# Ptolemaic Berenike: Resources, Logistics, and Daily Life in a Hellenistic Fortress on the Red Sea Coast of Egypt

MAREK A. WOŹNIAK, STEVEN E. SIDEBOTHAM, MARTA OSYPIŃSKA, ALFREDO CARANNANTE, JOANNA K. RĄDKOWSKA

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Excavations at Berenike (Trogodytika) on the Red Sea coast of Egypt provide a foundation date in the third quarter of the third century BCE, which corroborates Pliny the Elder's (*HN* 6.33.168) claim that Ptolemy II Philadelphus (ca. 285/2–246 BCE) established the port. Named after Philadelphus' mother, Berenike is the only archaeologically attested Hellenistic-era Red Sea emporium. According to literary evidence, it was one of about a dozen founded by early Ptolemaic rulers along the African coast. Study of Berenike's artifacts and ecofacts has confirmed the presence of elephants and has provided data on the diet of the residents and the location, acquisition, and distribution of drinking water. Research has also documented industrial and economic activities. This report presents highlights of these studies.[1]

## INTRODUCTION

The early Ptolemaic government explored the African Red Sea coast for political, military, commercial, and scientific reasons. One result was the creation of a chain of permanent harbors and bases, among them Berenike, located at 23°54'62"N, 35°28'53"E, approximately 825 km south-southeast of Suez and 260 km east of Aswan (fig. 1). The foundation of Berenike required the creation of a transportation system that supported exploration, construction, and security and linked the Nile Valley to the coast via the Eastern Desert.[2] This infrastructure facilitated movement of material, animals, and information between Berenike, other Red Sea ports, and the Nile Valley. At Berenike itself, ensuring that food supplies, drinking water, protection against external threats, and settlement organization and operation were in place amidst extreme environmental conditions was paramount.[3]

Permanent stations in the desert between the Red Sea and the Nile were essential for coastal settlements.[4] Government officials, military forces, and

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[2] Strabo 17.1.45; Sidebotham et al. 2019a.

[3] Gates 2005; Sidebotham 2011, 28–31; Cobb 2018, 56–59.

[4] Manning 2010, 106–7; Sidebotham 2011, 28–31; Sidebotham et al. 2019a, 1–49, 73–285.

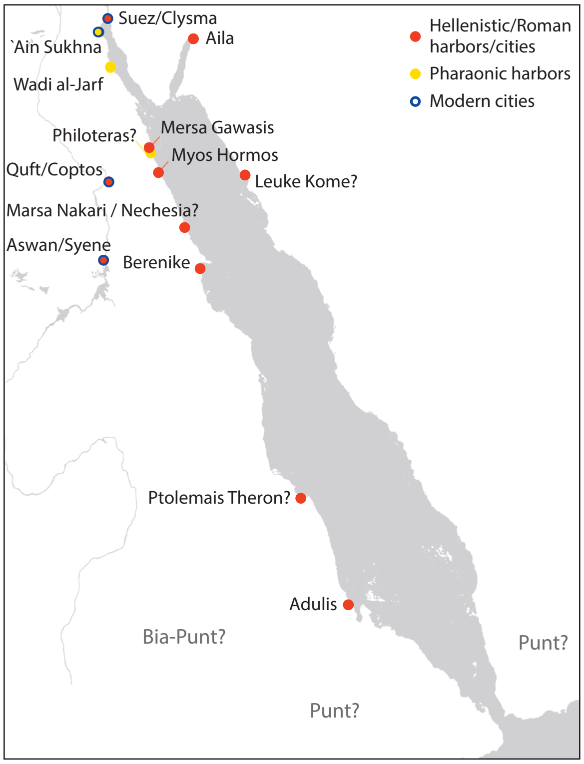


FIG. 1. Map of the Red Sea with locations of Berenike and important harbors marked (M. Woźniak and S. Popławski).

civilians operated in this hyperarid, mountainous region inhabited by people living outside government authority whose attitudes toward them were, initially, unclear.[5] It was critical that desert and coastal centers control and exploit their environs safely and efficiently.[6] To live and operate in such adverse circumstances required outsiders to rely, in part, on the knowledge and cooperation of indigenous peoples.[7]

Pharaonic expeditions dispatched into the Eastern Desert and to the northern Red Sea coast of Egypt for mining, quarrying, and maritime trade were codependent as both used the same desert routes and were resupplied from the Nile Valley.[8] Pharaonic contacts with polities and peoples in Bia-Punt and Punt in the southern Red Sea area created broader maritime exchange systems. These efforts also extended land routes along the Nile Valley to the south, where regional networks already existed.[9]

Evidence from Pharaonic Red Sea harbors at Mersa Gawasis, Wadi al-Jarf, ʿAin Sukhna,[10] and from Berenike itself[11] (see fig. 1) suggests that during the Old Kingdom (ca. 2613–2181 BCE), Middle Kingdom (2040–1782 BCE), New Kingdom (ca. 1570–1069 BCE), and Late Period (525–332 BCE), long distance contacts were not systematic but occasional.[12]

The Ptolemies developed and systematized earlier efforts, initiating more regular contacts.[13] They constructed and maintained permanent settlements in the desert and along the coast and explored territories previously unknown to Mediterranean peoples.[14] Any maps of East Africa created during these expeditions would have been the first ever produced for this part of the world.[15]

The expanded Ptolemaic desert network initially relied on that from the Predynastic and Pharaonic periods (fig. 2). This included construction of fortified or unfortified sites, some of which protected wells (*hydreumata*)[16] and most of which had cisterns (*lakkoi*) filled by rainwater runoff or wells;[17] springs and surface water supplemented supplies. These combined water sources were indispensable to caravans of people and animals.[18]

Ptolemaic authorities monitored those who passed by and used these sanctioned facilities; however,

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[5] Strabo (16.4.7) lists some tribes and the ways of dealing with them practiced by the Ptolemaic strategoi; see also Cuvigny forthcoming.

[6] Cf. Casson 1993, 254–56.

[7] For the Roman period, see Cuvigny 2014.

[8] See, e.g., Sidebotham 2011, 21–31; Tallet 2016.

[9] Bard and Fattovich 2018, 156–91.

[10] Tallet 2016.

[11] Hense et al. 2015; Hense 2019, 259–61; Sidebotham et al. 2019b, 14, pl. XX, fig. 3; and forthcoming.

[12] Dates based on Mark 2016a, 2016b, 2016c, 2016d.

[13] E.g., the expedition sent to Punt by 18th Dynasty pharaoh Hatshepsut depicted on her funerary temple at Deir al-Bahri; see Wicker 1998; Smith 2008, 45; Sidebotham 2011, 24; Creasman 2014; Braulińska 2018.

[14] For possible locations of Hellenistic and Roman-era ports in East Africa, see Casson 1993, 255–56; Cohen 2006, 305–43; Burstein 2008, 141–45; Macleroy-Obied 2010; Bower and Farrar 2015.

[15] Rawlins 1982; Burstein 2000; Geus 2013, 224–31; Habicht 2013; Prontera 2013; Gallo 2019. There is no certainty that Hellenistic geographers drew maps, but some probably did (D.W. Roller, professor emeritus, Ohio State University, pers. comm. May 2020).

[16] Sidebotham 2011, 87–124; Sidebotham et al. 2019a, 1–49, 73–285.

[17] Sidebotham et al. 2008, 303–27; 2019a, 13–18; Sidebotham 2011, 87–124.

[18] Sidebotham 2011, 87–124; Sidebotham et al. 2019a, 13–18.

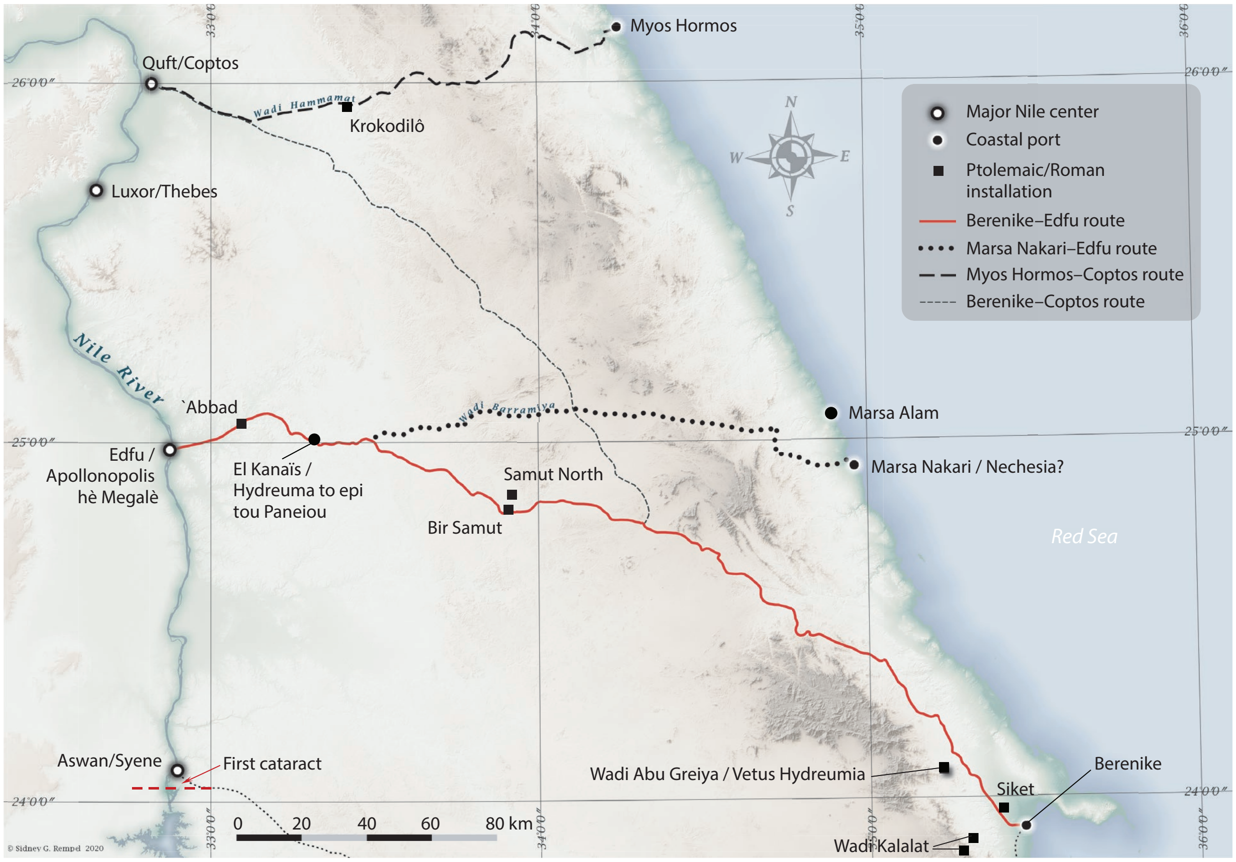


FIG. 2. Berenike, other Red Sea ports, and Eastern Desert routes in Ptolemaic and Roman times (drawing by S. Popławski after S. Rempel).

government attempts to manage desert dwellers were less successful. These desert stations also provisioned and guarded mines and quarries and, together with de facto stops created by the travelers themselves,[19] supported traffic between the Red Sea and the Nile. Excavations at some road stations between Berenike and the Nile emporium of Apollonopolis hè Megalè / Apollonopolis Magna (modern Edfu), and between Berenike and the Nile at Coptos (modern Quft) (see fig. 2), have documented activities in the third to early second centuries BCE and later.[20]

This Ptolemaic network grew in Roman times and developed into a communication grid linking Europe, Africa, and Asia.[21] This, in turn, expanded to the south and east in the Islamic period.[22] Berenike was a nodal point in this network until abandoned sometime before ca. 550 CE; there was no subsequent reoccupation of the site.[23]

## METHODS

The basis for this study was archaeological work conducted in the central and western areas of Berenike (fig. 3), in the early Ptolemaic fort, in buildings near the gate, and along the northern defensive city wall (fig. 4).[24] These areas contained predominantly Ptolemaic remains with little or no later material.

[19] For examples of de facto stops at least in Roman times, see Sidebotham et al. 2019a, 39.

[20] For Ptolemaic-Roman Eastern Desert routes (not exhaustive), see Bagnall et al. 1996; Sidebotham 2011, 28–31; Brun et al. 2013; Faucher and Redon 2015; Redon and Faucher 2015, 2015–2016, 2016a, 2016b; Cuvigny 2017; Cobb 2018, 28–60; Redon 2018; Sidebotham et al. 2019a.

[21] See, e.g. (not exhaustive), Raschke 1978; Sidebotham et al. 2008, 151–95, 329–43; McLaughlin 2010, 2014, 2016; Sidebotham 2011; Evers 2017; Cobb 2018.

[22] Power 2012.

[23] Sidebotham 2011.

[24] Osypińska and Woźniak 2019, 368–69.

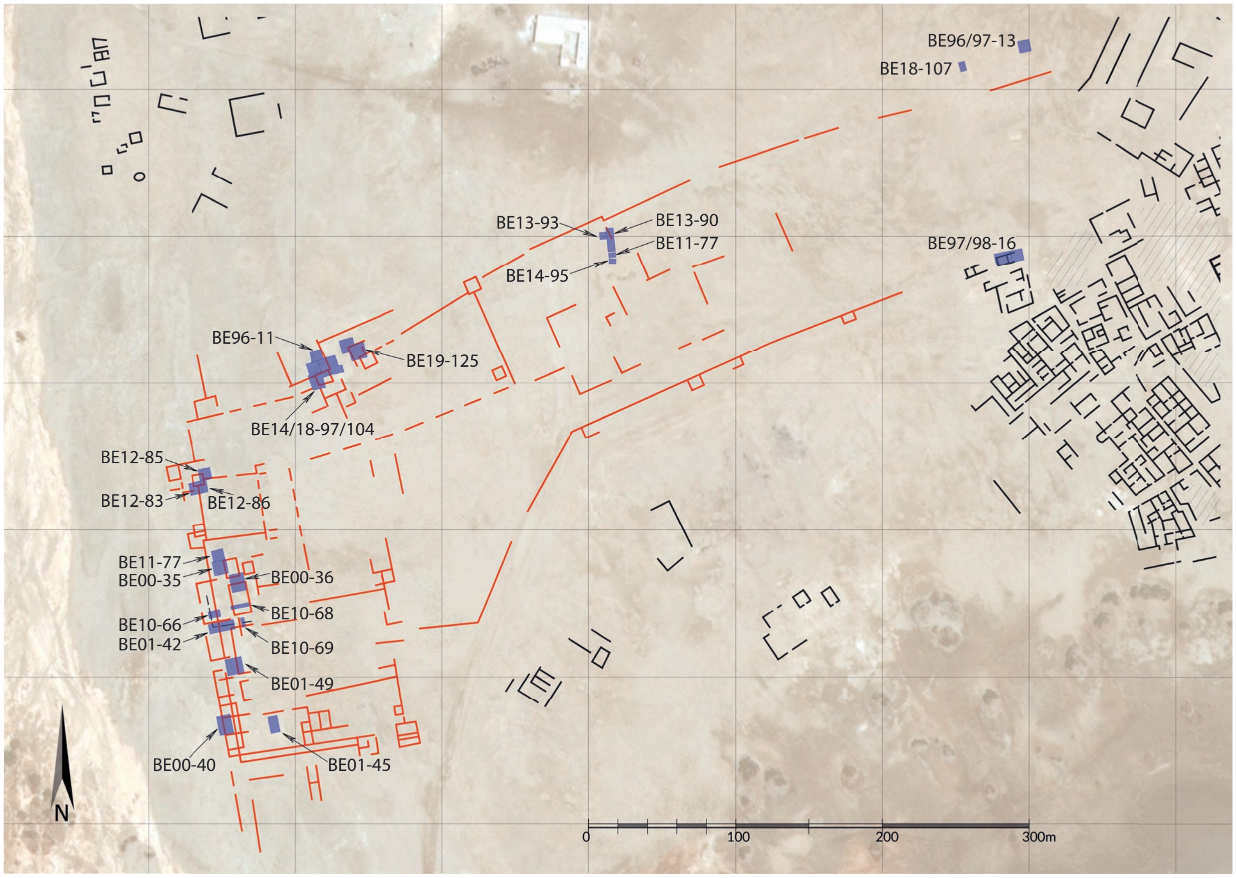


FIG. 3. Ptolemaic structures (in red) in the western and central part of Berenike with trenches (in blue) mentioned in the text (drawing by S. Popławski and M. Woźniak).

Ptolemaic Berenike was quite large, as indicated by substantial architectural, sculptural, metallic, ceramic, and numismatic evidence.[25] Surveying plus geological and environmental analyses, including examination of exposed outcrops,[26] sea currents, winds, and coral reef systems, provided additional evidence, as did studies of faunal and malacological finds.[27] There has been little analysis of botanical material from Ptolemaic contexts, though Roman-era remains have been published.[28] Combined, these studies have revealed the economic foundations of the settlement and its logistics.

Beginning in 1999, geomagnetic surveying complemented traditional surface surveying methods.[29] Geomagnetic surveying measures changes in the magnetic field of the subsurface to depths of approximately 0.5–1.0 m depending on the composition and magnetic properties of the soil and buried structures. This method may locate structures invisible from the surface and works well when identifying features such as walls buried by less compact windblown sand or trash, furnaces, slag heaps, burnt bricks, and structures cut into bedrock such as shafts, wells, and cisterns.[30]

[25] For pottery, project ceramologists R.S. Tomber and K. Domżalski, pers. comm. March 2020; for coins from 1994–2000 seasons, see Sidebotham 2007a; for all coins (including Ptolemaic) from 2001 and 2009–2019 seasons, S. Sidebotham, pers. comm. March 2020; for Ptolemaic metal artifacts, see Hense 2007, 216–17; for sculpture, see Sidebotham and Wendrich 2001–2002, 26–27; Sidebotham 2007b, 43.

[26] J.A. Harrell, project geologist, pers. comm. January 2020.

[27] Osypińska and Woźniak 2019, 369–71; A. Carannante, project malacologist, pers. comm. January 2019.

[28] Cappers 2006; C. Newton, project archaeobotanist, pers. comm. during the 2019 excavations.

[29] For the 1999 geomagnetic survey, see Herbich 2007; for 2008–2012 survey, see Sidebotham and Zych 2010, 8–10; for up to the 2015 survey (the last geophysical survey), see Sidebotham and Zych 2012, 29–31, fig. 3; Sidebotham 2019, 187.

[30] On the problem of identifying a rock-cut structure such as a cistern shaft on a geophysical map, see Woźniak 2019, 241.

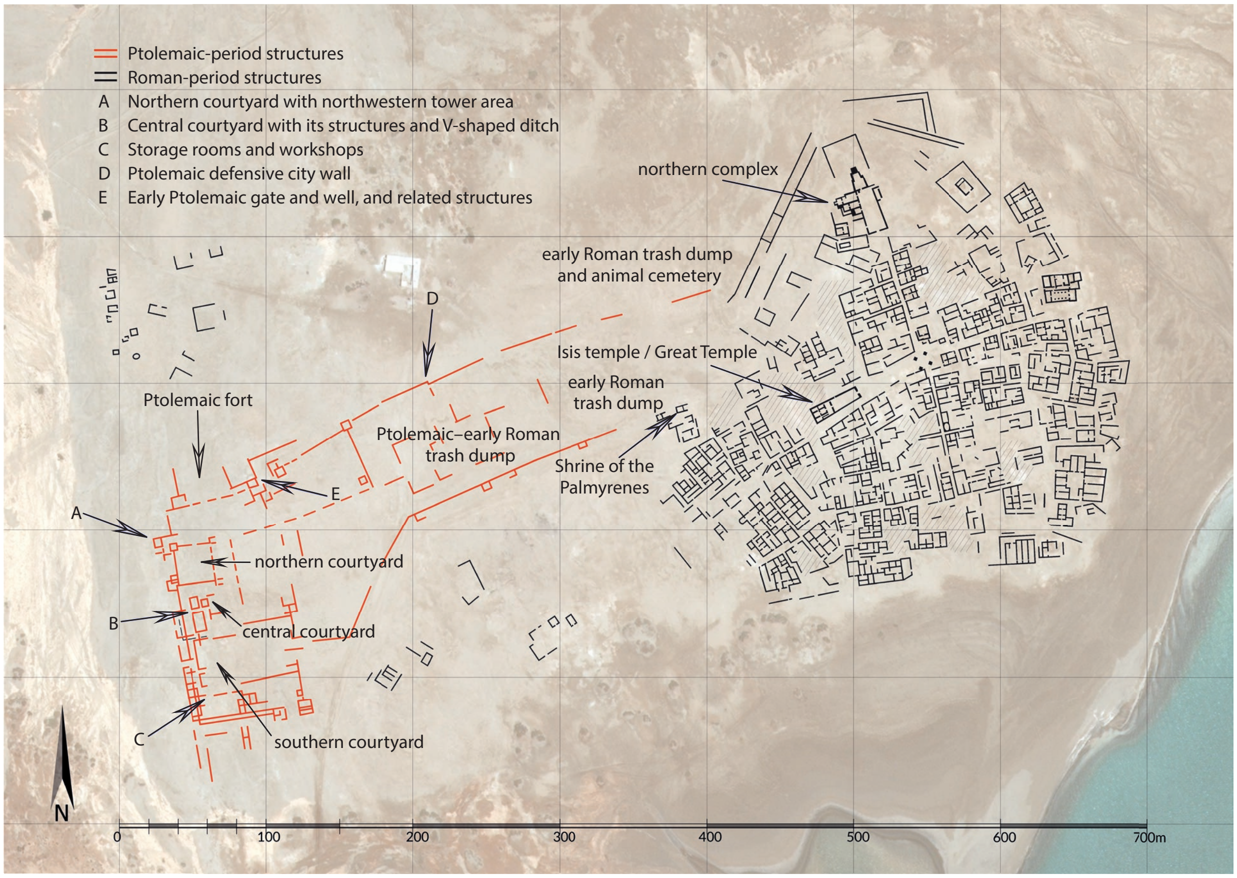


FIG. 4. Ptolemaic (red lines) and Roman (black lines) structures at Berenike with areas mentioned in text (drawing by S. Popławski and M. Woźniak).

## LOCATION OF PTOLEMAIC BERENIKE

Berenike was a major Hellenistic transshipment hub[31] for ivory, aromatics, and especially elephants, imported from the south[32]—that is, from today's Sudan, Eritrea, Djibouti, and perhaps Somaliland. Berenike was pivotal in the Ptolemaic maritime chain of East African commercial centers because of its favorable location. It was far enough south that northern winds in late fall through early spring were weak and diversified enough to make sailing northward possible.[33] Yet Berenike also was far enough north that travelers could access the Nile Valley below the cataracts at Aswan that made river navigation difficult. Ships operating in the northern Red Sea, for example from Clysma/Cleopatris or Aila, could deliver supplies to Berenike perennially.[34] In the winter, large ships operating in the central and southern Red Sea could convey goods and elephants to Berenike.[35] Near Berenike, specialized

[31] On Berenike generally as a transshipment hub (e.g., for supply transport), see Meredith 1957; Sidebotham 2011; Cobb 2018, 52–56.

[32] On Ptolemaic elephant hunting and Berenike's role in importation of these animals in the Hellenistic period, see Desanges 1978; Rice 1983, 91–92; Casson 1993; Burstein 2008; Sidebotham 2011, 39–53; Cobb 2018, 52–56.

[33] Sidebotham 2011, 52. Observations of the authors: during full moon days, winds often blow from the south or southeast bringing higher temperatures, more humidity, and greater precipitation (these might be associated with recent changes in climate and wind patterns). In winter 2019, southern and southeastern winds were more common than usual and brought warm, humid weather and rain. Modern winter wind systems today may resemble those in the early Hellenistic period. On difficulties of sailing more generally, see Whitewright 2007.

[34] On tacking and winds in the Red Sea, see Strabo 17.1.45; Sidebotham 1986, 51–52; 2011, 52; De Romanis 1996, 19–31; Whitewright 2007; Nappo 2010, 343–44; Langodan et al. 2014; Bard and Fattovich 2018, 184–85.

[35] Scullard 1974, 126–33; Kistler 2007, 70–74; Whitewright 2007; Nappo 2010, 343–44.

*elephantegoi* (elephant transport ships)[36] and other vessels overcame the winds or capitalized on changes in their directions.[37] Farther north, navigation with heavy vessels was extremely problematic,[38] though to some extent possible.[39] Graffiti of and references to elephants and teams seeking to capture them[40] confirm their transport from the Red Sea, usually via Berenike, across the desert to the Nile.

Corroboration of the use of the Edfu–Berenike road (see fig. 2) by teams transporting elephants include ostraka from ʿAbbad, a station about 21.5 km east of the Nile. These documents, dated to ca. 240–210 BCE, recorded the distribution of water to elephant-hunting specialists.[41]

Construction crews built Berenike on the northern side of a lagoon connected to Foul Bay (Akathartos Kolpos), so named due to the dangerous reefs and winds. The harbor entrance was only approximately 50 m wide and joined the southern lagoon toward the southeast to Foul Bay. Ras Benas, a 32 km long and mountainous cape, lay north of Berenike.[42] It blocked some sea currents and was also an excellent landmark for mariners.

Based on descriptions of Ptolemais Theron in Strabo (16.4.7) and Pliny the Elder (*HN* 6.34.171)[43] and on discoveries at Berenike, it seems that Ptolemaic builders preferred rocky or sandy promontories for Red Sea bases as they were easy to fortify. Berenike and Ptolemais Theron (see fig. 1) had defensive enceintes.[44] The harbor of Marsa Nakari (perhaps ancient Nechesia), located approximately 150 km north-northwest of Berenike (see fig. 2), was probably walled in the Ptolemaic era, although fortifications thus far excavated are early Roman in date.[45]

The southern lagoon at Berenike has silted up extensively, but satellite imagery and geological coring indicate that it was larger up to the first to second centuries CE.[46] At its northwestern end, the eastern termini of Wadis Mandit, Umm Salim al-Mandit, and the northern branch of Kalalat debouch into the lagoon (fig. 5),[47] which flash floods over the centuries have filled with enormous amounts of sediment, thereby leading, in geological terms, to rapid siltation. This is common along the Red Sea coast of Egypt and has also been documented at Mersa Gawasis[48] and the Roman port of Myos Hormos,[49] about 320 km north-northwest of Berenike.

The Ptolemaic fortress at Berenike was situated on two peninsulas, the western ridge and the central promontory, perpendicular to one another (see fig. 5). The western ridge runs roughly north–south; it is about 800 m long, 170 m wide, and rises to about 3.0–3.5 m above the current sea level.[50] This western ridge comprises the remnants of a hard and heavily eroded Late Pleistocene coral reef.[51] The second peninsula, on which are ruins mostly of the Roman city, extends east–west. It is about 560 m long and 200 m wide. The eastern portion comprises windblown and waterborne sand covering an extinct coral reef with evidence of human occupation from the Roman era and earlier.[52] A sandy spit joins the western part of the

[36] Two sources mention *elephantegoi*: a papyrus discovered in the Fayum dated to 224 BCE (Wilcken 1963, 452) and Agatharchides 5.85 (Burstein 1989, 141 n. 3). Other references to transportation of elephants appear in the Pithom Stele, dated to ca. 264 BCE (Naville 1885, 18 line 24), and Diodorus Siculus (3.40.4).

[37] Whitewright 2007; observations of authors in winter seasons 2009–2020.

[38] Diodorus Siculus 3.40.4–8; Nappo 2010, 343; De Romanis 2020, 45–46.

[39] Naville 1885, 18 line 24; Roeder 1959, 125–26; Sidebotham 2011, 51.

[40] Bernand 1972, 44–46 (no. 9bis), pl. 54.41–42 (al-Kanaïs); Sidebotham 2011, 41–42 (Abraq), 42 (near Bir Menih, perhaps not Ptolemaic); Cuvigny 2017 (ʿAbbad).

[41] Cuvigny 2017. Some teams reached more southerly destinations via the Nile Valley (Sidebotham 2011, 48) or at Adulis (Sidebotham 2011, 43).

[42] Strabo 16.4.5; analysis of satellite maps and survey of the lagoon by the authors. For more on the topography, see Sidebotham 2011, 9; Kotarba-Morley 2017, 63–66; Woźniak 2017, 47.

[43] The *Periplus Maris Erythraei* 3 lists Ptolemais Theron as a small port around the mid first century CE; see Casson 1989.

[44] For more on Berenike's walls, see Woźniak 2017, 43–46. For Ptolemais Theron, see also Roeder 1959, 125–26; Cohen 2006, 341–43.

[45] Seeger 2001, 81; Sidebotham 2011, 186.

[46] Kotarba-Morley (2017, 66 fig. 2, 68–90) notes the lagoon is smaller today than in antiquity.

[47] Harrell 1996, 102.

[48] Bard and Fattovich 2018, 28–31.

[49] Blue 2006.

[50] J.A. Harrell, pers. comm. 2019, and measurements by authors.

[51] For geology of the Red Sea and shaping and date of reef systems, see Veeh and Giegengack 1970; Hoang and Taviani 1991, 268–71; Arvidson et al. 1994, 12184; Plaziat et al. 1995, 18; Mansour and Madkour 2015, 381, 388–89; Pugh and Abualnaja 2015, 326.

[52] Harrell 1996, 102–3, 106, 108; 1998, 125–30; 2019.

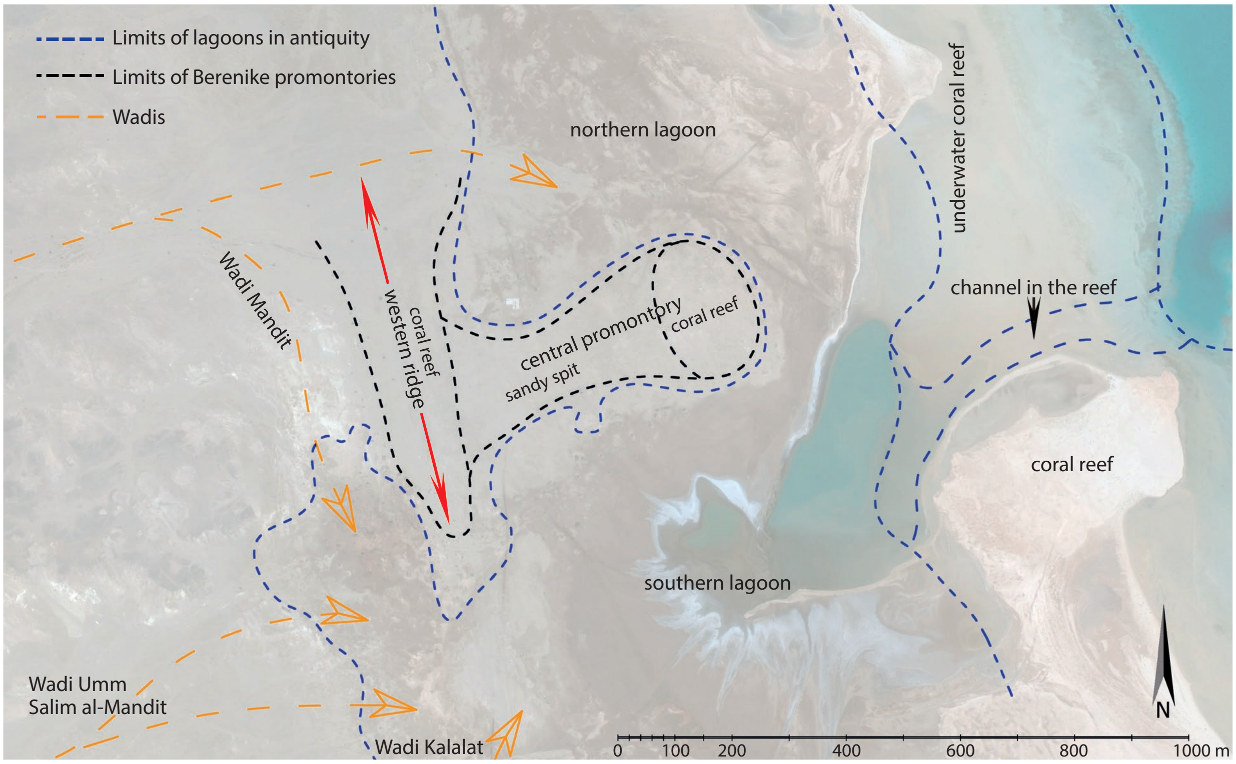


FIG. 5. Geological features of Berenike and environs (drawing by M. Woźniak and S. Popławski).

central promontory with the central section of the western ridge. The central promontory contains part of the Hellenistic-era settlement, located west of the main concentration of Roman-era ruins.

Few ancient writers described the sea approach to Berenike,[53] and no ancient descriptions survive of the city itself. Aside from brief mentions in Strabo (16.4.5, 17.1.45), Pliny the Elder (*HN* 6.34.175, 6.28.107–8), and the *Periplus Maris Erythraei* (1, 18, 19, 21),[54] and some ancient maps and itineraries, descriptions derive from 19th- and early 20th-century travelers and from excavations begun in 1994. Fieldwork in the Eastern Desert has also documented infrastructure that linked Berenike and other Red Sea and desert settlements to emporia on the Nile.[55]

## THE SITE OF BERENIKE

Excavations at Berenike have identified two main zones: the eastern on higher ground, which has primarily Roman-era ruins that overlie some Ptolemaic remains, and the western, flatter area, dominated by Ptolemaic vestiges (see fig. 4). There was Ptolemaic activity in the eastern area, and some Roman material appears in the western zone. Excavations, surface remains, and geomagnetic surveys in the western area[56] indicate its defensive, storage, and industrial character in early Ptolemaic times.[57] Trash dumps from the Ptolemaic and early Roman periods separate the eastern and western zones.

The eastern and northwestern limits of the Ptolemaic settlement remain unknown. In the northwest, water erosion has destroyed most structures that may have once existed here. In the eastern part, Ptolemaic remains often were 2.5–4.0 m beneath Roman overlay, and therefore there is insufficient data about the functions or the precise northeastern or eastern boundaries of the Ptolemaic settlement.[58]

[53] Peppard 2009.
[54] Casson 1989.
[55] Cf. Sidebotham et al. 2019a.
[56] Woźniak and Rądkowska 2014, 510, 516–20, figs. 6, 7.
[57] For the Ptolemaic fort and industrial area, see Sidebotham 1998a, 85–88; 2007b, 30–44; Sidebotham and Wendrich 2001–2002, 25–27; Sidebotham and Zych 2010, 10–11; 2012, 31–32; see also Woźniak 2019, 240.
[58] Sidebotham 2007b, 56–58.

At the northwestern edge of the Roman remains on the central promontory, Ptolemaic mudbrick walls were found beneath early Roman trash and an animal cemetery (see figs. 3, 4).[59] The pottery, mainly third- to second- century BCE domestic wares, suggested residential activities.[60] There were late Ptolemaic levels in trench BE96/00-10,[61] immediately north of the Isis temple. There were also third-century BCE strata beneath the Shrine of the Palmyrenes (trench BE97/98-16),[62] located west of the Isis temple and south of the early Roman trash dump and animal cemetery.

Ptolemaic-era artifacts excavated from the Isis temple suggested that an edifice from that time preceded the Roman-era one now visible. These included a statuette of the god Sobek[63] and the fragment of a Ptolemaic-era pictorial stele (fig. 6).[64] Part of an inscription dated to 133 BCE[65] joined with a larger piece recovered before the beginning of the current project. Excavators recorded a Ptolemaic-era block depicting a king offering to Min and Isis found in the foundations of the Roman-era Isis temple.[66]

There were traces of walls built of gypsum-anhydrite, a common construction material in Ptolemaic and early Roman Berenike,[67] and extinct coral heads in the central part of the site (see fig. 4), in the Ptolemaic to early Roman trash dumps. Waste from the working of bone, turtle shell, semiprecious stones, and ostrich eggshells suggests that the walls were those of ateliers-cum-residential areas.[68]

FIG. 6. Top of Ptolemaic stele from Isis temple, scale = 10 cm (S. Sidebotham).

A geomagnetic survey conducted in 1999 identified buildings aligned north–south on the edge of Wadi Mandit at the western boundary of the site. Subsequent excavations identified these as part of the Ptolemaic industrial area.[69] However, more advanced geophysical surveying and excavation determined that the remains comprised the western part of a large fort with industrial and storage areas (see fig. 4).[70] Its overall measurements were about 150 m north–south x 80 m east–west. This complex contained at least three courtyards. Rooms surrounded the central and southern courtyards, as is typical of smaller contemporary forts in the Eastern Desert.[71] The northern part of the Berenike fort had a small courtyard with massive walls, equipped with two or three square corner towers. The geomagnetic survey in the northern courtyard recorded only a small tank or silo in the southeastern corner. Any additional features probably were composed of lighter organic materials that have since disappeared.

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[59] In trenches BE96/97-13.008-009 (Sidebotham 1999, 46–57) and BE18-107.079-080 (Sidebotham et al. 2019b, 10, pl. V, no. 4).

[60] Sidebotham 1999, 49–50. Bricks discovered in trench BE 96/97-13 were very poor quality, made of sandy mud (typical for Ptolemaic mudbrick in Berenike) more than of good clay.

[61] Sidebotham 2007b, 56–59.

[62] Sidebotham 2000a, 45–47.

[63] Sidebotham and Zych 2012, 39, pl. F; 40 (and parallels).

[64] Sidebotham and Zych 2016, 16–17, fig. 27.

[65] Ast 2020.

[66] Observations of the authors from 2020 season.

[67] M. Woźniak pers. observations January 2019; gypsum and anhydrite are macroscopically indistinguishable without proper analysis and are extremely similar in chemical composition (Harrell 1996, 106–7). Using only one of the names might suggest the occurrence of only one of the abovementioned rocks in Ptolemaic constructions and, therefore, can be misleading, especially since often in the block there are alternately thin gypsum and gypsum-anhydrite laminae. Following the suggestion of Harrell, we provide both names.

[68] Woźniak 2019, 240.

[69] Sidebotham and Wendrich 2001–2002, 24–27; Sidebotham 2007b, 30–44; Woźniak and Rądkowska 2014, 508–14.

[70] See Woźniak and Rądkowska 2014 for phases of the fort.

[71] Redon 2018.

Excavations in trenches BE12-83, BE12-85, and BE12-86 (see figs. 3, 7)[72] documented the northwestern tower of the northern courtyard, which belonged to the first phase of the Ptolemaic fort, but its walls had been almost completely robbed,[73] leaving only some foundations containing third-century BCE amphora fragments.[74] The exterior of the tower measured approximately 5.0 x 5.0 m, its walls were about 0.8–0.9 m thick, and inside was a room about 3.1 x 3.1 m. The foundations were 1.2–1.3 m wide x 0.55–0.57 m deep.[75] The western tower wall of the northern courtyard consisted of blocks and fragments of gypsum-anhydrite and large pieces of coral. These same construction methods and materials appeared in the southern part of the fort in trenches BE00-40, BE01-42, BE01-45, and BE10-66[76] (e.g., fig. 8). Other smaller walls, perhaps slightly later and appearing in trench BE12-83, were made up of irregular pieces of sandstone, likely sourced from outcrops approximately 300–500 m north of the city.[77]

One of the oldest features at the western limits of the site was a long and never fully excavated north–south trench approximately 2.0 m wide x 0.60–0.65 m deep. It probably marked the western edge of the structures built near the fort.[78] The western wall of the northwestern tower and the western wall of the northern courtyard had been erected in this trench. Farther south, part of a V-shaped ditch, cut into the rocky bottom of the large north–south running trench (see fig. 8),[79] contained pottery dating ca. mid third to mid second century BCE. The ditch was 1.5–2.0 m wide at the top, tapering to a depth of 1.2–1.5 m. It ran north–south in trenches BE10-66 and BE01-42 (see fig. 8), then it made a 90° turn and continued east–west in trenches BE01-42 and BE10-68. Despite excavation of these trenches and part of a fourth (BE11-75), the overall dimensions of the V-shaped ditch remained undetermined. This ditch had not been used for hydraulic purposes as there was no lime plaster lining as appears in water-related installations in Berenike and elsewhere in the Eastern Desert. The appearance and measurements would have exposed any water to increased evaporation, which occurs rapidly in this hyperarid environment[80] and which would have made any water remaining more brackish unless protected by some covering. The V-shaped ditch must have served some other purpose. The documentation nearby of elephant molars[81] (species undetermined due to poor DNA preservation)[82] suggested that the ditch was a retaining area for pachyderms. This putative animal pen, south-southeast of the northern courtyard, was part of the oldest section of the Ptolemaic settlement.[83] Third-century BCE accounts indicate that Berenike was a main port where *elephantegoi* disembarked elephants transported from farther south on the African coast. This V-shaped ditch and elephant molars and skull fragments (see below) are the first recorded archaeological evidence for this important Ptolemaic activity.

There followed three additional phases of the fort's operation in a relatively short period of approximately 75 years, ca. 275 BCE–200 BCE. The earliest of these dated to the latter part of the first half of the third century, the next began at the middle of the second half of the third century, and the third dated from the end of the third century.[84] An important activity in the fort was metallurgical production—the smelting, casting, and working of copper alloy and lead.[85]

In the second of these phases, the fort attained its largest size and an almost rectangular shape, becoming one large building with massive stone walls and at least three internal courtyards (see figs. 3, 4).[86] During this phase, the two larger courtyards were built south of the older, towered, northern courtyard mentioned

[72] Sidebotham and Zych 2012, 31–32; Woźniak and Rądkowska 2014, 510, 516, fig. 2.

[73] Woźniak 2019, 241–42.

[74] Woźniak and Rądkowska 2014, 515–18, fig. 6a.

[75] Woźniak and Rądkowska 2014, 516.

[76] For trench BE00-40, see Sidebotham 2007b, 37–44, figs. 4.5–4.8; for trenches BE01-42 and BE10-66, see Woźniak and Rądkowska 2014, 512–13, figs. 4, 5.

[77] Woźniak 2019, 242.

[78] Woźniak and Rądkowska 2014, 516.

[79] Sidebotham and Wendrich 2001–2002, 26–27; Sidebotham et al. 2008, 162–64; Sidebotham 2011, 55; Woźniak and Rądkowska 2014, 511–13, 517–19.

[80] Sidebotham 2011, 103.

[81] Sidebotham and Wendrich 2001–2002, 41; Sidebotham 2011, 50; Woźniak and Rądkowska 2014, 517; Osypińska and Woźniak 2019, 374; Woźniak 2019, 243.

[82] Osypińska and Woźniak 2019, 374.

[83] For reconstruction of fort phases, see Woźniak and Rądkowska 2014, 520–22; Woźniak 2019, 243.

[84] Woźniak and Rądkowska 2014, 520–23; Woźniak 2019, 243–44.

[85] For metallurgical waste in the fort, see Sidebotham and Wendrich 2001–2002, 25–26; Sidebotham 2007b, 34–37; Woźniak 2019, 244.

[86] Woźniak and Rądkowska 2014, 520–22; Woźniak 2019, 243–44.

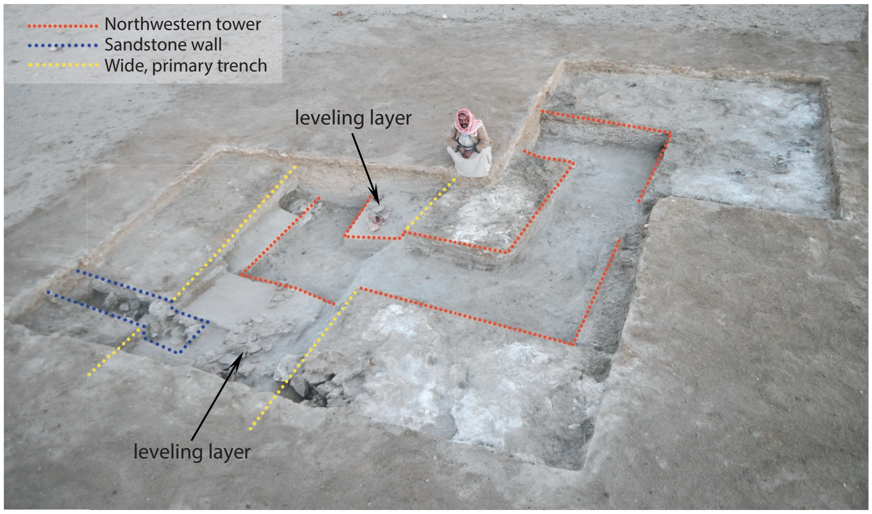


FIG. 7. Northwestern tower of the Ptolemaic fort in trenches BE12-83, BE12-85, and BE12-86, view looking northwest (S. Sidebotham, modified by M. Woźniak and S. Popławski).

FIG. 8. Part of V-shaped ditch in the central courtyard of the Ptolemaic fort: trenches BE10-66 (left) and BE01-42 (right), view looking east, scale = 50 cm (S. Sidebotham).

above. The V-shaped ditch was filled in, and the new central courtyard probably functioned as the new elephant pen. The central courtyard received additional structures including a cistern, granaries, and perhaps a well (see fig. 4[B]).[87]

Excavations in 2000 partially exposed two of these features (fig. 9) and, with the aid of geomagnetic surveying, their original sizes could be estimated. The southern structure measured about 7.5 m north–south x 5.5 m east–west, and the northern one was about 6.5 m north–south x 5.0 m east–west. Both were probably grain silos and could have accommodated a combined minimum of 60 $m^3$. Both lay west of a heavily plaster-lined cistern of which only the southwesternmost portion, with dimensions of 2.25 x 1.02 m, has been excavated.[88] After the cistern was abandoned, it accommodated a skeleton of an adult human in the fetal position, found badly decayed.[89]

Excavations in trenches BE00-40, BE01-45, and BE01-49 documented the southern and southeastern parts of the central courtyard and fragments of massive external walls of the fort's second and third phases (ca. 250–200 BCE) along with rooms and walls separating them. There were no additional structures inside the rooms. These trenches yielded amphora and keg sherds, including a Rhodian amphora handle with a rectangular stamp from trench BE00-40 in the Ptolemaic zone south of the hydraulic area (discussed below). The stamp records in two lines ΕΠΙ ΑΡΙΣΤΑ[Ρ] (Epi Aristarchos) and dates to 270–247 BCE.[90] This area also had remains from metallurgical production including slag, crucible fragments, small pieces of raw

[87] For structures in trench BE00-36 in the fort courtyard, see Sidebotham 2007b, 32–34; more generally, see Sidebotham and Wendrich 2001–2002, 24–27; Woźniak and Rądkowska 2014, 520; Woźniak 2019, 243.

[88] Sidebotham 2007b, 32–34, Woźniak and Rądkowska 2014, 509; Woźniak 2019, 243.

[89] Sidebotham 2007b, 35–36, pl. 4-4.

[90] Finkielsztejn 2001, 188, table 17; Cankardeş-Şenol 2015a, 315 RE- ΑΡΙΣΤΑΡΧΟΣ no. 004. Dating and reading of the inscription courtesy John Lund, National Museum of Denmark, pers. comm.


FIG. 9. Probable silos and portion of a cistern (upper left) in the central courtyard of the Ptolemaic fort (trench BE00-36), view looking southeast, scale = 1 m (S. Sidebotham).

copper and iron, and nails made of copper alloy and iron. The geomagnetic map revealed features that were probably also storage rooms or workshops.[91]

Excavations in trenches BE13-90 and BE13-93 at the northern edge of the Ptolemaic trash dump recorded a large robber trench oriented northwest–southeast, which measured about 2.50 m wide and up to 1.65 m deep. At the bottom of the robber trench were the damaged remains of a massive wall built of gypsum-anhydrite blocks and fragments of various shapes and dimensions (see figs. 4[D], 10).[92] This portion of the wall had been robbed during the early Roman period or perhaps somewhat earlier. The foundation was 1.6 m wide, while the wall itself was 1.0 m thick. The best-preserved eastern section ran in a zigzag fashion; its eastern end shifted about 1.5 m south of the western part. Robbers had removed the western end and only irregular chunks of gypsum-anhydrite remained.[93] Geomagnetic surveying indicated that the exposed section was the central part of an approximately 180 m long northern defensive Ptolemaic city wall,[94] provided with at least one square tower measuring about 5 x 5 m. This small, exposed stretch of the defensive wall may be where two segments of the northern wall joined, or it may represent the western remnant of a small gate.

A single wall formed the eastern and central parts of the fortification. There were two lines of walls in the northwestern part of the site, the only land approach to the city.[95] The geomagnetic survey suggested that a single wall with square towers protected Berenike on the south, in the direction of the port, though excavations have not yet confirmed this.[96]

Excavations recorded skull fragments of a juvenile elephant in trenches BE13-90 and BE13-93 (fig. 11). This find shows clearly that imported elephants were not invariably adults. Acquiring younger elephants would have been cost-effective not only because, once trained, they could contribute more years of service but also because they were lighter weight to transport. It is also possible that the elephant hunters transported individuals of different ages together because of the highly social nature of these beasts. These wall remains

[91] Sidebotham 2007b, 37–40.

[92] Woźniak 2017, 45; 2019, 244.

[93] Woźniak 2017, 45–46.

[94] For the size, course, and structures related to the northern defensive wall, see Woźniak 2017, 46.

[95] The geomagnetic survey plan and limited excavations (trenches BE13-90, BE13-93, and BE14-104) permit determination of the line and direction of the fortifications.

[96] Woźniak 2017, 46–47.

FIG. 10. Part of northern Ptolemaic defensive city wall (trenches BE13-90 and BE13-93), view looking south (S. Sidebotham).

FIG. 11. Fragments of juvenile elephant skull from trench BE13-90/93, scale = 10 cm (S. Sidebotham; courtesy the Berenike Project / Polish Centre of Mediterranean Archaeology of the University of Warsaw and University of Delaware).

and skull fragments were adjacent to the Ptolemaic trash dump in trenches BE11-77 and BE14-95.[97]

## SUPPLIES AND RESOURCES

### *Grain, Olive Oil, and Wine*

Written and archaeological sources suggested that Berenike's initial residents, as well as the parties sent to procure elephants, were mainly soldiers and specialists commanded by high-ranking Ptolemaic officers.[98]

We know little about the methods used to resupply Berenike or other Ptolemaic Red Sea ports. Ptolemaic stations south of Egypt possibly amplified preexisting indigenous settlements. While the non-native residents, mainly Egyptians and Greeks, undoubtedly relied to some extent on resources available locally, a contemporary papyrus suggests that they imported items from more northerly ports.[99] We do not know, however, how dependable these shipments might have been. Some items may have been transported on ships that were tasked solely with resupply or that also carried merchandise destined for areas beyond Ptolemaic suzerainty elsewhere in the Red Sea and into the Indian Ocean.[100]

Items sent to Berenike, including grain, wine, olive oil, and some livestock, would have been shipped from the Nile Valley, and especially from the Fayum, along a canal completed by Ptolemy II in 270/69 BCE to Clysma/Cleopatris at the northern end of the Gulf of Suez.[101] Excavations at Clysma in the 1930s documented little, if any, evidence of Hellenistic-era occupation.[102] Yet there was no complete excavation of the site, and toponyms affiliated with Clysma, including Arsinoë and Cleopatris, and the termination of the Ptolemaic-era canal nearby, suggest a Ptolemaic settlement somewhere in the region. From near Clysma, vessels transported items, communications, and people south and returned with ivory, elephants, other commodities, messages, and passengers. The prevailing northerly winds allowed relatively easy communication and resupply missions to come from the north at any time. The same winds made return from the south difficult.

[97] Osypińska and Woźniak 2019, 374.

[98] E.g., Strabo mentions the strategos Satyros (16.4.5) and the strategos Eumedes (16.4.7), founder of Ptolemais Theron. For strategoi Lichas and Charimortos, see Fraser 1972, 173–84, 308, 370–74; for strategoi involved in elephant hunting, see Peremans and van 't Dack 1952, nos. 4419–428; for soldiers of Eumedes, see the Pithom Stele in Naville 1885, 21 line 24; for Greek-speaking soldiers with Egyptian names and for sea transport of grain from Heroopolis via Berenike, see Wilcken 1963, 534–35, n. 452; for soldiers in an elephant hunting party, see *Papyrus Petrie* 3.114; Desanges 1978, 297–98; Sidebotham 2011, 48–49, 50–52.

[99] Wilcken 1963, 534–35, n. 452; cf. Sidebotham 2011, 49 n. 122.

[100] Sidebotham 2011, 32–38.

[101] Sidebotham 2011, 178–82; Aubert 2015.

[102] Bruyère 1966.

The most convenient way to reach ports such as Philoteras (precise location unknown), Myos Hormos, or Berenike from Clysma/Cleopatris was to use the strong northern winds in late summer and return in the winter when northerly winds were weaker. At Berenike, shipborne supplies, including grain, olive oil, wine, possibly textiles from the Fayum, and some livestock,[103] may have been transferred to *elephantegoi* returning south. These ships probably also carried personnel and communications for those more southerly coastal garrisons. Authorities, and in later times also private merchants, would have maximized the carrying capacities of vessels sailing in either direction. It is also possible that some cargo ships arriving from Clysma/Cleopatris may have accompanied *elephantegoi* sailing south from Berenike. A papyrus from the Fayum, dated to December 224 BCE, provides information about *elephantegoi* and the dangers they faced.[104]

Some cargoes and animals, both those to be eaten and the draft or transport animals destined for the elephant hunting stations, undoubtedly arrived at Berenike overland from the Nile. These included species less suitable for shipboard transport such as goats, cattle, or donkeys. Perhaps additional supplies, such as timber to repair or outfit ships also made the overland journey from the Nile to Berenike and were transported onward to the more southerly elephant hunting stations for repair of vessels there. It was a practice of the Pharaonic[105] and Roman periods[106] to transport prefabricated ship parts to the Red Sea for the repair or assembly of vessels, and this practice likely also took place in the Ptolemaic period.

Ptolemaic Berenike had large storage facilities. There were at least 20 rooms filled with amphora sherds and other storage wares in the western and southern portions of the Ptolemaic fort. Evidence was found that industrial activity, including metalworking in lead, copper alloy, and iron, also took place.[107] As mentioned above, excavations revealed the two large silos in the fort's central courtyard.[108] Construction and use of both dated to the early Ptolemaic period. Their interiors lacked any coating of hydraulic mortar; thus no liquids could have been stored here. Rather, they probably held grain. In their final phases, both served as dumps for kitchen and industrial waste.

Surviving structures and small finds permit reconstruction of the delivery methods and types of supplies. Amphoras, kegs, and spouted jars dominated the ceramic corpus from trenches in the fort and in its vicinity.[109] An early Ptolemaic water distribution facility also was excavated in this area. The vast majority (about 70%) of the vessels consisted of Egyptian-made Nile silt amphoras. They later served as pipes connecting shallow pools and channels in the rainwater collection facilities discovered in trench BE15-104 (fig. 12; on which, see below).[110] They probably also functioned as buckets for extracting water from a well in the internal chamber of the gate in the north defensive wall of Berenike (trenches BE14/18-97/104; see fig. 4[E]). Rhodian amphoras were much less common (approximately 2–3%). Two stamped Rhodian amphora handles came from trench BE19-125. One (fig. 13a) had a circular stamp with ΕΠΙ ΕΥΚΛΕΥΣ (Epi Eukleus, for Eukles [II]) and is dated to 232 BCE.[111] A second (see fig. 13b, c) had two circular stamps: ΕΠΙ ΠΑΥΣΑΝΙΑ (Epi Pausania(s), for Pausanias [I]), dated to 233–200 BCE,[112] and ΚΡΕΟΝΤΟΣΘΕ[Σ]ΜΟΦΟΡΙΟΥ (Kreontos The[s]mophoriou, Kreon being the fabricant and Thesmophorios the month), also dated to ca. 233–220 BCE, likely 225 BCE.[113] A third Rhodian handle (see fig. 13d) stamped ΦΙΛΙΝΟC (Philinos), dated to 269–240 BCE, was found in the foundation trench of the tower in trench BE12-83.[114] These stamps provided

[103] Sidebotham 2011, 11–13.

[104] Wilcken 1963, 452; Casson 1993, 257–58, n. 40.

[105] Summarized in Tallet 2016; Ward and Zazzaro 2016; Bard and Fattovich 2018, 90–96, 194–95.

[106] For Coptos Tariff (dated May 90 CE), see Bernand 1984, 199–208, no. 67; for ostrakon (dated to July 109 CE) from Krokodilô on the Coptos–Myos Hormos road, see Cuvigny 2005, 77–85 = *Ostraca Krokodilô* 41, lines 17–26 on pp. 79, 81.

[107] For lead sheathing, see Hense 2007, 216–17; Sidebotham and Zych 2010, 21; 2012, 33; Sidebotham 2011, 197, 200, 213; and forthcoming. For sheathing of ships' hulls in Hellenistic and Roman times, see Steffy 1985; Sidebotham forthcoming.

[108] Sidebotham 1998a, 85–88; 2007b, 31–43; Woźniak 2019, 240, 243.

[109] Tomber 1998, 164–69; pers. comm. November 2018.

[110] Cf. Peña 2007, 144, for recycling of pottery vessels in the Roman period elsewhere in the Mediterranean.

[111] Cankardeş-Şenol 2015b, 142, nos. 002–008. Dating courtesy John Lund, pers. comm.

[112] Finkielsztejn 2001, 191, table 18; Cankardeş-Şenol 2016, 183–89. Dating courtesy John Lund, pers. comm. Badoud (2015, 254), however, gives a date of 257 BCE for Pausanias I.

[113] Supra n. 111.

[114] Sidebotham and Zych 2012, 31–32; Woźniak and Rądkowska 2014, 517.


FIG. 12. Water-collecting installation east of the Ptolemaic gate (ca. mid third century BCE): *top*, eastern part of trench BE15-104, view from the east; *bottom*, amphora-neck conduit, scale = 20 cm. Conduits made of cut-off amphora necks connect pools with drainage channel (S. Sidebotham; *top* modified by M. Woźniak and S. Popławski).

terminus post quem dates for activities near the well, discussed in more detail below. Excavators also recorded Ptolemaic-era kegs (about 6% of the ceramic corpus) from this part of the site. Likely of Egyptian origin, the kegs arrived by sea or overland from the Nile Valley primarily by donkey. Finds of donkey bones in the Ptolemaic trash dump (trenches BE11-77 and BE14-95) confirmed the use and presence of these quadrupeds at that time.[115]

Most of the ceramic corpus from the fort and its environs dated to the third and second centuries BCE. Numerous Nile silt amphoras originated from central Egypt or the Fayum (fig. 14).[116] This is not surprising as the Fayum was an important source of food staples and textiles in Ptolemaic and Roman times. The Fayum had many settlements of Greek and Egyptian *kleruchs*,[117] especially after the extensive irrigation project of Ptolemy II.[118] From here, supplies could be shipped to locations in the deserts and along the Red Sea coast for consumption there or for onward transport.[119]

Amphoras most often contained liquids; those from early Ptolemaic contexts probably originally contained olive oil or wine. Such comestibles promoted good morale among those living in Berenike for extended periods. Imports of wine may have been less common than those of olive oil. The latter was probably transported in Egyptian-made amphoras and wine in amphoras such as those from Rhodes and Kos.[120] However, Berenike's residents undoubtedly also consumed Egyptian wines conveyed in Egyptian-made amphoras.

Other products included *garos*, a fish sauce.[121] Excavations uncovered an intact third- or second-century

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[115] Osypińska and Woźniak 2019, 372, table 2.

[116] Amphoras from the Fayum and central Egypt reached Berenike together with other supplies. These areas are well known to have participated in the transport of elephants in one direction, and in the other, supplies for hunting teams and ports of the Red Sea region serving hunting expeditions; see Tomber 1998, 165; K. Domżalski pers. comm. January 2020. For a papyrus indicating the importance of the Fayum in the capture and transport of elephants (and also supply of Red Sea ports and hunting stations), see Wilcken 1963, 452; also Mahaffy and Smyly 1891–1905, 2:20, col. IV; Edgar 1931, papyrus 115; Casson 1993, 258–59.

[117] Manning 2010, 5–6.

[118] See McKechnie and Guillaume 2008, 35.

[119] For the Fayum (Arsinoite Nome) as a production center for wine, oil, textiles, and livestock, see Sidebotham 2011, 181.

[120] Tomber 1998, 165.

[121] The Romans called this variously *garum* and, later, *liquamen*. On an amphora with residues of fish sauce found in the gate of Berenike, see Zych et al. 2016, 324–25; for *garum*, see Flower and Rosenbaum 1958; Curtis 1991; Grocock and Grainger 2006, 377–87; van Neer et al. 2010.

FIG. 13. Rhodian amphora stamps: *a*, ΕΠΙ ΕΥΚΛΕΥΣ (Epi Eukleus); *b*, ΕΠΙ ΠΑΥΣΑΝΙΑ[Σ] (Epi Pausania[s]); *c*, ΚΡΕΟΝΤΟΣ ΘΕ[Σ]ΜΟΦΟΡΙΟΥ (Kreontos The[s]mophoriou), same amphora as *b*, diam. 5.5 cm; *a–c* from trench BE19-125; *d*, ΦΙΛΙΝΟϹ (Philinos), from trench BE12-83, stamp diam. 6 cm (*a–c*, K. Braulińska; *d*, S. Sidebotham; courtesy the Berenike Project / Polish Centre of Mediterranean Archaeology of the University of Warsaw and University of Delaware).

BCE Egyptian amphora[122] in a sand-filled inner chamber of the early Ptolemaic gate (see fig. 14, left) deposited probably in the late second century BCE. An improvised lid sealed the vessel. Inside were dried residues and bones of small unidentified fish,[123] which may have been the remains of salted fish (known to the Romans as *salsamentum*) or remnants of a lower quality, unstrained fish sauce.

*Animals*

Pigs, goats, sheep, and cattle[124] supplemented bread, olive oil, and wine. Among 1,404 mammalian bones and fragments from Ptolemaic trenches, 98 were sheep and 321 were goats, 112 cattle, and 87 pigs (tables 1, 2). The remainder (360) could only be identified as ovicaprid, as preservation was too fragmentary to distinguish goat from sheep.

Goats and sheep tolerate very arid conditions, and the residents of Berenike could have bred or kept them for some time in or near the settlement. Today, local ʿAbabda Bedouin manage large numbers of goats and sheep that move between the mountains and the coastal plain. Portions of Wadi Mandit located northwest of Berenike provide optimal grazing, especially in autumn and winter. However, measurements of ovicaprid bones (esp. goats) from Ptolemaic Berenike indicated particularly robust and large bodies,[125] likely suggesting that conditions then were better than those currently prevailing in the region. Bones of similar dimensions have been documented in the ovicaprid

[122] Date and identification as Egyptian, R.S. Tomber, pers. comm. 2018.

[123] Zych et al. 2016, 324–25.

[124] Osypińska and Woźniak 2019, 370, table 1-376.

[125] Osypińska and Woźniak 2019, 373–75, table 5.


FIG. 14. Amphoras from the Ptolemaic gate chamber: *left*, Egyptian-made amphora containing remains of *garos* sauce, scale = 50 cm, with inset showing inscription ANTIOXOY (Antiochou) below the handle, scale = 10 cm; *right*, broken Egyptian-made amphora found a few cm below the *left* amphora, scale = 50 cm (S. Sidebotham; courtesy the Berenike Project/Polish Centre of Mediterranean Archaeology of the University of Warsaw and University of Delaware).

TABLE 1. Frequency of animal taxa in bone materials found at Ptolemaic Berenike.

| Taxa | NR | % |
|---|---|---|
| Invertebrates: Brachyura, Gastropoda, Bivalvia, Cephalopoda | 8,644 | 65.5 |
| Fish: Serranidae, Lethrinidae, Scaridae, Lutjanidae, Acunthuridae, Platacidae, Pomacanthidae, Siganidae, Ostraciidae, Tetraodontidae, Diodontidae, Sparidae, Dasyatidae, Mugilidae, Carcharhinidae, Carangidae, Scombridae | 2,982 | 22.6 |
| Reptiles: Chelonioidea | 15 | 0.1 |
| Birds: *Coturnix*, *Gallus* | 160 | 1.2 |
| Mammals: Rodentia, Canidae, *Felis*, Elephantidae, *Camelus*, Equidae, *Sus*, Bovidae | 1,404 | 10.6 |
| TOTAL | 13,205 | 100 |

NR = number of remains.

remains excavated at Elephantine Island in the Nile near Aswan.[126] These animals probably consumed much larger quantities of more nourishing food than those bred in antiquity and by today's ʿAbabda in the region around Berenike.

There are two possible explanations for the large ovicaprid bones excavated at Berenike. The first is that goats, sheep, and some cattle raised in the Nile Valley were driven through the desert to Berenike and then slaughtered and consumed shortly after their arrival. However, without meat storage facilities, such a modus operandi would have necessitated frequent consignments of small flocks or herds of animals. This method of resupply may have taken place initially or occasionally, perhaps for breeding stock, but could not have been sustained on a regular basis for animals destined for slaughter soon after arrival. It would have been logistically challenging and expensive to provide ample fodder and drinking water for a desert crossing of at least two weeks. Animal weight loss would have been significant and resulted in far less meat per head. To transfer these animals on a large scale on a regular basis would also have put tremendous strain on the desert road infrastructure. No ostraka studied from the desert forts suggest the regular passage of herds of animals. Documents suggest, as noted above, that elephants landed at Berenike and crossed the desert,[127] but in what numbers and how often remains an open question.

[126] Boessneck and von den Driesch 1993.

[127] Supra n. 41.

TABLE 2. Proportions of animal species in remains found at Ptolemaic Berenike.

| Taxa | NR in 1st group of trenches ("fort") | NR in 2nd group of trenches ("tower") | NR in 3rd group of trenches ("dump") | NR in 4th group of trenches ("gate") | Total NR | % |
|---|---|---|---|---|---|---|
| Chicken | 129 | – | 17 | 13 | 159 | 3.3 |
| Quail | – | – | 1 | – | 1 | 0.04 |
| Birds | 129 | – | 18 | 13 | 160 | 3.3 |
| Gerbils | 2 | – | – | 1 | 3 | 0.06 |
| Spiny mouse | 6 | 3 | 26 | 3 | 38 | 0.8 |
| Dorcas gazelle | – | – | 46 | – | 46 | 0.9 |
| Dog | 5 | – | 69 | – | 74 | 1.5 |
| Cat | 7 | – | 14 | – | 21 | 0.4 |
| Elephant | 24 | – | 3 | – | 27 | 0.5 |
| Dromedary | 8 | – | – | 18 | 26 | 0.5 |
| Donkey | 40 | – | 149 | 2 | 191 | 3.9 |
| Pig | 6 | – | 56 | 25 | 87 | 1.8 |
| Cattle | 1 | – | 62 | 49 | 112 | 2.3 |
| Sheep/goat | 277 | 22 | 264 | 216 | 779 | 16.3 |
| Identifiable sheep | 35 | 8 | 51 | 4 | 98 | – |
| Identifiable goat | 121 | 5 | 154 | 41 | 321 | – |
| Mammals | 376 | 25 | 689 | 314 | 1,404 | 29.2 |
| NISP | 1,516 | 1,522 | 1,156 | 613 | 4,807 | 50.6 |
| Unidentified (mammals) | – | – | – | – | 4,691 | 49.4 |
| TOTAL | – | – | – | – | 9,498 | 100 |

NISP = number of inspected pieces; NR = number of remains.

The second possible explanation is that residents bred some ovicaprids at Berenike, likely near the fort, where excavations recorded numerous goat and sheep bones.[128] If bred at Berenike, the sheep should have had smaller physical proportions than the goats because goats can better tolerate lower quality fodder than sheep.[129] One would expect sheep from Ptolemaic Berenike to resemble those found today in the Eastern Desert.[130] Yet Ptolemaic-era sheep bones from Berenike were larger than their modern counterparts. If breeding of sheep and goats took place at Berenike, then conditions at that time were better than those prevailing today.

A prerequisite for breeding larger sheep and goats would have been access to better and more abundant fodder. Even a slight increase in rainfall turns the entire seaside plain near Berenike into a green meadow.[131] Installations near the early Ptolemaic gate for collecting and draining rainwater may indicate that this area received more precipitation at that time than today.[132] Unfortunately, there is no evidence for whether or for how long a more favorable climate existed that might have facilitated animal breeding.

[128] Osypińska and Woźniak 2019, 373 table 3.
[129] Osypińska and Woźniak 2019, 374.
[130] Osypińska and Woźniak 2019, 374.
[131] Sidebotham et al. 2008, 303–8, pl. 14.4.
[132] Woźniak 2019, 248–49; 2017, 49 fig. 4, 57.

Although the area around Berenike apparently favored animal breeding in Ptolemaic times more than today, the practice was never extensive. Small pieces of meat were probably cooked together with the bones, as is done today by the ʿAbabda Bedouin, who consume meat only on special occasions. When they prepare dishes, they waste no part of the animal, using even the head.[133]

Pig bones constituted 16.3% of domestic mammal species remains recorded in Ptolemaic Berenike between 2010 and 2018.[134] However, the transport of pigs across the desert would have been difficult. They likely arrived by sea, probably from Clysma/Cleopatris. Faunal material obtained from Ptolemaic contexts at Berenike suggests extensive consumption of young animals.[135] Transport of piglets would be much easier than of adult animals, which may indicate that they were imported and slaughtered at a relatively young age. Yet management of pigs at Berenike on a limited scale would have been relatively easy. Both pigs (87 bone fragments of all animal bone material from the 2010–2018 seasons from Ptolemaic trenches) and poultry (160 bone fragments, 1.2% of all animal bones from the 2010–2018 seasons from Ptolemaic trenches) can consume almost the same food as humans. Whether pigs compete with people for food[136] depends on the relative abundance of nutriments and the number of people and pigs present. It is possible to feed human food waste, including the remains of fish, mollusks, and grain, to some animals. In a coastal settlement with biologically rich ecosystems, such as Berenike, various seafoods were abundant, as evidenced by numerous remains of edible marine fauna in the archaeological record. If pigs were raised at Berenike, most were probably slaughtered when relatively young because of the need to manage the types of food that they could consume (tables 3, 4).[137]

Most of the 160 poultry bones found were from domesticated chickens (*Gallus gallus* f. *domestica*). Although the bones were well preserved, it was difficult to distinguish sex; at least one leg bone with a spur belonged to a rooster. Chickens were easily transported by land and by sea and could consume wide varieties of food and food residues. The abundance of food for chickens at Berenike would have facilitated breeding them on site. This was a great advantage in view of the difficulty of storing the meat of slaughtered animals. In addition to meat, domestic chickens provided eggs. Other birds included quail (*Coturnix coturnix*), but they were much rarer than chickens.[138]

*Possible Desert Gardens*

Botanical material from the very dry and highly saline Ptolemaic strata was so badly preserved that no vegetable residues could be identified. There were, however, residues of weeds that are often found with cereals. Archaeobotanical materials also suggest that Ptolemaic-era residents probably cultivated some herbs such as coriander and celery.

In general, however, one must extrapolate from evidence gleaned from the Roman period what other crops the Ptolemaic inhabitants might have cultivated. In Roman times these included fruits and vegetables and some grains, including sorghum.[139] Whether organized officially or at the initiative of individuals in the Roman period remains unknown. However, the Roman-era occupants undoubtedly learned to cultivate desert gardens from indigenous people, and such may well have been the case in the Ptolemaic period.

*Marine Fauna*

Marine resources were fundamental to Berenike. The large amounts of shells and bones from marine snails, mussels, and fish recovered in Ptolemaic layers indicate that these creatures complemented terrestrial meat and played an important role in the inhabitants' diets.

Between 2010 and 2018, specialists studied 2,609 marine remains from Ptolemaic contexts. These included the remains of 790 bivalves, 1,817 gastropods, and just two cuttlefish (*Cephalopoda*), from 36 different species. Of the malacological assemblage, 82% in weight was taxonomically and anatomically identified and taphonomically analyzed, while 18% was not representative or was without statistical influence because of natural deposition or a high degree of fragmentation. The remains were catalogued according to archaeological context, biological information, and taphonomical

[133] Osypińska and Woźniak 2019, 372.
[134] Osypińska and Woźniak 2019, 373, table 3.
[135] Osypińska and Woźniak 2019, 373–75.
[136] As proposed by Blench (2000, 356).
[137] Osypińska and Woźniak 2019, 377.
[138] Osypińska and Woźniak 2019, 373.
[139] Cappers 2006.

TABLE 3. Proportions of animal species in remains found at Ptolemaic Berenike.

| Taxa | 1st group of trenches ("fort") | 2nd group of trenches ("tower") | 3rd group of trenches ("dump") | 4th group of trenches ("gate") | In all Ptolemaic Berenike |
|---|---|---|---|---|---|
| NISP | 324 | 22 | 531 | 292 | 1,169 |
| | | % of NISP | | | |
| Sheep/goat | 85.5 | 100 | 49.8 | 74.0 | 66.6 |
| Cattle | 0.4 | – | 11.7 | 16.8 | 9.6 |
| Donkey | 12.3 | – | 28.0 | 0.7 | 7.4 |
| Pig | 1.8 | – | 10.5 | 8.5 | 16.3 |

NISP = number of inspected pieces.

TABLE 4. Percentage of young animal remains found at Ptolemaic Berenike.

| Taxa | Juvenile[a] (%) | Subadult[b] (%) | Young animals in taxonomic group (%) |
|---|---|---|---|
| Sheep/goat | 1.5 | 12.2 | 13.7 |
| Cattle | – | – | – |
| Pig | 26.4 | 39.1 | 65.5 |
| Donkey | 0.5 | – | 0.5 |

[a] 0–12 months old

[b] 13–40 months old

analyses including predation holes, marine erosion marks, bioerosion, or biofouling (table 5).[140]

Malacological material showed the diversification of ecosystems from which residents of Berenike obtained their marine resources. They collected most along the shore, during low tide in the intertidal zone or just below the low tide line. They gathered bivalves and gastropods in different ecosystems near the town: gravel beaches, sandy beaches, muddy beaches, and reefs. They also obtained large amounts of *Strombus tricornis* and *Murex*/*Chicoreus ramosus* in slightly deeper waters. Today, these are abundant on large mats of seagrass growing on reef terraces.[141]

Among the snails, species of the genus *Murex* predominated.[142] Excavations also documented snails from the genera *Turbo*, *Nerita*, and *Lambis* in slightly smaller quantities. Of the mussels, the genera *Circenita*, *Chama*, and *Gafrarium* were most common, with *Tridacna*, *Spondylus*, and *Saccostrea* (*Saccostrea cucculata*) less so.

One advantage of marine protein was the ease with which the residents could obtain it. Seafoods dominated the inhabitants' diets. Even when the settlement was fully operational during the second half of the third century BCE, residents consumed only small amounts of terrestrial animal meat. The ethnoarchaeological analogy of the ʿAbabda Bedouin living in the nearby villages of Arab Saleh and Manaziq may be useful; they breed sheep, goats, camels, and donkeys, yet they still exploit maritime resources, mostly snails.

There were various preparation and cooking processes for different species. Some spiny oyster (*Spondylus*) and *Chama* valves preserved pry marks from forced opening, evidence that the meat was eaten raw or possibly extracted before cooking. The most exploited mollusk species, the *Chicoreus ramosus*

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[140] Biofouling is incrustation of ships' hulls, other sunken man-made objects, and shells by other marine organisms, e.g., bryozoans, worms, barnacles, or mollusks.

[141] A. Carannante, pers. comm. 2018.

[142] Esp. *Murex*/*Chicoreus ramosus*, *Terebralia* (*Terebralia palustris*), *Tectus* (*Tectus dentatus*), and *Strombus* (*Strombus tricornis*).

TABLE 5. Marine invertebrate species remains found at Ptolemaic Berenike.

| BIVALVIA | NR | MNI | DIET |
|---|---|---|---|
| *Anadara erythraeonensis* | 7 | 7 | – |
| *Asaphis violacescens* | 2 | 2 | 2 |
| *Atactodea glabrata* | 33 | 23 | 33 |
| *Barbatia setigera* | 20 | 18 | 20 |
| *Brachidontes variabilis* | 5 | 3 | 5 |
| *Callista* sp. | 1 | 1 | 1 |
| *Chama brassica* | 69 | 60 | 69 |
| *Circenita callipyga* | 522 | 273 | 498 |
| *Grafarium pectinatum* | 32 | 18 | 32 |
| *Hyotissa hyotis* | 6 | 6 | 6 |
| *Modiolus auriculatus* | 4 | 4 | 4 |
| *Ostrea subucula* | 33 | 17 | 33 |
| *Periglipta reticulata* | 1 | 1 | – |
| *Pinctada margaritifera* | 6 | 6 | 6 |
| *Plagiocardium pseudolima* | 1 | 1 | – |
| *Saccostrea cuccullata* | 18 | 16 | 18 |
| *Spondylus marisrubri* | 16 | 14 | 13 |
| *Tridacna* sp. | 14 | 14 | 6 |
| TOTALS | 790 | 484 | 746 |

| GASTROPODA | NR | MNI | DIET |
|---|---|---|---|
| *Cerithium caeruleum* | 3 | 3 | – |
| *Chicoreus ramosus* | 875 | 875 | 875 |
| *Conomurex fasciatus* | 185 | 185 | – |
| *Conus betulinus, C. textile* | 3 | 3 | – |
| *Cypraea* spp. (*C. annulus, C. lynx, C. teres, C. tigris, C. turdus*) | 8 | 8 | – |
| *Lambis truncata* | 2 | 2 | 2 |
| *Murex* sp. | 11 | 11 | 11 |
| *Nerita textilis* | 10 | 10 | – |
| *Polinices mammilla* | 2 | 2 | – |
| *Strombus tricornis* | 211 | 179 | 211 |
| *Tectus dentatus* | 226 | 226 | 226 |
| *Terebralia palustris* | 244 | 244 | 243 |
| *Turbo radiatus* | 33 | 33 | 33 |
| *Tutufa* sp. | 1 | 1 | – |
| *Volema paradisiaca* | 3 | 3 | 3 |
| TOTALS | 1,817 | 1,785 | 1,604 |

| CEPHALOPODA | NR | MNI | DIET |
|---|---|---|---|
| *Sepia officinalis* | 2 | 1 | 2 |

DIET = number of dietary remains, i.e., fragments of edible species of marine organisms with no signs of natural causes of death: predation holes, marine erosion marks, bioerosion, or biofouling; MNI = minimum number of individuals; NR = number of remains.

murex, never exhibited burn marks or broken parts; they were, apparently, boiled slowly to extract the meat. Inhabitants probably used a similar cooking method to prepare other *Murex* species and the *Turbo.*

Most pearl oyster valves[143] preserved burn marks on their external surfaces; these suggested that they had been placed directly on burning charcoal, a method used today by ʿAbabda Bedouin, though not for this species. The almost total fragmentation of the large *Strombus tricornis* shells, in contrast to the remains of other species whose shells exhibited little or no fragmentation, reveals that consumers broke these shells to extract the edible parts prior to cooking.

Fish remains recorded from Ptolemaic Berenike (2,983 fragments amounting to 22.6% of all animal remains except mollusks in the 2010–2018 seasons) can be divided into three groups depending on where each species lived. Most frequently documented were reef fish.[144] The second group included genera living on sandy sea bottoms.[145] The third group, pelagic (deep sea) fish remains (family Carangidae), were very rare. These findings point to an abundance of fish found primarily in an easily accessible coral reef environment and suggested that most fishing used nets from small fishing vessels close to shore. Present-day ʿAbabda Bedouin use mainly nets and small, shallow-draft boats.

[143] *Terebralia*, many *Tectus*, and *Pinctada.*

[144] Parrotfish (Scaridae), grouper (Serranidae), Percidae and Lethrinidae, snappers (Lutjanidae), Acanthuridae (*Naso*), and triggerfish (Balistidae).

[145] Sea breams (Sparidae) and mullets (Mugilidae); see van Neer and Ervynck 1998, 362.

An oar more than 0.80 m long from a late Roman-era context[146] near the Isis temple may corroborate the size of at least one vessel from that time, which could not have been much larger than a small fishing boat.

Residents caught reef fish, especially parrotfish, using nets. Today, in the local villages of Manaziq and Hamira near Berenike and Shalateen, a town about 100 km south of Berenike, fishing is rarely done using lines with large metal hooks and then usually only when fishing for the most valuable species beyond the edge of the coral reef.[147] Such was likely the case in ancient Berenike. Excavations and surface surveys have recorded large copper alloy and iron fishing hooks from Ptolemaic and Roman-era Berenike.[148] It is possible that Ptolemaic-era fishing was done using small sea snails and crabmeat as bait. Perhaps crabs were used only for this purpose, hence their small representation in the archaeological record.[149]

Some mussel shells preserved traces of an artificial ecosystem. Several lower oyster valves (*Spondylus*, *Chama*, and *Hyotissa*) were very flat, an indication of growth on an extremely smooth submerged surface, too smooth and flat to have been natural. These flat shell surfaces may indicate the existence of an artificial feature related to the port's infrastructure.

Many mollusks (*Terebra* and *Saccostrea*) in the archaeological corpus belonged to species living in mangrove thickets. Some, especially snails (*Terebralia palustris*) and oysters (*Saccostrea cuccullata*), preserved traces of the impressions of roots and stalks of the mangroves to which they adhered.[150] At Myos Hormos, Roman-era residents consumed oysters of this genus, and samples excavated there also preserved the impressions of mangrove roots and stalks.[151]

Today, there are no mangroves within a few dozen kilometers of Berenike as their exploitation in antiquity led to their extinction locally.[152] In antiquity, however, they grew extensively at the coastal interface of the lagoons (see fig. 5).[153] Most of the burned wood and charcoal remains studied from the Ptolemaic dump in trench BE96-11, located north of the blocked-up early Ptolemaic gate, was mangrove.[154] Mangrove wood was likely not used in industrial applications such as metalworking and brickmaking, but rather for construction, ornamental purposes, or as cooking fuel,[155] as is the case today in many places.[156] It is unlikely that Ptolemaic soldiers understood any medicinal applications for parts of the mangrove as current inhabitants do now in Southeast Asia; even ʿAbabda today do not use it for such purposes.[157] Ash found in the Ptolemaic dump was probably from a kitchen, given that it contained fragments of fish and animal bones.[158] Due to the need for high temperatures, almost all metallurgical production at Berenike used the hot-burning charcoal made from acacia, obtained in the nearby desert. ʿAbabda Bedouin today make charcoal from desert acacia trees. Mangrove wood has a lower burning temperature and shorter burning time than harder woods such as acacia, but it was abundant and readily available.

Ptolemaic Berenike had storage facilities for grain, olive oil, and wine, arrangements for fishing, herds of animals, fodder, and supplies of fuel necessary for food preparation. The most pressing task, however, was to obtain, store, and distribute potable water.

### WATER SOURCES, STORAGE, AND DISTRIBUTION

During the early Roman period, the army controlled the acquisition, storage, and distribution of potable water in Berenike.[159] Wells and cisterns inside and near three forts built at Siket and Kalalat (see fig. 2) supplied some water to Berenike in early Roman times.[160] These *praesidia* were located 7.0–8.5 km from the city, and camel or donkey caravans must have conveyed water to Berenike, as there is no evidence for

[146] Sidebotham et al. forthcoming.

[147] Information from ʿAbabda Bedouins near Berenike.

[148] Hense 1995, 50–51; 1996, 217, 220–21, 226–27; 1998, 210; 2007, 214.

[149] There were only 16 fragments of crab shells, amounting to ca. 0.1% of all animal remains from Ptolemaic contexts from the 2010–2018 seasons.

[150] A. Carannante, pers. comm. January 2018.

[151] Hamilton-Dyer 2011, 271–72, fig. 20.25.

[152] For mangroves in Egypt, see Mahmoud 2010, 44; Khalil 2015, 587.

[153] Khalil 2015, 585.

[154] Vermeeren 1998, 345, 347.

[155] Cf. Khalil 2015, 586, 588.

[156] Giesen et al. 2007, 29–30.

[157] Giesen et al. 2007, 29–30.

[158] Contra Sidebotham 1998a, 101–8.

[159] Sidebotham 2011, 102–3, 109, 123; Ast and Bagnall 2016, 71–163 = nos. 274–455.

[160] Sidebotham 1995, 85–93; 2000b, 359–65; 2011, 97–99, 107–8; Sidebotham and Zitterkopf 1996, 386–91; Sidebotham et al. 2000.

aqueducts. The city was open to the countryside at that time and the Roman army ruled over the nearby plain by maintaining small garrisons in nearby *praesidia* and by controlling the *hydreumata* along or close to the routes linking Berenike to the Nile (see fig. 2).[161] The situation in Ptolemaic Berenike was completely different.

Excavations undertaken north of the large fortified industrial and storage area focused on a structure built around a blocked and rebuilt early Ptolemaic gate (see fig. 4[E]).[162] South of a 3 m high mound of ash excavated in trench BE96-11[163] was a rectangular structure partially visible on the surface and built of blocks of gypsum-anhydrite.[164] Initially, this appeared to be the well-preserved remnant of a western pylon of a blocked Ptolemaic gate 3.4 m long x 1.4 m high x 2.1 m wide (fig. 15).[165]

Originally a single, massive tower housed a gateway of unknown width; only the western half of the gateway has survived. Numismatic and ceramic evidence date the complex to between the third quarter and the end of the third century BCE. There may have been some revitalization at the end of the second and into the first century BCE.

The oldest tower walls adjacent to the gate were 0.6 m thick and built of precisely cut gypsum-anhydrite ashlars of varying sizes[166] visible in the western part of the northern wall of the gate's internal chamber that houses the well (fig. 16). After an indeterminate period, there was additional reinforcement of the external northern half of the gate tower. This 0.55 m thick addition was probably added to both sides of the gateway, but only the western part is extant. It was composed of gypsum-anhydrite ashlars and large extinct coral heads. The original height of this casing and whether it covered the entire original wall of the tower remain unknown. Builders added the reinforcement at about the same time that they constructed a low wall approximately 0.4 m wide that ran from the northwestern corner toward the west, parallel to the old curtain wall and approximately 1.5 m in front (north) of it.[167] Its purpose is not clear, but it may have protected the main defensive city wall from water erosion, as is suggested by its 0.8 m wide foundation and a thick clay ledge on its external, northern side. A possible parallel exists for such anti-erosion measures at the Ptolemaic-Roman-Islamic fort at al-Kanaïs east of Edfu on the Berenike–Nile road.[168]

Excavations removed rubble and windblown sand that filled the rectangular inner chamber of the gate located south of the pylon; this chamber measured 2.0 x 3.9 m.[169] South and southwest of the chamber was a large water basin, Basin 1, about 1 m deep with sides supported by gypsum-anhydrite walls (0.22–0.60 m thick) and a bottom founded on bedrock. A 5–6 cm thick layer of pinkish hydraulic mortar coated the interior surfaces of Basin 1.[170] Northwest of and adjacent to Basin 1 was another similar structure, Basin 2. The combined capacity of Basins 1 and 2 was about 17,000 liters. A lead pipe joined Basin 2 with the third, smaller (approximately 0.60 m in diameter), semicircular Basin 3 (fig. 17). The rolled lead pipe (about 1 mm thick) was 3.60 m long and about 0.08 m in diameter. At least two massive gypsum-anhydrite pillars were found south of Basins 1 and 2 and east of Basin 3. These probably formed an entrance leading from the south into Room 1, which housed all the basins. Hydraulic plaster coated the interiors of the basins and all floors of Room 1 and the interior of a narrow channel running south along its eastern wall. The mortar in the interior of the basins was reddish and brittle, but the grayish floor mortar was extremely hard. The complex extended farther west from Basin 3, a small basin lined with hydraulic mortar, on the southern side of the complex. A lead pipe, at least 1.4 m long, led westward, probably to another basin.

Numerous early Hellenistic (third to second century BCE) ceramic cup fragments[171] from Basins 1 and 2 indicated their use as water containers. Basin 2 also contained one broken amphoriskos, two halves of mussel shells, and one half of a large cockle shell. The shells probably served as ladles or drinking cups. The water in the basins may also have had other uses. Fragments

[161] Bagnall et al. 2001; Sidebotham 2011, 125–74; Sidebotham et al. 2019a, 1–49, 73–285.

[162] Sidebotham and Zych 2016, 21–22; Woźniak 2017, 47–59; 2019, 246–52.

[163] Sidebotham 1998a, 101–8.

[164] Sidebotham 2007b, 40–41; Woźniak and Rądkowska 2014, 513 fig. 5, 517; Woźniak 2017, 45–46, 49–59.

[165] Woźniak 2019, 246–47.

[166] Woźniak 2017, 50–51.

[167] Woźniak 2017, 50–59; 2019, 246.

[168] Sidebotham et al. 2019a, 224.

[169] Woźniak 2017, 49–53.

[170] Woźniak 2017, 49, fig. 4, 56–59.

[171] Dating and identification as drinking vessels, R.S. Tomber, pers. comm. 2018.

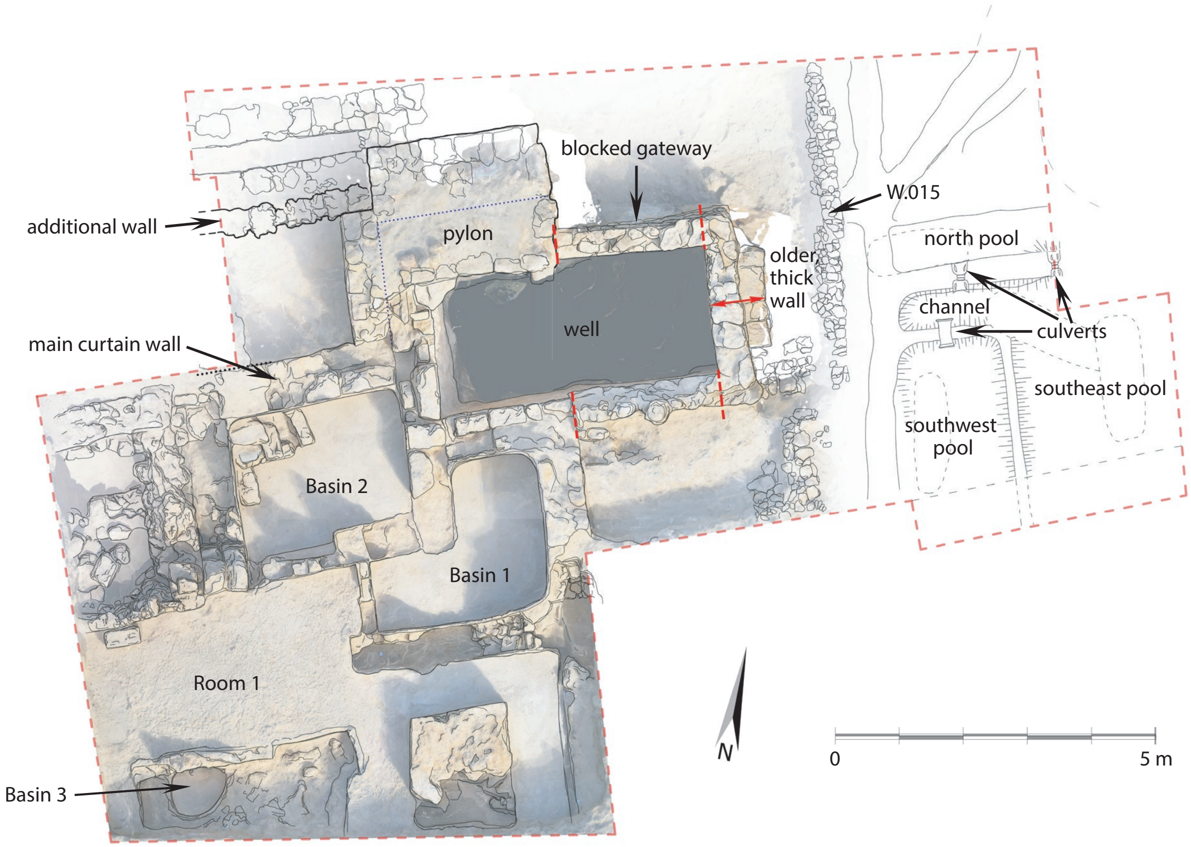


FIG. 15. Ptolemaic gate and related structures in trenches BE14/18-97/104 (drawing by S. Popławski and M. Woźniak).

of terracotta unguentaria found here may be evidence for perfumes or oils and may suggest that some part of the hydraulic system functioned as a bath.[172]

The purpose of this complex was water storage and distribution. From the time of its discovery, a key question had been whether the water stored there was, as in Roman times, transported from wells dug in nearby wadis[173] or derived from other sources. Exploration of the inner chamber of the gate (2.0 x 3.9 m x 3.7 m deep) provided the answer. Here, carved in bedrock, was a well that was located below the gate. Initially, this well probably operated inside the functioning city gate. At that time it was an irregular square, about 1.7–1.8 x 2.0 m, which is still visible in the deepest, western part of the expanded well of the second phase (see figs. 16, 18). Housing the well, however, soon dominated the gate's operation. In the second half of the third century BCE, the entire building and its surroundings were extensively rebuilt to acquire, store, and distribute water. The gate, in this second phase, lost its eastern half. A large section of the eastern curtain wall was also dismantled at that time. The small, square well was widened into the rectangular feature measuring 2.0 x 3.9 m and was enclosed on the east and west by walls of roughly worked gypsum-anhydrite blocks (see figs. 15, 16, 18).[174] Basin 2 existed in the first phase in order to store water from the small well. Perhaps builders added Basin 1 in the second phase.[175]

For unknown reasons, the eastern part of the gate was soon rebuilt, and thinner walls replaced more massive ones (see fig. 15).[176] Only the northwestern corner of the gate remained unaltered. Two gypsum-

[172] Cf. Bergmann and Heinzelmann 2009; Boraik 2009; Boussac et al. 2009; Guimier-Sorbets 2009; Trümper 2009; Redon 2017, 13–139.

[173] Sidebotham and Zitterkopf 1996, 384–91; Sidebotham 2011, 92–124.

[174] Woźniak 2019, 246, 250.

[175] Woźniak 2017, 57; 2019, 247–48.

[176] Woźniak 2019, 246.

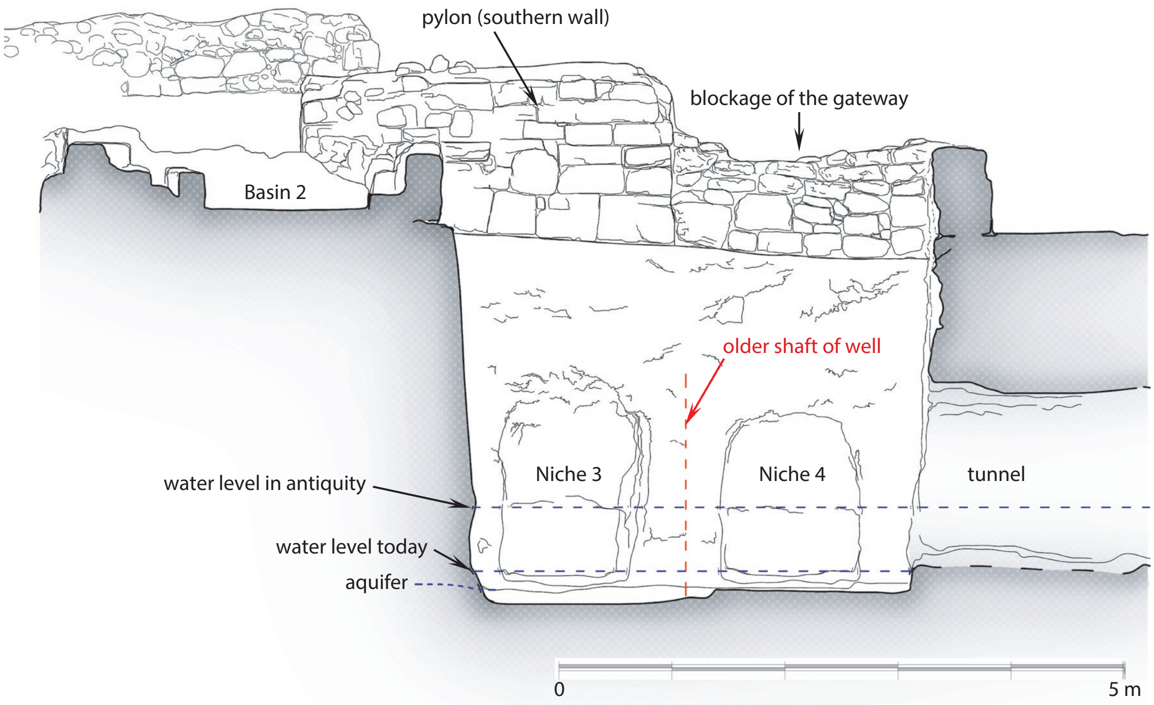


FIG. 16. Cross-section of gate chamber with well and Basin 2, view looking north (drawing by S. Popławski and M. Woźniak).

anhydrite blocks from the chamber's earlier phase had been embedded in the wall of the northwestern corner on the southern side. One measured 0.50 m wide x 0.07 m thick. About 1.2 m farther east was another block 0.35 m wide x 0.08 m thick. Both blocks were firmly fixed and protruded into the chamber about 0.30 m from the face of the wall in which they had been embedded (fig. 19). The blocks most likely supported a wooden floor or cover, which initially was in the western part of the gate chamber above the smaller original well and later covered the entire enlarged well.[177] It may have protected the well from windblown pollutants and excessive evaporation. Similar arrangements appear in Roman-era wells and cisterns throughout the Eastern Desert,[178] and the Ptolemies undoubtedly also practiced analogous water protection measures.

In the sandy fill of the gate chamber, excavators documented a worked gypsum-anhydrite stone roughly rectangular in shape (0.48 x 0.40 x 0.25 m) with a round hole 5 cm in diameter drilled through it toward one end. This stone had tumbled into a layer of windblown sand in the gate chamber beneath the stones projecting from the wall, shortly after it had been abandoned. This block, in the well installation likely a counterweight for a device such as a shadoof, was probably fixed to a rope and used to lift water. Perhaps it fell here after the rope had broken but before the collapse of the walls of the early Ptolemaic structure.[179]

This worked stone, judging by the shape and characteristic hole location, before reuse in the well installation may have originally been an anchor. It has parallels from elsewhere in the Mediterranean and the Red Sea throughout antiquity.[180] Workers

177 Woźniak 2017, 51–52.

178 Sidebotham et al. 2008, 314; 2019a, 26; Sidebotham 2011, 103, 105.

179 Zych et al. 2016, 322–23; Woźniak 2017, 56.

180 Cf. Zazzaro 2006; Zazzaro and Abd el-Maguid 2012; Tallet


FIG. 17. Water distribution system south and southwest of gate chamber, view looking north (S. Sidebotham, modified by M. Woźniak and S. Popławski).

made stone anchors of this kind at Mersa Gawasis,[181] and similarly, this stone was likely fashioned locally at Berenike. Gypsum-anhydrite was readily available and would have been suitable to make anchors.[182] Yet the stone has a longitudinal groove cut on one side that does not resemble other ancient stone anchors. Perhaps, made in the shape typical of anchors, it was originally used as a mooring stone,[183] placed on a beach and secured with one or more large pieces of wood, to which a boat could be tied. It is also possible that there were more stages of its use: carved as an anchor, used as a mooring stone, and finally installed in the well as a counterweight. Alternatively, the groove might just have served to attach the stone to a bar when it served as a counterweight for raising water.

At about the same level as the putative counterweight stone, excavations revealed the tops of five niches carved into the sidewalls of the inner chamber beneath the sand. Four were 1.23–1.35 m wide x 1.0–1.4 m deep with ceilings descending toward the rear

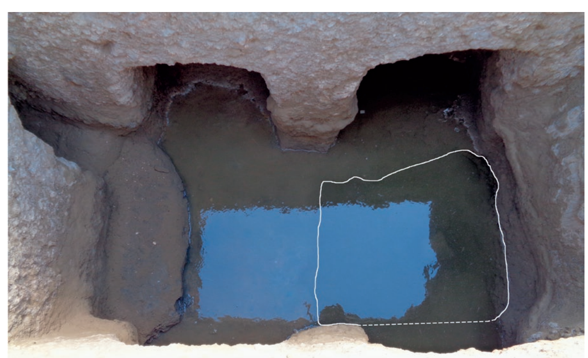

FIG. 18. Well in the chamber of the Ptolemaic gate, looking south, showing rock-cut niches in the southern side and narrow tunnel leading out of southeast corner; the first phase of the well is indicated by the white outline. The chamber measures 3.9 m east–west (J. Rądkowska, modified by M. Woźniak and S. Popławski).

2016, 6; Bard and Fattovich 2018, e.g., 15–17, 53–54, 93–94, 195–97.

[181] Zazzaro 2006; Zazzaro and Abd el-Maguid 2012.

[182] J.A. Harrell, pers. comm. in the field 2019.

[183] Cf. Wachsmann 2011, 213.

FIG. 19. Two blocks embedded in the southern wall of the pylon of the Ptolemaic gate, above the well located inside the gate chamber, view looking northwest; the blocks probably supported a wooden floor or cover above the well; scale = 50 cm (S. Sidebotham, modified by S. Popławski).

at a 45° angle. Niches 1 and 2 appeared carved in the southern side of the chamber, and another two, Niches 3 and 4, in the northern side (see figs. 16, 18). That these niches were cut into walls of the well on which calcareous sand and washed gypsum deposits had previously accumulated indicated that they were not part of the original well construction but were from some later enlargement.

A fifth entrance (0.57 m wide), dug into the southeastern corner of the chamber wall, was the mouth of a tunnel (see fig. 16) that continued 6 m to the east and then turned at a 45° angle toward the northeast. After another 2–3 m, its course could no longer be traced because sand filled it completely.[184] Hand- and footholds cut into the walls in the southeastern corner of the well around the opening of the tunnel were clearly associated with this later phase of well usage.

The four niches had been cut into bedrock to increase the capacity of the enlarged chamber during its second phase. Niches 1–3 contained large sherds of early Hellenistic amphoras, many of which had horizontal holes about 1 cm in diameter drilled into their shoulders. During excavation, water flooded the lower part of the chamber (see fig. 16), rising to 0.44 masl. However, traces of erosion and infiltration on the chamber walls, in the form of an approximately 8 cm thick accretion ring of calcareous gypsum, mark an ancient water table about 0.4–0.5 m higher than today and indicate that before the bottom of the chamber filled with sand, the ancient water table had reached approximately 0.90 masl. The water that flows today into the chamber is slightly brackish and does not differ much from that available in Bir ("well") Umm Bela located 650 m northwest of the Ptolemaic gate. ʻAbabda Bedouin today use Bir Umm Bela to water their animals. They also claim that people can drink it for several days but that longer consumption poses potential health risks. Water from the inner gate chamber, after the mud and sand suspended in it sank to the bottom, was less turbid than that found in Bir Umm Bela.

The water level at Bir Umm Bela currently reaches 1.73 masl. Together with the 0.44 masl water level in the gate chamber, this indicates that the current water table is lower as one moves toward the coast. Excavations in the gate chamber reached the top of the aquifer and identified that the water there derives primarily from Wadi Mandit,[185] which carries subterranean water from the mountains in the west, not from the sea. Traces of the highest water level visible on the

[184] Woźniak 2017, 53–59; 2019, 250–51.

[185] J.A. Harrell, pers. comm. January 2020. The lower section of Wadi Mandit runs ca. 100 m west of the gate.

walls of the gate chamber signaled that the amount of water coming from Wadi Mandit in antiquity was much greater than it is today. This indicates more precipitation at that time.

Greater precipitation in Ptolemaic times increased the amount and flow of fresh water in the aquifer. This would have pushed out the seawater and diminished the degree of salinization of the groundwater. In addition, the hard, fossilized limestone reef plateau in the western part of Berenike acted as a dam in Wadi Mandit that caused a rapid change in the direction of water flow (see fig. 5) and increased accumulation. This further increased water pressure in the aquifer and indicates that the quality of the water available from this well in the early and middle Ptolemaic period might have been better than it is now.

Ultimately, the best evidence that the water was potable, tapping an aquifer originating in the mountains, is the well itself and its associated installations. The effort expended to dig the well was one indication of its importance to residents of Berenike. Drinking cups and amphora fragments found in and around it further attest the critical role it played in supplying the settlement. The enlargement of the well also strongly suggests that it produced potable water; it would not have been enlarged if the water had been unpotable. If water in the well is potable today it might have been better, or at least not inferior, in the past. Nothing in the environment has changed sufficiently to diminish the water quality. The geological formations that the waters pass over and through are the same now as in Ptolemaic times. Also, the rainwater was just as pure then, or more so, than it is now. The only factor possibly impacting the water quality in the well that has changed is the sea level, which has dropped about 0.80 m since the third century BCE. Thus, saltwater intrusion was possibly somewhat greater in the Ptolemaic period than it is today. Yet, even if there was slightly elevated salinity, the increased inflow of fresh water from Wadi Mandit, caused by higher rainfall, would have counteracted it.[186]

The well water has not been analyzed for salt, sulfates, and other contaminants, and it is not known whether people and animals today can consume it long-term without harm. The water may not be tasty, but if it did not make the consumer sick, then it was adequate. This would probably have been more acceptable to people more than two millennia ago, especially those living in a desert.[187]

The water collecting system east of the well (see figs. 12, top; 15) and rock-cut channels north of Cistern 1 (fig. 20) indicate that rainwater supplemented well water and might have mixed with it. There were three pools or basins, each about 10 cm deep, adjacent to the well. The northernmost was 0.75 m wide x 2.20 m extant length. The two southerly ones were less well preserved. The western one was at least 2.2 m long north–south x 1.5 m wide east–west. Excavations only partially exposed the third, eastern one. All three pools were situated on slightly clayey soil separated by low earthen dikes. There was a channel 10 cm deep, 2.2 m in exposed length, and about 0.32–0.35 m wide between the pools. The channel was connected to the pools by three conduits that ran under the ridge dividing the pools from the channel. Each conduit was formed by the cut-off upper parts of two early Hellenistic Fayum-made amphoras joined at their mouths (see fig. 12, bottom). Two conduits linked the water collection channel with the northern basin. One linked the channel with the southwestern basin. The use of ingeniously made conduits indicates the hydraulic purpose of the shallow, makeshift basins. Damage by early Roman graves prevented determination of the precise methods of their operation, but these structures probably collected and drained rainwater from an open area, likely at the foot of the robbed early Ptolemaic defensive wall[188] or in the open courtyard east of the gate. Though these features have not been completely exposed, the geomagnetic plan indicates that they probably drained rainwater into the well. Another channel, 0.5 m wide x 8.0–9.0 m long, probably also drained rainwater, but from the foot of Wall 015 built in the eastern part of the gate sometime in the second century BCE.[189]

About 15 m east of the gate chamber was an approximately 5 x 5 m shaft, which likely led to rock-cut Cistern 1 (see fig. 20).[190] Gypsum-anhydrite ashlars on the northern and eastern edges protected the shaft. These partly robbed walls continued below ground level and

[186] J.A. Harrell, pers. comm. May 2020.

[187] J.A. Harrell, pers. comm. May 2020.

[188] Zych et al. 2016, 323–25; Woźniak 2017, 57.

[189] Woźniak 2019, 247.

[190] Zych et al. 2016, 323–25; Woźniak 2017, 57.


FIG. 20. Trench BE19-125 showing rock-cut Cistern 1 (bottom right corner), with surrounding walls (W) and rock-cut channels (drawing by S. Popławski and M. Woźniak).

formed the sides of the shaft. Three rectangular channels were cut into the walls of the cistern, two on the north side and one on the west side. The three channels, after passing through the walls built around the cistern, branched out in a network cut into bedrock north and northwest of the cistern.

These rock-cut channels north of the cistern protected Walls 035 and 037 and related structures from erosion by heavy rains (see fig. 20). The channels also collected rainwater and diverted it to Cistern 1. The northernmost portions of the channels descended into another shallow basin, the poorly preserved remains of which were visible in bedrock on the northern side of the installation under later Walls 009 and 010. Only the southern halves of the channels descended toward the south and southeast leading to the cistern. These channels point to so much rainwater that it was not necessary or possible to collect and store all of it in the cistern and suggest, perhaps more importantly, greater precipitation in antiquity than at present.

The eastern end of the narrow tunnel, leading from the southeastern corner of the gate chamber (see figs. 16, 18) toward the east and northeast, has yet to be completely excavated. Therefore, we cannot confirm that it led to Cistern 1. If it did not, then rainwater in Cistern 1 was stored separately from the well. In either case, rainwater supplemented the well water from aquifers. The discovery of hydraulic installations inside the fort and an efficient well that today produces about 2,500–3,000 liters of water per hour clearly indicates that there were adequate amounts for drinking, bathing, industrial activities, and animals.

A well within the fortifications does not preclude the possibility that Berenike's residents also imported water, at least occasionally. About 25 km northwest of Berenike in Wadi Abu Greiya, along the road linking the settlement to the Nile (see fig. 2),[191] there was probably a small Ptolemaic fort that seems to have had cisterns.[192] Although the existence of an ancient well here cannot be confirmed, it was likely since the Romans enlarged one Ptolemaic installation and built four more forts here; the ʿAbabda Bedouin still use a well in Wadi Abu Greiya.[193] Of course, any Ptolemaic installation here may have provided water only to passing travelers and may not have exported it to Berenike, at least on a regular basis.

The uniform geology across the entire western part of Berenike suggests the existence of more wells in the western part of the fortress. Excavations in 2000 revealed structures possibly related to another water intake.[194] In the area of the central courtyard (see fig. 4[B]) was the corner of a heavily damaged rock-cut cistern, briefly described above.[195] The documented remains were part of a basin or cistern similar to those uncovered near the gate. Here the basin or cistern was partially cut into the rock and encircled with walls, the stones of which were later robbed.[196]

The cistern and facilities east of the gate are too distant to have been part of the same water distribution system as the basin or cistern in the central courtyard. The incompletely excavated structure in the fort's central courtyard might have been part of a different water distribution system connected with an unidentified well, probably located north of the excavated structures. The geological formation here is identical to that at the gate about 150 m to the north; the fort lies on the same reef plateau as the gate, with Wadi Mandit directly to the west. A well in the central courtyard would thus have been possible.

The exposed corner of the basin or cistern in the central courtyard was in the same trench as the two silos described above (see fig. 9).[197] About 10 m to the southwest was the V-shaped feature identified as a retaining pen for elephants. The garrison may have used the silos to store grain or fodder for the elephants. The fragments of an elephant molar noted above were found a dozen meters to the north.[198] The central courtyard, therefore, seems to have accommodated animals and supplies intended for the garrison or temporary accommodations for elephants until their conveyance to the Nile Valley. It would have been desirable to separate water intended for human consumption, most likely located in the gate building, from that used for industrial purposes and that supplied to animals, perhaps located in the central courtyard.

The Rhodian amphora stamps noted earlier (see fig. 13) suggest that the square tower (in trenches BE12-83, BE12-85, and BE12-86) and perhaps the nearby fortifications likely date to Berenike's foundation during the reign of Ptolemy II (r. 283–246 BCE). At least one set of water installations (trench BE19-125) east of the well in the gate (trenches BE14/18-97/104) represent a later phase constructed during the reign of Ptolemy III (r. 246–222 BCE). Excavation of the hydraulic installations south of the well (BE14/18-97/104) did not provide evidence for such refined dating, but they were likely made during the internal expansion of the well with the addition of the four niches and the tunnel. Overall, the construction of hydraulic installations external to the well in the third and fourth quarters of the third century BCE suggests a growing settlement requiring more water for human, animal, and industrial consumption. At this point, we cannot determine whether the supposed increased precipitation in the region spurred the growth of the Ptolemaic settlement and concomitant expansion of the hydraulic installations or, conversely, that the growth of the settlement necessitated the additional construction of hydraulic facilities to increase the water supply.[199] Of course, both factors might have been in play at the same time. Whatever the case, after the settlement's initial foundation sometime about the mid third century BCE, its population and activities grew. This was due, no doubt, to fuller implementation of the Ptolemaic government's policy of importing elephants, ivory, and other commodities from more southerly areas of the Red Sea and beyond.

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[191] Sidebotham 1998b, 415–17; Sidebotham et al. 2019a, 80–91.

[192] Sidebotham et al. 2019a, 82–84.

[193] Sidebotham et al. 2019a, 80–91.

[194] Sidebotham 2007b, 31–37.

[195] Sidebotham 2007b, 34.

[196] Sidebotham 2007b, 40.

[197] Sidebotham 2007b, 32–34.

[198] Osypińska and Woźniak 2019, 370 table 1, 371, 372 table 2, 379; Woźniak 2019, 244–46; for possible species, see Brandt et al. 2014; Schneider 2016; Thouless et al. 2016, 95–98.

[199] See Woźniak and Harrell forthcoming for geological and hydrological formations relevant to the well and water supply.

## CONCLUSIONS

The findings described above are difficult to place in a broader context. Archaeological work along the Red Sea littoral has not documented another comparable Hellenistic-era settlement. While there has been some work,[200] more extensive archaeological research along the Red Sea coasts and beyond[201] should document additional sites of this period. Any Hellenistic-era settlements located in these regions, as indicated by ancient written accounts[202] and future fieldwork,[203] should provide parallels for Ptolemaic Berenike and offer evidence for interactions among these locales and Berenike and with other areas of Africa and southern Arabia.

Despite the dearth of comparative data, aside from a few Ptolemaic forts in the Eastern Desert,[204] the research presented here on Berenike has revealed three basic aspects of the settlement. The first is its utilitarian nature, evident in its placement, the type of architecture employed, and the methods used for the supply and delivery of goods. The fortress was as self-sufficient as possible for security reasons. Second is the minimization of the quantity and cost of supplies imported either from the north by sea or across the desert from the Nile. Third is the garrison's effort to supplement and diversify its externally obtained supplies with local resources of fuel, building materials, food, and water.

To this end, the residents utilized their environs for water and food. The diet consisted of bread, olive oil, wine, and meat, supplemented by locally available resources. Archaeological evidence documents intensive exploitation of the sea for fish, mussels, snails, and crustaceans. There were few faunal remains of feral species, and these animals played little role in the diets of either the Ptolemaic or Roman populations of Berenike.[205] During the Ptolemaic period, residents sought food mainly in the immediate vicinity of Berenike and not farther afield where larger feral game animals could be found.

The archaeological evidence reflects the impressive efforts of the Ptolemaic central authorities and the creativity of the residents of Berenike. In addition to their own ingenuity, the inhabitants of Berenike must have depended, to some extent, on the knowledge of the indigenous populations in order to survive and function efficiently and effectively in this inhospitable environment.

Marek A. Woźniak
Institute of Mediterranean and Oriental Cultures
Polish Academy of Sciences
Warsaw, Poland
wozniakarcheo@gmail.com

Steven E. Sidebotham
Department of History
University of Delaware
Newark, Delaware
ses@udel.edu

Marta Osypińska
Institute of Archaeology and Ethnology
Polish Academy of Sciences
Poznań, Poland
archeozoo@O2.pl

Alfredo Carannante
International Research Institute for Archaeology and Ethnology
Naples, Italy
alfredo.carannante@iriae.com

Joanna K. Rądkowska
Institute of Mediterranean and Oriental Cultures
Polish Academy of Sciences
Department of Ancient Egyptian and Near East Cultures
Warsaw, Poland
radkowska@gmail.com

[200] E.g., Seeger et al. 2006; Peacock and Blue 2007; Peacock and Peacock 2007; Gawlikowski 2019.

[201] See Salles and Sedov 2010 for fieldwork conducted at the Hadramawti port of Qana', Yemen.

[202] In general, see Cohen 2006, 305–43.

[203] For recent fieldwork in Sudan, see Seeger et al. 2006; Adam 2017, 238–53.

[204] Supra n. 21.

[205] See Sidebotham 2011, 12 n. 29, 79 n. 76, for the 1994–2001 seasons; Osypińska and Woźniak 2019, 371, 377–78, 380, for the 2010–2018 seasons.

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