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Centros de Estudios Africanos  
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# The Emerald Mines of Wadi Sikait (Egypt) from a Diachronic Perspective. Results of the 2020 and 2021 Seasons of the Sikait Project

Sergio GARCÍA-DILS DE LA VEGA, Joan OLLER GUZMÁN,  
David FERNÁNDEZ ABELLA, Vanesa TREVÍN PITA

This article outlines the preliminary results of the fieldwork carried out by the Sikait Project, in the 2020 and 2021 seasons, in the *Smaragdus* area (Egyptian Eastern Desert). Our work is focused on the study of the beryl/emerald mining in the Roman and Late Antique periods, from a diachronic perspective. By the end of the 2021 season, some 150 mines had been identified. The total area so far of the delimited mining zones is about 100,000 m<sup>2</sup>.

*Las minas de esmeraldas del Wadi Sikait (Egipto) desde una perspectiva diacrónica. Resultados de las campañas 2020 y 2021 del Sikait Project*

En las líneas que siguen se presentan los resultados preliminares del trabajo de campo desarrollado por el Sikait Project, en las campañas de 2020 y 2021, en el área del *Smaragdus* (Desierto Oriental egipcio), centrado en la minería de berilo/esmeraldas en épocas romana y tardoantigua, desde una perspectiva diacrónica. Al término de la campaña de 2021, han sido identificadas unas 150 minas. La extensión total de zonas mineras delimitadas hasta el momento se eleva a unos 100 000 m<sup>2</sup>.

**Keywords:** Eastern Desert, *Smaragdus*, mining, survey, beryl, Roman Egypt.

**Palabras clave:** Desierto arábigo, *Smaragdus*, minería, prospección, berilo, Egipto romano.

The *Smaragdus*<sup>1</sup> region was well-known in ancient times as the only source for emeralds in the Roman Empire and several classical authors refer to it, such as Strabo (*Geog.* 17.1.45), Pliny the Elder (*HN* 37.17.65, 37.18.69), Claudius Ptolemy (*Geog.* 4.5.15.4), Olympiodorus (*FHN* 3.309), the fourth-century monk and bishop Epiphanius (*FHN* 3.305) and the sixth-century monk Cosmas Indicopleustes (*Christian Topography* 11.21). Rediscovered at the

<sup>1</sup> We use *Smaragdus* as the geographical denomination of the area since this is the only one directly attested in Antiquity – “Σμάραγδος ὄρος”, Ptol. *Geog.* 4.5.15.4 –, rather than the usual *mons Smaragdus*, which is merely a historiographical construct. Cf. Cuvigny 2018: “Coined by modern scholars, the toponym ‘Mons Smaragdus’ is an incorrect construction.”

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Sergio García-Dils de la Vega — [sergarcia-dils@sevilla.uned.es](mailto:sergarcia-dils@sevilla.uned.es)

Universidad Nacional de Educación a Distancia / Centro Asociado de Sevilla / Spain

Joan Oller Guzmán — [joan.oller@uab.cat](mailto:joan.oller@uab.cat)

Departament de Ciències de l'Antiguitat i l'Eclat Mitjana / Facultat de Filosofia i Lletres / Universitat Autònoma de Barcelona / Spain

David Fernández Abella — [daferabe@gmail.com](mailto:daferabe@gmail.com)

Programa de Doutoramento en Historia, Xeografía e Historia da Arte / Facultad de Xeografía e Historia /

Universidad de Santiago de Compostela / Spain

Vanesa Trevín Pita — [vanetrevinpita@gmail.com](mailto:vanetrevinpita@gmail.com)

Departamento de Edafología e Química Agrícola / Universidad de Santiago de Compostela / Spain

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beginning of the 19th century by the French mineralogist Frédéric Cailliaud, more recent archaeological work identified this region, *grosso modo*, with the current Wadi el Gemal National Park, in the Egyptian Eastern Desert. There, an extensive network of mining settlements was documented by a team directed by S.E. Sidebotham, from the University of Delaware.<sup>2</sup>

This network shows the relevance of emeralds in Antiquity and the intensive extraction of this mineral. In fact, when we talk about emeralds, we refer to a green-coloured gemstone consisting of the chromium and/or vanadium variety of beryl, an aluminium-beryllium silicate.<sup>3</sup> The Egyptian Eastern Desert was not the only source of emeralds. However, it was the only known source within the Roman Empire borders and this added value to Egyptian emeralds, as in general their quality is poor.<sup>4</sup>

In the Wadi el Gemal National Park area, there are three main zones in which most beryl sources are concentrated: the Wadi Sikait – Wadi Nugrus zone, Gebel Zabara and Umm Kabu.<sup>5</sup> All of them have evidence for ancient mining operations, at least since the Ptolemaic period, but with a peak in Roman and Byzantine times and continuing until Islamic times. However, from an archaeological point of view, the most relevant area is in the Wadi Sikait,

where several mining settlements have been identified, including the most important ancient community in the region: the site of Sikait – ancient *Senskis*.<sup>6</sup> The presence of such settlements, together with the extensive mining operations documented all along the wadi, has prompted several archaeological interventions since the end of the 20th century, including survey, topography of the sites and excavation at Sikait. This work was resumed by the Sikait Project in 2018. The main goal of this paper is to offer an insight into the first results of our work in the emerald mines of Wadi Sikait during the 2020 and 2021 seasons.

### 1 | Generalities about the Mine Workings documented in Wadi Sikait

Thus, as one of the objectives of the Sikait Project, an archaeological survey of this wadi was carried out in order to map the distribution of all the mine workings, of any historical period, as well as their related infrastructures. It is important to emphasise that it is essential to have a knowledge of all of the sites present in the area, as their precise date is not always obvious and, in many cases, the most recent workings overlap, cancel out or extend the older ones.

<sup>2</sup> For a recent summary about this archaeological work, see: Sidebotham, Gates-Foster and Rivard 2019.

<sup>3</sup> Schwarz and Schmetzer 2002.

<sup>4</sup> Some authors have proposed the possibility of another ancient source of emeralds for the Roman Empire located in the Habachtal deposit, near Salzburg. This hypothesis is supported by the analysis of the oxygen isotopic composition in several pieces of jewellery that include emeralds, recovered in Roman archaeological contexts. These studies identify the origin of some of these emeralds in the Austrian mines – Heuzè 2000: 56–58; Giuliani *et alii* 2001. However, for the moment, no direct archaeological evidence for an exploitation of these mines in Roman times has been recovered.

<sup>5</sup> Regarding the geology of this area and the geological characteristics of the Wadi Gemal emeralds, see: Hume 1934: 109–125; Lucas and Harris 1962<sup>4</sup>: 389–390; Grundmann and Morteani 1998; Shaw, Bunbury and Jameson 1999; Giuliani *et alii* 2000a; Harrell 2004, 2006; Abdalla and Saleh 2021: 606–612.

<sup>6</sup> For the site of Sikait: Grundmann and Morteani 1998: 168–170; Shaw, Bunbury and Jameson 1999; Giuliani *et alii* 2000a, 2000b, 2001; Rivard, Foster and Sidebotham 2002; Sidebotham *et alii* 2004; Harrell 2004; Harrell 2006; Foster *et alii* 2007; Sidebotham, Hense and Nouwens 2008: 328–336; Sidebotham 2011; Oller *et alii* 2019; Sidebotham, Gates-Foster and Rivard 2019: 136–145; Oller *et alii* 2021.

The following considerations on the mine workings of Wadi Sikait, from an archaeological and historiographic point of view, are based on several weeks of fieldwork by the authors in the 2020 and 2021 campaigns.

The objectives of the fieldwork were: to obtain a detailed map of the mining operations, together with a database, processed by means of a GIS, which would also be used to study these workings at different scales, including an intra-site approach and the survey of the main underground mines; to study the methods of prospecting and extraction used by miners in different historical periods, mainly in Roman and Late Antique times, with a global and diachronic perspective; to obtain an overview of the complete process of mining exploitation in the area, including the construction of infrastructures linked to it.

During the fieldwork, the detection and study of the tip heaps – located on the sides of the wadis and essentially composed of schist fragments – were essential for the location and assessment of mining activities and underground workings, to establish their full extent.

In general, the ancient mine workings were excavated in the softer phlogopite schist, following the quartz/pegmatite veins.<sup>7</sup> The main type of exploitation, which is documented everywhere in the Sikait area, are open-cast works, usually divided in benches distributed at different levels, and sometimes connected by a system of ramps. When a promising vein was detected, the works continued perpendicular to the slope excavating a trench, or even underground, producing shafts, adits and tunnels.<sup>8</sup>

<sup>7</sup> Harrell 2004, 2006.

<sup>8</sup> Cf. Shaw, Bunbury and Jameson 1999; Shaw and Bunbury 2003.

<sup>9</sup> For general notices concerning the Medieval mine works carried out in Sikait area, *vid.* Ismalun 1943: 54–55.

<sup>10</sup> A recent study about the Cailliaud expeditions in Oller 2021.

<sup>11</sup> In France, an imperial decree issued by Napoleon on February 12, 1812, established that a foot was equal to a third of a metre.

<sup>12</sup> Cailliaud 1821: 62.

In most of the cases that have been documented by us, these old mines only pursued the mineral veins down to about 10-20 m below ground. Nevertheless, we have some examples of highly complex underground mining workings, with a development of hundreds of meters, and galleries and connection shafts distributed at different levels, which will be discussed later in this paper.

It is also clear from the results of the fieldwork that mine workings in Wadi Sikait were approached with a completely different philosophy in the 19th and early 20th centuries.<sup>9</sup> We have established that huge square-sectioned shafts were dug in this period, sometimes without following obvious ore veins, using auxiliary means such as mining derricks. On other occasions, these works amplified ancient underground workings or, as has been pointed out above, even cancelled them out.

It is well known that Cailliaud, in the service of Mohammed Ali Pasha, was the first Westerner in modern times to visit and document the Zabara beryl/emerald mines in November 1816.<sup>10</sup> He gave an exhaustive and vivid description of the ancient mines he found there, noting again and again that in all cases they consisted of narrow galleries, accessed through tiny entrances. The author shares his surprise at the narrowness of the mines in eloquent descriptions like these ones:

J'allai encore parcourir quelques-uns des souterrains : dans l'un d'eux, j'arrivai avec beaucoup de peine et par un sentier très-étroit, à quatre-vingts pieds<sup>11</sup> [27 m] sous terre, jusqu'à une petite plate-forme (...) ma foible lumière me fit apercevoir à mes pieds un précipice horrible.<sup>12</sup>

Il paroît que les anciens cherchoient peu à rendre commodes leurs travaux d'exploitation; car ces mines seroient regardées en Europe comme presque impénétrables. Il faut s'introduire par de petits sentiers très étroits, dirigés selon des lignes obliques, ou plutôt se laisser glisser, tantôt sur le côté, tantôt sur le dos, tantôt sur le ventre (...) partant d'une pareille excavation, vont s'étendre à de grandes profondeurs, et forment des labyrinthes inextricables.<sup>13</sup>

After a preliminary exploration of the area, Cailliaud returned there in 1817 with Albanian and Greek miners, with the aim of resuming emerald mining. After overcoming the initial difficulties, due to the scarcity of water, he returned to work in some of the mines with forty workers. He was overwhelmed by the sheer size of the underground workings he found at Zabara in his second expedition, as well as by the number of mines he found seven leagues – about 30 km – from there:

Les travaux y ont été poussés jusqu'à huit cents pieds sous terre [267 m]: il s'y trouve des excavations assez vastes pour que quatre cents hommes y travaillent à-la-fois (...) carrières d'émeraude beaucoup plus considérables que les précédentes. Elles renferment peut-être mille excavations. (...) des chaussées de pierre d'une longue étendue ont été pratiquées pour faciliter les communications.<sup>14</sup>

From the description he gives, he is undoubtedly referring in this case to Middle Sikait, which is confirmed by the fact that he points out that half a league from there – about 2 km – to the south, he reaches *Sekket Bendar el Kebyr*, i.e. the

settlement of South Sikait, with its noteworthy temples.<sup>15</sup>

When Giovanni Battista Belzoni visited the area the next year, in 1818,<sup>16</sup> he found the miners still working here, but he did not pay too much attention to the mine workings themselves. Belzoni confirms the veracity of the information provided by Cailliaud:

In the description of the mines Mr. Caliid [sic] was pretty correct<sup>17</sup> (...). The mines or excavations of the ancients were all choked up with the rubbish of the upper part that had fallen in, and the labour to remove this rubbish was great, for the holes were very small, scarcely capable of containing the body of a man, crawling like a cameleon [sic].<sup>18</sup>

From Belzoni's account, it is clear that in the time since Cailliaud's departure, work had been focused mainly on cleaning up the old mines and enlarging the most promising seams in them - an activity, by the way, not without danger for miners:

They rose several times against their leaders, and in one instance two of them were killed. On the day we were there one of the poor wretches nearly fell a victim to the avaricious caprice of their powerful employer. As he was penetrating into one of the holes, part of the roof fell down upon him, and not only cut off his retreat, but nearly killed him on the spot.<sup>19</sup>

In any case, there is no mention of any major mining work, such as the above-mentioned shafts with derricks, which necessarily had to be excavated after the departure of the Italian explorer.

<sup>13</sup> Cailliaud 1821: 74.

<sup>14</sup> Cailliaud 1821: 71.

<sup>15</sup> Oller 2021.

<sup>16</sup> For a complete study on this visit, *vid.* Oller 2019.

<sup>17</sup> Belzoni 1820: 297.

<sup>18</sup> Belzoni 1820: 314.

<sup>19</sup> Belzoni 1820: 314.

Giovanni Battista Brocchi worked in this region in 1823, exploring Gebel Sikait and Gebel Zabara, his findings being incorporated in a posthumous work. Brocchi depicted the ancient mines as follows:

Cotali scavi hanno forma di pozzi, talvolta verticali, per lo più a piano inclinato, e la massima parte tortuosi, irregolari ed angusti".<sup>20</sup>

Describing the Sikait settlement – “Sacchetto” –, he wrote about the remarkable shaft that we have studied there, SKP-US001, which he called “il gran pozzo”:

Il più grande che abbia veduto è verso la sommità di una eminenza alla destra della valle, e sopra le rovine di alcuni caseggiati. Esso è quadrilungo: ha un lato di dodici piedi [3,90 m], l'altro di sei [1,95 m], e la profondità de trentatré [10,72 m].<sup>21</sup>

Since this huge shaft was not described by Cailliaud and Belzoni, we think that this one was excavated between 1818 and 1823, by the Albanian miners that worked there at that time. Moreover, if he considered the shaft SKP-US001 as the largest in the whole area, the rest of the huge shafts, which are clearly visible, had not yet been excavated.

In the spring of 1891, a scientific expedition was dispatched to the Sikait area, led by Ernest Ayscoghe Floyer, with the purpose of making a detailed examination of the ancient workings. The description of the mines by Floyer was included in the 5th and 6th editions of the well-known book *Precious Stones and Gems* of the London jeweler Edwin William Streeter.<sup>22</sup> According

to Floyer, in the 1819 expedition, sent here by Mohammed Ali Pasha under the supervision of Cailliaud, the Albanian miners “did an immense amount of work,” making “good square-sectioned shafts.” Floyer himself descended one of these shafts “and took out string to the length of 450 feet” – about 140 m –, finding a chamber in the bottom “where were ranged some thirty baskets of ore all ready for raising to the surface (...). From the chamber radiated further galleries which were not explored.” He also notes that “The descent was a steep incline, with occasional perpendicular drops of six to ten feet.” Floyer reproduces a similar description in his own article on his visit to Sikait “broad deep shafts of the Albanian miners who worked under Cailliaud in Muhammad Ali's time.”<sup>23</sup>

Special mention in this section should be made of the expedition dispatched in 1899-1900 to Wadi Sikait by Streeter & Co., led by the long-experienced emerald miner Allan A. Forster, with the participation of the geologist Donald Alexander MacAlister.<sup>24</sup> This expedition carried out an exhaustive study of the area from a geological point of view, studying the viability of the exploitation of emeralds, and producing the first general map of the Sikait-Nugrus area. Thanks to information provided by MacAlister, we know that they spent a number of months working in Wadi Sikait area from their camp established at the foot of Gebel Sikait on 28 December 1899, the remains of which are still visible today.<sup>25</sup> This author relates how they located and documented more than a hundred mines of different typologies and chronologies, defining seven or

<sup>20</sup> Brocchi 1841: 68–69. In his measurements, the author uses the *piede parigino* –32,484 cm.

<sup>21</sup> Brocchi 1841: 69; *vid. infra* Mining Zone A.

<sup>22</sup> Streeter 1892<sup>5</sup>: 222–226; Streeter 1898<sup>6</sup>: 203–207.

<sup>23</sup> Floyer 1892: 829.

<sup>24</sup> MacAlister 1900; Claremont 1913.

<sup>25</sup> MacAlister 1900: 541.

eight groups of mines within a radius of about two hours from Gebel Sikait, as well as a whole series of infrastructures linked to them – buildings, tombs, watch-towers – and at least five ruined settlements.

Concerning the results of this expedition, we also have the reports made by A. Forster, emerald miner and fellow of the Royal Geographical Society, which were submitted by him and E.W. Streeter to the general meeting of the shareholders in the Egyptian Gold and Gem Syndicate Ltd. at Winchester House, London, in May 1903.<sup>26</sup> According to their report, the Sikait mines “may be split up into seven different workings, and their extent will be gauged by the fact that in one of these workings he numbered over 200 mines.” Also, he speaks of Nugrus and Zabara mines. About the ancient mines, he affirms that “in no instance are the workings of any great depth. They simply follow the vein as long as it remains broad enough to give passage, and the rock was soft and easy enough to be worked by the primitive tools of the ancients.” Concerning the techniques used in these workings, Forster states that “They could (...) very easily be worked by a big adit being driven into the foot of the hill.” Streeter concludes the meeting, saying that “We have now at work on the mines a very competent staff under the able management of Mr. John James, a gentleman well-known to the mining world. We are opening up some of the old emerald mines, and hope before very long to be able to report satisfactory results.”

In June 28, 1905, the Syndicate of E.W. Streeter was registered in Egypt as a new company, called

Egyptian Gold and Emerald Company Ltd., formed:

To acquire what appears to be one of the most important mineral concessions in Egypt. The concession comprises an area of some 3,000 square miles, and it is reported upon by responsible engineers as being rich in gold, silver, lead, copper and emerald mines.<sup>27</sup>

The objects of the Company were:

To acquire from the Sudan Finance Syndicate, Limited, certain mining rights or concessions over lands in Egypt; to adopt an agreement with the above-named syndicate, E. W. Streeter and the Egyptian Gold and Gem Syndicate, Limited; and to carry on the business of miners, explorers, prospectors, winners and workers of and dealers in precious stones, company promoters, financiers, etc.<sup>28</sup>

According to internal reports of the Egyptian Geological Survey and Mining Authority,<sup>29</sup> the miners sent by Streeter worked in Sikait until 1905, and the last to work this area was the company of Jacques Bienenfeld, carrying out some explorations in Sikait and Umm Kabu during the years 1928-1930, and also at Gebel Ras Umm Gamil in 1929-1931, without obtaining promising results.<sup>30</sup>

In conclusion of this section, it can be stated with certainty that the large-scale mining works that have been detected in prospecting, specifically the mentioned *supra* deep square-sectioned shafts, whose typology and remarkable dimensions do not fit in at all with the ancient mine workings, correspond specifically to the excavations

carried out by Streeter's company (1899-1905).<sup>31</sup> Along with the direct information on this subject provided by the EGSMA reports,<sup>32</sup> are the traces of tools documented on the walls of these shafts, or the traces of the use of mining derricks, located at their entrances, which provide further solid evidence. In any case, we cannot discount that some of the squared vertical shafts, of lesser size, can be assigned to the Albanian miners who accompanied Cailliaud and continued the works after his departure, or to the later expeditions of Bienenfeld (1928-1930) and James (early 1930's).

## 2 | Mining Zones (SKMZ)

At the moment, up to twelve mining zones have been identified in a 6 km long strip from North to South, with Sikait located approximately in the middle – Sikait Mining Zones (SKMZ) A to L (fig. 1). Therefore, we systematically surveyed the mining areas in South Sikait, Middle Sikait and North Sikait, and also in the area between South Sikait and Wadi Nugrus, that we called West Sikait.

In the course of the fieldwork, a detailed inventory of the underground workings was carried out, and each one assigned a code in the GIS database. This database also includes all of the previous information available about the respective mines, whether archaeological, historiographical or from previous fieldworks. Apart from documenting access to the mines, we have accessed most of them ourselves for a preliminary study, carrying out an accurate survey of

two of the most relevant –SKP-US015 and SKP-US125. By the end of the 2021 season, some one hundred and fifty mines have been identified. The total area so far of the delimited Mining Zones is about 100,000 m<sup>2</sup>.

The delimitation of these mining zones was made according to several criteria with the aid of the GIS. Firstly, the inventory includes all types of underground structures; although most of them correspond to underground mining, this criterion was chosen because it has been verified that there were mining operations which, after being abandoned, were transformed into storage spaces or even religious and funerary structures.<sup>33</sup> Secondly, a minimum of four underground structures, with significant vertical or horizontal development, have been considered to define a zone. The rest of the structures have been listed as isolated, while further surveying is required in order to establish new zones or to clarify the limits of those already defined. Finally, the delimitation of zones was established on the basis of 25 m radius buffers measured from the entrances, which we estimate to be the average extent of underground galleries, as well as being the area of the open-air mining operations linked to them.

The delimited mining zones include a good number of open-cast mining pits and open-cut trenches that follow the quartz/pegmatite veins within the phlogopite schist, which in some cases followed these veins underground, becoming shafts, adits and tunnels. Given the difficulty of individualizing them, we have considered these open-air works as part of the zones, as many of

<sup>26</sup> *The Economist. Weekly Commercial Times* vol. LXI, n°3116 – May 16, 1903, p. 891. We wish to thank Dr. J.A. Harrell for providing us with this useful information.

<sup>27</sup> *The Egyptian Gazette* n°7237 – July 11, 1905.

<sup>28</sup> *The Egyptian Gazette* n°7238 – July 12, 1905.

<sup>29</sup> Hawari 1934; EGSMA 1951a: 86–87; EGSMA 1951b. We wish to thank Dr. J.A. Harrell for providing us with these reports.

<sup>30</sup> Ismalun 1943: 57–58; cf. Harrell 2006: 5.

<sup>31</sup> Judging by the photographs and the reports available, we associate a good number of mines, labelled with huge painted letters of the acronym “AF” – which we interpret as the initials of Allan A. Forster, leader of the expedition – followed by correlative numbers, with the expedition dispatched by Streeter.

<sup>32</sup> EGSMA 1951a: 91; *vid infra* the section dedicated to Zone I.

<sup>33</sup> Some of the buildings in South Sikait incorporate underground structures that were excavated in the talc schist bedrock. As Harrell (2006: 5) rightly points out, “although these rooms resemble some of the mine workings, they cannot be the result of mining because the talc schist contains no beryl.”

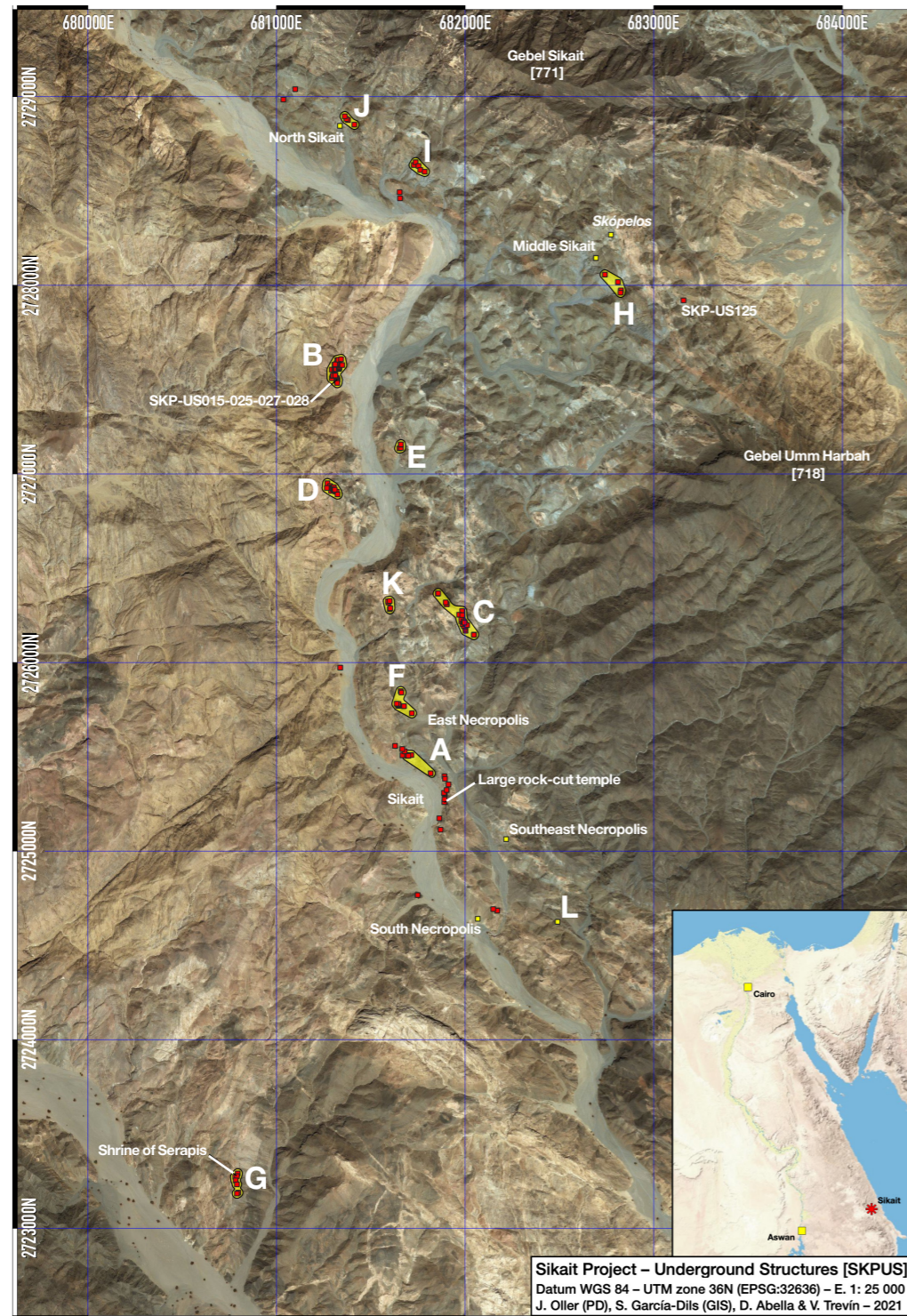


Figure 1. General map of the Mining Zones in Wadi Sikait area (Sikait Project).

them extend across dozens of metres along the mountain slopes, as well as being distributed over several benches.

These areas, except for Zone A in South Sikait, have similar features and their analysis shows how the mining work was structured and how logistical infrastructures accompanied these operations. The survey enabled the identification of small villages, necropolises, cairns, ramps, pathways, working zones besides the mines, watchtowers, etc., showing the complexity and intensity of the processes associated to obtaining beryl. Most of the work took place in the Roman and Early Byzantine period, but as already has been noted *supra*, the presence of 19–20th centuries structures and mine workings indicates that the interest in Egyptian emeralds continued until recent times.

## 2.1 | Zone A

Zone A is located inside the place that is commonly referred to by the historiography as “Sikait” or “South Village”, the main settlement of all the mining area, extended in both sides of the wadi.<sup>34</sup> The mining zone covers 10,710 m<sup>2</sup>, on the northeast slope of the wadi, at around 340–360 m a.s.l., consisting mainly in open-cast works.

There are just four subterranean structures that are clearly mine workings, from different chronologies. The first of them is the shaft SKP-US002, which joins with the adit SKP-US013 in a single underground mine. The entrance to SKP-US002 is a rectangular mouth, measuring 1.88 m (NW-SE) x 1.13 m (NE-SW), giving access to a shaft that descends to a depth of -4.57 m, with carefully excavated and regularised interior

walls (fig. 2). From its base, it gives access to a main gallery that follows a course of 255° SW, beginning its development horizontally, to then rise with a slope of +30°, until it comes to the surface through the narrow mouth SKP-US013, with a total length of 8.90 m. At the access to the horizontal section from the base of the shaft, the miners found a large block that threatened to collapse from the ceiling, and decided to reinforce the gallery by filling it with tailings from the excavation, resulting in a structure 1.10 m wide by 0.70 m high, with a depth of 0.40 m or more (fig. 3). The morphology of the mine indicates the Roman period. From this period, there are other two mines of little underground development, SKP-US012 and SKP-US014.

The shaft SKP-US001 opens with an irregularly shaped access, with maximum dimensions of 7.11 m (W-E) x 6.96 m (N-S). At a depth of -4.3 m, the shaft is regularised, presenting a practically square section of 3.70 m (NW-SE) x 3.40 m (NE-SW). The shaft develops to a relative depth of -12 m below the surface, with a stepped access on the southern and western sides, consisting of up to six large steps, interspersed at a distance of 1.5–2.0 m between them (fig. 4). Taking into account the morphology of the shaft, and also the description offered by Brocchi,<sup>35</sup> its chronology would be between 1818 and 1823, perhaps being amplified in subsequent expeditions to the area.

Apart from these four mines, most of the underground structures in Zone A consist of small warehouses linked to nearby buildings: SKP-US003 to SKP-US008, SKP-US010, SKP-US011, SKP-US143 and SKP-US144.

Next to Zone A, we have also included several underground structures of evident religious/funerary character in the GIS. In the north, SKP-US145 is a small burial place carved in the

<sup>34</sup> Oller *et alii* 2021; Oller *et alii* 2022.

<sup>35</sup> *Vid. supra*.



Figure 2. Entrance to mine SKP-US002 (Sikait Project).

bedrock. In the south, the shrines SKP-US009 and SKP-US155 (mountain shrine), as well as the temples SKP-US153 (large rock-cut temple) and SKP-US154 (small rock-cut temple).

## 2.2 | Zone B

In Zone B, measuring 12,840 m<sup>2</sup>, a total of forty-six underground structures have been located around 380-400 m a.s.l., with codes from SKP-US015 to SKP-US056 and from SKP-US126 to SKP-US129. All of them were characterized as subterranean mines, except for SKP-US050, a deep circular section shaft located at the base lev-

el of the wadi which was identified as a water well. In this area, exploration and surveying of the mining complex SKPUS-015-026-027-028-029-030 was completed in the last campaign.

## 2.3 | Zone C

In Zone C, with 19,760 m<sup>2</sup>, up to twenty-six subterranean structures have been located at around 410-430 m a.s.l., with codes from SKP-US057 to SKP-US081, all of them mine workings, plus SKP-US119, a small burial place carved in the bedrock. The SKP-US057 mine has been documented in this area, consisting of a very inclined



Figure 3. Inside mine SKP-US002 (Sikait Project).

40 m shaft, almost vertical, with a complex system of steps carved into one of its walls; its date is clearly not ancient, and could correspond to the mine workings carried out after the Cailliaud expedition by the Albanian miners who continued the exploration works in Sikait for some time (fig. 5).

## 2.4 | Zone D

This zone corresponds with the Area n<sup>o</sup>7 defined by the 1950-1951 EGSMA expedition, described as “An area (...) of a few tunnels, occupy the head of a small schistic hill surrounded by red gneiss. Few fine crystals were collected from the dump.”<sup>36</sup> The

zone covers 7,610 m<sup>2</sup>, with fourteen underground structures located at around 410-430 m a.s.l., with codes from SKP-US087 to SKP-US100. From the Roman period, it is worth mentioning the mine SKP-US095, where mining techniques similar to those inside SKP-US015 have been registered.

## 2.5 | Zone E

It corresponds with the Area n<sup>o</sup>8 defined by the 1950-1951 EGSMA expedition:

Another group of two mines are situated on the other side of wadi Sikait opposite to the previous



Figure 4. The shaft SKP-US001 (Sikait Project).



Figure 5. Shaft SKP-US057. Note the steps in the left-hand side (Sikait Project).



Figure 6. Shrine probably dedicated to Serapis, in West Sikait – Mining Zone G (Sikait Project).

area but slightly to the north. The more important of these two mines begins with an inclined gallery that widens inside and branches in no systematic manner after the mica schist. No agreeable crystal of beryl was found either inside the mine or out in the dump; but something particular in the mica schist caught the attention of recent miners. A horizontal clean and wide adit or cross-cut was dug on the other side of the hill for about 12 metres, probably with the intention to reach the mica schist band but eventually did not reach it.<sup>37</sup>

In this zone, extended for 3,280 m<sup>2</sup>, four subterranean structures have been located around

380-390 m a.s.l., with codes SKP-US102, SKP-US103, SKP-US105 and SKP-US106.

## 2.6 | Zone F

In Zone F, with 11,050 m<sup>2</sup>, ten underground structures (all of them mines) have been located at around 370-390 m a.s.l., with codes from SKP-US109 to SKP-US118. The water well SKP-US101 is about 320 m northwest of the area's boundaries, located at the base level of the wadi.

<sup>36</sup> EGSMA 1951a: 89.

<sup>37</sup> EGSMA 1951a: 89–90.

## 2.7 | Zone G

We have named this sector inside the Sikait mining district West Sikait. It corresponds with Area n<sup>o</sup>1, that extends “between wadi Nugrus and wadi Sikeit,” defined by the EGSMA expedition.<sup>38</sup> They describe the area as follows: “The mines about 20 in number are mostly restricted to the northern side of the khor. Dumps are nearly all washed away by rains, and most of the entrances are closed by debris. Few are still open, which are narrow and winding.” Systematic survey of this area is planned for the 2022 season of the Sikait Project; in the pre-

liminary exploration of the zone, we have defined a 7,430 m<sup>2</sup> area. Seven remarkable Roman mines, with codes from SKP-US146 to SKP-US152, have been found on the western slope of this secondary wadi tributary of the Wadi Nugrus at 390 m a.s.l. We have explored over one hundred metres of galleries in our first exploration of the area, and the huge dumps that can be seen on the hillside prove the extent of the underground works. A shrine, carved in the bedrock and probably dedicated to Serapis has been documented next to the entrance to SKP-US148 (fig. 6).<sup>39</sup> In addition, in the highest part of the hills, other structures have

<sup>38</sup> EGSMA 1951a: 87.



been identified. First, a large tripartite building composed by a courtyard  $4.70 \times 4.50$  m, followed by a hall  $1.35 \times 3.45$  m, accessed by a ramp – and a third room, more elevated and smaller, that seems to contain some kind of altar ( $1 \times 0.85$  m). The architecture of the building, with three consecutive rooms and a last one acting as a possible *cella*, recalls the temples located in Sikait, and we propose the possibility of dealing with another sacred space related to the mining community. Besides this structure, we have documented a small necropolis composed of some twenty-three tombs, mainly circular tumuli made of local cobbles, all of them looted. First analysis of the recovered pottery indicates the Early Roman period. As far as we know, this is the first time that these structures have been mentioned and they reinforce the relevance of this area within the context of the Wadi Sikait mining zone.

## 2.8 | Zone H

This zone, which covers  $10,260 \text{ m}^2$ , is located to the south of the Middle Sikait settlement, at 470-490 m a.s.l. There, five mines of moderate size have been found, with codes from SKP-US120 to SKP-US124. Following a well-marked path from the main settlement, 300 m to the east of the boundaries of the zone, we reached the entrance of SKP-US125, the largest mine found to date anywhere in the Wadi Sikait area.<sup>40</sup>

## 2.9 | Zone I

Our Zones H and I, along with the isolated mines SKP-US136 and SKP-US137, in the west,

and SKP-US125, in the east, correspond with Area nº10, called “*Gebel Sikeit itself*”, defined by the 1950-1951 EGSMA expedition.<sup>41</sup> Their report offers a vivid description of the area and their mines, which we have found to be very accurate:

This area extending for not less than 2 Kilometres, was thoroughly mined, and not a single band of black mica was left, at least, unprospected. Mining operations are not of the same mode: for while some mines are primitive with narrow and winding galleries with bad ventilation, others are much more advanced and comfortable. It can be seen also that some of the primitive mines were reopened by later miners.

The report also contains specific information on the expedition sent by Streeter in 1899-1900:

The Mac Allister [sic] expedition who visited the area in 1899, traced on of the mica schist bands which was worked anciently and opened a new horizontal adit of 10 metres length which bends to the left for another 15 metres. A thin vein of black mica 20 cm wide with stringers of quartz is seen at the end of the gallery. The expedition advanced for some 30 cm in this mica, but it apparently produced no beryl.

In the same report, we find the confirmation about the origin of the deep squared shafts:

A deep rectangular shaft –our SKP-US136– was also dug by the Mac Allister Expedition to a depth of more than 30 metres near an ancient working. They also cleaned the northern well of Wadi Sikeit at the foot of the mountain. Its depth is 34 metres and its water is brackish.

Concerning the characteristics of the mineral deposits in this area, they conclude that “Our inspection of tens of mines and dumps did not give

<sup>39</sup> This shrine had previously been identified by the Streeter expedition during their visit in the area; MacAlister 1900: 544. Later, in the course of the 1950–1951 EGSMA expedition, the Arabic graffiti that nowadays surround the shrine was made.

<sup>40</sup> *Vid. infra*.

<sup>41</sup> EGSMA 1951a: 90–91.



Figure 7. Shaft SKP-US136. Note the traces of the use of a derrick with four supports (Sikait Project).

satisfactory results regarding the quantity and quality of beryl.”

In the  $6,480 \text{ m}^2$  Zone I, located about 400 m southeast of North Sikait, five structures have been located at around 420 m a.s.l., with codes from SKP-US138 to SKP-US142.<sup>42</sup> South of the limits of this zone, 140 m away, at the level of the wadi and at 390 m a.s.l., two entrances, SKP-US136 and SKP-US137, were opened by the

Streeter expedition. The first of them consists of a remarkable, absolutely vertical exploration shaft with a depth of about 30 m, with traces at its entrance of the use of a derrick with four supports, from which a winch was hung to extract debris and to transport workers (fig. 7). Regarding the second mine, SKP-US137, its entrance is protected from falling water, from the nearby secondary tributary of the wadi, by a stone wall.

<sup>42</sup> The mine SKP-US138 received the code “AF.19” by the Streeter expedition, and SKP-US141 corresponds to “AF.18”.

### 2.10 | Zone J

Our Zone J, along with the isolated SKP-US134 and SKP-US135 mines, correspond with the Area n°9, called “Hemeira”, described by the 1950-1951 EGSMA expedition as:

Area west of wadi Sikeit called Hemeira (...). Some low hills of creamy talc, schist with ferruginous concretions associated with the beryl bearing mica schist (...). The group of mines is about 40 in number and is of no importance as the dumps are practically empty.<sup>43</sup>

This 5,290 m<sup>2</sup> zone is located immediately to the northeast of the North Sikeit settlement. There, in our preliminary survey of the zone, four mines have been located, at 410 m a.s.l., with assigned codes from SKP-US130 to SKP-US133.<sup>44</sup> In the SKP-US130 mine, we have documented how the original entrance, from the Roman period, was significantly enlarged by the Streeter expedition (fig. 8). Also resulting from the works carried out by the same British company, is the shaft SKP-US133, about 25 m deep, with similar characteristics to the above-mentioned SKP-US136, along with the mines SKP-US134 and SKP-US135, located 300 m to the northwest of the limits of this zone.

### 2.11 | Zone K

Zone K covers 4,570 m<sup>2</sup>, containing five mines at 400-420 m a.s.l., with assigned codes from SKP-US082 to SKP-US086.

### 2.12 | Zone L

This corresponds with Area n°5, “Area south of Wadi Sikeit”, defined by the 1950-1951 EGSMA

expedition.<sup>45</sup> According to the description in their report, “Some 20 old mines are present, nearly all filled [with] silt and rain wash (...). There are no visible beryl crystals inside the mines, and the dumps are poor.” Systematic survey of this area, located in a secondary tributary of the Wadi Sikeit, is planned for the 2022 season of the Sikeit Project.

### 2.13 | Isolated Mines SKP-US107 and SKP-US108

These two mines, SKP-US107 and SKP-US108, are located at 340 m a.s.l., on the western slope of a secondary tributary of the wadi Sikeit, between Mining Zones A and L. The subterranean structures were originally Roman mines, reopened and amplified in the early 20th century by the excavation of large trenches.

## 3 | Ancient Underground Mining Methods

As has been noted *supra*, ancient underground mines of Sikeit are described by early explorers as being primitive in construction, with long, narrow and tortuous galleries, excavated in such a way as to barely allow the passage of one person, making it necessary to crawl through most of them.<sup>46</sup> Most of the adits are sloped galleries, which follow the ore veins, reserving the use of vertical shafts for the connection between the different levels of the mine, as have been seen in SKP-US125.

Within the underground exploitations, we have documented several different mining techniques, which have been carried out according to the geological and geotechnical conditions

<sup>43</sup> EGSMA 1951a: 89–90.

<sup>44</sup> The mine SKP-US130 received the code “6.” by the Streeter expedition, and SKP-US131 corresponds to “5+AF”.

<sup>45</sup> EGSMA 1951a: 89.

<sup>46</sup> Belzoni 1820: 314; Cailliaud 1821: 62, 74; MacAlister 1900: 544; EGSMA 1951a: 86, 91.



Figure 8. Adit SKP-US130 in 1900 and now (Streeter Expedition – Royal Geographical Society / Sikeit Project).

and the means available. In mines like SKPUS-015-026-027-028-029-030, with a predominantly horizontal development, we have registered the use of a pillar-and-chamber method of working, with the presence of big pillars of country rock being left for roof support. In mines with vertical development (SKP-US125), or when different levels are present in the mainly horizontal or sloped ones (SKPUS-015-026-027-028-029-030), steps were carved in the walls to facilitate the transit of the miners.

Inside the mines, niches were carved in the walls at regular intervals to hold oil lamps, addressing the fundamental issue of interior lighting (fig. 9). Considering the adverse environmental conditions underground,<sup>47</sup> the question of water supply must have been equally important, and consequently we interpret a number of ceramic fragments found in the mines as water containers, e.g. pottery flasks.

In addition to ropes and cords of different lengths and diameters, we have documented numerous fragments of esparto grass fabric, of different thicknesses, which we do not automatically interpret in all the cases as the remains of baskets (fig. 10). Thus, while the thicker ones could be interpreted in this way, other thinner ones probably correspond to, e.g., protective covers for pottery flasks,<sup>48</sup> or even part of the miners' work protection, such as kneepads, essential for crawling for hours through the tortuous galleries.<sup>49</sup>

At the time of writing, we have not located any tools inside the mines, but we have been

able to extensively document their marks on the walls, usually on the schistic ones. The most common tool marks registered were made by flat-edged hammered iron chisels (rather than by flat-edged picks), 10 to 30 mm wide and up to 30 cm in length. Much more rarely, we have also detected V-shaped marks left by pointed picks.

### 3.1 | Two Case Studies: the Mines SKP-US015-025-027-028 and SKP-US125

The survey and the documentation of the mining structures were complemented with the digital survey of two of the mines, the SKP-US125 being especially remarkable because of its dimensions.

These Roman mines are poorly accessible, with narrow passages, very low ceilings, etc.; use of the traditional method of compass-clinometer would have been time-consuming, difficult, and not particularly accurate. Therefore, we used a completely paperless alternative (Leica DistoX2)<sup>50</sup> (fig. 11) and processed the data in real time on a tablet, which was linked to the measuring device with Bluetooth (fig. 12).<sup>51</sup>

This assessment was essential for improving our knowledge of emerald mining for, although several explorers and researchers had entered the mines before, this was the first time that

<sup>47</sup> In January 2021, we measured deep inside the mines, with a stable air temperature of between 30–31°C, and a relative humidity of 24–25%, these are the most benign working conditions in Sikait mines, being much worse in summer.

<sup>48</sup> In *Hispania Citerior*, there is an outstanding example of a pottery flask with an esparto grass protective cover, found in the Roman mine of La Unión (Cartagena), which is on display in the Municipal Archaeological Museum of Cartagena.

<sup>49</sup> For instance, in *Hispania Citerior*, inside the Roman mine of La Fortuna (Mazarrón, Murcia, Spain) kneepads woven from esparto grass were found, with two cords to hold them to the legs; Gossé 1942: 53–54 and Plate V.4.

<sup>50</sup> The Disto X2 is a hand-held electronic measuring device composed of a Leica DistoX310 laser distance meter retrofitted with a tilt-compensated (3D) digital compass, clinometer, along with a Bluetooth module for wireless data transfer.

<sup>51</sup> For a recent general overview on this digital survey system applied to archaeology, *vid.* Almeida-Warren, Braun and Carvalho 2021.

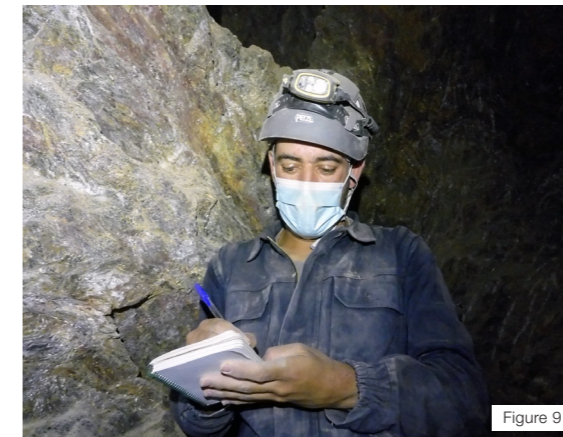


Figure 9



Figure 11



Figure 10



Figure 12

Figure 9. Documenting the niches of the oil lamps, inside mine SKP-US015-025-027-028 (Sikait Project). Figure 10. Fragments of esparto grass fabric inside mine SKPUS-015-025-027-028 (Sikait Project). Figure 11. Taking measures with the Leica DistoX2 inside mine SKPUS-125 (Sikait Project). Figure 12. Processing the survey data real-time in a tablet, inside mine SKPUS-125 (Sikait Project).

detailed documentation of the interior of a Roman beryl mine had been performed. The preliminary results show that the decision to focus the study on the mines was correct, as the large amount of data obtained has dramatically increased our knowledge of emerald mining in the Roman period, not only in terms of the extraction methods and the structure and typology of the mines but, thanks to the inscriptions found inside SKP-US015 and SKP-US125, also of the people who worked in the mines and the way the production was recorded.

### 3.2 | Mine SKP-US015-026-027-028-029-030

The SKPUS-015-026-027-028-029-030 mining complex, (the numbers are the codes of the six different entrances), is located in Zone B, at 380 m a.s.l., at the western slope of the Wadi Sikait. The complex at first consisted of an open-cast mine, which was later excavated further as a trench, following the mineral vein, perpendicular to the slope, with a width of 4.90 m and an open-air length of 5.08 m, continuing underground with a width of 2.58 m, a length of 2.76 m and a height



Figure 13. Main entrance to mine SKP-US015-026-027-028-029-030 (Sikait Project).

of 2.30 m. At this point, a central pillar was left and the excavation was divided into two galleries that continue in parallel; the one on the right was extended by a further 0.87 m, with a width of 0.65 m and a height of 0.86 m; the one on the left was 2.07 m, 1.50 m wide and 1.66 m high. Following this, the ancient miners opened adits from the trench (SKPUS-015) and in the slope of the hill (SKPUS-026-027-028-029-030), which were then joined underground, becoming a single underground mining complex (fig. 13). We have surveyed 202 m of galleries here, which reached a maximum depth of -12.5 m (station n°15.2) from the open-cast trench (fig. 14).

As is usual for Roman mines, the entrances to these adits are very narrow, giving access to tortuous galleries with a width and height of around 0.80-1.20 m. Inside the mine, which is mainly horizontal, the pillar-and-chamber method was used, with big pillars of country rock being left for roof support. The galleries are on several levels, with steps carved in the walls to facilitate the transit of the miners.

Concerning the typology of the galleries, we have noted that the older ones, clearly from the early Roman period, present a quadrangular profile on the ceiling, while the more recent ones have an irregular rounded one. In the second period of

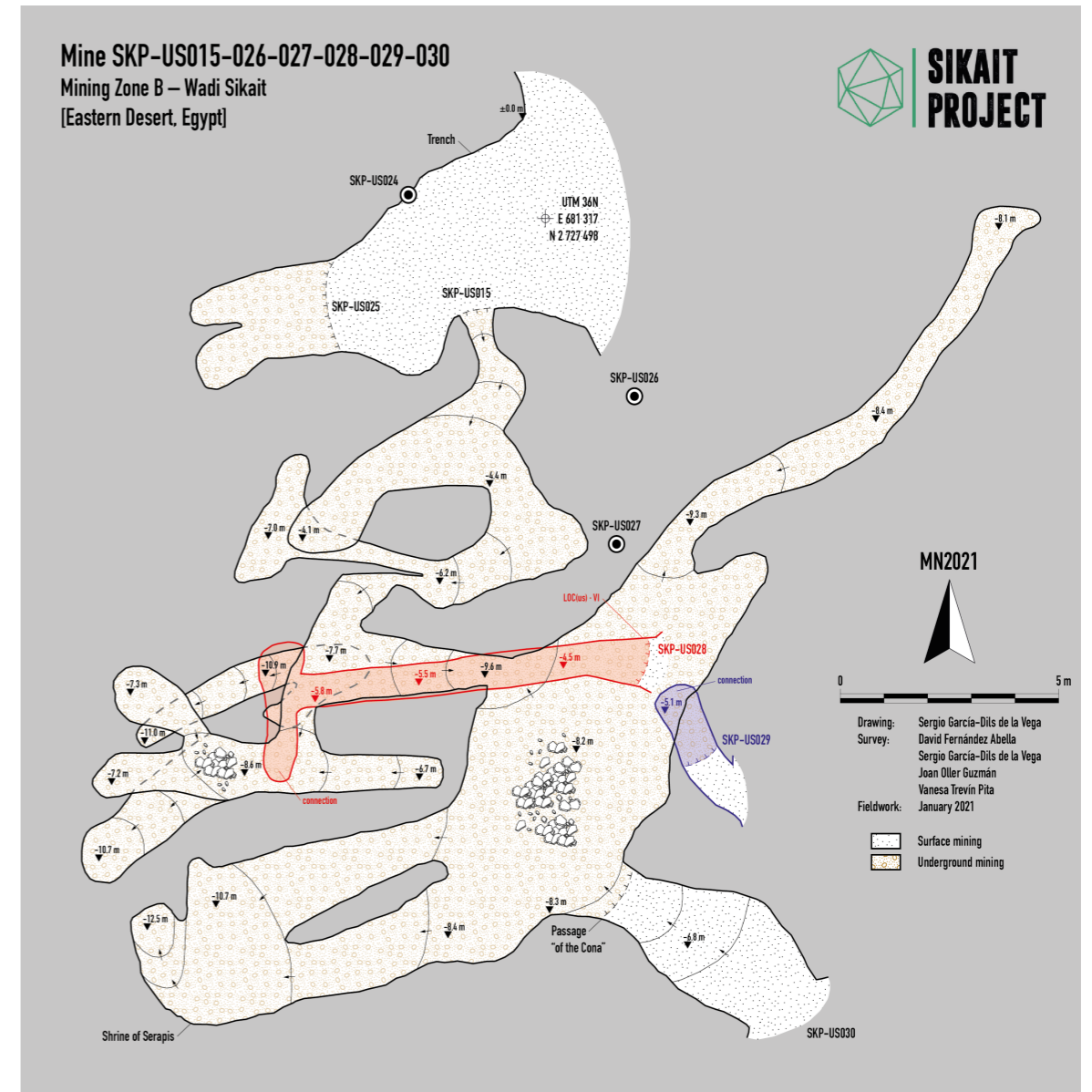


Figure 14. Survey of the mine SKP-US015-026-027-028-029-030 (Sikait Project).

working inside the mine, the oldest and already exhausted galleries were filled with the debris of the new excavations. Nevertheless, the rubble was carefully deposited, leaving enough space in these abandoned galleries to crawl through.

Regarding the archaeological evidence, in one of the chambers a fragment of *lucerna* with figural decoration was found, inside a niche carved in the wall (station n°15.1), featuring an image that can unequivocally be identified with the god



Figure 15. Fragment of *lucerna* with a representation of the god Serapis, inside mine SKP-US015-026-027-028-029-030 (Sikait Project).

Serapis (fig. 15). Pottery and textile fragments, as well as the remains of ropes and esparto grass fabric were also found in different parts of the mine (see fig. 10). For the date of these works, the only diagnostic pottery fragment recovered is a trefoil flagon from the Trajanic period.<sup>52</sup> In the entrance to the adit SKP-US027 (station n°33), a graffito with the text “*LOC(us) · VI*” was recorded, which we interpret as a mining record from the Roman period.<sup>53</sup>

### 3.3 | The Mine SKP-US125

This underground exploitation was extensively documented and surveyed by our team in the 2021 campaign, verifying that its morphology is qualitatively and quantitatively different from the other mines that have been recorded. The entrance to the mine is located at an altitude of 480 m a.s.l., 300 m away from the eastern boundaries of the Mining Zone H, in Middle Sikait,

<sup>52</sup> Tomber 2006: 62–63.

<sup>53</sup> The graffito will be edited in a paper on the epigraphic evidence documented in 2020–2021 seasons of the *Sikait Project*, which is currently in the process of publication; also: Oller *et alii* 2021: 139–140.



Figure 16. Detail of the entrance of mine SKP-US125. Empty frame probably used to place an inscription (Sikait Project).

following a very well-marked path from this settlement. On the right wall of this entrance, in a visible place, there is an empty frame carved onto the rock, which was probably used to place an inscription that is now lost. Its dimensions are 12 x 48 cm, with a depth of 4 mm. In the centre there is a small concavity with a perforation, which would have been used to fix a plaque (fig. 16).<sup>54</sup>

This entrance leads to an inclined gallery (fig. 17), with steps distributed at regular intervals, followed by two successive levels of adits and a shaft (fig. 18). Inside, we have surveyed 388 m of shafts and galleries, exploring more than 500 m in total,<sup>55</sup> which reached a maximum depth of -32.7 m (station n°129) from the primitive entrance to the mine, located 8 m away, northwest

<sup>54</sup> The missing inscription was presumably made on slate, a rock that is ubiquitous in the area, or perhaps on bronze, containing the name of the operation or some kind of commemorative text related to this mine. Sidebotham, Hense and Nouwens (2008: 337) refer to this feature as a “*tabula rasa* carved beside the entrance”, probably a recording method for “indicating the mine number and labor force assigned here.”

<sup>55</sup> Finishing the survey of this mine is planned for the 2022 season.



Figure 17. Entrance of mine SKP-US125 (Sikait Project).



Figure 18. Exploring the main shaft of mine SKP-US125 (Sikait Project).

of SKP-US125. This original access, narrower and more uncomfortable than SKP-US125, was carefully sealed off in Roman times, probably as a consequence of the progress made inside the mine, which required better working conditions, as well as a stricter control of the access to the exploitation.

In general terms, absence of artifacts in most galleries is striking. There are no abandoned tools, no *lucernae*, no remains of ropes or baskets, and no debris from ancient excavation work.

<sup>56</sup> Given the high temperatures that would be reached in summer inside the mines, it is likely that the mining expeditions were seasonal. *Vid. supra* n. 47.

<sup>57</sup> *Vid. supra* n. 53.

<sup>58</sup> For an overview of the features and evolution of this *legio* in Roman Egypt, *vid.* Wolff 2000.

<sup>59</sup> *Cf.* Shaw and Bunbury 2003: 207–209; Harrell 2006: 6.

Some debris was detected only in areas belonging to later phases of exploitation, perhaps in Late Antiquity. These circumstances indicate that the work in this mine, which is particularly demanding because of its development and depth, would most probably be strictly organised and, moreover, had seasonal character.<sup>56</sup> In other words, once the work had been completed in a given season, efforts would be made to clean up the mine for the following one.

Among the most significant finds are an *ostrakon* (station n°30.2) and several parietal graffiti. Of particular interest is one with the text “*LEG(io) III C(yrenaica)*”, located in the deepest part of the mine, coinciding with the end of the excavation of the main shaft (station n°143).<sup>57</sup> Thus, an initial chronology of the mine can be suggesting as being between the reigns of Augustus and Trajan, when this legion was stationed in Egypt.<sup>58</sup>

#### 4 | Processing Techniques

Considering the great piles of fine-grained tailings found around most of the ancient workings, it seems that the removal of beryl crystals from the schist was done in the immediate vicinity of the mines, and therefore unusually small or poor-quality fragments of the mined material have been left behind. Near the entrances of the documented Roman mines, this fine-grained waste takes the form of terraces, comprising groups of small circular heaps, with diameters from 0.5 to 3 m, including each of these heaps of emerald fragments inside their central circular depressions.<sup>59</sup> The absence of these characteristic

circular heaps near the mines is a clear clue for distinguishing those of 19-20th centuries from the ancient ones.

The prospectors of EGSMA expedition noted that:

Pieces of mica schist were ground at the entrance of mines for search of emerald, grinding was done by mortars of country rock and balls of white quartz handful in size. The balls are frequently seen in the neighborhood of the mines and in the ruins of Medinet Nugrus and Medinet Sikeit.<sup>60</sup>

In the absence of direct evidence on this matter, the use of these mortars does not seem reasonable in principle, as they would most probably cause the beryl crystals to break. Thus, it seems much more reasonable that the crystals were extracted by hand, using some kind of sharp-pointed metal tool.<sup>61</sup>

As for the further treatment of the emeralds/beryls after their extraction, the research is unanimous that these gemstones were not faceted, but that the intersection edges of the crystal faces were polished. In Roman jewelry, therefore, the natural hexagonal prisms were almost directly used, which were fixed into metal settings or drilled along the axis of the prism and strung as beads. Thus, as can be seen in the well-known emerald

necklace from Scafati, dated between the 1st century BC and the 1st century AD, these gems are basically polished prism sections of Egyptian crystals, alternating with gold links and pearls.<sup>62</sup>

Regarding the polishing of the crystals, given the hardness of the beryl, a very abrasive rock of high hardness must have been used, such as emery stone, rich in corundum, supplied from the island of Naxos and from several places in Asia Minor.<sup>63</sup> In this respect, Theophrastus referred to emery as the abrasive par excellence for engraving gems,<sup>64</sup> information confirmed by Pliny.<sup>65</sup>

An imperfection inherent in emeralds is cracking, systematically appearing in concealed fissures in the stones.<sup>66</sup> The most widespread traditional technique for concealing these cracks in the final treatment of crystals, well known since Antiquity, consists of treating the gems with oil.<sup>67</sup> So, the practice of “oiling” rough crystals, which continues today, consisted then in filling in the natural fissures with some suitable fluid –olive oil in this case– enhancing the colour and giving an impression of flawlessness.<sup>68</sup> In the first half of the 14th century, Shihāb ad-Dīn Aḥmad ibn Faḍl Allāh al-ʿUmārī, in his work *Masālik al-abṣār fi mamālik al-amṣār*, gave the following detailed account about handling the new-found emeralds, which he had received from Abder-Rahim, who

60 EGSMA 1951a: 86. On this subject, Klemm and Klemm (2013: 82) note that “in Abu Mureiwat are very small anvil stones with tennis ball-sized spherical hammer stones indicative of more cautious pounding processes, possibly comparable to those known from Egyptian emerald mines at Sikait, where they have served in the careful extraction of emeralds contained in quartz chunks.”

61 Cf. Harrell 2006: 6.

62 Sinkankas 1989: 8, 16. Cf. Jennings *et alii*. 1993: 101, fig. 1; Giuliani *et alii* 2001: 23; Harrell 2006: 2.

63 Sinkankas 1989: 325.

64 Theophr. *Lap.* 19, 44.

65 “Signis e marmore poliendis gemmisque etiam scalpendis atque limandis Naxium diu placuit ante alia”, Plin. HN 36.54.

66 Sinkankas 1989: 184–186; Jennings *et alii*. 1993: 105.

67 “*qui-dam> tamen virides nasci videntur, quoniam oleo meliores fiunt, neque est aliorum amplitudo maior*”, Plin. HN 37.71.4-6; “*Laudantur austeri. Sed mero viridi proficiunt oleo, quamvis natura inbuantur*”, Solin. 15.27; “*Smaragdi autem mero et viridi proficiunt oleo, quamvis natura inbuantur*”, Isid. Etym. 16.7.2.

68 Sinkankas 1989: 293.

had been employed at the mine as a notary public: “Wenn man einen Smaragd findet, wirft man ihn in heisses Oel, dann legt man ihn in Baumwolle, die man mit einem Stück Leinwand oder anderem Stoffe umwickelt”.<sup>69</sup> In this regard, it is worth mentioning that we have found fragments of fine textiles inside the mines that do not fit at all with miners’ work clothes, but they do fit with the described emeralds’ wrapping for their transport.

Concerning the last stage of the treatment of the beryls/emeralds, or even their falsification, a detailed description of the process is to be found in the *Papyrus Graecus Holmiensis*, a collection of craft recipes compiled in Egypt in the time of Constantine.<sup>70</sup> The fifteen sheets of this papyrus contain 154 recipes for dyeing textiles, coloring gemstones, purifying pearls, and imitating gold and silver. From these, a total of thirteen recipes are dedicated to the emeralds,<sup>71</sup> and five to the beryls.<sup>72</sup>

## 5 | Gold Mines

We do not exclude the possibility that several of the 19–20th centuries mine workings documented around the Sikait area – even some ancient ones – correspond to gold mining prospecting excavations, considering that several mine workings, like some of the above-mentioned deep, squared shafts, seem to not follow any evident mineral vein directly related to beryl/emerald exploitation.

For instance, it is known that E.W. Streeter sued the Egyptian Gold and Gem Syndicate Limited in 1906, claiming that they had no right

or title to a certain concession or prospecting license. The published news specifies that:

Mr. Streeter applied to the Egyptian Government for a prospecting license. The mining concession was merely for precious stones, and did not give the right to the gold or minerals. The prospecting license was for three years. The holder was not allowed to keep any precious metals, but was allowed to see whether there was gold.<sup>73</sup>

Previously, in 1903, Streeter declared, “As to the prospect of finding gold in payable quantities I cannot speak so authoritatively [sic], because the expedition I sent out under Mr. Forster was ostensibly to search for emeralds. That gold exists, however, there is not the least doubt.”<sup>74</sup>

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69 Schneider and Arzruni 1892: 69.

70 Halleux 2002: 23.

71 Falsification –P. Holm. 17, 21, 32, 34, 42, 71, 76, 83, 84, 88–, coloring –P. Holm. 30, 74– and polishing –P. Holm. 37.

72 Fabrication –P. Holm. 39, 48, 63, 75– and coloring –P. Holm. 47.

73 *The Egyptian Gazette* n°7547 – July 17, 1906; *The Egyptian Gazette* n° 7550 – July 20, 1906.

74 *The Economist. Weekly Commercial Times* vol. LXI, n°3116 – May 16, 1903, p. 891.

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Amparo Errandonea  
aeamparo@gmail.com

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