Chert for the Masses... Mining Archaeology in Wadi el-Sheikh. A Preliminary Report

Michael Klaunzer, Felix Mustar and E. Christiana Köhler

Keywords

Ancient Egypt, opencast workings, deep mine workings, knapping places

Abstract

The chert mines of Wadi el-Sheikh in Middle-Egypt have been well known for over 100 years now; however, archaeological research on this important raw material source is still lacking. In 2014 and 2015 the Vienna Middle Egypt Project of the University of Vienna in cooperation with the University of Virginia and the Deutsches Bergbau-Museum Bochum conducted surveys and archaeological excavations in Wadi el-Sheikh. In this article new results concerning chert mining, mining technology and the organization of labor in this desert valley are described.

Introduction

The Wadi el-Sheikh in the Eastern Desert of Middle Egypt, approximately 150 km South of Cairo, between el-Fashn and Maghagha, expands in meandering tributaries over a length of 30+ km from the Nile valley to the southern Eastern Desert (Figure 1). Chert[1] layers are embedded in limestone host rock and have been exploited since prehistoric times (Köhler, Hart and Klaunzer, 2017, p.10-11). The amounts of material are striking. Mining remains, truly in a magnificent state of preservation, are found on the terraces left and right of the wadi bed.

The big game hunter Heywood Walter Seton-Karr was the first to describe the chert mines in Wadi el-Sheikh. It was due to his interest in archaeology and Paleolithic cultures that he recognized the sites as relics of ancient chert mining (Forbes, 1900). Over the course of two expeditions into the wadi in 1896 and 1897 he set up 15 camps for the collection of artifacts (Seton-Karr, 1898). He donated and sold the collected artifacts, including finished and semi-finished objects, to several museums in Europe and overseas (most objects were sold to the Merseyside Museum in Liverpool).

Even though the wadi and its ancient chert resources have been known for over 120 years now, little research has been done so far. Only a few researchers have visited Wadi el-Sheikh. These visits were exclusively short excursions to the mines and quarries, sometimes including artifact collection.[2]

In 1981 Gerd Weisgerber from the Deutsches Bergbau-Museum Bochum investigated the ancient remains of chert mining for only a single day. Nonetheless his observations are still a good introduction to mining archaeology and exploitation of chert (mining techniques, mining tools etc.) in Wadi el-Sheikh. Moreover he gives a detailed history of research from the beginnings to 1981 (Weisgerber, 1982, 1987).

Due to the initiative of E. Christiana Köhler a new research project is currently being formed. The venture is part of the Vienna Middle Egypt Project[3] that has been conducted under her leadership in cooperation with the Ministry of Antiquities in Egypt since 2014. In the following years the Wadi el-Sheikh and its ancient chert mines shall be investigated systematically and holistically in an interdisciplinary way.

During a four week campaign in November and December 2015 an international team with members representing the University of Vienna, University of Virginia and Deutsches Bergbau-Museum Bochum conducted several surveys as well as archaeological investigations in Wadi el-Sheikh. Some of the initial results of the investigation are already available (Köhler, Hart and Klaunzer, 2017). The aim of the current article is to describe aspects of the chert mining activities in Wadi el-Sheikh in greater detail. It combines the State of the Art of mining archaeological research and the latest observations and new results made during investigations in 2015 including the first archaeological excavations ever made in

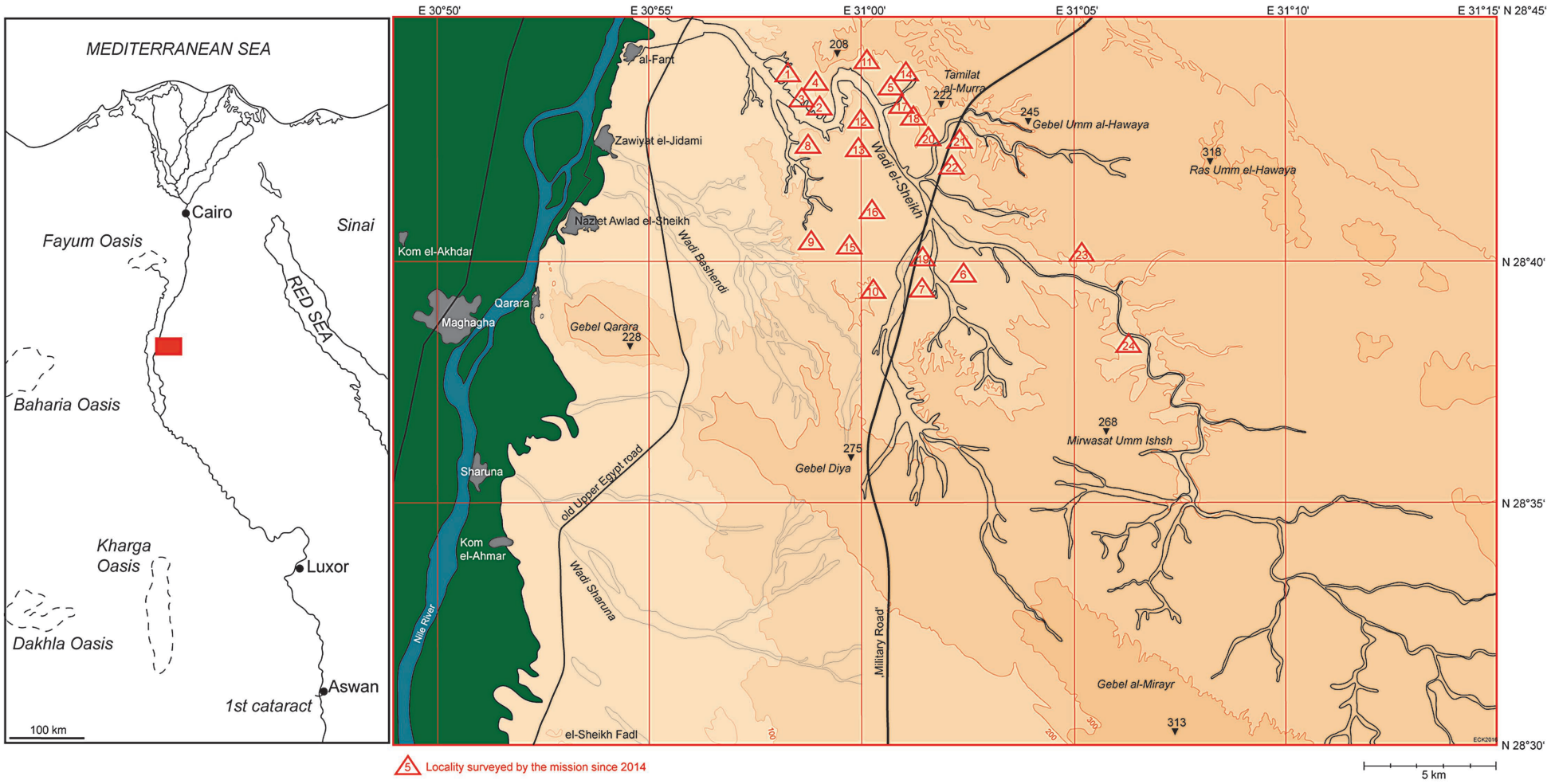

Figure 1: Location of Wadi el-Sheikh in Middle Egypt with sites visited in 2015. Map: E. Chr. Köhler.

the wadi in its research history. Besides excavations of knapping places (Hart, et al. in prep.), one of the shallow, silted-up pits was partly excavated. Furthermore a unit was set up in an opencast working in order to get information on mining processes and finally a horizontal exploitation chamber was documented for the first time in Wadi el-Sheikh.

Raw Material Acquisition in Wadi el-Sheikh

The mining areas in Wadi el-Sheikh are found on the Eocene limestone terraces / plateaus of the wadi where, on varying altitudes, chert layers can be found uncovered on the surface or under capping as alternating chert layers in between limestone layers.

Depending on the location of chert layers, whether they are superficial or under capping, different extraction methods of raw material were documented: opencast workings (e.g. Localities 1, 4, 6, 7, 19, 20, 21) and deep mine workings (Localities 5, 11, 20).[4]

Workshops in form of knapping places are found at all mining sites, as is indicated by accumulations of debitage and unfinished tools. These lithic concentrations show that after exploitation of the raw material the first production step involving testing and (pre-)production of objects took place right on the spot.

A wide range of artifacts were produced in Wadi el-Sheikh: blades, bifacially retouched tools, knives, axes and other implements. Moreover, chert bangles, a product that shows the extremely high skill level of the stone knappers´ craft in Ancient Egypt, were actually made in the wadi, as is indicated by preforms and broken but nearly completed examples.

During survey campaigns in Wadi el-Sheikh, Middle Paleolithic artifacts were also found (for example at L20A), although it cannot yet be confirmed whether or not they were associated with any kind of mining. At least one site with mining and tool production activities, the most remote locality that this mission has surveyed so far, can be dated to Neolithic times (6th Millennium BC based on the presence of chronologically diagnostic lithic artifacts (L24)). At other sites, e.g. L20B and L20C, pottery fragments dating to Early Dynastic (late 4th to Middle of 3rd Millennium BC, 3300–2600 BC) and Old Kingdom (Middle to End of 3rd Millennium BC, 2600–2050 BC) periods were found and prove that the wadi was a chert source for Pharaonic Egypt. Some sherds can be assigned to the New Kingdom (2nd Half of 2nd Millennium BC, 1550–1070 BC) as well (found at L6), and even younger and more recent ceramics indicate that Wadi el-Sheikh was used again and again throughout the millennia (Köhler, Hart and Klaunzer, 2017).

To date, only a few examples are known where lithic material from Wadi el-Sheikh was found in other archaeological sites in the Nile Valley. For instance, Pawlik was able to identify material in the nearby Pharaonic settlement at Kom el-Ahmar / Sharuna that seems to have been mined at the wadi. This evidence indicates that chert exploitation covers much of the 3rd and early 2nd Millennium BC (at least the Early Dynastic, Old and probably Middle Kingdom Periods) (Pawlik, 2006). Furthermore, Tillmann could draw comparisons between the raw material of lithic artifacts found in Middle and New Kingdom layers at Tell el-Dab'a in the eastern Nile Delta and the chert material from Wadi el-Sheikh (Jeuthe, 2015; Tillmann, 1994).

The fact that chert was definitely an important resource for Old Egypt and used in everyday life can be seen at tomb drawings in Tomb 15 of Beni Hassan. It is the Tomb of Baqet III (11th Dynasty, i.e. 21st century BC) where the manufacture of flint artifacts is shown on a tomb wall (Newberry and Fraser, 1893).[5]

Survey and Prospections Mining techniques[6]

Mining is the term for prospecting, winning, extracting and processing of raw materials, in our case chert as the wanted resource. Mining can roughly be divided into two kinds: first opencast mining and second deep mining.[7]

A. Opencast workings

Simple collection of raw materials and small diggings were observed in areas where there are layers of chert exposed on the surface. These layers are mostly quite heavily weathered. The raw material appears dark brown to black in color due to wind and sun impact over thousands of years, at least on the side that was exposed to the sun, and the material is consequently of a poorer quality. The ancient Egyptian miners therefore sought out a better quality raw material. This is indicated by the many smaller depressions on the higher plateaus up the wadi bed which have been filled up by windblown sand. These now silted up shallow pits have a diameter of about 0.5 m to 1 m. Sometimes these workings can be larger in size and interconnected pits were joined to form trenches. In the most cases there are related heaps of waste material beside these pits (Figure 2).

Moreover workings in the form of pits and trenches along the edges and on the upper slopes of the plateaus

Figure 2: Parts of the plateaus of L7 and L19 are full of extraction pits and heaps (photo shows L7). Photo: M. Klaunzer.

Figure 3: Slope-edge workings characterize some of the sites (here L19). Photo: M. Klaunzer.

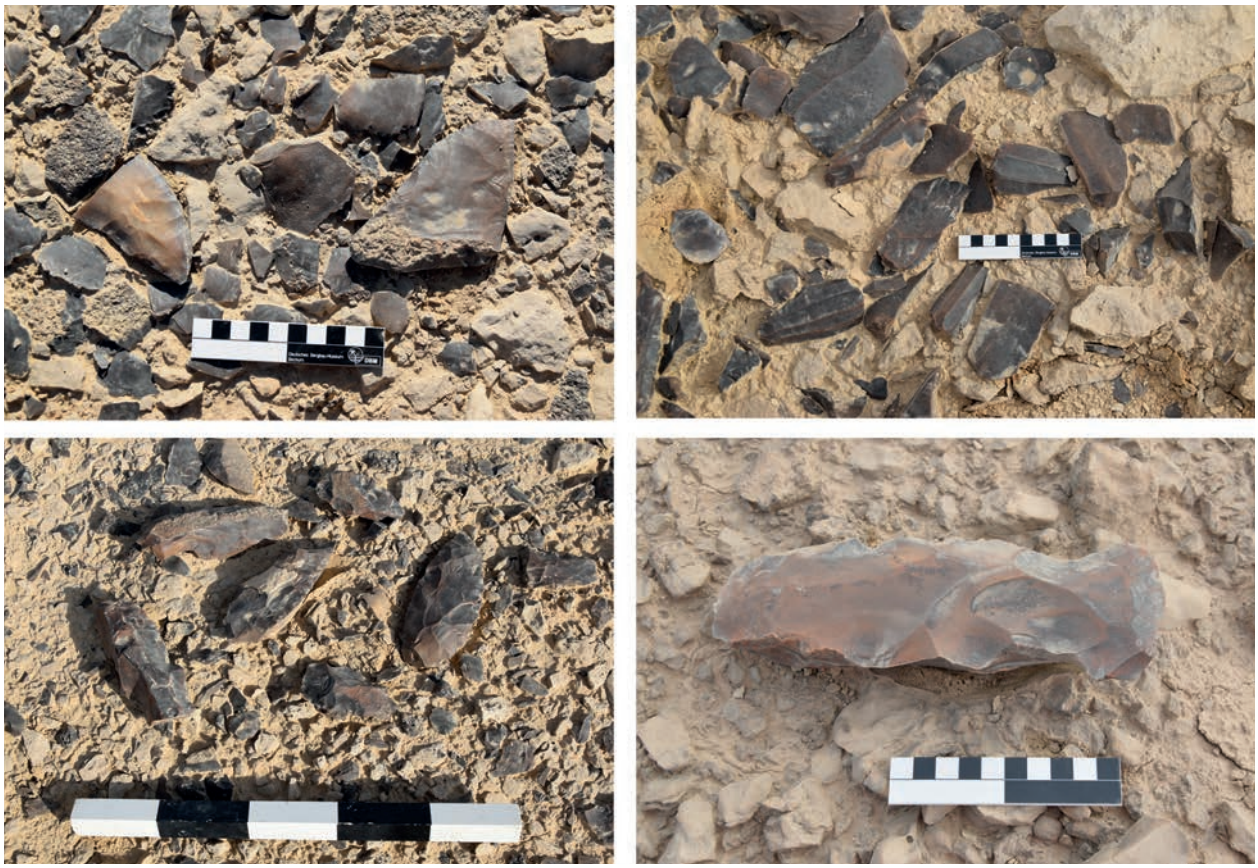

Figure 4: Lithic artifacts from Locality 20: knife fragments, blade cores, bifacial tools, chert pick. Photo: M. Klaunzer.

Figure 5: L20B – Area 1: Massive opencast working (open-digging) in trench-form, heaps are piled up to the East and South-East (view from E). Photo: M. Klaunzer.

are visible (Figure 3). At the slopes, probably due to erosion, heaps are small or non-existing. It seems that the miners worked from the edge in the direction of the plateau's center. The advantage of this kind of mining is that once the layer of chert has been uncovered it can easily be prospected, followed and exploited with a reduced amount of workload.

Another outstanding mining area within Wadi el-Sheikh is site L20, which was subdivided in L20 A-C. It is located to the west of the Eastern Desert Road on a middle level plateau and characterized by enormous heaps, trench-shaped opencast workings, pits, numerous knapping places and stone structures, e.g. dwellings/=-settlement structures, wind shelters and other features of unknown purpose. Here many kinds of lithic artifacts were definitely produced, including one focus on blade production and another on bifacial tools (Figure 4). Pottery fragments of the Old Kingdom that were collected during the surveys in 2015 give hints about the dating of this locality.

In the southern part of L20B there is a massive trench-shaped opencast working near the edge of the plateau, with the associated heaps piled up to the south-east of this open-digging (*Pingenbau*) (Figure 5). Open-diggings are a kind of surface mining where miners extracted raw materials from deeper layers (secondary horizons of chert). These diggings are deeper and wider than shallow pits and reach at least 2 meters depth or the height of a person. Naturally, when there was more than one subsequent layer of exploitable / valuable raw material, smaller pits were extended in size to open-diggings.

The open-diggings at the edge of the plateau at Locality 20B can be traced over several hundred meters. One part of this open-digging (Area 1) was selected for further investigations (see: New results of archaeological investigations, Section A).

B. Deep mine workings

When deep layers of chert are extracted and the access to the deposit is ensured by (mostly) vertical shafts and / or horizontal galleries, in mining terminology this is referred to as deep mine workings / subterranean mining.

Most impressive within the whole mining area of Wadi el-Sheikh are the remains of extensive underground mining projects in form of vertical shafts[8] and the imposing heaps around them. This form of mining is found on certain middle-level plateaus in the wadi. Many of the shafts are nowadays silted up, but a few were thought to have been reopened by local Bedouins in order to mine salt.[9] The related dumps around the shafts can reach more than 3 m in height and can have

Figure 6: C-shaped and U-shaped heaps were piled around shafts such as this one at Locality 5. Photo: Th. Stöllner.

different forms: some are sickle-shaped, some are ring-shaped and others are U-shaped. One thing they have in common is an area that was left free or is lower than the other sides in order to access the shaft (Figure 6). The vertical shafts were driven into the bedrock to exploit preferred layers of good quality chert. The shafts have a diameter of about 1-2 m and reach some 4-5 m in depth. The irregularities in the limestone layers made it possible to easily climb into and out of the shafts. Miners extended narrow galleries from the bottom of the shafts (chamber-extending with backfilling).[10] The deep mine workings can reach up to 20 m in length and were backfilled by mining debris, sometimes smaller stowing, sometimes bigger limestone slabs and rocks. The exploited raw material is evident in the chert blocks that still remain *in situ* in the walls and ceilings underground. Tool marks were observed on the ceilings that seem to stem from metal tools. Weisgerber assumed two stages of mining – the first using stone tools and a second using metal tools (see below). He even identified a massive rock pillar left as a mining support in one of the underground galleries (scale is not given, approximately 1-2 m wide and 2 m high).[11]

Low dry walls were documented near the heaps and related to the shafts. Presumably theses could have been huts / houses used by the ancient miners for living and working.[12] This is indicated by knapping areas with semi-finished broken objects, numerous flakes and debris as well as mining tools like stone hammers or grooved hammer stones and pottery fragments within the mostly rectangular stone structures. Such features could provide information on the dating of the sites as

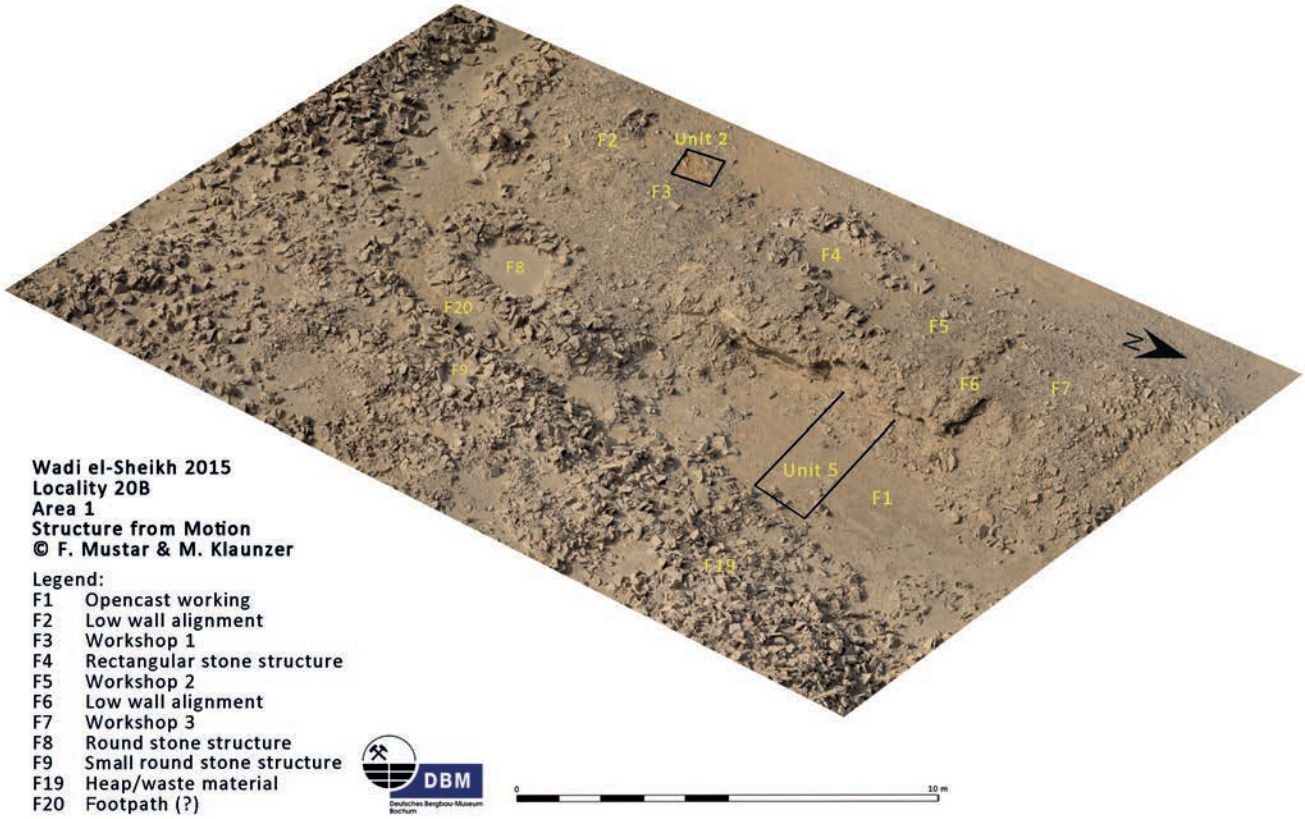

Figure 7: Locality 20B: Structure from Motion (SfM) of Area 1 with marked Features and Units. Unit 2 is a surface collection of artifacts within a knapping place; view from N-E. Illustration: F. Mustar and M. Klaunzer.

well as on the subsistence / supply and the organization of labor of ancient Egyptian miners.

Similar house structures were also documented in the neighboring Wadi Sannur, a valley just a few kilometers in the south of Wadi el-Sheikh. Here a French mission investigated chert debitage and workshops. Nearby low, rectangular stone structures were documented (Briois and Midant-Reynes, 2015, pp. 51-53, Figure 35-36).

New results of archaeological investigations

A. Opencast workings

During the course of the 2015 Wadi el-Sheikh-Campaign one of the shallow silted up pits at the edge of the plateau of L19 was partly excavated and the Aeolian sand was removed. The bottom of the pit was not reached during excavation. The aim was to find out if these pits and diggings were actually directed toward exploitation of chert. In fact chert of reddish color was found at approximately 30 cm depth and probably was the desired raw material in the pit.

In-depth investigations were conducted in a location designated Area 1. As mentioned above Area 1 is part of a large opencast working that can be traced along the edge of L20B (Figure 5). Here there seems to be an organization to the features and structures in the area around the trench-shaped opencast working. For example, near the opencast working several features can be seen (Figure 7): there are knapping places, stone wall alignments, possible house structures in the form of low dry stone walls and other stone structures. These features give important information about the spatial organization of the mining and working activities.

To investigate the archaeological potential of the site a small excavation (Unit 5) was conducted in the now silted up open-digging of Area 1 (Figure 7, F1). The unit was set up to a size of 4 x 1.5 m in the middle of the trench (Figure 7-8) below the possible house structure (Figure 7, F4). The aim was to find out how deep the open-digging originally was, if there were any adits for horizontal mining activities and how the ancient miners organized the exploitation of chert.

A small layer consisting of windblown sand formed the top layer in the Unit (Figure 10). This layer (F15) was about 30 cm deep. On the east side the massive heap continues far into the trench (F19).

Some of the lithic debris and artifacts definitely eroded from above, from the house structure and knapping

Figure 8: L20B – Area 1 – Unit 5 after excavation (Final Situation). Photo: F. Mustar.

Figure 9: Detail of the West Profile in Unit 5: platy chert is visible in between the different calcareous layers, and a step is present at the bottom. Photo: M. Klaunzer.

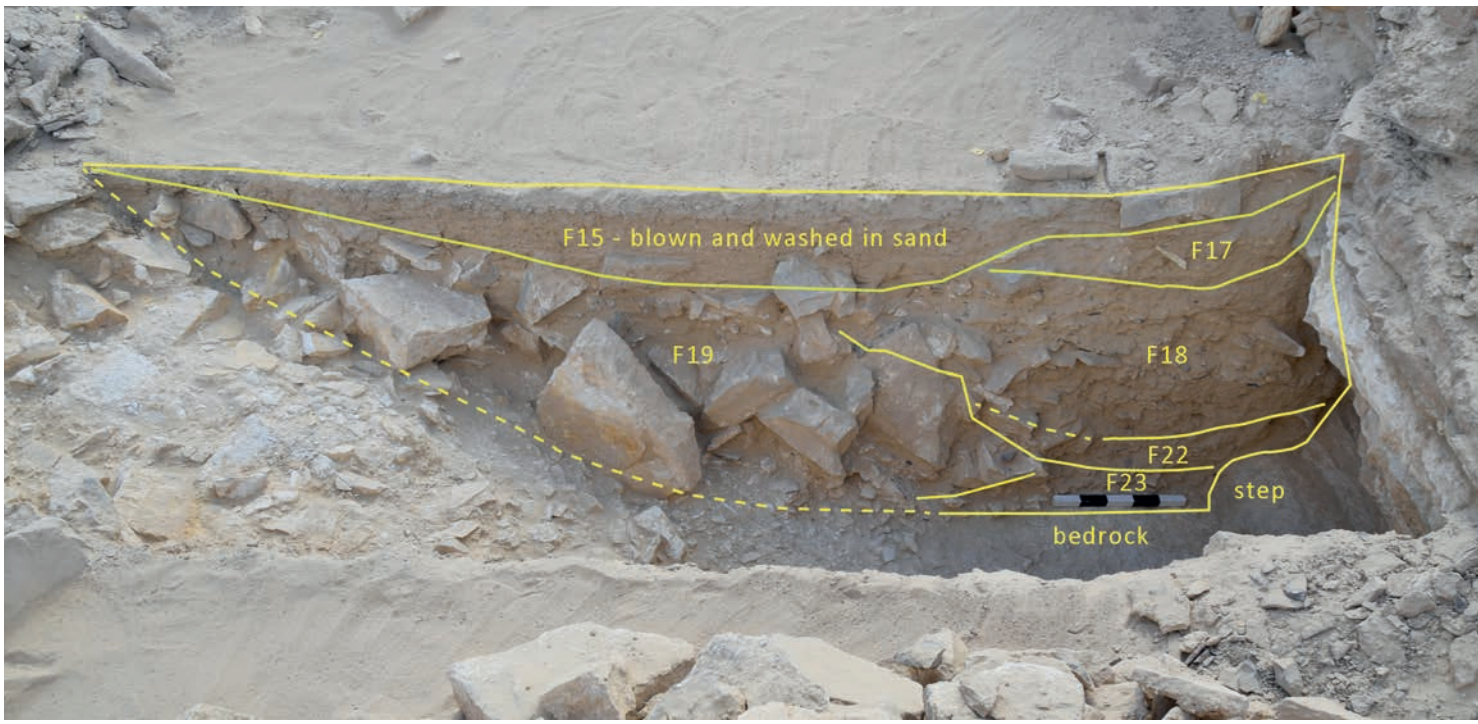

Figure 10: L20B: Stratigraphy in the South-Profile of Unit 5 in Area 1. Photo: M. Klaunzer.

Figure 11: Collection of lithic artifacts, including semi-finished objects, debitage and debris out of layer F18. Photo: M. Klaunzer.

places into the open-digging; at least those lithics that appeared in the top layers of Unit 5 (F15, F17). F17 represents a calcareous layer with only a few lithics whereas F18 is a massive layer full of tested raw material, debris, debitage as well as preforms and unfinished artifacts, mostly with remains of the cortex on them (Figure 11). F22 is a sandy layer with fewer lithics and F23 is the layer just above the natural ground.

Interpretation

The ancient miners dug a trench in the natural landscape and broke through different layers of limestone rocks. In between these limestone layers desired raw material, flat nodules and tabular chert, was exploited. The mining waste rock was left behind in the heaps to the east. Broken mining tools like fragments of axes and hammer stones were also found, one of them was lying directly in F23 just above the natural ground (Figure 12). A step in the bedrock was discovered that may indicate the exploitation technique: it can be assumed that miners prepared tabular and nodular chert on top of this step and quarried them by levering the pieces from the step (Figure 9).

It is not yet clear whether the ancient miners tested the raw material and produced artifacts directly in the open-digging (trench) or if they sat somewhere else (maybe at the knapping places immediately above) and just refilled the trench afterwards.

B. Deep mine workings

Gerd Weisgerber (1987, p.168) assumed there was "adit mining" for chert in some parts of Wadi el-Sheikh. He meant an exploitation of chert in the form of chambers that were installed horizontally. During the campaign 2015 one such horizontal exploitation chamber was discovered at Locality 20C (Unit 6).

From time to time, pits approximately 1-2 m wide and 1-4 m deep were observed at site L20. These recently dug pits point to a subsequent use and could have been installed by looters who were on the search for ancient valuables, or by other Egyptians (maybe Bedouins) who wanted to get good quality chert for flintlock rifles.

One of these pits in L20C (pit 6) leads directly into a horizontal stope. Originally, the portal for the adit was set up from an opencast working (Figure 13).

There are several reasons that support the interpretation that this chamber was made by ancient Egyptians and not by looters or other people in recent times: Firstly, exploited limestone blocks outside mines are weathered and show a gray color due to sand and dirt on them. At this looters hole there are only few "fresh", white and unweathered limestone rocks out of the mine entrance. This means that if a chamber was completely made by modern looters or Bedouins, there should be much more of these unweathered limestone pieces outside. Secondly,

Figure 12: Unit 5: Broken mining tool in layer F23 just above the natural ground. Photo: M. Klaunzer.

the looters rarely touched the original mining waste rock to the left and right of the exploitation chamber. They only removed the washed in and wind-blown Aeolian sand.

The stope is approximately 19 m long and 6-7 m wide, the height is about 0.70-0.75 m (Figure 14). The looters excavated through Aeolian sand and reopened the original narrow pathway area (approximately 0.6-0.7 m wide) that was left free of waste material.

Stowing was piled up on both sides of the stope by the ancient miners. Two pillars, built up by limestone blocks, were installed and a working cavity opens in front of them (Figure 15) where remains of nodular chert are visible in the bedrock (Figure 16). Already seen at the excavation of Unit 5 in the opencast working of Area 1 is a kind of step in the bedrock right under the remains of exploited chert nodules.

The two pillars seem not to serve as stabilizing the underground mining as buttresses; rather they seem to actually function as barriers separating the cavity from the riding trench (the miner's route through the chamber) and for filling the mining waste rock behind them.

The whole stope shows pick marks of mining tools on the ceiling (Figure 17). Some big stone axes that were used to exploit the raw material[13] were found inside the mine[14] (Figure 18). One of these mining tools shows a green, copper-like residue on one side. This might be an indication that also copper / bronze-objects were

Figure 13: Looters´ hole No. 6 leads directly into a horizontal gallery. Photo: M. Klaunzer.

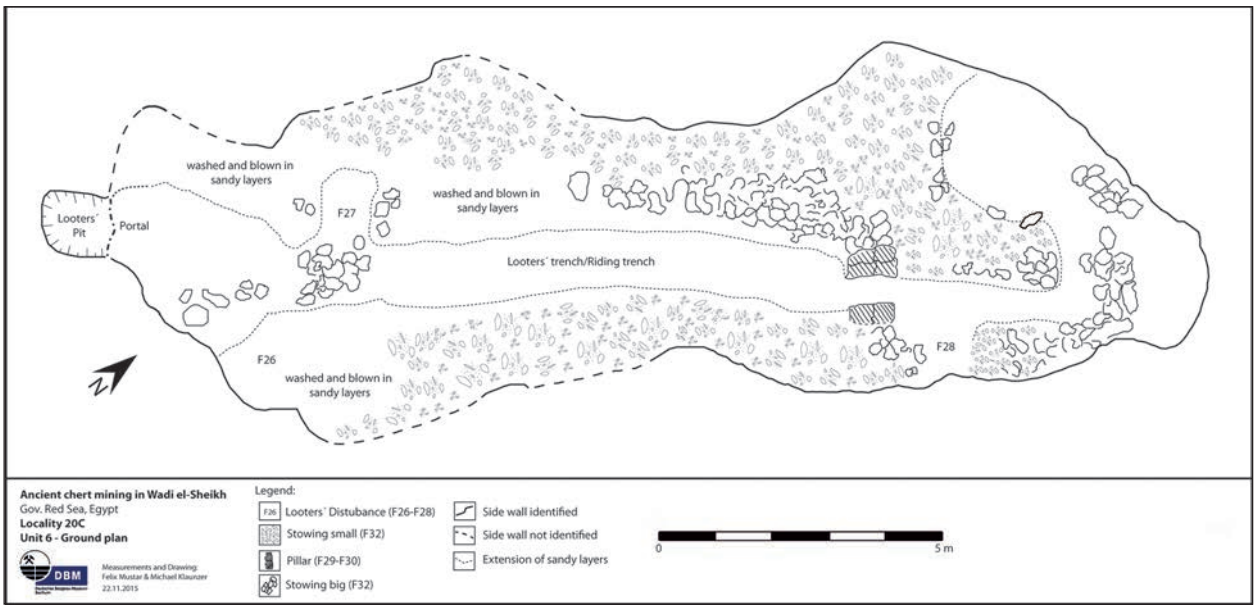

Figure 14: Plan of Unit 6: Underground mining in L20C. Illustration: F. Mustar and M. Klaunzer.

used for mining in Wadi el-Sheikh. Although such tools haven´t been found yet, it is quite likely that metal and stone mining tools were used side by side to exploit the raw material.

The use of copper (or bronze?) tools was also indicated by a small piece of metal found within a knapping place (Unit 4) and by another copper piece that was found during the surveys in 2015 near another looters´ hole (Looters´ hole 2 at L20C; although it is not yet clear, if this copper piece is ancient or was left in more recent times).

The pick marks in the horizontal mining gallery are quite thin, about 10-15 cm long and only a few mm wide and deep, and could be, in accordance with Weisgerber's observations, marks of metal tools. Though, it would be worth doing some experimental archaeology to test

Figure 15: A mining cavity opens behind the two pillars. Photo: M. Klaunzer.

Figure 16: The remains of the exploited chert are visible in the bedrock at the back of the mining cavity, along with pick marks from mining tools. Photo: M. Klaunzer.

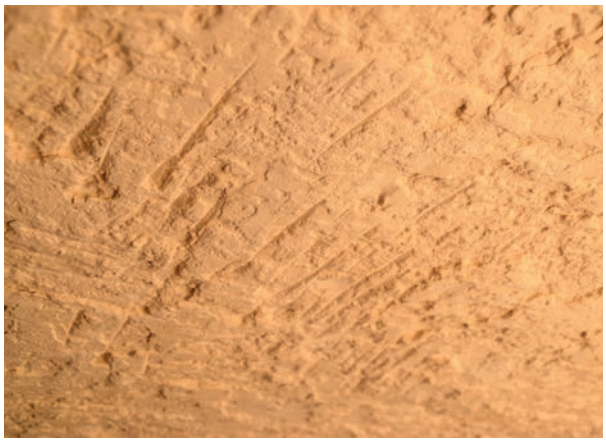

Figure 17: The whole ceiling of the exploitation chamber shows pick marks from mining tools (presumably metal tools or maybe stone tools – a research question that could be verified through experimental archaeology). Photo: M. Klaunzer.

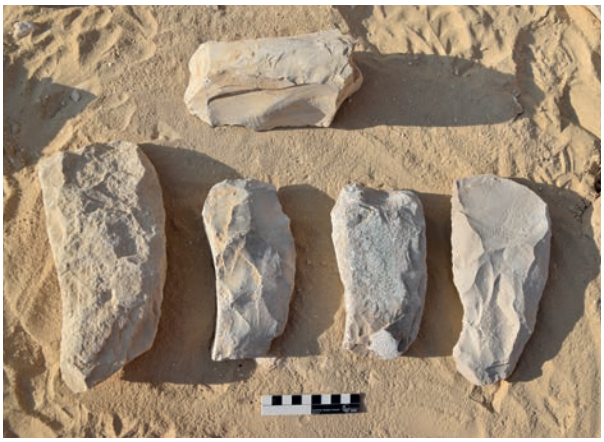

Figure 18: These mining tools were found inside the mine (big stone axes and a hammer). Photo: M. Klaunzer.

whether such marks could also be made by chert picks or by stone mining tools, like the stone axes found in the gallery.

However, it is one of the research questions within this project to find out if metal tools were in use as early as in the Old Kingdom (2600–2050 BC). Tool marks of metal tools can as well be an indicator for a subsequent use in later times, for example during New Kingdom (1550–1070 BC) or even younger times.

For the discovered horizontal deep mine working (Unit 6) it is possible to determine an average amount of exploited material. The calculation includes waste material (limestone) and chert raw material. As mentioned above, the gallery is approximately 19 m long, 6 m wide and the height is about 0.7 m. Limestone has an average density[15] of 2600-2900 kg/m^3 and chert 2500-2700 kg/m^3. When calculated for the whole gallery with 19 x 6 x 0.7 m, the total volume is c. 80 m^3. The calculation can be taken further, considering that limestone and chert an average density of 2600 kg/m^3. By multiplying the density with the volume, a mass of exploited material of 208 tons can be obtained. A part of the waste material was backfilled in the gallery right and left of the riding trench for a reduced workload but also to build the pillars (although a structural function of these pillars is questionable).

Chert nodules are still visible in the bedrock at the rear of the chamber (Figure 16), with approximately three to four nodules per square meter, suggesting an estimate of 12 nodules per cubic meter. Based on the sizes of the nodules still in place, a mean size of an ellipsoid nodule is 14 x 7 x 12 cm, a volume of 615 cm^3 per nodule can be calculated ($\frac{4}{3}\times\pi\times ra\times rb\times rc$). Multiplication by 12 gives a volume of 0.00738 m^3, and multiplication by 80 m^3 for the amount of exploited rock indicates that 0.6 m^3 of chert was exploited. By applying an average density for chert of 2600 kg/m^3, it can be estimated that at least 1.5 tons of chert (or 0.75 % of the total extracted material) could have come out of the horizontal stope. No information about the amount of chert debris in the mining waste is available because excavations were not carried out. It should again be underlined that these calculations should be refined and that the estimated chert output was most probably higher than calculated because the nodule size used in the calculation may be under representative of the size exploited in the past. Here another research question is stated for which experimental archaeology could provide information, for example on the temporal dimension of mining or on performed man-hours.

Once more, these calculations highlight the immense effort that ancient Egyptian miners undertook to get this raw material. The estimated 208 tons of rock come out only of one exploitation chamber (Unit 6). If the massive heaps still visible all over the wadi are any indication, millions of tons of extracted material and hundreds of tons of chert must have been removed. These quantities indicate that Wadi el-Sheikh chert was quite significant for the Egyptian civilization through the ages.

It is currently unknown how much underground mining actually took place at L20 or at other mining areas in Wadi el-Sheikh. For example, at L5 and L11 with extended underground mining in the form of vertical shafts, it would be an interesting research question to estimate how many tons of material was exploited. In this case the calculations are a bit easier to conduct because the reopened shafts simplify observations underground (e.g. how much stowing was backfilled) and because the

calculations of heap sizes around the shafts are straightforward since the heaps are often distinct and can be separated from other shaft-areas.

Summary

Chert from Wadi el-Sheikh was an important raw material for tools and weapons not only during prehistoric periods but also for pharaonic Egypt. Mining remains in the form of shallow diggings / pits, open-diggings as well as deep mine workings, along with their related heaps and knapping places are spread all over Wadi el-Sheikh.

The archaeological surveys and excavations in 2015 led to many new results concerning mining archaeology: At Locality 19, one of the shallow silted up pits was partly excavated and the Aeolian Sand was removed. The layer of chert that appeared in the profile showed that these pits and diggings were actually directed towards the exploitation of chert.

At Locality 20B an archaeological excavation at one of the trench-shaped opencast workings was conducted. Here the ancient miners broke through approximately 3 m of limestone layers in order to extract the tabular chert layers in between. The raw material was tested on the spot and then presumably processed at nearby knapping places.

Gerd Weisgerber (1987, p.168) assumed mining by adit driving for chert in some parts of Wadi el-Sheikh. In contrast to vertically driven shafts and extending narrow side galleries from the bottom of the shafts as seen for example at site L5 and L11, the authors could verify Weisgerber´s assumption and explore the underground mining in the form of a horizontal exploitation chamber at site L20C.

Originally the adit was set up from an opencast working. Miners exploited approximately 200 tons of limestone blocks to extract estimated one and a half tons of chert (tabular and nodular raw material). A large amount of the stowing was left in the mine. The mining was done with big stone axes, some of them were found directly in the mine. In accordance with thin tool marks on the ceiling of the exploitation chamber, it can be assumed that also metal tools were in use.

Archaeological investigations should be continued in Wadi el-Sheikh to get a better understanding of the exploitation of chert. Due to the very good state of preservation of the ancient relics it is possible to answer research questions on mining archaeology, the spatial distribution and chronology of chert mining, the production sequences and the living and working conditions of the ancient Egyptian miners.

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Notes

1 In archaeology there are different words that are used for cryptocrystalline siliceous lithic raw material: the German word is Hornstein, chert is the Anglo-American expression, flint is used in Anglo-Saxon countries and silex is the word in French and German literature as well. For a description and differentiation of different lithic raw materials see Hauptmann, 1999, pp.7-11.

2 Max Blanckenhorn described the geological setting of the chert layers (Blanckenhorn, 1901); Elise Baumgärtel looked at the ancient chert mines and took some photos (Baumgärtel, 1930); Alfred Pawlik, University of Tübingen / Germany, conducted an excursion to Wadi el-Sheikh for a few days (Pawlik, 2000; 2006); Giancarlo Negro and Massimo Cammelli made a short study showing how worthy of protection the sites are (Negro and Cammelli, 2010) and Theresa Barket and Robert Yohe did a technological lithic analysis and presented a model reduction sequence for the production of trapezoidal blades (Barket and Yohe, 2011).

3 For more information on the Vienna Middle Egypt Project see: http://www.univie.ac.at/egyptology/ProjMiddleEgypt.html [Accessed: 15 February 2016].

4 The numbering of the different locations follows the order of discovery by the authors. Some of the localities had already been visited during smaller surveys in 2014 (L1, L5-L7, L11). The newly prospected localities are L12, L19, L20, L21, L23 and L24.

5 http://wellcomeimages.org/indexplus/obf_images/c7/52/d19e354436b0d31ebc75f2735b41.jpg

6 For a description of different types and techniques in flint mining, see Fober and Weisgerber, 1999.

7 The systematics of mining archaeological terms is based on Stöllner, 2008.

8 Underground mining with shafts and chamber extending from the shaft landings for the exploitation of raw material is a common technique in other prehistoric chert mining areas of Europe: for example in Spiennes / Belgium (Collet et al., 2008), Rijckholt – St. Geertruid / Netherlands (Felder, 2006) or in Grimes Graves / England (Mercer, 1981).

9 Weisgerber, 1987, p.168 – the authors think this is questionable; salt was relatively easy to extract at other localities like L12; maybe looters were here searching for gold or other valuables in what they may have thought were shaft graves.

10 Weisgerber (1987, p.168) writes of a shaft landing from which two galleries branch off.

11 Weisgerber, 1982, p.201, Abb. 21.

12 Stone features that might resemble baracks or something like living places can be seen at various localities in Wadi el-Sheikh. Negro and Cammelli (2010, p.115) described such shelters as well as Weisgerber (1982, pp.202-203).

13 Mining tools were often found at all sites near heaps and knapping places. Ancient Egyptians used chert picks with a groove close to the end of the hammer, other (grooved) stone hammers, big stone axes made of hard rock and smaller stone hammers for knapping etc. They were made of different lithic materials, e. g. chert or silicified limestone.

14 The described mining tools were moved by the looters and are therefore not included in the ground plan.

15 Density values. [online] Available at: www.oberrheingraben.de/Geophysik/Dichte.htm and https://de.wikipedia.org/wiki/Feuerstein [Accessed 24 February 2016].

Authors

Michael Klaunzer
Deutsches Bergbau-Museum Bochum
Forschungsbereich Montanarchäologie
Am Bergbaumuseum 31
44791 Bochum, Germany
michael.klaunzer@bergbaumuseum.de

Felix Mustar
Ruhr-University Bochum
Am Bergbaumuseum 31
44791 Bochum, Germany
Felix.Mustar@rub.de

E. Christiana Köhler
University of Vienna
Institute for Egyptology
Franz-Klein-Gasse 1
1190 Vienna, Austria
e.christiana.koehler@univie.ac.at

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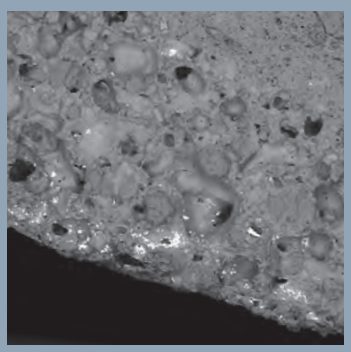

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Cover Images

1 and 2: Example of the mining landscape of Wadi el-Sheik, Egypt, where chert was mined in prehistory and during the Pharaonic Period. Chert was extracted using opencast and underground mining techniques and preliminary results of surveys and the first excavation in Wadi el-Sheik are presented by Klaunzer, Mustar and Köhler. Photos: Th. Stöllner.

3: Scanning electron backscatter image of crucible from the Roman Iron Age beach market site of Elsfleth-Hogenkamp in northern Germany. The image shows a section of the crucibles interior with silver droplets and corrosion. Features of the technical ceramics and their implications for the meaning and organization of metallurgy at the site are discussed in the contribution by Merkel, Schlotfeldt and Struckmeyer. Photo: S. Merkel.

4: A remarkable gold bead entirely constructed of 96 granules was discovered during the excavation of a tomb of the Umm-an-Nar culture in Oman, but because the tomb was re-used in the later Bronze and Iron Ages precise dating of this object is problematic. The technical goldsmithing challenges surrounding the fabrication of this granulated gold bead its experimental replication are the focus of the contribution by Loepp and Maass. Photo: D. Loepp.

metallum, i, n:
Mine (often pl.)
Metal, also stone, mineral

μεταλλον, το:
Mine, shaft, gallery;
esp. a) Mine (usually pl.)
b) Quarry

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