

# Berenike's natural riches: rocks and minerals in the archaeological record



**Abstract:** The article reviews the published and unpublished evidence for selected natural rocks and minerals collected from the excavations between 1994 and 2015 at the harbor site of Berenike on the Red Sea. This assemblage is part of the natural resources and commodities that were either traded through the port or used by local residents over the 800 years of the harbor's existence: as an elephant-transfer station and fort in Ptolemaic times, a global emporium in early Roman times (from the rule of Augustus through the 3rd century) and a briskly trading harbor, apparently under Blemmyan control, from the late 4th through the mid-6th century CE when it was ultimately deserted. A separate category is building stone, both locally procured and imported. The tabularized review of the material provides a base for a preliminary analysis broken down by utilitarian categories, chronological phases and, last but not least, topographical units, such as harbor-related trenches, domestic quarters, religious buildings and trash dumps. One of the objectives of this approach is to work toward a network visualization of the resources (and other commodities and less obvious resources like water, wine and olive oil). The results can then be compared in the future to the existing network visualization of the list of goods extracted from the *Periplus Maris Erythraei*, a 1st-century-CE sailing and trading guide.

**Keywords:** Berenike, mineral resources, natural rocks, chalcedony, carnelian, sard, onyx, agate, obsidian, beryl/emerald

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The excavations at the harbor site of Berenike on the Red Sea coast of Egypt—15 season's worth by 2015 and ongoing—have yielded extensive archaeological material that may be listed in the categories of natural resources and related commodities. These include spices/condiments, incense/frankincense, minerals and metals (gold included), rocks, precious and semiprecious stones, both worked (like cameo blanks) and unworked, ivory, cowry shells, turtleshell, raw glass, as well as botanics (foodstuffs) and exotic and domestic animals [Fig. 1]. Written sources also mention human slaves. The less obvious resources, attested indirectly in the archaeological record, include water, wine and olive oil. A separate category are the building materials: stone of different kind and wood, both locally procured and imported. All this

lends itself to a study using the toolkit of network analysis as described by Eidvind H. Seland (2016 with further literature), allowing to map, visualize and measure the interconnectedness of the different finds on a scaled-down, single-site level. An adapted version of the network approach in the case of large, multi-unit and multi-phased sites like Berenike, dug over many seasons, is particularly relevant to ensure proper interpretation. The results can then be compared with the archaeological record from other excavated sites in the trade network of which Berenike was part.

It will be of equal interest, once the analysis has been completed, to compare the results with the visualization of the list of goods extracted from the *Periplus Maris Erythraei*, a 1st century CE sailing and trading guide. From the point of



Fig. 1. Selected minerals from the 2009 excavations in Berenike: beryls, carnelians, rock crystal and worked selenite (plus mother-of-pearl); scale 5 cm (Berenike Project | photo S.E. Sidebotham)

view of Berenike, Egypt's southernmost gateway to the broadly understood East—including, beside India and beyond, the coasts of eastern Africa, southern Arabia and the Gulf—it is less of a problem that the *Periplus* is, as Seland puts it, “likely the work of a single person with limited knowledge and cultural and personal bias”, whose considerable personal experience came from the regions he was interested in, namely, parts of the Red Sea and the western Indian Ocean (Seland 2016: 191).

The present paper collects published data on selected rocks and minerals from the Berenike excavations carried out by the Dutch–American expedition in 1994–2001, and supplements it with the results of a recent, as yet unpublished evaluation of the finds from the 2009–2015 seasons. The recent excavations are carried out by a Polish–American project which has ensured continuity with the first project by maintaining the same excavation and documentation standards. The present review of the material is obviously the first step in preparing a network analysis, but will hopefully be of interest anyway, contributing to a discussion of the traffic in rocks and minerals within the framework of regional trading circuits as well as a long-distance exchange.

### APPROACH AND DATA SET

The data on mineral resources identified by an expert geologist have been compiled from published reports for the seasons 1994 through 2000 (Harrell

1996; 1998; 1999; 2007) and an unpublished report for seasons 2009 through 2015 (Mandera 2020). Harrell's first report, which gave an initial geological appraisal of the site, included a section on building materials (4.3), in which the author discussed in detail coral, anhydrite, gypsum, and limestone, and a section on exotic rocks and minerals (4.4), characterizing basalt, carbonate cobbles, marble, and under a joint heading: peridot, emerald, obsidian and dolerite (Harrell 1996). His second report dealt with, among other issues, finds from the 1995, 1996 and 1997 seasons. His model of description from this report has been applied to the present review [Table 1]. He divided the samples by categories: decorative, precious and semi-precious materials (4.7.1), and utilitarian materials (4.7.2), and provided a table of the distribution of these finds by trenches, but without characterizing them in chronological or functional terms (Harrell 1998). In his third report, he focused on the ancient trade in rocks and minerals that passed through Berenike, using the *Periplus Maris Erythraei* as a launching board for a discussion of these materials from a geological standpoint and noting which of the commodities listed in the *Periplus* had not been discovered still in Berenike (e.g., turquoise, diamond or colourless corundum, amethyst and garnet, orpiment, stibnite) (Harrell 1999).<sup>1</sup> The latest report, covering finds from the 1998/1999 and 1999/2000 seasons, presented a continuation of the previ-

1 Harrell (1999: 107) adds that a complete description of the 268 geological samples from the 1997 season is available from him and the registry records. I have not reached out for this data for this contribution, preferring to go by the selected published records, especially as I am perfectly aware that the dataset analyzed here is not quite complete for a variety of reasons.

ously published section on the distribution of selected rocks and minerals, providing detailed information on recorded usage and possible geological sources only for the few materials not previously recorded at Berenike (Harrell 2007). The samples from the seven seasons of the Polish–American expedition (a cumulative 400 plus samples) were examined by geologist Sara Mandera (Polish Academy of Sciences) in consultation on site with James A. Harrell (University of Toledo), adopting the earlier methodology and identification standards. This material is still under study, hence it was sourced here only with respect to adding new finds to the already listed categories. Missing from this compilation is the bulk of geosamples (the term used in the Berenike registry system for this particular category of finds)<sup>2</sup> from the 2000/2001 season, the last season of the Dutch–American expedition, which is in storage in the SCA storeroom at Quft (trenches BE-42 through BE-53, plus material from trenches from previous seasons that were continued, notably Ptolemaic-age levels in trench BE-10).

The compilation includes all the data published by Harrell, adopting a division into three general categories: worked stone (A), utilitarian resources (B) and decorative/(semi-)precious minerals (C). Within these categories the order of items is alphabetical. The big difference compared to Harrell's presentation is the way in which the provenance of the identified samples is listed. For the sake of clarity, only trench numbers are given, grouped into larger chrono-topographic units [see *Fig. 3*]. The provisional division adopted here is as follows [see *Fig. 3*]: Hellenistic fort area; harbor-related areas, which are for the most part of early Roman date (by which is meant the period from the rule of Augustus to the 3rd century CE); trash dumps, mostly the dump north of the southwestern embayment and west of the city proper, dated similarly as the harbor trenches; domestic contexts, which reflect for the most part the late period in Berenike (from mid-4th through mid-5th centuries CE); and sacral units. In the lattermost case, the excavation methodology adopted at the Berenike site often results in a single architectural unit being investigated in more than one trench over several seasons.

## SELECTED ROCK AND MINERAL CATEGORIES AT BERENIKE

The three general categories under which the rock and mineral finds from the excavations at Berenike are considered are purely functional (a selection is illustrat-

ed in *Fig. 2*).<sup>3</sup> Building stone, as a bulk material, is obviously ubiquitous in the town and harbor wherever architecture of any kind is to be expected. Four dif-

2 To be on the clear side, “geosamples” in the Berenike registry system refer to rocks and minerals that do not reveal any signs of being worked. Worked pieces, if recognizable, are treated in the relevant worked stone/architectural/sculptural etc. categories. For the purposes of his report, Harrell obviously included also the worked items; integration of the worked items from the 2009–2015 seasons into a general discussion of the materials has yet to be done.

3 The following characteristics are based entirely on Harrell's reports.

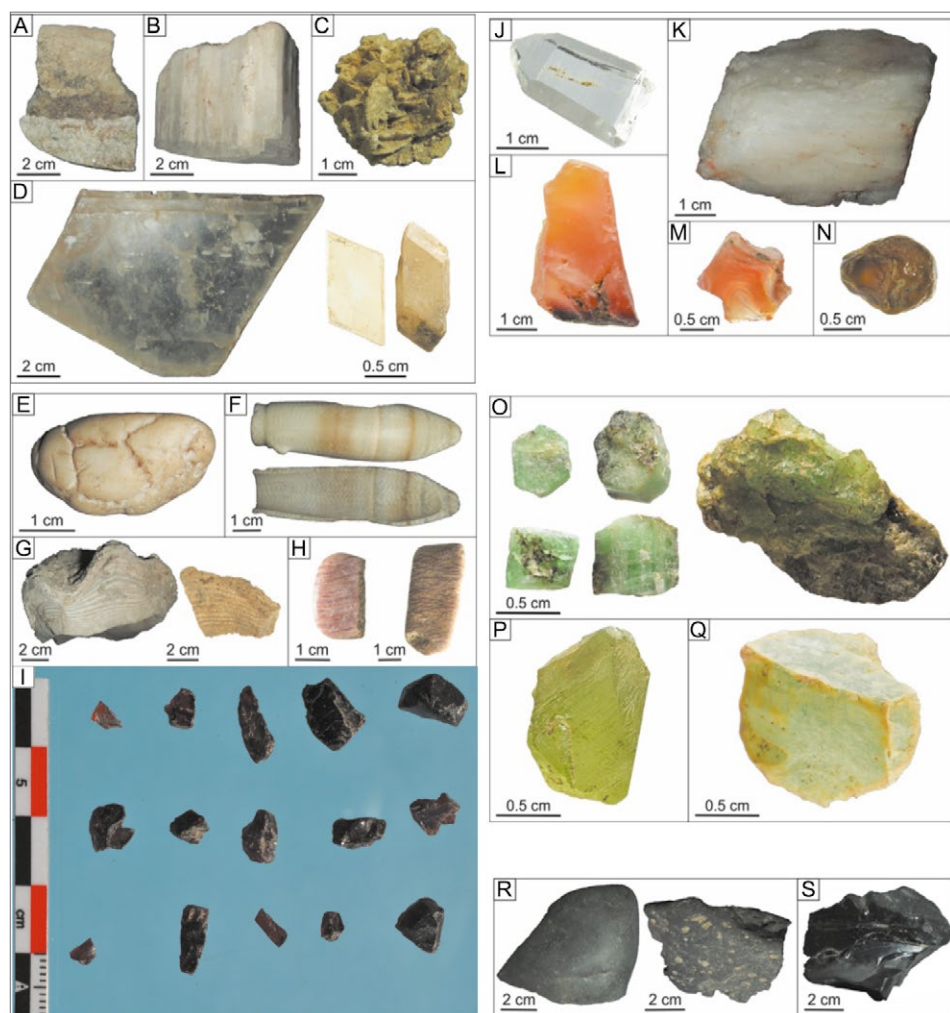


Fig. 2. Starting from top left: top left, gypsum varieties: A – gypsum with anhydrite; B – fibrous gypsum; C – desert rose; D – selenite (different degree of crystal development, smaller crystals on right); center left, examples of carbonates and feldspar of similar layered structure: E – calcite carbonate pebble with evidence of coring by *Pholas dactylus*; F – travertine, so-called “Egyptian alabaster” (fragment of an aryballos); G – fragmentary carbonate shell of *Tridacna squamosa* (at left); H – feldspar, so-called pertite and smaller fragment at right in G; bottom left, set of garnets from trench BE15-103, late 4th century CE (I); top right, siliceous rocks: J – rock crystal (quartz); K – milky quartz; L–N – chalcedony: carnelian (L), carnelian/agate (M), sard (N); center right, green minerals: O – beryl, fragments of euhedral crystals (on left) and beryl in rock (on right); P – olivine – peridot with evident natural crystal facets; Q – glass often mistaken for one of the green minerals; bottom right, black rocks: R – basalt: dense (on left) and with visible gas bubbles (on right); S – obsidian (Berenike Project / photos K. Braulińska, S.E. Sidebotham; sample identification and plate make-up S. Mandra)



ferent materials have been grouped here: anhydrite and gypsum, coral from the reefs and limestone which forms the bedrock at the site. Among the worked stone one finds some elements of architectural decoration, which could be considered as building material, but on the whole the category is composed of tools: grinding stones, hammer stones, pestles and mortars, weights, perhaps tally stones and stone vessels. This section is represented by the following eight different materials: dolerite and limestone (cobbles), granite/granodiorite (granite gneiss, aplite), selenite (veins in gypsum stone), metaconglomerate, metadiorite/metagabbro, milky vein quartz and sandstone.

The utilitarian category gathers together some very disparate resources, from ship ballast (vesicular basalt, carbonate cobbles) and bitumen and tar, both found in many trenches, to steatite, which is also highly common, being used for cooking vessels, gaming pieces and other objects. Tremolite is common, although its uses in antiquity are unknown—it comes as unworked pieces of a pink fibrous mass that breaks into hair-like splinters. Sulfur is also quite frequent, it being an agent in melting processes of metal and glass, but also having

medicinal properties, like also bitumen and realgar. Pumice, rare at Berenike, may have been used as an abrasive. Finally, there are malachite, used as a green colorant for paint and cosmetics among others, and azurite, a blue pigment or ore from which copper could be smelted.

By far the most numerous (22), varied and impressive (when worked objects are discovered) is the third category, namely, decorative materials. A broad division here is into materials used for decorative purposes, like alabaster gypsum which is not the same as travertine (a kind of calcite called Egyptian alabaster) and marble, predominantly of the Proconnesian variety, and stones used primarily in jewelry. The list of precious and semiprecious stones includes beryl (the emerald variant dominating the group), chlorite schist cut or ground to look like hexagonal beryl crystals (“false emeralds”), chalcedony—variants: carnelian and sard, chrysophase, onyx and sardonyx, and agate—jasper, sapphire, garnet, lapis lazuli, magnetite, olivine, quartz (amethyst and rock crystal), serpentinite. Obsidian may have been used for pieces of jewelry, but is more likely a cutting blade, and graphite schist could have had a cosmetic application.

## IN AND OUT —ACCORDING TO THE PERIPLUS

A handy look at the materials brought from Egypt to Eastern ports and from Eastern ports to Egypt is given by Harrell in his study of the trade described in the *Periplus* between Egypt (which would have passed through the Red Sea ports,

Berenike being one of these and the other being Myos Hormos) and the ports in coastal northeast Africa, eastern Africa, the Arabian Peninsula, the Gulf, Pakistan and India (Harrell 1999: Table 4-2). The “outbound” goods according to the *Periplus*

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Table 1. List of minerals and rocks discovered in Berenike between 1994 and 2015, based primarily on James A. Harrell's publications in the Berenike excavation reports (Harrell 1996; 1998; 2007) and updated (Mandera 2020)

No.	Material	Use	Provenance
<b>WORKED STONE</b>			
A1.	<b>Anhydrite</b>	Architectural	Practically all the trenches
A2.	<b>Coral</b>	Building stone	Practically all the trenches
A3.	<b>Gypsum</b>	Building stone	Practically all the trenches
A4.	<b>Limestone</b>	Building stone	Selected trenches
A5.	<b>Dolerite/dolerite cobbles</b>	Tallies or possibly weights	Sacral unit <b>Palmyrene temple</b> BE95/96-6
A6.	<b>Granite/granodiorite, granite gneiss, aplite</b>	Grinding stones, hammer stones, weights, mortars, pestles	Hellenistic: BE00-36 Trash dump (ER): BE99-29; BE99-31 Domestic (late): BE96/97/98/99/00-10 Sacral unit <b>Church</b> BE98/99-22+BE99/00-30
A7.	<b>Gypsum, var. selenite</b>		Hellenistic: BE12-82+BE12-83 Harbor-related (ER): BE09-54; BE09-55; BE10-62; BE10-64; BE10-67; BE11-78 Trash dump (ER): BE98-19; BE09-57; BE11-73; BE11-74; BE11-76; BE11-77; BE12-80; BE12-84; BE12-88 Domestic (late): BE86/97/98/99/00-10 BE10-59 Sacral unit <b>Square Feature</b> BE10/11-70 <b>Harbor Temple</b> BE12-61
A8.	<b>Limestone cobbles</b>	Tallies or possibly weights	Domestic (late): BE96/97/98/99/00-10
A9.	<b>Metaconglomerate</b>	Possible stone vessels	Trash dump (ER): BE99-29
A10.	<b>Metadiorite/metagabbro</b>	Grinding stone, hammer stones, weights, mortars, pestles	Trash dump (ER): BE00-33 Domestic (late): BE96/97/98/99/00-10 BE97/98-18; BE98-20



Source	Finds / References	No.
WORKED STONE		
Available locally, on Ras Benas cape (Harrell 1996: 106–107)	Blocks Harrell 1996: 106; 1999: 110	A1.
	Harrell 1996: 106	A2.
	Harrell 1996: 107	A3.
	Harrell 1996: 107–108	A4.
Eastern Desert, common in most of the Red Sea region; local wadi gravel	Rectangular block, dressed, rectangular trough cut across the top and sheathed in a thin layer of lead (to hold a stele?) Cobbles carved with a series of short, nearly parallel grooves Harrell 1996: 111; Harrell 2007: 174	A5.
Locally derived wadi gravel, but also Aswan	Flat grinding stone, pestle or weight, circular disk  Harrell 2007: 173	A6.
	Occurs as veins in building stone used in Berenike; cut edge, possible bead, worked  Harrell 1996: 107–108; 2007: 173	A7.
Imported from a distant source, possibly as ship ballast (see Harrell 1996: 109–110)	Cobbles carved with a series of short, nearly parallel grooves Harrell 2007: 174	A8.
Eastern Desert (Hammamat Formation), mostly central and northern parts with small outcrops in the south along the coast beginning just north of Marsa Alam; quarried by the Romans in Wadi Hammamat, between Quseir and Quft (Aston, Harrell, and Shaw 2000: 57–58; Harrell, Brown, and Lazzarini 2002), referred to by them as <i>lapis hexecontalithos</i> or “stone of sixty stones”	Platter? Harrell 2007: 173	A9.
Locally derived wadi gravel	Flat grinding stone, grinding mortar, pestle or weight, macehead or hammer? Notched to take a handle, circular disk Harrell 2007: 173	A10.

Table 1. continued.

No.	Material	Use	Provenance
A11.	<b>Milky vein quartz</b>	Pestles?	Domestic (late): BE97/98-18
A12.	<b>Sandstone</b>	Pestle or weight	Domestic (late): BE00-34 Sacral unit <b>Church</b> BE99/00-30+BE98/99-22
<b>UTILITARIAN</b>			
B1.	<b>Azurite</b>	Blue pigment, ore from which copper was smelted	Sacral unit <b>Temenos</b> BE95/96-7
B2.	<b>Basalt, vesicular</b>	Ship ballast, grinding querns	Domestic (late): BE97/98-18; BE99-41 BE98-20+BE99-27; BE99-28+BE00-38; Sacral unit <b>North Shrine</b> : BE98/99-23+BE99-32 <b>Harbor Temple</b> BE11/12/13/14/15-61
B3.	<b>Bitumen and tar, var. asphalt</b>	Medicine, sealant for vessels, possibly fuel	Hellenistic: BE00-40? Trash dump (ER): BE96/97-13; BE98-19; BE00-33 Domestic (late): BE96/97/98/99/00-10 BE95/96/97-5; BE95-15; BE97-18; BE00-37 Sacral unit <b>Palmyrene temple</b> BE97/98-16 <b>North Shrine</b> BE98/99-23 <b>Church</b> BE96/97/98-12
B4.	<b>Carbonate cobbles</b>	Ship ballast	Domestic (late): BE95-2
B5.	<b>Malachite</b>	Green colorant for paint and cosmetics, copper metal, jewelry	Sacral unit <b>Palmyrene temple</b> BE97/98-16
B6.	<b>Pumice</b>	Abrasive, possibly for metal or removing rough skin	Trash dump (ER): BE98-19 Sacral unit <b>Temenos</b> BE97/98-17 <b>Church</b> BE99/00-30

Source	Finds / References	No.
Locally derived wadi gravel	Harrell 2007: 173	A11.
Unknown, probably Eastern Desert (outcrops of Nubia sandstone)	Pestle or weight, platter Harrell 2007: 173–174	A12.
UTILITARIAN		
Eastern Desert, three known ancient copper mines plus numerous other deposits within about 100 km of Berenike (Afia and Imām 1979: 12–17 and map), ancient mine at Umm Semiuki near Bir Abu Hamamid, 105 km northwest of Berenike, one of the largest and highest grade copper deposits in Egypt and the only one where azurite reported (Lucas and Harris 1962: 205; Hussein 1990: 542–543)	Unworked piece  Harrell 1998: 148	C2.
Basalt outcrops at or near the shore on the Saudi Arabian coast around the Tropic of Cancer, further to the south	Boulder used for cult purposes (Harbor Temple), rotary grinding querns, subcylindrical possible weight or pestle, unworked pieces Harrell 1996: 109; 2007: 173	B1.
Possibly Gebel Zeit-Ras Gamsa area, about 60 km north of Hurghada, where natural petroleum seeps (Barron and Hume 1902: 267–280); nearest known ancient source of asphalt is in the Dead Sea region of Palestine (via the Gulf of Aqaba)	Small pieces, piece with drilled hole, carved piece  Harrell 1998: 146; 2007: 172	B2.
Almost certainly one or more formations of the Lower Eocene Thebes Group or the Middle Eocene Mokattam Group; possible source – beach at the mouth of Wadi al-Ambagi which flows to the sea at Quseir/Myos Hormos	Well rounded and flattened clasts occurring together with other, less distinctive rock types, abraded coral fragments and disarticulated pelecypod shells. One cobble bears an inscribed carving of a giraffe and snake. Harrell 1996: 109–110	B3.
Unknown, probably Eastern Desert, associated commonly with copper deposits (Hussein 1990: 515, 518, 550; Aston, Harrell, and Shaw 2000: 43–44), e.g., 16 ancient copper mines of indeterminate age within a 100-km radius of Berenike, closest on Ras Banas (Afia and Imām 1979: 14–16 and map).	Harrell 2007: 173	B4.
Unknown, not from Egypt; highly vesicular glass associated with geologically recent rhyolitic volcanism, common in the Mediterranean and washed up on northern Egyptian coast (Lucas and Harris 1962: 73); also numerous locales south and east of the Red Sea	Single pieces, carved with red-painted circles (BE97/98-17), carved cone (BE99/00-30)  Harrell 2007: 172–173	B5.

Table 1. continued.

No.	Material	Use	Provenance
B7.	<b>Realgar</b>	Medicine, paint pigment	Domestic (late): BE96/97-10 Sacral unit <b>Temenos</b> BE95-4 <b>Church</b> BE98/99-22
B8	<b>Steatite</b>	Cooking vessels, gaming pieces and others	Hellenistic: BE00-36; BE00-40 Harbor-related (ER): BE99-26 Trash dump (ER): BE99-31, BE00-33 Domestic (late): BE96/97/98/99/00-10 BE95/96/97-5; BE97/98-18; BE98-20+BE99-27; BE99-28+BE00-38; BE00-34; BE00-37 Sacral unit <b>Temenos</b> BE95/96-7+BE97/98-17 <b>Palmyrene temple</b> BE95/96-6+BE97/98-16 <b>Church</b> BE96-8+BE96/97/98-12+BE99/00-30 <b>North Shrine</b> BE98/99-23
B9.	<b>Sulfur</b>	Medicine, metal smelting, cloth manufacture	Harbor-related (ER): BE09-54; BE10-67; Trash dump (ER): BE96/97-13; BE10-33/48; BE11-73; BE11-77 Domestic (late): BE96/97/98/99/00-10 BE95/96/97-5; BE10-59; Sacral unit <b>Temenos</b> BE95-4.004+BE95/96-7 +BE97/98-17 <b>Palmyrene temple</b> BE95/96-6 <b>Church</b> BE96/97-12
B10.	<b>Tremolite</b>	Ancient use unknown; modern use for heat insulation	Hellenistic: BE00-35 Harbor-related (ER): BE99-26 Trash dump (ER): BE98-19; BE99-31; BE00-33 Domestic (late): BE96/97/98/99/00-10 BE95-1; BE95/96/97-5; BE98-20; BE98-21; BE00-37 Sacral unit <b>Temenos</b> BE95-4.004+ BE95/96-7+ BE97/98-17 <b>Palmyrene temple</b> BE95/96-6+ BE97/98-16 <b>North Shrine</b> BE98/99-23
DECORATIVE / (SEMI-)PRECIOUS			
C1.	<b>Alabaster gypsum</b>	Decorative	Hellenistic: BE96-11; BE00-40 Trash dump (ER): BE99-31 Domestic (late): BE96/97/98/99/00-10 BE99-27; BE99-28; BE00-41 Sacral unit <b>Palmyrene temple</b> BE95/96-6+BE97/98-16 <b>Church</b> BE96-8+BE99/00-30+BE00-39 <b>North Shrine</b> BE99/00-32

Source	Finds / References	No.
Unknown, probably Eastern Desert where hydro-thermal sulfide veins, which may have realgar, are common; apparently imported by the Romans from Persia (Warmington 1974: 270)	Unworked pieces Harrell 1998: 145–146; 1999: 116–117; 2007: 172	B6.
Eastern Desert, 14 deposits within 100 km of Berenike, none known to have been worked in ancient times (Afia and Imām 1979: 27–30 and map), one of the largest and closest is Atshan near the coastal village of Hamata, 58 km northwest of Berenike (green steatite) (Lucas and Harris 1962: 421; Hussein 1990: 453)	Worked piece, bead, decorated wall+base fragment, vessel, platter, pendant, pear-shaped, rod, statuette, decorated cup, pendant, palette, carved block  Harrell 1998: 145; 2007: 172	B7.
Common along the Red Sea coast in close association with gypsum and anhydrite deposits from which it is derived. East end of Ras Benas, near Berenike, and Bir el-Ranga near Wadi Abu Ghusun, about 65 km northwest of Berenike (Ball 1912: 28, Pl. 21; Lucas and Harris 1962: 269; Afia and Imām 1979: 28 and map; Hussein 1990: 550)	Small pieces of yellow “native” sulfur  Harrell 1998: 146; 2007: 172	B8.
Unknown, probably Eastern Desert where serpentized ultramafic rocks which often contain massive asbestos and tremolite veins, are common, seven known deposits between Berenike and Marsa Alam, also Wadi Mukhit, 40 km northwest of Berenike (Hussein 1990: 553), no ancient workings known	Unworked pieces of pink, manganese-rich fibrous mass, breaking easily into hair-like splinters – rare variety  Harrell 1998: 145–146; 2007: 172	B9.
DECORATIVE / (SEMI-)PRECIOUS		
Marib; Yemeni quarries near Sana’a (Scott 1947: 125; Fricke 1953: 1063) are NOT the source	Architectural and sculptural elements: vessels, statuette head, carved sphinx, pedestals, altar, relief, offering basins, capital, unusual polygonal block, platter, circular disk with square hole, circular ring; but also many ashlar blocks. Statuette of goddess from trench BE99-31 of finer-grained alabaster gypsum than the above. Harrell 1996: 107–108; 1998: 136–139; 2007: 170	C1.

Table 1. continued.

No.	Material	Use	Provenance
C2.	<b>Beryl, var. aqua-marine</b>	Jewelry	Domestic (late): BE98-21
C3.	<b>Beryl, var. emerald</b>		<p>Harbor-related (ER): BE99-26; BE09-55; BE11-71; BE11-72</p> <p>Trash dump (ER): BE96/97-13; BE99-29; BE99-31; BE00-33; BE09-57; BE10-60; BE11-74; BE11-76; BE11-77; BE11-80</p> <p>Domestic (late): BE96/9798/99/00-10 BE95/96/97-5; BE97-18; BE98-20+BE99-27; BE98-21; BE99-28+BE00-38; BE00-34; BE00-37; BE00-41; BE10-59</p> <p>Sacral unit</p> <p><b>Temenos</b> BE95-4+BE95/96-7+ BE97/98-17</p> <p><b>Square Feature</b> BE10/11-70</p> <p><b>Palmyrene temple</b> BE95/96-6+ BE97/98-16</p> <p><b>Isis (Serapis) Temple</b> BE11-ST</p> <p><b>Church</b> BE96/97/98-12+BE98/99-22+ BE99/00-30</p> <p><b>Harbor Temple</b> BE12-61; BE11-81</p>
C4.	<b>Calcite, var. crystal</b>	Jewelry	Domestic (late): BE00-37
C5.	<b>Calcite, var. travertine (Egyptian alabaster)</b>	Sculpture, decorative objects	<p>Hellenistic: BE00-40?</p> <p>Trash dump (ER): BE00-33</p> <p>Domestic (late): BE96/97-10</p>
C6.	<b>Chalcedony, var. carnelian and sard</b>	Jewelry	<p>Hellenistic: BE00-40?</p> <p>Harbor-related (ER): BE09-54; BE09-55; BE11-71; BE11-72</p> <p>Trash dump (ER): BE96/97-13; BE97/98-19; BE99-29; BE99-31; BE00-33; BE09-57; BE10-63/65; BE11-74</p> <p>Domestic (late): BE96/97/98/99/00-10 BE96/97-9; BE97/98-18; BE98-21; BE99-27; BE99-28; BE00-34; BE00-37; BE00-41; BE10-59</p> <p>Sacral unit</p> <p><b>Square Feature</b> BE11-70</p> <p><b>Church</b> BE96/97/98-12+BE98/99-22+ BE99/00-30</p> <p><b>Harbor Temple</b> BE12-84</p> <p><b>North Shrine</b> BE98/99-23+ BE99/00-32</p>
C7.	<b>Chalcedony, var. chrysoprase</b>	Jewelry	Domestic (late): BE96/97-10

Source	Finds / References	No.
Probably Sri Lanka or, more likely, India (Warmington 1974: 250–251; Herath 1975: 60–63; Wadia 1975: 458; Sinkankas 1989: 445–455)	Bead Harrell 2007: 171	C2.
Eastern Desert, Roman mines at Gebel Sikait, Gebel Zabara, Gebel Nugrus and Gebel Umm Kabu (ancient Mons Smaragdus), about 90 km northwest of Berenike (Harrell 1996: 112), low quality like that from Berenike (Smith and Phillips 1972: 308)	Bead, possibly worked piece, mostly unworked hexagonal crystals Harrell 1996: 112; 1998: 142–143; 2007: 170	C3.
Unknown; ubiquitous mineral and colored varieties occurred in many areas where the Romans traded	Bead Harrell 2007: 171	C4.
Romans quarried the rock at several sites in Middle Egypt (Aston, Harrell, and Shaw 2000: 59–60); Nile Valley in Middle Egypt, many ancient quarries (Lucas and Harris 1962: 59–61)	Piece with one cut/sawn side, cylinder with longitudinal hole, carved fragments Harrell 1998: 145; 2007: 172	C5.
Eastern Desert, found commonly as pebbles in wadis and on desert pavements (Lucas and Harris 1962: 391), e.g. Wadi Kalalat (J. Harrell, personal observation); carnelian and sard imported by the Romans from Persia and especially India (Warmington 1974: 237–239)	Bead, engraved disk or cabochon, cameo blank fragment Harrell 1998: 143; 2007: 170	C6.
Eastern Desert possibly; apparently imported by the Romans from India (Warmington 1974: 242–243)	Unworked fragment	C7.



Table 1. continued.

No.	Material	Use	Provenance
C8.	<b>Chalcedony, var. onyx and sardonyx agate</b>	Jewelry	Hellenistic: BE00-40 Harbor-related (ER): BE99-26 Trash dump (ER): BE96/97-13; BE99-29; BE00-33 Domestic (late): BE96/97/98/99/00-10 BE95-1; BE95/96/97-5; BE95/96-9; BE97/98-18; BE98-20+BE99-27; BE98-21; BE99-28; BE00-37 Sacral unit <b>Temenos</b> BE97-17 <b>Church</b> BE95/96-8+BE98/99-22+BE99/00-30 <b>Palmyrene temple</b> BE97/98-16 <b>North Shrine</b> BE98/99-23+ BE99/00-32
C9.	<b>Chert, var. jasper</b>	Jewelry	Harbor-related (ER): BE99-26 Domestic (late): BE96/97-10; BE99-28
C10.	<b>Chlorite schist</b>	Gaming pieces?	Domestic (late): BE96/97-9 Sacral unit <b>Palmyrene temple</b> BE95/96-6+BE97-16
C11.	<b>Corundum, var. sapphire</b>	Jewelry	Domestic (late): BE96/97-10
C12.	<b>Garnet</b>	Jewelry	Harbor-related (ER): BE99-26 Domestic (late): BE96/97/98/99/00-10 BE98-21; BE00-37 Sacral unit <b>Harbor Temple temenos</b> BE15-103
C13.	<b>Graphite (graphite schist)</b>	Cosmetic?	Sacral unit <b>Palmyrene temple</b> BE95/96-6
C14.	<b>Lazurite, var. lapis lazuli</b>	Jewelry	Trash dump (ER): BE96/97-13
C15.	<b>Magnetite</b>	Possible jewelry or gaming piece	Domestic (late): BE98-21
C16.	<b>Marble, var. Lygdos?</b>	Sculpture, carved objects (unguent jars)	Domestic (late): BE96/97/98/99/00-10

Source	Finds / References	No.
Unknown, Romans imported onyx and sardonyx agate from India (Warmington 1974: 239–241)	Bead, cameo blank, worked piece, engraved disk, teardrop pendant Harrell 1998: 144; 2007: 170	C8.
Eastern Desert, where many small deposits, especially in the region between the latitudes of Safaga and Quseir near wadis Fatiri, Abu Gerida and Saga, Gebel Semna (Barron and Hume 1902: 221, 266; Afia and Imām 1979: 24 and map), no ancient workings known.	Worked pieces  Harrell 1998: 144; 2007: 171	C9.
Unknown, probably Eastern Desert where chlorite-bearing metamorphic rocks are common	Cut or ground to look like hexagonal beryl crystals ("false emeralds"), small rectangular block Harrell 1998: 143	C10.
India or Sri Lanka probably (Smith and Phillips 1972: 299–300; Warmington 1974: 247–248)	Double cabochon Harrell 1998: 144	C11.
Probably India, although occurs in metamorphic rocks in the Eastern Desert. India produced red almandine, commonly known brown to orange grossular and spessartine (Smith and Phillips 1972: 332, 335–336; Warmington 1974: 252–253; Wadia 1975: 459) found in Berenike; Sri Lanka confirmed for the set from BE15-103 (H.A. Gilg, personal communication)	Carved tear-shaped cabochon (red), 12-sided crystal (brown and red)  Harrell 2007: 171	C12.
Central Eastern Desert, numerous deposits, the closest of which is near the Red Sea at Gebel Ghadir, 120 km northwest of Berenike (Afia and Imām 1979: 27–28 and map), no ancient workings known.	Pieces  Harrell 1998: 148	C13.
Probably Kokscha Valley in Afghanistan, the only known ancient source for this mineral (Smith and Phillips 1972: 446–447)	Unworked fragment  Harrell 1998: 144–145	C14.
Unknown, probably Eastern Desert (common accessory mineral in many igneous and metamorphic rocks), possibly associated with some iron-ore deposits especially rich in magnetite (Hussein 1990: 518–519)	Crystal (perfect octahedral/8-sided)  Harrell 2007: 172	C15.
Unknown; fine-grained, brilliantly white marble could be the "lygdos" mentioned by ancient writers as coming from Arabia Felix, modern Yemen (Harrell 1999: 109–110)	Decorated platter  Harrell 2007: 171	C16.

Table 1. continued.

No.	Material	Use	Provenance
C17.	<b>Marble, var. Proconnesian</b>	Decorative floor tiles, wall veneer	Domestic (late): BE96/97/98/99-10 BE97/98-18; BE98-21; BE99-27; BE99-28; BE00-34; BE00-37 Sacral unit <b>Palmyrene temple</b> BE95/96-6+BE97/98-16 <b>Church</b> BE96-8+ BE96/97-12 <b>North Shrine</b> BE99-32 <b>Isis (Serapis) Temple</b> as a whole
C18.	<b>Obsidian</b>	Jewelry or cutting blades	Hellenistic: BE00-40 Harbor-related (ER): BE09-54; BE09/10-54-62; BE11-72; BE11-78; BE14-98 Trash dump (ER): BE96/97-13; BE11-77; Domestic (late): BE96/97/98/99/00-10 BE98-20; BE98-21; BE00-37 Sacral unit <b>Temenos</b> BE95-4 <b>Square Feature</b> BE11-70
C19.	<b>Olivine, var. peridot (known as chrysolite)</b>	Jewelry	Trash dump (ER): BE11-76; BE11-77; BE00-33 Domestic (late): BE96/97/98/99/00-10 BE10-59; BE00-37 Sacral unit <b>Temenos</b> BE95-4+BE97/98-17 <b>Harbor temple</b> BE10-61 <b>Church</b> BE98/99-22
C20.	<b>Quartz, var. amethyst</b>	Jewelry	Trash dump (ER): BE99-29 Domestic (late): BE99-27 Sacral unit <b>Church</b> BE99/00-30
C21.	<b>Quartz, var. rock crystal</b>	Jewelry	Hellenistic: BE00-40 Harbor-related (ER): BE99-26 Trash dump (ER): BE96/97-13; BE96/97-14; BE98-19; BE98-24; BE99-29; BE99-31; BE00-33 Domestic (late): BE96/97/98/99/00-10 BE95-1; BE95/96/97-5; BE96-9; BE97/98-18; BE98-21; BE99-27; BE99-28; BE00-34; BE00-37 Sacral unit <b>Temenos</b> BE97-17 <b>Palmyrene temple</b> BE95/96-6+BE97/98-16 <b>Church</b> BE96/97-12+BE99/00-30 <b>North Shrine</b> BE98/99-23+BE99/00-32
C22.	<b>Serpentinite</b>	Jewelry	Domestic (late): BE00-34 Sacral unit <b>Church</b> BE99/00-30

Source	Finds / References	No.
Eastern Mediterranean, especially the Island of Proconnesus in the Marmara Sea (Harrell 1996: 111)	Flat slabs, cut (sawn) and polished on two sides, thickness from 1.8 to 5 cm (2.5–3.2) Harrell 1996: 111; 1998: 142	C17.
Eastern Mediterranean or, more likely, the southern Red Sea region (Harrell 1996: 112)	Unworked pieces Harrell 1996: 112; 1998: 145; 1999: 115; 2007: 171	C18.
Zabargad (St John's) Island, 80 km southeast of Berenike (Harrell 1996: 112)	High cabochon Harrell 1998: 144; 1999: 115–116; 2007: 171	C19.
Probably Eastern Desert (Roman-period quarries: Wadi el-Hudi, 25 km southeast of Aswan, Shaw and Jameson 1993; Wadi Abu Diyeiba, 25 km southwest of Safaga, Murray 1914; Shaw and Jameson 1993; Aston, Harrell, and Shaw 2000: 50–52); Romans are known to have imported amethyst from India (Warmington 1974: 245)	Carved oval cabochon, bead  Harrell 2007: 171	C20.
Western Desert or Sinai (Lucas and Harris 1962: 402–403); Eastern Desert; Romans also imported rock crystal from India (Warmington 1974: 245–246)	Colorless mostly, also milky white: bead, bead on a string, pendant, possibly worked, also unworked with natural crystal faces Harrell 1998: 143; 2007: 170	C21.
Unknown, outcrops common in the Eastern Desert (Aston, Harrell, and Shaw 2000: 56–57)	Worked piece, bead Harrell 2007: 172	C22.

consist of miscellaneous gemstones, peridot (which was actually extracted on Zabargad Island situated off the coast, just 80 km southeast of Berenike), realgar, stibnite and orpiment. The first three items are represented among the finds as unworked stones as well as ready items, chiefly cabochons. “Inbound” was the whole glory of the East: turquoise, lapis lazuli, agate, chalcedonic quartz, diamond, sapphire, “transparent stones of all kinds”, meaning miscellaneous gemstones. Add to this obsidian from Hauachil bay on the Red Sea coast in Eritrea and gypsum alabaster from

quarries around ancient Muza on the Red Sea coast of Yemen (which does not seem to be borne out by petrographic analyses of the material; see Harrell 1999: 109–110). That trade in *lapis universis* (“all sorts of stones”) continued at a brisk rate into the 3rd century is confirmed by a rescript, or legal ruling, in the Digest of Justinian (39.4.16), which was excerpted from an early 3rd-century CE manuscript on fiscal law, giving a list of trade items subject to import duty; six of the nine stones in the rescript appeared also in the *Periplus* (Harrell 1999: 120).

## FREQUENCY AND CHRONO-TOPOGRAPHICAL DISTRIBUTION ON SITE

The main goal of the exercise in this paper, beside compiling the data currently available, is to take a closer look at the

distribution of the individual categories of rocks and minerals. Without going into the minutiae of contexts within individu-

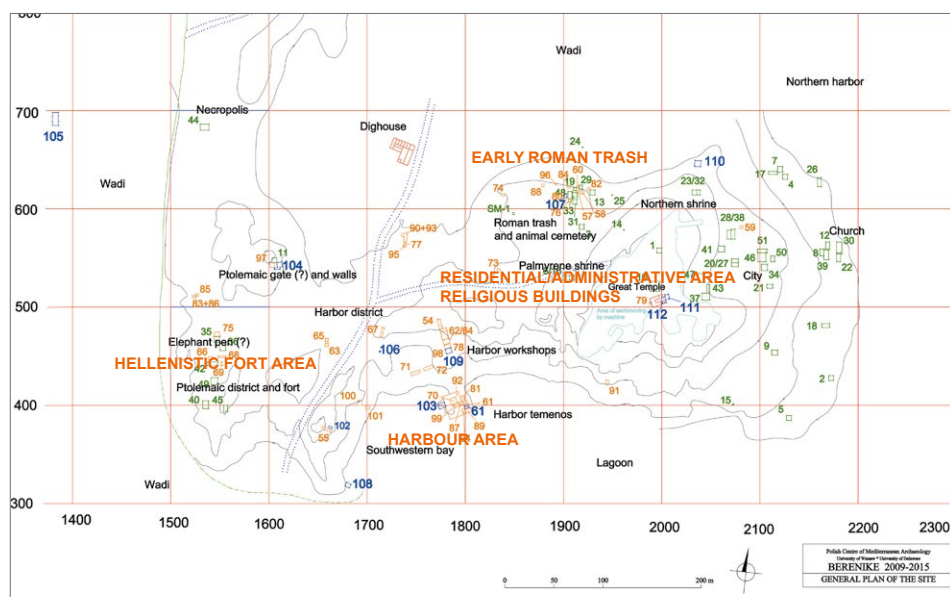


Fig. 3. Plan of Berenike marking the location of all trenches excavated from 1994 through 2015 and identifying overall areas on site (Berenike Project | original map updated J. Rądkowska; editing I. Zych)

Table 2. Quantification by chrono-topographic units and by chronological phases (more than four attestations in orange, more than 10 in blue). Key: 1 – Hellenistic; 2 – harbor-related (early Roman); 3 – trash dumps (early Roman); 4 – domestic contexts (late 4th–6th centuries CE); 5 – sacral units; LH/ER – Late Hellenistic/early Roman transition and earlier; ER – Early Roman; Late – late 4th–6th centuries CE

No.	Material	1	2	3	4	5	LH/ER	ER	Late
A5.	Dolerite, dolerite cobbles					1			
A6.	Granite/granodiorite, granite gneiss, aplite	1		2	1	1	1	2	2
A7.	Gypsum, var. selenite	1	6	9	2	2	1	15	4
A8.	Limestone cobbles				1				1
A9.	Metaconglomerate			1				1	
A10.	Metadiorite/metagabbro			1	3			1	3
A11.	Milky vein quartz				1				1
A12.	Sandstone				1	1			2
B1.	Azurite					1		1	
B2.	Basalt, vesicular		1		4	2		1	6
B3.	Bitumen and tar, var. asphalt	1					1		
B4.	Carbonate cobbles			1		3		1	3
B5.	Malachite					1		1	
B6.	Pumice			1		2		1	2
B7.	Realgar				1	2			3
B8.	Steatite	2	1	2	7	4	2	3	11
B9.	Sulfur		2	4	3	3		6	6
B10.	Tremolite	1	1	3	6	3	1	4	9
C1.	Alabaster gypsum	1		1	4	3	1	1	7
C2.	Beryl, var. aquamarine				1				1
C3.	Beryl, var. emerald		4	12	10	6		16	16
C4.	Calcite, var. crystal				1				1
C5.	Calcite, var. travertine (Egyptian alabaster)	1		1	1		1	1	1
C6.	Chalcedony, var. carnelian and sard	1	4	8	10	4	1	12	14
C7.	Chalcedony, var. chrysoprase				1				1
C8.	Chalcedony, var. onyx and sardonyx agate	1	1	3	9	4	1	4	13
C9.	Chert, var. jasper		1		2			1	2
C10.	Chlorite schist				1	1		1	1
C11.	Corundum, var. sapphire				1				1
C12.	Garnet		1		4			1	4
C13.	Graphite (graphite schist)					1			1
C14.	Lazurite, var. lapis lazuli			1				1	
C15.	Magnetite				1				1

Table 2 continued on page 148

Table 2 continued from page 147

No.	Material	1	2	3	4	5	LH/ER	ER	Late
C16.	Marble, var. Lygdos?				1				1
C17.	Marble, var. Proconnesian				7	4			11
C18.	Obsidian	1	1(4)	2	4	2	1	6	6
C19.	Olivine, var. peridot			3	3	3		3	6
C20.	Quartz, var. amethyst			1	1	1		1	2
C21.	Quartz, var. rock crystal	1	1	7	10	4	1	8	14
C22.	Serpentinite				1	1			2

al trenches (although it goes without saying that some of the generalizations thus assumed here may prove off the mark once contextual dating is also taken into account), the provenances of individual samples were assigned to one of the categories described above on the basis of general knowledge about the dating and function of individual trenches. Sums of occurrences reflect not the actual number of finds—there could be several per trench/context—but the individual units and these could be either single trenches or sets of trenches (for example, the record “BE95/96-6+BE97/98-16” should be read as two trenches, 6 and 16, excavated respectively in the 1995 and 1996 and the 1997 and 1998 seasons, making up a single interpretative unit, in this case the so-called Palmyrene temple; other instances of conjoined trenches include the so-called North Shrine, an apparent temenos in the northeastern part of the site, the Church, two late-period houses; and a series of trenches in the southwestern embayment. To a certain degree, the early Roman rubbish dump north of the embayment and west of the town should also be treated, at least in the part where the trenches join up into one large group, as a single unit.

Looking at the quantification, first from the point of view of the division into discrete chronological phase, one notes few finds from the Hellenistic period, barely 5.5% of the total. The proportions between early Roman (1st–mid-3rd centuries CE) and late period (mid-4th–6th centuries CE) finds is slightly in favor of the late period (about 41.5% to 53%). However, this reflects—roughly—the proportion between trenches generally assigned to the 1st through 3rd centuries CE and those of late date, meaning that finds from these two phases demonstrate more or less the same level of frequency per stratigraphic unit. Proportionately less finds relative to the number of trenches assigned to the Hellenistic period starts to be meaningful in this situation. And to some degree easy to explain considering that most of the Hellenistic trenches were located on the western plateau, at the site of the military fort and elephant pen. Presumably whatever trade in rocks and minerals passing through the port in this period would have taken place elsewhere on the site.

Looking at the total of finds of selected rocks and minerals in the three categories, one sees the absolute preponderance of the category of decorative/



(semi-)precious stones: an estimated 64%. The worked stone category amounts to 13% and the utilitarian one to roughly 23%. Breaking down the largest category by chronological phases, we find that there is roughly twice as many finds of this type in the late period compared to early Roman times (the Hellenistic period makes up about 6% only). The proportions in favor of the late period finds are the same for the utilitarian category, but in the worked stone category, the early Roman finds are slightly more numerous. This is due to the overrepresentation of gypsum selenite in the trenches in the harbor and the rubbish dump north of the embayment.

The preponderance of finds in the late period shows the sheer volume of the trade in rocks and minerals taking place in the late 4th and 5th centuries CE. Seven of the 22 materials recorded are represented for the first time and they include aquamarine, chrysoprase, sapphire, graphite, magnetite among the *lithia diaphanes pantoia*, “transparent stones of all kinds”. Another “newcomer” are garnet stones, a whole handful of unworked stones stashed away in a storeroom/workshop context (J. Rądkowska, personal communication) in the southwestern bay, possibly late 4th century CE.<sup>4</sup> Rock crystal is twice as popular in the late period, as are the onyx and sardonyx varieties of chalcedony, the latter often appearing as cameo blanks, even as the carnelian and sard varieties of chalcedony and beryls (emerald variety) maintain a high repre-

sentation. Beryls were definitely sourced locally, for example, from the emerald mines at Sikait; rock crystal and carnelian and sard, however, could have come from local sources, but they could also have apparently been imported from India (Warmington 1974: 237–239). The larger volume of finds of semiprecious stones from apparently local sources—peridot, jasper, serpentinite—probably reflects a greater demand for these products, for trade as well as for personal use, which could have social implications, portending the population shifts that are being recognized with increasing frequency in Berenike itself as well as in the harbor’s Eastern Desert hinterland.

Alabaster gypsum is a stone used extensively, among others, for sculptural items and its preponderance in late Berenike contexts is associated with a trend that the chrono-topographic analysis of the findspots has highlighted. The excavations have uncovered so far several sanctuaries: a centrally located temple of Isis (formerly recognized in the literature as a temple of Serapis) and the so-called Palmyrene Temple, an apparent temenos in the northeastern part of the town, and the North Shrine at the northern end of one of the streets in town, a Harbor Temple and adjoining so-called Square Feature, which could be speculated to be a sanctuary of the imperial cult as was often the case in early Roman harbors. Last but not least, there was also an early 4th-century church standing on the eastern shore of the town. Some of these

4 The handful of unworked garnets from trench BE15-103 in the harbor temenos has been identified by geologist Hans Albert Gilg (Technical University of Munich) as probably of Sri Lankan origin (personal communication). Generally on the source of garnet stones in Nubia from an archaeometric perspective see Then-Obluska et al. 2021

were multi-phased structures, others were established in the late period, but they invariably demonstrate their users' penchant for collecting heritage items, often broken pieces of statues and various cultic and decorative paraphernalia, from the ruins of the Roman town and leaving them as votive offerings in their shrines, alongside other objects of value, which could also have been deposited with a similar, votive purpose in mind. The number of buildings of religious function, where excavations yielded finds of minerals and rocks, is indicated in *Table 2* (column 5): all but one of the materials in the utilitarian category are represented in the shrines (between one and four), and 12 out of 22 in the case of the decorative/(semi-)precious stones category (between one and six shrines), with the different varieties of chalcedony and rock crystal occurring in four sanctuaries each, beryls in all six, and peridot in three.

Interestingly, slabs of Proconnesian marble, cut or sawn, often polished on two sides (an average thickness of 2.5–3.2 cm), were recovered from at least four religious shrines<sup>5</sup> and seven separate domestic contexts, while the material appears to be absent from the early Roman contexts. However, this absence is not entirely surprising considering that the excavated early Roman contexts are limited to the rubbish dump in the foreground of the town, in a location where a unique animal cemetery was also located, and some harbor-related structures of a storage character in the southwestern embayment. It is likely that the marble found in late assemblages

was actually in a secondary context, having originally been brought to Berenike as part of building investment in the first half of the 2nd century CE.

Utilitarian materials are also present in the shrines, while worked stone (save for building materials, of course) is virtually absent. Characteristically, worked stone items are relatively common in late domestic contexts just as they are present in the early Roman rubbish, suggesting they had been discarded from domestic or workshop contexts of contemporary date. A similar trend can be observed with regard to the utilitarian materials, while in the case of the (semi-)precious stones, the numbers correspond to the picture for the category as a whole: several materials not identified in the earlier contexts, others appearing in greater numbers and the three major stones, beryls and the different varieties of chalcedony, as well as rock crystal dominating the group.

An interesting case is presented by obsidian. Unworked pieces of this stone have been recorded in the fill of two shrines believed to have been established in the early Roman period (hence they could be residual in the late contexts), both of these in harbor-related locations, and in four different late-period domestic contexts in town. But the lion's share of this stone, several kilograms in fact, was excavated in the harbor stores situated in the southwestern embayment, indicating its relation to shipping. This again suggests a penchant of the late Berenikan population for collecting "shiny goodies" along with other memorabilia.

5 It has since been established that the courtyard of the Isis Temple was decorated with Proconnesian marble slabs for at least the floor and wall revetment; for identification of the material and discussion see Bojanowski et al. forthcoming.

## IN LIEU OF CONCLUSIONS

The review of rocks and minerals presented here marks the beginning of a project applying a network approach to the analysis of natural resources found in the archaeological record at Berenike. An analysis of this assemblage, broken down by chronological phases and stratigraphic units (reflecting site topography) has already resulted in interesting observations concerning the traffic in these particular resources, at the same time bringing to the forefront the issue of area specialization at a site as big and functionally varied as Berenike.

Moreover, one should keep in mind that a transit port like Berenike will obviously differ in the quality and quantity of the relevant finds from the destination points at either end of the trade routes. After all,

these resources were being traded away from the harbor; hence, it is actually their absence or limited presence in the archaeological record that is significant. While the second condition is met by many of the semiprecious minerals discussed here, that is, a trace presence in the excavated assemblages, the notable differences in frequency compared to the most common minerals should be noted.

A third point to be made here, in anticipation of a future fuller and more detailed analysis, including also other traded natural resources, is that the results can reflect the socio-political transformations that were taking place in Berenike, especially in the late phase, that is from the late 4th century CE until its complete abandonment.

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