the WFLS survey and that the database would benefit from its inclusion. To indicate size of site some common site types have categories with graded variations, such as grave, funerary structures, and cemetery. In this case grave is a single structure, funerary structures are less than nine burials, and cemetery more than nine. The increments of structures, usually multiples of nine, were based on the WFLS gradation system. I found it to be a useful way of quantifying sites, allowing their relative sizes to be compared; thus this feature was retained and applied to the JHF data.

Twenty-four categories of site were designated, as well as some sub-types. Sites from both survey data sets were relabelled to fit these categories for the purposes of this study. This technique was employed to prevent confusion and create consistency within the database. The designators chosen are generally descriptive rather than interpretive, since without excavation, while the typology is certain, the purpose or activities that took place on the site are not. This does not limit further interpretation in the future; it does, however, indicate that the site assignment is likely but still speculative. For example, Fidan 52 has wall lines and three large structures (approximately 10x20m) as well as slag scatter (Levy *et al.* forthcoming a). It is listed as a hamlet since the purpose of the

buildings and their relation to copper production is unclear. Sites such as this were placed within the general category; more unique qualities can be explored in future. Some sites could only be listed in specialist categories, for example ‘aqueduct’ and ‘watermill,’ but these are not found frequently in the landscape. Although placing sites in broad categories loses some of the detail that was recorded in the original studies, it allows for an expansive synthesis to take place. With these designations larger trends and patterns can be easily identified on a regional scale.

One difficulty in developing the database was that often the same location was used over time but for different purposes and the nature of site use in each time period can be unclear. For example, Fidan 107 was both a Roman and Iron Age site, but it is unclear which buildings belong to which period (Levy *et al.* forthcoming a). However metallurgical evidence suggests a Roman smelting facility was located here. Fidan 107 is listed as a ‘metallurgical site’ as this is the designation that is most clear from the evidence. Fortunately, remains dating to the Roman and Byzantine periods are usually the ones appearing near the surface.

Thus sites were assigned a type, taking into account the sites’ typology, functions and locations, as well as finds. An important caveat is that this assignment should not be taken to suggest that the site engaged only in that function; likely multiple tasks were taking place. But the main purpose or typology of the site during the Classical period, as determinable by survey, was used as its signifier (after Barker *et al.* 2007, 97-100). Categories were assigned for 24 main site types (see Appendix 3 for site symbols).

Agricultural Site

This category refers to areas that were under cultivation as well as the structures associated with agriculture. There are multiple levels of complexity encompassed in this term. Simple fields as well as those with intricate floodwater farming such as WF4 are included. Hydraulic structures, channels, floodwalls, terraces, field divisions and cairn clearances are included in the category. This category does not include related domestic structures like farmsteads that are listed under various domestic structures (see below). Without excavation to substantiate the activities taking place, agricultural sites were described by type, rather than speculate about function.

Artefact Site

An artefact is any object, either made or modified for use by human beings. Artefact Sites are surface find spots not in visible association with architecture. These sites were not isolated shards but discrete concentrations, higher than the low-density pottery distribution throughout the wadi system. These sites could be ‘offsite’ activity centres; indicating where actions have taken place in the landscape (Banning 2002, 19). For example, they could represent transhumance, the pottery accumulating from frequent pastoral activities instead of habitation or agriculture. For the purposes of this study, if the pottery were datable to any Classical period, it was included in the database.

Aqueduct

This site type encompasses all constructed channels to direct water for consumption or industry. This does not include irrigation or hydraulic channels that were

related to agriculture; these were supplied by rain water, while the aqueducts channelled water from the perennial springs.

Cemetery Site

This term is used when referring to funerary sites with nine or more burials. The designation includes both the burials themselves and any accompanying funerary structures. The largest cemetery of the region was WF3, the early Christian cemetery that was part of the Khirbet Faynan complex. Other cemeteries less elaborate than WF3 are found along the wadis.

Cairn Site

Cairns are a human constructed pile of stones. Tumuli, collections of stone placed over a soil base, were also included within this category. These cairns could act as boundary markers, ground clearances, trail signs and shrines. Some of these may have been graves, but without excavation it is not possible to tell. If the designation was unsure, the site was included within this category.

Campsite

Features of these sites suggest a seasonal pastoral camp; these can include hearths, pens, bedding platforms, and tent footings. These sites are usually ephemeral in nature.

Church Site

A structure built for Christian worship. Five known structures and a possible sixth

(WF32) were found in the Khirbet Faynan and its surrounding satellite settlements.

Domestic Structures (DS) (O/R)

These are domestic structures likely to have been used for human habitation, not as animal enclosures. Construction for a DS was simple (see below for complex domestic structures), walls were made of uncut stone and boulders. Most structures in this category are single room buildings, although some have up to three rooms. The more simple structures may represent less permanent structures, perhaps seasonal dwellings for populations practicing transhumance. They are very similar to enclosures and there may be some overlap between these categories. In the DS category, a further classification was created to record shape; O for oval or R for rectangular.

Domestic Structures Complex (DSC) (O/R)

These are complex domestic structures, comprised of multiple rooms with associated external structures. A few of these structures are elaborate with well constructed walls and signs of domestic industry. Included in this group are farmsteads, as they were primary domestic sites that also practiced agricultural activities. DSCs were also given a designation recording their rough shape; O for oval or R for rectangular.

Enclosure Sites

Enclosures are sites formed of uncut stone enclosing a space; if found in conjunction with domestic structures, they are included in the DS category. Some were free-standing, and in that case, the sites are assigned to this category- Enclosure sites. Comparison with modern ethnographic studies strongly suggests that these enclosures

were used as pens for animals or storage rooms (Barker *et al.* 2007, 379-380).

Fortified sites

These are fortified buildings that likely had a martial purpose. Identified by construction, they are thick-walled structures, sometimes made of cut stone. A range of sites is covered within this designation; WF592 for instance, is a Nabataean fort. Also included in this category are free standing watchtowers and smaller fortified buildings.

Funerary Structures

Funerary Structures are smaller burial clusters numbering 2-8 distinct graves. These are middle-sized groupings that could relate to family or tribal burials.

Grave Site

This is defined as a single burial that could be identified as a grave rather than another stone grouping. If the evidence were ambiguous, such sites were placed in other categories (see cairn). Single graves with multiple inhumation burials also are included in this category. Graves can take the form of cairns, kerbs, cists and stone rings, some tombs exist as well. Grave robbing is common and is often the most frequent indicator of the presence of a grave rather than a miscellaneous cairn. Often the remains of grave goods or bones are visible after such illegal excavation.

Hamlet (O/R/mix)

Hamlets are groupings of multiple structures that are not large enough to fall under the category of settlement. These sites may have been satellite occupations related

to, but not physically connected with, other settlements. These sites may also have been settlements but not enough evidence survives to the present day to include them in that category. Hamlets are given the designation O oval, R rectangular or mixed depending on the shape of the domestic structures. The description 'mixed' means both rectangular and oval domestic structures are present.

Khirbet/Town

Khirbet means 'ruin' in Arabic and usually designates a major settlement. Several sites in the survey zone have names prefixed by Khirbet - Khirbet Hamrat Ifdan, Khirbet al-Ghuwayb, etc., but these were not operating as major centres of activity during the periods under study and are therefore designated as other site types. Only one site stands apart from all the rest as a town during the Classical period, Khirbet Faynan. This site is comprised of multiple domestic, industrial, fortified and religious structures as well as architecture of substantial construction covering over 70,000m². This town site was a religious, cultural, economic, and social centre for the region and the location of many different activities. This site is listed separately from the Category 'settlement,' as that term does not distinguish the unique characteristics of Khirbet Faynan.

Metallurgical Feature

These sites are where copper ore was refined or smelted, indicated by the structures of production such as furnaces and remains of ore processing. By far the best indicators of copper industry are the slag piles, such as that found near WF11.

Mining Feature

This category encompasses the structures associated with the metal ore extraction, the foremost of which are mines, shafts, audits, prospecting shafts and tailings.

Reservoir Site

There are two reservoirs included in the database, WF39 and WF1348. These sites are catchments dug into the ground that hold water, usually for drinking, but WF39 fed the aqueduct for the mill. Some sites, such as WF1415, had a reservoir but this was only one of the many structures in the settlement.

Rock Shelter

These are natural or human modified rock formations that provide cover; rock overhangs and caves are grouped together under this category. Often utilised in modern times as animal pens, the natural overhang acts as a protection from the elements and the walls prevent the flock from straying. This category does not include subterranean works that were created for the purpose of ore extraction (mining features, see above).

Settlement Site (O/R/mix)

These sites are those that include more than nine domestic structures and associated domestic architecture, pens and enclosures as well as industrial areas. Domestic features are often associated with the structures, such as hearths and millstones. Settlements have a further distinguishing characteristic of shape- buildings were recorded as oval, rectangular and mixed. Satellite settlements to Khirbet Faynan were recorded

separately in the original WFLS survey and these designations have been kept. Hamlets or settlements located near, but not actually part of the Khirbet, have their own designation. This distinction is particularly important, as the satellite communities were the centre of different activities taking place around the Khirbet.

Stone Setting

This category includes rock structures that are clearly artificial but not easily identifiable as to exact type or purpose. This category contains many different structures, some of which can only be further identified by excavation. Eroded graves and cairns, if they have become unrecognisable, may be included in this category. These settings may also be ephemeral constructions on pastoral sites, such as tent footings and hearths where the rest of the camp is obliterated.

Wall line

These are sites where all that remains is a single wall, or two unconnected walls. These walls are isolated from other sites or structures, thus the need for separate designation, and show no evidence of being related to agricultural or hydraulic function.

Watermill

One site falls under this definition, WF33. This mill is of penstock type powered by overflow from the reservoir. Theories regarding its purpose, whether agricultural or industrial, are discussed in Chapters 5.5.3 and 6.5.

4.3.1 Sub-type Designation

Sites often had additional information that it was vital to retain, such as multiple features. For example, WAG 57 had industrial remains and rectilinear domestic structures (Levy *et al.* forthcoming b). This could indicate a metallurgical site where people also lived and thus both pieces of information are relevant. For these multiuse sites a category of sub-type was created, including the relevant information.

This multi-functionality occurred frequently in categories such as settlement; these sites were used for habitation as well as industry or centres of travel. This classification allowed for easy referencing when using attribute tables in the GIS program. Other information was included in this category. If sites were part of the main Khirbet Faynan, but had been given a separate designation, then this category was used to indicate its relation to the larger settlement. Grave types such as ring, headstone or tomb, were included in this category so that funerary monument types could be mapped.

4.3.2 Inclusions into the Database

As this database was designed to be flexible and inclusive there are parts of it that do not relate directly to this thesis. The initial decision to include such information was to increase the avenues of research I could pursue, but upon further examination I found the information was not useful in studying the Roman and Byzantine administration. An example of this is the O/R/mix category, which recorded the general shapes of domestic structures, hamlets and settlements. Upon further exploration there were no clearly discernible spatial patterns for certain structure typologies. There was no clustering of

different building types that could have indicated different populations with separate building cultures. In a similar manner, the separate descriptions of grave types, kerb, cairn, headstone, or tomb, proved unfruitful. Although this information was not pertinent to the current study, future work may benefit from the extra information developed in the full, integrated database.

4.4 Site Dating

Sites were assigned to a time period based on three criteria. Pottery found during the survey was the main method for dating. Without excavation to confirm surface finds, one could raise questions about the validity of this dating method. However as the pottery scatter across the landscape was low, the concentrations appear to be significant rather than the result of formation processes (Barker *et al.* 2000, 32). Another technique was proximity to other, more securely dated sites or similarities in construction indicating a relationship between two sites. Finally, a few sites had dateable finds such as coins or inscriptions, although only a few instances of this occurred. If pottery could be assigned to a discrete time period then it was recorded in a separate data box. If dateable pottery had been collected by other surveys, for example from MacDonald's (1992) Southern Ghors and Northeast 'Arabah Archaeological Survey, then it was also included in the database.

4.5 Rating System

One of the ways to address any ambiguities found in the data was by the creation of a rating system. Based upon confidence in the dating evidence and site type, the sites were assigned a number from 1-5. A rating of 1 represented absolute confidence in the

site dating and function. Sites that were rated 2 were datable on pottery and finds such as coins or building styles- for example the use of *opus quadratum*. The presence of Classical occupation was clear, but there could also be evidence of occupation in other periods.

Table 4.1 Assigning confidence ratings for accuracy of site typing and dating.

Degree of confidence	Characteristics of site rating	Comment/example
1	Absolute confidence in dating evidence/site type	Khirbet Faynan
2	Confidence in dating evidence/site type but evidence from other periods is present	Fidan 120- Roman/Byzantine site built over large Bronze Age settlement
3	Sites with majority of Nabataean, Roman, and Byzantine pottery, identifiable site type and usage	Fidan 107- likely Roman metallurgical site with Iron Age structures
4	Some distinctive site features but no pottery or minority of pottery datable to Nabataean, Roman, or Byzantine Periods	WF54- Likely Nabataean farmstead, no pottery found
5	Classical pottery, no distinctive site features	WF756- cairn

The sites in Categories 1 and 2 are relatively rare in the landscape, most others being open to wider interpretation. The Faynan landscape has been in use for thousands of years and sites have often been reused or adapted, obscuring usage patterns. Even in the present day the modern Bedouin are part of an active living landscape, changing it to suit their needs. Thus the sites that fall into the first two categories are relatively unique in the Faynan; they tend to be large structures, stereotypically Classical in form; for example, Khirbet Faynan, with its massive amounts of pottery, churches and aqueducts.

This site has plentiful evidence and there is no doubt that the occupation layer visible to surveyors relates to the Roman and Byzantine periods. Also included in confidence ratings 1 and 2 are settlements with an overwhelming majority of Classical pottery or clear Christian iconography. These sites are also clustered around Khirbet Faynan at the east end of the wadi, which reflects the importance of this area during the Roman and Byzantine period and should not be considered an artefact of the combination of the surveys.

Sites that were rated 3 had pottery that was assignable to distinct time periods within the Classical period- Nabataean, Roman, or Byzantine. However the architecture was not distinctive and pottery from other periods was sometimes present, indicating multiple occupations of the site. This rating required that more of the pottery be datable to the Classical periods than to other eras, suggesting heavy usage during these periods. Given the lack of large-scale excavation, it is not surprising that the second most common confidence rating is Category 3. Found throughout the Faynan, these 242 sites reflect the long history of the area and multiple occupancies. This category includes most of the settlements, funerary sites and smaller scale metallurgical sites.

Sites that were rated 4 had some pottery that could be identified as belonging to a distinct period, but not the majority of sherds collected. Also, if a site were described as having Roman/Byzantine pottery with no other further delineations, it was assigned to Category 4. These sites may have had multiple usage periods and pottery may cluster around certain areas of the site rather than others. Many mines are also included in this category, having been reused in multiple eras. Category 4 sites also had non-distinctive architecture, or architecture that had been destroyed by modern activity. Site Fidan 615 is

an example of this rating; although Roman/Byzantine pottery is predominant, the site has been bulldozed. The distinction between Category 3 and 4 is sometimes a fine one. Proportions of pottery found depend on the collection methods. The WFLS pottery was collected in a systematic fashion in order to gather a representative sample. Undoubtedly this data can be considered very robust and well suited for use in this manner. The JHF survey collected a representative sample of pottery but not in a systematic fashion. Using these data requires a caveat. The categories for this study were created with the information given. Further excavation work would enhance this model, but this research project concentrated on the presently available pottery data.

Finally, sites in Category 5 had pottery which could only be identified as belonging to a Classical period, not to any specific one. There are 313 sites in Category 5, a sizable number, adding to the richness of the dataset; however, these must be interpreted with caution. This category includes all sites that could only be dated by Classical pottery. Also some sites are included in this category by virtue of location or typology alone. Mines make up a large proportion of these sites; many have no datable elements, yet they are accompanied by other sites, such as habitation or fortified structures which were datable and indicate they were likely worked in the Classical periods.

Table 4.2 Table of the number and type of sites in each confidence rating.

Site Type	Confidence 1	Confidence 2	Confidence 3	Confidence 4	Confidence 5	Total Sites
Agricultural	1		13	8	10	32
Aqueduct	1					1
Artefact Site		1	15	6	7	29
Cairn			7	2	10	19
Campsite			8	3	5	16
Cemetery	1		24	11	10	46
Church	1					1
DS			21	6	29	56
DSC			12	6	10	28
Enclosure			6	4	15	25
Fortified Structure	2	1	4	2		9
Funerary structures		1	37	11	28	77
Grave			13		7	20
Hamlet		2	14	7	6	29
Khirbet (Town)	1					1
Metallurgical Features	3		15	5	6	29
Mining Features			5	5	144	154
Reservoir	1		1			2
Rock Shelter			3	1	4	8
Settlement	3	4	12	2	2	23
Stone Settings			23	4	15	42
Wall Line			9	3	5	17
Water Mill	1					1
Total Ratings	15	9	242	86	313	665

Sites in Category 5 do cluster in the Faynan and this is likely a product of the survey methodology. The pottery collection by the WFLS was more comprehensive and a further study of the sherds was made. Thus it was more likely that a pottery date range could be assigned, even if only to the Classical periods. Category 5 fulfils an important function. Although the archaeologist is easily drawn to sites such as those from Categories 1 and 2, these are not the majority of sites. Nor do they represent the interests and lives of the lower classes, whose habitation, seasonal movements and burials are not elaborate, but still important to include when building an understanding of daily life in the Faynan. Also, smaller, more ephemeral sites, or ones that have been badly preserved over time, are not priorities to be excavated, and such survey evidence may well be the sum total of data gathered on them. Sites grouped in this category can suggest modes of behaviour, though it can not prove them conclusively.

The sites that most likely indicate transhumance or seasonal housing are also included in this category. Fifteen more stone settings can be included, these relate primarily to tent clearances and footings. Other, more ephemeral sites include 5 wall lines, 5 campsites, 10 cairns and 15 enclosures.

This thesis explores themes of imperial administration and its effect on the landscape. Thus sites in Categories 1-4 are discussed most frequently. These categories include all of the administrative structures that are easier to date due to intensity of usage and substantial construction. Sites in Category 5 are useful when discussing general settlement patterns and industry (see Chapter 5.8 and 5.16). The fuller data set creates a more complete picture and, as the industry and administration were not operating divorced from the rest of the landscape, it is important to consider all human habitation.

4.6 GIS

With the creation of a database the information about the sites from the two original surveys can be placed into a Geographical Information System (GIS) for further analysis.

At its most basic a GIS can be described as “A set of programs aimed at storing, transforming, manipulating, and analyzing spatially attributed data...” (Vermeulen 2001, 9), and applications of the technology to archaeology have been repeatedly demonstrated (see Allen *et al.* 1990; Lock and Stančič 1995). It is not the purpose of this thesis to provide a history or review of the development and general use of GIS, especially as this topic has been covered in a number of recent books (see Wheatley and Gillings 2002; Conolly and Lake 2006). However a discussion of GIS and its pertinence to this project is necessary in order to properly frame the context of its usage.

GIS was chosen as the tool of analysis for its strengths in handling spatial data. All archaeological information has spatial components; this is especially true of field surveys and it is worth noting that the JHF and WFLS used a GIS to collect, store, and present data.

A GIS does not just handle data, but facilitates its analysis, which can take place at different resolutions. It assists spatial analysis at multiple scales and can facilitate the analysis of sites in context rather than as isolated events, making it the perfect tool for such studies (Vermeulen 2001, 9). One of the key questions to be answered by this thesis is multi-scale, namely the evidence for the impact of the Roman Administration on the

landscape.

Another strength of GIS is that with it one can easily combine different data sets and types. As this project sought to incorporate aspects of decades of research, this was a particularly useful trait. Multiple sources of information were used: contour maps, satellite images, as well as the spatial data.

It is a mistaken impression that because a GIS has been used all results generated are scientifically objective. A GIS does not find inherent patterns within data, rather it finds a pattern for a particular value that the researcher believes to be important (Gaffney *et al.* 1996, 136). The theoretical standpoints held by the researcher will be present in the data set and interpretations rising from it. This limitation cannot be avoided. However, by clearly stating the research hypothesis and the approach taken to the data, any analysis can be interpreted in context.

The approach taken with this project was from the theoretical standpoint that both environment and human agency were active forces on the landscape and neither could be studied in isolation. Any serious consideration of this landscape must include acceptance of the importance of the mineral resources and the restraints imposed by the environmental and physical difficulties in exploiting that resource. The challenging topography of the Faynan and the effect of the landscape on human behaviour must be included. However an entirely environmentally determinist viewpoint is not acceptable. Although humans are influenced by their surroundings, cultural and social requirements can be just as important in shaping how humans function in a landscape (Gaffney *et al.* 1995, 212). Including cognitive or cultural analysis is important for the Faynan, while

accepting that the environment and geology played crucial parts in influencing human behaviour. To best address this I have approached this study from the explicit standpoint of balance between the two factors; factors that I would argue cannot be considered in isolation from one another. As a result, both the landscape and human activity within it were considered, especially in relation to the administration and the copper industry.

In stressing balance it is important to note that GIS applications to date have tended to favour one or the other factor. For example, GIS is often used for predictive modelling or spatial statistics in an attempt to identify or assess environmental constraints and affordances for site location. (see Kvamme 1989). Conversely, viewshed analysis has been employed in isolation to explore humanistic aspects of landscape exploitation (e.g. Gaffney *et al.* 1995). This thesis seeks to use GIS in a more exploratory way. To this end a number of different tools of analysis have been employed, each can add richness to the discussion and the ability to examine the Faynan in a systematic manner. However, these techniques each come with their own set of methodological or theoretical problems. These potential problems and strengths of techniques will be discussed as the relevant tools of analysis are introduced into the thesis; for example, Viewshed analysis is discussed in Chapter 7.

4.7 Steps Taken

Once created, the database was analyzed using Esri's ArcGIS 9 program. This software package is a particularly useful program for archaeological research. It has robust spatial analysis extensions and is able to handle and combine multiple types of information and combine them into one set of data. The Filemaker database was exported

as a .dbf file and imported into ArcGIS. A legend was created and applied consistently throughout (See Appendix 3 for symbol legend).

4.7.1 DEM

To study the topography of the landscape a Digital Elevation Model (DEM) was created, the formation of which involved a number of steps. Paper maps of the Levant at the scale of 1:50,000km were scanned and geo-referenced in WGS84 projection at the National Resource Authority of Jordan in a collaborative project with the National Endowment for the Humanities, the American Centre for Oriental Research and the Department of Antiquities, Jordan. These are available as part of JADIS (The Jordan Archaeological Database & Information System). Stephen Savage provides access to these maps on his website (Savage 2008, <http://gaialab.asu.edu/Jordan>). The contour data of the scanned map were digitized by hand at 20m intervals. Part of the work was done by Paul Newson who used the AutoCAD program. Expanding his work, I created the final contour map, incorporating his work with mine in ArcGIS. The contours were then re-projected into UTM WGS84 36N, the projection used for all the geo-spatial data in this research.

The DEM was created from these contours with Esri's ArcInfo Topogrid Tool. This program mimics hydrological effects when creating a DEM, leading to greater accuracy (Conolly and Lake 2006, 110). In a wadi system the landscape is strongly shaped by hydrological phenomena. Incorporating water effects and drainage basins was essential to the model and this created a DEM more useful for the purposes of this research.

The resulting DEM has the following specifications (Fig. 4.2):

- Projection: UTM WGS84 zone 36N
- 10 metre resolution
- 15 by 19 kilometre extent

As with all DEMs created from paper maps, there are inaccuracies. Ideally paper maps should not be over-handled or exposed to changes in humidity or temperature. These conditions and ill treatment can cause the paper to expand or wrinkle, warping the contour lines. This is unavoidable, but utmost care was taken in handling the paper maps to limit these effects (Savage 2008, <http://gaialab.asu.edu/Jordan/>).

In order to test the general accuracy of the DEM it was compared to the elevations of sites collected during the JHF survey. By overlaying sites and contours, a check could be made that the sites' recorded elevations fell within the corresponding contour lines. The elevations were found to be within +/- 10m of the JHF's recorded heights, with no great discrepancies between them. Although survey points were not collected throughout the entire landscape, this test provided a basic check of the robustness of the DEM.

DEMs can be generated in other ways, for example using radar data, and this admittedly would have created a more accurate terrain model (see Connolly and Lake 2006, 77). At the start of this project it was difficult to find an appropriate high resolution DEM of the region. Moreover, given the limited period to conduct research for the thesis I decided it was not effective time management to become proficient at programs that analyse remote sensing data. Over the course of my research the accessibility of these datasets has increased tremendously (for general discussion see Ridd and Hipple 2006).

A future avenue of research would be to incorporate a radar-generated DEM into the project. However, I believe strongly that the DEM created here is robust enough for the purposes it is used for, to model potential views (see Chapter 7). It is not an exact model of the Faynan but it was never intended to be.

Another issue that has to be taken into consideration is how the landscape has changed over time. A DEM, either generated from radar or topographic maps, is based on the modern topography of the landscape. The landscape has of course changed since the Byzantine period. This creates a situation where our representations of the topography of the landscape are modern estimates rather than true models. The outlines or ‘bones’ of the landscape remain the same below the surface despite the fact that the ‘skin’ may have been changed (Tilley 1994, 74; Llobera 2007, 54). But regardless of the period, the Faynan had a topography that included rocky mountainous regions and low lying floodplains. It did and will continue to provide a corridor between the Wadi ‘Arabah and the higher elevations of the Jordanian Plateau. Even though new paths in the wadi beds may have been eroded in the intervening years, they still have not greatly changed direction and are still flowing out into the Wadi ‘Arabah. Because these elements remain the same, the modern landscape contains enough information about the past that it can be used as a proxy, providing valuable insight into the past (Llobera 1996, 622).

4.7.2 NIMA SPOT

To better orient viewers of the maps produced using the GIS, a satellite image is used as a background. This image was produced by the National Imagery and Mapping Agency (NIMA) derived from SPOT satellites (Fig. 4.3). The Giff image is a 10m

resolution, black and white image that was ortho-rectified to correct for camera tilt. The map projection is WGS84 and is transferable into ArcMap without conversion. Although it is copyrighted it can be used under an unrestricted license. This image contains no topographical data but is useful in mapping the location of sites in the wadi system.

4.8 Conclusion

The creation of the database posed problems in design and content that had to be resolved to create a workable product. The most challenging of these were dating, site classification and ambiguity of data. These problems were best addressed by the creation of a new database flexible enough to incorporate the two surveys' data without repetition. This new database combined elements of the original surveys as well as new categories such as the rating system, which allows the database to include more ephemeral pieces of evidence. Despite the inclusive nature of the total database, the sites most used for the analyses in this thesis were those that were dated to the Classical period by, at the least, the presence of Roman/Byzantine pottery.

With the database complete, a GIS can be employed to study the landscape of the Faynan and the archaeology within it. However it should be stressed that a GIS is only as good as the data entered and this analysis required both a working database of sites as well as an understanding of the principals behind the GIS program. These GIS techniques and the new database will be put to use to examine the evidence for imperial industry and management in the landscape of the Roman and Byzantine Faynan. This exploration is the subject of the succeeding chapters.

Chapter 5 – The Faynan Landscape

5.1 Introduction

With the information from the surveys compiled into a database it is possible to study human occupation in the Faynan in detail during the Classical periods. Although the JHF and WFLS projects have laid out their respective surveys they were not combined until this project, and the overall patterns of habitation during the Roman and Byzantine periods have never been studied at the level of detail attempted here. Thus an important component of this chapter is to study the Faynan with the data from both surveys in order to understand better the habitation, industry and agriculture that occurred in the Roman and Byzantine Faynan. With the region defined, the behaviour of humans within it can be properly studied across this industrial landscape. Archaeological evidence for settlement during the Classical periods (63 BC-AD 640) can be found throughout the entire Faynan region, along all the major wadis. Although this thesis deals mainly with the region as a whole, the component pieces are described here separately for clarity.

5.2 Layout of Wadi System

Archaeologists have long noticed that the Levant has general patterns of human occupation based on the topography of the landscape. As discussed by MacDonald, certain areas are more likely to have a higher percentage of sites, and sites of a certain type (MacDonald 1992, 12-13). MacDonald identifies five general strata that are present

in his Southern Ghors and Northeast 'Arabah archaeological survey (SGNAS): cultivated land, dunes, colluviums, piedmont and wadi beds. The Faynan with its widely varying topography contains elements of all of these landforms within a relatively small region. The patterns of occupation noted by MacDonald generally hold true for the Fidan as well. Since part of his survey bordered along the Wadis al-Ghuwayb and Fidan, this similarity is not surprising (MacDonald 1992, 21).

Stratum 1- Cultivated land, farms, orchards and flat lands

This stratum includes all modern agricultural land (MacDonald 1992, 10). Since these types of lands are presently under cultivation, traces of archaeological remains are difficult to discern. Ploughing and terracing destroy most structures and crops obscure matters further. The number of sites found in this stratum is low; the rare sites that are identifiable are mostly artefact scatters. In the Faynan, stratum 1 comprises the modern fields outside of Quarayqira that spread all the way to the Jabal Hamrat Mountains. It is difficult to determine if these fields are built over archaeological remains. Portions of the ancient field system WF4 are also now being re-cultivated and cannot be surveyed intensively.

Stratum 2- Gravels and colluviums

Like Stratum 1, this land type is not characterised by a plentiful number of sites in the Faynan. Gravels are found at the bottom of the wadi beds and colluviums at the bases of mountains (MacDonald 1992, 10). Colluviums are deposits originating from the slopes that cover the former ground surfaces and make finding archaeological evidence by mere

survey very difficult. This stratum represents a small proportion of land in the Faynan and is associated with wash from flooding.

Stratum 3- Dunes and sandy areas

Stratum 3 is another zone with few finds; usually those that are present are artefact scatters. Like colluviums, sand deposits can obscure archaeological finds (MacDonald 1992, 10). In the Faynan sand dunes are present outside of the village of Quarayqira. The only finds in this area during the 2005 survey were sherd and flint scatters. The stratum, although largely site-less now, was not so in the past. Classical sites were found by the WFLS during their survey and further excavation would likely reveal more. The sand dunes are presently being reclaimed by the villagers for farm land; fields now come directly up to the dunes. This suggests that the size of the dunes is variable and subject to human intervention. Also in previous periods deforestation (see Chapter 6.3.2) was not as severe and this may have lessened the effects of erosion and the size of the dunes.

Stratum 4- Piedmont foothills

Stratum 4 is commonly found in the Faynan region. This zone includes the terraces above the wadis leading up to the mountains (MacDonald 1992, 11). A large proportion of sites are found here, principally large settlements, funerary sites and clearances. As the piedmont rises in elevation, becoming mountainous, the number of sites drops off.

Stratum 5-Wadi beds and their shelves

In the Faynan this stratum includes all the wadi beds and the terraces lining them.

This stratum has a high percentage of sites including ones related to agriculture, transhumance, defence, funerary or communication functions.

5.3 Overall Layout of Landscape

In the Faynan Stratum 4 and 5 are the most common land forms. It is here that the major settlements, funerary elements, fortified sites and metallurgical features are concentrated. The wadis of stratum 5 provide easy routes of travel, acting as narrow corridors between more mountainous regions. The terraces lining the wadis and piedmont foothills are more suited to habitation and it is perhaps not a surprise that sites are often found in these zones.

The transition between the piedmont and the higher elevations is sharp and the number of sites decreases dramatically at this point. The mountainous region that lines the open wadis is not suitable for most forms of human habitation or activity. Given the rocky, crumbling nature of the mountains, they are difficult to build on. The zone is more likely to be used for pasture, which is an important component of human life in the landscape, but ‘off site,’ without archaeological structures. Although lithics and sherd scatters can be present, this activity is harder to detect.

The pattern of habitation, clustering around wadis and being sparse at higher elevations, is so marked throughout the Levant that it is rarely commented upon (Wilkinson 2003, 42). Thus most projects design their surveys to focus intensively on surveying the lower elevations (Levy and Alon 1983, 107). This, it must be noted, is a circular argument. Expecting most sites to be near the wadi edges, surveys concentrate on

these areas. Sites away from this zone are likely to be less well represented in these surveys, thus furthering the impression of a settlement pattern centring on the wadis.

The one exception to this general pattern of fewer archaeological sites at higher elevations is mines and their support structures. These are placed regardless of geography and topography to best exploit the natural mineral deposits (Wilkinson 2003, 42). Both the JHF and WFLS survey teams performed systematic survey of higher elevations. This was in part because they decided that identifying mines was vital to the goal of understanding the industrial landscape. During the course of these investigations the supposition that the higher elevations are largely devoid of permanent structures was largely proven true; site frequency drops dramatically upon reaching the foothills and peters out quickly at higher altitudes.

The majority of sites in the Faynan are located clustering along the wadi banks and in the flatlands. In the Wadis Fidan, al-Jariya and al-Ghuwayb, 88 percent of sites are within 250m of the edges of the wadis. The rest are within 350m of the wadis. The main type of settlements in the Faynan is nucleated, surrounding the Khirbet and immediate structures, and linear, following the wadis (Fig. 5.1).

The basic land-types identified by MacDonald prove useful for understanding the Faynan; generally the strata correspond with patterns seen on the SGNAS survey, with the exception that mines are found at higher elevations. Although this thesis seeks to characterise the region as a whole, the component pieces must be studied in depth to better understand the patterns of habitation, industry and agriculture that occurred in the Roman and Byzantine Faynan. With the region defined and understood, the activities of

humans and their structures within it can be properly studied. In conjunction with this analysis, examining the data provided by micro-scale surveys and archaeological excavations in the region will further enhance the study. This holistic view, incorporating information from both surveys and other studies, can more fully illuminate the landscape and enable us to identify the changes and patterns that occurred in the region.

5.4 Routes in the Faynan

The Faynan was part of a wider Roman and Byzantine province and the routes and roads to and from the region were likely heavily travelled to supply the industry (see Chapter 6.3) (Fig. 5.2). Starting from the west there are three main routes out of the area. One is the Old Road that leads up to the Wadi al-Jariya, from here Arusa can be reached to the north. This is one of the connections between the Faynan-Fidan corridor and the Wadis al-Jariya and al-Ghuwayb. The other route leads out through the mouth of the Wadi Fidan to the Negev and Gaza (Fig. 6.9). Further out in the Judean province, portions of a road have been found linking to Mampsis; it is likely that this road connected up to the Faynan as well (Bienkowski 2006, 87). A route running south-west into the Wadi ‘Arabah towards ‘Aqaba exists as well, it originates near the field system and travels out below the southern end of the Jabal Hamrat Ifdan mountains. In the Wadi Faynan there are two routes for external travel to the east. One is up the Wadi Dana, a 14km route up to the plateau ending near the *Via Nova Trajana*. This road was built shortly after conquest and linked the cities of Bostra, Amman, Karak to the north and ‘Aqaba to the south. It was a pipeline for supplies and allowed rapid movement of the army. The final external route is up the Wadi Ghuwayr to Shobak. Now famous for the

crusader castle founded in the 12th century, it is unknown what sites existed in Shobak in the Classical periods; these may have included Roman sites.

Two internal routes exist as well, one runs north past the Wadi Ratiye and connects to the Wadi al-Ghuwayb system. The other is the 7km paved road that connects the mines at Umm al-Amad to the Khirbet (Barker *et al.* 2007, 310). This latter route may also have allowed access to the plateau if it continued above the Umm al-Amad mines, although this is presently uncertain. Through these routes, the Faynan was a region that was both internally and externally connected.

5.5 Wadi Faynan

The Wadi Faynan was the central area of habitation during the Classical periods and there are a plethora of sites related to all manner of activities; 383 out of the 532 sites in the database are located in the Wadi Faynan (Fig. 5.3). Some of these sites are complex enough to need to be discussed at length. The first of these is Khirbet Faynan.

5.5.1 Archaeology of Khirbet Faynan

The region's largest and most significant site during the Roman and Byzantine periods was Khirbet Faynan (Barker *et al.* 2007, 313) (Fig. 5.4). This settlement shows signs of occupation from the Bronze Age through to the Islamic period, reaching its zenith during the Roman and Byzantine periods when it was called *Phaeno* in ancient sources (Eusebius *MP* 7.2). It lies in the eastern end of the Wadi Faynan at the confluence of the Wadi Dana and Wadi Ghuwayr. This position lends itself easily to defence, with wadis to the sides of the main settlement and superior views of the valley. It also stands at

the entrance to the Wadi Dana and could control movement to and from the Jordanian Plateau. The Khirbet is sprawling, composed of three main sections that spread to cover both banks of the Wadi Ghuwayr. On the north side of the Wadi Ghuwayr is the central tell WF1, on the south side is the satellite community WF2 and to the south-west is the industrial area WF11 (Barker *et al.* 2007, 315-319, 511). Various aspects of these sites have been studied by researchers; the cemeteries by Knauf (1986) and Findlater *et al.* (1998), WF2 by Freeman and McEwan (1998), and mapping of WF1 by Barnes *et al.* (1995), Ruben *et al.* (1997).

Khirbet Faynan proper, WF1, has never been excavated, but the substantial ruins and its size (70,000m²), attest to its importance (Ruben *et al.* 1997, 436). It has multiple layers of occupation forming a sizable mound of cultural material. Collected pottery sherds indicate the site was in use during the Bronze and Iron Age, as well as the Nabataean, Roman, Byzantine and Islamic periods. The surface is covered with a jumble of sandstone blocks that obscure the structures underneath. Fortunately the visible remains largely date to the Byzantine Period and lend themselves readily to answering the questions of this study. *Phaeno* was not an architecturally developed town, boasting few of the classic Greco-Roman settlement features (Kind *et al.* 2005, 169). The large structures it did have were administrative, religious and military in nature.

The north-western slopes of WF1 are gentler and thus more favourable to construction. A church was built there as well as a structure that has been tentatively identified as a monastery (Fig. 5.4). A Greek inscription found here dated the monastery to AD 580 (Sartre 1993, 145-146). The largest cemetery on this bank of the wadi, the 'west cemetery,' has approximately 300 burials grouped around the 'monastery.'

Christian elements are visible and some graves are marked with headstones with carved crosses. Also present is a multi-storey building of well-dressed stone, still standing many courses high, which can be identified as a tower by its construction (Ruben *et al.* 1997, 438). A building occupies the top of the tell, a substantial structure of unknown purpose (Ruben *et al.* 1997, 447). Various suggestions based on its complex layout have included a military fort or a central administrative site (Kind *et al.* 2005, 191; Barker *et al.* 2007, 315). Smaller domestic and mercantile structures are located on the steeper slopes to the east and south (Ruben *et al.* 1997, 439). One of these is a stone-built pottery kiln located on the outskirts. The jumbles of wall lines have set 'lanes' separating sides, showing regulation and zoning of the community. Also located on these slopes are another two churches and a graveyard of approximately 100 burials.

To the north of the Khirbet is the barrage WF441 (Fig. 5.5). This massive dam, 65m in length, blocks a minor drainage between the Khirbet and Wadi Dana. It could impound an estimated 5,000m³ worth of water (Barker *et al.* 2007, 127). The double faced dam wall is a substantial construction and a curiously over-engineered feature. As it was only collecting the water from a minor drainage, the strength of this wall is not necessary to withstand powerful winter floods. As discussed in Chapter 2.5.3, chemical analysis of the sediment layers reveals extremely high levels of heavy metals and toxins (Barker *et al.* 2007, 163). A sluice is present, perhaps to act as an outlet for water after industrial processing (Barker *et al.* 2007, 164). The area around the barrage is covered with industrial waste from metal processing. All of these findings combine to strongly support the conclusion that the barrage and the surrounding area was a site of industry.

To the south-east of the Khirbet is WF2, surveyed by Freeman *et al.* (1998). This

area functioned as a satellite community to the central Khirbet (Fig. 5.6). The area has several terraces that unfortunately were bulldozed, but was described in 1995 as having many walls and structures relating to the Roman/Byzantine periods (Findlater *et al.* 1998, 82). It is most notable for the second large cemetery, given the separate designation of WF3 (Fig. 5.7). The population of the cemetery is an estimated 1,500 to 2,000 individuals of varying ages and both sexes (Findlater *et al.* 1998, 69). The cemetery dates mainly to the 4th thru 7th centuries (Findlater *et al.* 1998, 82; Barker *et al.* 2007, 343). It covers an area of 36,000m² and its layout is organised and regulated. A number of headstones bear inscribed crosses and some have inscriptions. A photogrammetric map created prior to 1994 recorded the remains of a large building to the north of WF2, likely a church; however, any remains have subsequently been destroyed by the bulldozers (Freeman and McEwan 1998, 67). Numerous structures, some domestic in nature, were located to the north of the cemetery.

The most concentrated industrial site of the Roman and Byzantine periods (WF11) is located to the south of the central tell (Fig. 5.6). It was the area of greatest metallurgical activity in the Roman and Byzantine periods (Barker *et al.* 2007, 124). Large slag mounds and furnace elements indicate that this was an active area of smelting (see Chapter 2.5.2). Radiocarbon dating of charcoal samples from these waste piles provides calibrated dates of 171 BC-AD 68, 194 BC- AD 209, AD 85-313, AD 89-317, AD 92-339, AD 128-330 and AD 127-375 (Appendix 4).

Also present on this bank are a water mill, aqueduct and reservoir (Fig. 5.8). The aqueduct originates at the Wadi Ghuwayr spring and travels several kilometres to WF11. Its length is composed of channels carved into the sides of the wadi and a freestanding

bridge over the Wadi Shaygar (Ruben *et al.* 1997, 445; Barker *et al.* 2007, 124). Though remains of the bridge have largely washed away, in some places the arches still stand 3m in height. Upon reaching the settlement, this aqueduct may have had a small branch to provide potable water to the community. However, the larger portion of the water emptied into a reservoir (31x22m and 4m in depth). The continuation of a spur of the aqueduct beyond the reservoir powered a penstock mill. Interpretations of the purpose of this mill are discussed further in Chapter 6.6.

This collective evidence indicates that a large population inhabited the Khirbet from the Nabataean period to the 7th century. The settlement was a location of religious and industrial importance as well as a centre of habitation. The evidence for at least five churches and multiple Christian cemeteries corroborates the historical sources that record *Phaeno* as a religious centre during the Byzantine period (Kind *et al.* 2005, 188). However the industrial complex of WF11 indicates that individuals in the Khirbet were also involved in copper production. The central structure WF1 could have been military in nature and likely functioned as the main administrative building for the industry. With Khirbet Faynan and its accompanying structures identified as the principal settlement in the region, we turn our attention to the surrounding landscape to better understand it and its relationship to the Khirbet.

5.5.2 Field System

Another significant site of the Faynan region is the field system, WF4, lying directly to the west of Khirbet Faynan (Fig. 3.2). The Wadi Faynan is relatively unique, with the largest floodplain of any wadi leading into the 'Arabah south of the Dead Sea

(Newson 2002, 155). Composed of c. 800 individual fields, it provided 209ha of arable land and extended 4km, an important resource for populations inhabiting the Faynan (Barker *et al.* 2007, 141-174).

During the Roman and Byzantine periods the floodplain had a complex and highly sophisticated irrigation system. While there were higher levels of precipitation in the Roman and Early Byzantine period than in the present day, rainfall was never plentiful enough to irrigate the fields directly (see Chapter 2.2). WF4 was farmed by using floodwater irrigation; rainwater was controlled by a series of walls and terraced units, redirecting water to maximum effect and distributing it over fields. This finding is contrary to the opinion of Hauptmann, who suggested that the aqueduct system was used for irrigation of the fields (2007, 48-49). As evidence he mentions that the major channel of the Wadi Faynan is particularly difficult to tap as a water source, because it has carved a path *lower* than the fields. The detailed examination of the field system and WF11 by the WFLS found no evidence to support the suggestion of spring-fed aqueduct irrigation (for details on how the fields functioned, see Newson 2002). Instead the construction of the “check dams” within the field walls and the channel system support the theory that water diverted from minor wadi streams was redirected and utilised for the fields (Barker *et al.* 2007, 142).

The field system is not uniform; portions of the fields are more suited to certain types of agriculture than others due to topology and soil types (Fig. 5.9). The northern fields with their relatively flat ground and soil likely contained cereal crops. These were watered with channel irrigation. The southern fields are rockier and more sloped than their northern counterparts (Barker *et al.* 2007, 153). These fields are terraced and

irrigated with run-off from the northern fields and localised water collection.

Estimations of the efficacy of this irrigation technique were explored by Evenari, Shanan and Tadmor (1982). They tested experimental reconstructions using run-off technology in the Negev Desert, Israel and these yielded substantial crops. Two experimental farms, Avdat and Shivta, were built and irrigated solely by runoff catchments. The farms were run over a number of years and successfully produced cereal and pasture crops as well as supporting orchards and vineyards (Evenari *et al.* 1982, 213). The ability of this type of agriculture to withstand the effect of drought was quickly established, as the Negev experienced one of the worst droughts in modern history during the trials (Evenari *et al.* 1982, 191). Utilising these sophisticated flood-water irrigation techniques, the WF4 field system was the greatest source of local food in the Faynan region during the Roman and Byzantine periods (for further discussion of flood-water farming see Barker *et al.* 1996, 192).

5.5.3 Other Sites of the Faynan

Moving further away from the Khirbet, the Wadi Faynan has many smaller sites located on the flat shelf of the wadi and floodplain itself (Fig. 5.3). The southern shelf is flatter than the northern one and has more open space before the rugged mountains encroach. Settlements, hamlets and graves all attest to the size of the Classical era population in the Wadi Faynan, and these are scattered throughout this shelf and nestle right up against the mountains.

The northern shelf possesses fewer settlements. Agricultural fields are found on the north bank of the wadi although they are a great deal smaller than WF4. They are also

in a less ideal location; the ground here is rocky and difficult to plough.

Funerary structures, graves and cemeteries are found above the flood plain, which is not surprising given the violence of the winter floods that would certainly wash any human remains away. Secure, they line the edges of the wadi beds, although some, such as WF867 and WF870, are found further back towards the mountains (Fig. 5.10) (Barker *et al.* 2007, 648-649). A cluster of funerary sites is found along a hilly outcrop to the south of the WF4 field system. The proximity to WF4 might suggest that some cairns may be field clearances. Though many of the funerary sites contain cairns, these are not the only grave type found. Graves are found with headstones or kerbs, making clearance an unlikely reason for the concentration of funerary sites near WF4. Another clustering is located to the north-east of the Khirbet.

Two fortified structures are located outside the Khirbet (Fig. 5.10). The first, WF1246, is a fortified building 15x15m. The amount of rubble suggests that it had multiple floors or perhaps a tower (Barker *et al.* 2007, 690). The building is located just south of WF11 and may be a structure related to the nearby copper smelting. Another fortified structure is WF592, a fort located 3km from the Khirbet on the rise of a hill (Fig. 5.11). There are three levels to the site. The summit has an oval platform (20x10m), and substantial walls. Two towers (6.5x6.5m and 2.5x2.5m) are below the summit to the south. The east level has multiple structures. The west had a stairway leading up to the site and a natural cave, which may have acted as a guard house (Barker *et al.* 2007, 606). WF592 dates to the Nabataean period although it may have been reused in Roman/Byzantine times.

There is a group of settlements and hamlets located near the mountains to the south (WF1001, WF1004, WF1009, and WF1282). Situated where the mountains' elevation begins, these settlements are near the road to the mines at Umm al-Amad. From here the travel distance to the mines is lessened from 7km to 4km; these may have been workers' villages placed to diminish travel times (Fig. 5.12). The sites have high quality door lintels and one site even has pieces of white marble (Barker *et al.* 2007, 325). They are not placed near arable land yet multiple quernstone fragments were found. This suggests that the sites were receiving grain, and given the quality of some of the structural elements and rotary stones, were connected closely with the administration (Fig. 5.13). Another theory is that the quernstones were used for initial processing of the ore before it was taken to the Khirbet.

The complexity and diversity of the types of sites clearly indicates that the Faynan was the centre of Classical era settlement. Although habitation was widespread, covering large portions of the wadi shelves, it is also clear that multiple economies were present including agriculture and industry.

5.6 The 'Gap' Area

Human use of the Gap area during the Classical periods is more difficult to understand, as the amount of the evidence for it is considerably less than that in the surrounding landscape. However, as stated in Chapter 3, a general idea of the region can be formed. The east bank, the focus of the author's survey, was not a site of large-scale settlement; no administrative buildings or extensive metallurgical sites were found. Some limited agriculture may have been taking place, but this may not have been Classical, as

the dating of the fields is uncertain. The west bank of the Gap area is more complex as it is the site of the modern village of Quarayqira. Any archaeological remains are covered by housing, fields and pavement. It is possible that the west wadi shelf may have had a similarly dense settlement in the past. This is speculation based on its geology, as it is a stratum 4 formation where settlements are commonly found (MacDonald 1992, 11). As noted above, in the Faynan this land type is typically the location of major settlements, funerary elements, and metallurgical features. John Grattan has studied the Faynan using radar imagery and identified a linear feature located below the fields (Grattan pers. com.). Its interpretation is tentative; it may be a large hydraulic channel or the wall of a public or official structure, but its construction is substantial.

Below Quarayqira, the area at the edge of the sand dunes was included in the WFLS survey. Several sites were located at the edge of the dunes and within them both lithics and pottery can be found (WF474, WF476, WF478) (Barker *et al.* 2007, 325). This suggests that the size of the sandbank has varied over time, or perhaps is of relatively recent origin, and may now be covering ancient sites. The route south towards 'Aqaba goes by here in order to pass below the Jabal Hamrat Ifdan (Fig. 5.14). Other routes in the Faynan, such as the road to Umm al-Amad, have settlements placed along them. It is possible that similar settlements or travel facilities existed here to service this route (Barker *et al.* 2007, 325). If this were the case, then excavation of the sand dunes may reveal a number of sites.

Site 6, the other structure of interest identified in the author's survey, may fit this interpretation in two ways. If it were a grave of a high status individual, it might have been placed opposite a frequently travelled route in order to be seen often. However it is

presently difficult to see the site from ground level and the placement of a lone grave away from the centre of Classical habitation is atypical (see Chapter 3.10). Another interpretation is that Site 6 was a surveillance platform that overlooked the route to the south (see Chapter 7.5.3). In general, the Gap survey indicated an area of lesser importance during Classical habitation. Unlike the Wadi Fidan, it was not an area of dense settlement for any period.

5.7 Wadi Fidan

The Wadi Fidan has multiple settlements that show signs of long-term habitation, from the Early Bronze Age to Byzantine periods; over 60 sites relating to the Classical periods are found here (Fig. 5.15). The Wadi Fidan is often referred to as “the gateway into the Faynan” due to the natural opening this wadi provides to the region, making it easily passable for human travellers (Levy *et al.* 2003, 248). This wadi functioned as the link between the major settlement in the Wadi Faynan and the road leading to Gaza and the Mediterranean. It was also the opening to the Fidan-Dana corridor that connected the lower elevations with the Jordanian Plateau, and an important route of west-east travel (Levy *et al.* 2003, 248) (Fig. 5.16).

Two large settlements dating to the Roman and Byzantine periods are located within this wadi, Fidan 50 and Fidan 120. First is Fidan 50, located directly at the wadi’s mouth (Fig. 5.17). This site has walls over 100m in length and had multiple structures, including a rectilinear group in the centre, along with a concentration of Classical pottery. Khirbet Hamrat Fidan (Fidan 120) also had a large building with an inner courtyard and substantial outer walls. A series of side rooms are attached (Levy *et al.* 2001a, 166) (Fig.

5.18). At Fidan 120 multiple structures relate to copper smelting, but there are no artefacts pertaining to Classical period metallurgy. The large amounts of slag date to the Early Bronze Age (Levy *et al.* 2001a, Levy *et al.* 2001b; Levy *et al.* 2002). There is evidence of sizable structures and although Fidan 120 was a settlement during the classical period, it was not of sufficient size to be listed under the 'Khirbet' site type in the database.

A notable difference between this wadi and the rest of the Faynan is the number of watchtowers and fortified sites (Fig. 5.16). Six in total line the wadi, their fortified walls and positioning suggest that they were military in construction (See Chapter 7.4). Starting at the mouth of the wadi, Fidan 50a was located near the large settlement of Fidan 50 (Levy *et al.* forthcoming a; Levy *et al.* forthcoming c). This site had a well and structural collapse indicating a multi-story watchtower (Anderson *et al.* 2004b).

Fidan 77a and 77b are a tower and a rectilinear structure respectively (Levy *et al.* 2001a, 175; Levy *et al.* forthcoming a). This site was originally Iron Age but has evidence to suggest it was reused in the Roman period (Levy *et al.* 2001a, 175; Levy *et al.* forthcoming a). Nearby Site 97 is a building with interior rooms and thick walls suggesting a fortification (Levy *et al.* 2001a, 175; Levy *et al.* forthcoming a). Finally, at the end of the Wadi Fidan are a possible watchtower Fidan 617, and Fidan 619 that has structures partially obscured by slope collapse. These two buildings use a similar construction technique of chinked stones in between courses (Levy *et al.* forthcoming c).

As in the Faynan, the habitations tend to be on the south side of the wadi and agriculture occurs on the north bank (Fig. 5.16). Five settlements and 6 hamlets are found

spaced throughout the wadi. Further south is a group of sites around the settlement Fidan 606 (Levy *et al.* forthcoming c). The spring 'Ain Fidan is located nearby and proximity to water may help explain the clustering. Another factor could be that the Jabal Hamrat Mountains end here and open out onto a relatively flat wadi shelf. These sites are located at the bottom and to the east of these mountains; perhaps they provided protection from the elements (See Chapter 3.10).

Agriculture was practiced at the mouth of the Wadi Fidan in five locations (Fig. 5.16). These fields, though smaller in scale than WF4, were nevertheless productive. Fidan 23, for example has walls 80m in length (Levy *et al.* forthcoming a). Fidan 83, a smaller-sized unit found further south, was likely a garden or *bustan*. These agricultural sites would have helped supplement the foodstuff needs of the local population and the larger region. Located on rocky soil, these smaller fields would have been better suited to olive growing. Furthering this theory, an olive press was found at site Fidan 606 (Levy *et al.* forthcoming c).

Funerary sites are found here, three cemeteries and four funerary structures with the largest cemetery of the Fidan region, Fidan 621, having over 70 recorded burials (Levy *et al.* forthcoming c). Metallurgical sites are located in the Fidan; however none of these are large-scale industrial sites like WF11. These sites are unexpected, given the overwhelming concentration of smelting in the Faynan, however there is convincing evidence. For example Fidan 631 has glass slag typical of Byzantine smelting techniques and Roman/Byzantine pottery (Levy *et al.* forthcoming c), while Fidan 614 has slag mounds with Roman and Nabataean pottery (Fig. 5.16). These smaller industrial sites will be discussed in detail in Chapter 6.5 and 7.6.

Two collapsed stone ‘domestic structures complex’ (DSC), Fidan 623 and 622, are also found here but their features and purpose are not identifiable from the surface remains (Levy *et al.* forthcoming c). Their layout is similar in form to other sites such as the mounds that accompany Fidan 619. These may be domestic or further fortified sites, but without excavation it is not possible to tell. Another site of interest is Fidan 112, a rectangular building of cut stone measuring 22x8m, with a plastered floor and two circular installations in the centre (Fig. 5.16). It is surrounded on three sides by cairn fields. This site is not related to any other structures and it is 600m away from Fidan 120. These elements suggest a ritualistic function to the site, possibly a mortuary cult (Levy *et al.* 2001a, 175; Levy *et al.* forthcoming a).

Although the Wadi Fidan was not the focal point of settlement like the Faynan, it was a heavily utilised area. Multiple activities took place here during the Roman and Byzantine periods. It had a substantial population that practiced farming and perhaps metallurgy (Appendix 5). This Wadi also served as the entrance from the Wadi ‘Arabah; an important part of the corridor that led up to the plateau.

5.8 Introduction to Other Wadis and Mining Zones

The Faynan-Fidan corridor was the main centre of habitation in the wadi, however the *raison d’être* of the region was the copper ore found in the surrounding mountains. The tributary and neighbouring wadis provide access to this mineralization belt and therefore are of as great importance to our understanding of the region as the main wadi system. Starting from the east, the Wadi Dana served as a connection to the plateau and was the location of a few mines (Fig. 2.3). Further west the Wadi Ratiye is a

tributary to the Faynan from the north and enters above WF4; Wadi al-Abiad and Wadi Khalid are branches of it. These were heavily utilised extraction areas. A path through these wadis connected to the al-Jariya and al-Ghuwayb. These wadis show evidence of being worked prior to the Roman period, especially the al-Jariya and al-Ghuwayb corridor, which was the centre of a thriving Iron Age industry (Levy *et al.* 2003; Hauptmann 2007, 127-132). Finally, the Umm al-Amad mines are not located off a wadi, tributary or otherwise, but are connected to Khirbet Faynan by a road (Fig. 5.2). Their heavy utilisation in the Roman and Byzantine periods make them part of this industrial landscape (see below for discussion of regions individually).

Any discussion of the mining regions requires an understanding of ore types. The copper mines of the Faynan have two types of copper ore, carbonate and sulphide beds. Carbonate ores are found nearer the surface in the Dolomite Limestone Shale layer (DSL) and are easier to access. They are simple to smelt because they already contain the magnesium fluxes necessary, no additional mineral additives are required. They yield a higher content of copper, usually around 1.4% percent (Hauptmann 2007, 71). Iron Age and Bronze Age mining extensively exploited the carbonate ores; concentrating on mines found in the Wadi Khalid, Wadi al-Jariya, Wadi al-Ghuwayb and Wadi Dana. It has been argued that by the Roman period these manganese loads had been largely exhausted (Hauptmann 2007, 146). Extraction in the Classical period therefore concentrated on the sulphide ores found in the Massive Brown Sandstone layer (MBS). These contain a smaller percentage of copper than the carbonate ore (Hauptmann 2007, 66). Mines with MBS layers included the Umm al-Amad, Wadis Ratiye and Abiad, as well as parts of the Wadi Khalid. The pollution signature characteristic of Roman Byzantine smelting

indicates that mostly the MBS ore beds were being exploited (Barker *et al.* 2007, 312). The DBM has posited that the placement of the Roman/Byzantine mines was of necessity concentrated on areas that still had productive ore bodies, regardless of the type of ore or the relative difficulty in reaching it. However to this day there are still areas with plentiful DLS copper resources, such as the Wadi Khalid. Rather, it may be that the MBS sandstone was more conducive to the style of Roman mining and the creation of galleys, rather than the audits used in the Iron Ages (Grattan pers. com.).

Hauptmann estimates that 120 mines were open while the Faynan region was functioning as an imperial *metallum* (2007, 155). This may be an underestimate as it is often difficult to determine the extent of workings beyond the entrances and their respective dates (Barker *et al.* 2007, 311). Included in the current database were the mines that had evidence of Roman Byzantine usage and those that had structures located nearby suggesting extraction was practiced during that period. Figure 5.19 shows all the mines in the Faynan region with geospatial coordinates recorded by various surveys.

As previously stated, WF11 was the main Roman/Byzantine smelting site for the entire region. The transport of ore to Khirbet Faynan indicates continuous contact between the mines and the central area. It is very unlikely that these regions were operating independently; instead they were part of a larger industrial landscape.

5.9 Wadi Dana

Although mines were important they were not the sole reason for Roman and Byzantine habitation in tributary wadis. The Wadi Dana was the eastern end of the

corridor that connects the Wadi ‘Arabah to the Jordanian Plateau and the *Via Nova* (Fig. 5.20). This wadi has a gentle ascent to the higher elevations. Only the lower parts of this wadi were surveyed by the WFLS, but even so, relatively few Classical period sites were found.

Nine mines are found along this wadi including 4 with pottery from the Late Byzantine period. Other structures are similarly sparse in this wadi. One of note, WF1432, is a complex domestic structure of dressed stone blocks. This site may have been a building related to the mining, functioning in an administrative capacity (Barker *et al.* 2007, 716). Two hamlets, WF60 and WF1431 are located here; these are over a kilometre away from the closest mine and their use as a miners’ community is probable but not certain (Barker *et al.* 2007, 716). In the present day there are many terraced gardens along this wadi, mainly composed of orchards and vegetable plots (Lancaster and Lancaster 1999, 153). The past usage of the wadi may have been similar and this could have been an additional source of food for the region.

5.10 Wadi Ratiye

The Wadi Ratiye is a tributary of the Wadi Faynan located c. 3km north-east from Khirbet Faynan. Small and relatively narrow, it is similar to the Wadi Fidan, cutting into the surrounding mountains. Located up this wadi are the remains of a very large building and a number of surrounding settlements, close to an extensive suite of mining features (Fig. 5.21).

The main complex, known as Khirbet Ratiye (WF1415) is a high status site. A

wall of cut stone surrounds the building, measuring 42x25m, with two possible entrances on the north and south walls (Fig. 5.22) (Barker *et al.* 2007, 319). On the east side of the wall facing the mines there is evidence for two towers. At the core of the fortified complex is a further substantial building; a tall structure, multi-storied, with plastered walls on the ground floor. A reservoir is located in the north-west corner of the site, fed by an aqueduct. Other internal structures are hard to discern as rubble from the walls and structures covers the site. Finds include glass and hypocaust/flue tiles suggesting a heated structure or bath (Barker *et al.* 2007, 321).

Satellite communities surround this main site, such as WF1446 to the south, a grouping of 14 one room structures. Similarly, WF1518 to the north has boulder constructed rectangular structures of a slightly more complicated nature, containing up to three rooms (Barker *et al.* 2007, 730). Two hamlets are located to the east of the main site, WF1516 and WF1515. A coin of the late 4th to early 5th century was found at WF1516.

A small field system, WF1519, with three terraces is found near these hamlets along the wadi edge (Fig. 5.21) (Barker *et al.* 2007, 730). Although WF1519 may have provided an important supplement to the diet of the inhabitants, it would not have been able to feed the entire community. Instead, all the sites in this wadi would have been dependent on supplies coming from outside sources such as WF4.

A significant point to note about these sites is that directly east from the settlement is a dead end side valley known as the Qalb Ratiye, where 55 mines were found, all within a small area (Hauptmann 2007, 114) (Fig. 5.24). Nearly all of these

were opened and worked in the Roman period (Hauptmann 1986, 416). The settlements and hamlets located in this wadi were likely housing for miners (Barker and Mattingly 2007, 112).

The high status buildings and finds suggest the presence of administrative officials located here to oversee the ore extraction (see Chapter 7.7.1). Likely the WF1415 structure was the mining administrative site for this wadi and Wadi Abiad to the north, where the bulk of Roman and Byzantine mines were located (Barker *et al.* 2007, 311).

5.11 Wadi Abiad

In the Wadi al-Abiad, 10 mines dating to the Roman period have been found in the northern slopes close to the mountains (Hauptmann 2007, 115). This wadi acts as a connection between the upper Wadi Khalid and Wadi Ratiye (Fig. 5.25). The shafts are of a room and pillar variety where miners leave pillars of stone to support the roof when excavating. Large waste piles and tailings indicate extensive mining activity occurred during the Classical period. The extraction was located in the MBS ore on the slopes of the mountains. Other structures related to the regulation of mining or the workers' housing are not yet identified.

5.12 Wadi Khalid

A total of 56 mines are located in this wadi, however this is an area of DLS ore, rarely exploited in the Roman Period (Hauptmann 2007, 116) (Fig. 5.25). Yet there was some Classical period extraction (Hauptmann 2007, 116). Of notable interest is mine

WF1422, a prospection shaft that was dug to explore an Iron Age mine (Hauptmann 2007, 121). Outside of this mine, pottery finds indicate Roman presence but the most interesting find is a Vespasianic coin (69-79 AD), a pre-conquest date (Kind *et al.* 2005, 192) (Fig. 5.26). Its presence raises two possibilities; the first is (limited) Nabataean or Early Roman exploitation of DLS ores (Barker *et al.* 2007, 311). The second is that the region was assessed pre-conquest by the Romans. If this were the case, it would indicate that someone had extensive knowledge of the potential of the Faynan mines, and support the hypothesis that upon conquest in AD 106, the Faynan was immediately appropriated by the imperial State (see Chapter 2.4.2).

Other mines located in this wadi have evidence of Roman masonry near their openings. Hauptmann believes that this wadi was not intensively exploited by the Romans; he posits that because it was a DLS mineralization, it was largely depleted by Iron Age workers. This could very well be the case. Still, there may be more evidence for Roman involvement present in the filled mines; the one excavated by Weisgerber was opened in the Bronze Age, but inside had Roman workings (Hauptmann 2007, 116-119). With further research it may prove that the Wadi Khalid was used more heavily in the Classical periods than previously suspected.

5.13 Umm al-Amad

The final mining district is Umm al-Amad, located 6km to the south of Khirbet Faynan. Four mines are found here at 700-800m above sea level (Fig. 5.2). This area lies outside the WFLS or JHF survey zones; however Glueck (1935, 89), Hauptmann (2007, 144), Meshel (2006), and Grattan *et al.* (2004) have conducted studies of the mines.

Umm al-Amad means ‘the mother of the pillars,’ a reference to the largest mine in which sixty nine pillars support the chamber roof (Meshel 2006, 230; Grattan *et al.* 2004, 101). This mine also has one of the best preserved mine entrances and galleries in the Roman Empire. It measures 120x55m from the entrance to the working face (Hauptmann 2007, 144). These mines were connected to the Khirbet by a road that ran along the mountain pass. Even with the road it is still difficult to reach the region due to the steep incline (Grattan *et al.* 2004, 106). The majority of the finds in the area, mainly coins and pottery, date to the Roman and Early Byzantine periods. Indications are that Umm al-Amad was a heavily exploited area and the ore produced here was brought to the WF11 site for processing and smelting. Meshel has suggested that the low yield ore (0.08 percent copper) is not high enough to warrant the construction of both the mine and the road (2006, 231). He believes that these may have been gold mines, based on the reference in Eusebius’ Onomasticon (115) to “...gold mines found beside the mines of Phaeno.” Traces of gold have been found 40km to the south at Wadi Abu Kushaybah and a mine there (designated U.e.A 3) is very similar in form to Umm al-Amad. However, he admits that the mineralogical evidence for gold in Faynan is scarce, and that copper ore was found at all three mines (Meshel 2006, 237). I believe, as do Hauptmann (2007) and Weisgerber (2006) that these were principally copper mines.

5.14 Wadis al-Ghuwayb and al-Jariya

Finally, the Wadis al-Ghuwayb and al-Jariya are included in this study although they are not tributaries of the main wadi system (Fig. 5.27). The Wadi al-Ghuwayb starts with wider wadi beds before becoming narrower as it travels east. Branching off of al-

Ghuwayb and running north-south is the Wadi al-Jariya, which also has a slender opening and at certain points is as narrow as a few metres wide. These wadis are accessible from the Faynan; a walk from WF1 to Khirbet an-Nahas takes about 2 hours but does include a steep slope (Mattingly pers. comm.). Another passable route lies near the mouth of the Fidan; it is still in use today and often referred to as the Old Road. Evidence that it was used in antiquity includes site WAG 3, a hamlet, and a pottery find, WAG 1. Along this road are scatters of Byzantine pottery (MacDonald 1992, 255).

Unlike the Wadi Faynan-Fidan corridor, these wadis have no connection with the Jordanian Plateau and were not used as a route for east-west travel. The most important resources found in these wadis are a perennial spring at the end of the Wadi al-Ghuwayb and access to the copper deposits in the surrounding mountains.

The JHF project was not able to survey the entirety of both Wadis al-Jariya and al-Ghuwayb due to time constraints. Another survey, McDonald's SGNAS (1992), documented sites along the wadi system using sampling strategies; the entire region was not covered (MacDonald 1992, 12). Although the full extents of the wadis were not surveyed either by SGNAS or JHF, the work done so far is certainly enough to form some conclusions. Further studies will no doubt increase our understanding of Classical period occupation in these Wadis.

Three major sites are found here dating to the Iron Age, Khirbet al-Jariya, Khirbet al-Ghuwayb and Khirbet an-Nahas, excavated by Levy *et al.* (2003; 2004a). The survey evidence shows that although some activities continued on these sites during the Roman and Byzantine periods, they were most definitely operating at a reduced scale from that

of the Iron Age (JADIS 1901002, 1901005, 1901001). As this was an area with mostly DLS mineralization, this is to be expected.

The only Roman settlement recorded so far is WAG 48, comprised mostly of various stone structures made from uncut shale or granite (Fig. 5.27). Seven stone circles, wall lines and stone settings are found as well as slag and some copper ore (Levy *et al.* 2003, 252; Levy *et al.* forthcoming b). There are 2 hamlets in the southern end of the Wadi al-Jariya, 511 and 512, numbering 5-7 stone structures each, as well as a small cemetery that has burials of multiple styles (Levy *et al.* 2003, 255; Levy *et al.* forthcoming b). Further north up the Wadi al-Jariya is another small hamlet, WAJ 512, near a metallurgical site WAJ 511. The rest of the sites are related to transhumance or shorter-term occupation with small cemeteries, enclosures, and campsites.

One mine of notable importance is WAJ 551 (Fig. 5.27). WAJ 551 was one of the few mines with copper magnesium ore deposits exploited in the Classical periods and there are Roman/Byzantine pottery sherds in association with it (Levy *et al.* 2003, 258; Levy *et al.* forthcoming b). The other mine along these wadis that shows evidence of Classical extraction is WAG 57, dated by pottery to the Nabataean/Roman periods. This mine is comprised of 11 shafts, tailings and some furnace elements. Near the mine is an ore dressing site suggesting that the initial ore processing took place here before transport (Levy *et al.* forthcoming b). Mines near Khirbet an-Nahas also show signs of Roman/Byzantine activity (JADIS 1901002). Finally near Khirbet al-Jariya, WAJ 540, are mines datable by pottery to the Roman-Byzantine period and it is likely that the site was used in conjunction with this local mine (Hauptmann 2007, 132).

There is some evidence to suggest Classical period smelting was practiced in these wadis but certainly not on the scale of WF11 (JADIS 1901002). WAG 57 was not only a mine and ore processing site, but also the scene for some smelting; slag and a furnace were found (Levy *et al.* forthcoming b). Another example is hamlet WAJ 511 datable to this period by pottery (Fig. 5.27). However further analysis of the typology of the slag is necessary to confirm Classical period smelting (Levy *et al.* 2003, 255; Levy *et al.* forthcoming b).

The picture gained from the survey evidence is of an area that was occupied but not as heavily used as the Faynan or Fidan during the Classical periods. Given the previous occupation and importance of this region, one might have expected more Roman presence; however the main focus of habitation and mining was now centred further south. Although settlement here was not a priority, there is evidence for it and it can be suggested that further study would reveal more Roman sites.

5.15 Summary

The Wadi Faynan was the centre of Roman and Byzantine settlement. It is here that the Khirbet Faynan, the central tell, and the field system WF4, are found. Surrounding these are numerous sites relating to multiple activities: habitation, agriculture, metallurgy and cultural/ funeral elements. WF11 served as the smelting site for the entire region. This was the clear centre of Classical habitation with no areas that rival its significance in terms of administrative or cultural importance.

The Wadi Fidan was the exit leading out into the Wadi ‘Arabah and the

Mediterranean (Levy *et al.* 2001a, 159). Sites along this wadi served multiple purposes, one important ones being defence. Other sites were the locations of activities similar to those that were taking place in the Faynan although at a much reduced scale; farming and metallurgy being the prime two examples. Wadi Khalid, Wadi Ratiye and Wadi Abiad were heavily utilised mining zones. WF1415 operated as the administrative hub for the extraction industry for these three wadis. Umm al-Amad was an area of several mines located to the south of the surveyed areas. Finally, current evidence indicates that mining activity was re-established in the Wadis al-Jariya and al-Ghuwayb at some point during the Roman period. This area was never as heavily inhabited as the other wadis and this suggests it was of lesser overall importance than the Fidan or Faynan. The Gap area, while it needs further investigation, does not have any evidence for significant metallurgical or administrative sites.

5.16 Distribution of Archaeological Sites

Now, with the general outline of the Faynan landscape established, overall trends can be identified by examining sites by their period of occupation and determining what type of sites were active.

5.16.1 Industrial Sites

What becomes rapidly apparent is that the region was heavily involved in copper production. A total of 183 metallurgical features or mining features are seen. Even sites without an obvious extraction or metallurgical purpose have links to these activities (Fig. 5.28). A further 10 settlements or hamlets can be postulated as miner's housing, given

their proximity to extraction (Fig. 5.29).

Table 5.1 The number of sites in each site type category.

Site Type	
Agricultural	32
Aqueduct	1
Artefact Site	29
Cairn	19
Campsite	16
Cemetery	46
Church	1
DS	56
DSC	28
Enclosure	25
Fortified Structure	9
Funerary structures	77
Grave	20
Hamlet	29
Khirbet (Town)	1
Metallurgical Features	28
Mining Features	156
Reservoir	2
Rock Shelter	8
Settlement	23
Stone Settings	42
Wall Line	17
Water Mill	1
Grand Total	665

Many of the 154 mines in the database have no associated pottery sherds or cultural material. Further confusing matters, the mines were often re-worked, making them difficult to date by extraction techniques. For the 15 mines that do have such evidence, a range of periods is shown (Table 5.2).

Table 5.2 Mining Features and the pottery associated with them.

SITE	NAB	NABR	ROM	LR	RB	Byz	LByz	Class
551 WAJ					1			
WF1420						1	1	1
WF1422	Coin		1					1
WF1459					1			1
WF1461				1		1	1	1
WF1462								1
WF1463								1
WF1465								1
WF1478							1	1
WF1510								1
WF1511							1	
WF1624	1							1
WF1626								1
WF604								1
57 WAG		1						

The most interesting mines are WAG 57 and WF1442. Roman pottery at these sites might indicate that these were some of the earlier extraction sites of the Roman occupation (see Chapter 2.4). Also of interest is that there are more mines datable to the Late Byzantine period than any other (Table 5.3). This is a small sample to draw conclusions from, and as reviewed in Chapter 2.5, the pollution record documented a scaling down of industry in the 5th century, and suggested its general cessation c. AD 500. However the presence of Late Byzantine mines indicates extraction was taking place

and that it may not have been an extremely limited enterprise.

In general what can be posited from the pottery collections is that mining was taking place from the Nabataean to the Late Byzantine periods. However the pottery dates are broad and whether these finds represent continuous or long periods of extraction is not determinable.

5.16.2 Occupation by Period

The Faynan valley has archaeological evidence supporting the supposition that occupation continued throughout the Classical periods. Examining the range and number of site types provides further information that can summarise the region (Table 5.3).

There are 112 sites with Nabataean pottery in the database, including the important Khirbet, large settlements and WF4 (Fig. 5.30). Other surveys such as the Wadi el Hasā (see Chapter 5.17) and Limes Arabicus recorded Nabataean sites uniformly distributed along wadis throughout the survey areas. In contrast, sites in the Faynan are rather sparse in the side wadis and the Wadi Fidan (for WHS, MacDonald 1988, 212; for Limes, Parker 2006, 43). This lack may be a relic of survey techniques; the JHF 1998 survey did not differentiate Nabataean pottery from Roman. It is likely that there are more sites, Nabataean pottery was found in the JHF 2004 survey. This is potentially important as large sites with substantial populations are under-represented. For example, given that Fidan 50a yielded Nabataean/Early Roman pottery during excavation in 2004, it can be suggested that the large associated settlement Fidan 50 was also occupied during this period.

Table 5.3 The type of site and the pottery evidence (see Appendix 1 for abbreviations).

Site Type	NAB	NABR	ER	ROM	LR	RB	B	LB	Class
Agricultural	5		1	3	6	5	11	1	18
Aqueduct					1		1	1	
Artefact Site	6	1		5	5	4	12		18
Cairn	1		1	2	1	1	3	1	15
Campsite		1		4	1	3	1		8
Cemetery	11		1	6	8	10	12	6	28
Church							1	1	
DS	14			2	6	1	10	5	29
DSC	11			7	3	2	4	3	20
Enclosure	5				2		6	1	20
Fortified Structure	3	1	2	2	3	4	3	3	3
Funerary structures	19			6	10	5	20	3	59
Grave	9			5	2		4	1	18
Hamlet	5		1	8	5	7	9	6	14
Khirbet	1		1	1	1		1	1	
Metallurgical Features	5	1		3	7	5	6	2	17
Mining Features	1	1		1	1	2	2	4	12
Reservoir	1				1		1	1	1
Rock Shelter	1			2	1	1			5
Settlement	6			4	7	6	13	8	14
Stone Settings	5			4	5		13	6	38
Wall Line	3	2		1	2	2	2		10
Water Mill					1		1	1	
Grand Total	112	7	7	66	79	58	136	55	347

It may prove to be the case that, similar to the findings from other surveys in Jordan, the Faynan had heavy occupation along most of its wadi catchments during the

Nabataean period. In the Faynan, settlement during the Nabataean period could be due to a number of factors such as the important trade corridor up to the plateau and the copper resources. Both of these reasons, along with the perennial springs made the Faynan an attractive region for settlement. It is very likely that further survey would reveal an additional number of Nabataean sites.

Only a small amount of pottery collected was identifiable to the Early Roman Period (Table 5.3). Pottery may not be a particularly good indicator of occupation in this period, as there are a number of factors to be considered. Nabataean wares did not go out of use; evidence from Petra suggests that the ceramic tradition carried on long after annexation (Parker 2006, 45). Moreover, the length of the Early Roman period in the Faynan was only about 40 years. These factors may account for the few diagnostic Early Roman forms found. However, pottery amounts do not equate to population size. This lack should not be taken to suggest that the valley was uninhabited. While only 7 sites can be securely dated to the Early Roman period, these include the Khirbet and WF4; it is clear that there was Roman occupation in the Faynan during this period, even if it is difficult to quantify its size (Fig. 5.31).

A similar issue regarding pottery is encountered when looking at sites with Roman and Roman/Byzantine sherds. The Roman pottery could be indicative of the early period; however, it could equally belong to the Late Roman (Fig. 5.32). Despite these limitations, what is clear is that the Late Roman and Early Byzantine periods were ones of heavy occupation in the Faynan in every wadi (Fig. 5.33). All site types are represented. Chapter 2.5 presented evidence that the Late Roman and Byzantine periods were the zenith of the mining industry and the number of sites seems to support this. If

the occupation of the Khirbet, settlements and hamlets are taken as a proxy to determine population numbers, the distribution of sites reflects this and suggests that the years AD 150-500 were the periods of greatest population as well (Table 5.4).

Table 5.4 Habitation sites that produced classifiable pottery. Sites with overlap such as ones with R and Rom/Byz pottery were included in both columns. While the Roman period has more evidence this does not exclude the possibility of a Byzantine date as well.

	NAB	R	LR	Rom/Byz	Byz	LByz	Class
Khirbet	1	1	1	1	1	1	1
Settlement	6	4	7	6	13	8	3
Hamlet	5	8	5	7	9	6	4

Habitation sites cannot be taken in isolation, they are supported by agriculture. The large number of settlements in the Byzantine period is mirrored by a corresponding increase in agricultural sites, including intensive farming of WF4.

The Late Roman and Early Byzantine period saw the reorganisation of the armies, increasing reliance on arms factories and large-scale monetary reforms (see Chapter 2.7). The Faynan's copper was vitally necessary to the State and the response to that demand can be seen in the spatial patterns; heavy settlement and investment in infrastructure. The large number of settlements further emphasises that the Faynan was more than a punishment post for convicts; the organised communities and large cemeteries indicate that a substantial free population was present as well (see Chapter 8.7).

A number of surveys agree that many sites in the Levant were abandoned in the Late Byzantine period. Southern and Central Jordan as a whole seems to have been experiencing a period of economic or civic depression (Parker 2006, 48). The Faynan has

only 53 sites datable to this period, and they are clustered rather than dispersed as they had been in previous eras (Fig. 5.34). Although this pattern is partially an artefact of survey techniques, it can be suggested that these numbers reflect an actual trend. The Late Roman period was also poorly represented in the JHF surveys, yet a total of 77 sites are recorded in the region. Although the number of sites drops, this may not indicate a substantial drop in population. The Late Byzantine period is one of expansion at Khirbet Faynan, 5 churches and a tower were constructed. As seen in Table 5.4, occupation continued at 8 settlements and, although no new ones were created, other site types, such as stone settings, cairns, and funerary sites were created. This observation suggests that the change in settlement patterns may reflect new circumstances, perhaps a reduction of large-scale industry, rather than a dramatic drop in population. This interpretation also fits well with the textual evidence; the Faynan was a Bishopric in the Late Byzantine period and religion may have had an increasing role in the area (see Chapter 2.6). That the Faynan continued to be populated even during this period when many settlements were abandoned in the wider Levant may be due to the religious importance of the region and the continued, albeit smaller scale, copper industry.

5.17 Comparison

With this overview of the region established, the current database can be compared to other surveys in order to demonstrate the unique nature of the Faynan and the impact of the industry on the landscape. Over the past thirty years a number of surveys have taken place in south and central Jordan and these make it possible to compare general trends and patterns between regions. The first survey to be considered is

the Southern Ghors and Northeast 'Arabah Archaeological survey (SGNAS). That survey covered an area from the north of al-Safi near the Dead Sea to the northern edge of the Wadi Fidan and it was approximately 40 km in length. Most of the survey took place at elevations below or just at sea level (MacDonald 1992, 1). The southern limit of the SGNAS survey overlaps slightly with the JHF survey. Thus the immediately adjacent area is useful and appropriate for comparison. Not all the survey was pedestrian and sampling strategies were practiced, rather than a 100 percent comprehensive pedestrian survey (MacDonald 1992, 10-11). Fewer sites were found per kilometre than in the Faynan, likely due to the less intensive nature of the survey. This finding could also indicate that the Faynan, due to its mineral resources and large floodplain was more intensively settled than surrounding areas.

Burton MacDonald also conducted a survey (WHS) examining the Wadi el Hasā and wadis that branch off from this main geological formation (MacDonald 1988). The survey area is a continuation of the northern end of the SGNAS survey further to the east on the Jordanian Plateau. Like the Faynan, the Wadi el Hasā was an east to west corridor connecting the Jordanian Plateau to the Wadi 'Arabah. The similar geologic formation provides an apt comparison. The Wadi el Hasā was also an important agricultural region, as it contains the only perennial river draining from the plateau to the Dead Sea (MacDonald 2007, 77). This survey found many more sites than the SGNAS survey; this result is likely due to the more intensive nature of the survey and the longer survey seasons (MacDonald 1992, 159).

The Faynan appears to be similar in many respects to the settlement patterns described by the other surveys. Most of the site types and their locations are not unique to

any one survey and have similar characteristics. However, there are some crucial differences that need to be emphasised. Surveys like SGNAS or MacDonald's Wadi el Hasā survey (1988) examined regions with a different purpose than the Faynan. MacDonald posited that, due to the large amount of cultivated land and sites relating to agriculture, agriculture was the main activity of the WHS and SGNAS regions (MacDonald 1992, 159).

The agriculture taking place in the Faynan was significantly different from that in the WHS or SGNAS territory. Although floodwater farming techniques were common during this period; WF4 was unique; no other system of fields of such size and complexity is known in the entire Levant (Barker *et al.* 2007, 327) (see Chapter 6.2). But regardless of its unique agricultural competence, the main activity in the Faynan was industrial not agricultural, as indicated by the numerous mining and smelting sites.

Military or policing structures were commonly found in all the surveys. Free standing watchtowers and fortified sites are not unique site forms in the Levant, and in the Faynan they should be seen as a continuation of a cultural response similar to that found in other regions. Usually the ends of the wadi system were guarded, as were the locations of caravansaries (Mac Donald 1988, 212). In the Faynan it is their placement in relation to the mining industry that is unusual. For example, WF1415 is located opposite the Qalb Ratiye mines. The WHS survey has no similar sites suggesting industrial monitoring (MacDonald 1992, 159).

5.18 Conclusion

An in depth discussion of how the Wadi Faynan and its tributaries, including secondary and nearby wadis, were structured in the Classical period has been accomplished. This is a vital step to understanding the Faynan region and human activity in it, and had not been done in detail previously in any other research.

The centrality of the Fidan-Dana corridor and the importance of Khirbet Faynan are highlighted by the scarcity of large sites in the secondary wadis. This is in contrast to the distribution of habitation patterns during the Iron Age (for Iron Age see Levy 2003; Hauptmann 2007, 127-132). Although parts of the wadi system have been discussed separately, it is important to reiterate how they connected together during the Classical period. There were similarities in settlement type and there is no evidence to suggest that the areas considered themselves as separate entities (see Chapter 8.5 for further discussion of interdependence). Roman and Byzantine settlement spread throughout the Faynan and worked as a functioning whole, routes connected throughout. What is striking is the connection of Roman and Byzantine sites with industry, in marked contrast to neighbouring regions explored in the Wadi el Hasā and Southern Ghors Northeast 'Arabah surveys. The landscape can be described as an industrial one with multiple indications of the extraction industry and accompanying administrative structures.

The arrival of Rome was clearly marked in the landscape and archaeological record. During the imperial eras the number of mines in use increased, MBS sandstone was exploited rather than DLS, the WF4 field system was expanded, and large structures such as the aqueducts and the barrage were built. It was a period of heavy settlement as

evidenced by the agriculture, settlements and hamlets. The increase of human habitation corresponds with the zenith of Classical industry. This human behaviour did not occur without serious effects on the region. Hunt *et al.* (2007) indicates, from his study of pollen in the area, that it was largely denuded of woodland and became a degraded steppe environment (1331). This corresponds with the detection by Grattan *et al.* (2007) of a massive pollution signature corresponding to the Roman and Early Byzantine periods. The pollution evidence from WF441 records that industry continued throughout the Early Byzantine period until the beginning of the 6th century (see Chapter 2.5.3). The presence Late Byzantine mines and settlement are evidence that copper production continued on a large-scale past the 4th century.

The growth in the Faynan both in population and in industry during the Roman-Byzantine period parallels the demands for copper throughout the empire. Now that the landscape has been laid out in full, the next chapter combined this information with textual and archaeological evidence to study the way the Faynan functioned as an imperial *metallum*.

Chapter 6 – The Imperial *Metallum* Faynan

6.1 Introduction

As documented in Chapter 5, Roman and Byzantine habitation was distributed across the Faynan landscape. This Chapter will demonstrate that this landscape contained some of the hallmarks of a *metallum* of the Classical period under imperial jurisdiction: 1) a powerful administration that was capable of reorganising the landscape for its benefit, 2) the ability to procure necessary resources and supplies, 3) the use of convict labour, 4) centralised production facilities and infrastructure, 5) the presence or ready availability of the military, and 6) monumental architecture. Together the archaeological data, exploitation of the landscape and textual sources create a singular case strongly supporting the existence of an imperial administration in the Faynan that was closely involved in the industry and lives of its workers, with the goal of intensive copper production.

6.2 Centralised Management of WF4

One way to approach ideas of how the administration affected the landscape is to study one of its most unique features, the floodplain and field system, WF4 (Fig. 3.2). The importance of WF4 as an agricultural resource cannot be overstated. These fields, with careful management using floodwater irrigation, are cultivatable in a semi-arid environment. WF4 was a focal point for the wadi system and it is significant to note that WF4 underwent extensive changes during the Roman Period (Barker *et al.* 2007, 327-

332).

The directing walls and channels in the fields are difficult to date securely by typology, and the tendency to reuse or modify existing walls further obscures the matter (Barker *et al.* 2007, 141). Pottery sherds are found in relation, but these indicate field usage and, while they can be associated with hydrologic structures, they cannot be used to date them securely. Even with these caveats, some clear patterns of usage appear.

Excavation and analysis of the field walls and sherd scatter suggest that portions of the floodplain had been farmed from at least the Bronze Age (Newson 2002, 220). Over time the fields had changed to meet the needs of the inhabitants or the flow of water across the plain (Barker *et al.* 2007, 327).

The floodwalls and associated pottery indicate that during the late Nabataean period, 1st century BC to 1st AD, small clusters of fields were watered independently of one another. Many fields were irrigated with separate hydraulic systems, the only exception being WF4.1/4.3, which were watered together as a unit (Newson 2002, 224; Wright *et al.* 1998). Concentrations of pottery sherds suggest manuring of core regions under use; these being WF4.6/4.7 and WF4.1/4.3 (Fig. 3.4). Other pottery scatters seem to be clustered around domestic structures (DS) contained within and directly to the south of WF4 (Fig. 6.1). Their location suggests that these DS were used by agricultural workers, perhaps for on-site observation and management of crops. Supporting the supposition of an agricultural focus for these structures, a sub-set of domestic structures/complex (DSC), WF54, WF476, WF478, WF481, WF538, WF645, and WF1214, have large enclosed yards. This aspect suggests that these were farmsteads

where agricultural processing took place (Barker *et al.* 2007, 295). This evidence supports the hypothesis that during the Nabataean period individual fields were independently owned (Newson 2002, 224). Small blocks of the fields were independently watered and had separate management structures associated with them. This independence in land use may be indicative of the region as a whole; similar to agricultural production, the copper production which took place may have been run by private citizens or groups. If the Nabataean kingdom were involved, it was not a centrally controlled industry.

Exactly when the change occurred is not clear, but by the Late Roman Period the field system had been altered substantially. Instead of a series of discrete adjacent irrigation channels, large areas of the plain were incorporated into an integrated system consisting of c.800 fields (Barker *et al.* 2007, 327). These were watered by a series of feeder channels with associated Roman and Byzantine pottery that fed secondary channels (Fig. 6.2). These channels were of a greater technical complexity than those of the previous period, well organised and efficient, with little water loss (Barker *et al.* 2007, 159).

Mirroring this change, the number of domestic structures related to fields dropped (Barker *et al.* 2007, 209). Fifteen out of the 26 DS used in the Nabataean period were abandoned, showing no evidence of continuing habitation. As posited above, these structures had been associated with individual fields; their absence suggests new cultivation practices. This new pattern of control seems to indicate that these new practices decreased the independence of inhabitants in the region and their personal relationships to specific fields. The new system with its centralised irrigation strongly

suggests increased regional control and a definite change in regional dynamics; in short, the insertion of a colonising power.

The larger system also meant that more land was under cultivation and that there were different types of agriculture practised (Newson 2002, 256). The northern fields were watered with channel fed irrigation; the southern fields had more simple construction for directed runoff (Barker *et al.* 2007, 331). These differences allowed for the best possible usage of field morphology and soil types. As stated in Chapter 5.6.1, the northern fields had a gentle gradient and contained better soil for cereal crops. Cereals require more attention, needing ploughing and higher amounts of fertilizer, and the northern fields were ideal. The pottery distribution in these fields reflects extensive manuring practices (Fig. 6.3). The southern fields were terraced, and with their rockier soil were likely used for grape or olive crops, activities that required less ploughing. Sediment cores taken in the Wadi Faynan contain pollen from olive trees and grape vines, confirming their cultivation (Barker 2002, 501). The fewer sherds found in these areas also point towards less manuring. The result of all these changes was that a larger area of the floodplain was intensively farmed and more food was produced (Barker 2002, 499).

In the Late Byzantine period the field system was again adapted. Excavation shows that the feeder channels went through a period of modifications (Newson 2002, 226; Barker *et al.* 2007, 176). The larger irrigation system changed into smaller independent systems and some areas were abandoned or minimised (Fig. 6.4). The changes could be due to shifting water flow patterns across the floodplain, with down-cutting or redirection of the wadis' course rendering some systems unusable (Newson 2002, 225). Another theory is that this adaptation indicates a social or political change

occurring within the Faynan in the post-Roman era, with a regression toward earlier decentralised farming practices.

The centralisation of WF4 and creation of larger hydraulic systems coincides with the period of most intensive Classical period copper production. Mining and agriculture are often viewed as separate activities; this has proven not to be the case in mining regions (Orejas and Sánchez-Palencia 2002, 582). Food production was increased to supply the needs of the non-subsistence populations such as miners and smelters. The increased need for food is understandable; there were two ways to accomplish this. The first was to import food; the second was to restructure the resources within the region. In practice this second response resulted in the most important piece of arable land in the southern 'Arabah being changed dramatically through the implementation of a single, carefully constructed and executed plan of land usage. If the centralised field system were created to supply the industry, the abandonment of this type of agriculture in the Late Byzantine period might indicate a downscaling of that industry. This is not evidence that copper production ceased; despite the modifications, some fields were still being intensively cultivated (Newson 2002, 225). However it does suggest that there may have been less of a non-subsistence population to support.

Land rights and especially control of irrigation systems in desert environments are not something that is spontaneously abandoned by a community. The local population present in the Nabataean period agreed or was forced to give up previous private land rights and accept new collective ones. The likelihood of this happening without imperial intervention, and the application of economic and physical force, is low. A point of departure for this supposition is the ethnographic studies of agricultural disputes close to

the region. In the early 1990s, the Rashaiyida and Shawabke tribes had a dispute over land rights in the Wadi Ghuwayr (Lancaster and Lancaster 1999, 123). The wadi was divided into two sections, one for each tribe. However only the Rashaiyida farmed theirs and eventually were allowed to be sharecroppers on the other half. The expansion of agriculture continued with the creation of a new hydraulic system. The Shawabke protested the building of permanent structures on their land and destroyed the pipes. This confrontation grew increasingly violent with armed opposition and destruction of crops and property (Lancaster and Lancaster 1999, 123). Eventually the matter had to be settled with royal mediation by Crown Prince Hassan. If similar attitudes to property and water systems existed in the ancient Faynan then the implementation of a centralised water system would have had serious social and cultural repercussions.

This centralizing trend and its timing during the Roman period suggest that WF4 was managed as a single system by the Faynan administration. The administration may have faced violent opposition to its plans, the fact that they succeeded points towards a powerful administration holding great authority and monopolizing resources in response to challenges posed by the copper industry; these are hallmarks of imperial *metalla*.

6.3 Resources and Supplies

The imperial *metalla* were large-scale industries and corresponding quantities of supplies were required (Given and Knapp 2003, 305). Rothenburg and Blanco-Freijeiro (1981, 174) believed that the ability to organise and provide supplies regardless of any environmental or economic constraints was a true hallmark of an imperial ownership.

In the Faynan some supplies were vital for the industry, for example, the supply of food to the community. The population size of the Faynan is difficult to determine without excavation, but WFLS estimates based on settlement density and cemetery data suggest at most 1,500-1,750 individuals in the Faynan region (Barker *et al.* 2007, 414). I would argue, after reviewing the JHF surveys, that the figure is slightly higher- 1,610-1,860 (Appendix 5). Although WF4 was a significant resource, its crops would not have been sufficient to feed this number of people. This becomes apparent when WF4's productive capacity is studied in more detail; for example, estimates can be made about how many calories it would have produced. The northern fields, as stated above, were likely used for cereal crops and measured 104.044ha (Fig. 5.9). Flannery postulated that a hectare of wild barley and wheat in the conditions of the Levant would yield an estimated two million kilocalories (kcal) per annum, enough to feed a family of three (1973, 278). Using Flannery's yield estimate, the northern fields of WF4 would have produced grain crops yielding 208,088,000kcal per year.

The Food and Agriculture Organisation of the United Nations (FAO) dietary standards estimate the daily caloric consumption by a 'very active male' is 3337kcal (Foxhall and Forbes 1982, 49). If a hectare can produce two million calories, then each hectare can support 1.6 'very active' males consuming 1,218,005kcal per year, if they are subsisting on grain alone.

'Active male' is an appropriate model given the labour intensive life style that inhabitants of the Faynan were likely to be leading. However there are other variables to be taken into account. Ancient authors such as Cato describe how diet varied depending on social class, he recommended slaves in chains be fed 4 or 5 pounds of bread a day (*De*

Agri Aultura 56). Slaves or convicts in the Faynan may have subsisted on the poorest diet, one of only bread. However, this was rare for other social groups; even the lower classes had access to other sources of food such as meat, wine and olive oil. For these populations an estimated 75 percent of calories were gained from grains (Foxhall and Forbes 1982, 56). Based on these data, the number of calories derived from grain needed for an active male would be reduced to 2,503kcal/day. Thus 2.2 active males would be supported by a hectare of cereals.

The population was also not likely to be entirely composed of active males; women and children were condemned to mines (Eusebius *MP* 8.1). These demographic groups would also have made up a portion of the free population and are represented in the cemetery evidence (Karaki 2000, 46). If, as Flannery believes, the two million calories produced by a hectare of wild grains could feed a family of three for a year the following figures are generated (Table 6.1) (1973, 278).

Table 6.1 Individuals supported annually from the northern fields based on Flannery and Foxhall and Forbes calculations.

Population	Annual caloric need from grain (kcal)	Persons supported per hectare of grain	Persons supported by northern fields per year
Active male (free) 75% of diet	913,504	2.2	227.8
Active male (slave) 100% of diet	1,218,005	1.6	170.8
Family (average 3) 100% of diet	2,000,000	3.0	312.1

These figures are of course estimates and many other considerations apply. For example not all of the population of the Faynan, most especially the convicts, would have received a healthy diet containing enough calories. Also the WF4 fields would have contained domesticated grain species, not wild as was the basis of Flannery's estimate. Domesticated grains should have had increased productivity and yields. However, even with a rough estimate of the productivity of the northern fields it becomes apparent that cereals produced by WF4 would not have been sufficient for a population of 1,610-1,860 individuals.

The northern fields of WF4 were not the only agricultural lands. Added to the above figures are the calories produced by the southern fields of WF4 (105.166 ha); the fields of the Wadi Fidan (perhaps a further 1ha), and WF406, WF408, WF409, WF410, WF424, WF442, WF443 (42.64ha). In total another 148.806ha could have been under cultivation (Fig. 6.5). These fields may have had cereal crops as well but this is not likely, the southern half WF4 especially was not suitable for this type of agriculture. However the pollen record does indicate the presence of another crop, *Olea*, olive trees (Barker 2002, 501). Olive fields can have between 100-250 trees per hectare; each tree produces an average of anywhere from 15-50kg of olives depending on age and environmental conditions (Mattingly 1988, 41; Info Com 2006, <http://www.unctad.org/infocomm/anglais/olive/crop.htm>). Depending on the variety and the environmental conditions it has been suggested that a hectare of olives can produce amounts of calories similar to those with cereal crops (Osborne 2004, 45). In this case the 149ha could have produced an additional 297,612,000kcal or supported 244 active slave males. Other sources of food in the region today include the gardens along the Wadi

Dana. Unlike WF4, which relied on floodwater farming, here perennial springs are used to irrigate small terraces (Lancaster and Lancaster 1999, 153). If these fields were worked in a similar fashion to the present day, a supply of fruit and vegetables would have been available close by. However, the garden plots in Dana are not usually given over to cereal cultivation, that takes place in the lowlands. Instead the gardens operate as supplemental/complementary source of food (Lancaster and Lancaster 1999, 182).

It was likely that non-cereal crops provided only a portion of the daily calories. Olives and other crops could have provided valuable calories and nutrients. Yet even factoring in these non-cereal calories, it was not feasible that these local sources could have supported the estimated 1,610-1,860 individuals. Supplies of food would have had to be imported to the region.

6.3.1 Luxury Goods and Rare Items

The pottery samples collected by the WFLS are useful as a basis for discussions concerning the importation of supplies. Given its durable nature, pottery can indicate trade even if other organic items have not survived in the archaeological record. In the Faynan pottery collection, imported fineware and amphorae sherds represent only slightly more than one percent of the collection (Barker *et al.* 1999, 285). The great majority of pottery was comprised of local wares that are more difficult to interpret than the more familiar pottery forms from the wider classical world.

The presence of amphorae is useful. ‘Aqaba amphorae are present throughout the Roman and Byzantine period, suggesting contact between the Faynan and the Red Sea. Other amphora sherds were found but in very small amounts, these show a variety of

origins including, Cilicia or Cyprus, Gaza, Western Asia Minor, Egypt and the Northern Jordan (Barker *et al.* 1996, 45; Barker *et al.* 2007, 456). The types found (LRA1, LRA3, LRA4, LRA5, and LRA6) are amphorae commonly used for wine and oil, though some may have contained other goods such as *garum* sauce (Keay and Williams, 2008, <http://ads.ahds.ac.uk/catalogue/resources.html?amphora2005>).

Fineware was equally rare in the collection. Many examples present in the Faynan were produced in Petra (Barker *et al.* 2000, 50). However, there were some from further away. Fineware of the Late Roman period included Cypriot and African red slipware as well as Syrian Mortarium (Barker *et al.* 2007, 455). In the Byzantine period red slipware from Tunisia, Cyprus, Phocaea and Egypt was also present (Barker *et al.* 1999, 285; Barker *et al.* 2007, 456).

Many diagnostic pottery forms were used throughout multiple periods making identifying individual eras sometimes difficult. However what can be said is that the limited amphorae and finewares imported came from a variety of places throughout the Levant and Eastern Empire (Barker *et al.* 1999, 285). The rarity of these items in the collection emphasises the primacy of local food sources. Certainly there is no evidence to suggest that the Faynan had a large, developed elite population that would be using the more recognisable pottery forms, and this may account for the small quantities found. However they *were* present and wine and fineware from as far away as North Africa were reaching the Faynan.

Supplies were not merely for subsistence; rare foods as well as other imported items were brought in to improve the lives of the supervisory elite and perhaps of free

workers. Life in the industrial landscape was a stark one; the pollution, lack of public structures and closely controlled existence would not have created a positive living environment. One strategy the administration may have employed was a reward/incentive program to increase productivity or morale. Without excavation it is difficult to determine the relative frequency of imported luxury supplies, or determine who was receiving them. While it is very likely the convicts never received more than the standard rations described above, there is evidence for imported luxury foodstuffs, fineware and wine.

Mons Claudianus has ostraca evidence suggesting that a regular supply of food was brought in, including rarer or perishable items. The free workers received some of their pay as food staples, rations of grain and wine (Hirt 2004, 131). Other supplies such as oil could be deducted from their wages. Despite lack of such evidence in the Faynan we might assume that a similar mechanism was in place. It is presently unclear whether luxury supplies were included in the rations, given as rewards, or had to be individually procured for private consumption.

6.3.2 Fuel

Another necessary resource for the successful running of the Faynan would have been a supply of fuel. While there was some domestic use, the majority of fuel was consumed by the smelting process. Hauptmann makes a cautious estimate of 320,000-560,000t of wood consumed in the Roman and Byzantine period for smelting alone (2007, 53). This would have been converted into charcoal, which burns hotter and is better suited to smelting (Tylecote 1987, 131). The charcoal-to-ore ratio depends on the

skill of the smelter and the ore, but rates anywhere from 1:1 to 1:3 have been suggested (Rothenburg *et al.* 1978, 43). Estimations in Barker *et al.* suggest that 80-258t of charcoal were required each year solely for industrial purposes (Barker *et al.* 2007, 346). Even given that this is a rough estimate, it is clear that vast quantities of charcoal were needed. There is evidence to suggest that it would have been difficult to supply this fuel from the local environment.

Soil samples from the barrage WF441 were analysed for pollen (see Chapter 2.5.3). The pollen of species present in different sediment layers can be used to reconstruct the vegetation record and to model the local environment. The species associated with the Roman and Byzantine periods are those found in dry steppe or desert environments. Desert flora and scrubs like *chenopodiaceae* predominated (Hunt *et al.* 2007, 1330) (Fig. 6.6). These species indicate that the local environment of the Faynan was degraded. However, also present were algae spores and pollen from plants that grow near water, reinforcing the idea that the Roman/Byzantine period was one of increased precipitation. It could be expected that the overall vegetation of the Faynan would reflect these more optimal growth conditions, but it does not (Hunt *et al.* 2007, 1331). It appears that the continual degradation of the environment is due to human impact, likely that of smelting, rather than environmental factors.

Supporting this interpretation, charcoal samples were taken from slag heaps (Barker *et al.* 2000, 28; Barker *et al.* 2007, 78). The majority of Late Bronze Age charcoal is composed of *juniperus phoenecia*, Juniper trees (63-67% at slag heap Faynan 9 or 59% at Faynan 16), which are found commonly in a steppe-woodland environment (Barker *et al.* 2007, 78). The species that forms the majority of the Iron Age charcoal is

Tamarix, an evergreen shrub usually found in a dry steppe environment (55.2-91%). Both Bronze Age and Iron Age charcoal collections also have some high calorie trees such as oak, although these are a minority species. Reflecting the pattern already established in the pollen record, the species used in the Roman period are indicators of a degraded environment- that of very dry steppe or desert (Table 6.2). Neither *Tamarix* nor *Juniper* was used as fuel and no woodland species are present. Instead the charcoal is made from desert species such as *Halaoxylon persicum* (Hauptmann 2007, 53).

Table 6.2 List of species collected from Roman and Byzantine slag piles and their relative percentage of the total (after Barker et al. 2007, 78).

Species	Percent of Collection	Environment of Species
<i>Acacia</i>	1.1-13.8	Very dry steppe
<i>Retama raetam</i>	14.3-19.0	Very dry steppe
<i>Halaoxylon persicum</i>	58.6-68.9	Desert
<i>Ephedra</i>	1.1-2.6	Desert

The diminishing supply of fuel meant that local resources would have been strained to meet this demand. The average 80-258t of charcoal consumed each year put pressure on an already degraded environment and likely exhausted local supplies (Barker *et al.* 2007, 346). The suggestion has been made that woodland management was practiced to meet this need (Hunt *et al.* 2007, 1331; Barker *et al.* 2007, 346; contra to Hauptmann 2007, 53). Another potential source of fuel was from external sources such as the upper elevations, especially the Jordanian plateau. The plateau had forests of highly caloric trees; for example, oak and juniper still grew in these higher elevations (Engel 1993, 210). Potentially, the declining local fuel supply could have been supplemented

with wood transported from the plateau. However, charcoal made from woodland species is yet to be found in abundance at Roman and Byzantine smelting sites. This finding may have more to do with the number of charcoal samples taken and caloric burn rates of different species than whether woodland trees were used. The relative ease with which fuel could be transported by the *Via Nova* to the Wadi Dana makes the plateau a probable source of fuel.

Highly caloric woods may not have been the only external source targeted. Another possibility is that increasingly large portions of desert were harvested (Hunt *et al.* 2007, 1329). An ethnographic example is provided by the 19th century Bedouin in the South Sinai desert. An important source of the Bedouin's income was the production of charcoal made in the Sinai and sold in Cairo, up to a twelve-day journey away (Rabinowitz 1985, 218). The *Acacia* and *Tamarix* species, found in desert and steppe environments, are mentioned by name as favoured species in travellers' accounts (Rabinowitz 1985, 218). The charcoal samples of the Faynan slag heaps indicate the use of desert species but not where they originated. It is possible that fuel sources from the Wadi 'Arabah or even further away were exploited as well as the plateau.

6.3.3 Supply Needs and Implications for the Administration

The supply of foods and goods both common and rare would have been a massive logistical operation, but one that was successfully tackled, as the intensive copper industry and material culture indicate. These supplies would not only have allowed the copper industry to continue, but also would have fostered a greater community dependence on the administration.

The animals most likely used for transport of supplies were donkeys or camels; these were adapted to arid environments and could cross the uneven ground of the Wadi ‘Arabah and Faynan and make the ascent to the plateau better than carts (Evenari 1982, 319; Bulliet 1975, 227). Excavation at Mons Claudianus has revealed that donkey and camel bones made up the majority of the faunal collection, indicating that these were not only the species best adapted to desert transport, but also the likely ones used (Maxfield 2001, 158). Both animals are also capable of carrying heavy loads; a donkey can carry 65kg and a camel can bear 195kg (Kuhrt 1998, 26; Bulliet 1975, 20).

Another *metallum* with similar transport concerns was the Egyptian desert quarry of Mons Claudianus; it provides a useful comparison as it has documented evidence of the requirements and importation of supplies. Unlike in the Faynan, local cultivation of grain was impossible and it had to be imported (van der Veen 1998, 223). Using the figure of 900 individuals to be fed as a basis, Adams estimated 1,800 camel loads per year were needed to supply the quarry community (2001, 183). Returning to the Faynan, WF4 cannot have fulfilled the total grain needs of the region, at best only 170-300 people annually could be fed by local cereal crops. Adding additional calories from other sources, the number could reach at most 500 individuals locally supplied. If the Faynan were importing food for the additional 1,110-1,360 people present, based on the previous calculations, 2,220-2,720 camel loads (or 6,660-8,160 donkey loads) per year were required. In years when the local fuel supply was insufficient, as much as 80-258t of charcoal (410-1,323 camel or 1,231-3,969 donkey loads) may have been added to the transportation requirements (Barker *et al.* 2007, 346).

Intra-site transportation of goods was also required at *metalla*. For example the

mines at Umm al-Amad were 7km away from the centre and needed supplies, as no local agriculture could take place. In return, copper ore from the mines had to be taken to the smelting areas, where Hauptmann estimates 40,000-70,000t of slag were produced during the entire Roman and Byzantine periods (~400 years) (2007, 147). As the copper ores exploited in the Roman period were of relatively low grade, the slag weight would not have been much higher than the original ore prior to extraction of copper; thus it can be used to estimate approximate weight. The mined ore is estimated to have weighed between 45,000-75,000t. If production was evenly spread across 400 years, this represents on average an additional 579-962 camel or 1,738-2,884 donkey loads per year to transport the mined ore to the smelters.

On average the Faynan thus required about 3,209-4,754 camel loads or 9,629-14,276 donkey loads of supplies and ore moving through the region per year (see Table 6.3).

Table 6.3 Estimation of the total transport loads per year.

	Low estimation		High estimation	
	Camel	Donkey	Camel	Donkey
Ore	579	1,738	962	2,884
Fuel	410	1,231	1,077	3,230
Grain	2,220	6,660	2,720	8,160
Total Loads	3,209	9,629	4,754	14,276

These figures represent loads, not the animals that made multiple trips. To calculate the number of animals, the length of the journeys needs to be taken into account. All ore bodies in the Faynan are within a day's travel of the Khirbet. Trips for

fuel, from the plateau or desert sources, were likely longer, perhaps three days in length. The grain transport was probably from the Jordanian plateau, it could be gathered from multiple fields up and down the *Via Nova* before being placed in a depot. The transference of grain to the donkeys or camels and then transportation down the Wadi Dana may have taken three days. These estimates do not include other transportation needs, for example, communication. Nor do they include the fodder for these animals, which is difficult to predict given questions of pasture and competition with fuel sources in the degraded local environment (Hunt *et al.* 2007, 1331). Luxury supplies may have travelled the longest distances. From Gaza to Khirbet Faynan is a seven day journey and from 'Aqaba is five days; these trips may have been a monthly occurrence.

In total, an estimate of 100-125 camels, or 300-400 donkeys, might have frequented the Faynan each month. Doubtless actual census was much less regular than the estimates here. For example, the size of ore transports would depend on the richness and size of the copper ore veins, the varying weights affecting calculations. Regardless of these fluctuations, there were times when the Faynan had to house and feed large herds of camels and donkeys. There are security implications to the presence of so many animals and their handlers transporting goods both within and out of the valley. Within an imperial *metalla* it is unlikely that free movement was allowed. Simitthus had a separation of civilian and imperial property and the Egyptian quarries had forts at exits within a militarised zone (Mackensen 2005, 4; Maxfield 2001, 160). The case studies suggest that traders frequenting the Faynan would not have been allowed free access to the area. Security measures and means of monitoring this trade are discussed further in Chapter 7.5.

Rothenburg and Blanco-Freijeiro (1981) suggested that overcoming environmental constraints was a hallmark of an imperial *metalla*. One of the means by which the Faynan did this was through the importation of supplies. Transportation would have been a major concern of the administration, as the local environment has been shown to be deficient in necessities. This response, the organisation of complex logistics, is also considered a hallmark of other imperial *metalla* (Maxfield 2001, 166).

6.4 Labour

Included in the discussion of supplies for the Faynan is the supply of disposable labour, in this case convicts. Eusebius describes the specific punishment of *damnatio ad metalla* in his texts; sentencing convicts to the Faynan can thus be seen as a representation of imperial power and economic interest in these mines.

The study of convicts or slaves has been described as a stagnant issue in Roman archaeology (Webster 2005, 162). Often it is claimed that they are poorly represented in the archaeological record, thus they are ‘invisible’. Material culture and architecture are often used to discover differences between populations. As the Faynan has only survey data for the Roman and Byzantine periods, these techniques are difficult to employ. However another approach to this topic, that of space and landscape, have been put forward in American historical archaeology looking at slave populations. Although these theories were formed from archaeology of the 17th and 18th centuries, they can serve as a departure point for discussions about class based control mechanisms. Similar issues are addressed when discussing slave populations regardless of the exact location. Delle (1998), when studying Jamaican coffee plantations, identified a means of control she

titled the 'spatiality of movement'. Restriction of movement was used by plantation owners to control slaves; from the absolute of physical restraints to the less intrusive 'permission to travel' (Delle 1998, 157). Some of these mechanisms of control are documented in the textual evidence for the Faynan. Eusebius describes the physical maiming of the condemned Christians, "These had first their right eyes and the sinews of their left feet destroyed by branding irons and the sword, and afterward they were given over to the mines to dig copper" (*MP* 13.1). By limiting sight and destroying the Achilles tendons, the convicts were rendered permanently lame, restricting their movement. However, no archaeological evidence exists in the Faynan to substantiate Eusebius's claim, for example none of the commonly sought indicators of slavery- shackles, prison buildings- such as may be present in Simitthus, or skeletons showing distinctive physical trauma have been found (for skeletons see Findlater *et al.* 1998, 82; prison structures see Mackensen 2005, 119).

Despite this lack of documented physical abuse, there is evidence for the less intrusive concept of the 'spatiality of movement.' This theory may be applied to the areas of the landscape where convicts were likely to be found, the mines. The physical remains of the mines, especially the shape of the entrances, may indicate the status of the labourer (Davis 1979, 16).

Restrictive mine entrances, either small diameter or vertical shafts, were common across the Roman Empire, such as those at Cythnos Milyes (Davis 1979, 14). This limited space meant that once within the shaft, movement could be controlled and openings could be blocked by a single guard. It is unclear whether convicts were allowed to leave the mines often or at all, since this exit shape does not allow for easy passage

(Grattan *et al.* 2004, 111). In Dacian mines, skeletons were found as well as living spaces, suggesting that miners lived and died within the mines (Davis 1979, 16). The ‘spatiality of movement’ is confined and it is likely that these mines were worked by individuals the administration wanted to spatially control- convicts and slaves.

Some mines have larger openings. Such entrances may have been provided for individuals who had some say in their working conditions; who were not spatially controlled and were allowed freer movement *in and out* of the mine. There are examples of this elsewhere in the empire, such as mines in England (Davis 1979, 16). In terms of technical ability it would be possible to create a larger entrance; the amount of effort invested was greater, but the benefits would be ease in moving ore and greater air circulation.

There are examples of this in Wadi Ratiye where some mine entrances were enlarged; in one case steps were formed to grant easier access (Hauptmann 2007, 114) (Fig. 6.7). The Wadi Ratiye has other lines of evidence for free workers, the sites WF1515, WF1516, WF1518 and WF1446 were likely miners’ accommodations. These are structurally similar to the settlements on the road to Umm al-Amad. A coin was found at WF1516 and the nearby agricultural site, WF1519, suggests personal property and time spent away from the mines (for discussion of composition of labour force see Chapter 8.7).

However, in the Faynan many mine entrances have characteristic small openings, even those in the Qalb Ratiye. It has been suggested this is because mines were opened in the Chalcolithic period and these entrances were retained, rather than expending extra

effort, when the mines were reopened (Hauptmann 2007, 114). It is more likely that this was not the case, as restrictive mine entrances seem to be a common form in the Roman Empire and may represent a purposeful choice by the administration and their engineers.

A good example of this type of mine in the Faynan is Umm al-Amad, which is entered by crawling for 10m (Fig. 6.8). After this restricted opening the space opens up into a large gallery, 4,000m³ in size with an average ceiling height of 1.7m (Meshel 2006, 231). This mine more than any other shows the great technical expertise and effort that could be expended in the creation of mines, yet entrances were purposefully kept small. The difficulty in exiting the mine is so great that it suggests that the convicts rarely if ever left Umm al-Amad. Certainly once inside the mines, the toxins, including radon, would result in a high mortality rate, which may not have been a concern with the use of unskilled slave labour (Grattan *et al.* 2005, 656). The danger was such that being sentenced to the mines was considered a form of capital punishment (Millar 1985, 138).

But was the administration only concerned with slave or convict revolts? There were also small mine entrances in Wadi Ratiye where the presence of some free workers has been suggested (Hauptmann 2007, 114). Although free workers were used in the mines during the Roman and Byzantine empires, they would still have been exposed to dangerous and brutal conditions. Mining as a profession has always been subject to poor labour relations. Strikes, organised refusals to work, did occur in pre-industrial societies (Knapp 1998, 9). The free workers would have greatly outnumbered the administrative and technical staff and if they rebelled, the situation would have been difficult to resolve and copper production would certainly have suffered. The workers, whether slave or free, could have been seen as a threat to the administration and efforts to control them would

have been in place either in the form of mine entrance architecture or, as discussed further in Chapter 7.7.1, in surveillance structures.

Weisgerber, who has studied the Faynan in depth, posits that the lower yield ore deposits were only economically feasible to extract if there were a large supply of cheap convict labour (2006, 18). If this were the case, then the convicts were a valuable yet disposable resource. The finding that there was control of ‘spatiality of movement’ may suggest the presence of convicts, previously only documented in the textual record of Eusebius. Control of these convicts and the other free workers would have been of paramount importance and a means by which the administration successfully produced copper.

6.5 Centralised Production of Copper

It has been argued that copper was the driving force behind the structure of the Faynan landscape. If this were the case, then evidence should exist for the administration exerting control over the ore and smelted metal. Smelting in the Roman period appears to have been strongly concentrated around Khirbet Faynan. The major area was WF11, the collection of associated structures and slag heap (see Chapter 2.5.2). This was a major site for smelting in the Roman/Byzantine periods (Hauptmann 2007, 94-96; Barker *et al.* 2007, 313).

WF11 is the location of the aqueduct/mill complex. As they are located near the smelting site, the implication would be that they were purpose built structures to help WF11 produce copper. As discussed in Chapter 5.6.1, these water bearing structures were

unlikely to have been used to provide spring water to irrigate WF4. However their purpose, especially that of the mill, is debated. It is a penstock type with a horizontal wheel suitable for grinding grain, suggesting an agricultural usage of this structure. The horizontal wheel would not have been suited for the vertical crushing required for ore preparation (Barker *et al.* 2007, 317-318). However there is evidence that the mill was modified and the mill may have served multiple purposes over time.

The dating of the mill is commonly ascribed to the Roman/Byzantine periods (Barker *et al.* 2007, 162; Newson 2002, 165; Hauptmann 2007, 48). Yet features of the mill are common to Islamic period penstock mills. Comparisons of plaster types revealed a similar white mortar in the channels feeding and exiting the reservoir and an earlier phase of plastering at the mill leat. The second phase of plaster of the leat, overlaying the first, has pink mortar with inclusions of tile and brick; this is similar to Late Byzantine/Early Islamic styles.

Table 6.4 Composition of mortar samples taken from the aqueduct /reservoir /mill water structure (after Barker et al. 1997, 39).

Sample	Gravel >2mm	Sand <0.15-2mm	Silt <0.15mm	Water Soluble	Inclusions
Mill leat first phase	83%	12%	5%	46%	
Channel exiting reservoir (east side)	67%	25%	8%	43%	
Channel exiting reservoir (west side)	55%	30%	15%	48%	
Mill leat second phase	3%	63%	34%	69%	Brick and tile

These mortar samples would suggest that the water mill and reservoir were built

contemporaneously and then repaired or rebuilt afterwards (Barker *et al.* 2007, 163). Given the location of the structure and the style of the reservoir and aqueduct, it is likely that the dates of the original water structures were Roman/Byzantine.

One hypothesis is that a previous version of the mill, before its Late Byzantine modification, was of a different type. The mill could have had two phases of use, the first for ore grinding during the Roman/Byzantine period when the Faynan was a *metallum*. The later modification to a horizontal wheel might have been an adaptation of the mill to grind grain, reflecting the needs of the later, largely agricultural community.

An industrial purpose during phase one is supported by the diversion of water. Instead of being poured from the mill into cultivated fields, it was carefully directed away from WF4. That water was not recycled when it was such an important resource in this arid climate suggests that it may have been unusable, perhaps because it was polluted (Barker *et al.* 2007, 318). Furthermore the aqueduct led to the reservoir where the water was stored. There is no evidence of a covering, despite its proximity to the polluting smelting activities. This means it was unlikely to have contained drinkable water (Barker *et al.* 2007, 317).

It is not as if pollution from metal industries and its detrimental effects were unknown concepts in the ancient world; it affected the visibility, smell and air quality noticeably (Hughes 1994, 128). Strabo relates how the metallurgists in the Spanish provinces built furnaces with high chimneys because the air is 'deadly and heavy' (*Geo* 3.2.8). Pliny the Elder indicated that lead smelting produces poisonous vapours.

While it (lead) is being melted the breathing passages should be protected

otherwise the noxious and deadly vapour of the lead furnace is inhaled; it is hurtful to dogs with special rapidity, but the vapour of all metals is so to flies and gnats, owing to which the annoyances are not found in mines (*NH* 34. 167).

In a similar fashion the placement of WF11 was interesting in terms of its proximity to the field system WF4. Pollution caused by smelting is both airborne and present in the waste products like slag, where heavy metals such as zinc, copper, and lead are present. These can detrimentally affect the health of plants, stunting root growth, and at high enough levels cause death (Bradshaw *et al.* 1965, 329). Plant life, though not verdant in the semi-arid environment of the Faynan, would have been negatively affected by smelting and this would have been visible in both crops and wild plant growth. A slagheap near Khirbet Faynan was examined to determine how pollutants affected wild barley plants (Pyatt *et al.* 1999, 306). The authors found copper toxins present at 200ppm (parts per million) on the surface of the slagheap. In this experiment a transect was taken from the slagheap to a distance of 1000m where there was no longer evidence of smelting activities (Pyatt *et al.* 1999, 306). The seed potential, the number of seeds produced by each plant, was dramatically affected. Even at distances of 1000m with no visible remains of metallurgy, plants produce only 30% of their full seed potential (Barker *et al.* 2000, 45). The poor health of the plants and low seed production would have decreased crop yield. Pollution may be the clue to why, after water was used by the mill to prepare ore, it was diverted to discharge into the Wadi Faynan, and was not used for irrigation of the fields directly adjacent (Barker *et al.* 1999, 277). Directing water from the mill away from the fields acknowledges an understanding, however crude, of the toxic by-products of the smelting process.

There is also evidence that the barrage WF441 to the north of the Khirbet was

used for washing ore, the size of the barrage is massive and does not seem to be linked to water storage for consumption (see Chapters 2.5.3 and 5.5.3). This huge structure is overbuilt and contains high levels of pollution indicating its industrial use. Both the aqueduct/reservoir/mill complex and the barrage are robust structures. The hydraulic system must have been costly to create and maintain and superimposed channels in the aqueduct show it was modified on at least two occasions (Barker *et al.* 2007, 124). Similarly the size of the barrage suggests that its building and upkeep were the responsibility of the administration. The location of these structures near the Khirbet, the main administrative site, and the scale of metallurgy practiced strongly suggest that these were officially administrated sites.

The creation of large smelting sites is logical in terms of efficiency. By gathering the materials and labour required, time and energy are saved. The quantities of supplies required, such as fuel, were great and the collection of these would be facilitated by establishing smelting in one area. Khirbet Faynan is placed at the confluence of many wadis, with transport routes up to the plateau and the *Via Nova*. Further, it is located in between the mining districts of Ratiye, Abiad and Khalid and at the end of the 7km road to Umm al-Amad, making transportation of ore convenient. This central location would also allow for oversight of production and quality. In the Early Bronze Age copper ingots were created (Hauptmann 2007, 135), and it is likely that a similar system of standardisation existed for the Roman and Byzantine periods.

Furthering this interpretation of the importance of centralised production, Hauptmann has suggested that the WF11 smelting site not only smelted the copper of the immediate region, but also most of the copper in the ‘Arabah during the

Roman/Byzantine period. There is no evidence of smelting at other copper mines such as Wadis Abu Khusheibah or Abu Qurdiya, located 40km south of Faynan (Hauptmann 2007, 155). It also appears that Roman smelting did not take place at the Timna copper mine in Israel. Further study is needed but it could be that the Faynan was the central smelting depot for other copper mining districts as well (Hauptmann 2007, 155). If so, the Faynan would have been a focal point for an even more complex and imperially organised administration and its role as a centralised copper control point would have extended across multiple regions as part of provincial planning.

A second possible location for processing copper ore is the Wadi Fidan, where seven Classical sites practiced limited metallurgy, namely Fidan 52, 53, 59, 78, 107, 614, and 631 (Levy *et al.* 2001a, 175-6; Levy forthcoming a and c). These smelting sites never reached industrial scales of production similar to that of WF11. Lacking industrial scale and without accompanying infrastructure, they do not seem to be related to the imperial *metallum*. These sites may represent community or private smelting operations. However the dates of the metallurgical activity here are not secure and are based on surface pottery collection and slag typology. Unfortunately neither the slag nor the generalised pottery categories used by the JHF (see Chapter 3.6) can be used to discriminate between Classical periods (Nabataean to Byzantine). It is by no means certain that this activity was contemporaneous with the main industrial phase of production around Khirbet Faynan. Another way to approach this question may be to ascertain the likelihood of private metallurgy taking place, using the example of another *metallum* as a basis for discussion.

The importance the administrations of *metalla* placed on controlling the ore is

illustrated in the Vipasca tablets, a set of bronze tablets found underneath the slag piles at Aljustrel, Portugal. The *Lex Metallis Dicta* (*LMD*) lists the regulations for a mining community extracting silver, lead and copper ore (Domergue 2001, IV 1A). Like the Faynan, Aljustrel was a large-scale operation with both mining and smelting taking place. Unlike the Faynan it was under indirect management, with private companies working the mines. However, the imperial administration still had strict control of the operations with the permission of the Emperor Hadrian (*FRIA* 104 5).

A large portion of the *LMD* discusses ore and the requirements and laws applying to it. Half the silver ore in a mine belonged to the State (*FRIA* 104 2-4). Upon finding and extracting ore, the lessee of the mine had to pay a *pretium* or the estimated amount of the State owned half (*FRIA* 104 1-4) (for discussions of the exact meaning of *pretium*, see Flach 1979, 420; Domergue 1983, 127; Hirt 2004, for discussion of Mateo 2001). Until they did this the company was not allowed to smelt ore. If they practiced metallurgy without payment their mines and any ore extracted were confiscated. Furthermore, informants who reported illicit smelting gained a reward, one-fourth the total share of the confiscated ore (*FRIA* 104 4). Further regulations were in place; for example, the ore also had to reach the smelters by nightfall. If any ore were moved during the night, the fine was 1,000 sesterces (*FIRA* 104 23). If an individual stole ore the penalties were severe. If the thief were a slave, he would be whipped and sold (*FRIA* 104 26-28). This sale included the condition that from that point the slave must be kept in chains and could not dwell in any mining district. If the thief were a free man, the procurator confiscated all his property and removed him from the mining region (*FRIA* 104 28; Cummings *et al.* 1956, 340).

While most of these regulations pertained to silver ore and cannot be applied directly to other types of mines, they do illustrate the emphasis placed on the ore and the administrative focus on the profits that could be generated from it. Returning to the Faynan, if the administration had a similar mindset, the likelihood of uncontrolled smelting is small. If the small-scale smelting in Wadi Fidan were coterminous with the main industrial site, it is probable that it was regulated in some fashion. Chapter 7.6 discusses this theory further with regards to visual monitoring. Another possibility is that the metallurgic activity in the Fidan occurred before or after the phase of State control. This could be another indication of the adaptations the Faynan experienced over time. Small-scale copper production might have taken place in decentralised locations in the early years after conquest or the Late Byzantine period.

While these other smelting sites need further examination, it is apparent that WF11 was the chief location for metallurgy in the Roman and Byzantine period. It is probable that the structures found there, such as the mill, were created to facilitate copper production. These structures and their use of valuable water resources and the proximity of WF11 to Khirbet Faynan strongly imply the administration was closely controlling copper production. Like other *metalla*, investment into the region resulted in the creation of infrastructure to better meet the demands of the State.

6.6 Support of the Military

Private enterprise could not expect to receive support from the military, so its presence is a good indicator of an imperial *metallum* (Hirt 2004, 73). The archaeological evidence for the military in the Faynan is mixed. The Faynan is not mentioned in any of

the contemporary sources that list deployed garrisons, such as the *Notitia Dignitatum* (c. AD 400), but many small garrisons known to have existed are not mentioned (Fairley 1899, 2). Nor is it in the listing of military units on the Berbosaba marbles (Kind *et al.* 2005, 189). The Peutinger Table (segment 10), originating in the late 4th century, does not show the Faynan at all, although it may refer to the Faynan-Fidan corridor operating as a passage through to the Plateau. Textual evidence is scarce but Eusebius does mention soldiers (*MP* 13. 1-4).

The most suggestive evidence for the military comes from Khirbet Faynan itself, there is a large central administrative structure that some have suggested was a fort (Kind *et al.* 2005, 189). Others cite the lack of a single fortified wall surrounding it as evidence for it being merely an administrative site (Barker *et al.* 2007, 315). Without excavation, the purpose of this building is not at all clear. At site WF592 there is a Nabataean fort with associated pottery of the Nabataean and Early Roman periods. Walls are 1m in width, formed from well-cut masonry, and there are towers. Although highly indicative of the presence of military forces, it dates from the Early Roman Period and there is no evidence of later occupation.

WF1415 is a fortified building acting as a mining control site; its proximity to the mines and the solid construction are suggestive of a military presence. There are other sites in the Wadi Fidan that can be interpreted as military in construction. Fidan 77b, 97 and 619 are large rectilinear structures with thick walls suggesting fortifications. Fidan 77a, 50a, and 617 are similarly fortified and, due to the volume of collapsed stone, were likely towers (Anderson *et al.* 2004b; Levy *et al.* 2001a; Levy *et al.* forthcoming a and c) (See Chapter 7.4). Without excavation, the exact nature or size of the military presence in

the Faynan is not known, but there is little evidence for a full garrison.

If soldiers were present but not numerous, what roles could they have played in the community? Often the military is assumed to be present for martial reasons, but they could equally have been acting as a policing force, in this case to prevent theft and regulate the convict or slave populations (James 2002, 37). An equal threat may have come from the free miners who presumably would have been slightly healthier, more able bodied and able to cause more trouble. From this perspective it is difficult to explain the lack of a strong military presence without taking into account the landscape itself. It can be postulated that because of the topography of the Faynan, it did not require a large number of soldier to be secured. The constricting shape of the Faynan-Fidan corridor makes it a naturally contained landscape. The mountain ranges surrounding the valley are not impossible to cross, but certainly difficult. The semi-arid environment also inhibits escape, as the springs are located in the wadis. Travel away from them would require knowledge of other water sources. Human movement is encouraged to follow the wadis, near human settlement and within areas overseen by the administration. Escaped slaves or rebellious workers would not be able to travel with ease across such terrain. A small number of soldiers carefully placed at the entrances and exits to the wadi system and along the main routes of access could easily oversee most of the travel through it (see Chapter 7.5).

However, should problems requiring large-scale military action have arisen; the Faynan was located within a dense network of forts, any of which could have sent a military force. Legionary base Udruh, located 12km outside of Petra, is a two day march from the Faynan (Isaac 2006, 217). Small fortlets were located on the main road to

Mampsis, others at Tlah, Hazeva, and Bir Madkur (Fig. 6.9).

This is similar to the situation seen in the Egyptian quarries and Las Médulas (see Chapter 1.6). It does not appear that one needed express permission from military officials to travel along major routes such as the *Via Nova*, as one did along routes in the Eastern Desert (Isaac 2006, 219). However the multiple garrison points and fortlets at road junctions were ideally placed to monitor traffic, including that which went into the Faynan, and it is unlikely that there was unrestricted or unsupervised access to the region by road. The southern Levant as a whole underwent increasing militarization with the creation of the *limes* and Emperor Diocletian's reforms (Parker 2006, 5). A regular network of legionary bases, forts and fortlets were built where necessary along the empire's borders. Large numbers of soldiers were stationed in the Levant and near the Faynan at all times.

Eusebius mentioned that when convicts misbehaved and formed a ministering community, they were turned over to the military leader of that region (*MP* 13.4). Whether this meant an individual within the Faynan or an extra-regional commander is not clear. However, during the crisis military force was supplied, likely from nearby garrisons, and order was restored.

The other martial role of a garrison is to protect against outside threats. There is no documentation for these in the Faynan, but, like other parts of the empire, brigands and raiders could have been problematic from time to time. How great a problem outlaws were in the Levant is under debate. Isaac suggests there was a serious but intermittent problem originating from within the borders of the empire. The army was stationed along

the roads acting as a police force against highwaymen and rebels (1984, 186). Banning suggests that the relation between nomadic and sedentary groups are too often assumed to be negative, that pastoralists had a more symbiotic and positive relationship with settled communities, and that the idea of marauding nomads is overemphasised (1986, 25). The threat of nomads or raiders may not have been frequent but certainly these external threats could affect *metalla*. An *ostraca* from Mons Claudianus records that the author was terrified of an attack; so much so he did not eat for days (Maxfield 2001, 160). The threat of brigands may have been a serious one for slow moving caravans including those that transported valuable goods to and from the Faynan. This may explain the placement of watchtowers such as Fidan 50a, at the wadi entrance in order to give advanced warning and muster an appropriate response if raiders approached (see Chapter 7.5.2).

While many of these tasks of protection and maintenance of order through physical violence are normally assumed to have been performed by the Roman army, these duties could be carried out by non-military personnel. For example, the control of convicts would have required physical force, but how much is not clear, since Eusebius describes these convicts as crippled as part of their punishment (*MP* 13.1). Armed civilian personnel may have been sufficient to maintain control, backed when necessary by a small garrison. Certainly the small mine entrances could be controlled by a single individual, even by people without military training, the exits being blocked easily, (Grattan pers. comm.).

Soldiers did not have to be present only for policing reasons. The army was often used as an organisational body in the empire, a form of infrastructure. Engineering tasks often fell to them and certainly the difficulties encountered in copper mining would

require expert knowledge. Kind *et al.* suggests that the main purpose of the soldiers could have been mining management rather than any martial tasks (2005, 192). This is certainly possible; many mines in the Roman Empire provide evidence of being managed by the military (Davies 1979, 15; Jones and Mattingly 1990, 180). At Mons Claudianus the *ostraca* and epigraphy suggests that the organisation of transport and supplies fell to the army (Maxfield 2001, 151). Nor were they the majority of the population, of 900 individuals only 60-100 were soldiers. Their martial or policing duties would have been light (Adams 2001, 183). Soldiers in the Faynan may have had similar responsibilities; the challenges of supplying the region were complex and may have required logistical skills commonly found in the Roman army.

Kind *et al.* argue that the finding of large numbers of Roman coins dating to the 4th century at Faynan supports the presence of a military garrison (2005, 192). Similarly, they believe that the decline in coins after the 4th century parallels the withdrawal of troops and the ending of the copper industry. It is true that there are many examples of other *metalla* that have an intense exploitation period, involving use of the army, usually during conquest, followed by a deregulation of the mines or the hiring of civilian contractors. This appears to have been the case for iron production in parts of Roman Britain (Schrüfer-Kolb 2004, 104). However, as stated earlier in Chapter 2.6, the interpretation of the coin evidence is faulty and does not prove either an increase or decrease in military occupation.

I argue that there is no strong evidence that there ever was a large garrison at Faynan and that the Faynan copper industry was not dependent on large numbers of soldiers to function. If there were soldiers stationed in the area over the long term, they

were not likely to be engaged in martial activities or policing the region, but instead were the *metallum*'s staff in charge of logistics and administration. The lack of a constant, strong military presence in the region does not suggest the end of imperial ownership; instead it should be understood within the context of a naturally restricted landscape and the *Limes* network. This is a difference between the Faynan and the other *metalla* that have more evidence of long-term military presence. However the Faynan's administration had the support of the military when necessary; this ability to draw on State resources is another hallmark of an imperial *metallum*.

6.7 Monumental Architecture

Monumental architecture had long been employed in the Roman Empire to display wealth and power. Typically these were large structures of expensive construction designed for the purpose of being seen. Unlike other urban settings, there was never a strong tendency for euergetism in the Faynan. The community did not have many public structures and does not seem to have been participating in public building programs, with the exception of churches in the Byzantine period.

The population of the region was never large, possibly numbering around 1,860 at most (Appendix 5). Although there is evidence for class stratification there are no indications of very wealthy elites. This is reflected in the local architecture, some domestic structures were more elaborate, the farmsteads for example, but nothing extraordinary was owned by a private person. The wealth of the elite may not have been enough to produce monumental buildings or the emphasis in the Faynan was not centred on civic life.

Given the small regional population it is remarkable that there were any monumental buildings at all. The largest and most complex structures in the Faynan prior to the Byzantine period were those linked to the administration and the copper industry. These include the fortified buildings, the barrage and the aqueduct/reservoir/mill complex of WF11. The aqueduct is a structure imbued with multiple messages about power and public access. The first is of skill in engineering and the investment of resources. The initial construction and the continual upkeep required capital. Another message is contained not in the structure itself, but in the water that it carries. In a desert environment, the significance of water cannot be overstated. An individual in the Faynan is acutely aware of the need for water, especially in the summer months. By supplying water to the Khirbet, the administration ensured that the community was indebted to the builders and maintainers of the aqueduct. Yet the majority of the water brought in by the aqueduct was not consumed by humans. Instead it was stored in a reservoir and used by the mill (Barker *et. al* 1999, 277). These water-bearing structures, their placement within an industrial zone and their consumption of resources can be seen as physical manifestations of imperial power (Ellis 1997).

The industry itself also produced monumental features, although these were unintended side effects. Mines were monumental constructions in themselves, notably Umm al-Amad. Even if one did not venture inside the mine, tailings would be a sign of the effort put into the extraction industry. The act of smelting also created an unintended landmark. Smelting produces many toxic by-products and one pollutant that is visible even in the present day is slag, which litters the wadi banks. The black colour of the WF11 slag heap stands out in stark contrast amid the earth tones of the Wadi. The

sizeable pile produced would have had an impact on viewers, reminding them of copper production even on days when it was not occurring.

A discussion of the monumental structures of the Faynan must include mention of the churches; however, their link to the administration or the copper industry is not clear. There may have been a substantial change in society in the Late Byzantine period, the new architecture indicating a rival purpose in the Faynan. Five churches are indicated by the surface remains, these may have been built over earlier versions. It was not uncommon for smaller communities in the Levant to have an excess of churches in relation to population size (Watson 2002, 496). The Faynan, given its history of Christian martyrs, would have been an ideal pilgrimage destination. It certainly had a religious importance; a bishop from *Phaeno* attended the Council of 431 at Ephesus and 451 at Chalcedon (Sartre 1993, 145). The churches may have been built by money collected from religious tourists. An alternate source of funding is from the members of the community. Certainly a bishop qualifies as a member of the elite, capable of organising construction. This change in monumental structures reflects the evolution of power and wealth over the centuries and perhaps a period of waning copper production.

6.8 Controlling Resources

There were two limited resources in the Faynan, food and water. It has been mentioned that food supply was not sufficient to feed the entire population (see Chapter 6.3). The inhabitants would have been largely dependent on the administration to supply them with provisions. Control of individuals in the landscape could have been accomplished through the restriction of food. However, there is no clear evidence that

this stratagem was employed. There are no known central depots for food distribution or evidence of its restriction to anyone, it is not even mentioned by Eusebius as a punishment for the convicts, though it is unlikely that this lack of mention means they were fed regularly. As for the free miners I have argued that the entrances of the mines were purposefully small to restrict workers movements (Chapter 6.4). It would also be easy to prevent the miners from getting food or, potentially, air supply.

The most critical concern in the southern 'Arabah region is the supply of water. Despite the wetter climate of the Roman/Byzantine period, precipitation was never abundant. The Faynan had careful water management stratagems in place, for example the complex irrigation of WF4. The Faynan, unlike the rest of the Wadi 'Arabah, has perennial springs that provide water to the region. There are five springs presently in the region: three are located in the tributaries to the Faynan in the Wadi Ghuwayr, Wadi Dana and in the Wadi Shayqar; a fourth spring can be found in the Jabal Hamrat Fidan (Raikes 1980, 40). The fifth is located in the Wadi al-Ghuwayb Rawani (Levy *et al.* 2003, 249).

There is no evidence from the survey data for structures near springs that indicate they were guarded or monitored. The exception may be Fidan 50a that may have been next to, or incorporated within its walls, a well (see Chapter 7.4.1). However, given the damage done by bulldozers it is unknown whether the well was even in use during the Roman or Byzantine periods (Anderson 2004b). Fidan 120 has a commanding view of the 'Ain Fidan spring c. 1km away, but there are no local structures nearby. The barrage WF441 had standing water on occasions and, although heavily polluted, it could have been drunk from in desperate circumstances. Its size, 65m long, would make it difficult to

check usage (Barker et al. 2007, 315). Thus, while restricting access to water was a likely means of control, there is no way of exploring this supposition at the present time.

The lack of food and water would also inhibit travel outside the Faynan region. To the west and south is the Wadi ‘Arabah, an arid environment with few water sources. Once the “Arabah is crossed there are water sources.. The closest to the west is ‘Ain el Huferia, 13km from the mouth of the Wadi Fidan (Google Earth). However, in order to survive, one would have to know the location of these water sources. Without this knowledge travel outside the Faynan to the south or west would be difficult if not deadly.

To the east, up the Wadi Dana and on the Jordanian plateau, water is abundant; it can be reached within a day’s travel. Today the town of Dana has multiple springs used to irrigate gardens (Lancaster and Lancaster 1999, 73). Yet the Wadi Ghuwayr and Dana have relatively small entrances that could have been guarded, thus preventing access to the entire area rather than guarding each spring individually.

Food and water are two vital requirements for life. While control of these resources by the administration would constrain individuals’ behaviours, it is known from Eusebius that illegal actions took place regardless of any preventative steps taken by the administration. It is likely that access to food and water was one of the means which the administration could use to regain control during a revolt, but currently there is no evidence for how this control would have been implemented. A future area of research would be excavation around ancient water sources, looking for administrative structures.

6.9 Conclusion

Maxfield argued that the hallmark of a metallum was a powerful administration that could organise production, logistics, and supplies. The Faynan had such an administration and evidence for it is seen most prominently in the implementation of the integrated field system. It is also demonstrated in the ability to supply the Faynan with food and fuel. Rothenburg and Blanco-Freijeiro believed imperial ownership could be discerned from the scale of production, especially in environmentally or topographically challenging locations (1981, 174). Faynan copper production was at a scale beyond what the local environment could support. The degradation of the vegetative environment meant fuel was scarce. The local agriculture output was not able to meet the needs of the estimated population. The industry thus required a continuous source of supplies orchestrated by the administration. The ability to continue copper production despite these challenges is a hallmark of an imperial *metalla*.

For Hirt, the evidence of State ownership lies in the use of government institutions such as the military and the presence of convicts, the *damnati in metallum* (2004, 79). The presence of convicts can be inferred from certain features, such as mine entrances, and corroborated by the textual evidence of Eusebius. The presence of the military is not certain; it does not seem to have been a strong presence, although the military are commonly expected in *metalla*.

Also observable in the archaeological record are the effects of colonialism and what Given termed ‘settlement of empire.’ Infrastructure to facilitate production and transportation, and monumental utilitarian architecture related to the industry were visible

throughout the region. The monopolisation of resources and creation of industrial facilities are all indicative of empire.

The archaeological, landscape and textual evidence all indicate that the Faynan was an imperial *metallum* with the hallmarks of a powerful administration capable of dealing with the logistical and managerial issues involved in the running of a large-scale industry. In the next chapter I will examine in depth another feature common to imperial *metalla* and found in the Faynan as well. Observational structures (watchtowers, etc.) are common features and after reviewing the evidence for these in depth, I will put forward a theory of a landscape of surveillance.

Chapter 7 – Surveillance and Control in the Faynan

7.1 Introduction

As was demonstrated in previous chapters, the landscape of the Faynan was altered by the imperial administration in order to meet the requirements of the State. Focusing more closely, some of the mechanisms the administration utilised to accomplish this task can be discerned. A way to study the exercise of the State's administrative control is to explore aspects of its power and organisational ability in achieving visual control across the landscape. In exploring the topic of visual control through surveillance, a GIS was employed that provided the tools necessary to study themes of visualisation. Viewshed analysis was used for this research in order to enhance the existing argument of administrative power and make the argument more robust.

7.2 Viewshed Analysis

A variant on the traditional GIS based viewshed analysis was used in this project to discover which sites are the most visually striking and prominent, how sites stand in visual relation to one another and whether there are broader patterns of inter-visibility within the Faynan. This is especially relevant when determining methods of control and the implementation of power through visual prominence. Viewshed analysis involves a calculation carried out upon a digital elevation model (DEM) with the aim of mapping areas in and out of view from a given viewpoint. In this way a calculation of what can theoretically be seen from that point can be made from any point on the DEM (Wheatley

and Gillings 2002, 204). This calculation produces a raster based map layer that encodes whether intervening cells are visible from the observation point, assigning them a value of one or zero.

Viewshed analysis is a useful technique in estimating potential visibility, and also for beginning to model aspects of cognition (Llobera 1996). For example viewsheds can indicate if visual prominence in the landscape, inter-visibility between sites, or reciprocity of view were factors in the placement of sites (Conolly and Lake 2006, 224). Sites can be placed so as to draw attention to them or be hidden from sight, perhaps for religious or strategic reasons. A number of studies have been conducted using this technique to examine these aspects of human spatial organisation (Lock and Harris 1996; Llobera 2001). For example, viewsheds created by Woodman (2000, 103) suggest that one factor in the placement of Orkney Neolithic tombs was the visibility of the surrounding area from the tombs.

A more complex visual model can be created through what has been termed a Cumulative Viewshed analysis (CVA) (Wheatley 1995, 173). Cells of the raster map, in this case the DEM, record the total number of other viewpoints from which it is visible (ie. how many times it is seen). This process can identify the areas of the landscape that are the most visible (i.e. are included or overlapped by the most viewsheds from the site locations), or the areas that provide the best field of view of the selected point (Llobera 2003, 33). Such studies can answer questions about inter-visibility. For example, a cumulative viewshed was used to discuss the placement of long barrows around Stonehenge. It was determined that one of the reasons locations might have been chosen was because of the ability to see other barrows from them (Wheatley 1995, 179).

A further development of CVA is the creation of a ‘total viewshed.’ A cumulative viewshed is created from all possible locations on a DEM rather than specific sites. A viewshed is made from each cell and the value recorded is the number of other cells visible (i.e. cells that cell can see). This technique can be used to determine visual prominence.

The DEM created for this project had a 10m resolution (Number of cells on x-axis: 1883, Number of cells on y-axis: 1610). Although creating a total viewshed from this resolution would have made a very detailed map, it would have been very time consuming. Instead a systematic set of sample points was taken to calculate the total viewshed (for discussion see Llobera *et al.* 2004). This decision was based on the fact that during this stage of the research the GIS normally used, Geographic Resources Analysis Support System (GRASS) released an updated version with which the r.cva program no longer worked. This meant that instead of an automated program, each viewshed had to be made separately, greatly increasing the amount of computation time. Therefore the DEM was aggregated to decrease the resolution to 50x50m within a square. This lower resolution raster was then used to generate a 50m grid of 982 viewpoints. A viewshed was created for each point and the number of cells that could be seen was totalled. These values were then used to create a total viewshed that could be used to explore broader visibility patterns.

No total CVA is an exact replication of the landscape, but it must be said that the one produced for this thesis is of low resolution. It is an approximation and cannot translate directly into the landscape structure of the past, but this is not its intended purpose. CVA and total viewshed offer a way to explore themes of prominence and

visibility from which further discussion can be generated.

7.3 Estimating Ability to See

It is important to clarify that the aim of this visual analysis is not to accurately model an individual's ability to see, as this involves far more nuanced variables than are considered here. As stated, visibility in the landscape can change, and each viewer has his own height and ocular acuity. Factors such as the weather, time of day, and amount of sunlight or air quality also affect one's ability to see. Instead the research was designed to delineate a 'typical' field of view that could serve as a useful point of departure in considering past social organisation.

There are a number of factors to consider when performing visual analysis. Objects can obscure or block line of sight. This is most commonly a problem when considering the impact of ancient vegetation (Gillings and Wheatley 2001, 32). In the case of the Faynan, evidence from environmental reconstructions based upon pollen analysis show that large-scale vegetation had largely been exhausted during the Iron Age (Hunt and Mohammed 1998, 21-23). This means that the "tree factor," vegetation that would obstruct views, does not need to be taken into account in the current study (Gillings and Wheatley 2001, 32). However there are other factors common in a semi-arid landscape that could have affected visibility. The first is the sun. In a desert environment this can limit visibility due to brightness and heat wave distortion. Another is wind-blown sand. Sand storms are frequent during the winter months and also occur with frequency in the afternoons during summer. Finally, a by-product of smelting would be air pollution, which could create a significant haze effect. Pollution inhibits visibility

in a noticeable way. The particles and gasses present in the atmosphere reflect and refract light, causing it to scatter. This scattering affects the light wavelengths and the colour and clarity of what can be seen (Malm 1999, 13). The longer the vista, the more pronounced the effect becomes. The ability to distinguish objects at a distance is dramatically reduced.

In order to more closely model visibility patterns in the Faynan, a limit was set as to how far any viewshed extended. Wheatley and Gillings (2000, 15-20) used a model of 6.2km stating that this distance is representative of the point past which the human eye can not clearly distinguish objects. Their estimation was based on Higuchi's (1993) study of Japanese forests, an environment very different from the semi-arid desert. Given the limiting factors commonly present in the Faynan, bright sunlight, dust and pollution, this author considered a visibility range of 6.2km overly optimistic. Therefore for this study the distance at which an individual can still distinguish objects was chosen to be 4km. This figure was based on personal experience and research in the Faynan, which took place during different seasons (Fig. 7.1 and 7.2).

This limit was imposed because a view and the ability to distinguish objects at a distance are two different things. For example, from Khirbet Faynan views can extend to the Fidan. Although the mountain range can be seen, individuals on it are not distinguishable. If objects are large or moving, for example herds of animals, it is easier to identify them at a distance. What the 4km figure represents is an average estimation of the limit of clear vision; since viewsheds are primarily used in this project in discussion of individuals and the places where they are visible in the landscape. I considered 4km to be an appropriate distance to recognise a person and determine their actions. The

representative height of a human adult was chosen to be 1.75m (Gillings and Wheatley 2001, 33). Again this height is not used in an attempt to directly model every individual's ability to see; actual persons would have been of varying heights. For example, the skeletons of children were excavated from the cemetery WF2 (Karaki 2000, 46), but their viewpoint is not being simulated in this exercise. Like the other factors, this representative height has been chosen to create a plausible model of visibility that can be used for further discussion.

Viewshed is often used by archaeologists to create cognitive maps and explore cultural meanings of a landscape (Gaffney *et al.* 1995; Llobera 1995, 1996). This thesis does not seek to explore in any strict phenomenological fashion individual perception or experience in the landscape. This is not to say that such perceptions are not important; however they are not explored here. Like any landscape, the Faynan may have had multiple meanings to different individuals and this could form an important avenue of future research. However, given the scope of this project, visibility analysis is being used expressly to explore themes relating to surveillance and messages of power.

7.4 Structures Used for Observation

What observational structures exist in the Faynan and what understanding did Romans have of them? Observation towers have long been used in the Levant. Clark and Parker (1987) suggested that the best way to identify these structures was in terms of their placement in the landscape. They should have excellent views, be located near an object of interest such as a water source or wadi opening, and be placed within a network of military sites (1987, 171). The Faynan has a number of fortified structures that are

possible watchtowers Fidan 50a, Fidan 617, and Fidan 77a, located near the wadi's entrances and exits (Levy *et al.* 2001a, 175-176; Levy *et al.* forthcoming a, forthcoming c). This interpretation is further strengthened by the sites' fortified walls and, in the case of Fidan 50a and 617, an amount of wall collapse suggesting multiple stories (Anderson *et al.* 2004b; Levy *et al.* forthcoming a, forthcoming c). The wider region also had sites with towers of multiple stories incorporated into them, WF1415 exhibits these features; there were two towers and perhaps a third multi-story component to the site (Fig. 5.22). Another building with fortified aspects is the central building on top of the Khirbet. It was located at a high point with excellent views in all directions.

The interpretation of these sites as martial is based on their morphology, but, as discussed in Chapter 6.6, civilians may have been performing "military" jobs. This was the case for Mons Claudianus where the ostraca mention *skopelarios*, operators of the observation posts, believed to be civilians (Peacock and Maxfield 1997, 255). The suggestion that these observation posts were operated by civilians in no way detracts from their potential role as vehicles for the management of the region and its industry.

Other tower structures in the Levant built during late antiquity have been interpreted as civilian fortified farms, elite constructions related to private defence (Decker 2006, 520). Yet the Faynan does not experience much elite construction until the Late Byzantine period (see Chapter 6.8) and the pottery finds suggests use of these buildings before this point. These sites in locations at the ends of the wadi or near the Old Road, instead of bordering fields, do not support an interpretation as fortified farmsteads; it is much more likely that they were related to observing traffic in and out of the wadi system.

As seen in the comparative case studies discussed in Chapter 1, observation structures were used in *metalla*. Mons Claudianus and Porphyrites had both towers and *skopeloi*. At Mons Claudianus *skopeloi* were dispersed throughout the region, providing views of the quarries and perhaps acting as communication stations (Fig. 1.7, Fig. 1.8) (Peacock and Maxfield 1997, 254). At Mons Porphyrites they were not located for the most expansive views but in order to form a system and were inter-visible. The only quarries that were not in view of a *skopeloi* were those visible from the fort.

There are also military structures at the entrances leading to the regions. At Mons Claudianus a tower near the *Hydreumata* had a view up to 7km distant. It had a good view of the fort and surrounding wadis and could provide early warning of anyone approaching the region (Peacock and Maxfield 1997, 254). The Badia Fort and its towers acted in the same way. It guarded the southern approach to Mons Porphyrites and protected the animals and water supply (Peacock and Maxfield 2007, 417; 419). The footpath station and watchtower were built during the same period to monitor this exit from the region (Fig. 1.4) (Peacock and Maxfield 2007, 419). These visual platforms fulfilled two different functions; the first was surveillance of approaches and the second was observation of the internal industry. In this chapter we will see that structures in the Faynan can be interpreted as being placed to fulfil both of these purposes, as they were at other *metalla*.

7.4.1 The Estimation of Tower Height

Towers of these periods rarely survive to their original heights and this is certainly the case for the Faynan. None of these structures are complete, nor have they

been excavated with the exception of Fidan 50a. Recorded in 1998 by the JHF survey, this site yielded substantial amounts of Roman pottery (Anderson *et al.* 2004b, 1). The structure had partially collapsed into the wadi and cut stone blocks were visible. After this initial survey the site was bulldozed. Emergency excavation took place in 2004 (Anderson *et al.* 2004b). The damage was severe and greatly hinders interpretation; however some conclusions can be drawn. Pottery dating to the Nabataean/Roman period was found (Anderson *et al.* 2004b, 1). A well was located in close proximity, but it is unclear if it is contemporary with the Roman structure. Two wall corners were identified 6.8m apart (Fig. 5.17). Most Roman watchtowers are square, but no corresponding walls were found 6.8m apart in this instance. One hypothesis is that the tower was an irregular rectangular construction, 7x10m in order to include the well (Anderson 2004b, 8). It is also possible that the damage from the bulldozer destroyed the remaining sections of the wall.

The Limes Arabicus Project conducted a survey exploring the military frontier in central Jordan (Parker 2006a). They recorded multiple watchtowers and fortified structures that offer a context for Fidan 50a. While rectangular typology was rarely seen in watchtowers, there were some examples (Parker 2006a, 31). The most notable feature of Fidan 50a is the type of construction used for the tower, *opus quadratum* with mortar (Anderson *et al.* 2004b, 6). This style of masonry and the use of mortar are rare in Jordan, most buildings being of less substantial construction. Examples of such towers usually measure 8x8m to 10x10m (Parker 2006a, 32). The Fidan 50a tower was likely similar to these; the Limes survey team posit that this type of tower can be dated to the Late Roman/Early Byzantine periods.

Unfortunately, in the exhaustive study of the *Limes* by Parker, no estimations of tower heights were given. A well preserved example of a *limes* tower is Qasr Abu Rukba, which survives to 7.7m in height (Parker 2006a, Figure 2.11) (Fig. 7.3). It is similar in appearance to the Late Byzantine tower within Khirbet Faynan. However Qasr Abu Rukba was an exceptional construction (10x10m), larger than Fidan 50a and, in the author's judgement, not an entirely appropriate comparison. Other scholars have offered estimations of the height of towers. Hermon and Fabian at the Avdat military camp used the remains of the towers and graffiti that was found on a local building to infer a tower height of 12m (2002, 106). A Roman military fort, Tabus, located in the Euphrates valley, was estimated to have 15m high towers (Lönnqvist *et al.* 2005, n.p.). Fortifications in the Faynan, such as WF1415, are not 'typical' in form and are smaller than these other examples.

Because the towers of the Faynan are not well preserved, an estimated tower height was created based on other case studies, but using a more conservative height estimate, reflecting the circumstances of the Faynan. Two average heights were used for the viewsheds. The height of the substantial towers, such those incorporated into buildings like WF1415, was set at 10m (including human height). Viewsheds created from free standing towers were calculated from a height of 6m (including human height).

The heights chosen are informed and contextualised calculations; however they are estimations. It must be emphasised again that this chapter is not studying individual views or attempting to find exact heights of people or buildings. Further excavation may prove these height estimations inadequate, yet this does not detract from the ability to use viewshed to further theorise about observation and surveillance in the Faynan landscape

(see Wheatley and Gillings 2000, 8-9).

7.5 Using the Landscape and Views in the Wadi Faynan

Khirbet Faynan is positioned at the base of the route up to the Jordanian Plateau and at the junction of the three main tributary streams of the Wadi Faynan. This central site of Classical habitation has observation structures within it and some in close proximity. One is the tower located outside of the main Khirbet that provides visual coverage of the Faynan floodplain (Fig. 5.4). Although it is a substantial fortification it probably dates to the Late Byzantine period after the zenith of the industry (Ruben *et al.* 1997, 436). It is not clear that this structure is linked to the administration of the copper industry, therefore will not be discussed in depth here.

Another fortified structure that is linked to the administration is the central building. At the summit of the tell, it is ideally placed to facilitate visual survey of the Wadi Faynan. It has unobstructed views in all directions; covering the easternmost major entrances to the wadi system. Standing on its remains presently one can see the Wadi Dana to the west, and Wadi Shaygar and Ghuwayr are visible from the east side of the building. Observing from this point, it would be difficult for someone to pass from the Wadi Faynan to the Jordanian plateau or to travel up any of the side wadis without being visible (Fig. 7.4, Fig. 7.5).

The present view from the central building also covers the entire western bank of the Wadi Faynan. This includes the satellite communities and the industrial site of WF11. It has been argued by the author that the main smelting sites were located near the

Khirbet for logistical reasons as well as to exert authority over the product (see Chapter 6.5). A surveillance system may have been one of the means of control employed. It is likely that the smelting process was monitored from the central building to ensure safety of workers, quality of ingots produced, and to prevent theft.

Further west from the Khirbet is another fortified site WF592, the Nabataean fort (Fig. 5.11). Although this was principally a Nabataean site, there is limited evidence of Roman period reuse. Located on a high hilltop, this site has excellent views encompassing most of the wadi landscape. To the east, it can see and be seen by the Khirbet and signalling between the two was possible.

WF592 would also have fulfilled an important function, facilitating the monitoring of entrances and routes into the wadi system. A viewshed generated using the summit of the hilltop as an observation point illustrates this. From WF592 the road leading to Umm al-Amad was visible. The transportation of copper ore from these mines to WF11 could have been monitored. The visible area also extends to the beginning of the Gap and the sand dunes in the west (Fig. 7.6). This was where the route out of the region to the south cut below the Jabal Hamrat mountains to join the Wadi ‘Arabah (Fig. 5.14). This was a heavily trafficked passageway; supplies from ‘Aqaba such as pottery indicate that the two regions were in contact (see Chapter 6.3.1). If this site continued to be used as an observation point then the major route into the central Faynan was under surveillance. As it was within signalling distance, the Khirbet could have been given advanced warning of approaching caravans or threats. However, there is no evidence of Late Roman or Byzantine occupation. Given the visual coverage WF592 provides this is surprising. While it is tempting to suggest that further study will confirm later activity,

the lack may reflect a deliberate choice not to use the site. One theory that can be presented is that during the initial creation of the *metallum*, pre-existing sites were used for convenience. Later the administration constructed purpose-built structures to better meet the needs of an industrial *metallum*; rendering the WF592 observation point unnecessary.

7.5.1 Wadi Fidan

The most complicated situation involving line-of-sight is in the Wadi Fidan. Examining the Total Viewshed for the Faynan, the Wadi Fidan stands out as a unique visual area in the landscape. The area offers poor fields of view, so observation and surveillance are difficult to achieve (Fig. 7.7; Fig. 7.8). The CVA also shows the Wadi Fidan is not prominent; the corridor is not frequently seen from other points in the landscape (Fig. 7.9; Fig. 7.10).

There are structures in the Wadi Fidan that, due to their construction, can be postulated as fortified structures similar to military ones, even if they were not staffed by soldiers. Three of them are the possible towers and fortified structures of Fidan 97, 619 and 77b. The pottery collection from the JHF 1998 survey does need further refinement; however, for these sites there is particularly good dating (see Chapter 3.6). Fidan 50a yielded Roman pottery during the survey and Nabataean and Early Roman Pottery during excavation. It had construction forms most associated with the Late Roman/Byzantine period (Levy *et al.* 2001a, 174-175; MacDonald 1992, 252). Fidan 617 had pottery dating to the Nabataean, Early Roman, Late Roman, and Byzantine periods (Levy *et al.* forthcoming c). Fidan 619 had a similar style of construction to the nearby 617 and

yielded Late Roman/Byzantine and Byzantine pottery. Fidan 97 has pottery datable to the Roman/Byzantine period. The pottery evidence and building typology of Fidan 50a, 619 and 97, place them in Category 1-3 on the confidence scale (see Chapter 4.5).

The remaining two sites, Fidan 77a and 77b were Category 4 on the confidence scale, having originally been built in the Iron Age and yielding a majority of IA pottery (67 IA, 5R/B sherds) (Levy *et al.* forthcoming c.). It is possible that these structures were reused in the Roman/Byzantine period. This is not uncommon and was an especially prevalent practice during the Early Roman period (Parker 2006a, 43). Further excavation of these sites would be a profitable avenue of future research.

As stated previously, the Faynan-Fidan corridor provides an easy access route to the resources of the Faynan and the Jordanian Plateau. The Fidan, described as the ‘gateway into the Faynan,’ was significant as an entrance to the region (Levy *et al.* 2001a, 159). Indicative of this importance is the complex monitoring system seen in the Fidan. There are two possibilities to be discussed here, first is that the watchtowers were operating contemporaneously. The pottery evidence, although not conclusive, suggests that these sites had a long history of use and were of similar time periods. The second theory is that the watchtowers represent repeated actions of the administration over time, building observation structures in response to the lack of view.

To test the theory that the towers were all in existence at the same time, viewsheds were created from each of the chosen fortified sites. These viewsheds present a complementary picture; each tower covered a different section of the wadi and these views overlap (Fig. 7.11). These structures line the entirety of the Fidan corridor allowing

contiguous visual coverage of the entire wadi. No individuals would have been able to travel through without being in view a majority of the time. Furthermore, the entrance into the Faynan region has towers placed in such a manner that advanced warning can be provided for any external threats. The viewsheds generated support the idea that the Fidan towers were part of a single system.

Of course it is not certain that the towers were occupied all the time. Constant observation may have only been utilised if the situation required it; for example, to protect a caravan of copper or in anticipation of supply convoys. At other times only a few towers may have been in use. However the associated fortified structures near the towers, such as Fidan 97 and 619, perhaps served as guardhouses and may indicate that the towers were occupied most of the time.

The second possibility is that the number of towers is evidence of an evolving system, modified over time to adapt to the administration's desire for surveillance. Thus each tower and its purpose also need to be assessed individually.

In order to control properly the entrance into the Faynan, the only tower needed would be 50a. Today, standing at the remains of tower 50a, it is clear that it provided visual coverage of the Wadi 'Arabah. Even from the ground, with appropriate weather conditions, the view extends for kilometres and any approach to the Faynan would be easily detectable (Fig. 7.12). The elevated view from Fidan 50a would have been sufficient to identify any dangers approaching and provide adequate warning for external threats.

Another important function of the watchtowers could have been monitoring the

Old Road, the path that connects Wadi al-Ghuwayb to the Fidan and enters the Fidan between fortified sites Fidan 97 and Fidan 77a (Levy *et al.* 2001a, 174-175). Tower Fidan 77a could have performed two functions; first it was the middle tower in the surveillance control chain. Second it was the tower that provided visual coverage of the Old Road. The connecting path to the al-Ghuwayb could have been guarded so that movement between these two wadis could be monitored (Fig. 7.13). As stated before, 77a is a Category 4 site, so it may not have been used past the Early Roman period. Nearby Fidan 97 may have been built as a newer building to monitor traffic. A viewshed created from human height at Fidan 97 does not have visual coverage of the Old Road; it appears that any regulation of access from Wadi al-Ghuwayb without Fidan 77a was physical rather than visual.

Interestingly, although the views from the towers cover most of the habitation in the Fidan, WAG 3 falls out of visual range. This hamlet has no distinguishing features and no evidence of smelting, and the administration may have decided visual monitoring was unnecessary. Another possibility is that this site may have been deliberately located out of view, which would suggest that the population was avoiding monitoring by the administration. The freedom this location offered from surveillance may have been a preferred situation for its inhabitants if they considered surveillance intrusive and negative.

The location of Fidan 617 is also intriguing. Set at the southernmost end of the Jabal Hamrat Fidan, this tower could monitor no external threats. Fidan 617 suggests the administration created a surveillance system that monitored both external threats, such as those visible from Fidan 50a, and internal space as well. The presence of multiple towers,

especially Fidan 617, indicates that while raiders or bandits may have been a concern to the administration, so were individuals in the valley- convicts or workers (further discussion see Chapter 7.9). The placement of watchtowers at both ends of the wadi would monitor traffic both leaving and entering the corridor. Fidan 617 also may have served as a link in a signalling chain, as it was placed outside the visually restricted Fidan and could be seen from the Gap area (see Chapter 7.5.2).

Towers have the advantage of being of greater height, but this is not always necessary; they are not required in many topographical locations where observation posts do just as well. However, the clear choice made by the Roman administration in the Wadi Fidan was to construct visually imposing towers. These towers, some constructed from cut stone with mortar, required a great deal of effort to create. It can be argued that they were monumental structures designed to facilitate views and also substantial structures designed to be seen themselves. Yet, as the total CVA shows, despite their imposing nature, they are placed in the least prominent area of the landscape, instead of where they would be visible from many parts of the landscape. An individual had to have been *in* the Wadi Fidan to see the towers and, because of the twisting nature of the topography, would not be able to see all of them at once. Given the physical form of construction, the towers can be interpreted as symbols of imperial power, conveying a message of strength and unequal status between the viewed and the viewer. Structurally separated into three encounters, an individual travelling the wadi would experience the imperial message repeatedly and for the entire 3km of the wadi's length in either direction.

Although the Fidan is an area of little visual prominence, it is an important passage where structures were frequently seen by travellers and inhabitants. Given the

need for supplies (see Chapter 6.3), travel in and out of the Fidan would have been continuous. The wadi path is narrow and steep in many places and this would create a well travelled and rarely deviated route. Thus, although each tower would only be visible from a small portion of the landscape, that portion would be frequented more often than other areas of the Faynan region. The large numbers of individuals viewing the structures means that statements conveyed by architecture would be significant for individuals, even if not prominent in the landscape.

Given this, it is perhaps not surprising that the Fidan was the wadi with the largest number of towers. Unlike the Faynan, this passage is impossible to control visually without multiple observation points. A series of observation structures were built that physically testify to the administration's understanding of the visual vulnerability of the Fidan corridor.

7.5.2 The 'Gap' Area

The final area to be discussed is the Gap (Fig. 3.8). While the route south to 'Aqaba is visible from WF592, the line of sight does not extend past where the wadi bed turns sharply north (Fig. 7.6). In order to maintain observation around this bend it was necessary for another tower or observation structure to have been placed here. Also, if WF592 were not occupied in the Late Roman or Byzantine periods (see Chapter 7.5) another site located here could fulfil its role as the observation point to monitor this entrance. Unfortunately this is the area covered by the sand dunes and the modern village of Quarayqira. The sand dunes and evidence for settlement beneath them have already been discussed in Chapter 5.6 (Fig. 5.14). It is also possible that a watchtower or fortified

site was present to monitor the southern route.

On the east side of the wadi, opposite the modern village, the survey conducted by the author did locate possible observation posts, similar in form to the Egyptian *skopeloi*. One of these mentioned previously in Chapter 3.10 was Site 6. This site would have offered spectacular views that, under the right conditions, would extend from the end of the Wadi Faynan up to the start of the Jabal Hamrat Fidan Mountains.

Peacock and Maxfield suggested that the purpose of the Egyptian *skopeloi* was as communication stations (Fig. 1.7, Fig. 1.8) (1997, 254). If such a signalling chain existed in the Faynan it was not created by the fortified structures or watchtowers, from these points the visible areas were contiguous but not always inter-visible. For example, Fidan 617 did not have direct line of sight with any structures that may have been located where the sand dunes are today, or with WF592 (Fig. 7.11). However an observation post in between, visible to both sites, could convey a signal. Site 6 could have operated in this regard, creating the visual link between the fortified structures WF592 and Fidan 617. This would allow for the rapid communication across the Faynan-Fidan corridor.

A tower or watch post would have fulfilled multiple functions in the Gap area. Other entrances into the Faynan region have fortified surveillance structures; it could be expected that the Gap would have had them as well. An additional survey of the west bank of the wadi as well as the sand dunes would be essential to locate and date this type of site. However, observation posts located on the eastern bank would have allowed for further visual coverage of the route south to 'Aqaba. Given the natural elevation these observation structures occupied, multiple storeys or towers were not needed (Fig. 7.14).

7.5.3 Summary

All major entrances and exits of the Faynan region had towers or observation structures placed nearby. In the east, Khirbet Faynan itself was positioned at the entrances to the Wadi Faynan. It was at the base of the routes up to the Jordanian Plateau and the view from the central building provided visual coverage of the surrounding wadis (Fig. 5.2). The Wadi Fidan had freestanding watchtowers that could monitor movement. Finally WF592 was able to monitor the route south. This route could be further monitored from observation posts in the Gap area.

Thus, guarded by a surveillance system and perhaps aided by a signalling scheme, a bounded space was created with minimal effort. Although the ability to distinguish individuals would extend only so far, large groups, fires or movement would be visible at a greater distance. The arrangement of the Roman and Byzantine surveillance sites throughout the Faynan region shows evidence of careful thought; they create a largely seamless system of observational control.

7.6 Smelting Sites

As noted in Chapter 6.6, WF11 and other sites near the Khirbet were not the only places in the Faynan region where smelting may have occurred during the Roman and Byzantine period. Seven sites in the Wadi Fidan yielded metallurgical remains (Levy *et al.* 2001a, 175-6; Levy *et al.* forthcoming a and c). These sites were never practicing metallurgy on the same scale as the WF11, being much smaller operations (Fig. 7.15). However their presence in an imperially controlled valley is curious. There are two

possible explanations for this finding. The first is that these sites were not contemporaneous with WF11 and their activities do not coincide with the industrial operations of the Faynan *metalla*. Another interpretation is that these sites may represent private smelting performed by the local inhabitants of the Wadi Fidan during the Roman and Byzantine periods. I previously pointed out that the Vipasca tablets make clear that ore was closely monitored at imperial *metalla* (FRIA 20-23). If the freedom to smelt independently from the main sites was granted, it is likely to have been at the authorisation of the administration. Supporting this line of reasoning, there is evidence to suggest this metallurgy was visually monitored. Most of the metallurgy sites are visible from a fortified structure. For example Fidan 78, one of the largest metallurgy sites found in the Fidan, is located across from and in sight of 77a and 77b. Likewise Fidan 59 is within view of Fidan 50a, with easy access to the Wadi ‘Arabah. Covert smelting would have been impossible as the air pollution produced would have made such activities quickly apparent. The smoke would have been visible to the towers.

As one of the suggested purposes of the towers was to monitor the area as a whole, it may be coincidental that the metallurgical sites were located within view. They may have simply been situated along the wadi beds without thought to placement in regards to the towers. Equally possible is that the proximity to fortified sites and their guards may have also afforded protection for the metallurgical activities. The placement of these sites may have been actively chosen by the inhabitants of the Fidan for this reason.

However, there is no evidence for smelting sites placed outside of the monitored zone. If they were placed near the hamlet WAG 3 or in the Gap Area, they would have

been invisible and unguarded. Instead they were being monitored, as were other smelting sites in the region. It is possible that the mines of the Wadis al-Jariya and al-Ghuwayb were worked intermittently, with ore transported to the Wadi Fidan along the Old Road that was guarded by watchtower Fidan 77a or fortified building 97 (Fig. 7.13).

7.7 Panoptic Control

So far the discussions of surveillance in the Faynan have been relatively straightforward. The Fidan has been identified as a visually weak point in the bounded space and ‘shoring’ it up with carefully placed towers designed to facilitate observation makes functional sense. However there are situations in the Faynan where power relationships and visual control are much more complex.

Of particular interest to the situation of observational supervision in the Faynan is the notion of panoptic surveillance. Originally conceptualised by Jeremy Bentham ([1795] 1995) in regards to 18th century prison construction, the phenomenon was used by Foucault to explore ideas of hierarchy and discipline. His discussion was in specific reference to modern society, but the underlying concepts can serve as a useful framework in considering the Faynan landscape (see Foucault [1975] 1991, 195-230). The central idea in this theory is that human behaviour can be modified by visibility (Foucault 1991, 187). That is, the sight or “gaze” of a figure of authority can influence people’s behaviour, act as a strong deterrent towards misbehaviour and thus lead to greater self discipline. Put another way, the power of ‘mind over mind’ is exercised (Foucault 1991, 206). A few individuals, if placed at key points, can monitor and control the actions of many through the power of the gaze. Architecture is an essential element, both in

providing the viewing area, and in emphasizing the unequal power relationship that might exist between the viewer and viewed (Foucault 1991, 201). The structures themselves become a mechanism of power, further acting to control behaviour. Another central concept is that the viewers (in this case the authorities) are hidden and, although they can view everything, they are not reciprocally visible to the viewed (i.e. the prisoners) (Foucault 1991, 200). In fact, the hidden observer behind a 'blind' was considered to be a more powerful agent of control because the prisoners experienced uncertainty of privacy. Knowledge of the unequal power relationship and the idea of being viewed become so strongly entrenched that actual surveillance of separate individuals does not have to be constant, yet it remains effective. This creates a situation where fear of being viewed and subsequent good behaviour is continuous (Foucault 1991, 201).

Foucault argues that only modern societies use surveillance and psychological factors as a method of discipline, stating that previously control was exercised over the body directly through physical means (Foucault 1991, 216). He further posits that, in the Classical world, view was geared towards spectacle, that society was based on the concepts of the many viewing the few, and architecture, for example theatres, circuses, and temples, reflected this need. In modern society, especially in situations such as prisons designed to enforce discipline, the few watch the many. While Foucault generally puts forward astute analyses, one can certainly challenge the hypothesis that pre-modern societies did not use surveillance as a method of control. Clearly surveillance was used in military situations by ancient societies; the results of the *Limes Arabicus* survey provide abundant evidence of this. The survey recorded 83 sites that were likely towers (Parker 2006a, 31). These were located at the entrances and exits of wadis and were in signalling

distance of each other.

Foucault's application of this theory to industry is relevant to this discussion; "Surveillance thus becomes a decisive economic operator both as an internal part of the production machinery and the specific mechanism in the disciplinary power" (Foucault 1991, 175). The key point is that the power exercised through surveillance can be used not only for the exercise of discipline, but for economic means. This appears to be the situation involving surveillance in the Wadi Ratiye.

7.7.1 Wadi Ratiye

Located off the Wadi Faynan, Wadi Ratiye is c. 3km away (less than an hour's walk) from Khirbet Faynan. Site WF1415 was the main building around which were located a number of settlements (Fig. 5.23). Likely it was the administrative complex in charge of the nearby mines and local workers' community. The central building was a fortified structure with large stone walls. Its eastern wall had two towers both facing *towards* the location of the copper mines. The west side faces a slope and this makes this section particularly vulnerable, but no towers were placed here. This suggests that despite the defensive appearance of the complex, protection was not the primary purpose of the building. Moreover, if WF1415 were merely a control point physically limiting or monitoring access to the Ratiye, it could have been placed at the wadi mouth to prevent entrance. Instead it is located across from the Qalb Ratiye. This region was the centre of extraction in the Roman and Byzantine periods, and almost all the mines in the Qalb were reopened (Fig. 5.24) (Hauptmann 2007, 112).

If a representative height of 10m is used for this study, then the viewsheds

generated from WF1415 can oversee a large portion of the landscape and the surrounding workers' settlements, as well as the route to the Faynan. But of most importance is the ability to view the mines (Fig. 7.16). From the towers the officials at WF1415 would have been able to monitor the workers and extraction areas. Furthermore a CVA created using the mines of the Qalb Ratiye as observation points indicates that WF1415 was in a place of high visibility, one that could be seen often. Workers would know they were being watched (Fig. 7.17). The mines of the valley were visible from the towers; equally the towers were visible from many of the mines.

Building on Foucault's proposals, it can be argued that the administration used surveillance for economic reasons, as a control mechanism to encourage hard work and honesty in managing the ore. The reciprocal view creates a panoptic system that could have been employed to encourage discipline, preventing convict uprisings or worker disputes.

Foucault argued that architecture is an active part of any surveillance system and that the structures themselves encourage discipline. The scale of construction emphasises power disparity between the administration and workers, and psychologically this serves to further inhibit delinquent behaviour. The towers and walls of WF1415 certainly conform to this aspect of the theory as they were designed to be seen. WF1415 has been likened to a movie set; it is impressive and imposing from one point of view, yet in terms of defence, it is insubstantial (Grattan pers. comm.). The walls were large and conveyed messages of power from both near and far distances, which added to the effectiveness of the panoptic control. The view of the towers would make the surveillance of the workers an ever present reality and remind the workers of the power the administration held over

them.

Another component of the surveillance is that while the towers were constructed at a large-scale, capable of being seen from a distance, individuals on them would not have been as visible. The Faynan often experiences bright sun and the glare would make picking out an individual difficult, especially if the towers had shades constructed over them. At certain times of day, one would at best be able to make out a silhouette. Workers would therefore be unable to tell if they were being viewed or not. This would act as the ‘blind’ discussed by Foucault, encouraging good behaviour through uncertainty (Foucault 1991, 201). A worker would know there was a possibility of someone watching and behave accordingly.

The view from the towers is not all encompassing, there were parts of the valley that would have been invisible. Lack of some views of the valley from WF1415 does not mean that panoptic surveillance was not applicable. No worker was ever likely to climb the towers and discover just what their observational capabilities were; in other words they would not know if an area were visible or not. The scale of the towers combined with the uncertainty of privacy would encourage discipline.

There are also exceptions to the reciprocal view from the Qalb; as an individual moves through the landscape, even small changes in topography can block line of sight or reveal features (Tilley 1994, 77). There were areas where the towers were not visible, for example, mine WF1461 can be seen from the towers, but WF1415 cannot be seen from the mine (Fig. 7.19). However, a panoptic system would have encompassed the majority of the valley, including the likely miner’s settlements, which can see WF1415 (Fig. 7.18).

Although workers at mines like WF1461 would not see an architectural representation of the administration when they looked west, the psychological message of control would still be repeated when individuals travelled to and from the housing. Even if there were a rebellion at a mine outside of direct sight of WF1415, the workers or convicts would have *known* they had to exit Wadi Ratiye in full view of WF1415.

These towers may also have had other practical aspects in addition to their surveillance role; for example, signals from the mines would be visible. Within the mines, supervisors would be in charge of controlling the workers and convicts through physical violence if necessary. Only a few supervisors would have been sufficient; many of these mines had the small openings that prevented free movement. A small group could block these entrances, trapping workers in the mines. If a disturbance did occur, staff at the surface of the mines could signal for help.

What can be clearly shown by this visual model is that the majority of the Qalb Ratiye was under surveillance. Moving across the landscape, individuals would be visible heading to and away from the mines. Certain areas would always be invisible, but to get to those areas, travel through visually monitored zones was necessary. If most of the local areas were visible from the towers most of the time, this visibility would have been sufficient to create and confer the social or political message of observation structures. The panoptic system, if working properly, is a psychological form of control; as long as the idea of surveillance is present, the actual physical reality is of lesser importance.

WF1415 was not placed just for the Qalb Ratiye, it likely operated as the mining administrative site for the Wadis Abiad and Khalid as well (see Chapter 5.10). The

viewshed generated from the complex covers portions of these wadis as well as the approach from the Faynan. In this regard it was not operating as a panoptic structure but merely as one that facilitated surveillance. The location of WF1415 also permits monitoring of the path up to the Wadi al-Ghuwayb; this path, like that of the Old Road, is a guarded one. If one entered the region from the Wadi 'Arabah and followed the route from Wadi al-Ghuwayb to Wadi Ratiye, one would emerge within the viewed area (Fig. 7.20). Also as seen in Figure 7.16, there is the suggestion that a portion of Khirbet Faynan was visible from WF1415. WF1415 may have been able to receive signals directly from WF1. A viewshed generated from the Khirbet indicates this view was reciprocal (Fig. 7.21). WF1415 both acted as the onsite administration for the Qalb and was able to consult with the main control site of the region when necessary. This linked the two industrial centres and the activities of extraction and smelting together.

7.8 Other Examples

This use of panoptic control and surveillance is not unique to the Faynan; other Roman and Byzantine *metalla* have similar constructions. Yekutieli (2006) applied panoptic theory to both Bronze Age and Roman sites in the Negev, Israel. The Roman site, the Nahal Zohar canyon, was a quarry datable by pottery evidence to the 1st and 2nd centuries. Yekutieli suggests a large convict population recently gathered from the Jewish revolt of AD 66 would have worked here (Yekutieli 2006, 72). On a slope near the quarry a group of short term habitations were built. The structures were free standing, isolating occupants, and placed so that communication between individuals was inhibited. The entire region, including the habitations of the workers/slaves and the quarry, is visible

from a single point, a 'crevice' at the top of a slope. The crevice is a natural blind where an individual can see the entire landscape but cannot be seen by any individuals on that landscape (Yekutieli 2006, 77). A supervisor standing there could survey all the workers and their labour.

Another example comes from the Byzantine *metallum* of Bir umm Fawakhir, located in the Eastern Desert of Egypt. Gold mines located in this remote region operated from the 5th to 6th centuries (Meyer 1998, 259). Bir umm Fawakhir is similar to the Faynan in its topography. The wadis cut traversable paths through inhospitable areas. It is very isolated and is in an environmentally challenging climate. The site is notable for its lack of defences, even with such a valuable product as gold being mined. No building that could be identified as a fort was found, although this may be due to the modern settlement (Meyer and Heidorn 1998, 203). There is no evidence a large population of soldiers was present. There is, however, evidence of a surveillance system. The region had a number of observation posts holding a commanding view of the main roads, mines, settlements and vitally important wells (Meyer and Heidorn 1998, 203). Unlike the Faynan, these were not towers, but less dramatic structures with walls constructed of rough boulders. Though rudimentary, these posts were robust. In Bir umm Fawakhir, as in the Faynan, the environment itself, coupled with strategic placement of observation towers, seems to have been sufficient for defence and control of the *metallum*.

Surveillance systems may have been used commonly in *metalla* throughout the Levant. The environmental constraints, combined with observational control, would have been enough to encourage discipline and protect the products of the *metalla*. Certainly the multiple case studies, including the Faynan, indicate that the concepts that underlay

Foucault's theory have wider applicability to ancient societies than originally suspected.

7.9 Failure of the Panoptic System

The system of surveillance and panoptic control, backed by physical violence, seems to have been sufficient in the Faynan for the most part. Eusebius's account of the governor's visit (and the subsequent executions) is one of the occasions when this control system proved insufficient (*MP* 13.1-4). The persecutions during the 4th century brought an unprecedented number of convicts to the Faynan, including women and children (*MP* 7.2, 8.1). This mixed population of people was far more difficult to manage than all-male slaves and may have required different housing and treatment. Overseers may have been more likely to empathise with a population of criminalised citizens, making physical restraint through violence difficult to implement and leading to a relaxation of strict control.

The large number of convicts may have added to the unmanageability of the situation. Eusebius states that at one point 150 Egyptians were present in the Faynan (*MP* 13.1). If the number of soldiers or guards were similar to Mons Claudianus, 60-100 men, then the convicts would have outnumbered the soldiers (see Chapter 6.6). It seems that the existing system of panoptic control, backed up with threat of physical violence by the military, was insufficient to cope with these changes. The convicts not only formed a ministering community, but also started attracting local support, "...and there was a great crowd with them, who came from other districts to see them. And there were many others, who ministered to them in those things of which they had need..." (*MP* 13.2).

The key point of Eusebius's history is that he says the problems arose in the domestic and religious communities the convicts formed (*MP* 13.1-2). The copper industry is not mentioned and seems to have been unaffected. It was religious defiance and the spread of Christianity, not lack of copper production that upset the governor during his visit. The majority of the panoptic surveillance was focused on the industry, controlling the product and workforce near mines and smelting sites. The other areas monitored closely were the exits and entrances to the wadi region. Away from these areas, fewer means of invasive visual monitoring existed.

In an ideal situation the population of convicts, prevented from escape, would remain in the valley working in the mines. Domestic spaces would be monitored and regulated with physical restraints and violence. However, the large numbers, including family units and members of the local population, were more than the small body of guards could properly handle. It may have been this lack of control in domestic space that allowed convicts to practice Christianity in an organised manner.

Eusebius states that outside military forces were necessary to resolve the situation (*MP* 13.4). The administration did not have the military strength required within the Faynan region; however, as stated previously, the Faynan was located within the larger system of the *limes* (Fig. 6.9). This appears to be one of the situations where these surrounding forces were brought into play. Eusebius writes (long version see Appendix 2) that a *dux*, a high ranking military officer from outside the region, was placed in charge. The solution was to reduce the population by executions and send some of the convicts (and new converts) to other *metalla* (*MP* 13.4). The reduced numbers returned the population to a size that could be controlled by the existing panoptic system and

physical violence.

7.10 Surveillance and Perceptions of Safety

The previous arguments have focused on the idea that visual control was a method of discipline. This may not have been the only reason for creation of an observational system, and a different interpretation is that surveillance increased feelings of safety. This concept has been discussed most recently regarding the ubiquity of Closed Circuit Television (CCTV) cameras in modern life (see Norris *et al.* 2004). The effect of these cameras as a deterrent on crime is still undecided; however, some studies indicate that in some instances the public had increased perceptions of security as a result of their presence (Honest and Charman 1992, 22). In the Faynan these administrative structures may have provided the perception of safety, either intentionally or unintentionally. For example, most of the settlements in the Wadi Fidan can be seen from towers and are located within view of them. The Faynan and its security structures are several kilometres away and a more local representation may have been required to create feelings of safety. Placement of settlement sites within the range of the towers may have provided security, or the perception of security. Similarly, the imposing structure of WF1415 may have had a positive psychological effect. The building could inspire ideas of strength and permanence as well as material proof of the organisation and power of the overarching administration. Mining is a dangerous business, risk of injury and death are constant, and this can lead to a dissatisfied population. Strikes or revolts can occur frequently (Knapp 1998, 9). Such a display of imperial strength by WF1415 may have improved morale, making individuals feel safer. This in turn may have increased the productivity of the

Faynan.

There is a reverse argument; other studies have reported that the sight of surveillance structures like CCTV lowers perceptions of security. The public feels that the area is unsafe because it requires surveillance, 'the marker effect' (Zurawski n.d., 1; Gill and Spriggs 2005, 58). This response might have increased dependence on the administration, as the towers at the entrances and exits of the Fidan-Faynan corridor may have been viewed as markers of an outer area that was unsafe. The inner area that was less watched could have been perceived as a safe zone. Convicts or smugglers would have had to leave the safe zone and enter the unknown to escape.

7.11 Conclusion

In the Faynan the small number of soldiers and more numerous civilian officials would always have been outnumbered by convicts and workers. The application of physical force would not have been sufficient in maintaining control of these populations if it was the only means exercised. The author suggests that a sophisticated understanding of surveillance would also have been utilised. Observation and panoptic surveillance were part of a larger system of discipline including physical restraint of convicts and control of points of access. Surveillance can be considered a 'less intrusive' means of control; while it would discourage illicit behaviour, it would not prevent it.

The argument that the administration effectively used surveillance assumes that they had clear ideas of the power of observation and the ability to manipulate it. The use of observation and view in the Faynan is complex enough that it can be proposed that

purposeful choices were being made, and the careful placement of watchtowers suggests that an emphasis on visibility was deemed important. This sophisticated system used to secure and facilitate the production of copper is another example of the overarching control of the entire landscape that was a hallmark of an imperial *metallum*.

Chapter 8 – The Landscape of *Metalla*

8.1 Introduction

A central question of this thesis is how any *metallum*, be it Mons Claudianus or Faynan, can be recognised archaeologically as an imperially owned region. More specifically, without evidence from epigraphy or texts, can the landscape provide convincing evidence of the administrative structures of this imperial jurisdiction? This thesis has argued that the landscape can and does provide such evidence. The generalised patterns evident in the archaeological record are due to human behaviour and in this case, the behaviour of the administration. Now that the specific landscape of the Faynan has been elucidated it is time to review the spatial similarities it shares with other, known imperial *metalla* such as the ones discussed in Chapter 1: Mons Claudianus, Mons Porphyrites, Las Médulas and Simitthus.

8.2 Activity Zones in the Faynan Landscape

When discussing human behaviour it is important to remember that metal or stone manufacturing are not just technical activities but social ones. The *chaîne opératoire* (operational sequence) is a framework that has proven useful when approaching the study of the social and cultural aspects of metallurgical production (Schlanger 1994, 143-145). Originally discussed by Leroi-Gourhan in reference to flint knapping, it has been applied to other human manufacturing ([1943] 1993). Production is a meaningful sequence of stages or activities that manufacture a finished product. Individuals are repeating

behaviours they have learned: thus it is both a social and industrial phenomenon. This does not imply that the sequence of actions is the most productive, just that it is the one chosen to be performed, either by individuals and communities, or imposed by an outside source (Paffenberger 1998, 294).

This sequence does not just encompass the patterning of social behaviours but also the structuring of space. Activities across the landscape are organised in a socially meaningful way. The Sydney Cyprus survey used this concept as a framework to illustrate human choices when studying the copper mines of Cyprus (Given and Knapp. 2003, 302-303). Different areas of the landscape were utilised during different eras. Although copper production was always the final goal, the manner in which each culture approached the task and accomplished it was unique. In a similar fashion the Faynan can be studied as a landscape that is a result of human choice and behaviours.

Commonalities have been found between *metalla*, at least at the level of spatial similarities. Romans themselves acknowledged commonality, applying the term *metalla* to all types of extractive industries- opencast mines, underground mines, and quarries. The *chaîne opératoire* in this situation concerned the acquisition, production and distribution of metal or stone for the imperial State. *Metalla* were structured in response to the landscape and a desire to facilitate transport, but also to control access, with settlements placed where needed to best adapt to the topography. Logistical necessity will require certain structures and landscape layouts to supply, transport and extract the product (Maxfield 2001, 165; Rothenburg and Blanco-Freijeiro 1981, 174). These demands will cause characteristic changes to the landscape in all cases. As we have seen, despite operating in disparate parts of the empire, there are parallels between the Faynan

and all the exemplar *metalla*.

These analogies are especially visible in the concentration of tasks into activity areas, because the principles and purposes behind their creation are all roughly analogous. In the Faynan, four activity areas or ‘zones’ can be identified in the landscape; those devoted to transportation, administration and organisation of production, habitation, and the actual mines and infrastructure for mining. I argue that the four landscape activity areas or ‘zones’ can be extrapolated into a basic typology of *metalla*. These zones can be recognised by their location, activities taking place within them, and by identifying structures associated with the tasks, such as animal watering lines, surveillance towers or administrative buildings. I have characterised these four zones as Central, Extraction, Habitation, and Transportation Zones for the purposes of this discussion.

8.2.1 Central Zone

The Central Zone of a *metallum* will be a logistical hub from which the administration functioned. Reflecting this, the zone will have administrative structures, buildings whose purpose is to facilitate running the industry. They will be recognisable by their size; these structures are comparatively larger than others in the *metallum*. Another identifying feature may be their typology; they may be forts or fortified buildings. The location of the Central Zone would be based on a number of factors, balanced between the need to be in an accessible setting yet close to key resources and in proximity to the extraction areas. This Zone can also be where key production processes took place, for both logistical and administrative reasons. A single location would make it more convenient for the administration to supply the industry; for example with fuel for

the smelters. Also a central location for workers could increase productivity and allow for quality control. Surrounding the administrative centre will be the social centre of the region containing public gathering places and communal structures such as temples.

In the Faynan the Central Zone was the eastern end of the Wadi Faynan centred on Khirbet Faynan, which was densely populated, as evidenced by its size and cemeteries (Fig. 8.1). The central building, with its fortified aspect and excellent views, probably was the locus for administration of the industry (Chapter 7.5). No other settlement of the Classical period came close to rivalling the Khirbet in size or importance at Faynan (Ruben *et al.* 1997; Barker *et al.* 2007, 313).

The Central Zones of Mons Claudianus and Mons Porphyrites were also located in their main wadis, Wadi Umm Hussein and Wadi Abu Ma'amel (Peacock and Maxfield 1997, 84; Maxfield and Peacock 2001b, 12) (Fig. 8.2, Fig. 8.3). The zone contained a variety of sites that fulfilled many of the needs of the community. Large fortified structures, military in nature, were located here. Different strata of the population were represented. Mons Claudianus had a building inside the fort, larger than the others, that may have housed the legionary centurion in charge of the operations (Fig. 1.9) (Peacock and Maxfield 1997, 84-85). At Mons Porphyrites the 'bathhouse' may actually have been a heated residence.

Civilian housing would also have been present in the Central Zone. At Mons Claudianus the fort and annex were inhabited by workers (Peacock and Maxfield 1997, 84). Mons Porphyrites had a separate worker's village located close to the Fort (Maxfield and Peacock 2001b, 26) (Fig. 1.5). Near to these were temples and necropolises (Fig. 1.5,

Fig. 1.9). Finally Mons Claudianus had a storage building where fodder and food could be stored and distributed (Peacock and Maxfield 1997, 93). These Central Zones acted as the administrative, religious and habitation centre of the quarries. They had the structures necessary to run the industry and provide for the community, as well as the resources, such as water (Fig. 1.5, Fig.1.9).

Simitthus seems to have been different, with a genuine civilian town next to the extraction industry. However even here there was a segregated administrative structure on the opposite side of the quarry hill from the town. The most recent interpretation of the *fabrica* at Simitthus suggests that the west wing of this structure housed the administration (Fig. 8.4) (Mackensen 2005, 122). The building complex is similar to the Egyptian quarries with its large size and fortified aspects.

These four sites all had very compact landscapes; as opposed to Las Médulas, which was operating on a much larger scale (Fig. 8.5). Yet it too had a settlement that could be characterised as a Central Zone, that of Las Pedreiras (Sánchez-Palencia 2000, 291). Its buildings were not fortified, but are markedly different from its other sites, being Greco-Roman in character. Its location was along the roads to the provincial capital, but also close to the mines and other communities, indicating its role in both inter- and extra-regional affairs (Sánchez- Palencia 2000, 292) (Fig. 1.13).

8.2.2 Extraction Zone

Extraction Zones include the mines and quarries and the infrastructure necessary for industry. A central building may also be present from which the technical operations and distribution of supplies takes place. Finally there may be structures related to

surveillance, either for the purposes of communication or panoptic control. This zone is not a fixed location; once a mine or quarry is exhausted, the Extraction Zone may move (Knapp 1998, 11). One of its signifiers is its flexibility and ability to adapt to take advantage of the geology of the region.

The Faynan has an excellent example of an Extraction Zone in the Qalb Ratiye (Fig. 8.1). This zone contained the mines and WF1415 acted as the administrative building and a panoptic structure overseeing the Qalb. The Simitthus Extraction Zone encompasses the quarries and is clearly marked by its separation from the civilian part of the town by a wall (Fig. 8.4). The quarries were located to the east and only covered 0.4km² in total (Röder1993, 17). Part of the planning that went into the Extraction Zone here was organisation within such a compact space. Clearance of rubble was necessary to reach new deposits and this required detailed planning as to where dumps were located and the order in which areas were developed (Röder1993, 44).

Mons Porphyrites had multiple quarries throughout the surrounding mountains, some located at heights of 400m above Wadi Abu Ma'amel (Maxfield and Peacock 2001b, 133) (Fig. 8.2). Part of the infrastructure was the slipways, created to bring the stone down from these steep heights. At Mons Porphyrites these slipways could measure as wide as 10m (Maxfield and Peacock 2001b, 195). At Mons Claudianus 130 individual quarries have been recorded. There are slipways and paths similar to the ones at Mons Porphyrites. As mentioned in Chapter 7.4, *skopeloi* were interspersed throughout the quarries for communication and to monitor the industry. They were one of the ways the Extraction Zone was linked to the Central Zone.

Depending on the geology of the region the Extraction Zone could be extremely elaborate (Fig. 8.6). The main mine of the Las Médulas region had sixteen hydraulic ditches, which spanned average distances of 80km away (Pérez-García *et al.* 2000, 235). An estimated total of 93,550,000m³ of soil was removed, an average of 489,475 m³ per year (Sánchez-Palencia 2000, 157). Although this was an extremely large-scale example of a Roman *metallum*, it is not without precedent. Other gold mines, such as those at Dolaucothi in Wales had smaller but no less technologically impressive feats of engineering. There, 11km of aqueduct supplied an estimated 2.5 million gallons of water daily (Annels and Burnham 1986, 22).

8.2.3 Habitation Zone

Related to the Extraction Zone is the Habitation Zone, the housing for the workers. If the Central Zone were far enough from the mines or quarries, a secondary community would be formed closer to the resource; this would cut down travelling time. These settlements may be intense but short lived occupations, depending on the viability of the mine or quarry.

This Zone does not always appear as a separate entity if it is not required. For example the quarry of Mons Claudianus did not have separate Habitation Zones (Fig. 8.2). Most of the quarries were within 1.5km of the main Fort and its Annex in the Wadi Umm Hussein, so out-stationed accommodation was not necessary (Peacock and Maxfield 1997, 177). Proximity to the quarries in Simitthus also eliminated the need for separate villages (Fig. 8.4).

This was not the case in the Faynan, a good example being the miner's

settlements in the Wadi Ratiye, such as WF1416 and WF1419 (Fig. 8.1). These were a distance from the Khirbet in order to be close to the mines at Qalb Ratiye. In similar fashion, Mons Porphyrites had multiple villages located in the mountains, placed close to the quarries and along paths connecting to the administrative centre. The distance and elevation change between the villages and the central Wadi Abu Ma'amel was sizable enough that housing the workforce halfway up the mountain would expedite the process of reaching the quarries each day. An example would be the Northwest village; there were structures in this community for the workers as well as a high status dwelling, likely for the local administrative official (Maxfield and Peacock 2001b, 71) (Fig. 8.3).

Habitation Zones are defined by their relationship with the Extraction Zones but are not always in close proximity. The settlements (WF1009, WF1004, WF1009, and WF1014) on the road to Umm al-Amad can be considered in this category even though they are 4km away from the mines (Fig. 5.12; Fig. 5.29). They are still positioned half the distance from the Central Zone to the Extraction Zone to bring the workers closer to the mines. Las Médulas also had miner's settlements in proximity to the mining activity, such as El Castro Puente Domingo Flórez and El Cabuerco de Valdelobos (Sánchez-Palencia 2000, 271) (Fig 8.7).

8.2.4 Transportation Zone

The goal of the *metallum* was to export the products produced, and thus all have well developed Transportation Zones. However these transport networks worked in two directions, Chapter 6.4 demonstrated the large quantities of supplies, fuel, food and luxury goods required to sustain a mining operation, and the accompanying transportation

demands. Transportation Zones often included important facilities at ‘bottle necks’ in the landscape, the entrances and exits that must be traversed to enter the *metalla*. Military and surveillance structures tend to be present at these locations. The Roman and Byzantine *metalla* were dependent on water and animal-powered transport; structures such as caravansari and animal lines are indicative of this Zone.

As discussed in Chapter 7, Khirbet Faynan is ideally placed to monitor incoming traffic from the Jordanian Plateau. The central building has clear views of the Wadi Dana and Wadi Ghuwayr. Incoming fuel and foodstuffs would have been easily distributed from the building to the community. The nearby barrage, WF441, may have had an industrial purpose, but alternatively could have been used as a watering facility. The site had standing water although at times it was heavily polluted (Barker *et al.* 2007, 67; Grattan *et al.* 2007). The Khirbet is a multipurpose site combining aspects of the Transportation Zone as well as the Central Zone.

The Wadi Fidan has 2 sites that have been discussed as large settlements, Fidan 50 and 120. These sites also have archaeological characteristics that indicate they may have functioned as transport facilities or caravansaries. Fidan 120 has a large building with an open centre and multiple side rooms (Fig. 5.18). Fidan 50 was located at the wadi entrance and has a wall measuring over 100m in length, long enough to house large numbers of animals. Fidan 120 was a similarly large site with substantial walls, it had an open courtyard and rooms branched off the walls (Fig. 5.18). Moreover the Fidan had water sources. Fidan 50a had a well that may have been in use during this period. The spring ‘Ain Fidan is located a few kilometres away (south of Fidan 120), where animals could have been watered. These two sites were surrounded by surveillance towers and

accompanying fortified structures. The findings in the Wadi Fidan conform to the image of a protected route with facilities to care for traders and travellers who were journeying in and out of the Faynan to the Negev and Gaza.

The Transportation Zones of the Egyptian quarries contain both *hydreumata* and military structures able to provide for the animals and protect the routes. At Mons Porphyrites the Transportation Zone is located at the junction of the road to the Nile and was the location of the Badia Fort and animal lines (Fig. 8.2, Fig. 8.3) (Peacock and Maxfield 1997, 86). At Mons Claudianus the animal lines were located near the well and next to the Fort (Fig. 1.10). Both the Egyptian Quarries had fortified structures providing security and monitoring any approaching traffic along the access routes. By being located at the bottlenecks of the wadi systems they could control all entrance into the region.

At Simitthus a short road connects the quarry with the river where there was a loading dock. Smaller stone projects could have been shipped to the Mediterranean. However it appears that large projects travelled overland. A substantial road leads out of Simitthus towards Tabaraka with a favourable gradient for moving heavy stone. Abandoned columns were found along it, supporting this view (Hirt 2004, 23).

Les Médulas does not have a separate transportation zone, at least not one that has been identified (Fig. 8.7). It is connected by roads to the provincial capital and further excavation may reveal a storage depot. The paved roads would have provided easy transport and allowed movement by cart, reducing the number of animals needed. The structures to support large caravans, for example the animal lines, would not have been needed. Las Médulas was also located in a heavily militarised area and protection was

provided.

8.3 Differences in the Spatial Layouts of *Metalla*

Each imperial *metallum* changed the ‘layout’ of Zones to suit the individual situation. Yet it must be stressed that the underlying principles remained the same due to the physical constraints imposed by an extractive industry. Although a typology of spatial patterning can be produced, this does not imply that all details of *metalla* were similar. Because of the differences in environment, in exploitable resources and in location, the physical appearance and relative importance of each Zone could vary dramatically. Each *metallum* had elements of these Zones that can be identified as Administration, Transportation, Habitation, and Extraction, but none have the exact same pattern.

The topography of an extraction region can eliminate the need for separate zones. Mons Claudianus, for example, had the Central Zone close enough to the Extraction Zone that separate villages were not necessary. Sometimes the activities of a zone could differ greatly depending on the product. At each *metallum* there is archaeological evidence that the product was refined before leaving the district, either through smelting or rough carving. This made the eventual transportation easier. Marble objects could be made significantly lighter, especially the larger projects such as columns.

Mineral possessing took place in many areas of *metalla* landscapes; however if the extracted mineral were reasonably portable, some of the processing was centrally organised. For example, while in the Faynan ore crushing took place outside the mines and perhaps in Habitation zones like the Umm al-Amad villages, smelting was

centralised to the Khirbet. The slag heaps, furnaces and mill indicate a zone where the overwhelming majority of activity was linked to metallurgy (Fig. 8.1).

Having production facilities within the Central Zone made monitoring of the industry easier. The Vipasca tablets are very clear about movement from one Zone to the other; ore had to reach the smelters by nightfall. This is an indication that ore theft or misrepresentation of a mine's potential was perceived as a potential problem (*FRIA 104* 23). Thus surveillance structures or a means of monitoring production are often found in association with the Central Zone as well as the Extraction Zone.

Simitthus has an excellent example of concentrated production. Large stone objects were shaped in the quarries, however smaller objects were manufactured in the building complex (Fig. 1.12, Fig. 8.4). As discussed in Chapter 1.6.5, the large building complex likely had multiple uses. The central building (B2 on Fig. 1.12) was originally interpreted as a prison due to its segregated areas. Mackensen suggests that instead it functioned as a *fabrica*, and during the second phase of use this is very likely, as the finds include marble polishing benches (Mackensen 2005, 122). The shape of the rooms does suggest restricted access; however this may not imply prisoners, but rather workers. The joining together of skilled marble workers could create a 'factory' where marble pieces would be prefabricated and shipped as finished products. The regularisation of the work area and restricted access could thus be interpreted to mean that the rooms held skilled workers with restricted access of outsiders to the 'factory' floor. Alternatively it could have been meant to restrict worker movement, suggesting forced labour. Either way the corridor aspect of the building could imply tasks were performed serially, resembling an assembly line (Mackensen 2005, 119). The room structure could potentially have been

created to ensure the quality and standardisation of work. This structure combined the Central Zone and processing activities into a single building that allowed for easy monitoring of workers or convicts.

The situation in Las Médulas was different. Alluvial gold does not need to be smelted; it is already in a pure form. Pliny describes the process by which it was collected. The washing tables were lined with gorse that collected the gold flakes. This was then burned and the gold collected (*NH* 76-77). The administrative control of these washing tables and monitoring of the melting is not discussed. Since this process does not produce much industrial waste, there are no archaeological indicators. However, the Las Médulas region also had iron mines and production of this metal was concentrated in one area of the landscape (Fig. 8.7). Castro Orellán was a concentrated smelting area, as evidenced by metallurgical remains and large slag piles (Orejas and Sánchez-Palencia 2002, 591). This site also had a foundry and made the iron tools necessary for the gold mining.

All of these groups concentrated on production of small objects were vastly different from the Egyptian Quarries. The quarried stones from Mons Claudianus and Mons Porphyrites were large blocks not easily moved, thus for practicality, the decorative stone was roughly dressed in the quarries. Creating a separate production area would have been superfluous as projects were easily overseen; thus processing was located in the Extraction Zone (Maxfield and Peacock 2001b, 113) (Fig. 8.2, Fig. 8.3). This difference between mines and quarries is seen most clearly in the Transportation Zone where the quarries often had more elaborate travel facilities than the mines. This is due to the requirements of exporting large stone blocks. At Mon Claudianus a monolithic

column lying in situ is 60ft long and calculated to weigh 207t (Maxfield 2001, 158). Transporting columns and large-scale architectural elements required large teams of animals and this necessitated facilities with large animal lines. In the Faynan, although its import and export needs were sizable (see Chapter 6.4), the supplies and outputs were divisible and could be shared between animals; this was not the case with the quarries. Thus the travel facilities are smaller in size and less complex at Faynan.

Even within these common site types there was variation. Architecture was not regular; for example, the only distinguishing features of *hydreumata* are the animal lines (Maxfield 2001, 161). The other difference in typology is seen in the construction of forts. Ostraca confirm that the fortified building in Mons Claudianus had a garrison, although it does have differences from what is considered ‘a standard’ Levantine Fort (Peacock and Maxfield 1997, 84). This is similar to the Faynan, where the large structure in the Khirbet has fortified aspects but is not laid out like a conventional fort.

The Faynan can be said to have a fifth, Agricultural Zone, that of the field system WF4. The centrally managed floodplain was yet another way the administration and its goals impacted the landscape. The presence of WF4 meant a settled population could produce at least a third of its required food (Chapter 6.4). Other *metalla* do not show similar systems of administratively owned agriculture. Simitthus was located near the Medjerda River that formed the heart of the bread basket of Roman Tunisia. Food was likely plentiful and intense control of land was not needed. Les Médulas had communities that were devoted to agriculture, but there is no evidence that the surrounding region was farmed in a regulated manner. Orejas and Sánchez-Palencia (2002, 582) emphasised the importance of agriculture being interlinked with industry to support the non-subsistence

workers; WF4 at Faynan was an example of the agricultural side of the copper industry.

However regional, large-scale agriculture was not always possible. The Eastern Desert was a hyper-arid environment and, although there is some evidence of garden plots at Mons Claudianus, there was no floodplain comparable to WF4 (Maxfield 2001, 143). The Egyptian quarries were extremely dependent on the imperial State and the importation of food supplies. Without a resource such as WF4, the quarry settlements were largely abandoned with the end of the industry, remaining only sparsely populated by Christian hermits (Peacock and Maxfield 2007, 426) whereas the Faynan continued to prosper as the copper industry diminished, and emerged as a religious centre in the Late Byzantine Period (see Chapter 2.6).

8.4 Discussion of Spatial Layout and Zones

My division of Roman *metalla* into these Zones does not preclude any other activities taking place; it is a generalisation that is a useful starting point for exploring larger concepts. It is likely that the zones had multiple purposes and the evidence from the Faynan indicates this. Areas such as the Fidan Transportation Zone also practiced agriculture and metallurgy, albeit at a smaller scale than the Faynan. Moreover it is likely large portions of the landscape were utilised in ways that did not have specific concentrated activities regulated by the *metalla* administrations. For example, satellite imagery indicates that initial ore processing occurred at multiple locations across the Faynan (Grattan pers. com.). It is possible that the steeper inclines of the Faynan may have been used as pasture land to feed local flocks or transportation animals. The administration's attempt to enforce functional zones could also have been resisted; the

population might have balked at the assigned task or actively sought to introduce diversity. The local population may have resented the close control of the administration; for example, changes made to WF4 (see Chapter 6.3). Also individuals may have attempted to operate outside of the surveillance system, in effect becoming invisible, this may be the case with WAG3 (see Chapter 7.6). There is no evidence for this in the other *metalla*, except for the possible limits on covert smelting at Vipasca (*FRIA 104* 23; 4).

It is not that these zones are unique constructions; all extraction industries regardless of time period will show elements of them, as the activities are common. This topographical Zone pattern is partially based on the logistical requirements of an extraction industry; as such it is a blueprint that may not be limited to the Roman and Byzantine periods. It is possible that other eras with State-run operations may show similar landscape patterns in their extractive industries. I suggest that it is the way that extraction activity was done within the Roman/Byzantine imperial system that is unique. Each *metallum* operated with a similar set of social ideas, resources and imperial State administrative structures such as the military and provincial governments. They shared an understanding of the larger imperial structure in which they were embedded.

8.5 Similarities between *Metalla*

So far arguments made about the Faynan have been based on the evidence provided by the two survey projects. The dataset was used to explore the landscape and long term changes across it. However, the survey does not provide an appropriate scale for studying individuals or details. Other case studies have the advantage of bolstering survey evidence with large-scale excavation and epigraphic evidence, including

inscriptions and ostraca. These provide a wealth of information, furthering our understanding of more detailed processes. These sources have been referenced throughout this thesis where appropriate. But with the spatial commonalities between the Faynan and other Roman mines and quarries having been established, a more in depth comparison can now be advanced with relative confidence. Of course evidence from other sites cannot be directly projected onto the Faynan, but it does allow us to make informed hypotheses about what further studies in the region might reveal.

8.6 The Administration

The actions of the administration and some of the reasons behind those choices have been discussed throughout this thesis. The actual composition of an administration was introduced in Chapter 1.2. Returning to this topic, an examination of evidence from the other *metalla* suggests what management styles or officials may have been present in the Faynan.

The management of a *metallum* could be either direct or indirect. The Vipasca tablets list the considerable powers of the *procurator* who could control not only mining, but businesses and civilian professions as well (*FRIA 104* and Dessau 6891). This can be characterised as indirect management since the mines in Aljustrel were leased to private companies. These companies, after paying their leases and fees, were responsible for providing their own capital to start the extraction, as well as labour and supplies. Although companies functioned for private rather than imperial goals, their general actions were governed by the administration and ultimately benefited the State.

In contrast, an example of direct management of the extraction would be Mons Claudianus, run by military personnel and imperial officials who oversaw not only the quarrying, but transportation to and from the region and supply as well (Maxfield 2001, 150). Some of the workers were directly employed, earning their set wage from the administration. There is no evidence that private companies were involved (Cuvigny 1996, 145). Mons Claudianus was able to function because the administration was capable of organisation on a massive scale. Private companies would not have been able to organise province-wide resources- namely, grain, animals, water, workers and transport (Maxfield 2001, 166).

The Faynan seems to have been operating with a direct management; no evidence exists of another system. Eusebius does not mention any private companies. No markings on mine shafts have been found that could have indicated separate properties. Mining is a risky investment and large-scale production requires a great deal of capital (Pfaffenberger 1998, 296). During the Roman Period the type of ore heavily exploited at Faynan was MBS (Hauptmann 2007, 155). The MBS ore has a lower copper percentage requiring large amounts of ore to be collected to generate returns and meet the State's requirements. Difficulties especially arise when dealing with mines that had already been worked, as the Faynan mines had been, leading to rising costs and the need for an ever-increasing pool of labour (Weisgerber 2006, 18). The character of the ore and the difficulties of supply made for a high cost industry at Faynan. To successfully exploit the ore in the Faynan an investment of money and resources greater than that a private company could afford was needed. The scale of the mining enterprise, coupled with the lack of evidence for subdivision, supports the inference that there was direct imperial

management of the Faynan mines.

8.6.1 Staff

A *procurator* would have been in charge of operations at the local level. This individual did not always reside in the extraction district. *Metalla* could encompass multiple regions; for example, the Egyptian quarries were likely considered one region for the Roman period (Maxfield 2001, 150). Rather than reside at one extraction operation in particular, the *procurator* likely lived near the Nile (Hirt 2004, 84). This may have been because the mining regions were isolated and removed from where he could function best as the logistical and organisational head. For the Egyptian quarries, the ostraca suggest that requests were being sent out to the *procurator*, rather than him having regular on-site discussions. Ostraca indicate that messages were frequently sent back and forth (Hirt 2004, 84).

Hauptmann put forth the theory that Khirbet Faynan was the sole location of Roman copper smelting for the entire Wadi ‘Arabah (2007, 155). Although this theory is unproven, it raises an interesting question about the mines at Wadi Abu Khusheibah and Abu Qurdiya. Were they included in the mining district of Faynan? If this were the case, then a situation similar to that at the Egyptian Quarries may have existed, where the *procurator* lived elsewhere. Eusebius makes reference to the *procurator* who “...then came on the scene” (MP 13.3). This phrase seems to suggest that the *procurator* was absent during the events and arrived from elsewhere.

Judging by the limited evidence we have, most of it inscriptions, it is suggested that tenures were short and *procuratores* did not necessarily have extensive prior

experience (Hirt 2004, 163). The technical aspects of extraction would have to be handled by others with appropriate skills, such as the foreman of the *metallum* and his staff. These are the individuals who would have been in attendance year round. Inscriptions from the mining administration site of Ampelum in Dacia indicate that these positions were staffed by long-term ‘career’ men, who gained experience and were promoted through skill rather than political favouritism (Hirt 2004, 177). These individuals did not change frequently and could provide the incoming *procurator* with any technical knowledge he would need. The Ampelum evidence suggests that certain tasks would fall to different subdivisions, each handled by a different officer and his staff, such as finances, smelting, supply and record keeping (Hirt 2004, 175). *Tabularii* seem to have been involved with bureaucracy and records, *dispensatores* with payment for supplies and receiving payment, and *commentaries* for legal transactions (Hirt 2004, 174-176). Under these subdivisions were the engineers, mine bosses and other, lesser positions.

A law of the Theodosian Codex 1.32.3 (AD 373) discusses the amount of record keeping a job like this required. Within 30 days of assuming office, a procurator had to provide accounts of the ‘lesser monies,’ within 50, the ‘greater’. It was imperative to keep a correct accounting of transactions, lest a discrepancy be noted, whereby the procurator shall be ‘striped of his dignity,” experience “flogging... torture,” and other “disgraceful punishments” until the matter was resolved.

How many personnel staffed the Faynan during its height is unknown. However, if the bare minimum is estimated, the foreman, four subdivisions, and one engineer, six officials are already accounted for. The administrative building on the Khirbet suggests

more, it has 20 distinguishable rooms and measures 37x37m (Barker *et al.* 2007, 315). Kind *et al.* suggest these are dormitories; however that is speculation (2005, 191). If half of them were ‘offices’ or record keeping rooms, then the number of staff was perhaps 40 or more.

8.7 Free Workers

Utilising evidence from other *metalla*, a picture of the community and workers can be created. The information provided by the workforce in turn reveals more about the administration through the relationship and interaction of the two.

The skills necessary to profitably work a mine, called mining engineering, are acquired. It is described as “...the art and science applied to the processes of mining and the operation of mines.” (Hartman 1987, 2) Quarrying has a skill set as well; expertise is needed to cut and transport stone without breaking it (Ward-Perkins 1992, 26). For these operations to be run successfully, the work force they employed would have to possess these talents (Burford 1972, 76). When looking at the importance the Imperial government placed on the products of quarries and mines, it seems very unlikely that only slaves were working at these sites. The problems associated with an incompetent labour force would render operations unprofitable (Burford 1972, 73 and 76). Free individuals would feed, house and clothe themselves, and generally were a longer-lived workforce than slaves. They would not have to be replaced as often, and replacements would not have to be trained (Burford 1972, 59).

Who composed the free work force? Diodorus discusses the various populations

present at a gold mine in Egypt. Although this source dates to the 1st century BC, it can indicate the types of tasks often performed in mining and perhaps who performed them. He indicates that there were gender- and age-specific tasks. While the heavy labour of mining was performed by men, the gathering of the ore was performed by boys, and the milling by women and old men (*HL* 3.13).

A likely place to find the remains of these workers is in the South Cemetery; set burial practices and organised interment suggest that these bodies belonged to free inhabitants. As mentioned before in Chapter 6.4, there are no characteristic marks on the bodies suggesting they were convicts and it was unlikely that slaves and convicts were accorded the right to bury their dead.

Excavations at the cemetery in Faynan support the idea that there may have been gender specific tasks. Karaki writes that arthritis was present in different locations for men and women (Karaki 2000, 54). Although these data are derived from a small number of skeletons, they are indicative of different repetitive injuries.

Table 8.1 Percentages of skeletons displaying arthritis out of 42 adults aged 20-50, 19 males and 23 females.

Arthritis of the	Percent of Males	Percent of Females
Ribs	16.6	0
Sternum	20.8	9.5
Tibia	8.3	14.28
Vertebra	66.6	52.38

The workforce in the Faynan likely was composed of both males and females. Where were they from? Free workers could have come from a variety of places. First the

local community in the Faynan may have provided its own labour over successive generations. The Theodosian Codex law 10.19.15 (c. 362) states that miners *had* to follow in the profession of their fathers, indicating that this was an inherited vocation. Children's graves have been found in the cemetery, so it is known that families lived in the Khirbet. At Mons Claudianus there is evidence that civilians lived in the fort. Women and children were at hand; this can be seen from the papyri, ostraca and domestic artefacts. During excavation a full range of shoe sizes was found; evidence that this community was not composed of only adult males (for discussions of shoes see van Driel-Murray 1995; Maxfield and Peacock 2001a, 318).

However, naturally occurring carcinogens and industrial pollution such as heavy metals likely combined to cause health problems, reducing the life span of the free workers. Radon, a dangerous carcinogen, is naturally found within the Faynan mines and in such high levels that the population would have started suffering effects after 7-20 years (Grattan *et al.* 2004, 111) Radon exposure would also affect children, who may have worked in the mines and thus would have been exposed from a young age. Those who had positions of authority like mine bosses or engineers would also have been affected, although their exposure was likely less. Because of these health problems the life span of a worker, male or female, in the Faynan may not have been long; thus the region would have had to be a net consumer of labourers.

One solution to a dwindling population is immigration. At Rio Tinto, studies of inscriptions suggest that immigrants from other areas of the Iberian Peninsula, up to 200km away, were flocking to the mines (Hirt 2004, 259). The Rio Tinto situation was extraordinary, given the richness of the Spanish deposits. There is evidence that salaries

for workers in *metalla* were relatively high, reflecting the difficulty and danger of the work. For example, Cuvigny, when discussing ostraca from 2nd century Mons Claudianus, notes that the adult male work force was paid 38-47 *drachmae* per month, considerably higher than the income for workers along the Nile, calculated at 25 *drachmae* (1996, 141). Opportunities for high pay and steady work may have been a draw and individuals would have immigrated to the Faynan region.

Another suggestion put forth by Meyer, when discussing the Bir Umm Fawakhir gold mines of Egypt, was that there might have been free but compelled workers (Meyer 1989, 272). Requisitioned labour was common in Egypt; a fee could be paid to abstain from service, leaving the poor populations to shoulder the burden. This theory might be expanded to suggest that perhaps those who could not pay their taxes would pay in physical labour, perhaps at a *metallum*.

Finally, there is the practice of compelled labour as punishment for rebellions. Northern Iberia was an unruly area that was conquered after the Cantabrian wars, 143-133 BC, and then had regular revolts for 100 years after it was originally overcome (Curchin 1991, 53). Eventually it became pacified during the rule of Augustus. The ancient author Florus records that, as a result of the Cantabrian wars, the Asturians were resettled to prevent future revolts. They were ordered to work in and support the mining industry of north-west Spain (*Florus* 2.33 60).

After this we were able to rely on the loyalty of the Spaniards... wide measures taken by Caesar, who, dreading the confidence inspired by the mountains into which they were wont to retire, ordered them to occupy and cultivate the plain... the whole district bears gold and is rich in chrysocolla, vermilion and other pigments, he therefore ordered that the soil should be worked. Thus the Astures, digging deep into the ground in search of riches for others, gained the first

knowledge of their own resources and wealth.

These were not prisoners taken as slaves but whole populations being resettled for a purpose. At Las Médulas, post Roman conquest settlement patterns were markedly different from indigenous ones. The *castro* La Corona de Borrenes had large defensive walls and ditches that were destroyed and the site was abandoned. Another site, El Castrelin, has no destruction layer but occupation does not continue into the Roman period (Fig. 8.5). Its location, away from the mines, may have been a factor in its abandonment.

The use of the Astures as a labour force was likely successful due to the extensive military presence in the surrounding countryside. As discussed in Chapter 6, the Faynan was located within a network of forts, but not to the same extent as Northern Iberia. Moreover Arabia was relatively peaceful in its early years as a province; no mention is made of rebellions (Bowerstock 1983, 112). However it was in proximity to the Judean province, where many uprisings such as the Bar Kokhba Revolt (AD 132-135) may have led officials to resettle some populations to prevent further problems (Schäfer 2003, 145). The Palmyrene war of AD 212-217 reached as far as Bostra, the capital of the Roman province of Arabia Petra. This may have been another source of workers. However, given that the resettlement of entire communities seems to have been a rare tactic, it is more likely that criminals or dissidents were used as slave labour in the Faynan, and there is no evidence presently to support other suppositions.

The administration needed a reliable supply of workers, paid or compelled, but the manner in which they obtained workers would affect the industry. The Faynan was a low-grade ore region; to create a net gain, a large work force was necessary. If the

administration were paying salaries they may have incurred sizable costs, thereby reducing profit. The population of the Faynan has been estimated at 1,610-1,860 (Appendix 5). If only one fourth of the population (400) were waged miners, then using Cuvigny's estimation of (38-47 *drachmae* per month) 13,875-17,625 *drachmae* may have been the monthly salary costs. This sum is not inconceivable for the State to spend; legionary infantryman could earn 100 *drachmae* per month; thus 400 infantrymen would cost 40,000 *drachmae* a month (Cuvigny 1996, 141). There are obviously no numbers for the Faynan itself, so these figures can only be used as a very broad estimation. Moreover, these salary figures were for adult males; it is unlikely that women, children or unskilled males were paid similar amounts. However, as Cuvigny points out, the pay scale of quarrymen in Egypt was similar to that for miners in Dacia. This suggests that miners and quarrymen could expect comparative salaries in other *metalla* across the empire, and that they were normally higher than those of other professions (Cuvigny 1996, 145).

The other option is that some of the workforce was composed of compelled workers present either out of economic necessity or due to resettlement. Given the low grade of the ore in the Classical Period, a non-paid workforce may have been preferred as it would have made the endeavour more prosperous (Weisgerber 2006, 18). A conscripted workforce has implications for the administration beyond just the difficulty of procuring individuals. As an unwilling labour force, the miners may have been resentful and this would affect morale and production. It has been suggested in Chapter 7.7 that there was a system of surveillance that oversaw the free workers in the Wadi Ratiye. If the miners were there largely against their will, this would be another explanation for the need for a panoptic system.

8.7.1 Interaction between Free Workers and the Administration

How did the administration interact with the community? The ostraca from the Eastern desert and Vipasca tablets indicate that *metalla* had powerful administrations that ran the industry, but also had a profound effect on the daily lives of the local populations. There are manifestations of the Faynan's administration in the landscape that indicate it had a great deal of power and authority. An excellent example would be the centralisation of WF4, with the creation of a single field system out of individual fields.

The Vipasca tablet, *Lex Metallis Dicta*, has been discussed earlier to elaborate the laws affecting mining and smelting. The first tablet found, *Lex Metalli Vipascensis*, lists further duties of a *procurator*. It indicates that the close control exercised by the *procurator* was not limited to the mines themselves but extended to the surrounding community. The *procurator* regulated a wide range of activities, with a high level of intrusiveness into the private economies of the population. The support structures of a local community, including the entire social and economic needs of the populations, were carefully legislated. All the amenities of a working town had to be leased from the administration. This included trades such as the shoemaker, barber and fuller (Dessau 6891 32-45). The bathhouse could be opened or closed at the discretion of the *procurator*, or, if not kept in proper working order, the bathhouse staff could be fined 200 *sesterces* (Dessau 6891 19-31). Even opening hours were listed and how much could be charged for using the baths: dawn to the seventh hour for women- one *as*, eighth to the second hour of the evening for men- half an *as*.

This pattern of intense control is seen in more recent examples, where mining

companies tried to control every aspect of workers lives by both regulation and economics. For example, in the case of West Virginia coal mines, allowing purchases only at the 'company store' (Corbin 1981, 10). There are hints at Faynan of the power of the administration, for example the reorganisation of the field system; but the full extent of the State control over the community is uncertain. However, evidence from other Classical period mines, taken together with more modern ethnographic examples, suggests that the population of the Faynan experienced a high level of State intrusion in their daily lives. If the Faynan were similar to Vipasca, then the mining bureaucracy may have controlled leases and collected revenue from all aspects of daily life.

There is other evidence that strong control by the administration would evidence itself in site specialisation and interdependence. It has already been mentioned that at Las Médulas the landscape was changed dramatically post conquest (see Chapter 1.6.6). Pre-Roman *castros* were economically self sufficient, each having evidence for agricultural activities, pastoralism, and metalworking (Sánchez-Palencia 2000, 108). These communities, although culturally connected and trading amongst themselves, were autonomous. After conquest new communities were created that were specialised, operating together to supply the larger region and its main activity, gold mining. For example, settlements near the mines, El Castro Puente Domingo Flórez, La Corona Yeres, and El Cabuerco de Valdelobos, were accommodation for the workers. Excavation revealed mining equipment but no evidence of agricultural processing, suggesting they were dependant on received food supplies (Sánchez-Palencia 2000, 271) (Fig. 8.7). Further away from the mines were settlements focusing on other activities that supported the non-substance populations, such as agriculture, forestry and livestock. Other sites,

such as La Corona and Santa Cruz, maintained the hydraulic network essential for the gold mining (Sánchez-Palencia 2000, 271) (Fig. 8.6, Fig. 8.7). These communities were interdependent, forming an industrial landscape that encompassed the entire region (Orejas and Sánchez-Palencia 2002, 593).

Some evidence exists for specialisation in the Faynan. The mining communities of Wadi Ratiye and Umm al-Amad for example, would not have been able to support themselves without supplies. The degree to which other areas were interdependent is unknown. The Fidan would be an excellent candidate for excavation in this regard. Its use as a Transportation Zone is clear, but other activities were taking place and the extent to which they were regulated can only be speculated upon. It can be argued from other cases such as Las Médulas and Vipasca, that Fidan might have been strongly focused on its role as the transportation hub.

8.8 Faunal and Archaeobotanical Studies

Another way to examine the lifestyle of the inhabitants of the *metalla* is to study what they ate. Consumption patterns can provide insight into social status, community origins and standards of living (van der Veen 2003, 420). The life of the workers at Mons Claudianus at first appears bleak, the starkness of the landscape and lack of public structures do not recommend it as a working and living environment. However, some among the population did receive luxuries. Personal requests from soldiers are documented on ostraca; even discussions of gardens and requests for fresh vegetables are recorded (van der Veen 1998, 228). Some of the population had access to exotic foods like fruits and spices (van der Veen 1998, 224). Although this was a region harsh enough

to require water rations, some workers clearly enjoyed a lifestyle well above subsistence levels. A similar pattern has been found at the Mons Porphyrites quarries, where both the botanical and faunal evidence indicates that luxuries were reaching the site (Peacock and Maxfield 2007, 116, 160).

One of these luxuries was a supply of fish. Fish bones were excavated from the sekbas of Mons Claudianus. Species represented in the assemblage have origins from the Nile and the Red Sea (Maxfield and Peacock 2001a, 285). The ostraca also provide evidence for fish consumption, with requests for specific species as well as for their fresh delivery (Maxfield and Peacock 2001a, 287).

Fish were also imported into the Faynan from the Red Sea. During the WFLS survey, a number of environmental samples were taken from middens, one of these was collected outside WF1415. Most of the fish bones were not identifiable as any single species; however their presence in the middle of the desert is fascinating in itself. A few teeth have been tentatively classified as *Lethrinidae lethrinus*. Commonly known as emperor fish, they are a tropical salt-water species that inhabits the Red Sea (Barker *et al.* 2007, 321). Evidence of sheep, goat and donkey remains could be expected in this semi-arid environment; animals that could have been herded there alive to be sources of meat. Fish, however, are certainly not local and require elaborate transportation logistics.

The distance from Mons Claudianus to the Red Sea is a two to three day journey, which was a negotiable distance for transporting fresh fish, but only in certain seasons (Maxfield and Peacock 2001a, 287). The distance to the Red Sea from the Faynan is greater, over four days travel. It may be that fresh fish would have been impossible to

import to the Faynan, more likely the food was salted for preservation. If the social situation in the Faynan were similar to that at Mons Claudianus, then preserved fish could have been a common import available to both workers and officials.

At the Egyptian quarries plant and animal species were found in different proportions depending on which midden was sampled. At Mons Claudianus, fish were found across the site regardless of the status of the structures in proximity, although the distribution rates of species changed (Maxfield and Peacock 2001a, 287). For example, the Badia site had the highest proportion of fodder and animal dung found, reinforcing its interpretation as a Transportation Zone (Peacock and Maxfield 2007, 106). Other discrepancies are noted between sites of different status at Mons Porphyrites. Although all sites have large proportions of bones from marine animals, the high status sites of the Fort and Badia have exotics like turtle and murex (Peacock and Maxfield 2007, 162). This may prove to be the case in the Faynan as well. Material evidence for slaves and convicts is usually difficult to distinguish in the archaeological record. The presence or lack of species in different areas of the Faynan may help to differentiate the populations of free workers from slaves or convicts.

At Mons Porphyrites, studying the archaeobotanical remains increased understanding of the changes the region underwent over time. The early and later periods of the quarry were marked by the comparatively small range of plant species present. The height of production in the 2nd and 3rd centuries corresponded with the presence of the largest range of plant species, including the most number of exotics (Peacock and Maxfield 2007, 116). In the Faynan, the end of the *metalla* is not well understood and establishing patterns of food importation could help illuminate this issue. The supplies

received by an imperial project were likely different than those of a private community. The transition to an agricultural and religious community in the Late Byzantine period may be marked by a change in the faunal and botanical records that would further clarify the chronology of the cessation of copper production.

Studies of faunal assemblages from areas of Les Médulas proved to be a similarly productive line of inquiry. The different statuses of the settlements in the Las Médulas region are reflected in their diet. The pre-Roman site El Castrelin has bones from all parts of animals suggesting local livestock husbandry; whole animals were present. By contrast the faunal assemblage from Orellán, the Roman metallurgy site, shows that the site was receiving only parts of the animals, suggesting external supply (Sánchez-Palencia 2000, 275). Las Pedreiras had a diet that reflected the higher status of its inhabitants, it also received only parts of animals, and was also the only site with a sizable number of wild animal bones, suggesting leisure and hunting activities (Sánchez-Palencia 2000, 275) (Fig. 8.8).

A future avenue of research in the Faynan may be extensive faunal analysis and archaeobotanical studies. As these have proven useful at other sites, they could indicate the status of the inhabitants of the Faynan, the life styles of individuals and the intensity of site usage over time. They could also reveal the connection of the Faynan with other regions of the Levant.

8.9 Changes Over Time

The picture of imperial *metalla* gained from this thesis is that of a strong

administration that had multiple strategies to facilitate copper production. Given that survey data formed the basis of this research on the Faynan, only a broad overarching view was afforded. During the 400 year history of the Roman and Byzantine Faynan, many administrators and their staffs would have been present in the valley. These individuals may have had different management styles, strengths or weaknesses; they would have instigated changes, some of which may be visible in the archaeological record. The manner in which the administration of any one period operated may have been diametrically opposed to the actions of a successor. Smaller systems put in place by different administrators could have overlapped and, when combined, formed a larger picture. The administration that set up the panoptic surveillance in the Wadi Ratiye may have been separate from the one that created observational monitoring of the valley. Moreover, although there were many continuities, as the Roman Empire became the Byzantine Empire, the State underwent fundamental changes; the government was reinvented and the provinces were reorganised (Laiou 2002, 10). The close connection of *metalla* to the State would suggest that they would not be unaffected by larger events. Excavation in the Faynan would answer some of these questions and reveal better chronologies of the sites. Understanding of when structures were created and how they were used would indicate if patterns that I have attributed to the administration are the result of one plan or many (see Chapter 9.3).

What is shown by the other case studies suggests that a more pluralistic approach is needed, especially when dealing with the aspects of time. At Mons Porphyrites, different areas seem to have been active at different times, reflecting changing intensity of usage of certain quarries. For example, the Lykabettus village was active in the 4th

century when operations at the related quarry group were at their height (Maxfield and Peacock 2001b, 128). The Northwest village dates from before the establishment of the fort at Wadi Abu Ma'amel. It has been suggested that a complex structure there served the as the administrative headquarters and as accommodation for a high ranking official in charge of early operations in the region. After the Porphyrites Fort was built, this building was modified, indicating secondary usage when the village changed from being the Central Zone to a peripheral one (Maxfield and Peacock 2001b, 73). Another good example of this is the somewhat misnamed *Hydreuma* of Mons Claudianus. The settlement and structures acted as the Central Zone and date to the early 1st century before the creation of the main fort. When production shifted north, deeper into the Wadi Umm Hussein, the *Hydreuma* stopped being a central area, as it was a fair distance from the new active quarries. Its purpose in this later date is uncertain but Peacock suggests that it continued to be used, perhaps as a Transportation Zone, albeit with less intensity (Peacock and Maxfield 2001b, 166; Peacock and Maxfield 1997, 148).

What has been indicated by Mons Porphyrites, Mons Claudianus and Simitthus is that the elaborate structures relating to administration were created during periods of heavy production. This conclusion is not a new concept or even a particularly astute one. However, accompanying this building boom, previous structures in the landscape can often be reused. This concept deserves emphasis as most of the structures in the Faynan show evidence of multiple phases of occupation. This is especially true of the watchtowers in the Wadi Fidan; their contemporaneous occupation is strongly suggested but not certain. While these systems described in the Faynan region may not have been the work of a single period, it can be suggested that during the periods of greatest

production, most of the structures and systems I have discussed here would have been in use.

8.10 Conclusion

In this chapter I have argued that because of the shared goals of production, imperial *metalla* will have similar conceptual layouts. Although there are differences between all of the *metalla* due to geology and location, they have a general similarity. Because of this commonality it is possible to use information gathered from other *metalla* to discuss possible findings in the Faynan; particularly focusing on the social details of daily life for which a landscape survey cannot provide answers. It is vitally important to remember the individuals who existed in the landscape, the people whose behaviours and activities were the driving force behind changes. Using evidence from the comparison examples of imperial *metalla*, one can make a projection of the possible actions of people within the Faynan landscape. What is required to substantiate these theories is further study and excavation. In the concluding chapter a brief summary of this thesis and of the larger implications of the study will be accompanied by a discussion of where in the landscape this further evidence could be found.

Chapter 9 – Conclusion

9.1 Findings

This thesis has brought together multiple lines of evidence to investigate the Faynan region during the Roman and Byzantine period. It has been argued that the Faynan was an imperially owned landscape shaped by the extraction industry. To further understanding of how an imperial *metallum* was administered, aspects of structure, control and regulation of the Faynan mines were investigated. This chapter will review the knowledge gained and link these insights to the wider context of *metalla* and the ancient economy.

The hypothesis introduced at the start of this thesis was that the imperial status of the Faynan would be visible in the landscape. This study did indeed reveal characteristics of an imperial *metallum*:

- The scale of production was large enough to be called industrial
 - The pollen records show that the vegetation of the Faynan was severely compromised by fuel gathering. A steppe environment was present, which should not have been the case, since this was a period with wetter climate
 - The metallurgical remains such as slag and the pollution signature of WF441 document an output of tonnes of copper per annum
- A level of production occurred beyond what the local environment could support
- A complex logistics of supply was required to meet demand, including massive transport of grain and fuel
- ‘Settlement of empire’ was present as evidenced by the infrastructure and reorganisation of resources and land use for imperial benefit

Without a doubt the landscape itself shows the imperial nature of the Faynan. The scale of production was industrial; an estimated 2500-7000t of copper were produced overall (Hauptmann 2007, 147) a yearly average of 6.25-17.5t (Barker *et al.* 2007, 346). The centralised organisation and production, the ability to meet the demand for supplies for both the inhabitants and the industry, despite a constantly degrading landscape, and the creation of infrastructure and monumental buildings are all criteria for the designation of an imperial *metallum*. Food and fuel were not produced in sufficient quantities locally and would have had to be transported into the region. This would have required hundreds of transport animals and their facilities. These characteristics are evidence of a strong administration capable of directing trade and organising logistics, a feature that Maxfield identified as an imperial marker. The creation of the integrated WF4 field system is an excellent example of this; it attests to the powerful nature of this administration, which was capable of enforcing a new irrigation system and transforming land ownership and water rights.

If only one or two of these imperial traits had been present, the status of the Faynan might be arguable; however the combination of all of them is compelling. This designation is supported by the textual evidence of Eusebius, other church historians, and the Theodosian Codex. These sources mention military support for the Faynan and the use of convicts, neither of which is clearly visible in the landscape. But even without the awareness of these facts from literary sources, the landscape itself can provide enough evidence to conclude that the Faynan region was an imperial *metallum*.

This thesis has argued that the most important factor in determining human choice in the *metallum* was the administration. While not all actions can be attributed to the

administration, the combined evidence presented here clearly proves that the main purpose of this region was the copper industry. The majority of the region's and inhabitants' energies, resources, and supplies went to advancing this endeavour.

9.1.1 Landscape Archaeology and the Management of the Faynan

The methodologies of landscape survey have been proven appropriate for studying larger questions about the structure of the Faynan and its operation. It was an approach particularly fruitful because field surveys incorporated information about specific sites and spatial patterning within the natural environment.

This thesis used as its main source of data the JHF and WFLS surveys, which had never been comprehensively joined. The methodology I used to create the combined database involved assessing the terminology of each survey, creating a new database and conducting a further survey to ensure consistency in typology. This joined database provided a wider view of the landscape, and new insights about the Imperial era industry and occupation were gained. This methodology has further application. During the surveys of the JHF and WFLS projects, all sites encountered were recorded, dating from the Neolithic to those of the present day Bedouin. The study of these other eras could potentially benefit from a combination of the survey datasets that was used so successfully here.

The wealth of combined survey data and the comparative analysis meant that the Roman and Byzantine Faynan could be discussed in more detail in this thesis than previously possible. Study of the Faynan landscape and archaeology indicated that it was profoundly altered throughout the Roman and Byzantine period. Moreover, the study of

these adaptations, changes, formations and constructions provides concrete evidence for the manner in which the local administration managed the region. These include:

- The creation of a surveillance system
- The reorganisation of the landscape including the integrated field system and concentrated activity areas, termed the Central, Transportation, Habitation, and Extraction Zones
- The centralisation of copper production at WF11
- The creation of infrastructure such as the aqueducts, the industrial structures of WF11, and buildings near the mines, such as WF1415
- The maintenance of a population that included free and convict labourers

What this study has shown is that instead of one form of management, a number of strategies were employed in the Faynan and that these exhibited varying degrees of control. While some aspects were rather hands off, e.g. surveillance, others were very severe, e.g. constrictive mine entrances and the physical maiming of convicts.

9.1.2 Advances in the Understanding of *Metalla*

Throughout this study of the Faynan and comparison with other imperial *metalla*, the patterns of operation and use of landscape have proven to be similar. This thesis has suggested that the *chaîne opératoire* provides a reason for the resemblance. Similarities between *metalla* can be seen because they are an 'Imperial Era' cultural response to State demand and the challenges of production. Other ancient governments were remarkably different in their use of the Faynan, for example the Nabataeans. The Nabataeans were an advanced civilisation- the creators of Petra- but they did not exploit the Faynan on the scale of, or in a manner similar to the Roman period.

The *chaîne opératoire* employed in *metalla* is one imposed by an extra-regional force affecting the industry, human choice, and ultimately the landscape. While the Byzantine period is culturally different enough to be identified as a separate historical period, the Roman *metalla* system did not substantially change during that period (Matschke 2002, 115). If anything the system became more codified and bureaucratic, even if the scale of production was reduced during the Byzantine period. This is not to suggest there was a singular Roman (or Byzantine) point of view; rather, the stages of production would be accomplished with a common set of culturally and socially provided ‘tools,’ from technology to the logistics of supply in a Roman province. These tools included use of the military, State owned convicts, and the prerogatives of ownership by the State over that of private citizens.

A set of criteria for an imperial *metallum* have been gathered from these multiple examples. All *metalla* had in common a highly regulated landscape implying a controlling and deeply invasive administration. At Vipasca, which is the best example of a leased mining community, we might assume that the presence of private companies would affect the balance of power. However, what was documented in a detailed manner was the exact rules and regulations to be followed- posted by a procurator- even down to the hours of the bath opening. Other key indicators of imperial jurisdiction were present: a scale of production that can be defined as industrial; structures located at key regional points such as entrances, exits, and water sources; monumental structures such as aqueducts or forts; centralised agriculture; centralised production; a large volume of trade; observation structures and substantial impact on the environment. If these indicators are present a region without textual or epigraphic evidence can be identified as

an imperial-era State owned *metallum*.

Not only can these changes, or ‘settlement of empire,’ be seen in the landscape, but the organisation of the landscape itself, to best increase production, can be seen. From this observation, I have advanced a theory that the landscape of a Roman *metallum* can be organised into activity areas and that these ‘Zones’ can be compared across *metalla*. The Central Zone was where the administration was located; high status, administrative or military buildings are found here. It was also where key aspects of production took place and *fabrica* or industrial structures such as those found at WF11 are common. The Transportation Zone was located near the exits of the regions and was likely to be the site of ramps, hydreumata, roads or military structures. The Extraction Zone was the actual area of mineral exploitation where massive workings such as Umm al-Amad or the quarry face at Simitthus could be found. The Habitation Zone was placed near the extraction sites and was characterised by living quarters or dormitories, presumably for workers. Each of these Zones has characteristic structures and locations that can be identified by survey. This concept of activity Zones advances our understanding of imperial spatial patterning and function in *metalla*.

Despite the similarities noted, Chapter 8 demonstrated that a careful study of each individual *metallum* needs to be made. Although there are many overarching similarities, there are differences due to geological or logistical factors. These can be seen at the most basic level. Mons Claudianus was a quarry that functioned despite the limited water supply. Las Médulas used hydraulic channels outpouring tonnes of water, enough to wear down mountains. The individual study of these operations is not just interesting in its own right or to discover particularities of the region, but because the findings indicate the

workings of a empire-wide economy that was flexible, capable of working in vastly different circumstances, creative, and also stubborn, in that, despite environmental degradation, travails of regional development, or even threatened violence from workers or bandits, the *metalla* of the empire still kept producing. Each *metallum* can provide evidence of new adaptations and behaviours.

A GIS was used successfully in the Faynan; it facilitated analysis of spatial data and patterning. It may prove equally useful in other *metalla*, especially if the theoretically informed use of viewsheds is employed. The Roman/Byzantine Faynan had multi-storey buildings at key locations in the landscape, viewsheds and cumulative viewsheds were a way of exploring their potential roles. A complaint about the use of viewshed analysis in archaeology is that it commonly does not take into account limitations of human sight or impositions of the environment. The use of viewsheds in this thesis combined ideas of the limits of humans' ability to discern objects (based on Higuchi 1993) and information about the environment gathered during surveys. The other *metalla* have structures to improve view and if, as has been claimed here, there are similarities between *metalla*, this would be a fruitful path of research. This initial success of this technique validates the usefulness of such an approach and technique; further uses of viewshed in industrial landscapes are warranted.

9.2 Future Work

While this thesis has produced a deeper discussion of the Roman and Byzantine Faynan than was possible before, it has also highlighted areas where further information can be gained. A more extensive exploration of the activity Zones theory would be of

interest. Enriched by knowledge from investigation of other Roman *metalla*, informed theories were advanced about the Faynan. Suggestions have been made about what might be found in different activity Zones, but to truly test these hypotheses, excavation of sites in the Faynan is required.

Of the possible excavation sites, Khirbet Faynan is a priority. As the largest and most central site dated to the Roman/Byzantine era, it can be assumed to have been the administrative hub. Presently no large-scale excavations have taken place. To truly understand the Faynan as an industrial region, this site must be explored. The delay is logical, it is a massive tell site with multiple occupation layers; the size and scope of such a project would be a time-consuming and expensive undertaking. Moreover, the site is relatively protected by the collapsed masonry of the last phase of building on top of the tell, covering the structures beneath. Disturbing this layer would likely lead to looting. Despite these difficulties, many questions about the nature of the Faynan's administration could be answered. This is likely where administrative documents would be stored; if ostraca such as those found at Mons Claudianus, or mining laws like those of Vipasca exist, they would be there.

Even if excavation at the Khirbet failed to reveal written documents, information about occupation levels would do much to refine the chronology of the Faynan. The question of scale and intensity of industry over time needs further resolution. The WF441 barrage findings suggest fluctuations of industry, is this mirrored in the usage of buildings such as the central building? Perhaps the most interesting questions concern the Early Roman period and the creation of the Faynan's industrial landscape. This period is little understood, we can see the effects of the administration and industry in the Late

Roman period, but do not always possess the information necessary to explain when and why these changes to the landscape took place. Furthermore, the controversial theory of Nabataean extraction needs addressing. Although there are hints of its existence (contra Hauptmann 2007), we can speculate no further with the current information. The Nabataean occupation layers lie underneath the Roman and Byzantine; without excavation, only general conclusions can be drawn.

WF1415 would be another place to concentrate excavation; as an administrative structure, it likewise could answer many questions of management and administration. A better understanding of its relationship to the industry and the nearby miners' settlements would provide further data about the workforce and in turn, the administration. In this thesis it has been proposed that WF1415 is a surveillance structure; more information could further refine this theory.

The towers in Wadi Fidan are another opportunity to explore this aspect of administrative control of the landscape. Further examination of the towers could reveal for which periods each was in use. Presently, it is only possible to speculate about how intensively surveillance was practiced by the administration. The occupation history of each of these watchtowers could establish stronger correlations between them and with other sites.

Finally, in an environment as constrained as the Faynan, a possible means of control was the restriction of vital supplies- food and water. Without these, neither the individuals within the region nor the industry could function. However no evidence is presently found supporting the supposition that water or food were restricted or

monitored by the administration. Future research should include excavation around the springs or wells used in the Roman/Byzantine periods.

9.3 Larger issues

This study substantiates a key tenet of landscape archaeology, that the recording of sites and the surrounding landscape is essential to creating a fuller picture of the past. Space and spatial patterns can be considered a form of material culture and study of them is essential in understanding past human societies (Delle 1998, 8). Without the environmental and physical descriptions of the Faynan, human choices within it, or despite it, could not be placed properly in context. This study also shows the applications of landscape archaeology beyond rural environments; studies of industrial landscapes, too, can benefit from an integrated approach.

The idea of using the landscape to study mining has been embraced by scholars in the last decade, and studies such as the one presented in this thesis have been proliferating. The European Cooperation in the field of Scientific and Technical Research (COST) group A27 studied mining landscapes in Europe to place the industrial remains within the larger landscape and elucidate functions. Their results, such as the *Atlas Historique des zones minières d'Europe I and II* (Orejas 2001; 2003), allow for interpretation of both the regional landscape and the larger area of Europe, as well as understanding of the *longue durée*, where extraction activities are placed in the context of time as well.

9.3.1 The Broader Economy

The Faynan did not exist as a singular entity; it was influenced by being part of a larger empire. This was not a one-way relationship, however. The empire influenced the Faynan, but equally important was the impact that the copper had on the greater Levant region. Faynan was a difficult region to mine, the environment and geology, especially the lower grade ore, made it an expensive undertaking. It would not have been exploited as a resource if its products were not necessary; either to generate profit or to supply the Southern Levant with copper. Because it was both affected by and contributed to the empire, a study of the Faynan has wider implications than just as an example of a *metallum*, or for comparison with other case studies. The Faynan was an exemplar of a larger economic system, one in which there was a demand for copper even if it required elaborate measures to procure it.

This thesis has attempted to quantify some aspects of the Faynan extraction industry. Although they are at best estimations, they convey the size and scale of the operations. Since the entire region has been examined, overall costs can be estimated. Chapter 8.7 presented the monthly overhead for payment of the miners; for 400 miners-13,875-17,625 *drachmae* per month. Using the previous calculations, the total yearly sums reach 166,500-211,500 *drachmae*. In Chapter 6.4.3, the quantities of supplies and animal transport were discussed. I have argued that 100-125 camels were routinely present in the Faynan. Adams, using information from Egyptian sources, suggested that these animals were hired at an average of 2 *drachmae* per day (2001, 187). This would make a yearly cost of 73,000-91,250 for the Faynan animals. At the zenith of production

it has been suggested that 1,110-1,360 people would have needed outside food supplies (see Chapter 6.4.3). The standard ration for a soldier per month was one *artabata* of grain, costing on average 8 *drachmae* (Adams 2001, 183). Using these figures, up to 8,880-10,880 *drachmae* per month may have been spent on grain, or as much as 106,560-130,560 *drachmae* per year. Combined, the costs of food, animals and pay for miners may have reached a staggering 443,310 *drachmae* annually. Of course, as all of these estimations are based on Egyptian cost data and date to the 2nd century; they can only be used to approximate expenses. Furthermore, there would be fluctuations; for example, the economic crisis of the 3rd century would alter calculations (Duncan-Jones 1982, 9). However these figures do provide an idea of the kind of costs encountered and the order of magnitude these sums were likely to reach.

Clearly the Faynan was an expensive undertaking. Even if these figures are on the generous side, one must remember that only three potential costs have been discussed here; costs for charcoal, fodder, tools and equipment must be added. Also to be factored in are the building expenses for structures such as the aqueduct and WF1415.

The investment in developing the Faynan region, the expenditure of money, time, and even human life was immense; and yet it was but one of many *metalla* operating in the empire during this period. The combination of these multiple industrial regions is profound in terms of social, political and economic impact.

It is difficult to gain an idea of how many *metalla* there were in the Roman and Byzantine empires. It is also difficult to approximate how many were operating at any given time. However, with the mineral resources of Spain, Britain, Egypt, Cyprus, Gaul,

and Dacia, not to mention the rest of the provinces, it is plausible that hundreds of mines existed, organised as several score of *metalla* (Mattingly pers. comm.). The Faynan was by no means the largest copper extraction region; those were located in Huelva or Rio Tinto in Spain and in Cyprus (Rothenburg and Blanco-Freijeiro 1981; Hong *et al.* 1996, 158). For these regions, similar or even greater expenditures would be expected.

While the exact number of *metalla* is unquantifiable, their effects can be measured. Hong *et al.* studied the Greenland ice caps that preserved a record of air pollution. The highest copper pollution levels before the Industrial Revolution occur in the Roman era 250 BC to AD 350. Atmospheric copper flux fallout equalled 600,000 tonnes, which is equal to 50% of the amount produced in the 20th century (Hong *et al.* 1996, 190).

While not at the scale reached in the 1st and 2nd centuries AD, imperially owned mining districts were still being heavily exploited into the Early Byzantine period. Thus the Faynan is important as an exemplar of one of those Late Roman-Early Byzantine mines generally neglected by scholars. The Faynan is even more unique, as most of the other cases identified and studied were bullion mines. I have made the case that copper was also a vital state requirement, especially during these periods and in the Levant.

9.3.2 Economic Models

These calculations of cost and production return us to a question raised in Chapter 1. How does incorporating *metalla* into our understanding of the ancient economy affect its models? Debates about ancient economies have vacillated between primitive agricultural models, such as those championed by Finley [1973], and the application of

more modern economic principles to some aspects of the ancient world.

Finley was purposely trying to create a broad economic model that encompassed the ancient world from 1,000 BC-AD 500 (Finley 1999, 29). His main point was to identify themes he felt were common throughout both the Greek and Roman worlds. Some of these, as highlighted by Finley, cannot be disputed; the predominance of agriculture, slave labour, and the presence of redistributive systems. He himself stated that certain situations and details would not always be a perfect fit, that no model can incorporate all regional variations (Morris 1999, xxvii). The extraordinary examples of *metalla* described in this thesis can be characterised as industrial in scale. However the main portion of the empire was still agriculturally based. Thus Finley would argue that his model was applicable overall (Finley 1999, 182). I would argue that there are enough “extra-ordinary” situations that do not fit the model to suggest it needs revaluation (see Harris 1993; further discussion Mattingly and Salmon 2001). *Metalla* are one example of this, showing evidence of inscribed economies, long-distance trade, and metal production beyond that needed by a local region.

Moreover the need for copper and other metals is clearly demonstrated by the exploitation of these regions. *Metalla* do not just challenge a primitivist economic model by what they consumed, but by what they produced as well. Finley argues that coinage was struck to pay the military and to meet the needs of the imperial government, but otherwise there was a “chronic shortage of coins” (Finley 1999, 166). The exploitation of metal resources suggests otherwise; the intensity of extraction was matched by the increase in coinage (Harl 1996, 4-5; Howgego 1992, 8).

In light of this proliferation of *metalla*, the economy of the Roman and Byzantine Empires cannot be viewed as static or primitive. Instead extraction industries join the growing body of evidence that the appropriate model for the Roman economy is a hybrid, with elements of both Finley's and other, more dynamic models. Exploitation of the Faynan is another example of these large-scale projects. Thus the Faynan has proven itself to be of great interest, not only for how it was managed and how its landscape was changed, but for wider discussions of the Roman economy as well.

9.4 Summary of Thesis

Previous work in the Faynan by multiple scholars identified extensive Roman and Byzantine archaeological remains. These features led both the DMB and WFLS to conclude that the imperial State was involved in copper production. I agree with this conclusion and have provided corroborating evidence. In Chapter 2 the scale of production, references in ancient literature, and the pollution record as observed in the soil and the skeletons of the local population were examined. While the exact dates are not yet clear, a strong argument can be made that copper production was practiced from the Nabataean (pre AD 100) through to Late Byzantine era (post AD 500).

The presence of an imperially owned industry was established, however, the manner in which production was accomplished was not. This led to a larger question discussed throughout the thesis. Knowing that industry was present, what were the specific mechanisms of management employed by the administration? This thesis proposed that a detailed examination of the landscape would answer questions about the particulars of production in, and administration of the Faynan.

There are two main conclusions to be drawn from this study. First, this thesis asserts that the Faynan was not just imperially owned but also possessed a strong and controlling administration. The grand scale of production (Chapter 2) and the use of the military and convicts (Chapter 6) are evidence for imperial jurisdiction. Industry at this scale would not have been possible without a powerful administration capable of organising agricultural land and supplies, and controlling the labour force.

I further argue that by studying the spatial patterns and the location of structures, the specific mechanisms of management by the administration are revealed. Chapters 5 and 6 discussed the creation of infrastructure; roads, aqueducts and administrative buildings to facilitate production. There was a trend of centralisation, exemplified by WF4 and water resources, to support the industry. Chapter 7 investigated in depth the observation structures in the Faynan. I have posited that these were not simply structures to aid views, but rather they were imbued with complex understanding of the ability to exert control through surveillance and panoptic observation. Using the natural topography and logistical placement of fortified buildings, the region could be controlled without the constant application of physical force. The argument of Chapter 8 was that activities related to production were concentrated into different Zones in the landscape, and this spatial organisation created distinctive patterns.

Thus the answer to the question of how the administration managed the Faynan region is that multiple strategies were employed, including the creation of a highly regulated and controlled landscape. In its administration, the Faynan shows similarities to other imperial *metalla*, including the previously identified hallmarks: the use of State institutions such as the military and convicts, the large-scale of production in an

environmentally and topographically challenging location, and the powerful central management. The Faynan also possesses the spatial layout of activity Zones discussed in Chapter 8, and these zones are echoed in other *metalla* throughout the empire. There were many parallels found; enough that aspects recorded in other *metalla* could be discussed in relation to the Faynan.

9.5 Conclusion

This thesis has demonstrated that landscape archaeology is a robust method for studying the economy and specifically the *metalla* of the Roman and Byzantine periods. It has illuminated sites, structures and the landscape, but more importantly how these combined together to form an industrial region. This study has detailed the Roman/Byzantine Faynan in a way never before attempted. The Roman/Byzantine industry had a massive impact on the land and natural environment. Spatial patterning of the landscape was strongly directed by the administration and the requirements of the copper industry.

This study has yielded a richly nuanced picture of the imperial mines of Faynan from 150-550 AD. It has shown that the Faynan was in fact part of a continuum of imperial extraction districts, with many similarities to other *metalla*. It has demonstrated that the decisions and the behaviour of the imperial administration can be inferred from their disposition of the landscape. It has demonstrated that the hallmarks of imperial presence: reorganisation of the landscape to benefit the administration, control of vital resources, control of transportation and of access and egress, centralisation of production

facilities, control of the labour force and the use of the military when necessary, were all present at Faynan.

Industry and Empire: Administration of the Roman and Byzantine Faynan

Volume Two: Appendices and Figures

Thesis submitted for degree of
Doctor of Philosophy
at the University of Leicester

by

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Appendix 1 – Chronology

There are many accepted chronologies used by scholars for the Levant (Kennedy and Riley 1990, Khouri 1988, MacDonald 1988). Therefore to prevent confusion it is important to define which classification will be used for this thesis. The two main surveys, the Wadi Faynan and Jabal Hamrat Fidan projects, have similar classifications making it easy to calibrate to a similar chronology. A modified version of the chronology of the WFLS project is used; it is derived from pottery dates and historical periods.

Hellenistic	332 BC – 63 BC
Nabataean/Early Roman	63BC – AD 150
Late Roman	AD 150 – 324
Early Byzantine	AD 324 – 502
Late Byzantine	AD 502 – 638
Early Islamic (Umayyad and Abbasid)	AD 638 – 750

These pottery distinctions are abbreviated in tables, the categories are as follows

Nabataean – Nab
Nabataean/Roman – Nab/R
Roman – Rom
Late Roman – LR
Roman/Byzantine – R/B
Byzantine – Byz
Early Byzantine – Ebyz
Late Byzantine – Lbyz
Classical – Class

Appendix 2 – Writings of Eusebius

Eusebius mentions Phaeno/ Faynan in the following passages,

- Ecclesiastical History HE 8.12 10, 8.13 5, 8.14 13, 9.1 7-10
- Martyrs of Palestine MP 5.2, 7.2, 7.3, 8.1, 8.13, 13.1-4

In these he does not always refer to the region of Faynan as Phaeno. At times he only refers to ‘copper mines in Palestine,’ or the ‘aforementioned mines.’ The only other copper *metalla* in Palestine was Timna and it was mainly in use during the second century. During the periods referred to by Eusebius, Timna was being worked only on a small scale (Rothenberg 1972, 222). Eusebius never refers to Timna nor did its exploitation reach the scale of the Faynan operations. Therefore it is very likely that all references to ‘the mines of Palestine’ are referring to Faynan.

The following are translations of the relevant passages of Eusebius’ *Martyrs of Palestine*. The quotes are taken from the shorter text (S), which seems to be an abridgment of the first version he wrote (L) (Lawlor and Oulton 1928, 8). This version was placed at the end of the Ecclesiastical History as an addition to chapter 8. The short version is for a wider audience, those less likely to know Palestine and its people personally (Lawlor and Oulton 1928, 7). More detail is given about the province and this makes it more useful as a historical text, though there is less about the martyrs themselves. The exception is the last passage, which provides the most detail about Phaeno, both versions are given.

At Caesarea, Theodosia a virgin from Tyre... soldiers seized hold of her and brought her before the governor... he ordered her to be cast into the waves of the sea. Then from her he turned to the other confessors, and committed them all to the copper mines in Phaeno in Palestine. *MP* 7.2

The mine in Thebais, that derives its name from the porphyry stone which it produces, had an exceedingly large multitude of confessors of religion. Of these one hundred men, all but three, together with women and babes, were dispatched to the governor of Palestine... All this was done by the order of Firmilian (who

was sent there as a governor in secession to Urban) as if in obedience to an imperial command. *MP* 8.1

But no long time had elapsed when a second band of Egyptians, those marvellous champions in the confession of Christ, one hundred and thirty of them, endured in Egypt itself at the command of Maximin the same afflictions in eyes and feet as did those others a short while ago. They were sent away to the aforesaid mines in Palestine: but some shared the lot of those under sentence in Cilicia. *MP* 8.13

Short Version

























...in the neighbourhood of the copper mines in Palestine no small number of confessors was gathered together, who used great boldness, so as even to build houses for church assemblies. But the ruler of the province (a cruel and wicked person, as bad a man as his acts against the martyrs proved him to be), having come to stay there and learning the manner of their life, communicated everything he thought fit to the emperor in a letter that was meant to slander. Next came on the scene the superintendent of the mines, and acting, apparently on the emperor's orders he divided the body of the confessors, assigning to some a place of abode in Cyprus, to others in Lebanon, scattering some here and some there in the districts of Palestine; and ordered that they all should be oppressed with various kinds of labour. After that he picked out those four who seemed most like their leaders and sent them to the officer in charge of the armies in that quarter. *MP* 13.1-4

Long Version

a great spectacle gathered at Phaeno in Palestine. And all the champions were perfect men, in number about one hundred and fifty. Many of them, over a hundred, were Egyptians. These had first their right eyes and the sinews of their left feet destroyed by branding irons and the sword, and afterward they were given over to the mines to dig copper. And the Palestinians also endured the like sufferings as the Egyptians. But all of them together were assembled at the place called Zoar, like a church consisting of many persons, and there was a great crowd with them, who came from other districts to see them. And there were many others, who ministered to them in those things of which they had need... and were ministering all day in prayer and the ministry of God and in teaching and reading; and all the afflictions that befell them they counted a pleasure... But the hater of God ...could not endure these things, and immediately there he sent against them a Roman general, called a Dux. And to begin with, he divided them one from another, and some were sent to Zoar, an evil place, and some not; some to Phaeno where the copper is dug, and others went to other districts. And after that picked out four of these in Phaeno who were of special excellence, thereby to terrify the rest... *MP* 13.1-4.

Appendix 3 – Symbol Legend

In order to create consistency in usage a symbol legend was created for the site types. This legend provides a set usage for ease in interpretation. All symbols used in maps generated with GIS follow this schema.

Legend		
	Agricultural	 Enclosure
	Aqueduct	 Funerary structures
	Artifact Site	 Grave
	Cairn	 Hamlet
	Campsite	 Khirbet
	Cemetery	 Metallurgical Features
	Church	 Mining Features
	DS	 Reservoir
	DSC	 Rock Shelter
	Fortified Structure	 Settlement
		 Spring
		 Stone Settings
		 Wall Line
		 Water Mill

Appendix 4 - Radiocarbon Dates

The published radiocarbon dates. Hauptmann's samples were recalibrated using CALIB.

Samples collected by Hauptmann 2000, 65-66 and Hunt *et al.* 2007, 1333-1334.

Site	Context	Dates cal. BP 2σ	Dates cal.	Reference
Kh. Faynan Slag heap 1		2130 (95.4%) 1880	171BC- AD 68	Hauptmann (HD 14307)
Kh. Faynan Slag heap 1		2150(95.4%)1880	194 BC-AD 209	Hauptmann (HD 14378)
Kh. Faynan Barrage section 2.04-2.06 m		1900 (95.4%) 1710	AD 60-238	Hunt Beta 203400
Kh. Faynan Slag heap 1		1822 1633	AD 85-313	Hauptmann (HD 14380)
Kh. Faynan Slag heap 1		1870(1.6%)1840 1830(91.8%)1690 1650(2.1%)1630	AD 89-317	Hauptmann (HD 14066)
Kh. Faynan Slag heap 1		1801(95.4%) 1620	AD 128-330	Hauptmann (HD 14306)
Kh. Faynan Barrage section 2.24- 2.26 m		1800(95.4%) 1611	AD 92-339	Hunt Beta-203401
Kh. Faynan Slag heap 1		1790 (95.4%) 1575	AD 127-375	Hauptmann (HD 14097)
Kh. Faynan Barrage section 1.74-1.76 m		1610 (95.4%) 1403	AD 349-547	Hunt Beta-203399

Appendix 5 – Population Estimates

Very small sites < .1ha 5 person

Small sites < .5ha 10 people

Medium sites <1ha 20 people

Large sites > 1ha 100 people

Major > 3ha 200 people

JHF measured sites as the distinct spatial; clustering of artefacts, features, structures and eco-fact remains (Levy and Anderson 2000, 5). This means their recorded areas included not only domestic structures but other associated archaeology such as cairn fields or pottery scatters. This tends to make their measurements generous for the purposes of estimating population numbers. I have placed some sites in lower categories to account for this.

Very small sites (4) = 20 people

Site number	m ² recorded by JHF	category	Reason why
7	10	Very small	
26	76	Very small	
121	132	Very small	
607	3,520	Very small	Flint scatter but the DSC measures 2x3m

Small sites (6) = 60 people

46	4,500	small	
47	2,050	small	
82	1,000	small	
112	1,848	small	DSC measures 22x8m
622	3,857	small	DSC great deal of collapse
623	1,658	small	DSC great deal of collapse

Medium sites (4) = 80 people

49	9,900	medium	Camp site multiple periods?
60	10,750	medium	Unclear as to what is being measured
606	12,481	medium	Includes cairns- no definite wall lines visible
78	10,900	medium	Fewer structures then the large sites below

Large sites (2) = 200 people

50	24,600	large	
120	20,000	large	Measurement of west end of 'island' where the Classical material is concentrated

A very rough estimate is that 360 people lived in the Wadi Fidan.

Other Wadis

Given that the Wadis al-Jariya and al-Ghuwayb have not been surveyed in full, it is impossible to make an appropriate estimate. What is known is:

- Seven sites measured less than .5ha (WAG 18, WAG34, WAG 48, WAJ 511, WAJ 512, WAJ 516 WAJ 540)
- WAG 3 is larger, measuring 1.8ha, however the hamlet has few discernable domestic structures and many stone pens. It is likely that it had fewer people than its size suggests.
- WAG 62 (Khirbet an-Nahas) is an Iron Age site with some Roman activity but how much of the 10ha site was Roman and domestic is unknown, certainly not more than 1ha.

A very rough estimate is that at most 170 people lived in these two Wadis, making 530 people in the region of the Fidan, al-Ghuwayb, and al-Jariya.

When the WFLS survey made their calculations of the Faynan region they estimated these regions contained 420 people. I would add to this an additional 110 with my more thorough review of the evidence. This brings the grand total of WFLS and JHF population estimates to 1,610-1,860. It is very unlikely that the population ever exceeded these numbers as the environment has limited potential to feed more than this. (see Chapter 6.4). Over time no doubt these numbers fluctuated. In the Fidan the main population centres Fidan 120 and 50 yielded pottery from multiple periods, suggesting frequent occupation during the Roman and Byzantine periods. More commonly seen were sites with R/Byz (for pottery discussion see Chapter 3.6). The exact dating of these sites is unknowable. However if it is assumed that during the peak periods of industry most sites yielding R/Byz pottery were occupied then this is realistic estimation of population numbers for those periods. This situation changes later on, sites with Late Byzantine

pottery finds are few in both the JHF and WFLS surveys. It is likely that this reflects a smaller population occupying fewer sites.

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The WFLS and JHF Surveys

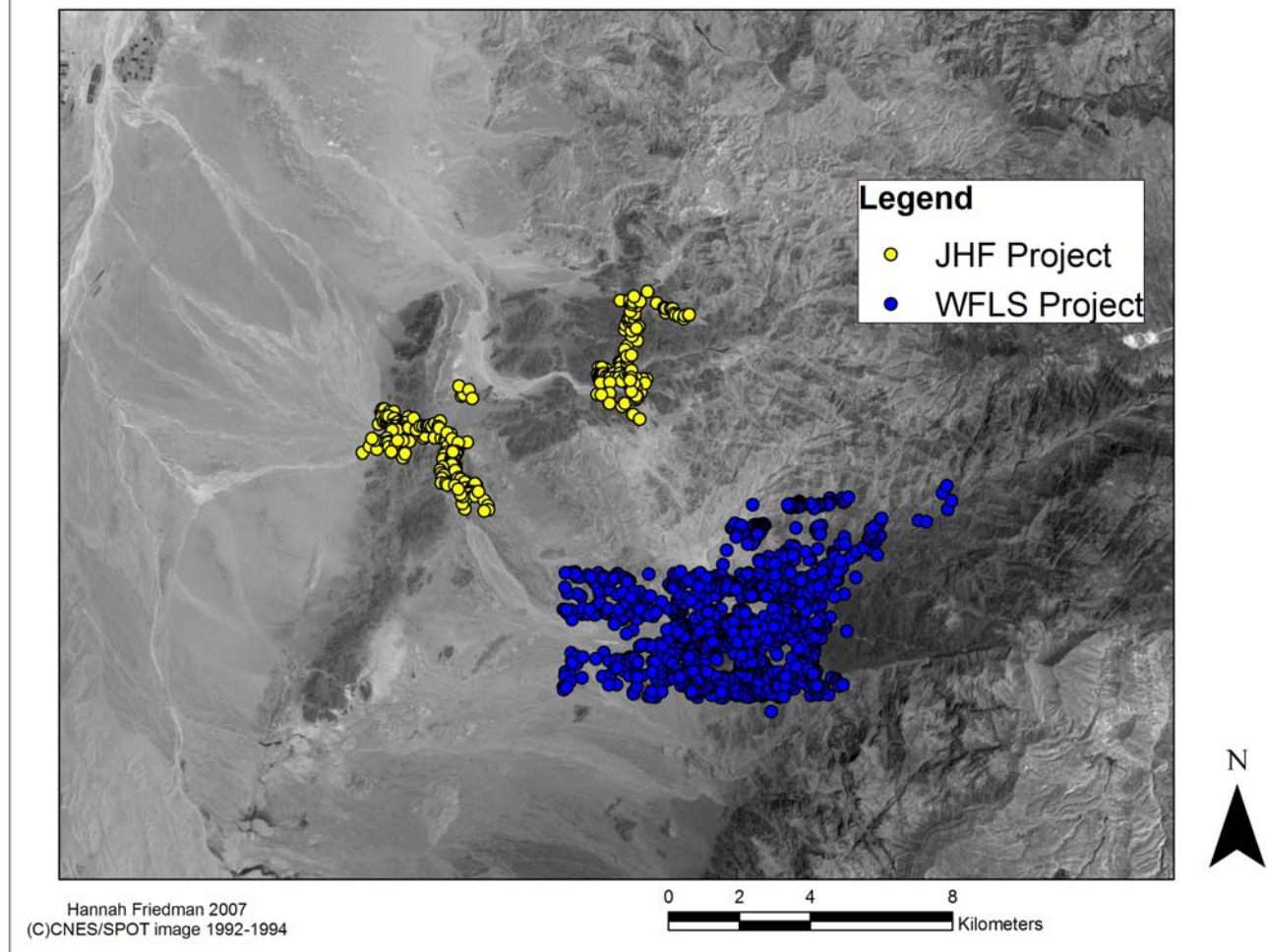


Figure 3.1 The map shows sites (all periods) recorded by each project.

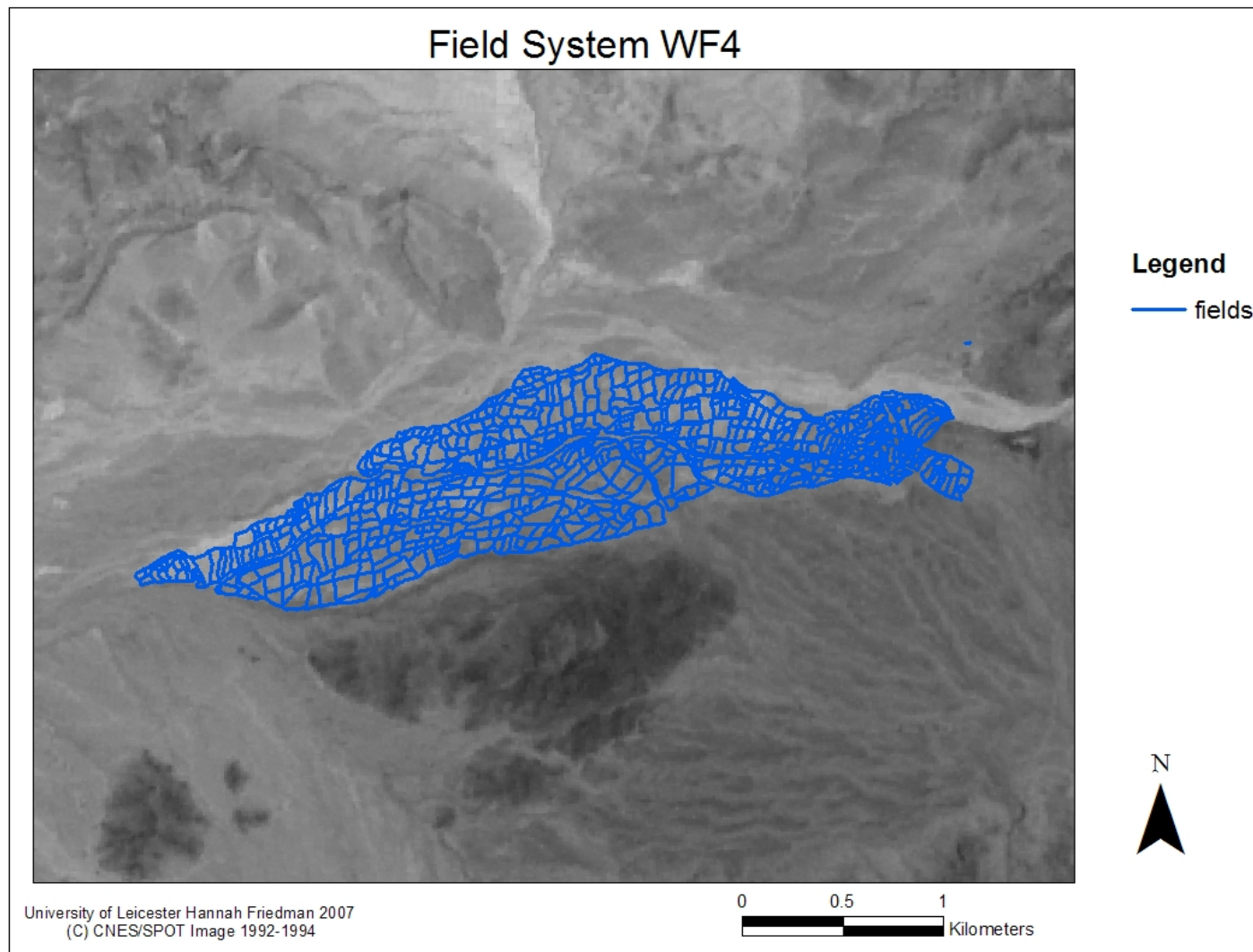


Figure 3.2 The field system WF4.

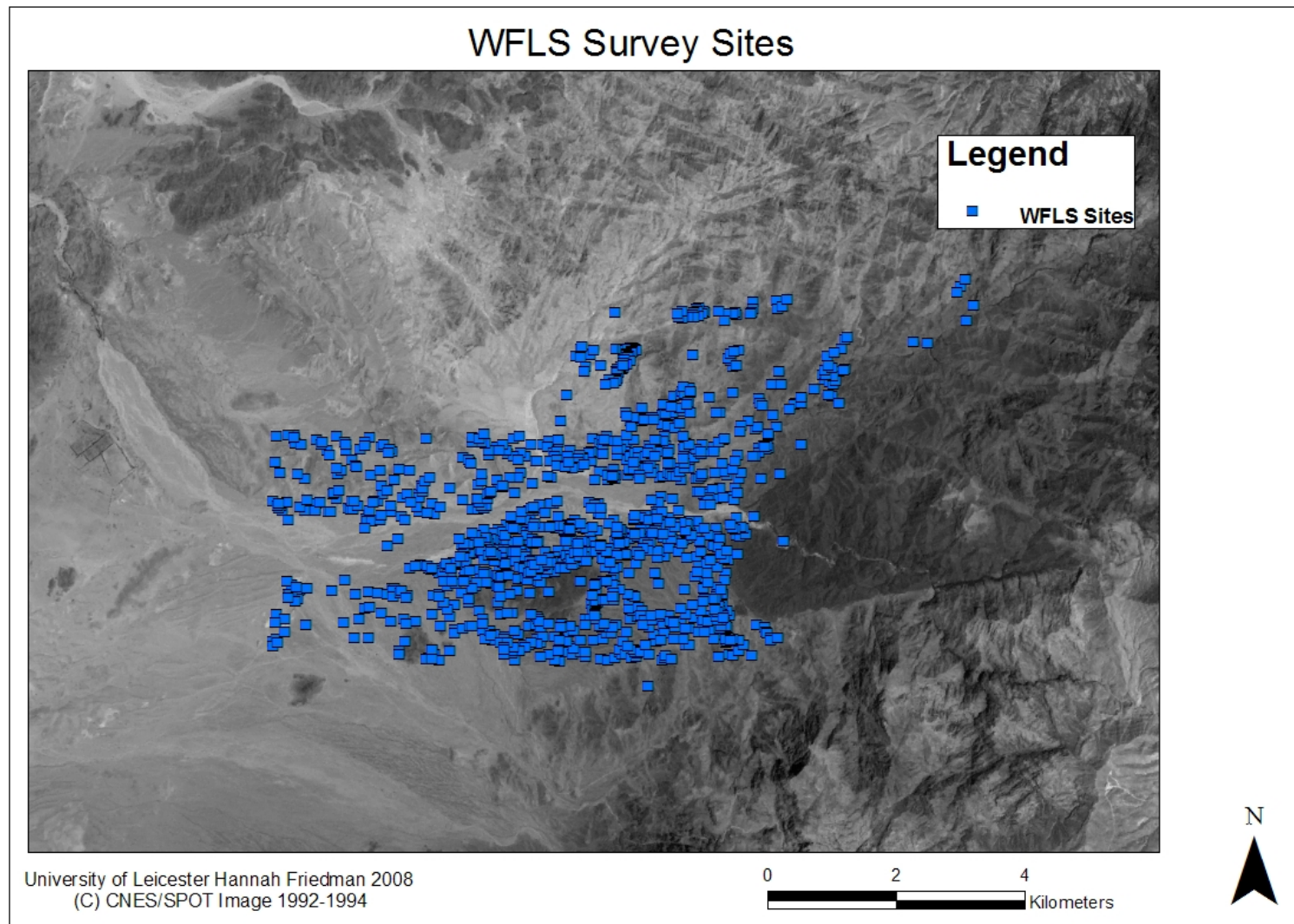


Figure 3.3 All sites regardless of period as recorded by the WFLS survey.

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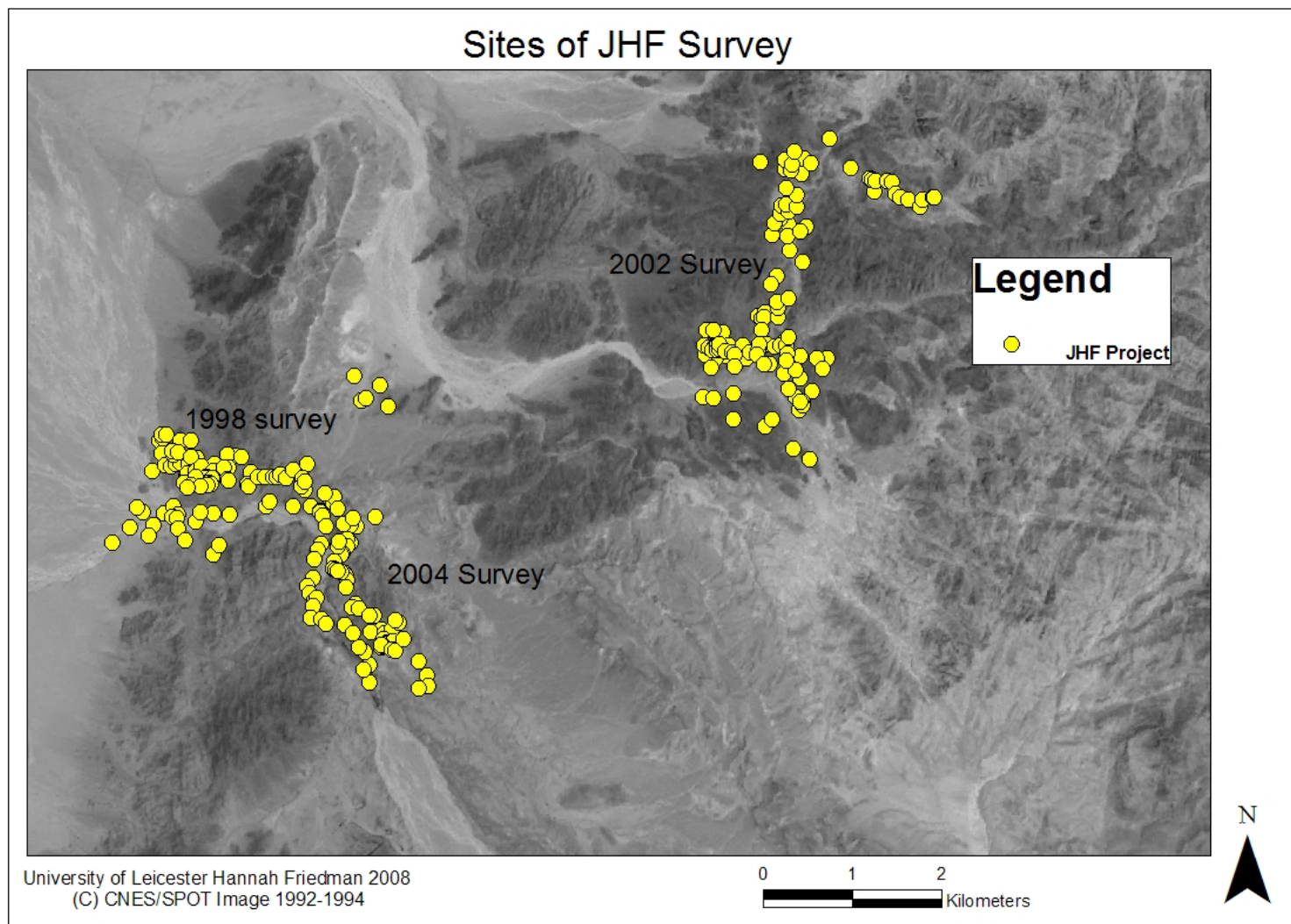


Figure 3.5 All sites recorded regardless of period during the JHF survey; 1998, 2002, and 2004 seasons.

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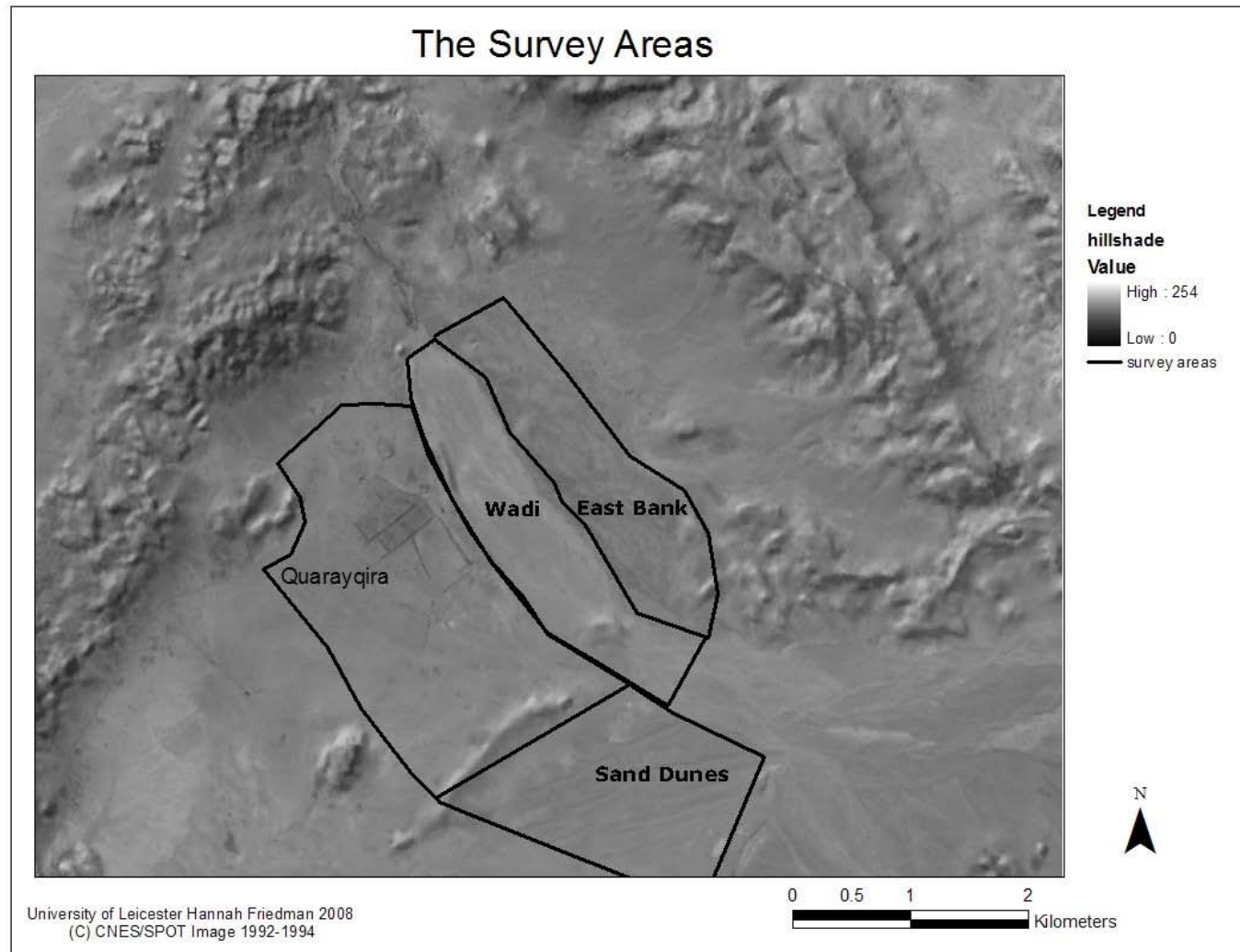


Figure 3.7 Map of survey sections labelled.

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Figure 3.9 The sand dunes to the south of Quarayqira facing south.

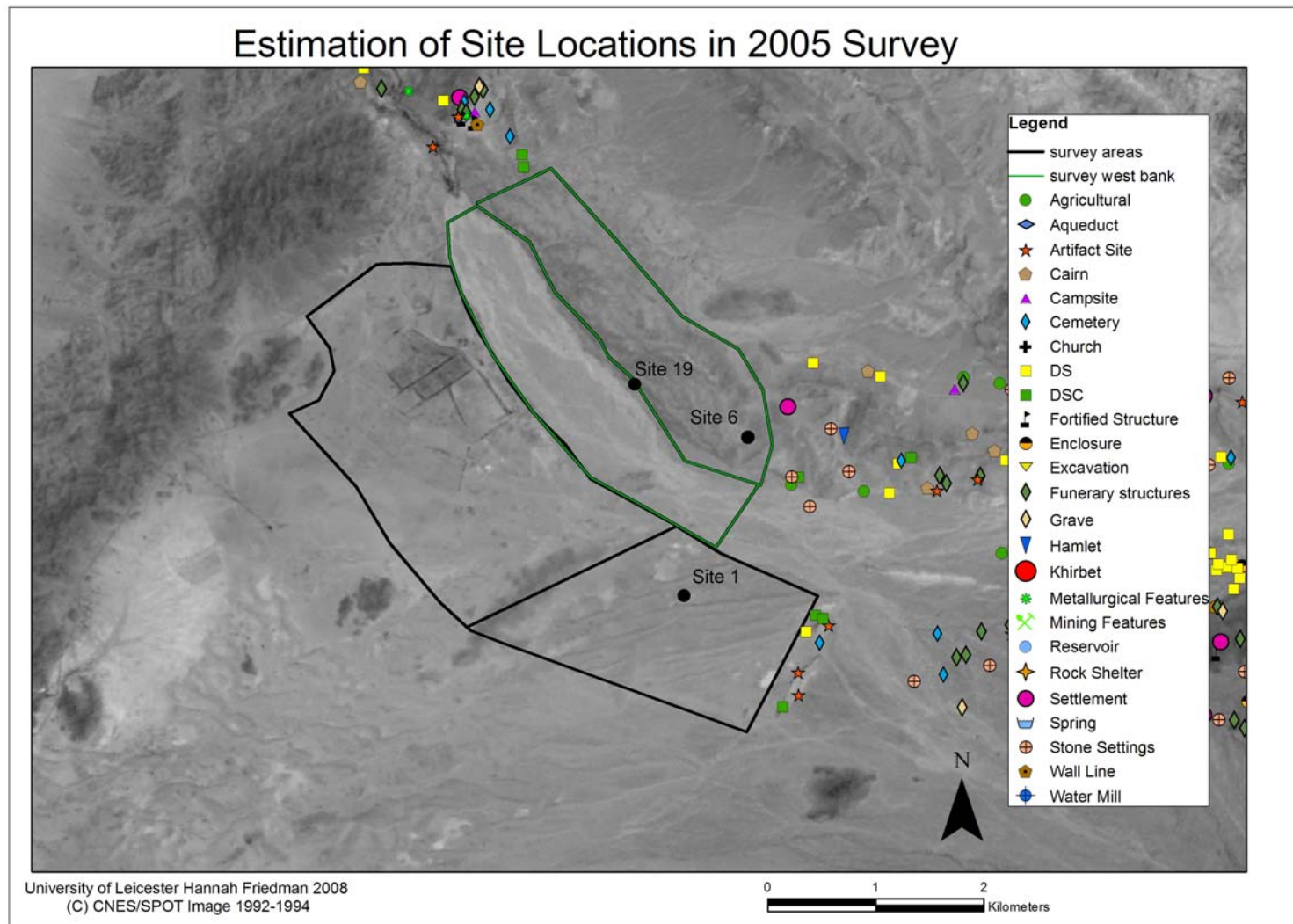


Figure 3.10 An estimation of the location of some of the sites.



Figure 3.11 Platform or kerb aspect of Site 6 facing east.

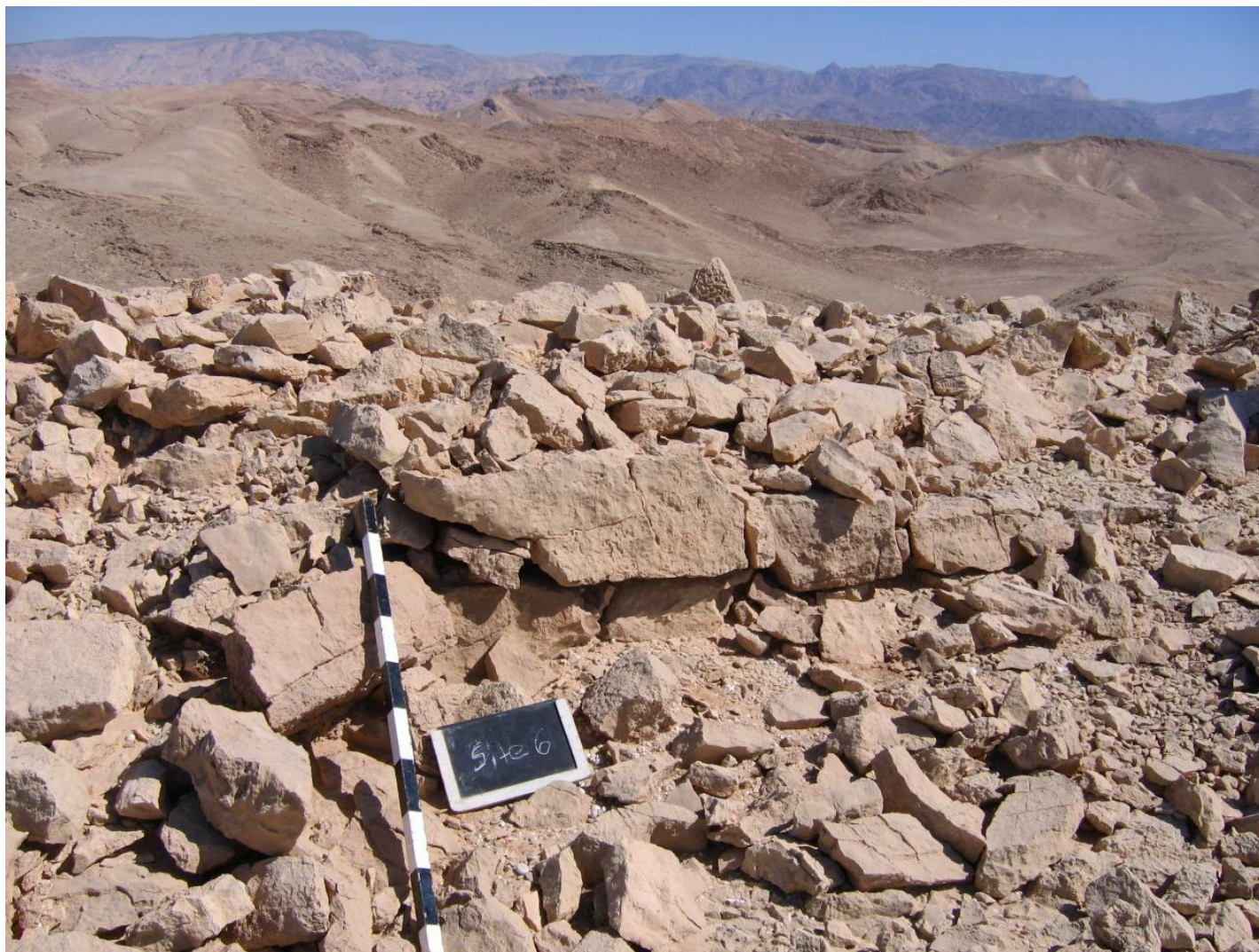


Figure 3.12 Site 6 facing east.



Figure 3.13 The cross design found at Site 6.

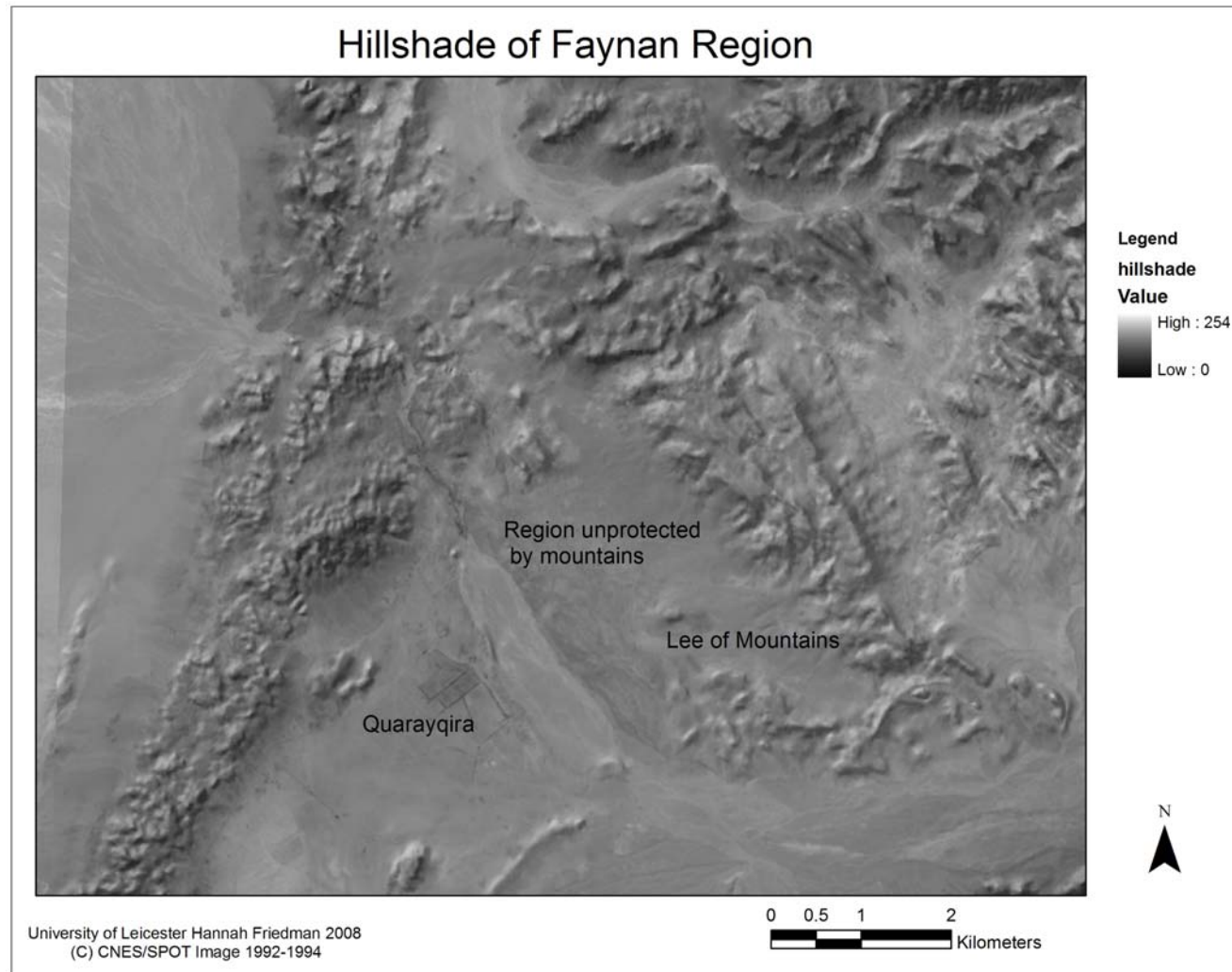


Figure 3.14 Hillshade of Faynan-Fidan Corridor. The southern east bank is protected by the mountains acting as a wind break. The mountains recede, leaving the northern half more exposed.

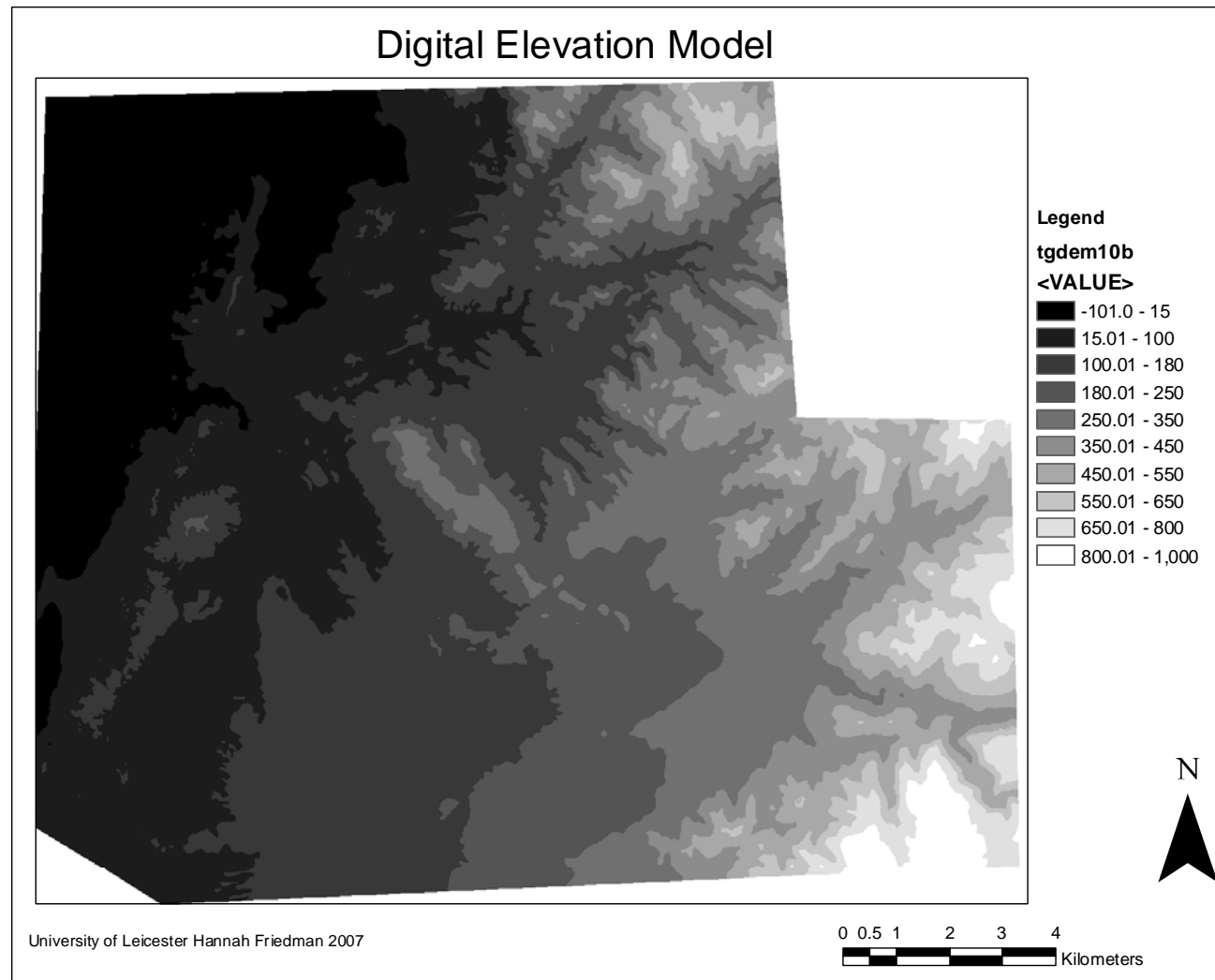


Figure 4.2 The DEM of the Faynan region. The dark areas represent low elevations; high elevations are signified with lighter shades.



Figure 4.3 The NIMA SPOT satellite image (C) CNES/SPOT Image 1992-1994.

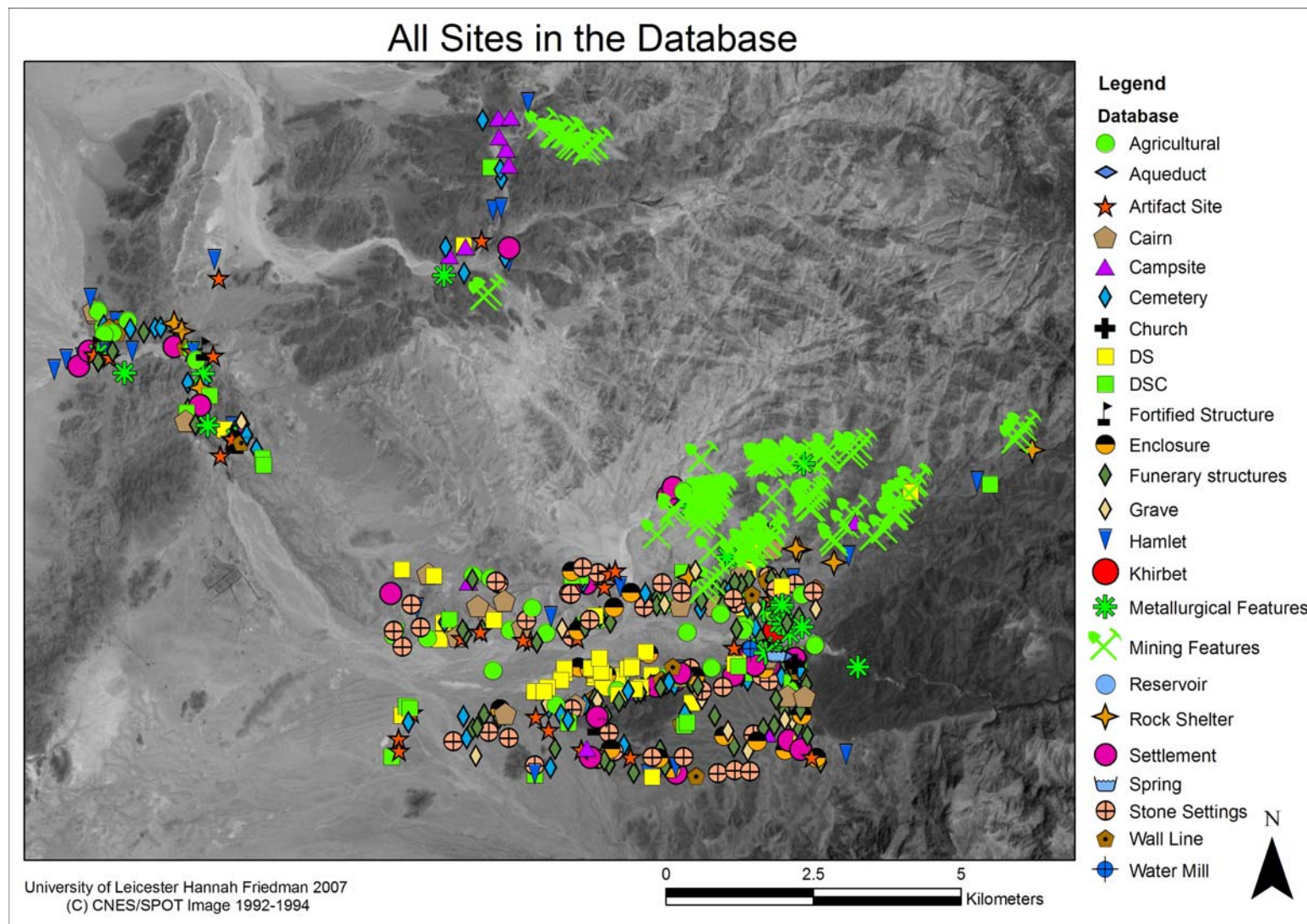


Figure 5.1 Map of all the sites in the database. See Appendix 4 for symbol legend.

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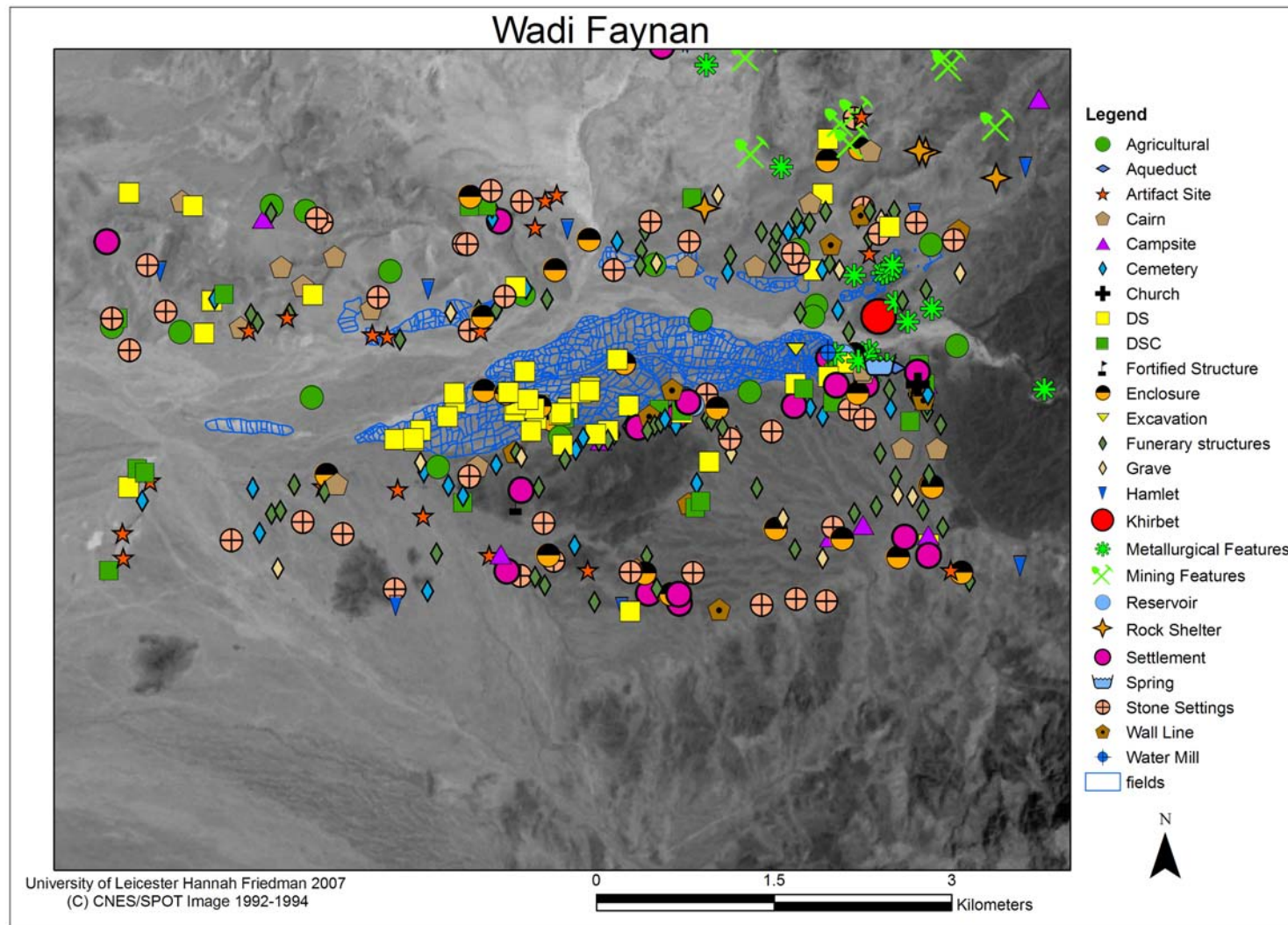


Figure. 5.3 The sites in the Wadi Faynan.

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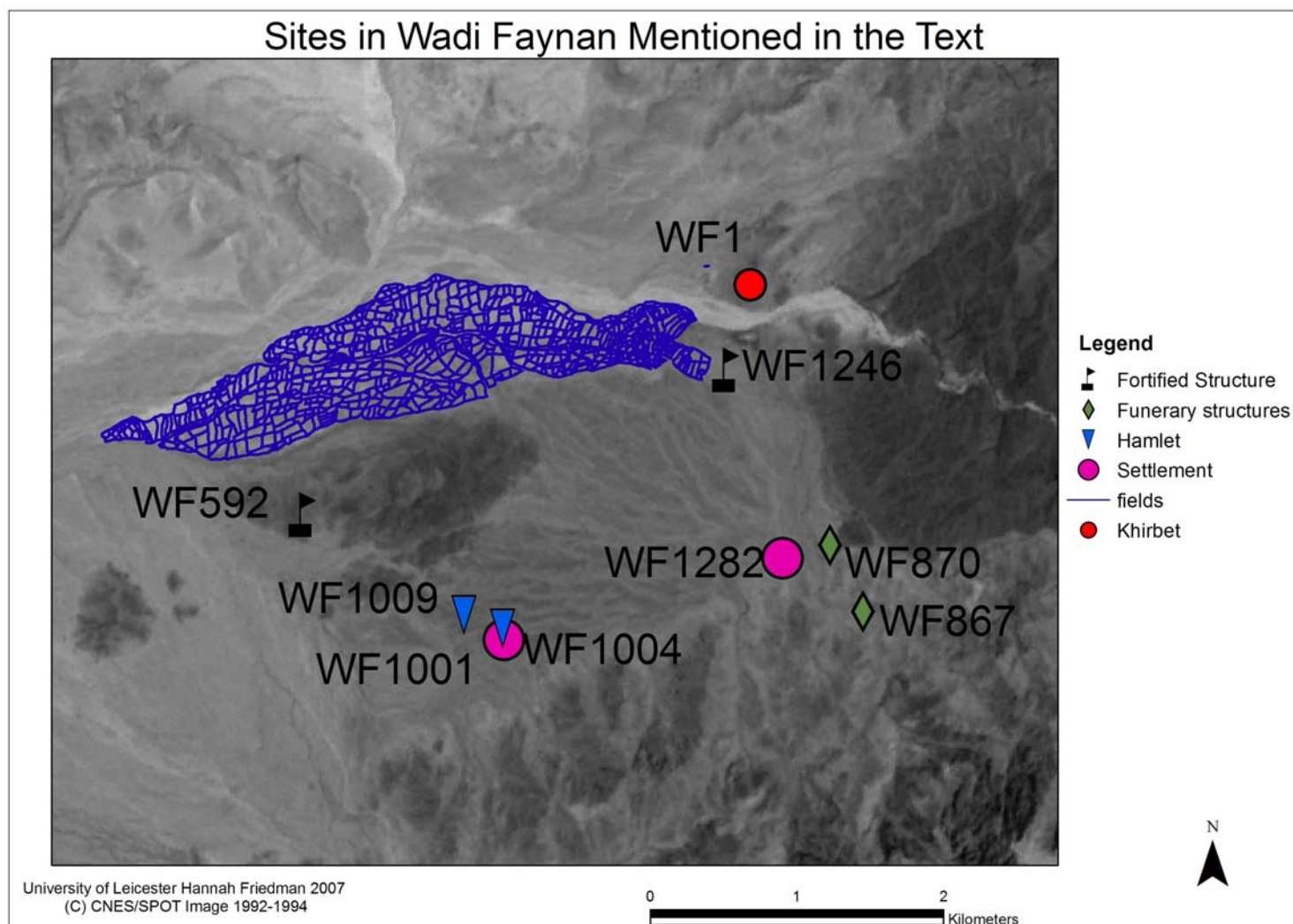


Figure 5.10 Location of sites in the Wadi Faynan mentioned in text.

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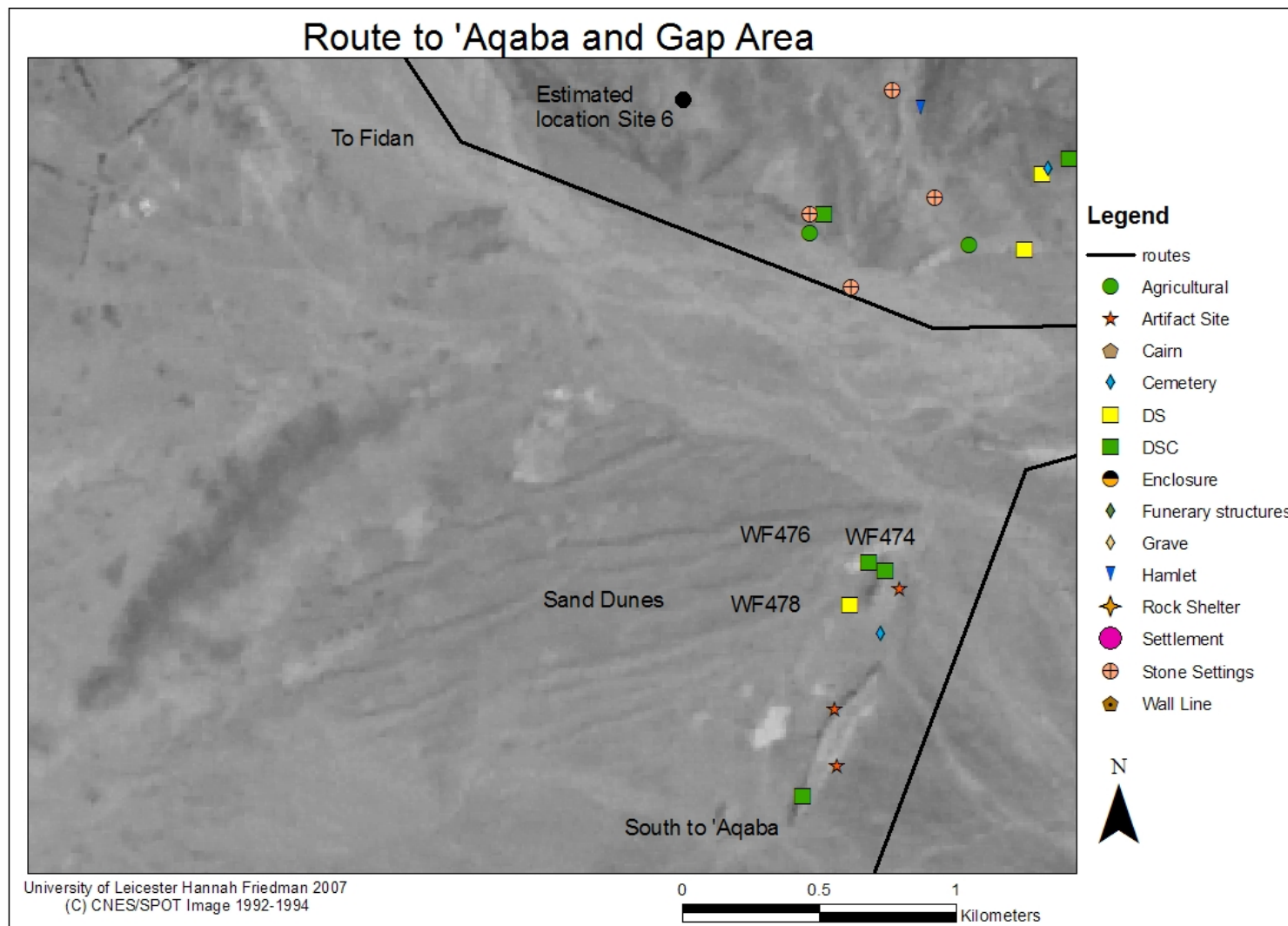


Figure 5.14 Map showing the route to 'Aqaba and sites along sand dunes. The estimated location of Site 6 is also marked.

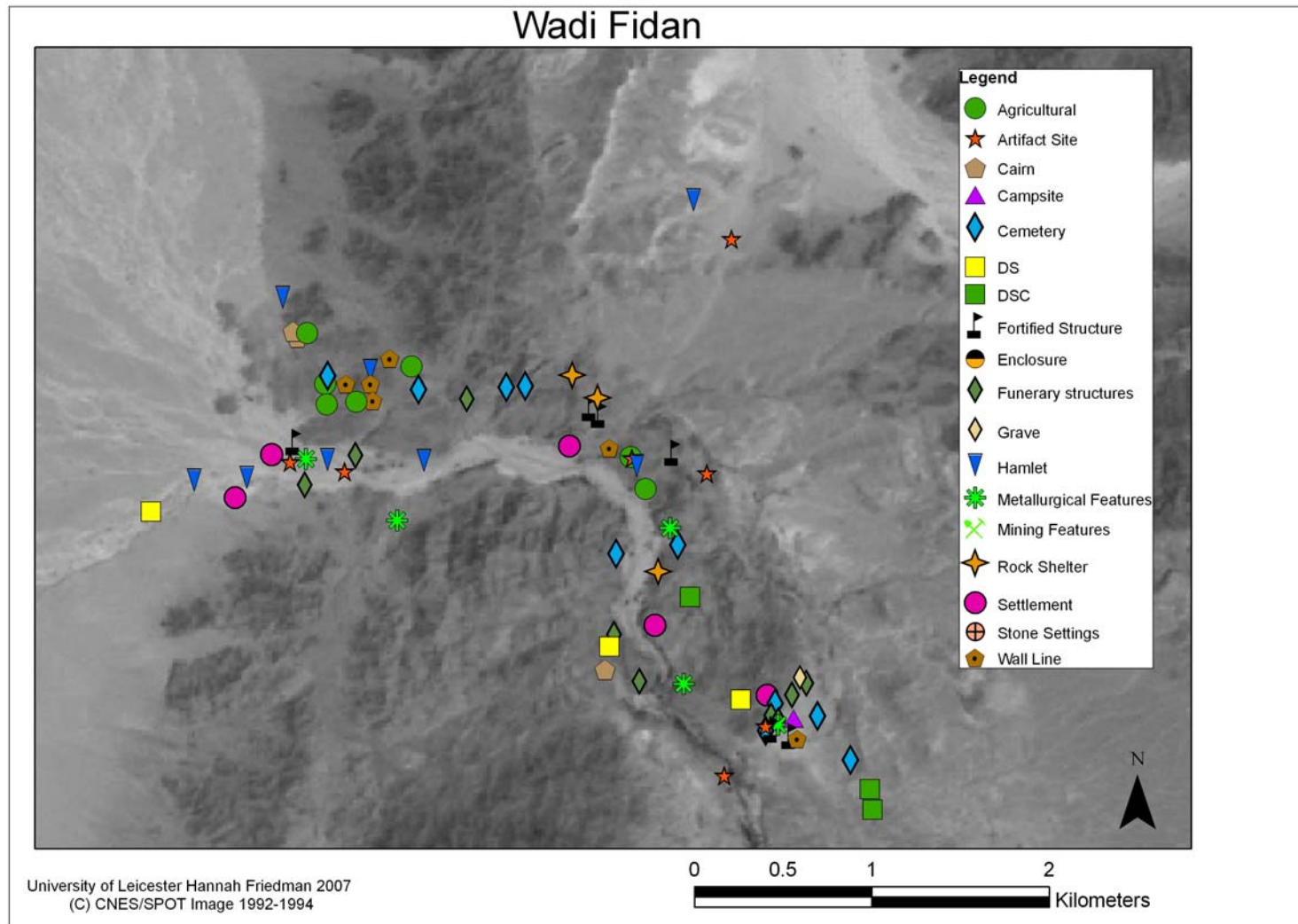


Figure 5.15 The layout and sites located in the Wadi Fidan.

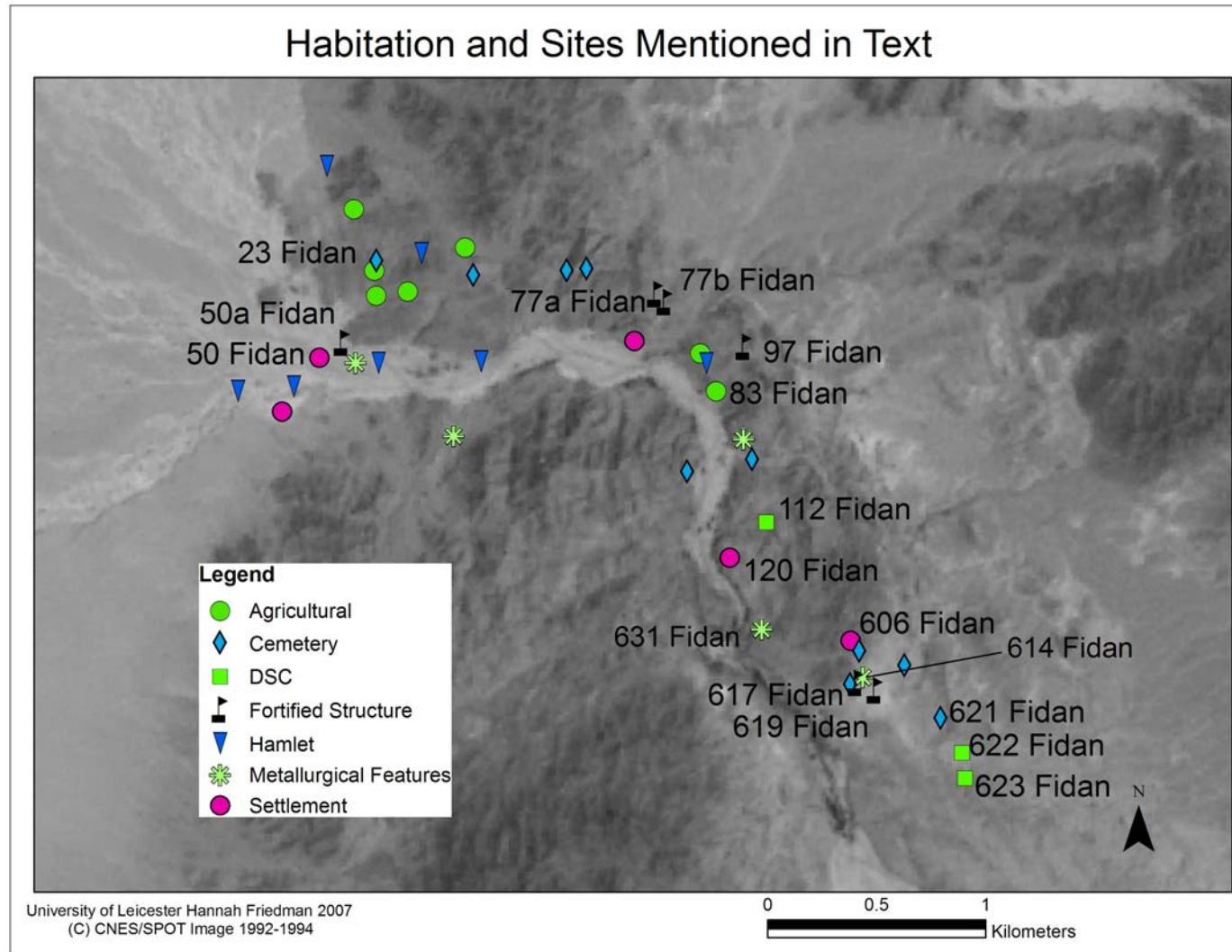


Figure 5.16 Sites in the Wadi Fidan mentioned in text.

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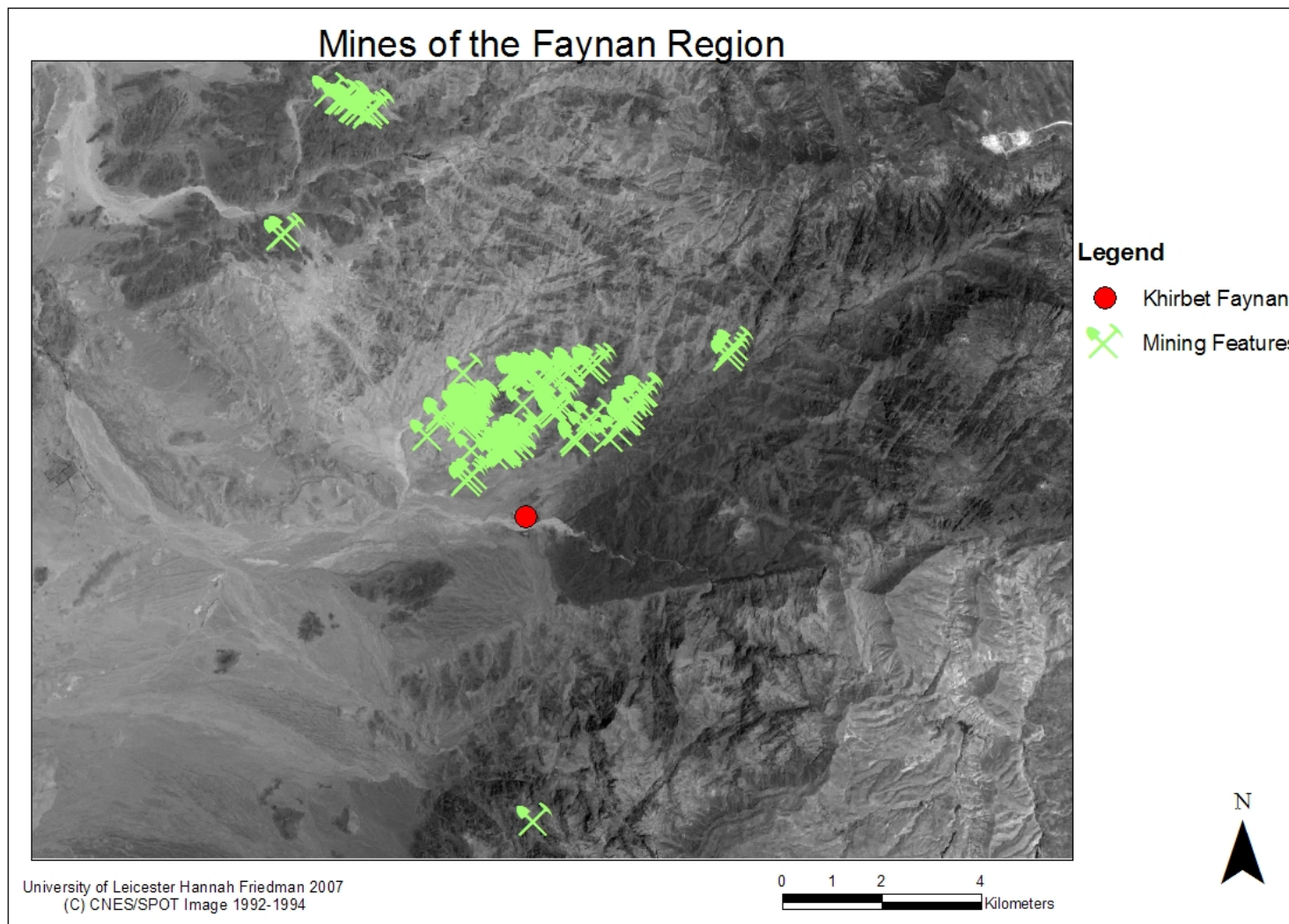


Figure 5.19 All mines in the database.

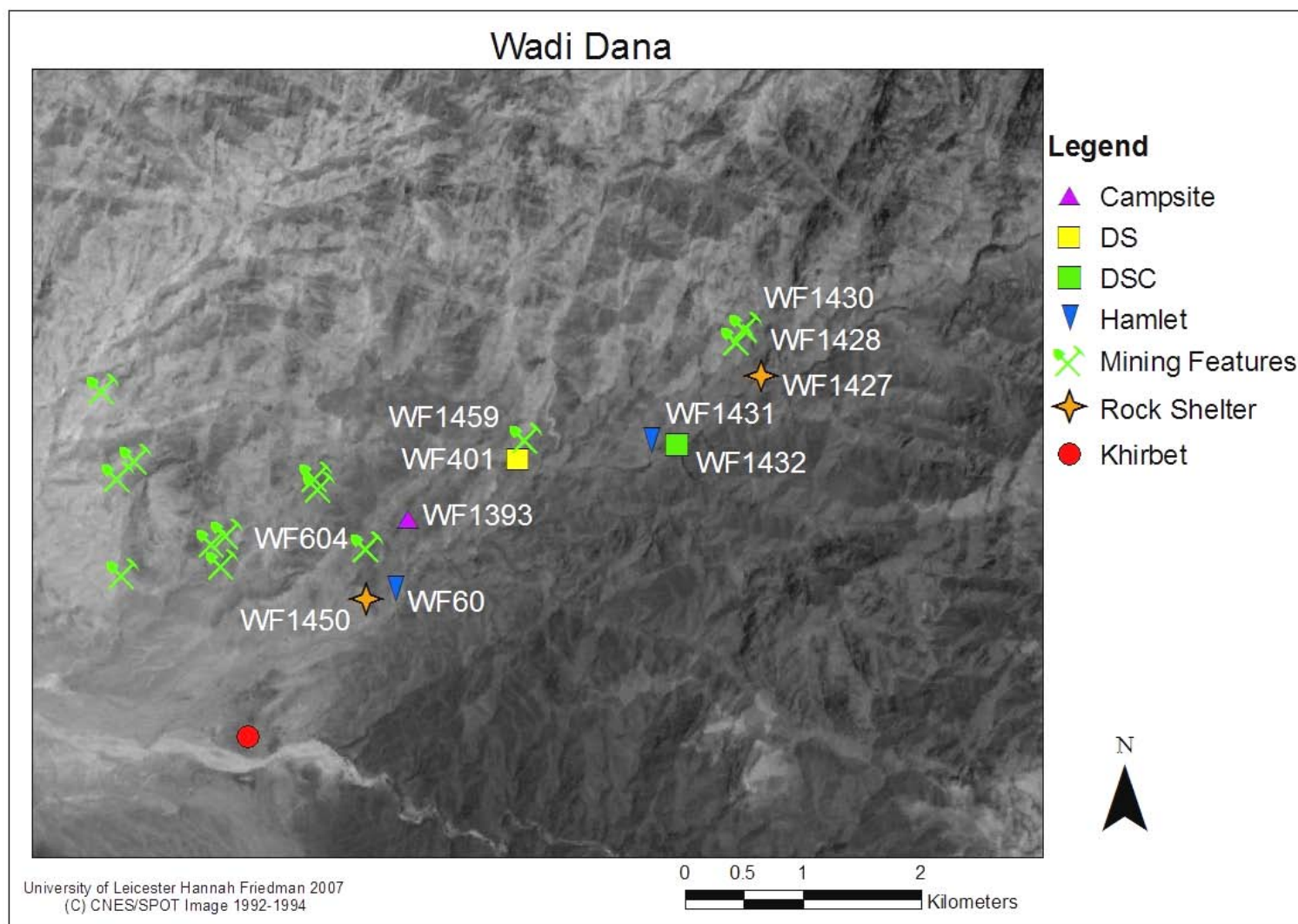


Figure 5.20 Sites of the Wadi Dana.

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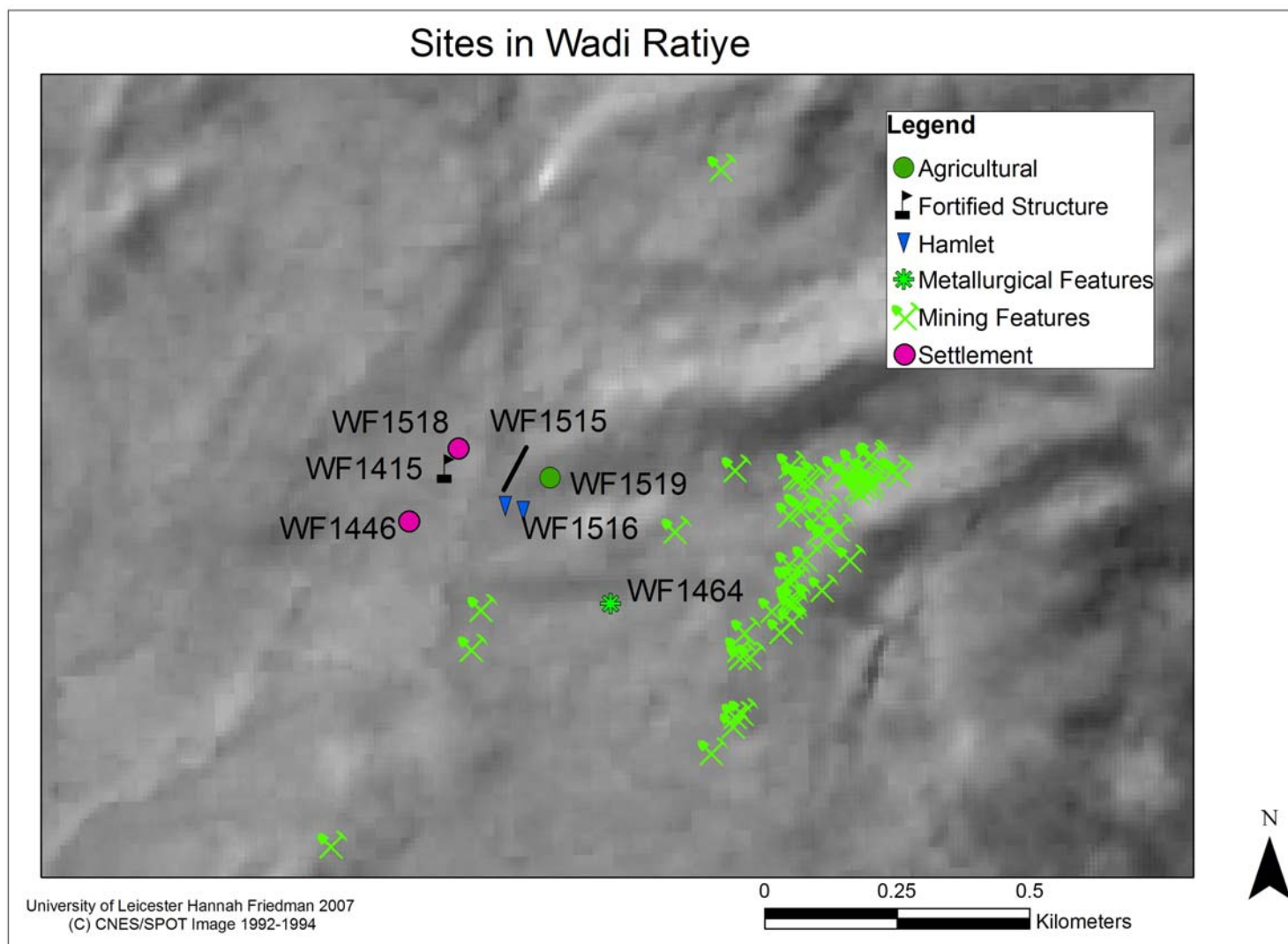


Figure 5.21 Sites in the Wadi Ratiye.

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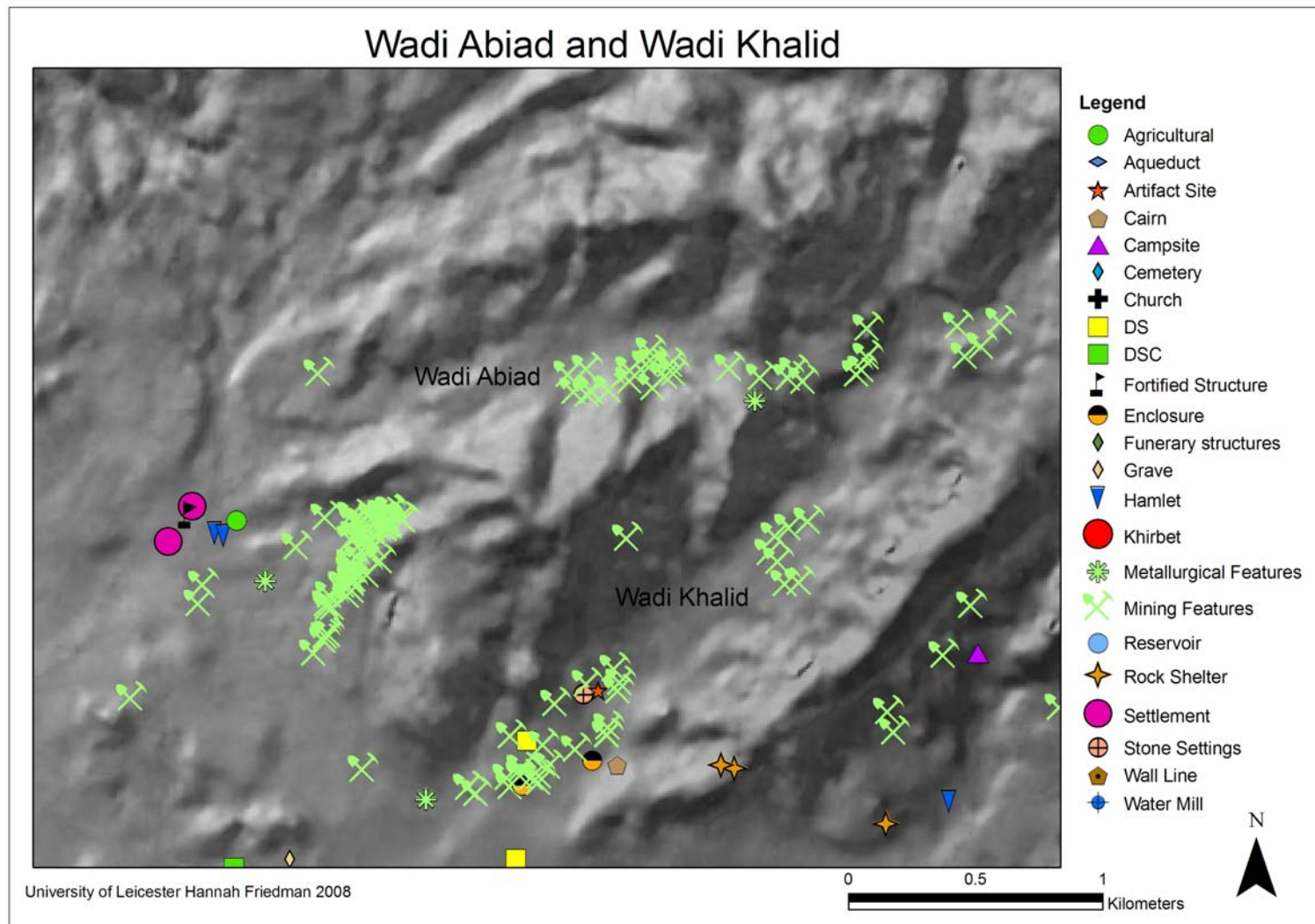


Figure 5.25 Wadi Abiad and Wadi Khalid.

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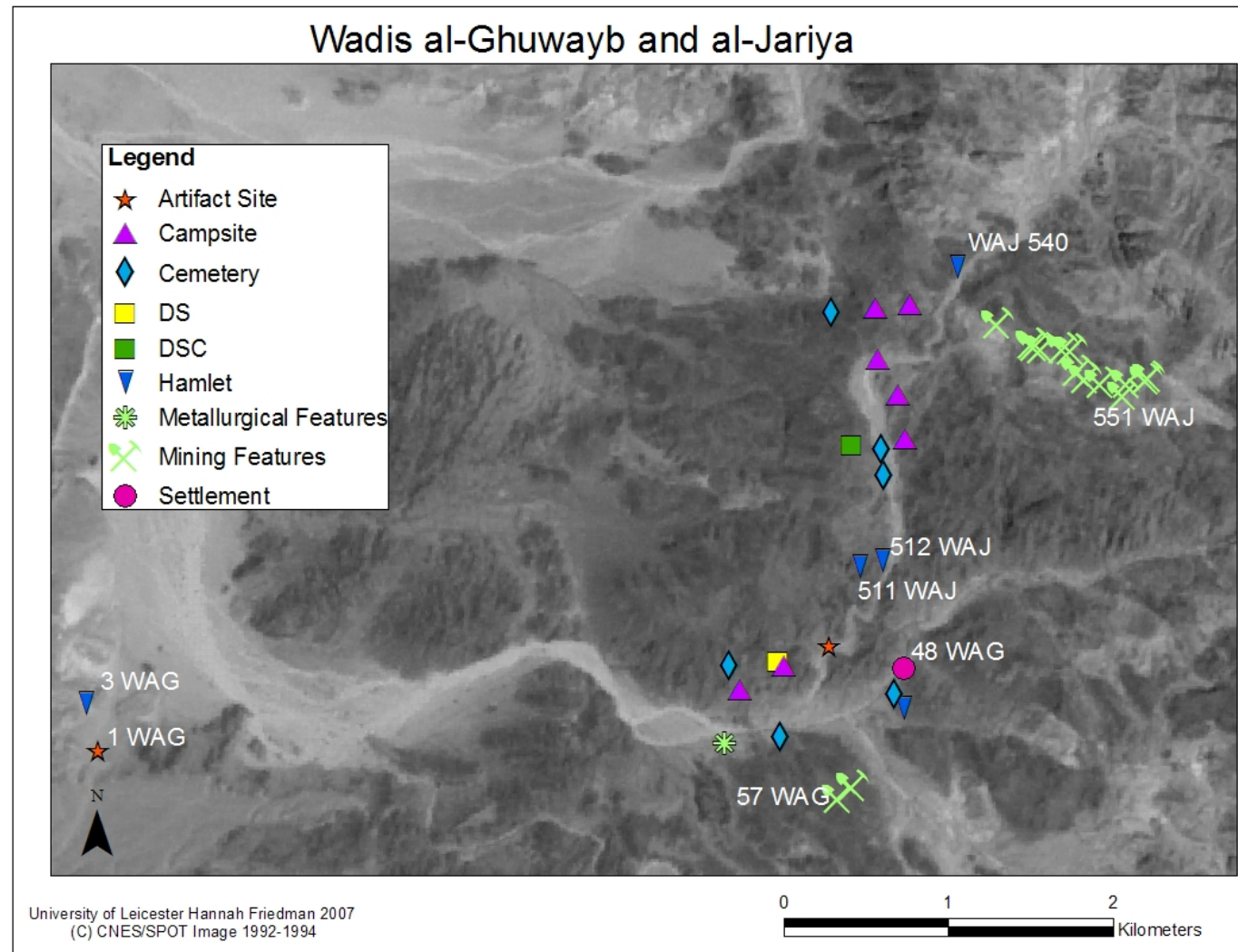


Figure 5.27 The Wadis al-Ghuwayb and al-Jariya.

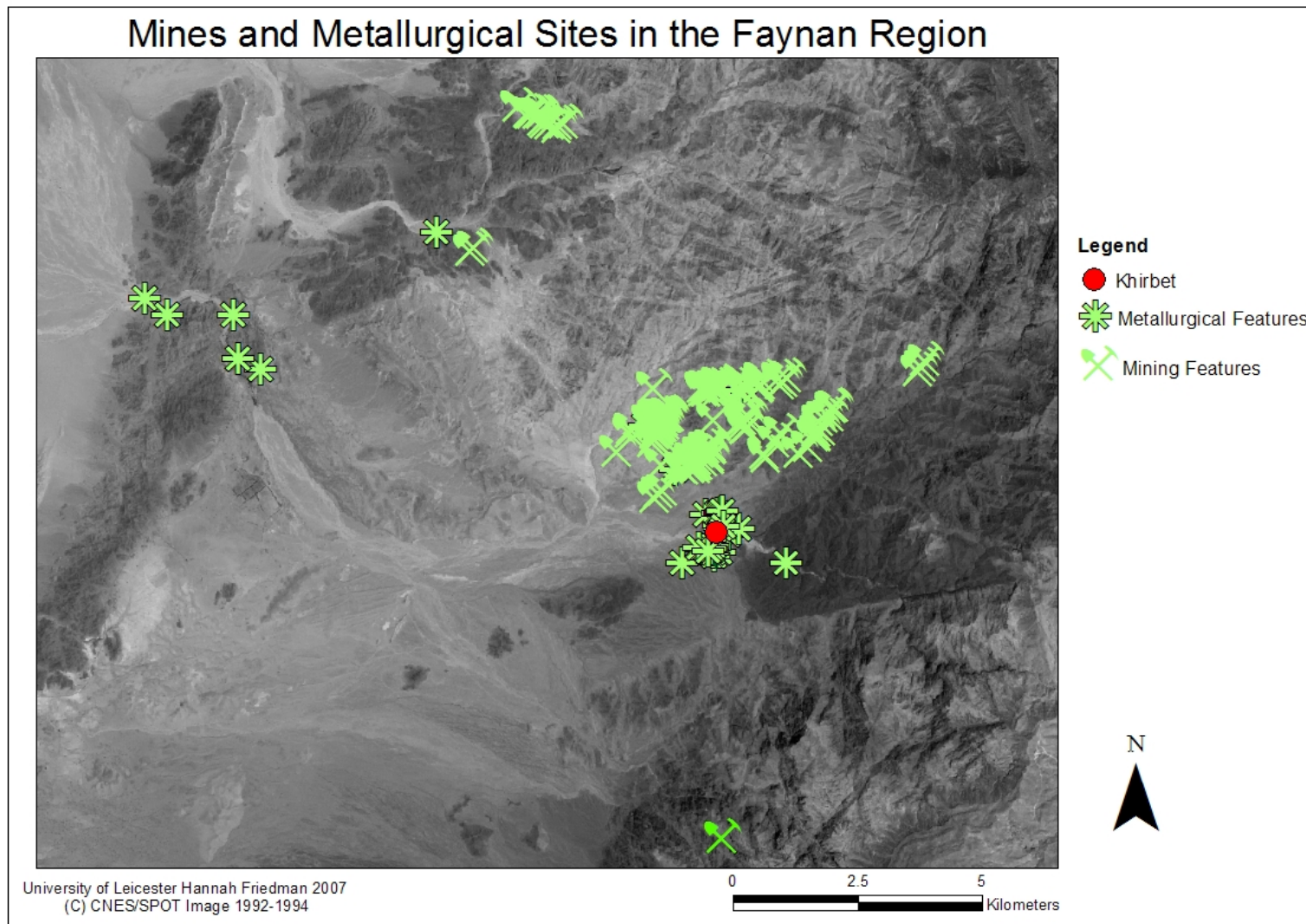


Figure 5.28 All mining and metallurgical sites in the database.

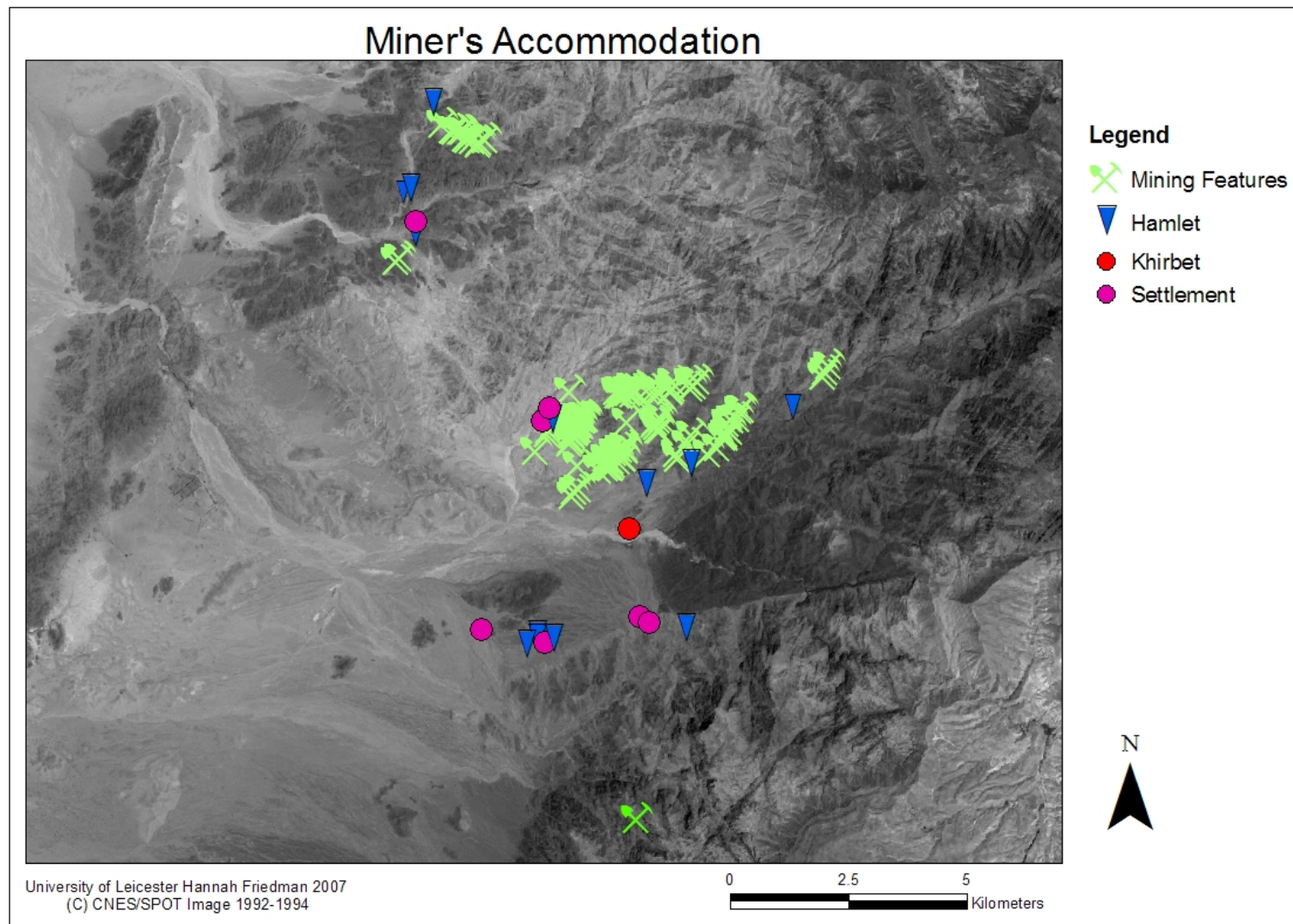


Figure 5.29 Habitation sites in relation to mines suggesting that they are miner's accommodation.

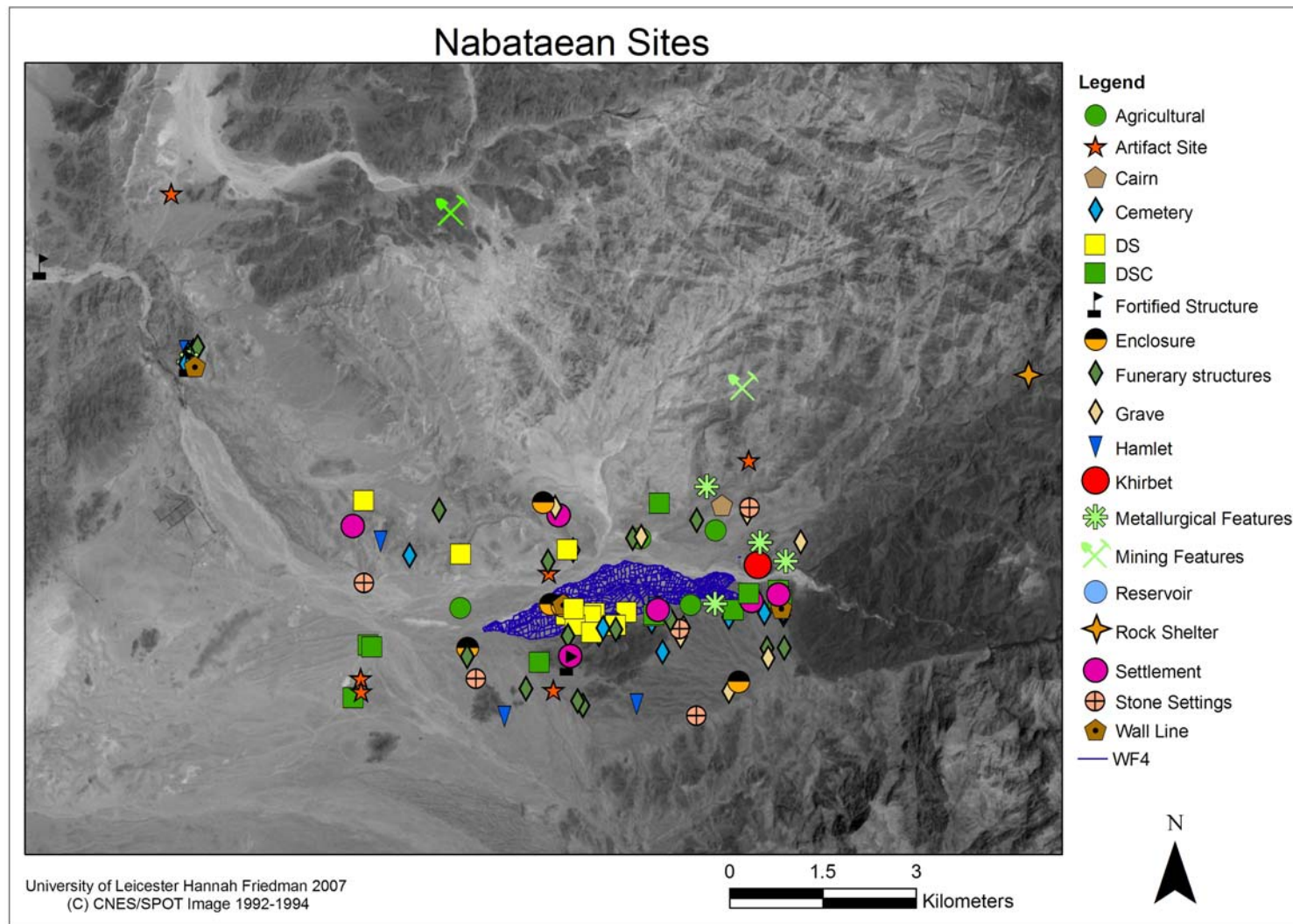


Figure 5.30 Sites datable to the Nabataean period. WAG 57 the Nabataean/Roman mine has been included, it is located along the Wadi al-Ghuwayb.

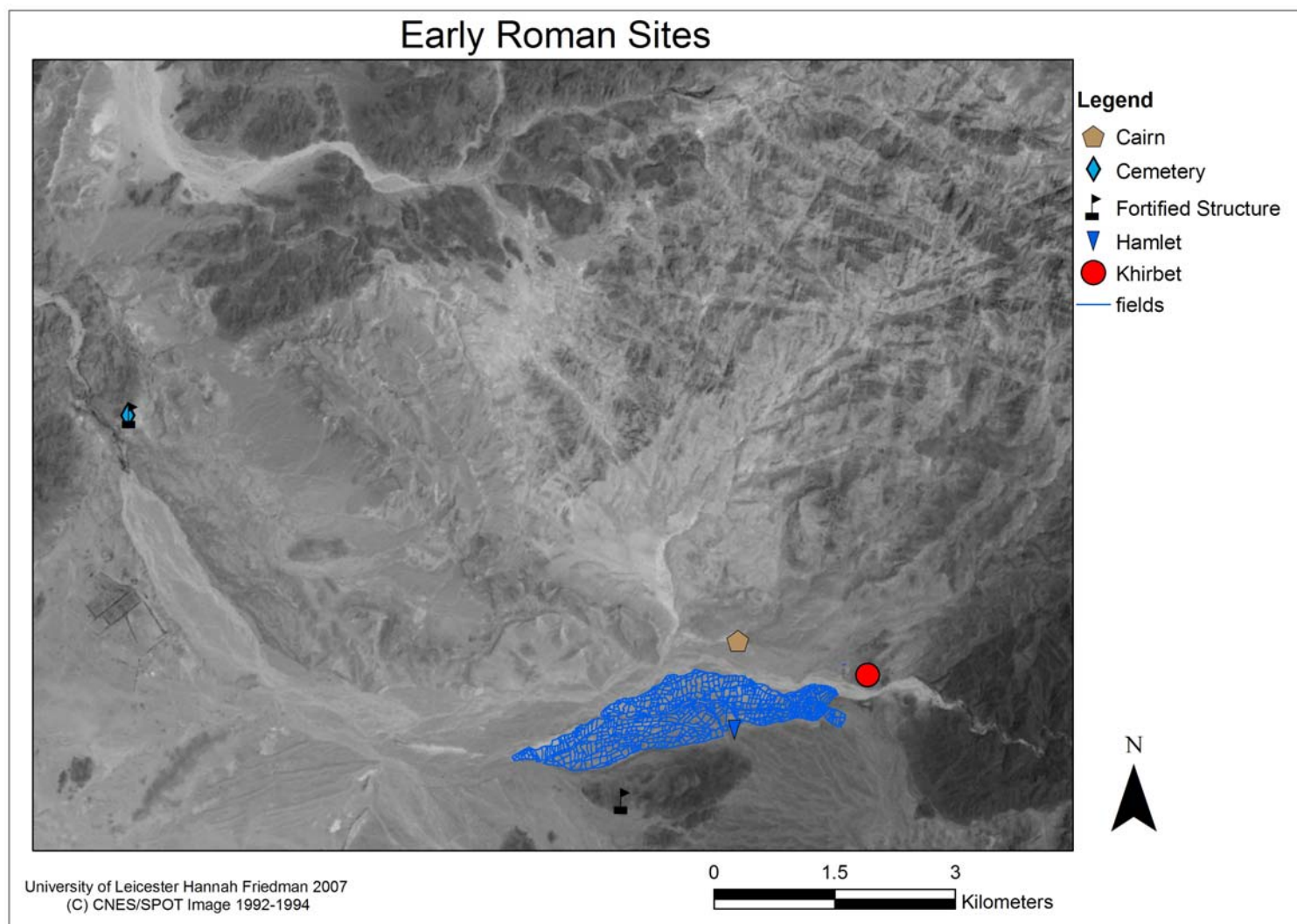


Figure 5.31 Sites datable to the Early Roman period.

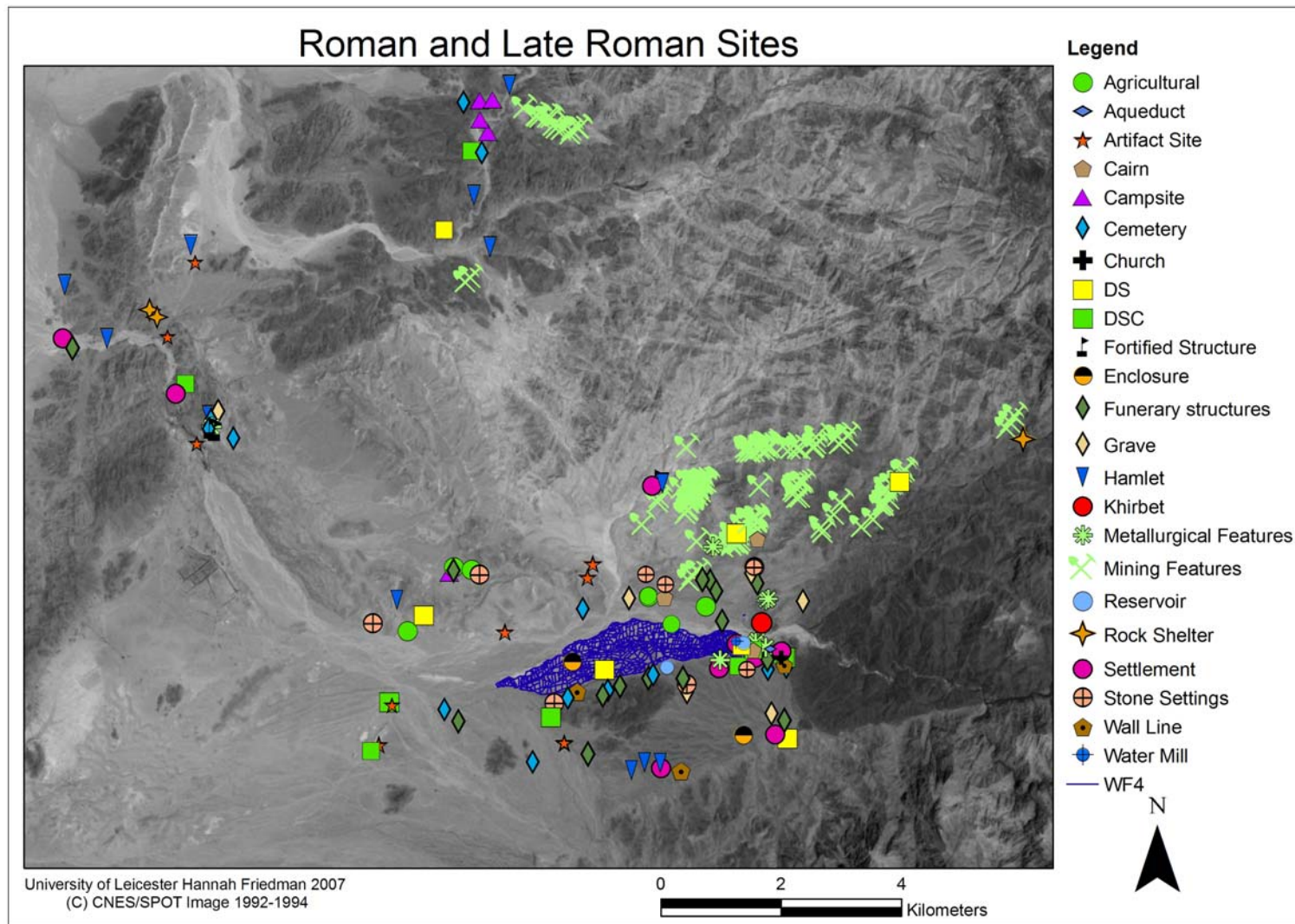


Figure 5.32 Sites datable to the Roman and Late Roman period. Umm al-Amad is located to the south see Fig. 5.28.

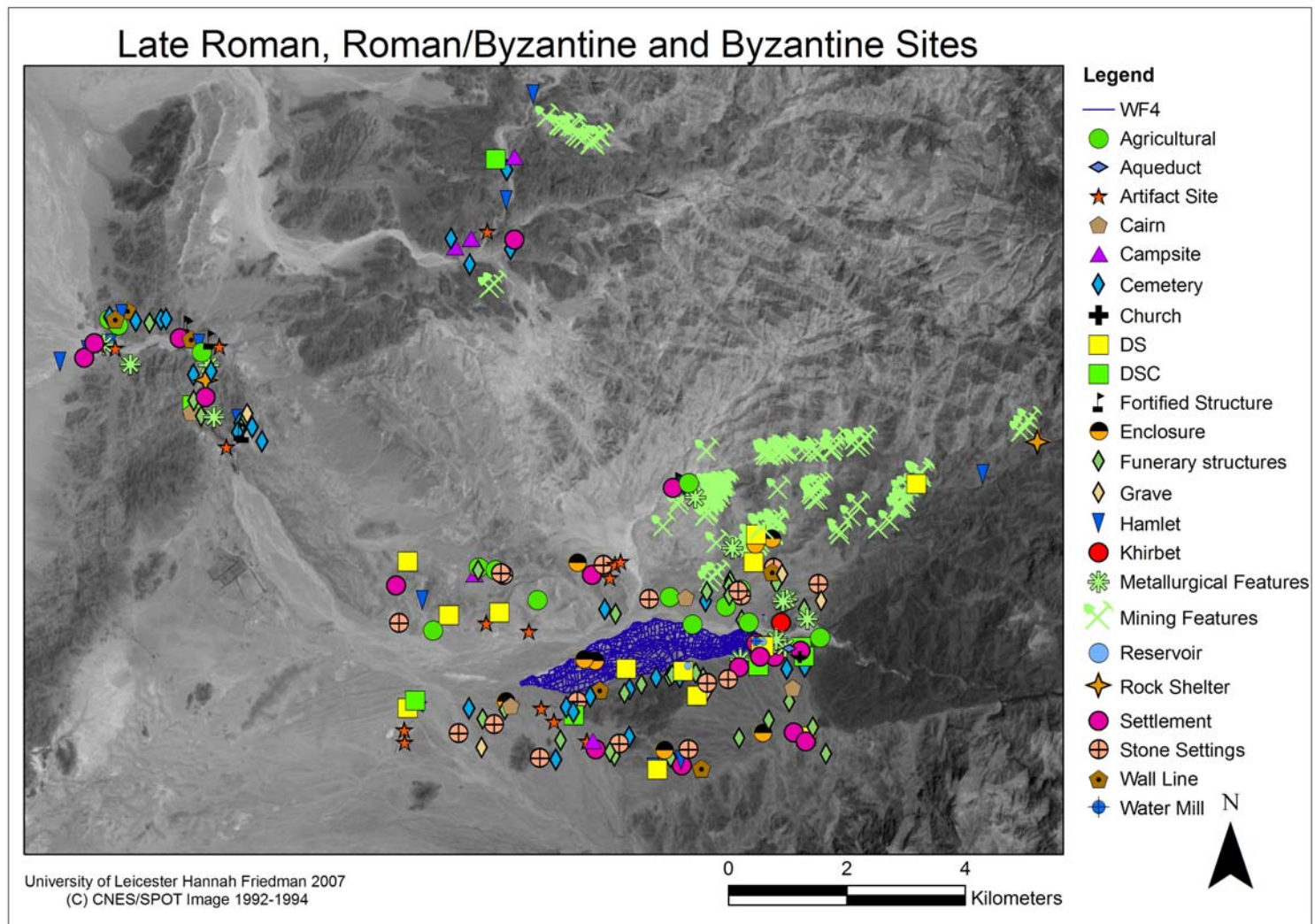


Figure 5.33 Sites with Late Roman, Roman/Byzantine, and Byzantine pottery and cultural materials. Umm al-Amad is located to the south see Fig. 5.28.

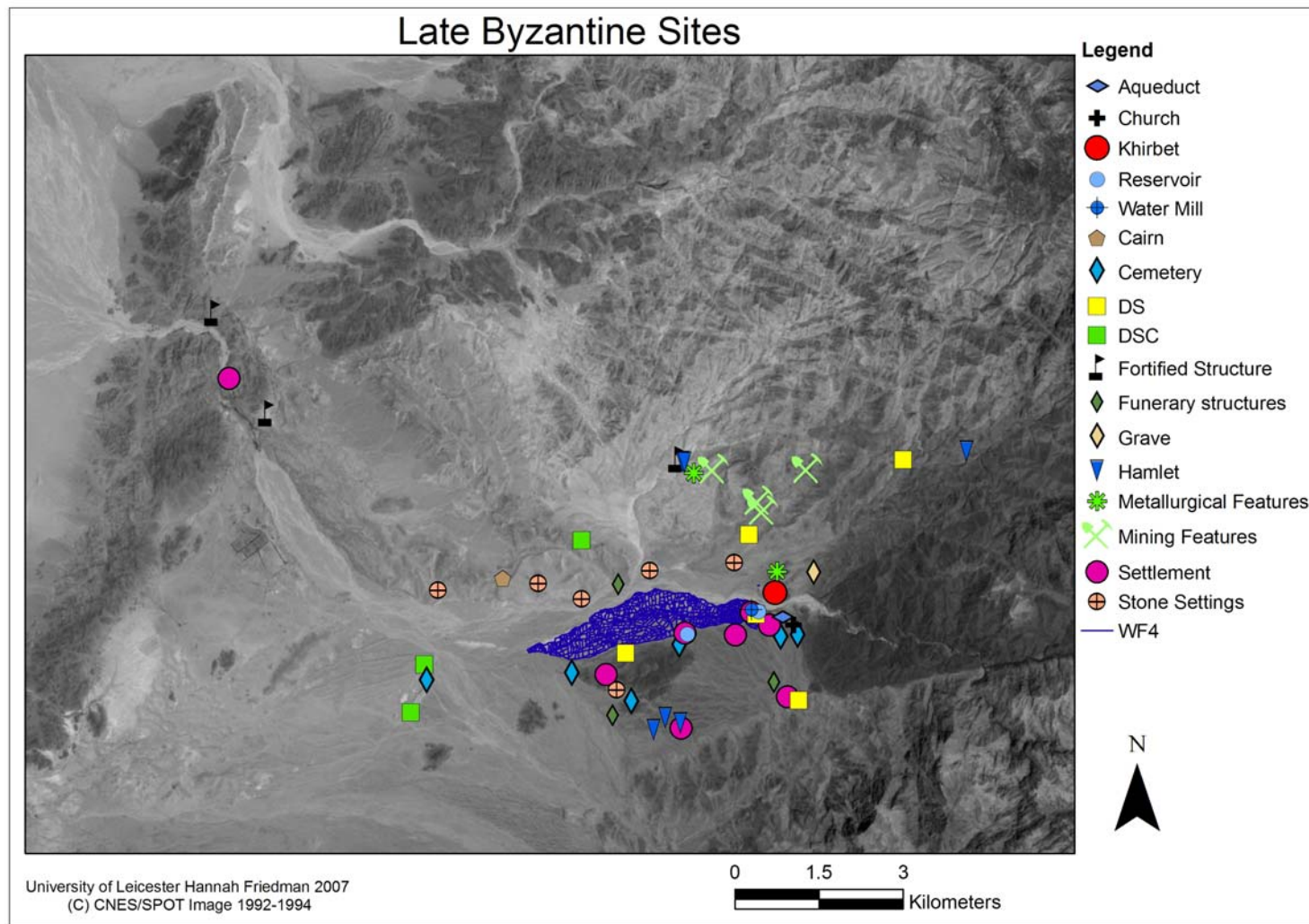


Figure 5.34 Late Byzantine sites.

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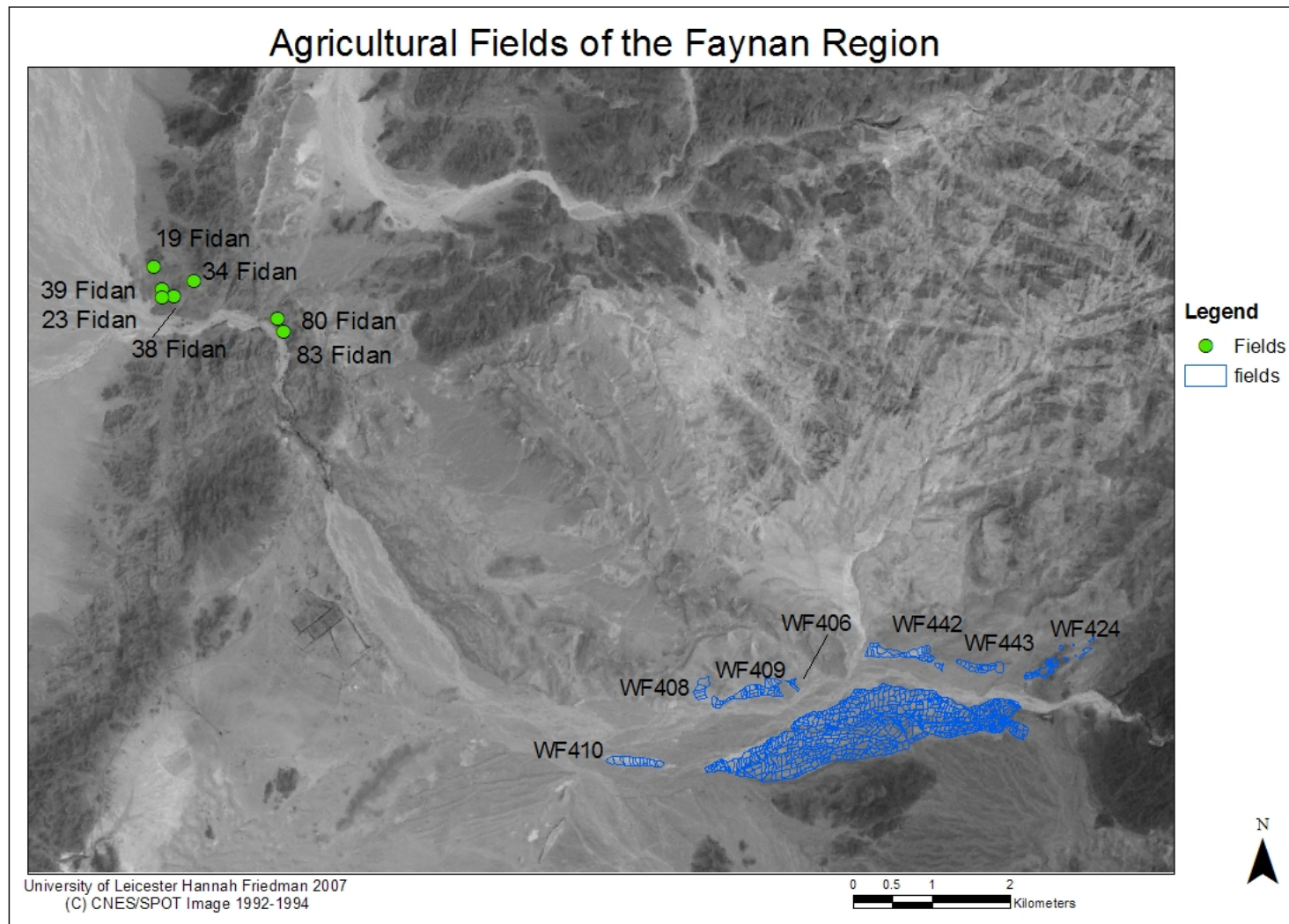


Figure 6.5 The fields included in calculations of regional productivity.

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Figure 7.1 Affects of sandstorm during JHF excavation of Khirbet an-Nahas, September 2002.



Figure 7.2 JHF survey in Wadi al-Ghuwayb 2002, sunset.

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Figure 7.4 View to the south-east Wadi Ghuwayr taken from the top of the Khirbet.



Figure 7.5 View to the east from the top of the Khirbet.

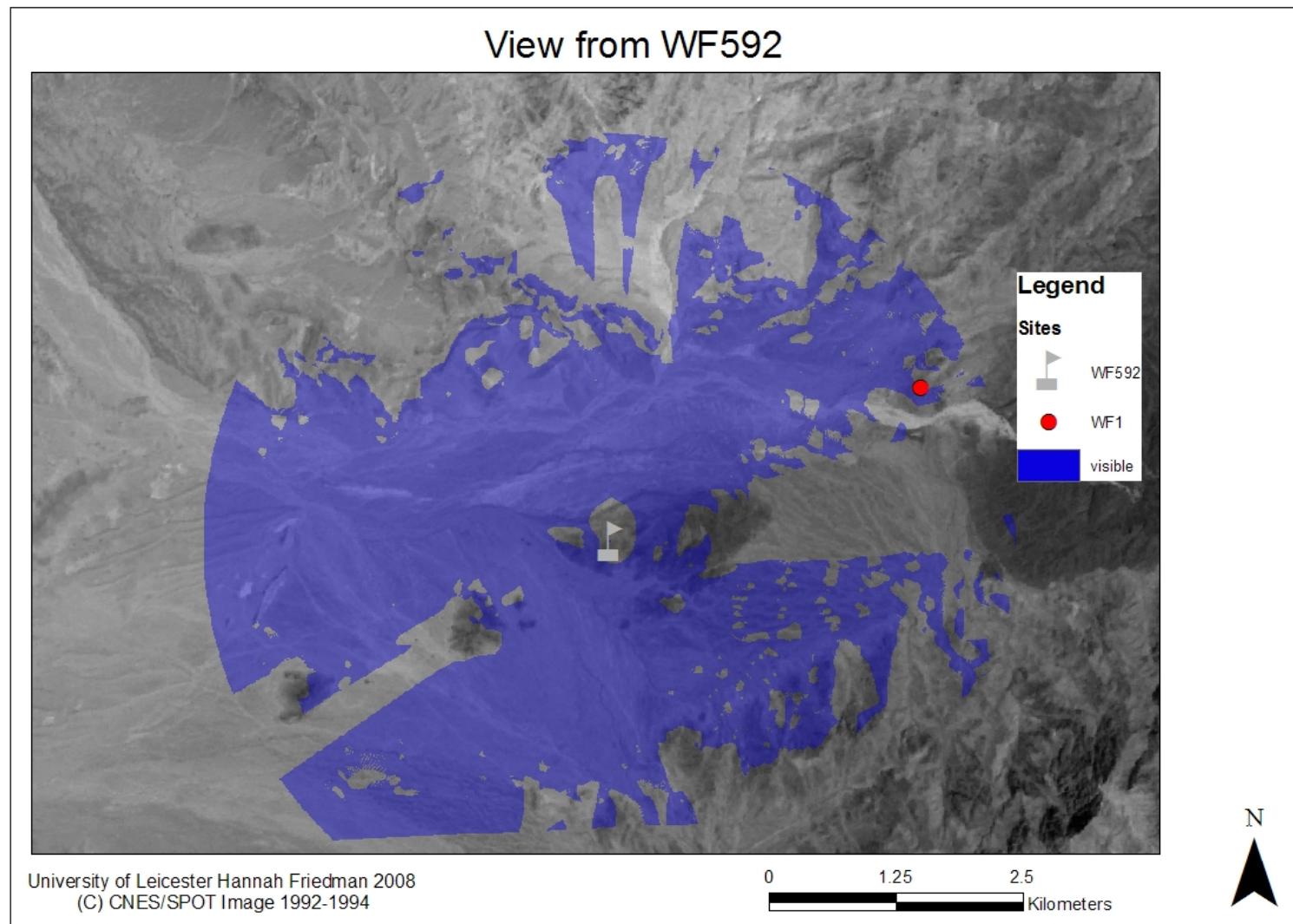


Figure 7.6 Viewshed from hilltop of WF592.

Total Viewshed for the Faynan

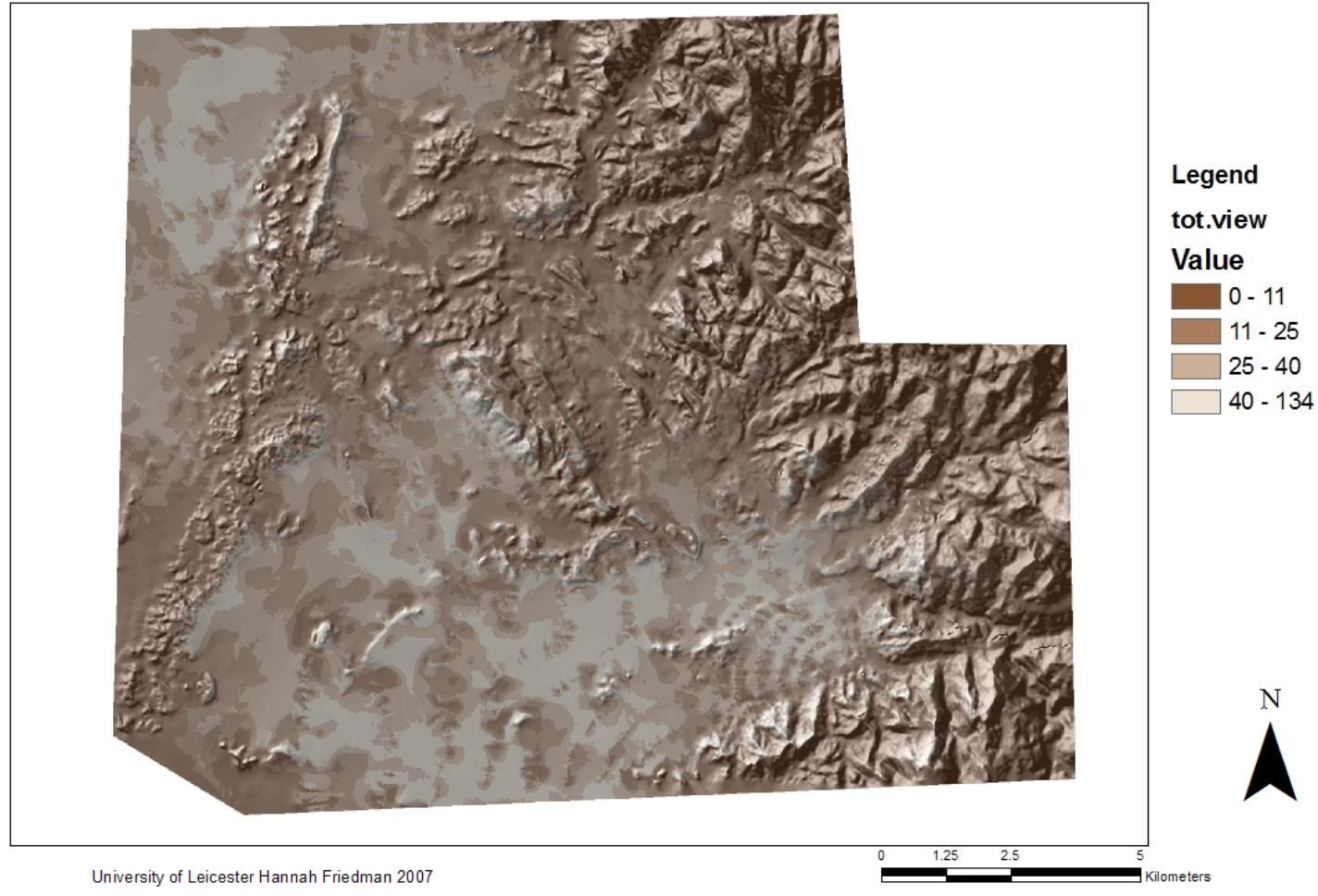


Figure 7.7 Total Viewshed for the Faynan landscape. Darker shading indicates lower visibility.

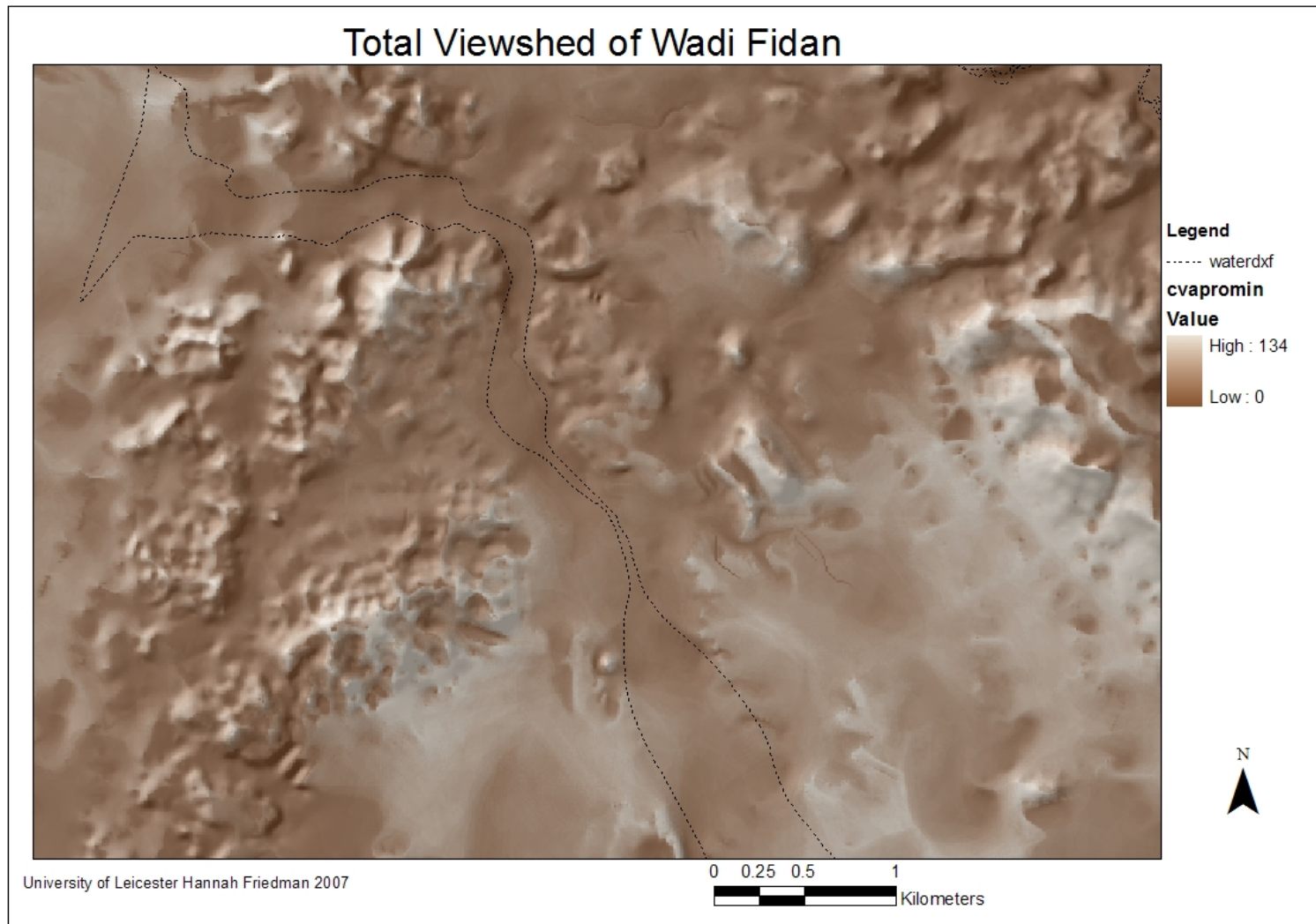


Figure 7.8 Total Viewshed close up of the Wadi Fidan with the wadi path outlined. Darker shading indicates lower visibility.

Cumulative Viewshed Analysis for the Faynan

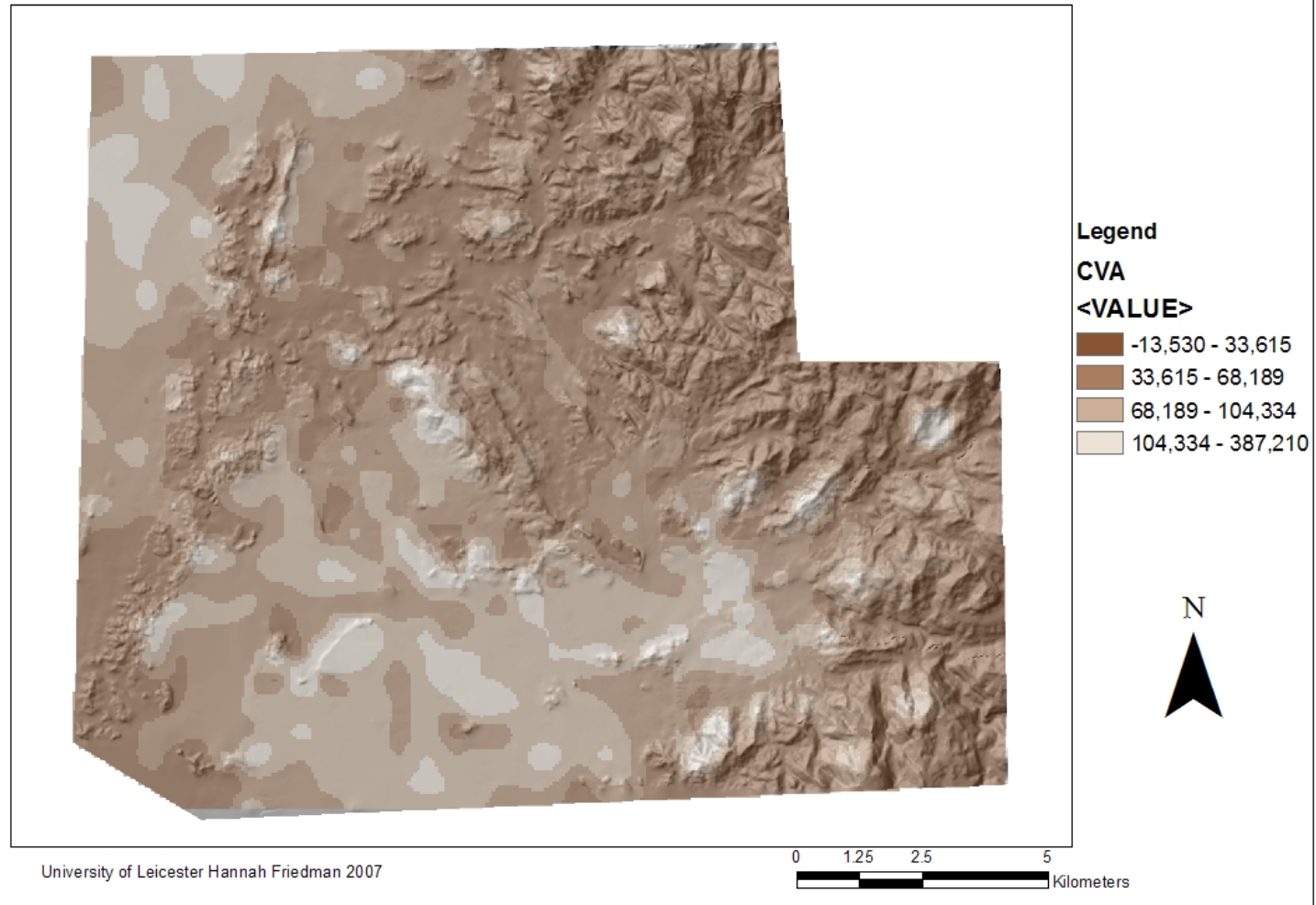


Figure 7.9 CVA of prominence of the Faynan region. Areas that are dark are less prominent.

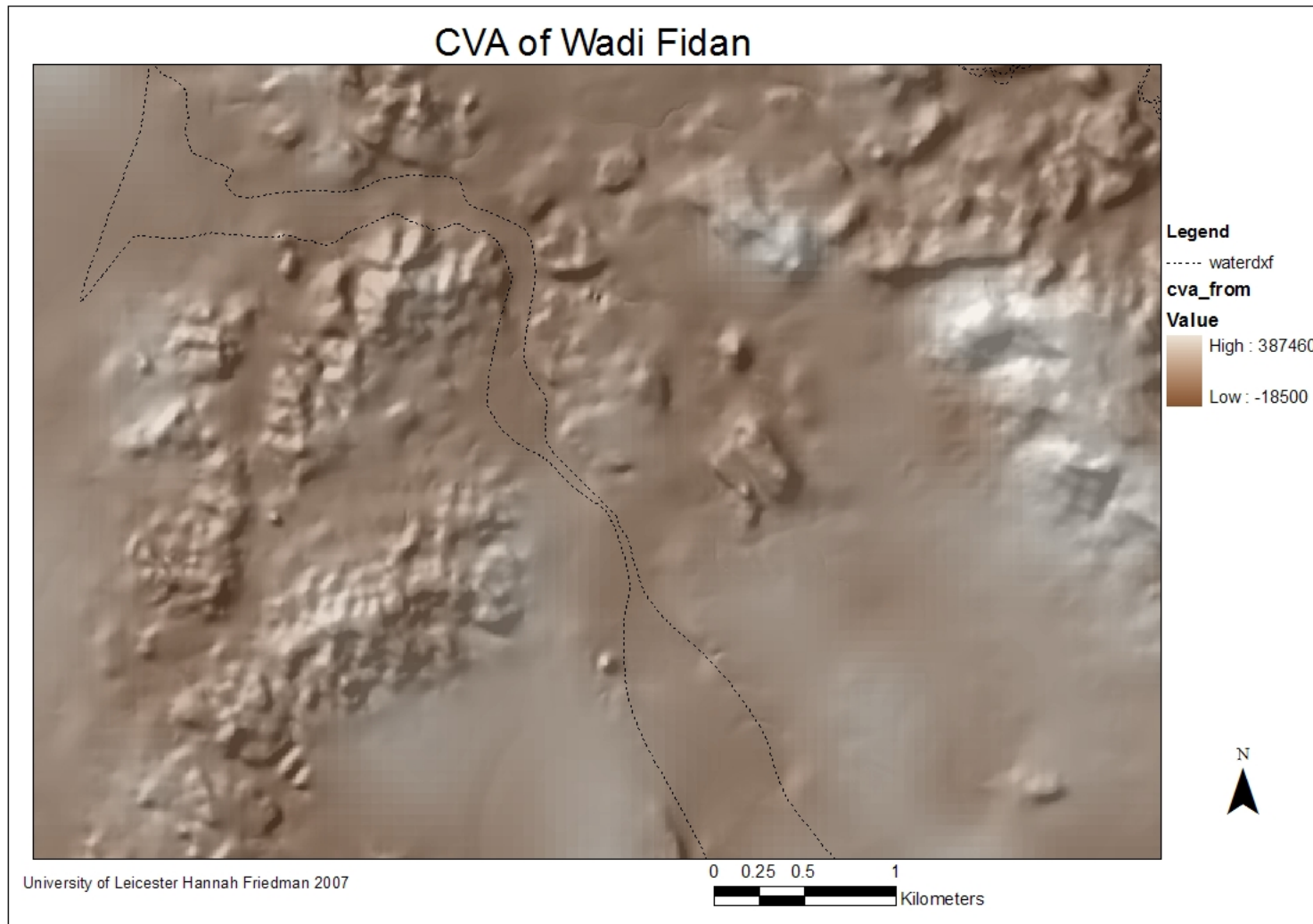


Figure 7.10 CVA of the Wadi Fidan with the wadi path outlined. Areas that are dark are less prominent.

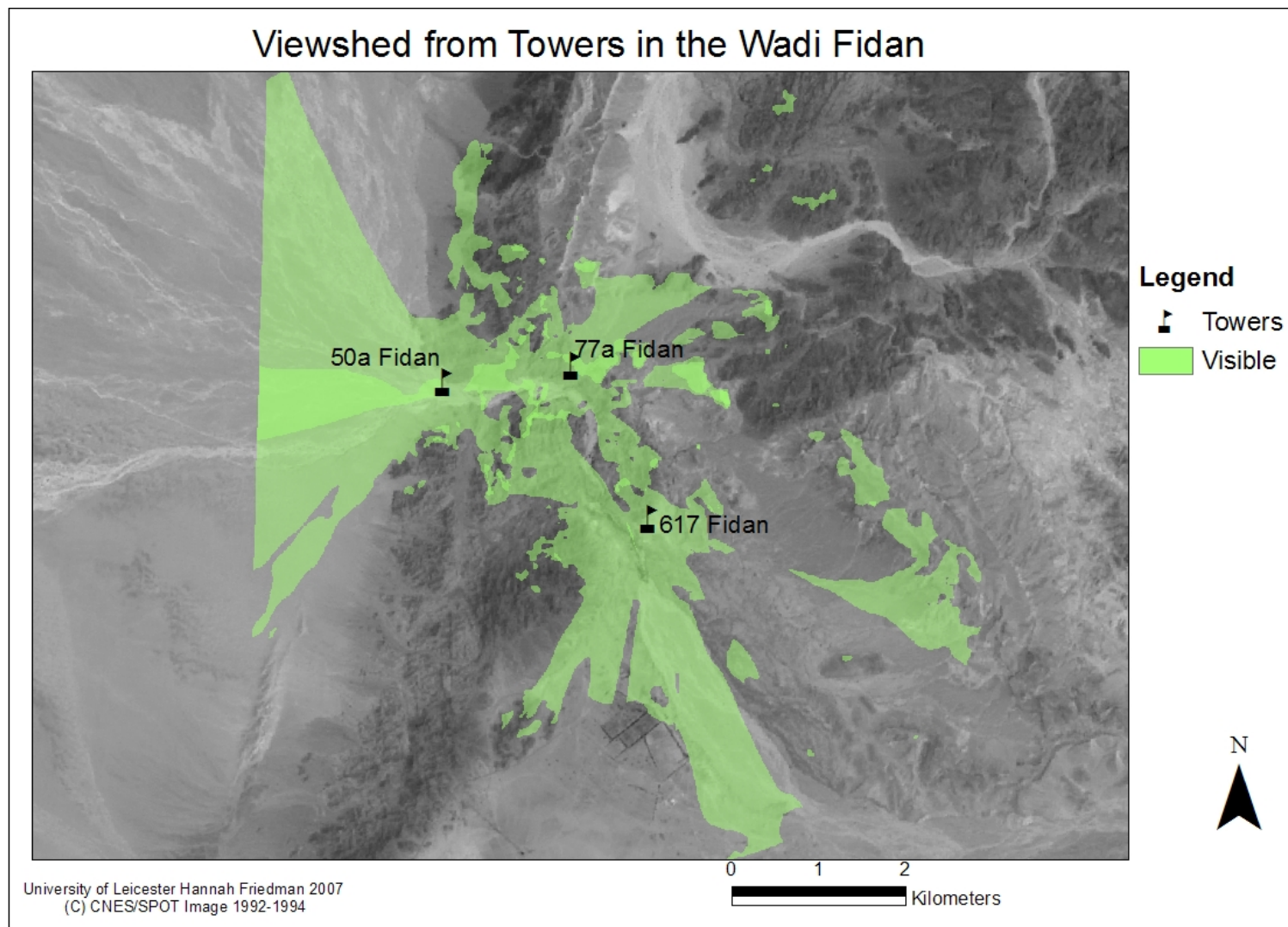


Figure 7.11 Viewsheds from watchtowers, green areas visible from the towers.



Figure 7.12 View from human height at Fidan 50a into Wadi 'Arabah.

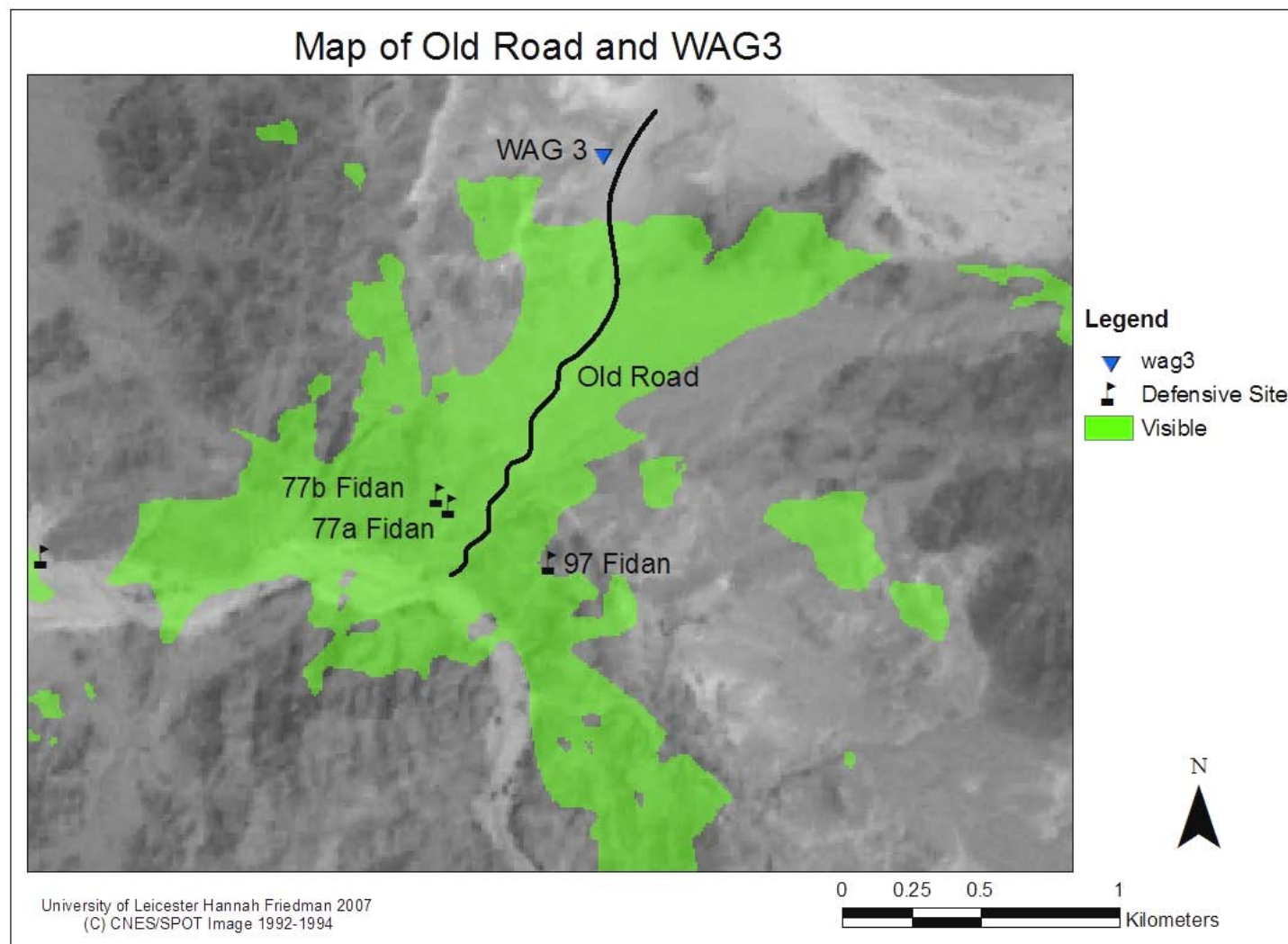


Figure 7.13 Map of Old Road and WAG3, areas in green are visible from Fidan 77b.



Figure 7.14 The view from the observation posts (Site 6) looking southwest.

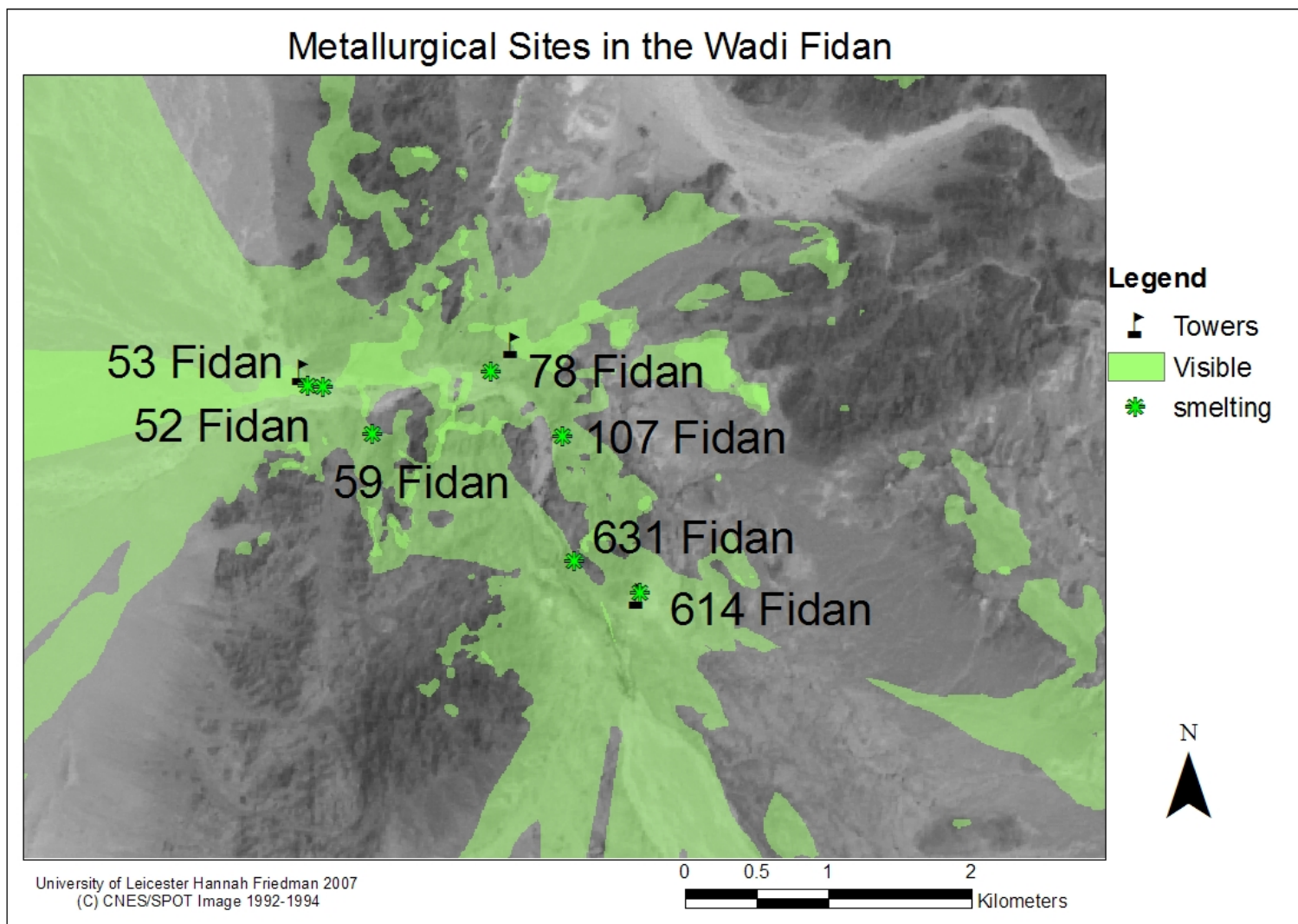


Figure 7.15 Sites which practiced metallurgy. Areas in green are visible from a defensive site.

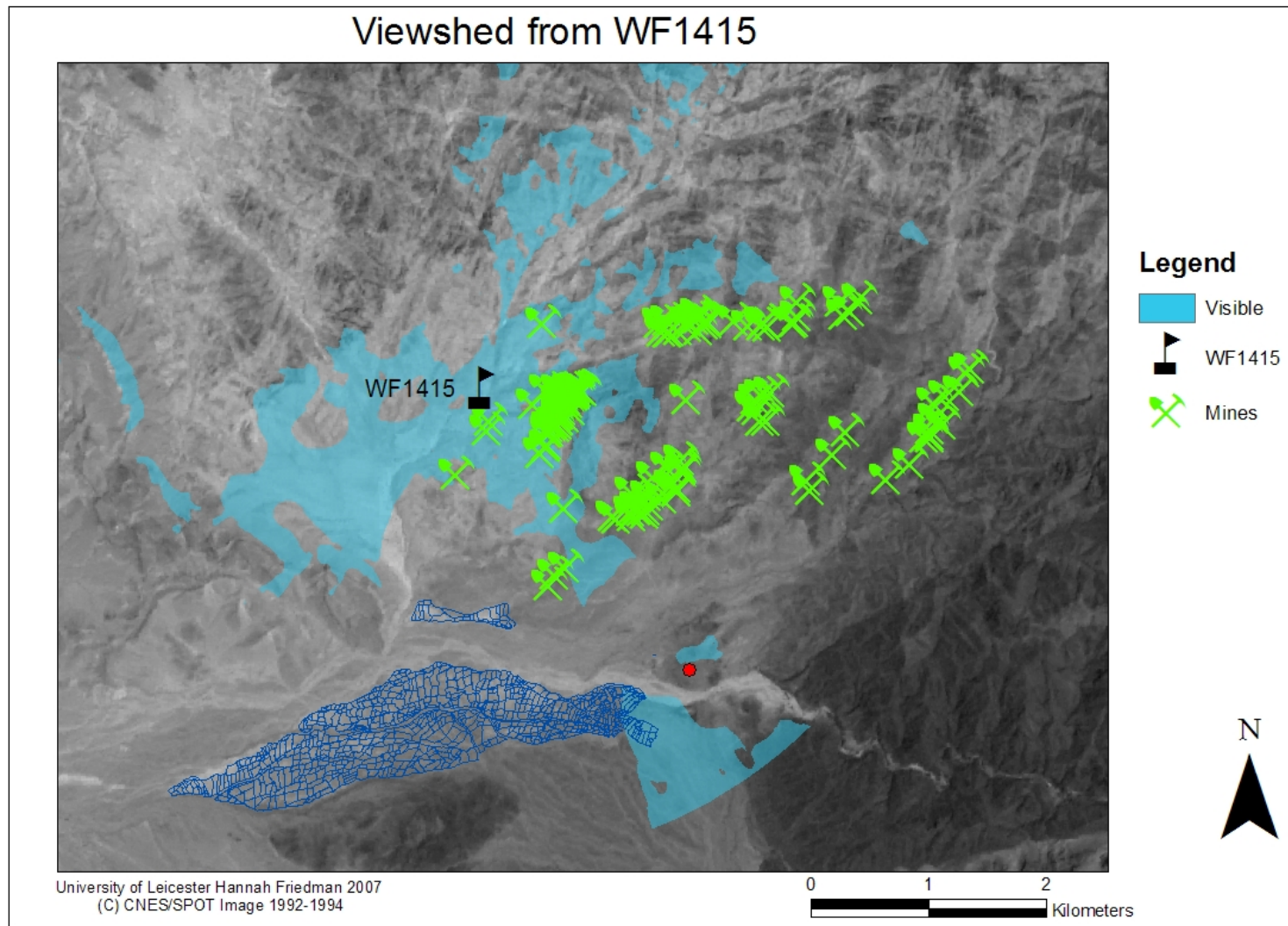


Figure 7.16 The viewshed from WF1415 calculated with 10m towers. Areas in blue are visible.

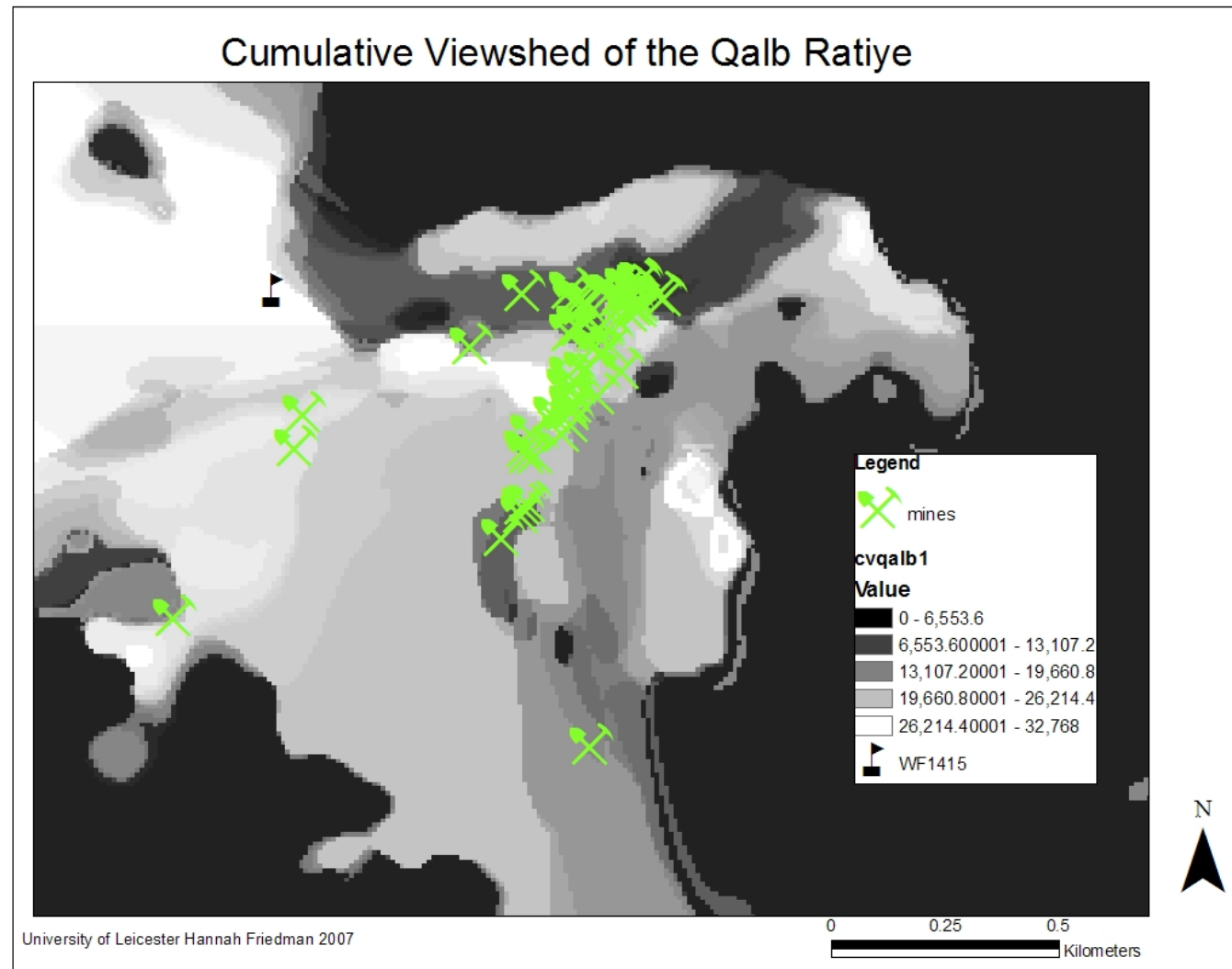


Figure 7.17 Cumulative Viewshed of the Qalb Ratiye with the mines as observer points. Light areas are more frequently viewed.

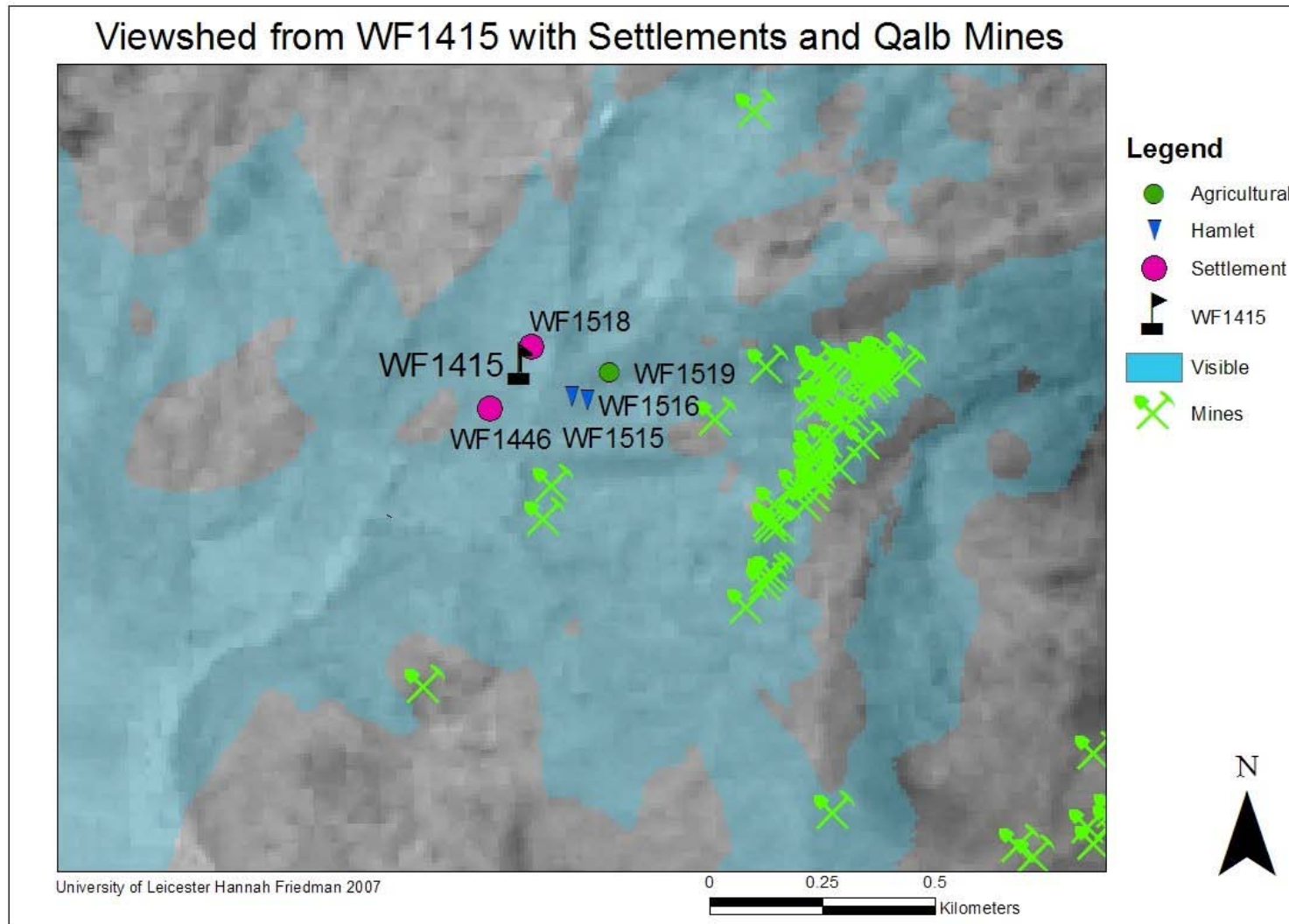


Figure 7.18 Viewshed of WF1415 which covers the surrounding habitation sites and Qalb Ratiye. Area in blue visible from WF1415.

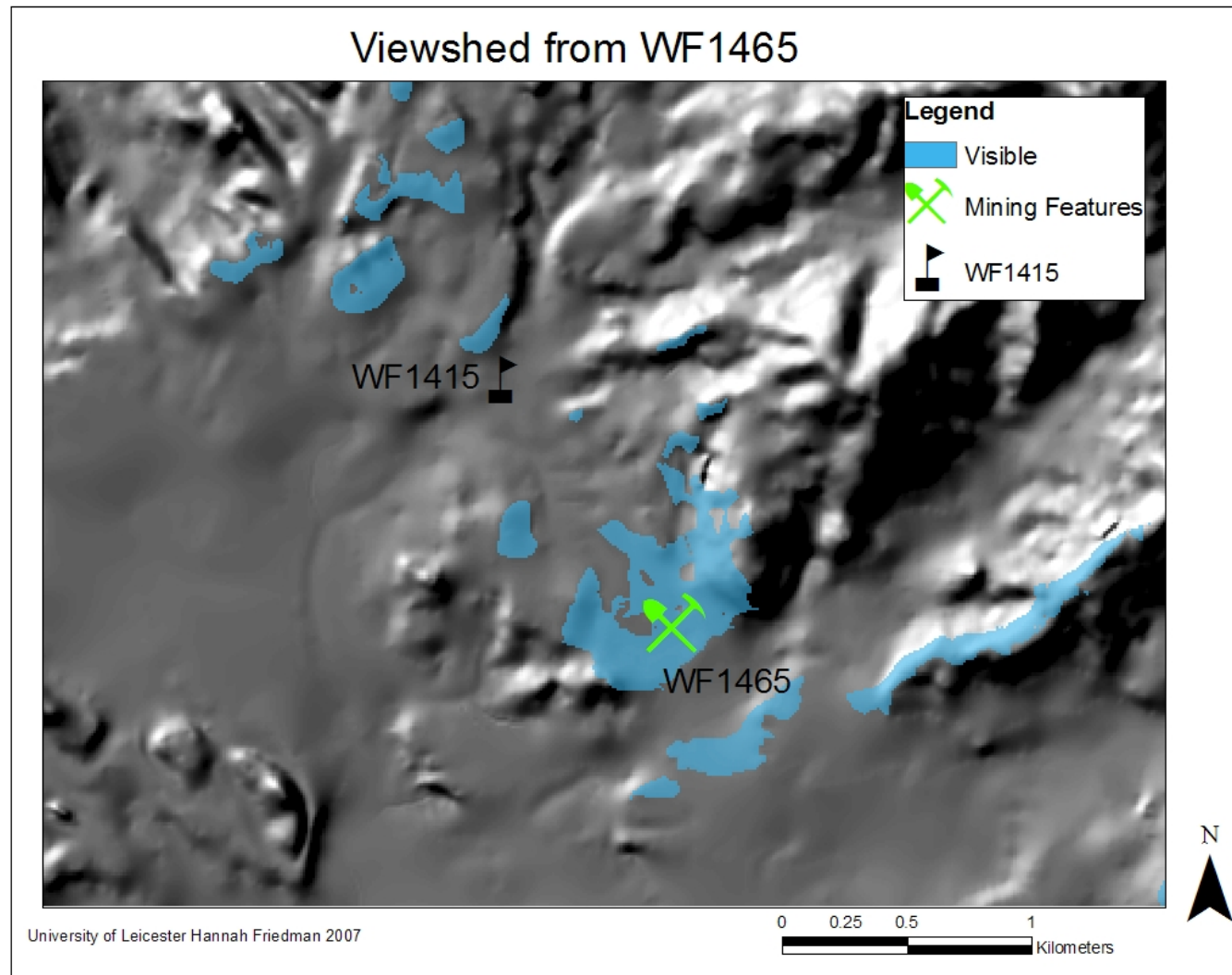
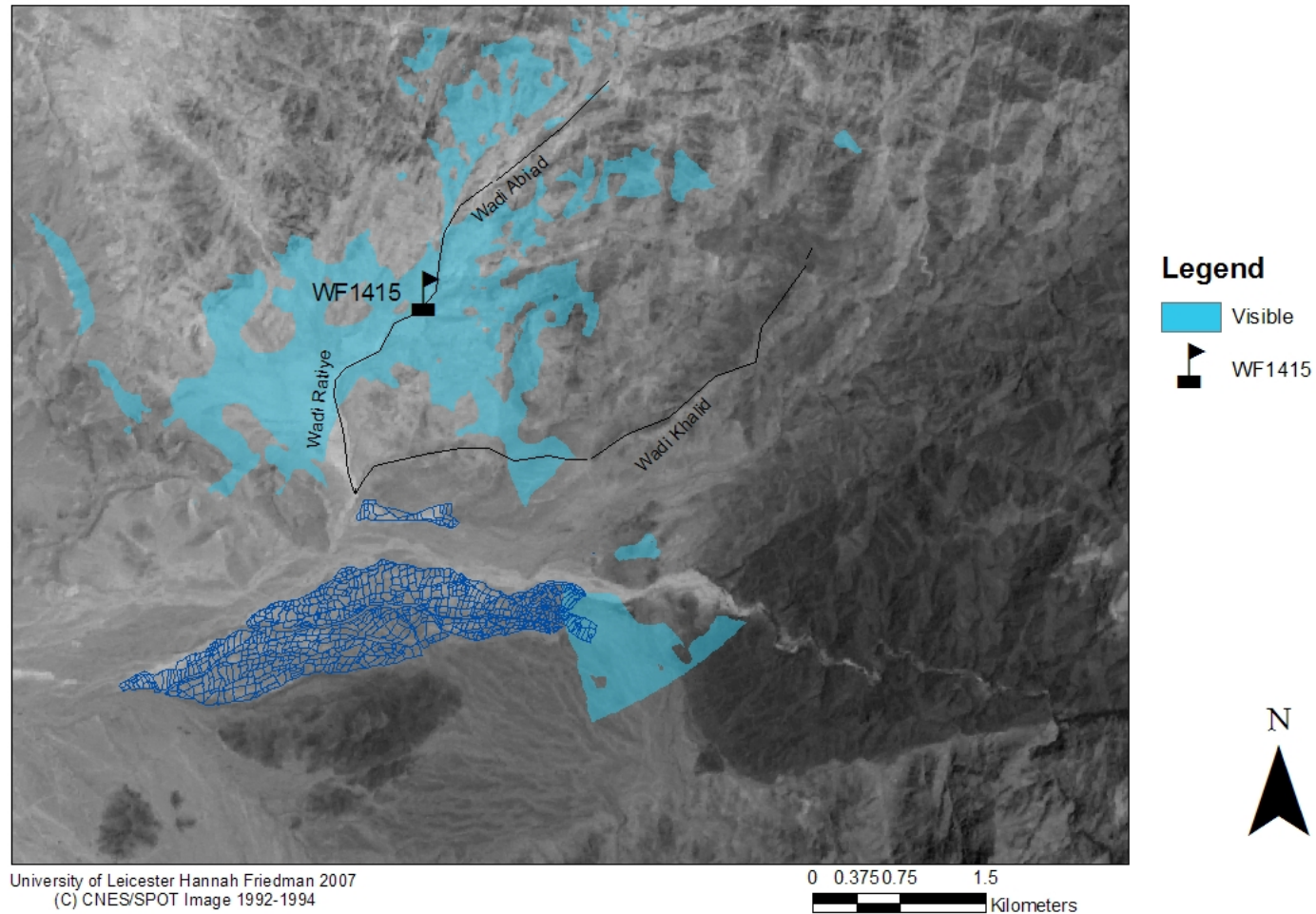
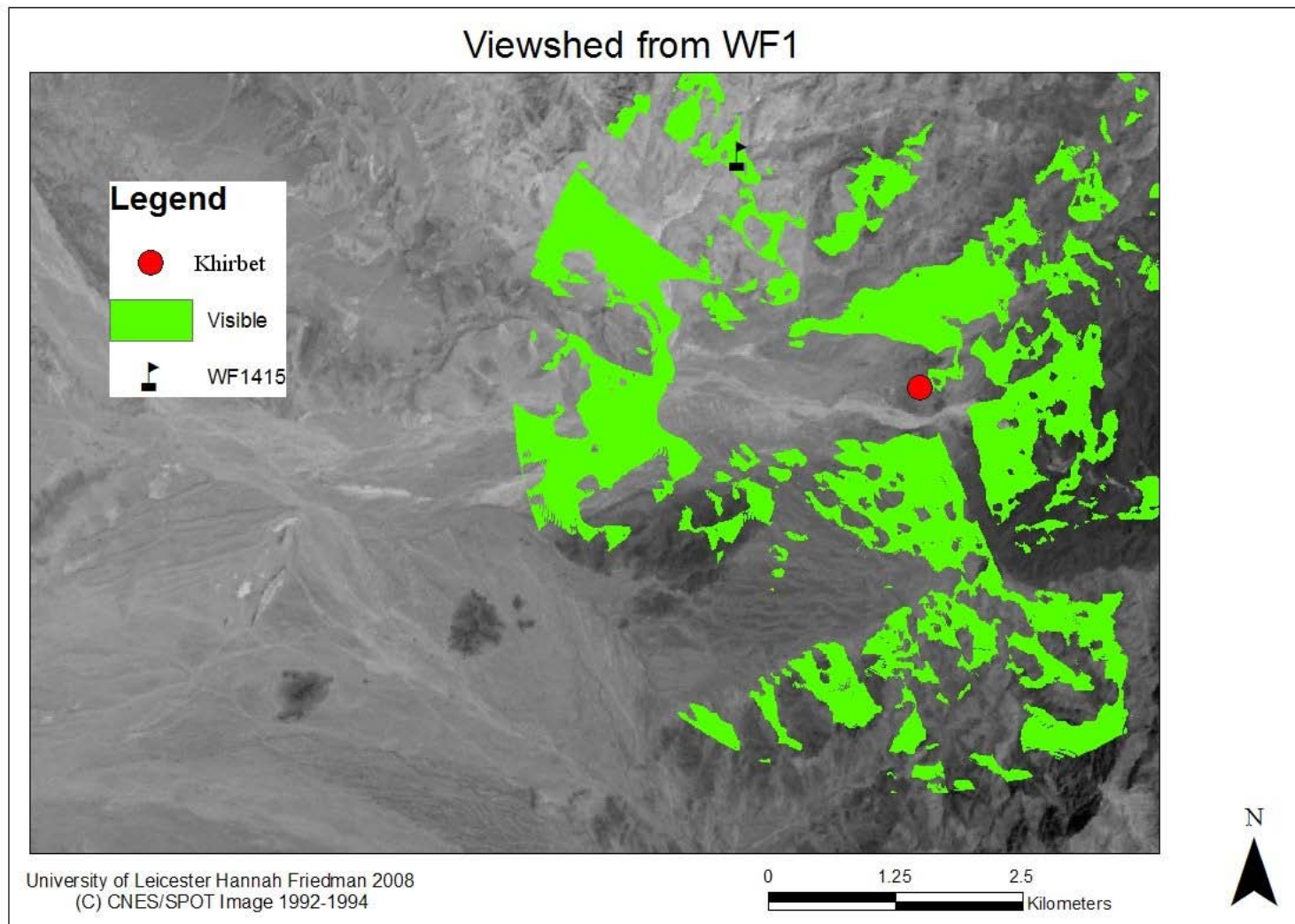


Figure 7.19 Viewshed from the WF1461 mine, areas in blue are visible.

WF1415 Viewshed and Wadis Ratiye, Abiad, Khalid



7.20 Viewshed from WF1415, wadi paths are marked in black, visible areas from WF1415 are in blue.



7.21 Viewshed from WF1 which does not include WF1415.

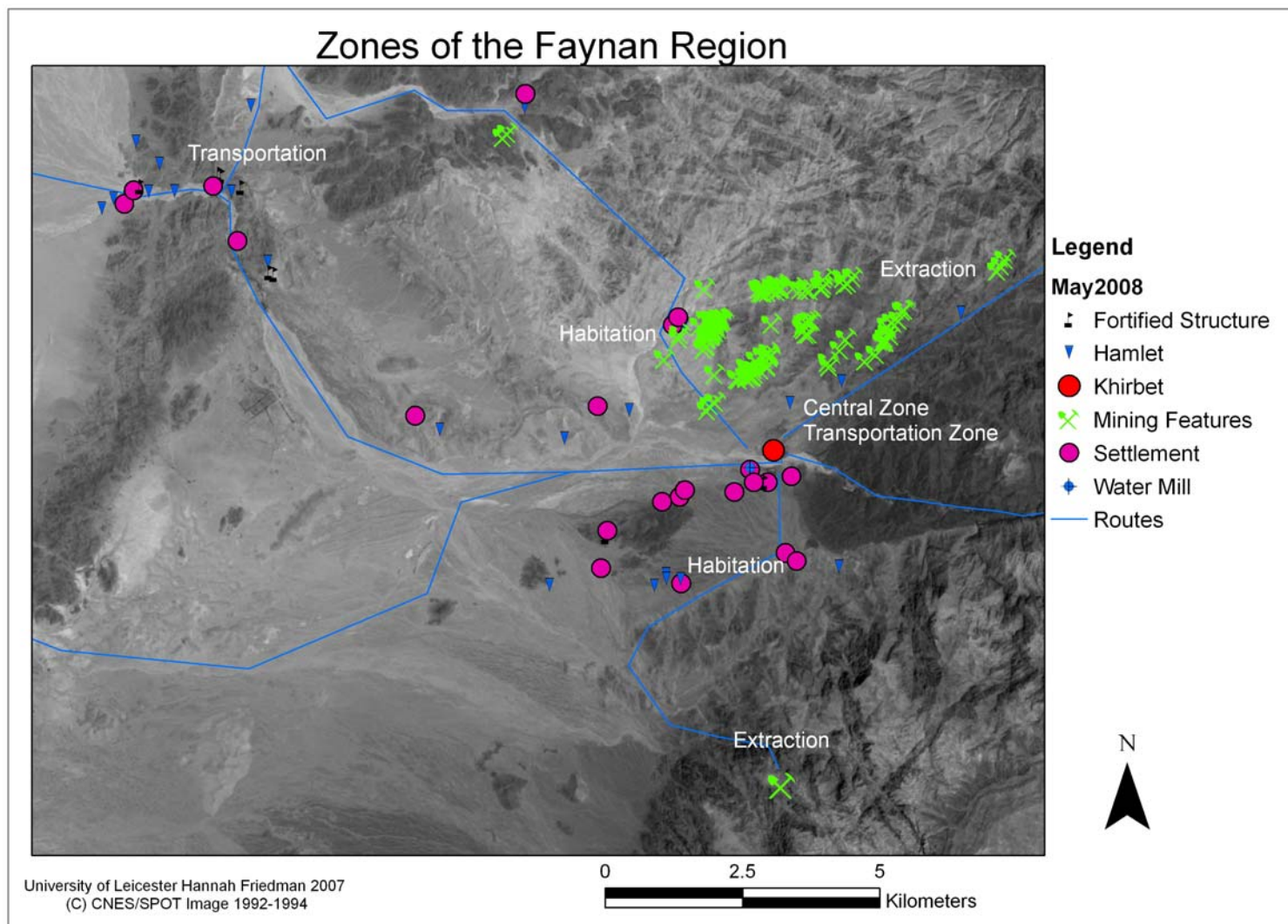


Figure 8.1 Activity zones in the Faynan region.

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Appendix 6 - 2005 Survey

Record 1-18

Site Number 1

Northing

Easting

Site Type Artefact site

Discription Find spot in the sand dunes slightly before the fields to the south of Quarayqira. No structures or walls seen. Finds were flint blades cores, grinding stone, and two hammerstones. Pottery was also found wheel thrown and black burnt. 140 paces spread

Site Number 2

Northing -

Easting -

Site Type funerary structures

Discription 3 graves well preserved. The first seems to be the oldest and largest measuring 6x3m. The next was contemporary measuring 3x1m. The final was likely old as well 1x1m. Also one cairn but was unable to tell if it was a burial. In total they covered 25x10m.

Site Number 3

Northing

Easting

Site Type wall line

Discription located near site 2 a one course wall line 8x2m. Finds included two hand made pottery sherds. The wall was well preserved to the south however the northern section crossed a wash and has suffered erosion.

Site Number 4

Northing

Easting

Site Type cairn

Discription Placed upon a hillside with excellent views. This site is one of the 5 cairn/structures on the hilltop. Loose rock stone circle uncut stone. Intrusive cairn grave not recent. 10x9.4m for the original structure the intrusive grave is 2.3x3.

Site Number 5

Northing

Easting

Site Type cairn

Discription On ridge below Site 4. Again a stone circle made of rough limestone rocks. Measures 5x6.2m.

Site Number 6

Northing

Easting

Site Type cairn

Discription Higher than any of the other cairns structures around 200m above the wadi floor. The ridge is narrow and the structures cover most of it. The stone platform is 4.58x5.85m made of cut stone forming a rectangular structure. Rubble covers the surface An accompanying cairn/stone circle looks intrusive and partially made out of the platform. It measures 7x7.9m. The inside of the circle is 1.5m in diameter. The entire spread of the site is 15.8m. No pottery findings however a stone with a cross shape was found nearby.

Site Number 7

Northing

Easting

Site Type cairn

Discription small cairn part of the hillside group 2x2m on small outcrop lower than others except for Site 8. Good preservation.

Site Number 8

Northing

Easting

Site Type enclosure

Discription Abutting a limestone rock exposure is a one course curving wall made of irregular stones. Using the natural features it forms a half circle enclosure measuring 5x3m. No finds

Site Number 9

Northing

Easting

Site Type cairn

Discription a one course wall line measuring 15m made of large wadi cobbles. Accompanying this feature is a grave measuring 3x3m. Two cairns/ possible graves are also located here. Finally a smaller segment of wall of only seven stones lies in-between the walls and the graves. Erosion of the site is very bad and makes the features hard to interpret. Found 10 pottery sherds most were hand made coarse wear. Some two pieces black thin wheel thrown pottery. The site measures 25x20m.

Site Number 10

Northing

Easting

Site Type agriculture

Discription Field system badly eroded. Three walls are visible but buried by alluvial wash in many places. Easternmost wall is 29m. Second is 54m in length . The final is 32m in length. After a area of wash two more possible walls were found but were much smaller measuring 13m and 9m.

Site Number 11

Northing

Easting

Site Type cairn

Discription Cairn 3x4m loose wadi cobbles no distinguishing finds or features.

Site Number 12

Northing

Easting

Site Type funerary structures

Discription two graves robbed and in a very bad state. Not modern but other than that was so badly damaged nothing else can be said. Flint blades found nearby.

Site Number 13

Northing

Easting

Site Type enclosure

Discription Circular structure next to steep hill close to the mountains.
Good preservation circular structure measuring 4x5m.

Site Number 14

Northing

Easting

Site Type DS

Discription three walls seem to form a rectangular structure. walls
were not preserved to a great height but two courses
deep. Leads out to the north

Site Number 15

Northing

Easting

Site Type enclosure

Discription enclosure with associated graves some have been recently robbed. Most look modern graves.

Site Number 16

Northing

Easting

Site Type cairn

Discription cairn field 17 cairns with two ephemeral walls. Finds pottery, flint, flakes, cores, and debitage. 102m long and 49m wide. All cairns small less than half meter in half.

Site Number 17

Northing

Easting

Site Type enclosure

Discription circular structure enclosure 7.15x6.25. Inerior space is 4.4x4.25m

Site Number 18

Northing

Easting

Site Type agricultural

Discription 15 wall lines badly eroded. Very scattered in some places. The walls from south to north 71m, 28m, 36m, 36m, 65m, 41m, 8m, 15m, 10m, 6m, 42m, 4m, 25m, 22m, 12m, 28m, and 36m. The site was about 300m in length. No pottery found. 263x172m in extent

Site Number 19

Northing

Easting

Site Type enclosure

Discription Two enclosures 6x4 4.5x5.3.

Database

Records 1-666

The data from the JHF project seasons 1998, 2002, and 2004, were provided with the kind permission of Professor T.E. Levy and the UCSD Levantine Archaeology Laboratory.

Key ceramic periods are abbreviated as follows:

EBA = Early Bronze Age (undifferentiated)
EBA1 = Early Bronze Age I
EBA2–3 = Early Bronze Age II–III
IA = Iron Age
IA2b = Iron Age IIB
C = Classical (undifferentiated Nabataean to Byzantine)
HN = Hellenistic
N = Nabataean or Early Roman
R = Roman
LR = Late Roman
R/B = Roman/Byzantine
B = Byzantine
EB = Early Byzantine
LB = Late Byzantine
I = Islamic
O = Ottoman

Question marks denote that the pottery is likely of this period for example N? is possibly Nabataean.

+ signs denote that the pottery belongs to that period or beyond, for example LB+ is Late Byzantine or Early Islamic

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