

Living in a fringe environment: three Late Roman settlements in the Kharga Oasis (Egypt's Western Desert)

Corinna Rossi¹ , Nicoletta De Troia¹ , Andrea Pasqui¹ , and Antonello Migliozi² 

¹Department ABC, Politecnico di Milano <corinna.rossi@polimi.it>, <nicoletta.detroia@polimi.it>, <andrea.pasqui@polimi.it>

²Department of Agricultural Sciences, Università degli Studi di Napoli Federico II <migliozi@unina.it>

Abstract: This article presents a comparative analysis of three Late Roman sites located at the northern outskirts of the Kharga Oasis in Egypt's Western Desert: Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex. These were part of the district of the Oasis Magna, which included the oases of Dakhla and Kharga. An analysis of their layout, including both shape and extent, is followed by an evaluation of their absolute and relative positions. These data are then compared to the administrative and historical contexts within which the three sites flourished. Both administrative and economic aspects are considered, as well as the presence of the army. The complex picture that emerges suggests that these three sites played several roles at the same time and were part of a large-scale strategic design that encompassed not only the Kharga Oasis but the entire Western Desert.

Keywords: Kharga Oasis, Late Roman Egypt, Late Roman forts, satellite images, agricultural systems, alum mining

This paper presents a comparative analysis of three Late Roman sites located in the Kharga Oasis in Egypt's Western Desert, each including the well-preserved remains of a settlement and its related agricultural system. The aim is to identify and analyze their common characteristics, which can then be used to study the fragmentary remains of similar archaeological sites located along the desert frontiers of the Roman Empire. This study, carried out as part of the ERC-funded project LIFE (Living In a Fringe Environment), aims at contributing to our understanding of the Late Roman strategy of control that was implemented in Egypt's Western Desert.

The three sites that are the object of this study are referred to by their modern names of Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex (Fig. 1).¹ Whereas the first and the second are self-contained, isolated sites, the third is a vast agricultural installation centered on the two fortlets of Qasr al-Gib and Qasr al-Sumayra but also including a scatter of other minor sites. The three sites discussed here are located along the northern outskirts of the Kharga Oasis, the eastern half of the ancient Oasis Magna, lying at a distance of 200 km due west from Luxor and the Nile Valley. The other half, the Dakhla Oasis, is located 180 km away to the west (Fig. 2).

Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex are still relatively little known because they were explored and surveyed only recently and have not been systematically excavated.² The characteristic that makes them especially interesting for a

¹ To enhance the legibility of this paper, the Arab toponyms are not transliterated. The spelling adopted here attempts to respect the structure of the Arabic words and may slightly differ from the one adopted by Google Earth and other publications.

² Rossi and Ikram 2018.

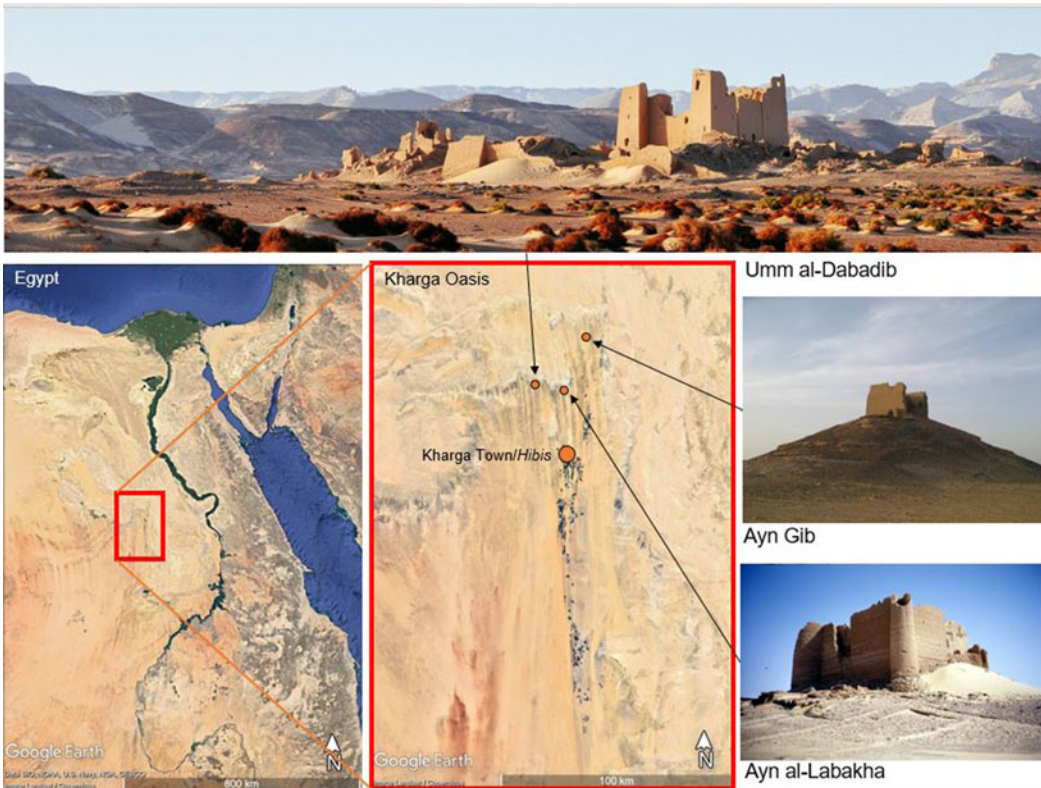


Fig. 1. Position of the Kharga Oasis in Egypt and of Umm al-Dabadib, Ayn al-Labakha and the Gib/Sumayra Complex within Kharga. (Google Earth, Image Landsat/Copernicus 2021, map by C. Rossi.)

comparative study is the combined presence of both the built-up area, where the community lived, and the agricultural system; the latter includes both a system to retrieve water and cultivated fields. Settlements and agricultural systems represent two faces of the same coin: each was simultaneously the cause and effect of the other. This duality is mirrored by the structure of the LIFE project, a collaboration between the Politecnico di Milano, in charge of the archaeological and architectural study of Umm al-Dabadib, and the Università degli Studi di Napoli Federico II, in charge of the study of the agricultural system.³

Unlike a plethora of other Roman sites that punctuate Egypt's Western Desert, these three sites survive in relatively good condition, albeit to different degrees of preservation: Umm al-Dabadib is virtually intact, Ayn al-Labakha coexists with limited but persistent modern activity, but substantial portions of the Gib/Sumayra Complex – well preserved until 20 years ago – are being progressively removed by the encroachment of modern cultivation, especially in the area of Ayn Gib, around Qasr al-Gib (Fig. 3). This article represents an opportunity to describe and analyze them together, before the physical evidence for the parallels among them disappears. A methodological introduction is followed by a description and discussion first of the layout of these settlements and then of their position. The data collected on these two aspects are then placed within the broader context of the

³ Rossi et al. 2015.



Fig. 2. Position of the archaeological sites of the Oasis Magna mentioned in this paper. Their ancient names, when known, are indicated in italics. (Google Earth, Image Landsat/Copernicus 2021, map by C. Rossi.)

Kharga Oasis and wider Oasis Magna. Finally, all this information is combined to discuss the possible function(s) of the three sites. A conclusion summarizes the results.

The (im)possible study

The archaeological investigation of these sites is extremely difficult. To start with, they are located away from the inhabited part of the Kharga Oasis, in areas where there is no electricity; at Umm al-Dabadib, there is no water and no telephone signal. For this reason, working there has always involved a significant logistical and economic effort, and the amount of information retrieved so far has been strongly influenced by the environmental conditions. Fieldwork at these sites has also been impossible for a number of years: the Western Desert was closed to all foreign archaeological missions in 2016 amid security concerns, and the hope that the situation might improve was brought to a fresh halt by the 2020 pandemic.

The situation is made even more complicated by the fact that these sites consist of not only archaeological remains that are acknowledged as such and are therefore protected by the law (e.g., buildings and cemeteries) but also the elusive traces of irrigation systems and fields, which are not included in the protected areas. This latter situation stems from a combination of factors.

On the one hand, these remains are generally perceived as secondary by-products of a settlement and as minor traces of basic activities. Similar difficulties are encountered in the study of ancient desert routes and quarries.⁴ On the other hand, it must be said that these faint remains are often nearly or completely invisible from ground level. This is certainly the case of the ancient fields at Umm al-Dabadib, which become visible to the naked eye only for a few minutes at sunset and only under specific conditions of light, but

⁴ Riemer and Förster 2013; Bloxam 2010.

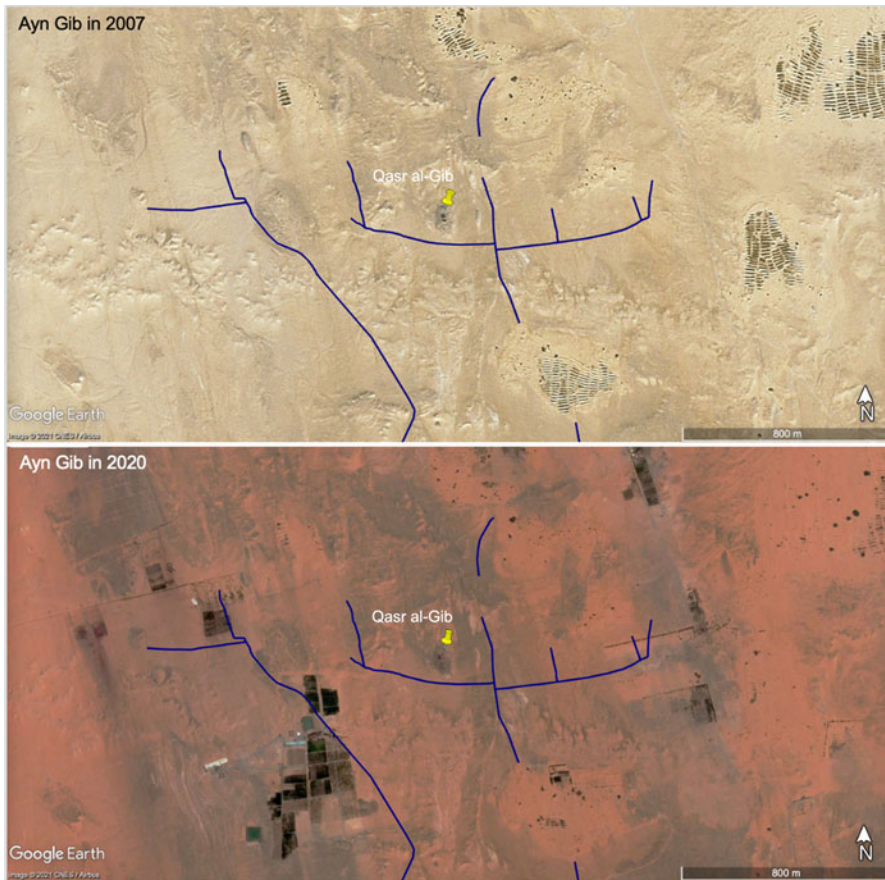


Fig. 3. The area of Ayn Gib seen from the satellite in 2007 and in 2020. The blue lines indicate the sequence of vertical shafts marking the presence of qanawāt. The progressive installation of modern fields is clearly visible. The older watermelon fields have been abandoned and are now engulfed by sand. (Google Earth, Image Landsat/Copernicus 2007 and 2020, map by C. Rossi.)

which are perfectly apparent on Google Earth. The same applies to most of the ancient and abandoned modern fields in the Kharga Oasis. The impressive extent of the mining area located in the desert to the west of Umm al-Dabadib can also only be appreciated on satellite images, given that the presence of a thick field of interlocking dunes makes it very difficult to explore the area from ground level. That said, the opposite is also true: some features invisible from the air are visible from the ground, either because the resolution of the available satellite images is insufficient or because the features themselves simply cannot be seen from above. In the case of mining areas, for instance, although the holes left by sieving operations can be clearly detected from above, even in the case of slightly blurred images, underground galleries are mostly invisible. Therefore, the actual extent of ancient occupation (and the mining areas are a perfect example of this) can only be determined by combining information retrieved from the air and from the ground.

Despite their relatively recent appearance, aerial images (satellite and remote sensing) are already contributing to an archive documenting the ongoing changes to the Earth's surface.⁵

⁵ See, e.g., Parcak et al. 2017; De Laet et al. 2015.

In the case of the Kharga Oasis, until 2007 the archaeological remains were barely visible on Google Earth. Then the situation improved significantly, and one of the best sets of images dates to the years 2010–2011. The images taken in the subsequent years document the changes that occurred (see Fig. 3) but are often less “legible,” due to the absence of colors in the images or their excessive contrast.

Aerial views can play an extremely important role in identifying the remains of ancient cultivation and therefore contribute to their preservation, not only because they represent an efficient tool but also because they represent a way to circumvent at least some of the difficulties listed above relating to fieldwork activities. In this specific case, they offer the chance to adopt a different methodological approach, based not on the most logical actions but on the only possible ones.

What was once true for ancient fields now applies to other remains as well. As a matter of fact, currently the only way in which we can study the archaeological remains of the Kharga Oasis (as well as those of the entire Western Desert) is remotely. The LIFE research team therefore adapted the project strategy and focused on how to retrieve fresh information on Umm al-Dabadib from a distance. This goal was achieved not only by re-examining the data collected in the past but by reworking them, thereby implementing a sort of “remote” archaeological study of the site and its surrounding area. Combining data in a flexible way represented the key to success: three-dimensional models were used to perform geometrical and metrological analyses, yielding important information on the cultural background of builders and workmen;⁶ photographs taken in the recent past were digitally processed to resolve doubts cast by lack of data in the three-dimensional survey or to correct mistakes made in the past;⁷ and data retrieved from similar sites were used to test fresh theories.⁸

Umm al-Dabadib, Ayn al-Labakha, and the area of Qasr al-Gib and Qasr al-Sumayra were all inhabited and exploited by the Early Roman period, at a scale that is difficult to define.⁹ At the beginning of the 4th c. CE, they were selected to play a crucial role in a large-scale strategic program of control and defense of the Kharga Oasis.¹⁰ Because this article focuses on the archaeological remains dating to this historical period, for simplicity, the names of the three sites will be here used to indicate the Late Roman remains. Early Roman and pre-Roman remains will instead be specifically identified as such.

Even if some important aspects of this large-scale, ambitious operation are bound to remain obscure until new fieldwork can be performed, a significant amount of information can still be retrieved by comparing these sites from a distance. This article therefore presents the results of a remote investigation into the layout, position, and function of these three Late Roman settlements.

⁶ Rossi and Fiorillo 2018; Rossi and Fiorillo 2020.

⁷ Fiorillo et al. 2020.

⁸ Rossi 2019.

⁹ Rossi and Ikram 2018, III.9.

¹⁰ Rossi 2013.



Fig. 4. Aerial views of the Fortified Settlement of Umm al-Dabadib and the Gridded Settlement of Ayn al-Labakha (at the same scale). (Google Earth, Image Landsat/Copernicus 2010.)

Layout

Shape

The ancient names of the three sites that are the object of this study are unknown.¹¹ The modern Arabic names of Ayn Umm al-Dabadib (in its extended form) and Ayn al-Labakha refer to the presence of water in the area (*ayn* means “spring”); the rest of their names have unclear origins. Both places are characterized by the presence of a Late Roman compact gridded settlement delineated by enclosure walls and surrounding a fort-like building.¹² They have been given modern names reflecting these characteristics: the “Fortified Settlement” of Umm al-Dabadib, endowed with a buttressed wall along its southern side, covered an L-shaped area (ca. 90 × 120 m), in the middle of which rises the Fort; the “Gridded Settlement” of Ayn al-Labakha surrounded the central Fort on at least three sides (covering an area of ca. 80 × 50 m), following a strict orthogonal pattern (Fig. 4). Both consisted of three-dimensional mosaics of interlocking domestic units separated by narrow vaulted corridors, which may well have originally looked like giant, geometrical anthills.¹³ In both cases, the contemporary aqueducts started in the surrounding hills and discharged their waters into elongated cultivation systems located at some distance from the settlements, although within a radius of 1.5 km (Figs. 5 and 6).

The Gib/Sumayra Complex is a large installation that included the two forts of Qasr al-Gib and Qasr al-Sumayra, and a vast area locally known as Maghatta. This area includes

¹¹ At Umm al-Dabadib, a Coptic inscription engraved on a wall of the church might contain a clue to the ancient name of the site (Rossi and Ikram 2018, 242–43).

¹² For the identification of these central buildings, see Rossi 2018a.

¹³ Rossi and Ikram 2018, 183–88, 225–36.

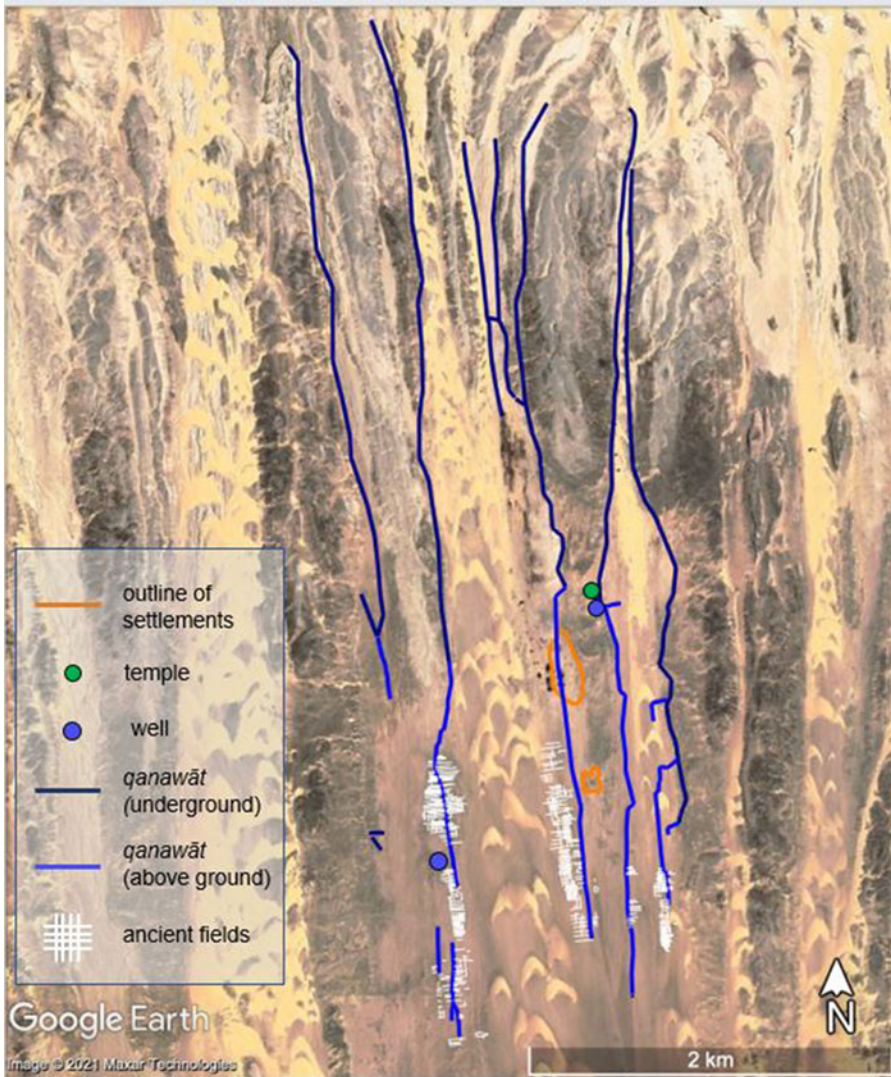


Fig. 5. Extent of the Late Roman remains of Umm al-Dabadib. (Google Earth, Image Landsat/Copernicus 2007, map by C. Rossi.)

two settlements, respectively nicknamed Two Houses (because only two buildings are still standing) and Watermelon Settlement (because it is surrounded by modern watermelon fields), that are accompanied by a scatter of cemeteries. All of these settlements are linked by a large system of underground aqueducts (Fig. 7). The Gib/Sumayra Complex is organized differently from Umm al-Dabadib and Ayn al-Labakha: of the two fortlets, Qasr al-Gib rises on an isolated rock outcrop, whereas Qasr al-Sumayra lies on relatively low ground. The latter, ruined but still standing, was accompanied by a number of buildings that are now totally engulfed by sand; their layout is unclear, but they do not seem to have been organized in a compact gridded pattern within an enclosure wall.¹⁴ In this area, in fact, the settlements are smaller and located exactly where the aqueducts discharged their waters and the cultivated areas lay. In this case, therefore, the relationship

¹⁴ Rossi and Ikram 2018, 66–72, 80–84.

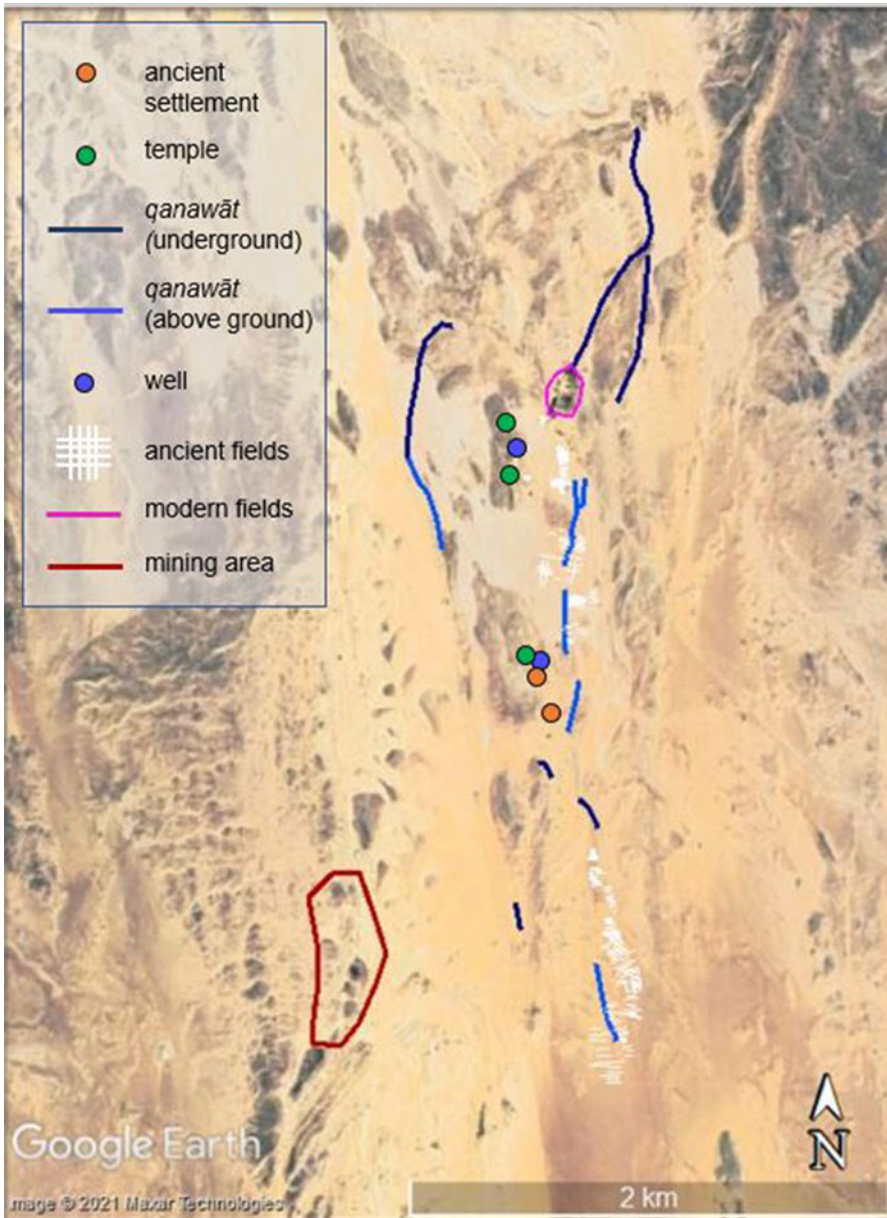


Fig. 6. *Extent of the Late Roman remains of Ayn al-Labakha. (Google Earth, Image Landsat/Copernicus 2007, map by C. Rossi.)*

between the inhabited areas and the fields was more direct than at Umm al-Dabadib and Ayn al-Labakha, perhaps indicating a different social and administrative organization (see below).

The structure of Umm al-Dabadib and Ayn al-Labakha may be schematized as a nucleus (the gridded and enclosed settlement) from which the population departed to work the surrounding land (Fig. 8); the structure of the Gib/Sumayra Complex may instead be compared to a cluster – that is, a network of small units each made up of an inhabited nucleus and an adjacent patch of land (Fig. 9). The element that appears to be missing at the Gib/Sumayra Complex is the overall defensive character of the settlements, and yet the

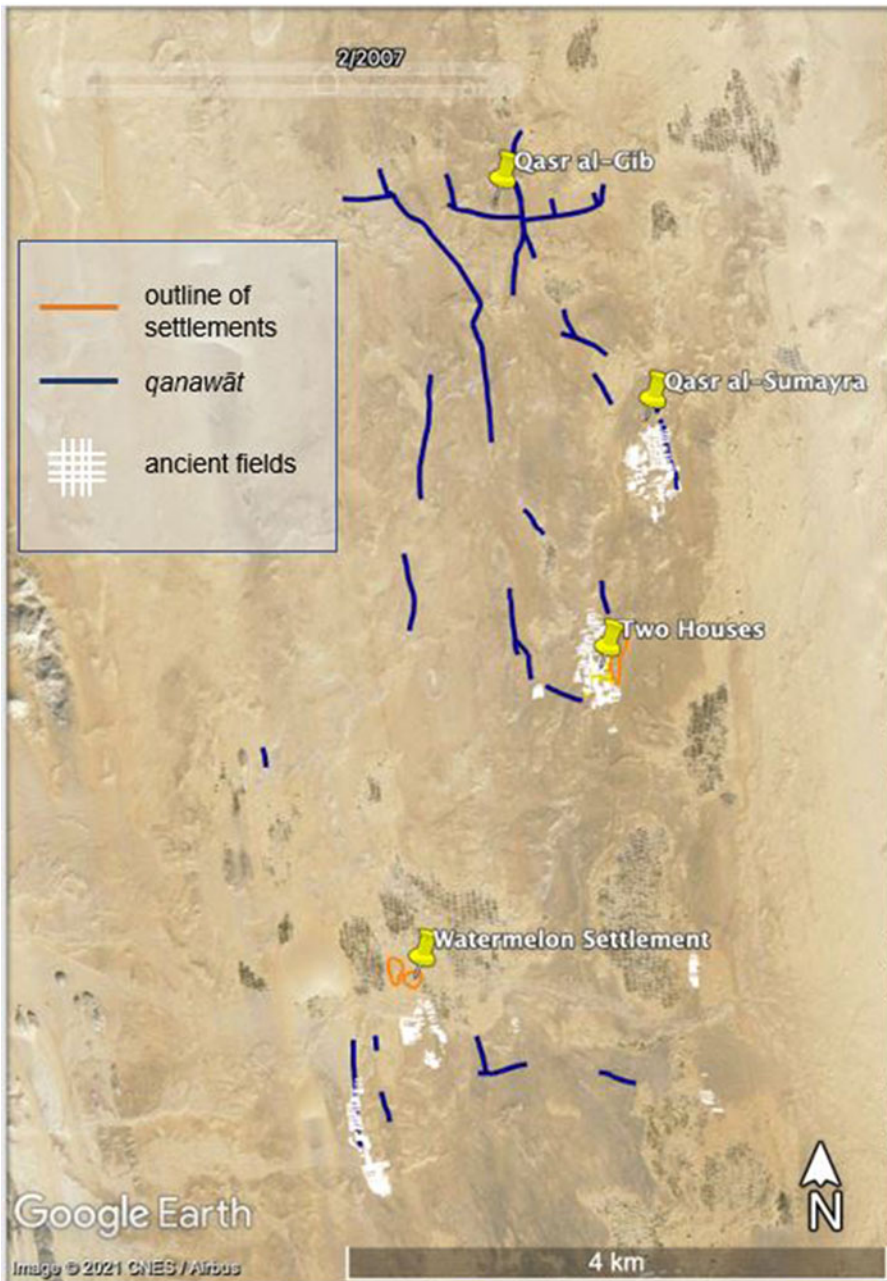


Fig. 7. Extent of the Late Roman remains of the Gib/Sumayra Complex. (Google Earth, Image Landsat/Copernicus 2007, map by C. Rossi.)

presence of the same architectural elements and characteristics of both the domestic and the military buildings clearly points to a common origin for the three sites, as if they were different conjugations of the same paradigm.¹⁵

¹⁵ Rossi 2018a.

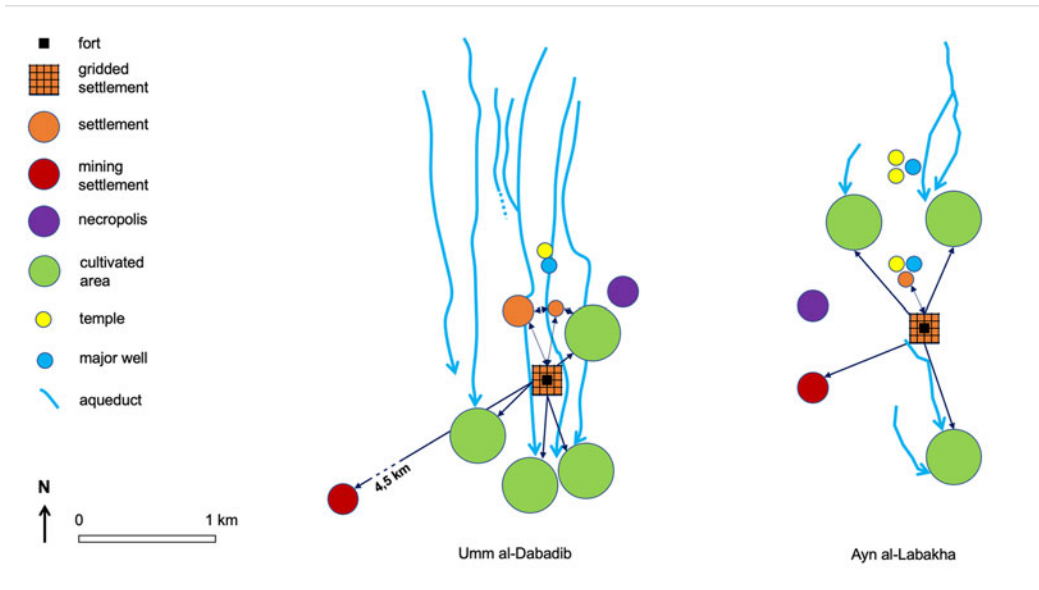


Fig. 8. Nucleus-type settlement: Umm al-Dabadib and Ayn al-Labakha (internal distances to scale). (C. Rossi.)

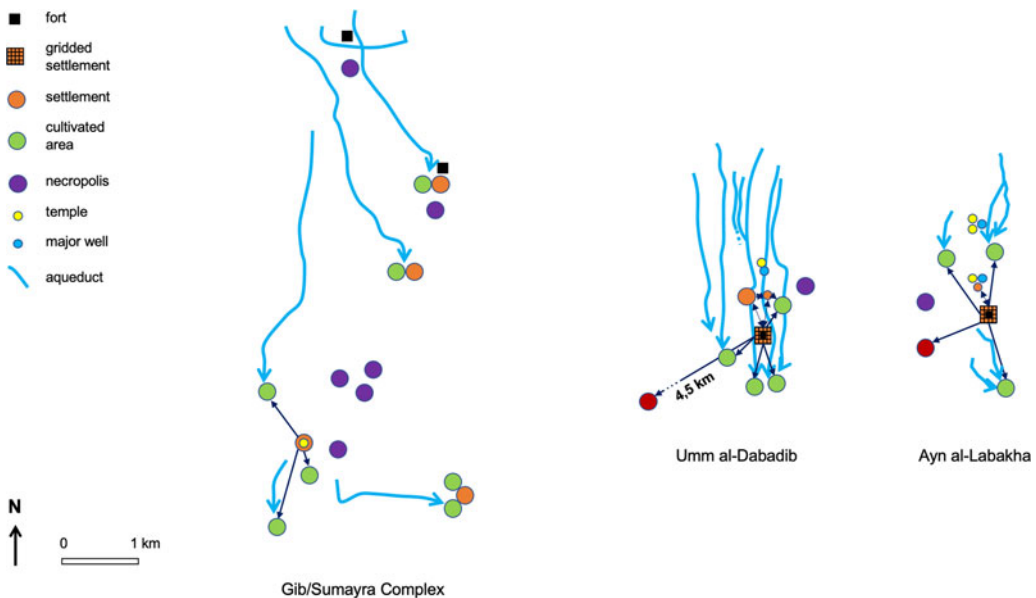


Fig. 9. Cluster-type settlement: Gib/Sumayra Complex, compared to the nucleus-type settlements of Umm al-Dabadib and Ayn al-Labakha (internal distances to scale). (C. Rossi.)

The cluster-type settlement seen at the Gib/Sumayra Complex is more difficult to spot than the nucleus type seen at Umm al-Dabadib and Ayn al-Labakha, because this type of installation – less dense and spread over an area rich in water – is more easily obliterated or absorbed by the subsequent reuse of the same water sources. In the northern Kharga, cluster-like settlements dating to the Roman period can be seen in the area of Ayn al-Tarakwa and Ayn al-Dabashiya, as well as all around the central green core that nowadays hosts Kharga



Fig. 10. Satellite view of *Qasr al-Nissima* and *Qasr al-Baramudy*. (Google Earth, Image Landsat/Copernicus 2011.)



Fig. 11. Satellite view of *Ayn al-Tarakwa*, *Nadura* and *Qasr al-Ghwayta* to the same scale. (Google Earth, Image Landsat/Copernicus 2011.)

Town (see below, Fig. 12). Bilayda and the surrounding scatter of agricultural installations represent a significant example, but many other sites that are currently classified simply as “Greco-Roman” might also be part of the picture.¹⁶ The nucleus-type settlement, such as at Umm al-Dabadib and Ayn al-Labakha, instead generally leaves behind evident concentrations of archaeological traces, given that compact settlements tend to turn into ruined mounds that are unlikely to be easily covered by spontaneous vegetation or destroyed by modern land reclamation, as is the case with the Watermelon Settlement. The main risk for this type of settlement is represented by *sabbakh*-digging – the dismantling of the ruins by local farmers – as has happened at Qasr al-Nissima.¹⁷ The “flattened” remains of Qasr al-Baramudy, located on higher ground and exposed to the strong sand-laden winds that batter the oasis, might be the combined result of human actions and natural erosion (Fig. 10).¹⁸

Walled settlements can also be found at Ayn al-Tarakwa,¹⁹ Nadura, and Qasr al-Ghwayta (Fig. 11), located respectively to the north, east, and south of Kharga Town,

¹⁶ Rossi and Ahmed 2019.

¹⁷ Ghica 2012, 217–21.

¹⁸ Rossi and Ikram 2018, 422–25.

¹⁹ Rossi and Ikram 2018, 339–48.

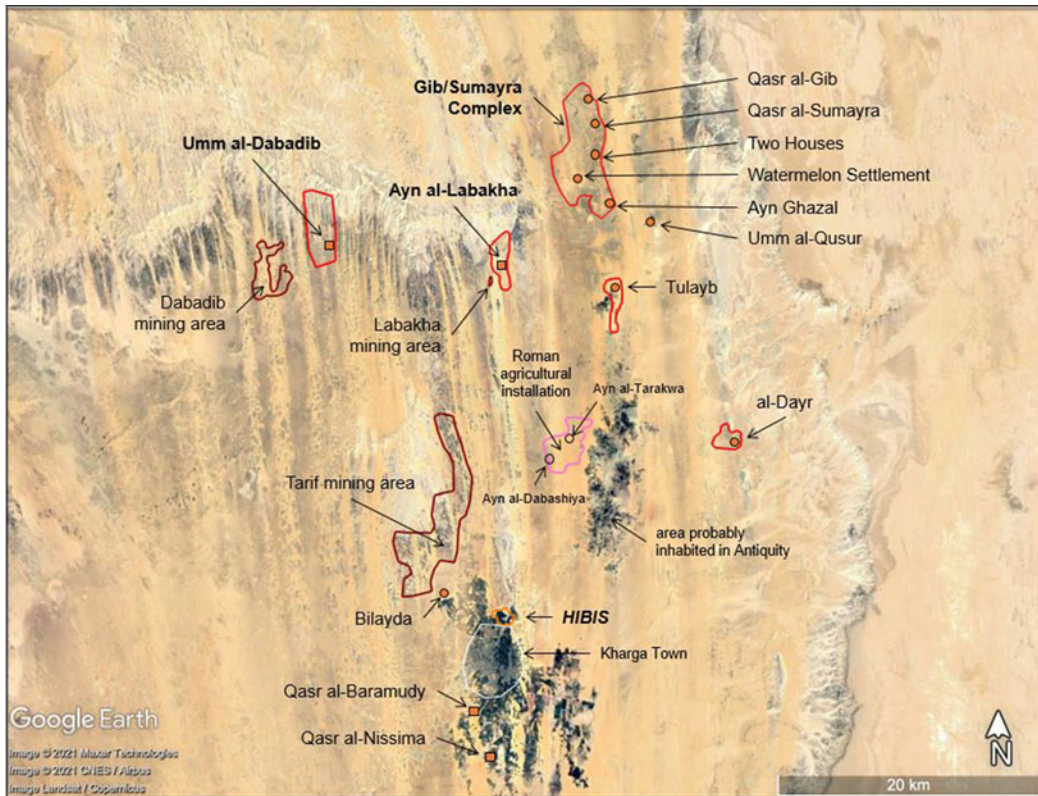


Fig. 12. Position and extent of the main Late Roman sites and the main mining areas in northern Kharga. (Google Earth, Image Landsat/Copernicus 2021, map by C. Rossi.)

but with the significant difference that they developed within and around the temena of earlier stone temples.²⁰ A hybrid site might be Tulayb, where a 4th-c. CE fort incorporated an earlier mudbrick temple.²¹

It is tempting to conclude that the convergence toward the same shape (walled settlements clustered around a central building) was due to the general condition of insecurity that characterized the 3rd c. CE,²² which Diocletian tried to combat with a reorganization of the country, including the foundation of a number of fortresses meant to host legions along the Nile and alae and auxiliary forces in the Western Desert.²³ This explanation makes sense and is, broadly speaking, probably correct. It must be underlined, however, that although we have some evidence for early Roman remains, we know very little about the shape, layout, and extent of pre-Roman settlements in the Kharga Oasis.²⁴

²⁰ Nadura dates to the Early Roman period (Klotz 2013). Qasr al-Ghwayta and Hibis were founded in the Saite period and subsequently decorated by Darius I (Arnold 1999, 77–79, 92).

²¹ Rossi and Ikram 2018, 131–48.

²² Starting from the second half of the 3rd c. CE, the extant sources mention raids of Libyan groups in the Fayyum (*P. Princ.* 29), in the Herakleopolite nome (*BGU* III 935) and in the southern Oxyrhynchite nome (*P. Oxy.* XXX 2681 and *P. Oxy.* XLVI 3292), as well as disorders in the district of the Oasis Magna caused by the Nobates, eventually pacified by Diocletian (Procop. *Pers.* 1.9).

²³ Rossi 2013; Rossi 2018a, 449–51; Rossi forthcoming.

²⁴ Snape 2014, 216.

Perhaps this type of enclosed, walled, anthill-like settlement had been adopted in the harsh desert climate of the Western Desert well before the Late Roman period, not necessarily (or at least not only) for security reasons. Testing this hypothesis will be possible only by comparing the results of thorough archaeological investigations into the pre-Roman levels of occupation of the oases – a major enterprise that is still far from being undertaken.

Extent

Plotting on Google Earth the extent of the Late Roman-period archaeological remains of Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex immediately conveys the scale of the Late Roman intervention in this region (Fig. 12).²⁵

When the Roman authorities decided to build a chain of new settlements at the very beginning of the 4th c. CE, the presence of earlier settlements must have played an important role in the decision-making process because their existence testified to the presence of reliable water sources. Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex all yielded evidence of earlier occupation, even if its exact scale and extent are difficult to establish with precision. At Umm al-Dabadib, the earlier Northern Settlement (dating to the 3rd c. CE and perhaps extending back to the 2nd c. CE) consisted of scattered houses that covered an elongated area of about 450 × 180 m.²⁶ At Ayn al-Labakha, a pre-4th c. CE settlement (probably contemporary with the Pyris temple and the necropolis to the west) might be located immediately to the north of the Gridded Settlement, over an area of about 250 × 100 m that is nowadays totally engulfed by soft sand (Fig. 13; see also Figs. 4–6).²⁷ Scattered clues indicate that the area of the Gib/Sumayra Complex was inhabited before the Late Roman period, but nothing can be said of the type and extent of the earlier settlements without extensive excavations.

At Umm al-Dabadib and Ayn al-Labakha, the extent of the new 4th-c. CE inhabited areas was smaller than that of the earlier inhabited areas, but the settlements were far denser in terms of construction. Although the surface covered by the settlements shrank, the total extent of the field of action of all three settlements increased enormously due to the installation of their agricultural systems (see Figs. 5–7, 12, and 13). Overall, including water catchment and cultivated areas, Umm al-Dabadib covered an area of 6 × 2 km; the mining area in the west covers a C-shaped area with a maximum extent of 3 × 4 km. The remains of Ayn al-Labakha spread over an area of 4 × 1.5 km, whereas the Gib/Sumayra Complex had an extent of 10 × 4 km.

Estimating the number of inhabitants of the new 4th-c. CE settlement at Umm al-Dabadib is extremely difficult. Although its general layout is clear, its internal organization is not. A number of domestic units can be clearly singled out, but the rest of the constructions remain to be identified. Moreover, the total height and number of floors of several buildings are still unclear. An interesting aspect of this settlement is the apparent

²⁵ The attribution of the subterranean aqueducts to the 4th c. CE is discussed in Rossi 2018b, 517–21.

²⁶ The presence of a pre-Roman settlement cannot be ruled out, but the lack of substantial archaeological traces makes any estimate of its possible size currently impossible.

²⁷ Although traces of parallel and orthogonal mudbrick walls suggest an orderly design, it is impossible to tell whether this settlement consisted of scattered, independent houses like the Northern Settlement at Umm al-Dabadib or a dense concentration of buildings.



Fig. 13. Aerial views of the earlier settlements of Umm al-Dabadib and Ayn al-Labakha (not to the same scale). The southern, gridded settlements date to the early 4th c. CE. (Google Earth, Image Landsat/Copernicus 2010.)

absence of streets: the built-up area consisted of a solid mass of interlocking buildings served by narrow vaulted passages. The 4th-c. CE settlement of Ayn al-Labakha is only partly preserved, but it shows identical characteristics.

The total area of the settlement of Umm al-Dabadib is about 8,100 m² (less than 1 ha). In general, Roman settlements are known to have a density of inhabitants ranging between 100 and 400 per ha.²⁸ Given that here there are no large streets and squares, and judging from what is visible, it may be suggested that about 75% of this settlement consisted of domestic units and the rest consisted of passages, and storerooms and warehouses. This results in an inhabited area of 6,075 m², which may be divided by the average surface of the various domestic units (75 m²) for a total of about 80 households. A low estimate of six family members per household would imply 480 inhabitants; a figure of eight would produce 640 inhabitants; and with 10 family members, the total figure would reach 800. Considering the density of the internal organization of this specific settlement, a higher figure is probably more likely than a lower one.

The earlier settlement at Umm al-Dabadib consisted of at least 36 buildings, many of which can be clearly identified as houses; a few more are likely to be buried under the sand. A figure of eight members per household would give a total of 320 inhabitants, whereas 10 would produce a total of 400 – both definitely lower than the figures for the later settlement. Given that this settlement does not contain evidence of 4th-c. CE occupation, it might be inferred that it was abandoned, or at least used much less, after the new settlement was built.²⁹ It is possible that the population moved from the old to the new settlement; the significantly higher number of inhabitants of the newer settlement (from

²⁸ Bagnall and Frier 2006; Wilson 2011, 161–95; Bowman 2011, 317–58.

²⁹ Rossi and Ikram 2018, 220, 307.

400 to 700–800?) could be explained by the arrival of other settlers, sent there to increase the local population and efficiently handle the new, larger agricultural system.

It is tempting to interpret Ayn al-Labakha in the same way, but unfortunately, the remains of the pre-4th-c. CE settlement are too engulfed in a thick layer of soft sand and debris to provide any conclusive evidence.

The situation at the Gib/Sumayra Complex is uncertain: apart from the two forts and the two standing buildings at Two Houses, it is difficult to assess the amount of new building work performed in the Late Roman period. The ceramic evidence and some architectural remains indicate a substantial occupation dating to the 3rd and 4th c. CE, but how much of this scattered settlement was really built at that time is currently impossible to tell. At any rate, the fact that all of these settlements were connected by the same system of subterranean aqueducts dating to the 4th c. CE implies that all were active in the same period. Even if only Umm al-Dabadib appears to provide substantial evidence pointing in this direction, the addition of new settlers to the original inhabitants of the three sites at the beginning of the 4th c. CE is a likely scenario. This will be further considered below, in the discussion of the function of these sites.

Position

Relative position

Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex are located in the northern portion of the oasis, at a distance – as the crow flies – respectively of 30, 25, and 32 km from the ancient capital Hibis. An average distance of 7–10 km separated the various sites that punctuated the northern area (Fig. 14).

Substantial human activities depend heavily on the presence of water, and in these desert areas, the places where water is easily available are basically always the same. For this reason, the modern land-reclaiming process is quickly taking over the ancient sites. The areas of Tulayb and Ayn Gib have already been encroached on: the main buildings are still standing, but the rest is rapidly being destroyed. The surroundings of Ayn al-Dabashiya and Ayn al-Tarakwa, which were clearly heavily exploited in the past – to judge from the remains of dozens of wells and a vast spread of fields – lie dangerously close to the expanding modern field systems. The low-intensity agricultural exploitation of a patch of land at Ayn al-Labakha might turn into a more substantial and problematic presence in the future. Only al-Dayr to the east and Umm al-Dabadib to the west remain, for the moment, untouched.³⁰

The actual traveling distances between the ancient sites are longer than the totals given in Fig. 14, which are measured as the crow flies, because the actual paths between them are not straight. Moreover, expressing distances through the desert in kilometers often makes little sense because the terrain plays a crucial role in determining the necessary effort. It is safer to speak about time, and yet, even this can be difficult to estimate: it depends on whether travelers walked or rode and what their load was. Finally, short trips were less likely to be affected by bad weather, whereas long journeys could be significantly slowed down or even halted by sandstorms and other events. In this instance, a speed of 4 km per

³⁰ A few years ago, the request to install a field of wind turbines at Umm al-Dabadib was rejected by the Egyptian Environmental Affairs Agency of the Ministry of the Environment.

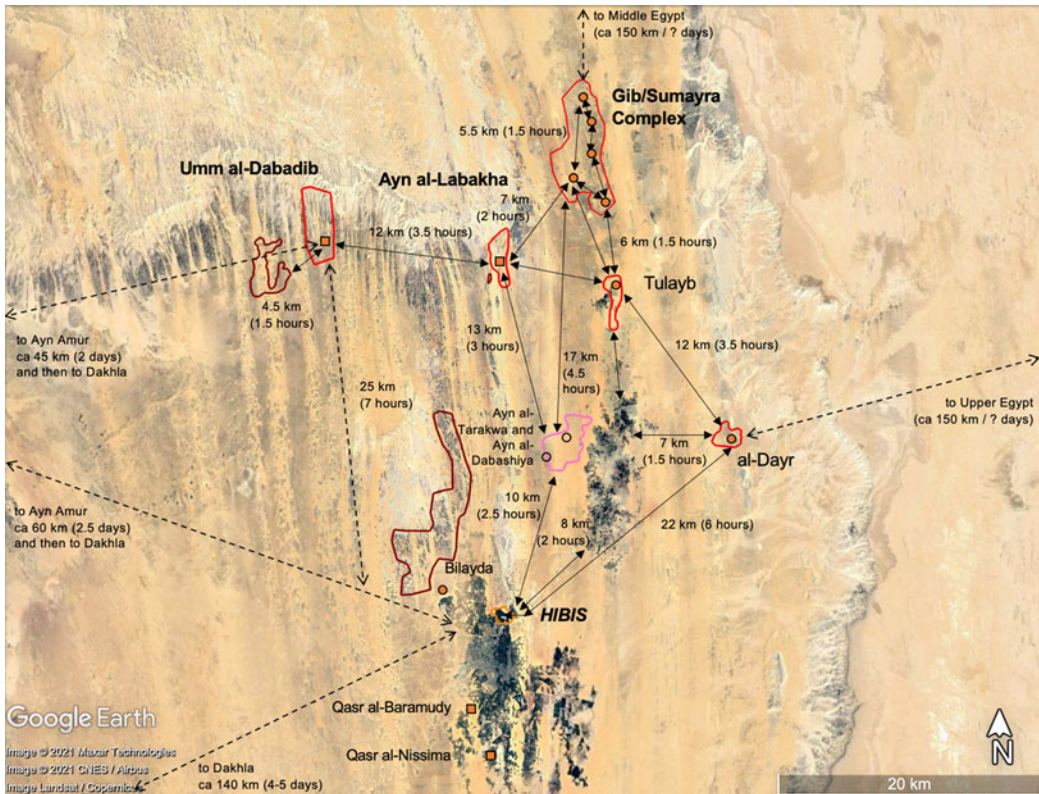


Fig. 14. The network of Late Roman sites in northern Kharga. The arrows and number of kilometers indicate distance as the crow flies, while in brackets there appears an estimate of the time that was necessary to move from place to place, based on a combination of number of kilometers, actual walking distance along winding paths, and type of terrain. (Google Earth, Image Landsat/Copernicus 2021, map by C. Rossi.)

hour has been used to calculate the lowest estimate; the upper limit of the range has been suggested instead on the basis of the conditions of the terrain. With these criteria in mind, it may be estimated that distances of 8–10 km could be covered on foot in 2–3 hours, depending on the load, whereas the slightly longer route between Ayn al-Labakha and Umm al-Dabadib probably took 5–6 hours. In general, all these sites were equally distributed in the territory and traveling among them must have been relatively simple.

A short distance separates Umm al-Dabadib from a large mining area, located to the southwest, beyond a chain of dunes (Fig. 15). This area has not been systematically investigated. The presence of at least four rather basic settlements, accompanied by ceramics of Roman date and surrounded by shallow diggings, was first noted in 2004.³¹ The site was subsequently re-examined and identified as a source of alum.³² The true extent of the ancient activities is only visible from the satellite. Here, alum was evidently retrieved by sieving the terrain right under the desert surface – a technique that left behind thousands of holes, now filled by sand, that punctuate the desert surface at intervals of 10–20 m. More must currently be buried under the sand dunes (Fig. 16). Three of four small clusters of

³¹ Ikram and Rossi 2007, 178.

³² Ikram et al. 2020, 324.

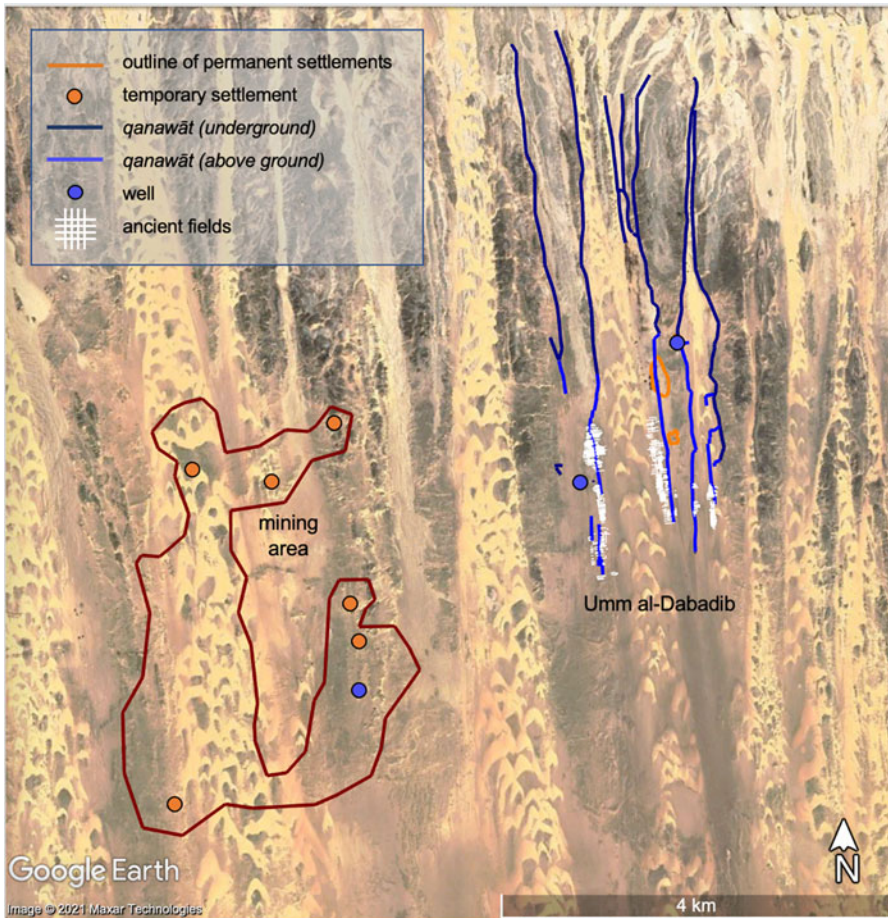


Fig. 15. *Layout and extent of the site of Umm al-Dabadib and its associated mining area. (Google Earth, Image Landsat/Copernicus 2010, map by C. Rossi.)*

shelters are located along the eastern edge of the mining area in the direction of Umm al-Dabadib (Fig. 15 and detail in Fig. 17). Desert tracks connecting the two areas are clearly visible from the satellite; some parts have been enhanced by modern tire marks because they represent the more logical way to travel in an east–west direction. At least one large well can be seen in the eastern portion of the area. The presence of others cannot be ruled out, but no traces of cultivation can be seen. Water was probably retrieved in this area and distributed in the jars and kegs noted there in 2004, but food and other supplies are likely to have been brought there regularly from Umm al-Dabadib. The walking distance was about 2.5 km to the southernmost edge of the Western Cultivation, and a total of 4.5 km to the Fortified Settlement. The first leg (corresponding to the distance between water sources) could easily be covered in one hour, regardless of the load.

Another mining area is located at a short distance from the Gridded Settlement at Ayn al-Labakha, precisely 1.2 km to the southwest (see Figs. 6 and 14). Noted for the first time by Beadnell,³³ it consists of a small cluster of crude shelters and an elongated area of underground

³³ Beadnell 1909, 222.

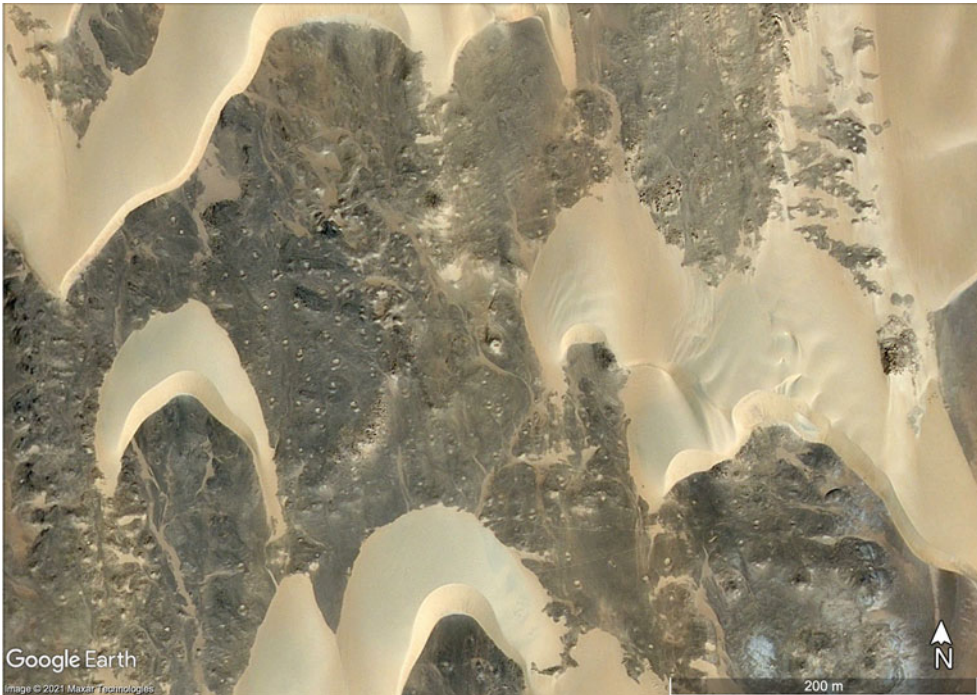


Fig. 16. Satellite view of the western portion of the mining area of Umm al-Dabadib. The terrain is punctuated by shallow pits dug at regular intervals; more are likely to be buried under the shifting dunes. (Google Earth, Image Landsat/Copernicus 2010.)



Fig. 17. Close-up satellite view of one of the four clusters of crude shelters built in the mining area of Umm al-Dabadib. (Google Earth, Image Landsat/Copernicus 2010.)

galleries, corresponding to the upper edge of the escarpment bordering the site.³⁴ This mining area, ca. 750 × 160 (maximum) m, appears to be smaller than the one lying to the west of Umm al-Dabadib, but it consists of underground galleries and is therefore far more concentrated. The low resolution of the satellite images of this area prevents any detailed analysis of the remains from a distance. No mining area is directly associated with the Gib/Sumayra Complex.³⁵

Absolute position

Moving to a regional scale, the position of Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex took advantage of the presence of – and ensured better control over – the caravan routes that crossed the oasis by enlarging the portion of desert under direct administrative control.

The north–south caravan route, nowadays called Darb al-Arba'in, cut across a merciless and waterless desert but allowed travelers to head straight north from Wadi Halfa, in modern Sudan, to Middle Egypt, avoiding the long eastward curve that the Nile Valley makes. In Kharga, it met an equally important east–west route, linking this oasis to the Valley and to the other half of the Oasis Magna – the nearby Dakhla Oasis.³⁶ Even if these major thoroughfares fanned out into a network of paths, the point where the major north–south and east–west paths intersected was located in the northern portion of Kharga, halfway between Tulayb and Ayn al-Labakha.³⁷ From this crossroads, travelers could head east via al-Dayr to Upper Egypt, north to Middle Egypt, west across the chain of oases that punctuate the Western Desert to Lower Egypt and the Libyan coast, south to Nubia, and southwest to the Gilf al-Kabir and its then-green valleys, from where it was possible to reach the massif of Uwainat. Nowadays, this area is completely dry, but the situation was different in the past. In 1923, there were still at least four active springs at Uwainat.³⁸

The routes through Kharga, therefore, could allow travelers to bypass the Nile Valley, a well-known escamotage used several times in antiquity³⁹ as well as in more recent times: the daring Operation Salam, carried out by László Almásy in 1942 on behalf of German military intelligence, took full advantage of the possibility of travel along this alternative network of desert routes.⁴⁰ These long-range travels obviously required specific arrangements, and the caravans that embarked on long journeys needed to complete their preparations at the last water stations before they headed into the barren desert. The northernmost area of the Gib/Sumayra Complex corresponded to the last watering point for the caravans leaving Kharga for Middle Egypt before they embarked on a 160 km-long journey in a totally barren land, and it was the first green place to be encountered by incoming travelers.⁴¹ This journey could take five days for fit travelers maintaining an average of 4 km per hour and walking for eight hours a day.

³⁴ Ikram et al. 2020, 322–23.

³⁵ On the suggestion that an alum deposit existed in the area, see Shortland et al. 2006, 154–55, and Ikram et al. 2020, 322–23.

³⁶ Rossi and Ikram 2013.

³⁷ Rossi and Ikram 2018, 129.

³⁸ Hassanein Bey 2006, 199–200.

³⁹ Rossi and Ikram 2018, 20–23.

⁴⁰ Gross et al. 2013.

⁴¹ Rossi 2018b, 551–53.

Things could be tragically different, however. In 1817, Caillaud witnessed the arrival in Asyut of a caravan of 16,000 individuals, including 6,000 slaves (men, women, and children), who “had been two months travelling in the deserts, in the intense heat of the year; meager, exhausted and the aspect of death on their countenance, the spectacle strongly excited compassion.”⁴² On their departure from Kharga, this caravan had probably loaded their last water at Ayn Ghazal.⁴³ In the Late Roman period, this operation would take place ca. 8 km further north, at the foot of Qasr al-Gib (see Figs. 2 and 14).

In antiquity, Umm al-Dabadib was en route to Dakhla along the track now called Darb Ayn Amur,⁴⁴ which exploited the presence of the tiny water station bearing this name, located halfway up the escarpment along the western border of the Kharga Depression (Fig. 2).⁴⁵ The distance between Umm al-Dabadib and Darb Ayn Amur was about 45 km as the crow flies, across a rather difficult and inhospitable terrain. The journey required at least a two-day march, depending on the load (see Fig. 14). Unlike the short-distance movements among sites and the long-range journeys to Middle Egypt or to the Wadi Halfa region, traveling to the other half of the Oasis Magna could therefore be classified as an intermediate, medium-range journey that required minimal assistance and support.

In conclusion, in northern Kharga, a scatter of Late Roman settlements of various sizes created a web-like network that was based on – and at the same time supported – short-, medium-, and long-range journeys. This system therefore played an important strategic role at the local and regional level, but it was also part of a larger, transregional system of military control of key communication routes.

Context

The Oasis Magna: a pluricentered district

Over the years, the desert surface of the Kharga Oasis has been thoroughly explored by archaeologists, travelers, and locals, but only a few sites have been subject to significant and systematic archaeological excavation. Fresh textual sources that may offer new insights into the administration and management of this portion of the Oasis Magna can probably be retrieved only by accessing archaeological layers currently buried under the sand. Until this happens, we can only attempt to place the visible archaeological remains within the broader picture provided by the information collected so far in this area.

From 48 CE to the third quarter of the 4th c. CE, the Oasis Magna combined the oases of Kharga and Dakhla into a single, strictly interconnected administrative unit. It included three poleis – Hibis in Kharga, and Mothis and Trimithis in Dakhla – each with its own civic institutions. Hibis and Mothis were the chief cities of the Hibite and the Mothite nomes respectively (see Fig. 2).⁴⁶

The picture that emerges from the documentary sources is that in the Late Roman Period, a scatter of rural settlements punctuated the entire extent of the oases. Among

⁴² Beadnell 1909, 34.

⁴³ See Beadnell 1909, 28.

⁴⁴ Ikram 2019.

⁴⁵ Rossi and Ikram 2010, 239–41.

⁴⁶ Bagnall and Tallet 2019.

them, there were full-scale villages, such as the *komē* of Kellis (modern Ismant al-Kharab, in Dakhla) and Kysis (modern Dush, in Kharga),⁴⁷ and minor inhabited centers closely associated with fields and vineyard-orchard properties (*chōria*, sing. *chōrion*).⁴⁸ In the vicinity of Kellis, large estates called *epoikia* (sing. *epoikion*, “farmstead”) are also attested – such as Thio,⁴⁹ Pmoun Tametra,⁵⁰ and others unfortunately unnamed⁵¹ – that functioned as centers of agricultural properties.⁵² Even if their origins and evolution were different,⁵³ *epoikia* shared some typical features of self-sufficiency, such as the presence of storehouses, weaving workshops, presses for oil and wine, mills, associated water sources, and a variety of plantings of trees and farmland.⁵⁴ The rural settlement of Pmoun Berri (modern Ayn al-Gadida), 5 km northwest of Kellis, has been tentatively identified as an *epoikion* (see Fig. 2).⁵⁵

In general, the rural landscape of the Oasis Magna comprised large estates operated by a staff of managers⁵⁶ and tenant farmers (*geōrgoi*) who cultivated the land and paid their rent to the estate storerooms in kind. This included field crops, cotton, and high-value fruit tree crops, such as olives and grapes, also in the processed form of olive oil and wine.⁵⁷ Wealthy oasisite landowners were involved in the city councils as well as in the administration of the district.⁵⁸ The economic interests of landlords, aided by local managers, are likely to have encompassed both the Kharga and Dakhla Oases.⁵⁹ An example is Faustianus, landlord of the estate for which the Kellis Agricultural Account Books were kept in the 360s CE.⁶⁰ He resided in Hibis, owned landholdings in the areas of Kellis in Dakhla as well as Hibis,⁶¹ and likely had commercial interests at Trimithis.⁶²

Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex must have played a role within this framework. Unfortunately, so far no textual evidence has come to light that

⁴⁷ In the documentary sources, the *komē* Madiophris (*P. Kellis* I 2, 301 CE) and that of Chosis (*SB* III 7205, 290/292 CE) are also mentioned; they were probably in Kharga Oasis.

⁴⁸ On the meaning of the word *chōrion* in papyri, see Bagnall 1999, 332.

⁴⁹ *P. Kellis* I 45.

⁵⁰ *P. Kellis* I 40.

⁵¹ *P. Kellis* I 8; *P. Sijp*. 11a.

⁵² Rathbone 1991, 31.

⁵³ 4th-c. CE *epoikia* were established either by taking over preexisting villages (e.g., the village of Pagkuleōs, attested as an *epoikion* after 360 CE, *P. Merton* 36) or plots of land no longer (or not yet) fully exploited (e.g., *P. Flor.* II 150, 268 CE).

⁵⁴ Lewuillon-Blume 1979, 184.

⁵⁵ Aravecchia 2018, 296–303.

⁵⁶ The estate managers are called *pronoētai* (sing. *pronoētēs*) in the Kellis Agricultural Account Book, a term attested also in *O. Waqfa* 37 from Kharga, as well as *phrontistēs* (*O. Trim.* I 4), indicating, literally, “a person who takes care” (Rathbone 1991, 71–82). See also Bagnall 1997, 27; Bagnall and Ruffini 2012, 40.

⁵⁷ Ast 2019, 110; Bagnall 1997, 25–61, 73–76.

⁵⁸ See, for instance, Ast and Bagnall 2015, 110, and Bagnall 2017, 215–17 on Serenos and Philippos, landlords of Trimithis.

⁵⁹ *P. Grenf.* II 75; *P. Kellis* I 2, 13, 22, and 35; Bagnall 1997, 13–14.

⁶⁰ *P. Kellis* IV 96; Bagnall 1997, 9–10, 59.

⁶¹ *MMA* X 608.7; Bagnall and Tallet 2015, 189.

⁶² *O. Trim.* II 476.

might explain their status within the Oasis Magna. Concerning the Kharga Oasis, it is known that at the beginning of the 4th c. CE, three *kōmai* were associated with the polis of Hibis: Kysis⁶³ (modern Dush; see Fig. 2), located in the south, and Madiophris and Chosis,⁶⁴ possibly located in the north. There are currently no clues to associate them with specific archaeological remains; moreover, there might have been several other *kōmai* that are currently unknown to us.

The constellation of sites that constitute the Gib/Sumayra Complex certainly includes one substantial settlement – the Watermelon Settlement (endowed with a stone temple) – plus at least four (smaller?) agricultural installations: Sumayra (around the fortlet), Two Houses, Ayn Ghazal (the extent of which in antiquity is difficult to establish), and Umm al-Qusur (see Fig. 12). It is tempting to see these sites as the remains of either a *kōmē* and its associated *epoikia* or as a scatter of *epoikia* and *geōrgia*. However, the presence of the forts of Qasr al-Gib and Qasr al-Sumayra and of the last water sources before the caravan route left the oasis clearly indicates that the function of this complex was not merely agricultural. This is even more evident in the case of Umm al-Dabadib and Ayn al-Labakha, isolated settlements devoid of satellite installations. The presence of alum mines nearby and the defensive character of their buildings suggest that these two settlements might have played more than one role and might therefore have been part of a complex network that ranged well beyond the local area. How this reflected on their administrative status, however, can only be revealed by future excavations and the retrieval of textual sources.

Agricultural exploitation

At the heart of agricultural exploitation lay systems to retrieve water, consisting of wells and subterranean aqueducts. Rainfall in Kharga is extremely rare. Years might pass between significant downpours, but when these do take place, they form temporary lakes that last a few months. The water slowly disappears and is replaced by patches of spontaneous vegetation that last several years.⁶⁵ No archaeological evidence has so far been retrieved regarding systems that could gather or store rainfall in this area in antiquity, but the rare and unpredictable occurrence of these downpours would probably make them unreliable for agricultural purposes.

Digging wells was the easiest and most widespread way to retrieve water. The importance of wells is clearly shown from a document dated to 246/249 CE addressed to the Rationalis Aegypti that concerns the *hydreumata* (sing. *hydreuma*) near the polis of Hibis.⁶⁶ It was compiled by the amphodarch of Hibis, who made a systematic survey of the area and listed the water sources near the polis, also recording hydrographic details. The name of each *hydreuma* (literally, “something that collects water” – probably corresponding to a pool of artesian water)⁶⁷ is accompanied by a genitive eponym; and for each of them, the amphodarch numbered the artesian borings that fed the reservoirs (Gr. *pēgai*, sing. *pēgē*). He also noted whether the pool was stagnant, whether the *pēgē* did

⁶³ *P. Grenf.* II 72 (308 CE) and *P. Grenf.* II 74 (302 CE).

⁶⁴ For Madiophris, see *P. Kellis* I 2 (301 CE); for Chosis, see *SB* III 7205 (290/292 CE).

⁶⁵ Rossi and Ikram 2018, 7.

⁶⁶ *SB* XIV 11938.

⁶⁷ Bonneau 1993, 61.

not generate a pool on the surface, or whether two or more *hydreumata* were connected (Gr. *sunepirrein*). The eponym is sometimes preceded by the word *pmoun*, the transliteration for the Egyptian expression “the water of.” Less frequently, the word *hydreuma* was followed by *phrear* (“well,” somewhat different from the artesian one), or by the Egyptian term *tchon*, the meaning of which remains uncertain, although it is certainly related to water.⁶⁸ The references to a previous survey suggest that the conditions of water sources were periodically monitored.⁶⁹ Only a quarter of the 86 *hydreumata* listed in this document were associated with a plot of land (Gr. *edaphē*), whereas the others were *en apeirō* (“in the open”) – that is, they did not lie within cultivated plots. It can be inferred that the productivity of the area had the potential to be increased, possibly under the supervision (or at least with the consent) of the Rationalis Aegypti. It is therefore possible that this survey was performed to assess the situation and organize a better exploitation of the local water sources.⁷⁰

According to Olympiodorus of Thebes, in the oases, wells were dug by *geōrgoi*, who were allowed to use them to irrigate their own fields.⁷¹ The use of the wells was time based, and the local tenants had to pay a rent (*phoros*) for the use of water, which was calculated in days and hours.⁷² The cost of digging a well and providing the necessary system for control and distribution is still unknown, but an account of the rent paid for the use of water at Trimithis allows the annual revenue for a fully exploited well to be calculated at around two-thirds of a pound of gold per year.⁷³ Even if there must have been expenses relating to maintenance,⁷⁴ the capital value was so high that wells might represent profitable investments for the private (and wealthy) owners. Wells not only made agricultural activities possible but also represented a defining element of the regional topography:⁷⁵ the documentary sources for Kellis, Trimithis, Hibis, and Kysis include several *kōmai*⁷⁶ and *epoikia*⁷⁷ that were probably named after the eponymous wells around which they developed.

The second system used to retrieve water in both Kharga and Dakhla was the draining tunnel or *qanāt* (plur. *qanawāt*), which collected water circulating in the fissures of the rocks at the junction of different geological layers and brought it by gravity to the areas to be cultivated. This system was already being implemented in Kharga during the Persian occupation of Egypt in the 5th c. BCE. The area of Kysis, in the south of the oasis, shows evidence of repeated reuse of and modifications to the original Persian system of *qanawāt* down to the Late Roman period.⁷⁸ The northern *qanawāt* – that is, those of

⁶⁸ Parsons 1971, 173–75; Reddé 2004, 192; Ast 2019, 106.

⁶⁹ SB XIV 11938.

⁷⁰ Parsons 1971, 180; Ast 2019, 108.

⁷¹ Olymp. in FHG 4.33.

⁷² E.g., the *phoros* of *Pmoun Taē* in O. Douch III 319; of *Pmoun Hēsios* in O. Douch IV 359; of *Pēgē Sykamineia*, O. Waqfa 22; see also O. Waqfa 61.

⁷³ O. Trim. I 19 (352/360 CE); Bagnall and Ruffini 2012, 40–41.

⁷⁴ For instance, the cost of the work of *hydrokathartēs* (literally, “well cleaner”) related to the maintenance of wells and probably of the water-distribution system too (O. Kellis 133; O. Trim. I 53; P. Kellis IV 96, ll 17, 345, 1134, 1402, 1748).

⁷⁵ Wagner 1987, 279–83; Bagnall and Ruffini 2012, 33–34.

⁷⁶ P. Kellis I 49; P. Nokr. 9 and 15.

⁷⁷ P. Kellis I 41.

⁷⁸ Bousquet 1996; Wuttmann et al. 2000.

Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex – are likely to date instead to the Late Roman period.⁷⁹

Unlike the Nile Valley, where the agricultural rhythm was dictated by the annual inundation, in the oases, the combination of wells and *qanawāt* allowed continuous irrigation of the land and therefore agricultural exploitation spread over the entire year. The fields, fertilized by guano collected from the pigeon towers that accompanied the cultivated areas,⁸⁰ produced wheat, barley, flax, and pulses in winter, and sorghum and pearl millet in the summer. Cotton became one of the most important products in the Roman period and is likely to have played a significant role in the local economy.⁸¹

Keeping centers of production and settlements connected with one another required considerable local movement and transport,⁸² accomplished by the hard work of armies of donkeys and their drivers.⁸³ Agricultural commodities were sent from farms to central storehouses where they were recorded and redistributed within the estate (to supply the local needs of humans and animals) and beyond to the Nile Valley (e.g., to Hermopolis).⁸⁴ Cotton and high-value tree crops (olives, dates, figs, and jujubes) that were not consumed locally constituted an effective surplus that could be exported out of the oasis.⁸⁵ Finally, a significant part of local produce, perhaps alongside cash payments, must have been requisitioned through the *annona militaris* for the needs of the army stationed in the oasis (see below).

In this context, Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex probably belonged to a large-scale program of coordinated exploitation of the agricultural potential of the oasis. The visible remains of their fields range between 10 and 50 ha; however, these total figures do not indicate single, large patches of cultivated land. Rather, they correspond to the sum of smaller, separate patches of cultivated fields fed by different water sources. At Umm al-Dabadib, there were three cultivated areas, corresponding respectively to 30, 15, and 5 ha (for a total of 50; Fig. 5); at Ayn al-Labakha, there were two areas of 10 and 22 ha (for a total of 32; Fig. 6); the Watermelon Settlement had two areas, of 10 and 15 ha, respectively (for a total of 35); Sumayra and Two Houses each had one area, of 20 and 22 ha, respectively (Fig. 7). Pairing this with the archaeological evidence retrieved from Ayn al-Tarakwa and Ayn al-Dabashiya, and around Hibis,⁸⁶ it may be concluded that the Late Roman agricultural system consisted of a scatter of relatively large cultivated patches, each fed by its own water source, an arrangement mirroring the overall impression conveyed by the list of *hydreumata* drawn by the amphodarch of Hibis. The success of this spread-out system resided in the possibility of counting on different, independent sources of revenues, but it depended heavily on keeping them connected and controlled.

⁷⁹ Rossi 2018b, 520–21.

⁸⁰ Ikram and Warner 2012.

⁸¹ Rossi 2018b, 539–40.

⁸² Bagnall 2015a, 47.

⁸³ *P. Kellis* IV 96, l 67; *O. Trim.* I 17 and 22; *O. Trim.* II 465.

⁸⁴ *P. Kellis* I 51 and 52.

⁸⁵ Bagnall 2015b, 169.

⁸⁶ Rossi and Ahmed 2019. The largest remains of ancient cultivations in northern Kharga are located around Ayn al-Tarakwa and Ayn al-Dabashiya. It is likely that not all wells were active at the same time and that, in ancient times, the area hosted some sort of “wandering cultivation” that progressively exploited a succession of water sources (Rossi 2018b, 509).

Considering the distance to be covered across the desert that separated the Oasis Magna from the Nile Valley, the amount of perishable agricultural produce that departed from the oasis must have been relatively limited. The substantial investment that the Roman authorities poured into the agricultural exploitation of the Kharga Oasis, therefore, is likely to have been meant to give a boost to the local communities. This suggestion appears to be even more likely if paired with the arrival of new settlers, perhaps relocated from the Nile Valley. The increase in agricultural production might therefore have been instrumental in the implementation of large-scale exploitation of the region, based not only on agricultural products but also on other commercial and strategic assets.

The exploitation of mineral wealth

It is generally assumed that the ancient mining areas that can be seen in the Kharga Oasis were devoted to the retrieval of alum. No physicochemical analyses have been carried out so far on samples retrieved there, making precise identification of the mined material impossible at present.

In ancient times, alum (Gr. *stypṭēria*; Lat. *alumen*) referred to a large group of minerals with astringent characteristics (LSJ, s.v. *stypṭēria*), including potassium aluminum and impure mixtures of sulphates of iron and aluminum, which occurred naturally.⁸⁷ As a result of different provenance, color, and specific features, alum and alunites were distinguished into different genera and species.⁸⁸ Among them were *alumen liquidum*,⁸⁹ which refers to a deliquescent variety of alum (Gr. *stypṭēria hygra*, “wet, moist, fluid”);⁹⁰ *alumen strongylen*, which is round and compact, and may be associated with the mineralogical class of the botryoidal alum (Gr. *stroggylē stypṭēria*),⁹¹ and *alumen concretum*, which is characterized by a scissile or fibrous form (Gr. *schiston*, “being split, divided”).⁹² A superficial analysis of the desert surface in the mining area west of Umm al-Dabadib suggests that the last type might have been quarried there.

Literary and documentary sources attest that alum was used for various purposes, often in combination with herbal, animal, or mineral substances:⁹³ in the preparation of *pharmaka*, in metallurgical processes, in glass production, in leather tanning, and in the treatment of fabrics.⁹⁴ In the Roman period, Egyptian alum, known for its high quality,⁹⁵ was one of the commodities subject to state monopoly, and it represented a highly

⁸⁷ Ikram et al. 2020, 317–18; Bogensperger 2017, 255.

⁸⁸ Dsc. 5.123; Plin. *HN* 35.183–90; cf. medical treatises: Gal. *De simpl. medicam.* 12.237; Paul. *Egin.* 7.3. They also included *stypṭēria baphikē* – literally, “alum for dyeing” (*P. Holm.* 89; Halleux 1981, 133; *P. Oxy.* III 467); *stypṭēria oixitis*, which tasted “like vinegar” (*P. Holm.* 107; Halleux 1981, 137–38), and some alunites identified with the name of the place where they were mined (Plin. *HN* 35.184).

⁸⁹ Plin. *HN* 35.185.

⁹⁰ *P. Holm.* 125; Halleux 1981, 144; Bogensperger 2017, 257.

⁹¹ *P. Mich.* XVII 758; Bogensperger 2017, 257.

⁹² *P. Ross. Georg.* V 52; *P. Ryl.* III 531; *SB VIII* 9860a, col. 2.

⁹³ Gazza 1956, 104; Préaux 1956, 139.

⁹⁴ Bogensperger 2017, 259; Adams 2013, 268; Hope et al. 2009, 165–66.

⁹⁵ Plin. *HN* 35.183; cf. Dsc. 5.122; *P. Oxy.* II 234 (2nd–3rd c. CE).

profitable business for all actors involved.⁹⁶ The procurator ad Mercurium (Gr. *Epitropos Hermou*)⁹⁷ in Alexandria was in charge of the general supervision of the alum monopoly, and an array of local functionaries were involved in the control of its production and transport, and – from the mid-3rd c. CE – also its sale and distribution.⁹⁸ Work contractors (Gr. *mistōthai*)⁹⁹ controlled the lease of the mining areas by the state, whereas private contractors (Gr. *telōnai*, literally “tax buyer”)¹⁰⁰ and liturgical officials (Gr. *epitērētai*) supervised the transports of alum to the Nile Valley.¹⁰¹ The beasts of burden – donkeys and camels – were probably provided by private owners who were involved in the alum transport (similarly to the *ktēnotrophoi* and *nauklēroi*, respectively involved in the transport of the Egyptian state grain by land and by sea).¹⁰²

The main Egyptian alum-mining areas lie in the two districts of the Oasis Parva and Oasis Magna, from where the alum was transported to the Nile Valley across the desert. A network of functionaries dedicated to the alum monopoly probably existed only in the nomes directly associated with the mining of alum and related transport activities.¹⁰³ Concerning the Oasis Parva, *mistōthai*, *telōnai*, and *epitērētai* associated with local alum mining are documented in the Oxyrhynchite¹⁰⁴ and Arsinoite nomes.¹⁰⁵ Concerning the Oasis Magna, the textual sources are limited to a 4th-c. CE tax receipt for alum found at Kellis.¹⁰⁶ The archaeological evidence is more abundant, and it includes the two mining areas of Umm al-Dabadib (at least 650 ha) and Ayn al-Labakha (mainly underground) in Kharga, described above, as well Gabal Tarif (over 3,000 ha), and a smaller site near al-Qasr in Dakhla.¹⁰⁷ A network of functionaries, similar to the one attested for the Oasis Parva, might have managed the alum of the Oasis Magna in the two Nile Valley nomes of Lykopolite and Panopolite.¹⁰⁸

The labor force in the Roman mining districts in Spain, Dacia, and Egypt’s Eastern Desert included not only slaves but also a substantial portion of free workers engaged both in extraction and in operative organization,¹⁰⁹ a similar workforce might also have been employed in the mining areas of the Oasis Parva and Oasis Magna. As recorded in the five-day accounts from Oxyrhynchus compiled by the *epitērētēs* Aurelius

⁹⁶ Kruse 2007, 531.

⁹⁷ *P. Oxy.* XXXI 2567 (253 CE).

⁹⁸ *P. Oxy.* XXXI 2567.

⁹⁹ *P. Oxy.* XII 1429 (300 CE); *P. Oxy.* XXXI 2567.

¹⁰⁰ Youtie 1936, 652.

¹⁰¹ *P. Col.* VIII 228; *P. Heid. Inv. G.* 5166; Kruse 2007, 529–30; Adams 2013, 270–71.

¹⁰² Adams 2007, 159–93.

¹⁰³ Picon et al. 2005, 43–57; Kruse 2007, 525.

¹⁰⁴ *P. Oxy.* XII 1429; *P. Oxy.* XXXI 2567; *P. Col.* VII 228; *P. Oxy.* XVII 2116; *SB* VIII 9860; *P. Heid. Inv. G.* 5166.

¹⁰⁵ *Chr. Wilck.* 321 (154 CE).

¹⁰⁶ *O. Kellis* 24.

¹⁰⁷ It is possible that the site had been exploited since the New Kingdom well into the Roman era (Hope et al. 2009; Ikram et al. 2020, 325).

¹⁰⁸ Kruse 2007, 543.

¹⁰⁹ Edmondson 1989, 95; Mrozek 1989; Andreau 1990, 89–92; for Egypt’s Eastern Desert, see Cuvigny 1996; Hirt 2010, 206–8.

Domitius,¹¹⁰ alum mining required a year-round labor supply and consequently the accommodation of workers and their supervisors in the vicinity of the mines.

The 4th-c. CE settlements of Umm al-Dabadib and Ayn al-Labakha seem to suit such needs: located near the mining areas and self-sufficient in terms of basic requirements, both settlements could support the workforce dedicated to the mining activities and act as administrative centers to organize and manage the ensuing trade. At Ayn al-Labakha, the mining area was very close to the main settlement, and water could easily be transported daily from the nearby sources. At Umm al-Dabadib, however, it was distant and larger, and it was therefore endowed with temporary shelters and at least one major well.

Concerning the subsequent transfer of the material away from the mining area toward the Nile Valley, the shortest and most logical way to send the alum from Kharga to the core of the Roman Empire was to travel straight east, across Ayn al-Labakha, then head north and leave the oasis from Qasr al-Gib. Alternatively, to serve Upper Egypt and other commercial routes heading east across the Red Sea or south along the Nile, caravans could head straight east and load the last water at al-Dayr before heading to Upper Egypt.¹¹¹ It is therefore likely that at both Umm al-Dabadib and Ayn al-Labakha, a number of *mistōthai* operated in connection with a network of *telōnai* and *epitērētai*, and that the two sites were the seat of officers of the Roman Empire who kept in contact with other sites belonging to the same network, probably in strict connection and coordination with the army.

The presence of the army

The increasing presence of the army in northern Kharga is attested by a large number of archaeological remains but, until now, by only a small number of textual sources. In a first phase, corresponding to the last years of the 3rd c. CE, the main oases of the Western Desert were endowed with a chain of fortresses meant to host alae and other auxiliary forces. These were the nearly-identical enclosures at al-Dayr in Kharga, al-Qasr in Dakhla, and Qarat al-Tub in Bahariya. Unlike the other oases, Kharga was also endowed, immediately afterward, with a scatter of fortlets and fortified-looking settlements. Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex belong to this second phase, together with Tulayb, possibly Qasr al-Nissima, Qasr al-Baramudy, and the reuse of Dush in the south.¹¹²

The most important textual source on the distribution of the Roman army in this period, the *Notitia Dignitatum*, contains only scant information on this area. Compiled toward the end of the 4th c. CE but also including information dating from a slightly earlier period,¹¹³ it lists the garrisons distributed in the western oases. The Ala prima Abasgorum, said to be

¹¹⁰ *P. Oxy.* XVII 2116.

¹¹¹ If alum was quarried also in the western half of the Dakhla Oasis, it is possible that part of it reached Kharga via Ayn Amur and, therefore, via Umm al-Dabadib; a longer but waterless route circumnavigated Gabal Tartur along its southern edge. Alternatively, Middle Egypt could be reached by embarking on a long march straight across the desert along the route now called Darb al-Tawil (literally, the “Long Track”), which probably exploited the water source of Abu Garara, an elusive site located out in the desert to the north of Dakhla (Fig. 2), and which still awaits a thorough archaeological investigation.

¹¹² Rossi 2018a, 450–51.

¹¹³ Southern and Dixon 1996, 1.

stationed at Hibeos – Oaseos maioris, served *sub dispositione viri spectabilis ducis Thebaidos* (under the command of the dux of the Thebaid);¹¹⁴ the same garrison is mentioned again a few lines below among those *quae de minore laterculo emittuntur* (“which are assigned from the lesser register” – that is, from the list of the minor military officers), together with the Ala prima Quadorum, Oasi minore – Trimtheos.¹¹⁵ The Oasis Parva fell instead under the command of the Comes limitis Aegypti and was guarded by the Ala secunda Armeniorum – Oasi minore¹¹⁶ and the Ala secunda Assyrorum – Sosteos¹¹⁷ – that is, Psobthis, modern Qarat al-Tub.¹¹⁸ The Ala prima Abasgorum is probably also mentioned in an earlier source dating to 309 CE.¹¹⁹

A slightly later list of soldiers indicates the presence around Hibis of an unnamed *cohors*.¹²⁰ Seemingly, the polis of Mothis in Dakhla hosted, at some point, the *cohors scutata civium romanorum Mutheos*, mentioned in the *Notitia Dignitatum*.¹²¹ Detachments from garrisons stationed along the Valley appear to have also spent some time in the Oasis Magna.¹²² Estimating the total number of soldiers who were present in the area throughout the 4th c. CE would be extremely difficult for a number of reasons, ranging from the lack of sources to the lack of precise information on the size of the garrisons, a problem that is typically encountered in the study of the Late Roman army.¹²³ At any rate, the need to collect the *annona militaris* for all these troops is attested both at Dakhla¹²⁴ and at Kharga.¹²⁵

The most obvious explanation for the presence of armed soldiers in the area would be an external threat – perhaps the recurrent attacks carried out by the nomadic populations that lived along the edges of the Empire. After the isolated disorders in the district of the Oasis Magna at the end of the 3rd c. CE, caused by the Nobates and successfully suppressed by Diocletian,¹²⁶ turmoil is again documented from the 5th c. CE, this time due to a group of Libyan origin called the Mazices. The disorders affected the entire Western Desert¹²⁷ and, in particular, the Oasis Magna. They started in the time of the exile of the deposed Archbishop of Constantinople, Nestorius, after 435 CE,¹²⁸ and continued at least until the first half of the 6th c. CE, as may be inferred from the episode recorded by Moschus during his visit to the oasis.¹²⁹ In fact, the presence of the Mazices near the

¹¹⁴ *Not. Dig. Or.* 31.

¹¹⁵ In that subsection, the comparative adjective *minor* associated with the oasis of Dakhla, where Trimithis lies, is likely a mistake.

¹¹⁶ *Not. Dig. Or.* 28; here, *minor* refers correctly to the district of the Oasis Parva, and it is likely opposed to the overall district of the *Oasis Maior*.

¹¹⁷ *Not. Dig. Or.* 28.

¹¹⁸ Rea 1984; Zuckerman 1994, 199.

¹¹⁹ *SB XVIII* 13852.

¹²⁰ *SB XX* 14884; see Rossi and Ikram 2018, 451.

¹²¹ *Not. Dig. Or.* 31.59.

¹²² Ast and Bagnall 2015, 2; Reddé 2004, 199–205.

¹²³ Southern and Dixon 1996, 16–20.

¹²⁴ Ast and Bagnall 2015.

¹²⁵ Wagner 1987, 82, 378.

¹²⁶ Procop. *Pers.* 1.9.

¹²⁷ Philostorg. *Hist. eccl.* 11.8.

¹²⁸ Evag. *Hist. eccl.* 1.7.

¹²⁹ Jo. Mosch. *Prat.* 112.

Egyptian oases is documented from the last decades of the 4th c. CE onward, but initially they did not seem to be considered a threat.¹³⁰

This changed in the first decade of the 5th c. CE, when the Mazices started to be perceived as barbaric marauders who sacked and raided villages throughout the entire Western Desert;¹³¹ their violence and cruelty was also acknowledged by other nomadic groups.¹³² It is possible that this sudden shift of perception was due to the fact that a group of Mazices established themselves in the proximity of an Egyptian oasis,¹³³ possibly Bahariya (given that the distance between Oxyrhynchus and the oasis *ubi genus est Mazicorum* (“where the people of Mazices are located”) was said to correspond to a four-day journey).¹³⁴ From this convenient position, the Mazices could easily move across the Western Desert and disrupt communications and trade that ran along the network of desert tracks. This disturbance, particularly if prolonged, might have caused a slow but constant decline of many oasis settlements, especially those that heavily depended on overland transport, such as for the alum trade.

Umm al-Dabadib, Ayn al-Labakha, and most of the Gib/Sumayra Complex do not seem to offer evidence indicating a full-scale occupation during the 5th c. CE. It must be stressed, though, that the study of the ceramic material of the oases (of Kharga in particular) still needs to be refined, because not many sites have been thoroughly excavated. For the moment, according to our current knowledge, it may be suggested that all the peripheral sites of Kharga were abandoned around the turn of the century. A dramatic lowering of the water table in the entire periphery of the oasis’s depression is attested in the same period. Whether this was caused by the extensive agricultural exploitation that had been taking place in the previous decades or whether it depended on other factors remains unclear. It is difficult to establish whether the disturbance by the Mazices and the lack of water resulted in a “perfect storm” that sealed the fate of these settlements or whether the Mazices dared to settle nearer to the oases because they felt emboldened by the abandonment of the fortified settlements, which was itself caused by the lack of water.¹³⁵

Despite the decline and abandonment of many settlements and the presence of the Mazices, the Egyptian oases remained part of the provincial territory of Late Roman and Byzantine Egypt. In fact, until the first third of the 6th c. CE, the Oasis Magna continued to be officially mentioned as a place of banishment.¹³⁶ Moreover, the 6th-c. CE *Synekdemos* (based on 5th-c. CE official documents) mentioned both oasis districts: the Oasis Magna is listed in the eparchy of Thebais, and the Oasis (scil. Parva), in the eparchy of Aegyptus.¹³⁷

Currently, we know very little about the role that the Roman army must have played in the Western Desert in the crucial period covering the last part of the 4th c. CE, the beginning

¹³⁰ See Palladius’s description of the monasteries of Nitria visited between 390 and 399 CE in Pallad. *Hist. Laus.* 7.2; and the description of the place of banishment assigned to Demetrius after 404 CE in Pallad. *Vita Chrys.* 20.

¹³¹ Philostorg. *Hist. eccl.* 11.8; Evag. *Hist. eccl.* 1.7; Jo. Mosch. *Prat.* 112.

¹³² Cass. *Coll.* 2.6; PL 73.1010; Evag. *Hist. eccl.* 1.7.

¹³³ Pallad. *Vita Chrys.* 20 and PL 73.1010.

¹³⁴ PL 73.1010.

¹³⁵ Rossi and Ikram 2018, 449–51, 521, 556–57.

¹³⁶ *Cod. Iust.* IX 47.26.5 (529 CE).

¹³⁷ Hier. *Synekdemos*. (ed. Honigmann 1939, 46–48).

of the 5th c. CE, and the transition into the Byzantine period. Future excavations in northern Kharga are likely to yield written sources that might shed further light on this subject. At the moment, the visible (and rather flamboyant) archaeological remains clearly testify to a substantial investment with a strong military character in the region. However, the written sources indicate that the area was manned by a scatter of newly raised, secondary, and obscure garrisons, which were, moreover, *ex laterculo emittuntur*. This apparent discrepancy remains to be accounted for and will be further discussed below.

Interpretation and conclusions

The information analyzed in the previous paragraphs may be combined in an attempt to sketch the role that Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex were expected to play in the 4th c. CE – in other words, to identify their function, or the reasons why they were built. These may be summarized under three labels: colonization, exploitation, and control.

The layout and position of the three settlements suggest that they were meant to mark the territory in a stable way: they were endowed with the means to be self-sufficient in all their basic needs and to support the local inhabitants in a continuous and comfortable way. They were built to last or, to be more specific, to trigger an independent and interconnected economic system able to sustain the life of their communities. The substantial population increase suggested by the archaeological evidence of Umm al-Dabadib might also have taken place at Ayn al-Labakha, and possibly also in the Gib/Sumayra Complex.

It is clear that the final aim of this operation was to distribute the population across the territory more evenly. In other words, it corresponded to an act of colonization. Whether or not it also corresponded to an act of colonialism cannot be established in a firm and final way without positive evidence for the identity of the newcomers. Evidence retrieved in an indirect way, however, suggests that no major cultural change took place: burial practices, for instance, remained the same,¹³⁸ and the use of the ancient Egyptian cubit in the construction of the forts suggests that not only the workforce but also the officers in charge of planning those buildings were Egyptians.¹³⁹ The overall impression is of a major operation to redistribute the population on the territory, possibly relocating people from the Nile Valley.¹⁴⁰

An increase in agricultural production was a *conditio sine qua non* to support the new settlements, and it was somehow implicit in this course of action. Different, on the other hand, is the role of the mining areas, a potential resource whose exploitation required an additional and significant effort. The vast mining area of Gabal Tarif lay close to the town of Hibis and could therefore be accessed from there (see Fig. 8); in fact, the vastness of the mining area could also be explained by this proximity, which allowed a prolonged exploitation of this deposit over the centuries.¹⁴¹ This is different from the situation of the

¹³⁸ Ikram 2018.

¹³⁹ Rossi 2019.

¹⁴⁰ Cf. Mattingly 2011, 30–37.

¹⁴¹ Ikram et al. 2020, 323–34. The Late Roman Period left significant traces in the area, but given that the quarrying methods have changed very little over the time, it would be difficult to securely

large mining area west of Umm al-Dabadib, located in a harsh environment and in an isolated position were it not for Umm al-Dabadib itself: the contemporaneity of settlement and mining area suggests that the exploitation of the latter might have been one of the reasons for the expansion of the former.

The pattern at Ayn al-Labakha is the same as at Umm al-Dabadib: a Late Roman settlement of fortified appearance, including a central fort, and built near a large mining area exploited in the same period. Considering that alum was subject to state monopoly, the coordinated construction of Umm al-Dabadib and Ayn al-Labakha near two important mining areas reinforces the hypothesis that these two sites belonged to a larger strategic program, set up by the Roman authorities, that appears to have encompassed the entire northern portion of the Kharga Oasis.¹⁴²

Unlike most of the agricultural produce, alum was expected to be mainly traded away from the area. Once more, this reinforces the need for an organized network of communications. In a desert environment like the Kharga Oasis, this translated into the construction of a series of stations and checkpoints rather than actual paved roads. The stretch of desert between the northern and eastern escarpment of the Kharga Depression and the Nile Valley was hopelessly waterless, so not much could be done there. What was instead done in the oasis was to extend the human occupation of the area as much as possible, thanks to a network of sites provided with independent water sources and local, basic agricultural produce. All the local movement among settlements and areas under exploitation took place along this network of local routes. At its northern edge, the Gib/Sumayra Complex took on the burden of preparing the large caravans for the ascent of the plateau and the difficult journey toward Middle Egypt, and of welcoming those who managed to arrive from there. Most of the alum quarried at Gabal Tarif, Umm al-Dabadib, and Ayn al-Labakha must have departed northward from there, under the close supervision of the Roman authorities.

Connectivity appears to have been the essence of the entire operation, which was meant to control the movements of people and goods. The amount of short- and medium-range movement of people and beasts of burden that took place on a daily basis in the Late Roman period along the desert track connecting these sites must have been significant; the cemetery for donkeys found at Umm al-Dabadib represents a reminder of the hard work performed by these animals during that historical period.¹⁴³ In terms of large-scale movements, all three sites represented important rest stations along medium to long desert routes, thereby providing at the same time support for and control over travelers.

The military component of the strategy of control of the Oasis Magna appears to have changed from being predominant at the end of the 3rd c., when each oasis of the Western Desert was endowed with a similar Late Period legionary fortress,¹⁴⁴ to being part of a more complex scenario that took shape in the first quarter of the 4th c. CE, with the construction of the fortified settlements in Kharga. Trade was an important component of this picture, but it alone would not explain the complexity of the operation that was staged

attribute all the mining activities to a specific historical period. Future investigations on the ceramic material scattered in the area might shed further light on this issue.

¹⁴² Rossi and Ikram 2018, 551–59

¹⁴³ Rossi and Ikram 2018, 258–59.

¹⁴⁴ Rossi 2018a.

there: alum was quarried also in Dakhla, which was equally exposed to the threat of nomadic incursions, and yet, no settlements of fortified appearance were built in that part of the Oasis Magna.

The main difference between the eastern and the western part of the Oasis Magna – respectively, Kharga and Dakhla – is the fact that Kharga acted as a major desert crossroads (see Figs. 1 and 2). Controlling this crossroads meant controlling access to various parts of the Nile Valley and movements along the border of the country. This might be one of the reasons why, perhaps as early as the Ptolemaic period, the capital of the Oasis Magna was transferred from the larger and wealthier Mothis in Dakhla to the smaller but evidently strategically more important Hibis in Kharga.¹⁴⁵ Thus, when Diocletian reestablished the southern border of the empire, Kharga was directly involved in the reorganization of the frontier thanks to the possibility of controlling the major desert thoroughfares, along which lucrative trade could be carried out for the empire's benefit.

Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex are likely to have been an integral part of this design: they had a fortified appearance and probably hosted small contingents of soldiers, located either near mining areas or at the exit/entry point of the oasis. Not only were these settlements self-sufficient in terms of water and agricultural production but they might even have contributed to the export of some specific crops. They therefore played a coordinated role within the northern portion of the Kharga Oasis and are also likely to have been part of a larger strategy of control encompassing not only the eastern part of the Oasis Magna but the entire Western Desert.

Further studies will be necessary to reconstruct the large-scale mosaic of the Late Roman strategy of control of the empire's desert frontier. The Kharga Oasis may represent a crucial tile, because it contains archaeological remains that can still be interrogated to retrieve specific answers. In particular, if the interpretation that Umm al-Dabadib, Ayn al-Labakha, and the Gib/Sumayra Complex belonged to a network encompassing the entire Western Desert is correct, at least some characteristics of these sites should be present in other oases.

The degree of analogy among sites might not be confined to their function but may also include the adoption of the same architectural solutions. The similarity in dimensions and design of the three late-3rd-c.-CE legionary fortresses of Kharga, Dakhla, and Bahariya is straightforward given that the three buildings played the same role. More intriguing is the striking architectural similarity between the Fort of Umm al-Dabadib and granary C65 at Karanis. The latter was dismantled during the archaeological excavations carried out by the University of Michigan, but its drawings, pictures, and samples are being reexamined together with other material from the same site.¹⁴⁶ The date originally attributed to this building is one century earlier than the Fort of Umm al-Dabadib, but the impressive similarity between the two buildings cannot be ignored and definitely needs further investigation.

Because the level of preservation of the Late Roman remains in the rest of the Western Desert is uneven, many sites have never been properly investigated and some no longer exist. The well-preserved remains of Umm al-Dabadib, Ayn al-Labakha, and the

¹⁴⁵ Cf. Bagnall and Tallet 2019.

¹⁴⁶ Burton 2020 and pers. comm.

Gib/Sumayra Complex may serve as sets of reference points to be used to recognize further elements of this complex picture.

Acknowledgments: Thanks to Paola Davoli for always being available to share her knowledge on the oases and the Western Desert, to Roger Bagnall for his precious insights and suggestions, and to Stefano Mazzoleni for his comments and support. Thanks to Shannon Burton for sharing her knowledge and insights on Granary C65 of Karanis. Finally, thanks to our home institutions – the Politecnico di Milano (Department ABC) and the Università degli Studi di Napoli (MUSA Center) – partners in the ERC project that constitutes the framework of our work.

This article is the result of the research carried out by the LIFE project (Living In a Fringe Environment), funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement No. 681673).

Author contributions: C. Rossi is responsible for the study of the layout and extent of the Late Roman sites; N. De Troia is responsible for the analysis of the textual and historical sources; A. Miglioizzi contributed to the study of the alum mines and, together with A. Pasqui, to that of the cultivated areas.

References

- Adams, C. 2007. *Land and Transport in Roman Egypt. A Study of Economics and Administration in a Roman Province*. Oxford: Oxford University Press.
- Adams, C. 2013. "Natural resources in Roman Egypt: Extraction, transport, and administration." *BASP* 50: 265–81.
- Andreau, J. 1990. "Recherches récentes sur les mines romaines. II." *RN* 32: 85–108.
- Aravecchia, N. 2018. *Ain el-Gedida. 2006–2008 Excavations of a Late Antique Site in Egypt's Western Desert*. With contributions by R. S. Bagnall, D. V. Campana, P. J. Crabtree, D. Dixneuf, D. Dzierzbicka, and D. M. Ratzan. New York: Institute for the Study of the Ancient World, New York University Press.
- Arnold, D. 1999. *Temples of the Last Pharaohs*. New York and Oxford: Oxford University Press.
- Ast, R. 2019. "Land and resource administration: Farmers, managers, and soldiers in the Great Oasis." In *The Great Oasis of Egypt: The Kharga and Dakhla Oases in Antiquity*, ed. R. S. Bagnall and G. Tallet, 105–21. Cambridge: Cambridge University Press.
- Ast, R., and R. S. Bagnall. 2015. "New evidence for the Roman garrison of Trimithis." *Tyche* 30: 1–4.
- Bagnall, R. S. 1997. *The Kellis Agricultural Account Book (P.Kell. IV Gr. 96)*. Oxford: Oxbow Books.
- Bagnall, R. S. 1999. "The date of *P.Kell.* I G. 62 and the meaning of *χορίον*." *ChrÉg* 74: 329–33.
- Bagnall, R. S. 2015a. "The economic landscape." In *An Oasis City*, ed. R. S. Bagnall, N. Aravecchia, R. Cribiore, P. Davoli, O. E. Kaper, and S. McFadden, 45–51. New York: New York University Press.
- Bagnall, R. S. 2015b. "The oasis economy." In *An Oasis City*, ed. R. S. Bagnall, N. Aravecchia, R. Cribiore, P. Davoli, O. E. Kaper, and S. McFadden, 166–73. New York: New York University Press.
- Bagnall, R. S. 2017. "The councillor and the clerk: Class and culture on a Roman frontier." *TAPA* 147: 211–33.
- Bagnall, R. S., and B. W. Frier. 2006. *The Demography of Roman Egypt*, rev. ed. Cambridge Studies in Population, Economy and Society in Past Time 23. Cambridge: Cambridge University Press.
- Bagnall, R. S., and G. R. Ruffini, eds. 2012. *Ostraka from Trimithis*. Vol. 1. *Texts from the 2004–2007 Seasons*. Amheida 1. New York: New York University Press.
- Bagnall, R. S., and G. Tallet. 2015. "Ostraka from Hibis in the Metropolitan Museum of Art and the archaeology of the city of Hibis." *ZPE* 196: 175–98.
- Bagnall, R. S., and G. Tallet. 2019. "The Great Oasis: An administrative entity from pharaonic times to Roman times." In *The Great Oasis of Egypt: The Kharga and Dakhla Oases in Antiquity*, ed. R. S. Bagnall and G. Tallet, 83–104. Cambridge: Cambridge University Press.

- Beadnell, H. J. L. 1909. *An Egyptian Oasis: An Account of the Oasis of Kharga in the Libyan Desert, with Special Reference to Its History, Physical Geography and Water-Supply*. London: Murray.
- Bloxam, E. 2010. "Quarrying and mining (stone)." In *UCLA Encyclopedia of Egyptology*, ed. W. Wendrich. Los Angeles. <https://escholarship.org/uc/item/9bb918sd>.
- Bogensperger, I. 2017. "Alum in Ancient Egypt: The written evidence." In *Excavating, Analysing, Reconstructing: Textiles of the 1st Millennium AD from Egypt and Neighbouring Countries: Proceedings of the 9th Conference of the Research Group "Textiles from the Nile Valley," Antwerp, 27–29 November 2015*, ed. A. De Moor, C. Flunk, and P. Linscheid, 255–63. Tiel: Lannoo Publishers.
- Bonneau, D. 1993. *Le régime administratif de l'eau du Nil dans l'Égypte grecque, romaine et byzantine*. Leiden and Cologne: Brill.
- Bousquet, B. 1996. *Tell Douch et sa région: géographie d'une limite de milieu à une frontière d'Empire*. Documents de fouilles 31. Cairo: IFAO.
- Bowman, A. K. 2011. "Ptolemaic and Roman Egypt." In *Settlement, Urbanization and Population*, ed. A. K. Bowman and A. Wilson, 317–58. Oxford Studies on the Roman Economy. Oxford: Clarendon Press.
- Burton, S. 2020. *Feeding the Roman World: A Reevaluation of Granary C65 from Karanis*. BA thesis, Department of Classical Studies, University of Michigan.
- Cuvigny, H. 1996. "The amount of wages paid to the quarry-workers at Mons Claudianus." *JRS* 86: 139–45.
- De Laet, V., G. van Loon, A. Van der Perre, I. Deliever, and H. Willems. 2015. "Integrated remote sensing investigations of ancient quarries and road systems in the Greater Dayr al-Barshā Region, Middle Egypt: A study of logistics." *JAS* 55: 286–300.
- Edmondson, J. C. 1989. "Mining in the later Roman Empire and beyond: Continuity or disruption?" *JRS* 79: 84–102.
- Fiorillo, F., C. Rossi, and S. Galli. 2020. "Interpretation of archaeological data based on direct and remote retrieval of information." In *International Conference Florence HeriTech: The Future of Heritage Science and Technology, 14–16 October 2020*. IOP Conference Series: Material Science and Engineering 949, online edition. DOI:10.1088/1757-899X/949/1/012072.
- Gazza, V. 1956. "Prescrizioni mediche nei papiri dell'Egitto greco-romano. II." *Aegyptus* 36: 73–114.
- Ghica, V. 2012. "Pour une histoire du christianisme dans le désert occidental d'Égypte." *JSav* 2012, no. 2: 189–280.
- Gross, K., M. Rolke, and A. Zboray. 2013. *Operation Salam, László Almásy's Most Daring Mission in the Desert War*. Munich: Belleville.
- Halleux, R. 1981. *Papyrus de Leyde. Papyrus de Stockholm. Fragments de recettes (Les alchimistes grecs I)*. Paris: Les Belles Lettres.
- Hassanein Bey, A. 2006. *The Lost Oases*. Cairo and New York: American University in Cairo Press.
- Hirt, A. M. 2010. *Imperial Mines and Quarries in the Roman World: Organizational Aspects 27 BC-AD 235*. Oxford: Oxford University Press.
- Honigmann, E., ed. 1939. *Le Synekdèmos d'Hiérokès et l'opuscule géographique de Georges de Chypre*. Brussels: Editions de l'Institut de Philologie et d'Histoire Orientales et Slaves.
- Hope, C. A., P. Kucera, and J. R. Smith. 2009. "Alum exploitation at Qasr el-Dakhleh in the Dakhleh Oasis." In *Beyond the Horizon: Studies in Egyptian Art, Archaeology and History in Honour of Barry J. Kemp*, ed. S. Ikram and A. Dodson, 165–79. Cairo: American University Press.
- Ikram, S. 2018. "The ways of death in North Kharga." In *North Kharga Oasis Survey: Explorations in Egypt's Western Desert*, vol. 1, ed. C. Rossi and S. Ikram, 495–503. British Museum Publications on Egypt and Sudan 5. Leuven: Peeters.
- Ikram, S. 2019. "The North Kharga Oasis Darb Ain Amur Survey (NKODAAS): Surveying the tracks between the two oases." In *The Great Oasis of Egypt: The Kharga and Dakhla Oases in Antiquity*, ed. R. S. Bagnall and G. Tallet, 135–51. Cambridge: Cambridge University Press.
- Ikram, S., and C. Rossi. 2007. "North Kharga Oasis Survey 2004: Preliminary report: Ain Tarakwa and Ain el-Dabashiya" *MDIK* 63: 165–82.
- Ikram, S., G. Tallet, and N. Warner. 2020. "A mineral for all seasons: Alum in the Great Oasis." In *Dust, Demons and Pots. Studies in Honour of Colin A. Hope*, ed. A. R. Warfe, J. C. R. Gill, C. R. Hamilton, A. J. Pettman, and D. A. Stewart, 317–33. *Orientalia Lovaniensia Analecta* 289. Leuven: Peeters.

- Ikram, S., and N. Warner. 2012. "A palace for pigeons: Restoring a Roman dovecote in the Kharga Oasis." *Bulletin of the American Research Center in Egypt* 20: 1–6.
- Klotz, D. 2013. "Yale University Nadura Temple Project: 2009 Season." In *The Oasis Papers 6. Proceedings of the Sixth International Conference of the Dakhleh Oasis Project*, ed. R. S. Bagnall, P. Davoli, and C. A. Hope, 297–301. Dakhleh Oasis Project Monograph 15. Oxford: Oxbow.
- Kruse, T. 2007. "P.Heid. Inv. G 5166 und die Organisation des Alaunmonopols im kaiserzeitlichen Ägypten." in *Proceedings of the 24th International Congress of Papyrology Helsinki, 1–7 August 2004*, vol. 2, ed. J. Frosén, T. Purola, and E. Salmenkivi, 523–47. Commentationes Humanarum Litterarum 122. Helsinki: Societas Scientiarum Fennica.
- Lewuillon-Blume, M. 1979. "Problèmes de la terre au IV^e siècle après J.-C." In *Actes du XV^e congrès international de papyrologie. Bruxelles-Louvain, 29 août–3 septembre 1977*, ed. J. Bingen and G. Nachtergaele, 177–85. Papyrologica Bruxellensia 19. Brussels: Fondation égyptologique Reine Élisabeth.
- Mattingly, D. J. 2011. *Imperialism, Power and Identity: Experiencing the Roman Empire*. Princeton and Oxford: Princeton University Press.
- Mrozek, S. 1989. "Le travail des hommes libres dans les mines romaines." In *Minería y metalurgia en las antiguas civilizaciones mediterráneas y europeas. Coloquio internacional asociado. Madrid, 24–28 octubre 1985*, vol. 2, ed. C. Domergue, 163–68. Madrid: Dirección General de Bellas Artes y Archivos.
- Parcak, S., G. Mumford, and C. Childs. 2017. "Using open access satellite data alongside ground based remote sensing: An assessment, with case studies from Egypt's delta." *Geosciences* 7, no. 4: 94.
- Parsons, P. J. 1971. "The wells of Hibis." *JEA* 57: 165–80.
- Picon, M., M. Vichy, and P. Ballet. 2005. "L'alun des oasis occidentales d'Égypte. Recherches sur le terrain et recherches en laboratoire." In *L'alun e méditerranée. Colloque international, Naples 4–5–6 juin 2003, Lipari, 7–8 juin 2003*, ed. P. Borgard, J.-P. Brun, and M. Picon, 43–57. Collection du Centre Jean Bérard 23. Naples: Centre Jean Bérard.
- Préaux, C. 1956. "Les prescriptions médicales des ostraca grecs de la Bibliothèque Bodléenne." *ChrÉg* 31, no. 61: 135–48.
- Rathbone, D. 1991. *Economic Rationalism and Rural Society in Third-Century A.D. Egypt: The Heroninos Archive and the Appianus Estate*. Cambridge: Cambridge University Press.
- Rea, J. R. 1984. "A cavalryman's career, A.D. 384(?)–401." *ZPE* 56: 79–88.
- Reddé, M. 2004. *Douch III. Kysis. Fouilles de l'Ifao à Douch, oasis de Kharga (1985–1990)*. With contributions from P. Ballet, A. Barbet, and Ch. Bonnet. Cairo: IFAO.
- Riemer, H., and F. Förster, eds. 2013. *Desert Road Archaeology in Ancient Egypt and Beyond*. Cologne: Heinrich-Barth-Institut.
- Rossi, C. 2013. "Controlling the borders of the empire: The distribution of Late-Roman 'forts' in the Kharga oasis." In *The Oasis Papers 6, Proceedings of the Sixth Conference of the Dakhla Oasis Project*, ed. R. S. Bagnall, P. Davoli, and C. A. Hope, 331–36. Dakhla Oasis Project Monograph 15. Oxford: Oxbow.
- Rossi, C. 2018a. "The architecture of the forts." In *North Kharga Oasis Survey: Explorations in Egypt's Western Desert*, ed. C. Rossi and S. Ikram, 429–51. British Museum Publications on Egypt and Sudan 5. Leuven: Peeters.
- Rossi, C. 2018b. "Water systems." In *North Kharga Oasis Survey: Explorations in Egypt's Western Desert*, ed. C. Rossi and S. Ikram, 505–51. British Museum Publications on Egypt and Sudan 5. Leuven: Peeters.
- Rossi, C. 2019. "Egyptian cubits and Late Roman architecture: The design of the forts of the Kharga Oasis (Egypt)." *ISAW Papers* 16. <http://dlib.nyu.edu/awdl/isaw/isaw-papers/16/>.
- Rossi, C. Forthcoming. "Searching for the right words: What happened in Kharga in the IV century AD?" *Proceedings of the colloquium Marges et frontières occidentales de l'Égypte (Cairo, 2–3 December 2017)*. Bibliothèque d'Étude.
- Rossi, C., and M. I. Ahmed. 2019. "Filling the gaps: Towards a comprehensive list of archaeological sites in the Kharga Oasis, Egypt's Western Desert." In *Archaeology in Africa: Potentials and Perspectives on Laboratory & Fieldwork Research*, ed. S. Di Lernia and M. Gallinaro, 89–100. Arid Zone Archaeology 8. Sesto Fiorentino: All'Insegna del Giglio.

- Rossi, C., and F. Fiorillo. 2018. "A metrological study of the Late Roman fort of Umm al-Dabadib, Kharga Oasis (Egypt)." *Nexus Network Journal* 20, no. 2: 373–91.
- Rossi, C., and F. Fiorillo. 2020. The vaults of Umm al-Dabadib: A geometric study. *Nexus Network Journal* 22, no. 4: 1063–80.
- Rossi, C., and S. Ikram. 2010. "North Kharga Oasis Survey 2007 – Preliminary Report: Ain Lebekha and Ain Amur." *MDIK* 66: 235–42.
- Rossi, C., and S. Ikram. 2013. "Evidence of desert routes across northern Kharga (Egypt's western desert)." In *Desert Road Archaeology in Ancient Egypt and Beyond*, ed. H. Riemer and F. Förster, 265–82. Cologne: Heinrich-Barth-Institut.
- Rossi, C., and S. Ikram. 2018. *North Kharga Oasis Survey: Explorations in Egypt's Western Desert*. British Museum Publications on Egypt and Sudan 5. Leuven: Peeters.
- Rossi, C., A. Migliozi, F. Fassi, A. Mandelli, G. B. Chirico, C. Achille, and S. Mazzoleni. 2015. "Archeologia, scienza e tecnologia: lo studio del sito tardo-Romano di Umm al-Dabadib (Oasi di Kharga, Egitto)." In *Proceedings of the Seminar L.O.S.A.I. (Laboratori Open su Scienza, Arte e Innovazione)*, 28–31 May 2015, ed. A. Chianese, 221–28. Naples: Artstudiopaparo.
- Shortland, A. J., M. S. Tite, and I. Ewart. 2006. "Ancient exploitation and use of cobalt alums from the Western Oases of Egypt." *Archaeometry* 48, no. 1: 153–68.
- Snape, S. 2014. *The Complete Cities of Ancient Egypt*. London: Thames and Hudson.
- Southern, P., and K. R. Dixon. 1996. *The Late Roman Army*. London: Routledge.
- Wagner, G. 1987. *Les oasis d'Égypte à l'époque grecque, romaine et byzantine d'après les documents grecs*. Bibliothèque d'Étude 100. Cairo: IFAO.
- Wilson, A. 2011. "City sizes and urbanization in the Roman Empire." In *Settlement, Urbanization and Population*, ed. A. K. Bowman and A. Wilson, 161–95. Oxford Studies on the Roman Economy. Oxford: Clarendon Press.
- Wuttmann, M., T. Gonon, and C. Thiers. 2000. "The qanats of Ayn-Manâwîr (Kharga Oasis, Egypt)." *Journal of Achaemenid Studies and Researches* 1, no. 1: 1–9.
- Youtie, H. 1936. "Publicans and sinners." *Michigan Alumnus. A Journal of University Perspectives* 43: 650–62.
- Zuckerman, C. 1994. "Le camp de Ψωβθις / Sosteos et les catafractarii." *ZPE* 100: 199–202.