



REMOTE SENSING OF ENDANGERED ARCHAEOLOGY ON GEBEL ATAQAH, EGYPT

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ABSTRACT

This paper reports on a recent survey of a range of archaeological sites on and around Gebel Ataqah, a mountain area to the west of Suez. These sites were identified through the analysis of publicly available satellite imagery, principally Google Earth (GE), as part of the Endangered Archaeology in the Middle East and North Africa (EAMENA) project, supplemented by historical references to the area and notes published by earlier travellers. The absence of existing archaeological data is due to a military presence in this area, from at least the 1950s, limiting access and exploration. The results of this survey show high levels of archaeological potential across large parts of Gebel Ataqah that require more detailed analysis on the ground, in an important, yet often underexplored, region. A series of major current and future threats to these archaeological sites are also identified which, alongside the presented survey data, will inform any future heritage management schemes.

INTRODUCTION

The EAMENA project, funded by the Arcadia Fund (<https://www.arcadiahfund.org.uk/>) and the British Council's Cultural Protection Fund (<https://www.britishcouncil.org/arts/culture-development/cultural-protection-fund>) is based at the Universities of Oxford, Durham and Leicester. It utilises satellite imagery as a key tool in identifying and monitoring heritage assets in this region. In response to a planned eastward expansion of Cairo, announced in 2015 (<http://www.acud.eg/> <accessed 29 May 2019>; <http://thecapitalcairo.com/vision.html> <accessed 07/02/2016>), a rapid evaluation of the planned development zone was undertaken by the EAMENA project between Cairo and Suez, at the northern end of the Eastern Desert. As part of this survey process an area west of Suez around Gebel Ataqah (Figure 1) was surveyed as it stands on the periphery of the original proposed development area. The data presented are based primarily on archaeological sites identified visually through the analysis of satellite imagery and, given the lack of previous research in this area, only conjectural interpretations of the features discussed can be offered. Analysis of a limited number of historical sources and pre-1950 travellers reports was also undertaken, although no documentary data could be linked conclusively to any archaeological sites identified by the remote sensing survey. However, this archaeological landscape is of major importance, in part due to the scale of undocumented potential sites, but also its geographical situation in the midst of the landward route between Africa and the Middle East. Gebel Ataqah's archaeological heritage is at risk, with the three major immediate threats to the area being urban expansion, mineral extraction and infrastructure projects. The survey data are presented in this paper to facilitate further detailed research and improve the capacity for the endangered archaeology of this area to be managed more effectively.

Figure 1. Location of Gebel Ataqah. Adapted from Natural Earth 1:10 m data.



METHODOLOGY

The EAMENA project survey methodology functions through the analysis of open-source satellite imagery through platforms such as Google Earth; systematically assessing areas for heritage sites, as well as monitoring the disturbance and threats to the cultural heritage (Bewley *et al.*, 2016). Data collected are then added to an online database on ARCHES platform (Zerbini, 2018), alongside data from earlier heritage surveys where available. Due to the extent of the EAMENA study area, spanning the MENA region, the focus is on rapid survey, and the data held are not assumed to be definitive assessments of site types or extent, and it is acknowledged that the definition of what makes up a single site is subjective and open to significant reinterpretation (Fradley & Sheldrick, 2017).

The project uses a square grid overlay measuring approximately 0.25 of a decimal degree of longitude by latitude (c. 0.25 km²). In the case of Gebel Ataqah, the mountain lies at a junction point of four grid squares, although this paper only deals with sites recorded on the mountain area and its immediate environs. Each record contains information on site location, including a shapefile for interpreted extent, site form, interpretation and an assessment of current disturbances and threats to the site. As a general rule the project only records sites with an assumed heritage value until 1950 CE.

GEOGRAPHY AND GEOLOGY

Gebel Ataqah is a roughly triangular mountain area located 10 km west of Suez (Figure 2). The massif rises toward a summit at the north-eastern corner of the mountain to a height above 800 m. Steep cliffs largely block the approaches from north and east, with a distinct lower plateau on the northern side; in the south and the west, the separation between Ataqah and neighbouring systems is less clear. The surface of the plateau was defined by Goby (1942: 397) as being covered by either a mix of small pebbles and calcareous sand, or by flat, unspecified stones.

The geology of the mountain is imperfectly understood, although it seems like a carbonate formation mainly composed of limestone, just like the neighbouring mountains which form in the last foothills of the Eastern desert mountain range. The Gebel also includes some important dolomite formations (Wanas, 2002). The quality of the limestone is variable; while most strata are composed of hard, well-bedded, white limestone, other bands tend to be looser and chalky (Sadek, 1926: 46). It is also very common to find samples of calcite in the stone. Besides limestone, Gebel Ataqah is composed of gypsum, alabaster, various types of iron oxide, especially in the south, aluminium and probably titanium (Goby, 1942: 400).

A quarry was opened at Gebel Ataqah in 1863 by the company of the Dussaud brothers, who were at the time in charge of building the dry dock of Suez on behalf of the French merchant shipping company of the *Messageries Impériales*. Later, the quarry was conceded by the Egyptian government to the Suez Canal Company, which used the Gebel Ataqah stone to extend the pier of Port Said. It is estimated that they extracted around 600,000 tons from the mountain between 1877 and 1905, and 4,000,000 tons between 1906 and 1940 (Goby, 1942: 399). Further north, another quarry was used from 1924 to 1927 by the Holzmann company to build the oil basin of the port of Suez. The impact of more recent quarrying activity will be discussed below.

The massif is broken up by wadi courses of varying sizes, and published names are available for some of the systems that emit from the southern side of the upland region along its lower incline. These wadis are flanked by high vertical escarpments characterised by a vividly red-coloured bed amongst their strata. Jean-Edouard



Figure 2. The Gebel Ataqah mountain, with the survey area discussed in the text outlined in red. Map data: Google, Landsat.

Goby (1942: 404) recorded that, generally, annual thunderstorms occur on the Ataqah around late October or early November, filling the wadis with waters which then flood the Suez plain, as well as the coastal plain of the Red Sea.

HUMAN ACTIVITY ON GEBEL ATAQAH: DOCUMENTARY SOURCES

Pharaonic Period

There is currently no documentary evidence of occupation on Gebel Ataqah during the Pharaonic period. The desert around Suez was considered to be dry, deprived of water, and had the reputation to be infested by snakes (Strabo: §21). According to Goby (1942: 209), Gebel Ataqah was probably only seen from a distance by travelers going from the Nile Valley to the Red Sea or to Palestine, who would rather stay within established caravan routes.

Graeco-Roman Period

From the Ptolemaic period through to the Islamic, a prominent port on the Red Sea developed to the east of Gebel Ataqah, the predecessor of Suez itself, known variously as Arsinoë, Cleopatris, Clysma, and al-Qulzum (Bruyère, 1966: 11-37). The proximity of this settlement may had a range of impacts on the mountain. Clysma underwent important changes after the arrival of the first Roman prefects in Egypt (30 BCE), with major construction projects designed to improve living conditions. In order to remedy the difficulties of a water supply system relying on transport by camels or boats, a rainwater collecting system was built on the slopes of Gebel Ataqah; completing an aqueduct connecting a nearby well to Clysma, this system allowed the development of both private and public baths (Bruyère, 1966: 47).

Coptic Period

During the Coptic period there is evidence that Gebel Ataqah sheltered several early Christian ascetics, hermits and monks. Saint Anthony the Great (251-356 CE) is recorded as having lived in the southern part of the Galala mountain, near Suez, and the toponym ‘Mountain of Saint Anthony’ is often interpreted as designating the ancient mounts of Kolzim. However, given that geography was not the primary concern of hagiographers, Gebel Ataqah was potentially included in their wider “Mountain of Saint Anthony” (Goby, 1942: 411). Some early authors explicitly identified Gebel Ataqah as the mountain of the saint. For example, Bernard de Montfaucon (1698: x) used such a title on a map that he produced in 1698.

Saint John the Dwarf, or John Colobos (c. 339-405 CE) potentially lived on Gebel Ataqah. In the 8th century, Saint Zacharias of Sakha wrote a biography of the saint, stating that Saint John fled Scetis, threatened by a foreign raid, to a place in or around Gebel Ataqah: “He left the desert and the rest of our fathers, bearers of the struggle, and Christ guided him until he arrived at the mountain of Saint Antony the Great in the interior of Clysma, one day’s walk from it. He settled in a rock on top of a place that he made for himself out of stones, just like the one he also inhabited in the wadi called Scetis” (Davis, 2008: 175).

The mention of Clysma is important, and the precision of this “one day’s walk” distance between the mountain and Clysma would suggest Gebel Ataqah as the possible site inhabited by John the Dwarf, or more specifically possibly in its southern edge called Gebel Ramieh (Goby, 1942: 412). However, the linking of John the Dwarf to this region is not secure, and it may have been an attempt by Saint Zacharias or one of his sources to simply link the narrative of John the Dwarf to the existing and more eminent pilgrimage network surrounding Saint Zacharias (Davis, 2008: 12).

In the 4th century an ascetic named Abba Tithoes may also have lived on Gebel Ataqah. In the *Sayings of the Fathers*, he is said to have asked his disciple to water palm trees, a command to which his disciple answered: “but we are at Clysma.” Abba Tithoes then replied: “What am I doing at Clysma? Take me back again to the Mountain” (Mayerson, 1996: 121). Once again, the proximity of the mountain with the site of Clysma makes the identification with Gebel Ataqah a possibility.

Modern Egypt

More recent occupation was mainly related to military activities, although there is no evidence that it was utilised by British and other European forces based along the Suez Canal prior to 1956. During part of the later 20th century, it is recorded that the north-eastern section of Gebel Ataqah was home to an Egyptian military observation centre. It was possibly subject to aerial assault on the 10-11 and 14 October 1973 during the Arab-Israeli conflict of that year, but Egyptian and Israeli sources do not agree on the details of these events (Dupuy, 1978: 540, 553; Sakal & Tlamim, 2014: 306).

PREVIOUS RESEARCH AND EXPLORATIONS OF GEBEL ATAQAH

Early Explorations

Filippo Pigafetta (1533-1604) is the first identified source mentioning the name of Gebel Ataqah (Goby, 1947: 10), following his visit to Egypt and the Sinai in 1577. In the 18th century, interest for the region around Suez rose as a result of religious and historical debates on the alleged crossing of the Red Sea. A major figure was the French Jesuit priest Father Claude Sicard (1677-1726). From 1706 to his death, he explored Egypt with a special focus on the region between Cairo and Suez (Girard, 1824: 2). Sicard’s purpose was to retrace the road from which the Israelites left Egypt as described in *Exodus*, and the exact point from which they would have crossed the Red Sea. While it was previously assumed that they had started their journey from the city of Tanis, in the Delta, using a road running on the north side of Gebel Ataqah, Sicard introduced the idea of a road departing from Memphis, near Cairo, and running alongside the south of the hill. In order to prove his hypothesis, he even did the journey from Cairo to the Red Sea alongside Gebel Ataqah on a donkey in 1716 over two days (Michell, 1927: 94). Since then, the mountain region has been of interest in the theatre of biblical archaeology simply due to its location between Egypt and the Levant, although this does not seem to have led to any form of active fieldwork (Kitto, 1845: 676-9).

Late 18th-early 20th Century: The Impact of the Suez Canal

The region was explored by the members of Napoléon Bonaparte’s scientific expedition between 1798 and 1801, partly as an opportunity to explore the ruins of Clysma. The engineer Pierre-Simon Girard mentions having to renounce verifying the existence of the ruins due to a lack of time, their military escort having planned only three days to reach Suez from Cairo (Girard, 1824: 7).

The major objective given to the engineers was to check whether the valley running from Cairo to the south of Suez, termed the “*Vallée de l’Égarement*”, could be used to establish a canal between the Nile and the Red Sea (Girard, 1824: 2). They developed a particular interest in ancient hydraulic structures, of which there were numerous in and around Gebel Ataqah, as there was a need for freshwater sources ahead of the excavation of the Ismailia Sweet Water Canal, completed in 1863 (Goby, 1942: 404). A set of these ruins were recorded at el-Touareq, the exact location of which is unknown. The engineer Édouard de Villiers du Terrage (1829: 156). estimated that they were about 31 km (6.5 leagues) south-west from

Suez, which would place them on the southern edge of Gebel Ataqah. Several sets of ruins were recorded around those sources by De Villiers; mainly, the remains of a fresh water supply point for ships, a tank, and debris from a kiln and from pottery, which he interpreted as the ruins of a vase factory once used by the navy (De Villiers, 1829: 156). Between the Touareq sources and the sea, De Villiers noticed multiple pipes forming the remains of a major fountain structure, which is also mentioned in the report of engineer Jacques-Marie Le Père (1822: 188). Both scientists compared these remains to the so-called “sources of Mose” – a set of small, conical mounds with a central basin, located on the Sinai peninsula, 20 km south-east of Suez (Le Père 1822: 76).

Later in the 19th century the engineer Louis Linant de Bellefonds (1799-1883) visited the area. He noted another set of ruins around Gebel Ataqah in the form of large basins dug in the soil, with dry stone sidewalls. According to him, they were used to collect the rainwaters drained by the wadis Oum Reseis and el-Ghal, to the east of Gebel Ataqah (Goby, 1942: 407; Linant de Bellefonds, 1873: 506). These ruins have later been interpreted as Roman (Clédat, 1918: 181), but there is a lack of any corroborating evidence, and the features have not been identified on the ground by subsequent surveys in this area.

De Bellefonds’ main interest was hydraulic and technical: he was the chief engineer of Egypt’s Suez canal operations in the 1850s. Interestingly, he notes that, especially on its northern side, the wadis of Gebel Ataqah conduct most of the rainwaters feeding down to the city of Suez itself (Linant de Bellefonds, 1873: 96), with relatively little flowing down to the Nile valley or the longer wadi courses running down to the Red Sea coast. The most important of those mountain streams, that he names Abu-Amatta-Wadée-el-Bahara, is modern Wadi al Bahharah which runs around the eastern side of the mountain and in part in parallel with wadis’ Pim Reseis and el-Ghal. The outflow of Wadi al Bahharah would be used to fill up a great tank near Suez, in a place named Moyet el-Gisir (“the water of the dyke”), which provided the city with fresh water for at least two months in a year (Linant de Bellefonds, 1873: 132).

In the first half of the 20th century, historical and geological interest around Gebel Ataqah continued to be linked to the workings of the Suez Canal. Jean Clédat (1871-1943) was the official archaeologist of the Suez Canal Company, and worked with the geologist Jules Couyat-Barthoux, to construct a detailed map of the region, potentially exploring the mountains of Geneffé, Chebreouet, and Ataqah in late January or early February 1912 (Meurice, 2014: 261). Clédat was also interested in the site Clysma, known in antiquity for its rainwater capture facilities, leading him to explore the foothills of Gebel Geneffé and Gebel Ataqah to locate the water sources and tanks that would lead to the ancient city (Meurice, 2011: 2). He documented a series of earth and drystone dams northward-facing wadis which he interpreted as the remains of the Roman system of collecting rainwaters for Clysma (Bruyère, 1966: 65). Clédat was also interested in the location of the Baal-Zephon, mentioned in the *Book of Exodus* as the place of the alleged crossing of the Red Sea, but dismissed the locale of Gebel Ataqah as this site (Clédat, 1918: 220). Original records of Clédat’s work, which have not been analysed as part of the present study, survive in the form of notebooks, correspondence, object/artefact files, and photographs kept for most of it at the Louvre Museum, with a smaller archive at his family home in Périgord, France.

After the First World War, the Suez Canal Company continued to drive the archaeological exploration of the region. The refusal of Clédat to come back to Egypt led the Company to contact the Institut français d’archéologie orientale (IFAO) and one of its archaeologists, Bernard Bruyère (1879-1971) took up the role (Meurice, 2016: 181). After focusing on a site near the Bitter Lakes, and the

Serapeum, Bruyère's third campaign of excavations in the region was centred on Clysma/Qolzoum, which he located to the north of Suez. Although he did not report any findings, he did briefly explore Gebel Ataqah before excavating the classical city (Bruyère, 1966: 38).

Later 20th Century Archaeological Analysis

In 1946 the Société d'études historiques et géographiques de l'isthme de Suez (SEGHIS), based in Ismaila, was established, leading to a renewed interest in Gebel Ataqah. This group presented themselves as amateurs (Goby, 1947: 15) with interests in history, archaeology and other subjects with a geographical element; but their reports were in fact increasingly detailed and rigorous.

An exploration of Gebel Ataqah was reported in 1948 by Jacques Daumas, one of the nine founding members of the Société. The precise nature of his explorations and methods he employed are not described, but his fieldwork is confirmed by contemporary publications (*e.g.* Field, 1952: 127). He is also known for having explored Gebel Lahram (*e.g.* Daumas & Laroche, 1947), as well as the Sinai during several expeditions (*e.g.* Daumas, 1937; 1951). In his report on Gebel Ataqah, Daumas focused on human occupation at the summit of the mountain. According to him (Daumas, 1948: 21), this location was the most important crossing point of paths over the mountain, with the complex relief of the mount forcing travellers to use the ridges instead of the wadis, although this does not seem to take account of the steep cliffs on the northern and eastern faces of the mountain. At this summit, near a point at Lat/Long coordinates 29° 58' 21"N and 32° 22' 22"E (see Figure 9), Daumas recorded the presence of three sets of ruins. He interpreted two of them as the remains of shelters or houses, and the third one, a stone circle located about 50 m away, as a tank for collecting rainwater (Daumas, 1948: 21).

Daumas also recorded the presence of a large number of 'silex' chips around the ruins recorded at the summit, but notably none inside these structures, and interpreted them as "microlithic crescents" ("*croissants microlithiques*"). He noted that some chips displayed traces of human alteration (Daumas, 1948: 22). Interestingly, Daumas also recorded the absence of natural flint layers in this area of Gebel Ataqah, the closest being south of Wadi el Abar, about 9 km away to the east, on the shores of the Red Sea. This led him (1948: 22) to suggest that a flint workshop was present at the summit, with raw materials brought in from elsewhere. Similarly, he recorded that inside the largest of the two 'shelter' ruins was a hole filled with a considerable amount of snail shells, without any trace of living specimens around (Daumas, 1948: 21).

Travelling c.1.5 kilometres to the north of the mountain summit, in the cliffs along the northern face of the mountain, Daumas (1948: 22) recorded a cave containing evidence of human occupation, as well as a tank, and remains from herdsman's shelters on the nearby plateau in the upper branches of the Wadi Oum Reseis. The names of the wadis mentioned and the distances given between the sites suggest that Daumas' reported explorations were limited to the north-eastern section of the massif.

Another of the founding members of the Société, Jean-Édouard Goby (1908-1992), undertook research on Gebel Ataqah as well. His report attempted to comprehensively gather historical, etymological, geographical, climatic, and geological data. Beyond his work, geological survey of Gebel Ataqah has been restricted, with early analysis limited to the northern and southern edges of the massif (*e.g.* Barron, 1907; Sadek, 1926). More recent surveys were hindered by the presence of landmines laid during 20th century conflicts in the region (Nibbi, 1997: 310). The latter issue relates to the use of Gebel Ataqah as a military position from at least

the late 1960s, although satellite imagery indicates that any army posts had been abandoned by 2004.

The recent history of interest for Gebel Ataqah revolves around similarly modern threats. In recent decades, concessions to mineral extraction firms around the edge of the mountain have been given over to a mixture of state and private organizations. Partly in response to this threat, the Oxford-based archaeologist Alessandra Nibbi (1923-2007) attempted unsuccessfully to organize a survey of the area in 1980-1981. Subsequently, she worked to raise awareness of the threat to the region's heritage, particularly to any unrecorded prehistoric caves or hieroglyphic inscriptions on the mountainside (Nibbi, 1997: 310). She reported entering into a dialogue with the Geological Survey of Egypt, requesting that the mountainside be systematically inspected in search for ancient inscriptions before the beginning of any future quarry (Nibbi, 1997: 16).

Nibbi attempted to link Gebel Ataqah to a historically recorded place named "Atika", *ꜥt-ṯi- kꜣ*, from the Pharaonic period. This Atika is famously mentioned in Papyrus Harris I, a document written under the reign of Ramesses IV (c. 1155-1149 BCE) and consisting for most of it in a long summary of the reign of his predecessor Ramesses III (c. 1186-1155 BCE). In the text, 'Atika' is described as a mountainous place abundant in copper and located east of Egypt: "(The king speaking:) I sent forth my messengers to the country of Atika to the great copper mines which are in this place... Their mines were found abounding in copper; it was loaded by ten-thousands into their galleys. They were sent forward to Egypt and arrived safely..." (Breasted, 1906: 204). Nibbi was not the first Egyptologist to connect the modern mountain to this ancient place (e.g. Gauthier, 1925: 137; Hayes, 1959: 365), although this was contested from early on, the ancient Atika being more frequently linked to areas to the east, such as the Sinai (e.g. Petrie, 1905: 156), or Timna in Israel. In the past few years, the debate has been fuelled by the exploration of the Red Sea pharaonic site of Ain Sokhna, where extensive rock inscriptions dating from the Middle Kingdom (c. 1975-1640 BCE) describe the extraction of copper from the Sinai, but also from local mines (Abd el-Raziq *et al.* 2002), which was interpreted as a proof of the existence of copper around Gebel Ataqah (Vandersleyen 2013: 113-114). However, on a geological front, the identification of modern Ataqah and ancient Atika seems unlikely since no copper deposits have been identified in the mountain.

Furthermore, Alessandra Nibbi made unsubstantiated claims that the area of Gebel Ataqah had been quarried since Roman times, and the erroneous suggestion that Ataqah was Egypt's highest mountain (Nibbi, 1997: 305, 310). If anything, this latter phase of interest would seem to highlight the significant absence of confirmed archaeological knowledge in relation to Gebel Ataqah, a situation that can now partially be remedied through the analysis of satellite imagery.

EAMENA ANALYSIS OF GEBEL ATAQAH

The EAMENA survey has produced a range of new data for the Gebel Ataqah area highlighting the archaeological potential of the region (Figure 3). The summit of the mountain is covered largely by military features from the later 20th century, which has restricted the documentation of archaeological sites in this area.

Routes

For an area that is so little understood, it is something of a paradox that the mountain area is criss-crossed by an extensive network of eroded track ways, principally crossing from south-east and north-west and south-west to north-east across the range. These features almost certainly range extensively in date of establishment, but have been mapped by the EAMENA project as an important component of

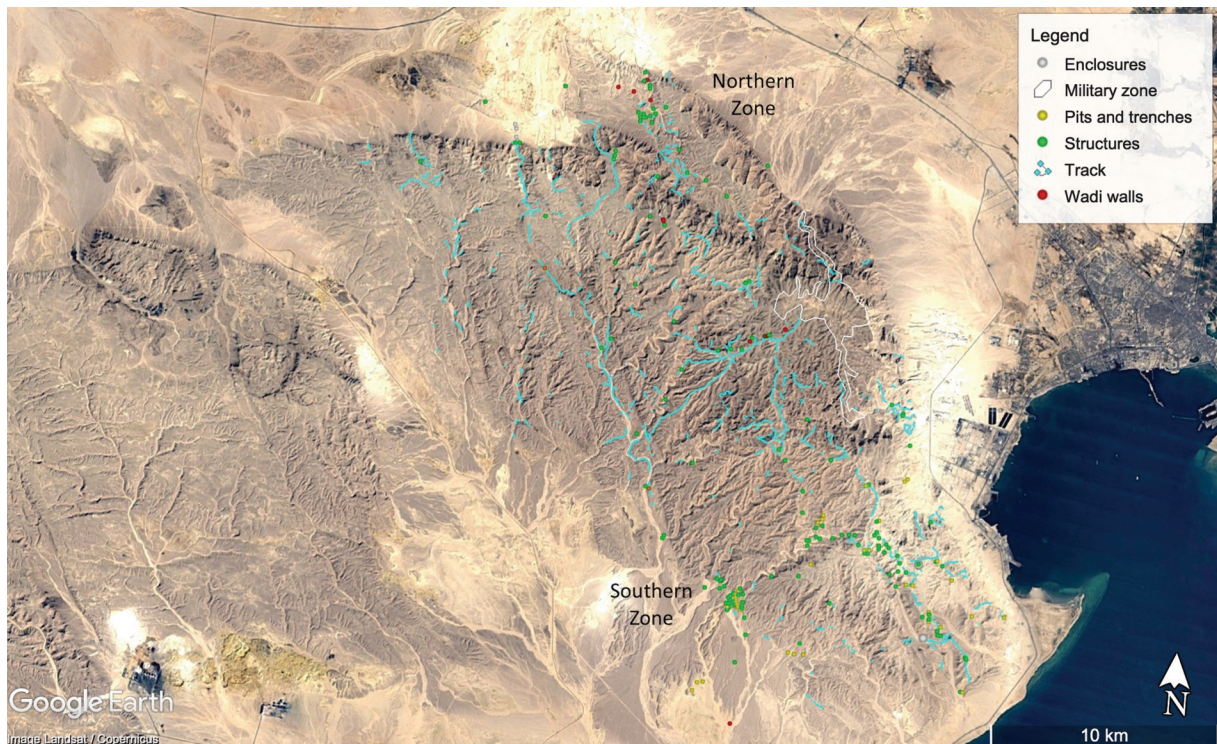


Figure 3. Sites documented by the EAMENA project. Map data: Google, Landsat.

how the massif was explored, utilized and experienced in the past by travellers, pastoralists and animal herds. At a more practical level, they give some indication of how the site could be explored on foot by any future survey, and may in some cases lead to the discovery of sites such as caves and rock inscriptions that cannot be detected via remote-sensing techniques. Evidence of surface-eroded track ways (Figure 4) can be identified via satellite imagery across most parts of the mountain, with the exception of the lower western slopes. The latter may be due to the fact that travellers could take the easier route to the west, in the gap between Gebel Ataqah and Gebel Kutayfa.

Where moving over steeper slopes, the tracks zigzag up the inclines, similar to the wider 'ramps' recorded at major quarry regions such as the Roman-era works at Mons Porphyrites (Maxfield & Peacock, 2001: 195-202). In other cases, particularly where paths follow the contour of the slope or in areas of lower resolution imagery on the western side of the massif, it is difficult to distinguish paths from areas of natural erosion along sedimentary interfaces. As a result of this, and the use of wadi bases in which historic track routes do not survive, the illustration of infrastructure at present is only provisional, although Daumas (1948: 21) argued that the nature of the mountains topography generally forced travellers to move across ridges rather than wadi channels. The resulting EAMENA dataset may therefore offer a credible indication of how the massif was crossed in the past. It is possibly relevant that it was the seemingly impassible wadi sections that led Sadek (1926: 2) to deem the inner sections of the mountain inaccessible during his geological survey of the area in the early 20th century, potentially indicating that knowledge of these paths had largely been lost by this time.

A number of tracks have been recorded leading up to the mountain summit from a number of sides, although evidence around the peak has been masked by more recent mechanised tracks cut as part of the military occupation on the summit. The most prominent routes to the summit are from the south-west. In the wadi course north of one of these tracks evidence of dispersed structures and small wadi-wall systems were recorded, suggesting that at some stage at least seasonal occupation just below the mountain summit was viable.



Figure 4. An earlier 20th century aviation arrow scraped into the ground surface from a satellite image captured 31 July 2010. An eroded footpath runs parallel to the east of the arrow. Map data: Google, DigitalGlobe.

Of the principal north-south route visible, the westernmost of the branched routes at its northern end runs down a steep wadi channel to the plain below. What makes this route distinct is that on the open plain beyond are a near-linear series of four sub-circular enclosures spaced over a distance of 800m, on the same orientation as the routes to the south (Figure 5). The southernmost of these enclosures includes a small structure on the south-west side of the enclosure wall, and a series of nearby structures. As will be described below, the two northernmost enclosures were destroyed by modern quarrying between 2007 and 2010, while the two southern examples were damaged between 2011 and 2018 and are now at high risk of complete destruction. There is some evidence that this route was also used during the earlier 20th century, with two large arrow markers (Figure 4) pointing south-east alongside sections of the track, created by clearing surface stones. These markers are almost certainly navigation markers for aviation traffic in the early 20th century, as with similar markers on the British Air Mail routes across the Middle East (Kennedy & Bewley, 2004: 272-273), possibly marking a route linking Cairo and Aden or Port Sudan.

The South-Eastern Settlement and Extraction Complexes

An unexpected discovery has been the identification of a range settlement and possible mining or mineral extraction activity across the southern zone of the Gebel Ataqah area. The settlement elements consist of clusters of small rectangular structures, with relatively little differentiation in size and shape. These are generally found in small clusters of 2-20 buildings, with a larger settlement hub identified to the south-west of the settlement distribution at the point where Wadi Naga leaves the upland area (Figure 6). Built along the edge of a wider wadi bed, this settlement uniquely includes a cluster of circular pits dug into the wadi floor. On the ridges above the wadi is evidence of larger circular pits that are highly likely to be part of a mineral extraction process, particularly given the linear arrangement of a



Figure 5. A linear arrangement of enclosures on the north side of Gebel Ataqah from a satellite image taken 21 June 2010, when the northern two examples had already been destroyed by quarrying. The inset shows a detail of the southern example, which was damaged by bulldozing in 2018. Map data: Google, DigitalGlobe.

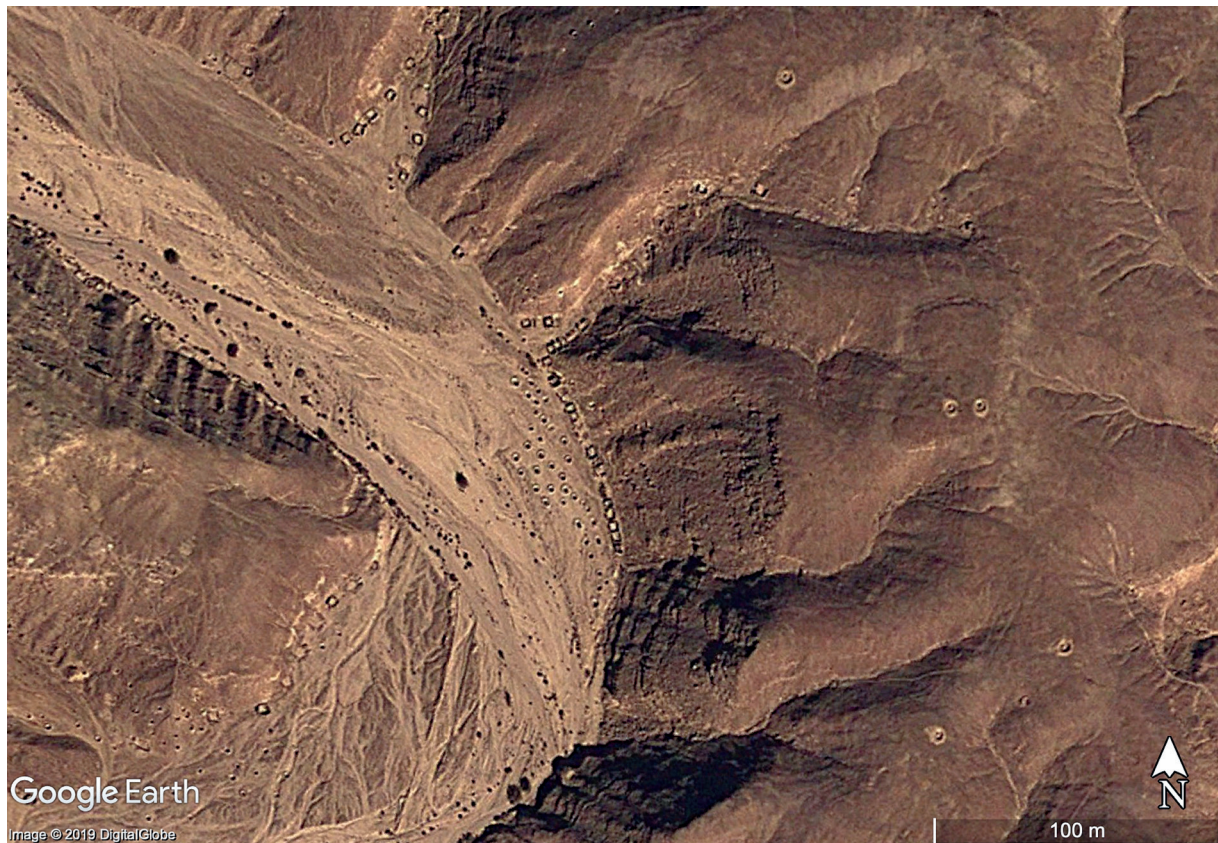


Figure 6. Part of the larger southern settlement complex from a satellite image captured 25 January 2014, with structures lining the edge of the wadi base, and pits cut into the wadi base and the slopes above. Map data: Google, DigitalGlobe.

central group of pits, suggesting that they are following some form of sub-surface geological layer. While structurally similar buildings can be identified in smaller, more dispersed groupings across other parts of the massif, it is the association with these potential extractive pits that marks this area as distinct from those to the north and west.

Further dispersed settlement and possible extraction sites have been identified to the north-east up the course of the Wadi el-Naga. It is tempting to see these as outliers of the relatively clustered settlement and extraction evidence described above. The more abundant sites have also been recorded looping round into two wadi systems running down to the south-east. In these wadi systems two comparable large enclosed areas have been recorded (Figure 7). Although they are not identical to each other, these cleared areas with possible enclosing walls share a number of distinct features. Unlike many of the small domestic/workshop structures described above, it seems unlikely that these areas have upstanding walls given the lack of shadows cast in any of the available satellite imagery, and there is no evidence of collapse or demolition rubble. Instead, these complexes are recognizable through either surviving foundation elements or the contrasting fills of negative features. The larger, southern example consists of an enclosed area with an L-shaped subdivision with a row of small circular features on its south side and two possible rectangular structures in its north-west corner. A second, smaller complex also survives c. 15 m to the south. The other example of an enclosed area to the north contains two adjoin irregular enclosures, with a possible small circular structure in the smaller of the two. These two enclosed areas have near-identical tracks or hollows leading out from their south-eastern corners.

The Central and Northern Areas

The archaeological evidence on the central and northern zone of the massif are distinct from that identified on the south side of the mountain. This principally



Figure 7. A comparison of two enclosure complexes on the south side of the mountain from satellite images taken on 25 January 2014 (top) and 6 August 2013. Map data: Google, DigitalGlobe.

consists of small, dispersed groups of sub-circular enclosures with no clear system governing their layout. In some cases these may be associated with a small number of potential wadi walls, or wadi-side enclosures, suggesting some level of small-scale agriculture or livestock rearing (Figure 8). In other cases the structures are again situated alongside the visible eroded terraces of the track way network that crosses the mountain. There is no evidence of the possible extraction pits identified among the southern settlement, indicating a different economic basis for these settlement units, which are generally located clustered to the sides of shallow, thin wadi courses.

The majority of these features are located on the lower, northern plateau spur of Gebel Ataqah (Figure 3). However, a possible small outlier has been identified c. 5 km to the south, on a fault line running up and across the higher massif. While this includes comparable wadi walls, the associated almost circular enclosures are larger and more amorphous in shape. Fragments of a number of tracks do survive in this section of the mountain, to the west of the main peak, but there is little evidence visible from satellite imagery of other structures, thus this southern space with semi-circular enclosures appears to be a solitary settlement area.

Finally, around the peak of the mountain, are a string of structures, embankments and bulldozed trackways. In the present study this area is not mapped in detail as it relates to a period of modern military occupation on the mountain during the late 20th century. It will, however, be discussed briefly below, as it has such a major impact on the ability of the present survey to identify archaeological sites around this part of the mountain.

DISCUSSION

Almost all of the small structures identified across the southern sections of Gebel Ataqah conform to a very basic type consisting of single cell rectangular and sub-rectangular units. In some cases, as at the larger settlement on the Wadi el-Naga, they are apparently adjoining to create small terraced rows. On the basis of satellite analysis it is not possible to make a credible interpretation as to what period these structures belong. For instance, elsewhere in the Eastern Desert it is possible to identify near identical structures as they appear visually in satellite imagery of New Kingdom date at Wadi Miyah and of Early Arab date at Aradiya-East (Klemm & Klemm, 2011: 115-117, 185-188). By the absence of a larger, more diagnostic structural form it would be inappropriate to suggest anything other than that these buildings could be of any date between ancient and modern. A few exceptions to this form can be highlighted, such as a small group of semi-circular enclosures associated with a wadi-wall system near the north-central precipice of the massif, which may be an outlier of similar types of features identified on the north side of the mountain.



Figure 8. A wadi wall complex with associated enclosures, on the northern side of the mountain from a satellite image captured 21 June 2010. Map data: Google, DigitalGlobe.

This analysis has suggested that many of these structures relate to some form of mining or quarrying, given the proximity of pit features to these structures, and a general absence of agricultural features across the southern section of the mountain (Figure 3). If there was some form of mining or quarrying, it is not clear what was the intended mineral. Nibbi (1997: 305-312) speculated that Gebel Ataqah was linked to the Pharaonic description of the country of Atika that was reputedly abundant in copper. There is no evidence that workable copper deposits were available on or around Gebel Ataqah, and that the potential evidence of historic quarrying or mining must relate to non-metallic mineral deposits. Analysis of a section in a tributary of Wadi Naga identified silicified wood with bands of flint and quartz pebbles in amongst false-bedded white and yellow sandstones (Sadek, 1926: 68), so flint or some other workable stone is a possibility. Interestingly, at the southern end of this distribution are two distinct areas of potential extraction, one formed of small pit clusters, while the second is represented by a series of large open trenches. There is a clear need for ground truth to better understand this range of features.

It is tempting to see the two distinct enclosed features in the area north-east of Wadi el-Naga as somehow connected to the wider distribution of settlement and possible extraction pits, although there is no direct spatial connection to any of the dispersed structures recorded. If they were linked to collection or processing of whatever mineral was being extracted, it is not clear why they would be located distinct from any concentrations of settlement or diggings. An alternative interpretation is that they acted as some form of way station, but in that case their proximity to the edge of the massif and the Red Sea coast would make this seem unlikely.

In general this analysis has attempted to draw a distinction between the types of settlement evidence on the northern side of the mountain and the sites documented to the south. The northern side of the mountain is characterised by dispersed distributions of small, undated structures, with some association with wadi wall

agricultural systems. The majority of these are located on the lower, northern slopes of the mountain, although a distinct complex was documented on the higher slopes to the south, and a series of structures and wadi walls set in a wadi alongside one of the main recorded routes to the mountain summit, to the west of the main peaks. These small, potentially seasonally-occupied settlements, given the small-scale of the identifiable field systems, appear to have a partial agricultural basis given that they are repeatedly recorded in close proximity to wadi wall structures. Drawing on the different structural morphologies documented, these structures may relate to several distinct phases of unconnected occupation across the mountain.

A distinct phase of 20th century military activity, almost certainly post-1950 in date, is represented by a station and outlying elements established around the north-eastern section of Gebel Ataqah. This station was abandoned by the beginning of the 21st century, based on what can be seen in the earliest available commercial satellite imagery, and may have become redundant by at least the close of the Cold War. It may have acted as a training station or an observational role providing views over the Red Sea, Suez and the Sinai Peninsula, and was reportedly the scene of an engagement during the 1973 Arab-Israeli War. Analysis of a scene from the Corona mission from 18 November 1968 indicates that parts of the mechanised access tracks were already in place by this date, although the imagery resolution is not high enough to identify many of the smaller abandoned features on more recent satellite imagery. These modern military features are largely spread across the central areas of the mountain, in an area distinct from the settlement area described above. There is some overlap at the southern end of this military distribution, often comprising small emplacements or dugouts that cannot always be conclusively distinguished from the structural and possible mining features recorded to the south, creating some ambiguity of identification in this area of overlap. A series of small emplacements, almost certainly for infantry units, was also identified on the western side of the massif.

In terms of more ancient remains, the work of early explorers would suggest that there were archaeological sites around the summit, in the area occupied by this military station. These modern features mask any ability to identify the remains of earlier sites, and it seems likely that only ground survey or the analysis of older high-resolution aerial imagery, such as that from the U2 archive (Hammer & Ur, 2019), could help identify sites such as those recorded by Daumas (1948). There are also a probable distribution of caves, rock inscriptions and other smaller sites not visible via the analysis of commercial satellite imagery that will require more detailed survey and documentation to build a more complete understanding of the archaeological landscapes of Gebel Ataqah.

ENDANGERED ARCHAEOLOGY

The exceptional preservation of the archaeology across this area has no doubt been significantly influenced by the military presence in this region during the 20th century, although it has created issues in terms of unexploded ordnance on the mountain. The future preservation of the archaeological sites is not assured in the 21st century as major mining and aggregate extraction concessions have come into play across extensive swathes of Egypt's Eastern Desert. In the vicinity of Gebel Ataqah this includes the industrial extraction of dolomite. Broad analysis of Landsat data would seem to indicate that modern industrial quarrying began in the vicinity of Gebel Ataqah from the mid-1980s onwards. There are continuing major digging operations cutting away at the base of its northern and eastern slopes, in some cases removing identified archaeological features, and satellite imagery can be used to highlight the scale of this physical process. Two clusters of underground entrance points can be identified at the base of the lower northern-western escarpment, with

a number of additional tunnel entrances added between 2016 and 2018. This has had an immediate impact on sites documented as part of the present survey, as discussed above, where a linear series of four circular enclosures and other features have already been partially destroyed over the last decade. The lower slopes of the eastern scarp of the massif have already been significantly altered by extraction of dolomite and other minerals. In 2011, more than 75 large-scale quarries were recorded in the vicinity of the mountain, where conventional heavy machines are used to extract carbonates – both dolomite and limestone (Amin *et al.*, 2011: 766). Satellite imagery updates for January 2016 indicate that new quarry operations have opened to the north-east and, to a lesser extent, the south-eastern slopes of the massif, as further western penetration into the body of the mountain have been abandoned. In the longer-term, if extraction is allowed to continue creeping along the northern and southern fringes of the Gebel Ataqah and begins to penetrate the various wadi systems accessible from these sides then it could have severe consequences for the archaeological remains identified as part of this survey.

A second significant threat comes in the form of the proposed eastward expansion of Cairo, known as Weidan, an avenue of development leading from New Cairo toward Suez (<http://www.udc5.com/project/wedian-new-capital-city/>). Although this speculation would stop west of the Gebel Ataqah area, it could have a twofold impact. Firstly, it will lead to a significant increase in the local population, potentially leading to greater access to and exploration of this upland area, which could be problematic for both the natural and historic environments if unregulated. The second issue is the displacement and intensification of local extraction industries relating to the construction industry in order to supply this major building programme, which may further encroach on the massif, as discussed above.

The most invasive threat is the planned construction of a large hydroelectric plant at Gebel Ataqah (Ingram, 2018). The project was announced in 2015 of a venture to construct a major pumped-storage hydroelectric plant at Gebel Ataqah, and will potentially have a massive impact on the surviving archaeology of this area. Nibbi (1997: 310) confusingly state that the development had already taken place by 1997, but this may have stemmed from the initial scoping project, the latter instigating at least a partial clearance of landmines and ordinance from the mountain and the development of access track up its northern face (Hoyt & Eriksson, 1999: vii). A pumped-storage facility differs from a classic Hydroelectric plant such as the Aswan Dam, in that an elevated reservoir is constructed and fed artificially by water pumped up from below, rather than naturally via a river. Water is pumped up during periods of low demand for electricity, generally at night, and released to generate electricity during periods of high demand.

Plans for this project have not yet been made available, but a basic visualisation has allowed us to make an initial assessment of impact (Figure 9). The upper reservoir is situated around the peak of the mountain, with feeders leading eastward down to the lower reservoir at the base of the mountain. The principal impact will be on the area occupied by the redundant military station, although as discussed above, this is an area in which Dumas recorded a number of archaeological sites. The impact of construction and indirect developments such as alteration of local hydrology may well have a significant detrimental result on the heritage of this region. It would seem probable that any reservoir would be excavated near the main peak of the mountain, and recent satellite imagery has enabled the identification of small working stations and the development of vehicular tracks in this area. It has also not been specified what will be the source of water for the system. If the Red Sea was exploited, which is possible given its proximity to the mountain, it could also lead to issues from saline water and pollutants from the sea water impacting the cultural and natural environment of the mountain. Efforts to contact the prin-



Figure 9. A satellite image from 20 November 2016, highlighting the extent of activity relating to an Egyptian military position in white, the planned core impact of the Pumped-storage hydroelectric plant in blue, and the centre point for features identified by Daumas in red. Note the scale of quarrying activity immediately east of the mountain. Map data: Google, DigitalGlobe.

cial consultant on this project to liaise on any management of heritage sites that will be affected by this project have been ignored.

CONCLUSION

There is a clear and pressing need for further research at Gebel Ataqah in light of the potential demonstrated through satellite imagery survey and the associated threats to the mountain's endangered archaeology. The EAMENA project has now taken the first major step in highlighting the archaeological potential and major heritage management issues at stake on Gebel Ataqah. The detailed remote-sensing survey of the mountain and its environs has enabled a basic model of site types and distribution, suggesting periods of dispersed occupation in the northern part of the mountain, and a focus on mineral extraction to the south. By collating data from historic documents that relate to the mountain, and the information published by subsequent travellers, explorers and engineers, it is clear that there are additional sites on Gebel Ataqah that cannot be identified via remote-sensing techniques, or have been disturbed or destroyed by subsequent activity, such as the modern military occupation of the area around the mountain peak in the later 20th century. For instance, the brief account by Daumas indicate the presence of caves and rock shelters, which could only be implied from the available satellite evidence, while his noting of quantities of snail shells, though not archaeologically derived, could be an important environmental indicator if preserved in stratified archaeological deposits.

The scale of archaeological preservation at a landscape level, coupled with the position of the mountain range between the Nile region and the Sinai Peninsula and the Levant beyond, signal the major importance of this locale. The use of open-access satellite imagery platforms has allowed us to rapidly reassess the archaeological potential of this region, and the broader value of the EAMENA survey methodology, particularly in terms of exploring areas away from the tradition

foci of archaeological research in the region. This survey has established a baseline dataset that can be used to mobilize resources to be directed towards this area before its archaeological resources suffer irreparable damage prior to more detailed ground documentation.

DATA ARCHIVE

The raw survey data discussed in this paper is held on the EAMENA database eamenadatabase.arch.ox.ac.uk.

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