CHAPTER TWO

BERENIKE SURVEY

F.G. Aldsworth and H. Barnard

In January 1994, a new topographic survey of the remains of the Ptolemaic and Roman port of Berenike revealed that approximately seven hectares of building foundations and middens were visible above ground (Aldsworth, Sidebotham and Wendrich 1995: 13-20). In January 1995, work continued west of the main site to understand better the topography of the ancient town (Aldsworth and Barnard 1996a: 5-6).

This report publishes a plan showing evidence for occupation west of Berenike (Figure 2-1, at the back of this volume) as well as the results of hydrological studies in the region.

2.1 TOPOGRAPHIC SURVEY

The extended topographic survey included all features described in previous volumes, as well as the position of the 1996 excavations on site R (trench BE96-11), the position of the permanent quadrant (PQ-1) studied by archaeobotanist R.T.J. Cappers (Chapter 15) and the shell midden (SM-1) studied by archaeozoologist A.M.H. Ervynck (Chapter 17). The feature marked "P" is an area outlined by a single line of coral blocks. It may be the remains of an area set aside for prayer of the type constructed by the Ababda work force employed on site during the 1995 and 1996 seasons. The feature marked "T" included remains that were previously described as a collapsed building, but which are now tentatively identified, by geologist J.A. Harrell, as a well or a cistern (Chapter 4). He, furthermore, considers the raised strip of land southwest of the main site, previously described as a partly artificial earthwork bank, to be a natural ridge of higher ground that extends farther to the south.

In January 1996, the authors took a series of levels down from the temporary datum, established in 1994 at 7.18 m on the remains of the Serapis temple, to the present high tide level east of the site. A wooden stake was driven into the ground until its top was 0.00 m relative to the temporary datum. Henceforth this should be regarded as the *site datum*. A very distinct black line marked the high tide level on 1 January 1996. This line was less than 3 cm above the new site datum and for all practical purposes the present high tide level can be considered equivalent to the 0 metre level for the site.

The 1 m contour line was established around to the east side of the main site and the 0.5 m contour line was added below this. After plotting them on the site plan, it was obvious that the archaeological remains fell within, and towards the east closely followed, the 1 m contour line.

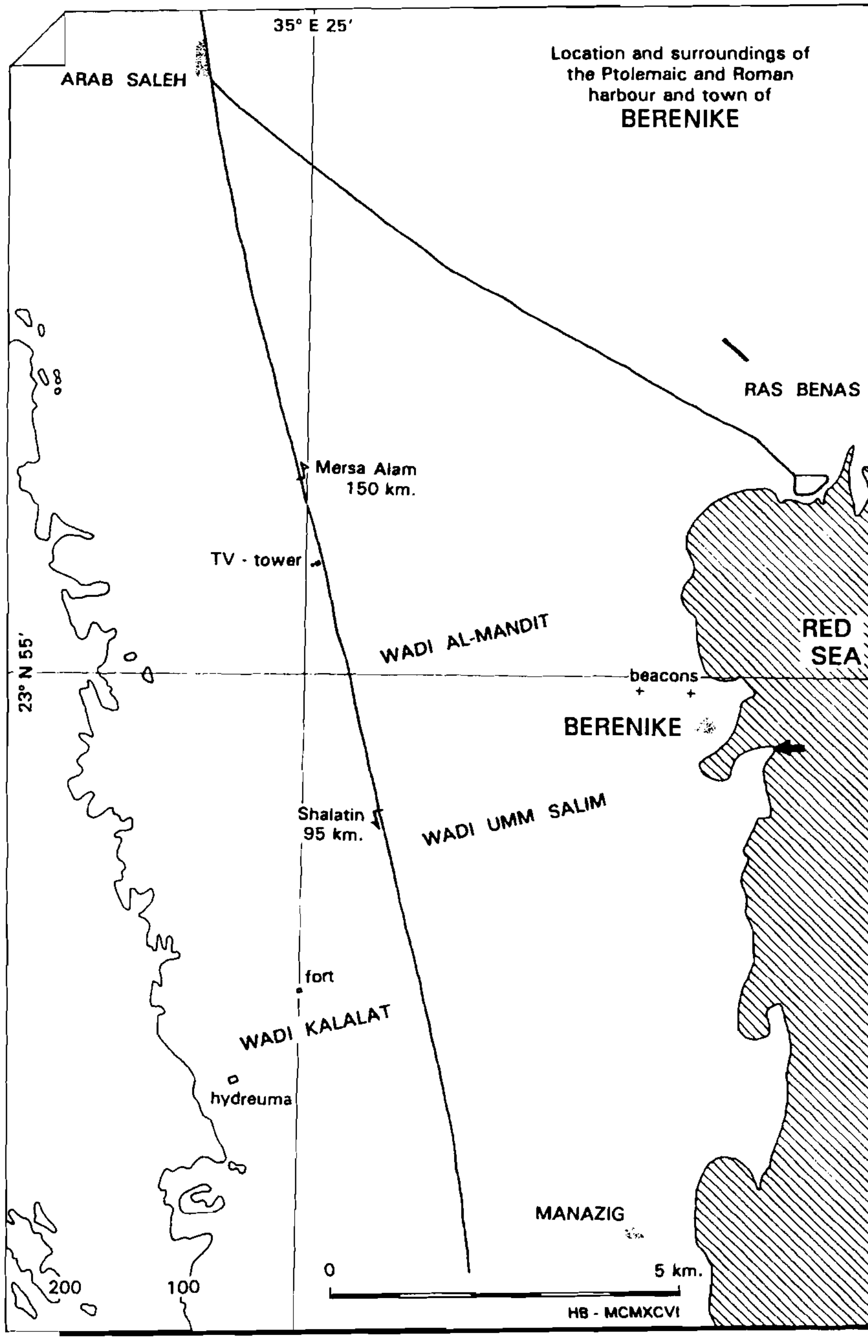

Figure 2-2 Map of the wider environs of Berenike, showing the correct coast line, the place where the tidal movements were measured and the position of the *hydreuma* at Wadi Kalalat. Surveyed by F.G. Aldsworth, B. Cannon, J.H.M. van Eijk and J.A. Harrell. Drawing by H. Barnard.

The authors mapped the coastline to the east and the northeast of the site, as represented by the high tide mark, including the sheltered inlet and the rocky outcrop beyond it, by tacheometry. J.A. Harrell and J.H.M. van Eijk mapped the coastline to the south using the Global Positioning System (Figure 2-2 and Chapter 4). This work was hampered by the alleged presence of mine fields and the fact that the tide in places flows beyond the distinct black line, indicating the dynamic nature of the area where *sabkha* (sandy, silty and clayey sediments) and Red Sea meet.

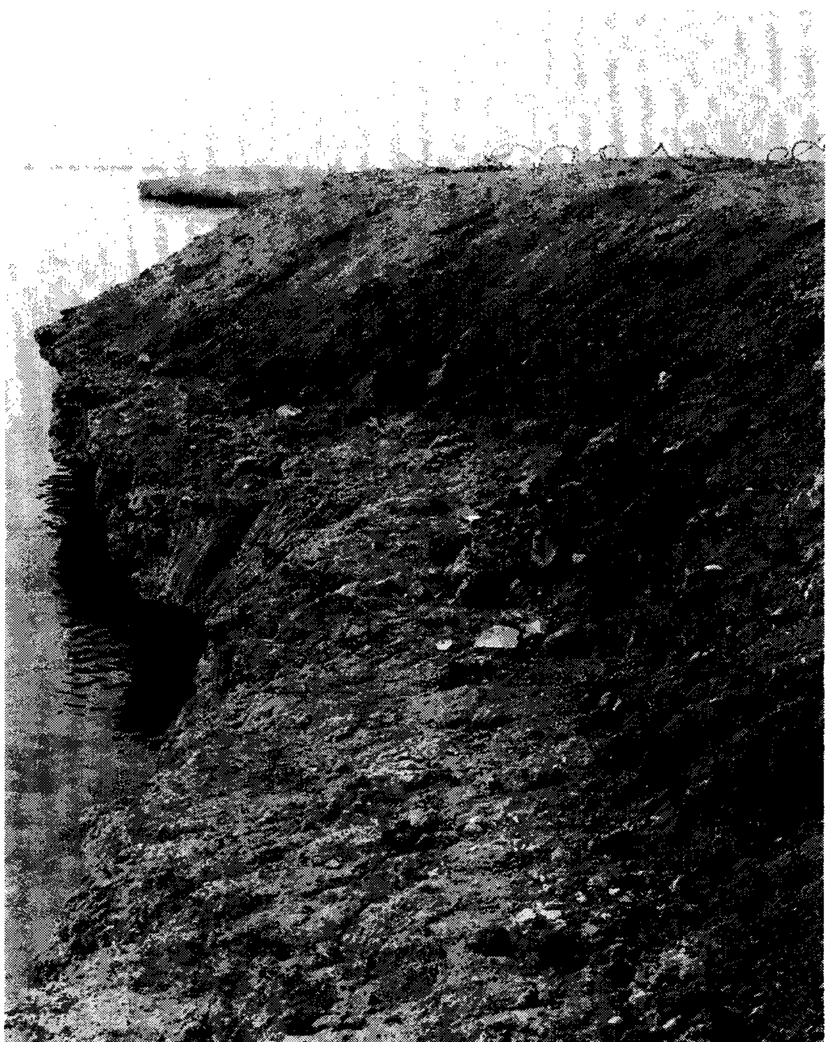

Plate 2-3 The tip of the peninsula east of Berenike, looking south, where the tidal movements were measured and the scattered remains of an ancient structure, probably a lighthouse, were seen. Photo by B.J. Seldenthuis.

2.2 SURVEY OF THE TIDAL MOVEMENT

The tidal movement of the Red Sea was measured during the spring tide caused by the new moon on 19 February 1996 and the neap tide caused by the full moon on 5 March 1996. This was done by measuring the height of the sea every half hour between 6:00 and 18:00 (local time) to the nearest cm at a fixed point just east of the small peninsula that shelters the inlet south of Berenike (Figure 2-2). Close to this point, old maps of Berenike show a circular tower or lighthouse (Aldsworth, Sidebotham and Wendrich 1995: 18;[1] Belzoni 1820: Plate 34) that was, most likely, destroyed by military activity during the 1970's when the site was levelled, as were portions of Berenike itself, and two small bunkers were built. Of the ancient structure no trace has been found *in situ*, but a large number of building blocks and potsherds, most likely originating from it, were seen on the slope towards the sea (Plate 2-3).

The results of the tidal measurements are shown in Figure 2-4, where the horizontal axis of both graphs represent the time of measurements and the vertical axis the level of the sea in cm below *site datum*. The rising and setting of the sun and the moon, the celestial bodies responsible for the tides, are represented above the lines that reflect the tidal movement of the sea.

The very limited tidal movement in the Red Sea, 0.4-0.6 m, can be explained by the relatively small extension of the sea, 150-300 km, in the east-west direction which is the direction of the pull of both the sun and the moon. The very small opening between the Red Sea and the Indian Ocean prevents the propagation of larger tidal movements into the Red Sea. The nearly north-south, very straight and almost parallel coastlines cause the tide to follow the moon without much delay: the high tide occurs when the moon passes the horizon.

These limited movements of the Red Sea combined with the large amount of water that evaporates from the surface and the fact that no rivers supply the sea with fresh water, make it much more saline than the Indian Ocean. A sample of sea water was taken for analysis, the results of which will be published in a future report.

The usual practice of sailing over the reef during high tide and anchoring in the lagoon between the reef and the beach is impossible at Berenike, not only because of the limited tidal movement, but also because the sea between the reef and the beach is very shallow (Plate 2-5). Today, the occasional flow of fresh water from Wadi Umm Salim al-Mandit into the Red Sea just south of the main site of Berenike prevents the growth of coral reef in the immediate area. This fresh water flow, however, also carries waterborne detritus which silts up the natural harbour, rendering its use by all but the smallest sailing vessels difficult. Despite the rise of both the sea and the land since Ptolemaic times, (Harrell 1996: 103-105; see Chapter 4) it is unlikely that this situation was fundamentally different in antiquity. This would have made construction and maintenance of a harbour west of the coral reef difficult, very labour intensive and quite unnecessary with such a small reef so close to the land and the protection of the large peninsula of Ras Benas

[1] Note that on this page J.G. Wilkinson's plan has been accidentally printed upside down.

towards the north. An alternate solution might have been that ships anchored on the reef, after which the cargo was carried ashore over a wooden board-walk or floating quay. This may be what both Strabo (*Geography* 17.1.45) and Pliny the Elder (*Natural History* 6.26.103) refer to when they describe the port (Sidebotham 1995c: 6-7).

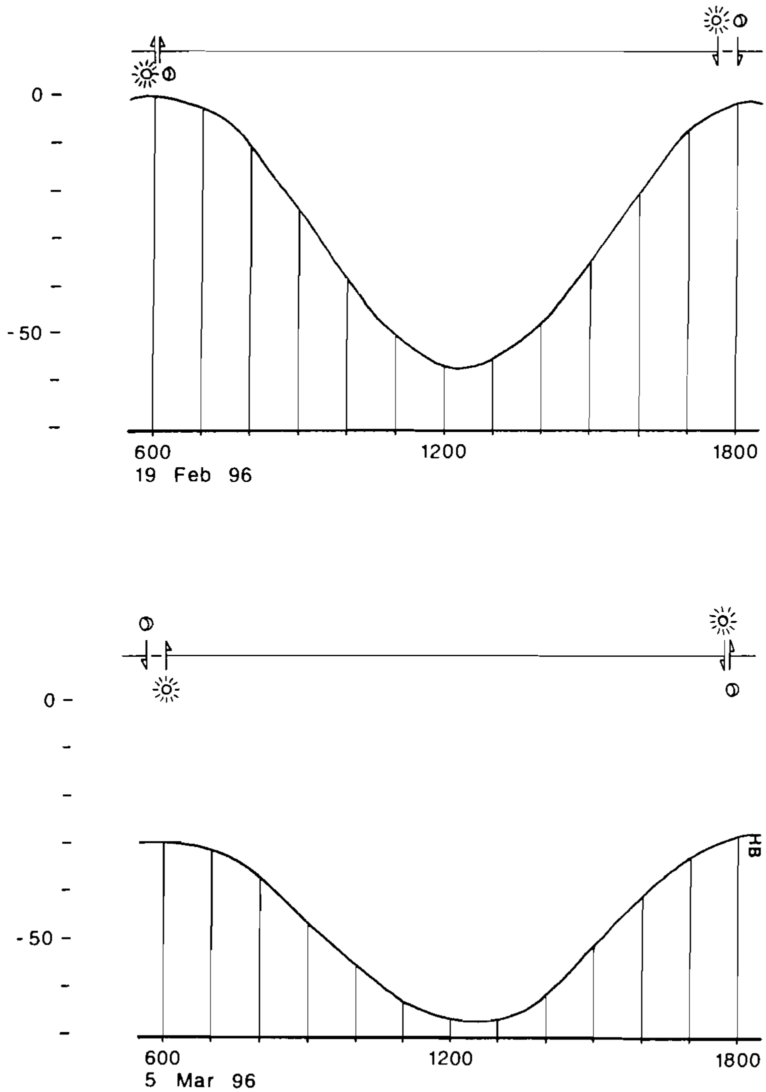

Figure 2-4 The tidal movement in the Red Sea near Berenike during the spring tide (new moon) and neap tide (full moon). Drawing by H. Barnard.

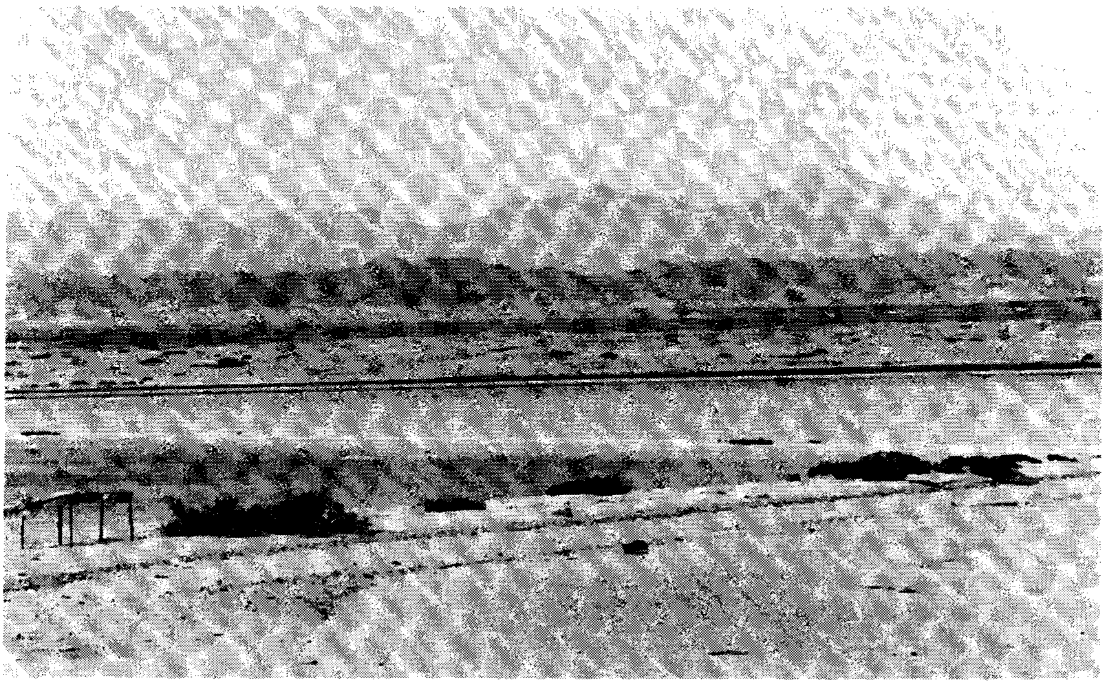

Plate 2-5 The inlet south of Berenike, during low tide, as seen from the tip of the peninsula, looking west. Photo by H. Barnard.

2.3 SURVEY OF THE GROUND WATER LEVELS

Using a Wild NK 10 levelling instrument, the absolute and relative level of the ground water table was measured, to the nearest cm, at three points approximately 500 m apart. The first spot was the 1 x 1 m probe [*068*, *096*, *097*, *098*, *100*] in trench BE95/96-7 that was excavated to below the ground water table (see Chapter 3). The water filling this probe was salty and the level was well below *site datum*. It was noted by the excavators that when the probe was emptied of water, to be excavated further, it took many hours for it to fill up again. The second spot at which the ground water table was reached, with a hand auger, and measured was 2 m west of the 30 x 30 m permanent quadrant number 1 (PQ-1). Here the water table was found to be slightly above *site datum* and over 2.50 m below the surface. The water, a sample of which was taken for analysis, tasted brackish which accords with the vegetation in PQ-1 (see Chapter 15). The third and last point where the water was reached and sampled, was a modern well west of the ancient remains of Berenike. This well contains potable water, used by the Bedouin for their livestock. The water table was almost 4 m below the surface and nearly 2 m above *site datum*.

The results of the measurements appear graphically in Figure 2-6; the analysis of the water samples will be published in a future report. The fresh water undoubtedly originates from inland reservoirs, making its way to the sea (Aldsworth and Barnard 1996b: 416-417). With a flow as slow as shown in trench BE95/96-7, due to an unfavourable combination of water pressure and soil permeability, this stream of fresh water will have a tendency to float on the salty water that is pushed in from the sea. It is obvious that extracting large amounts of fresh water from this system, which would have been necessary for a city the size of Berenike, would have increased the influx of salty water from the sea which would soon have rendered any well too close to the sea useless. For this reason, the main water supply for Berenike was probably located in the large fort in Wadi Kalalat, 8 km from the sea and 8.5 km southwest of Berenike, where the outlines of a large well can still be seen (Sidebotham and Zitterkopf 1996: 384-391).

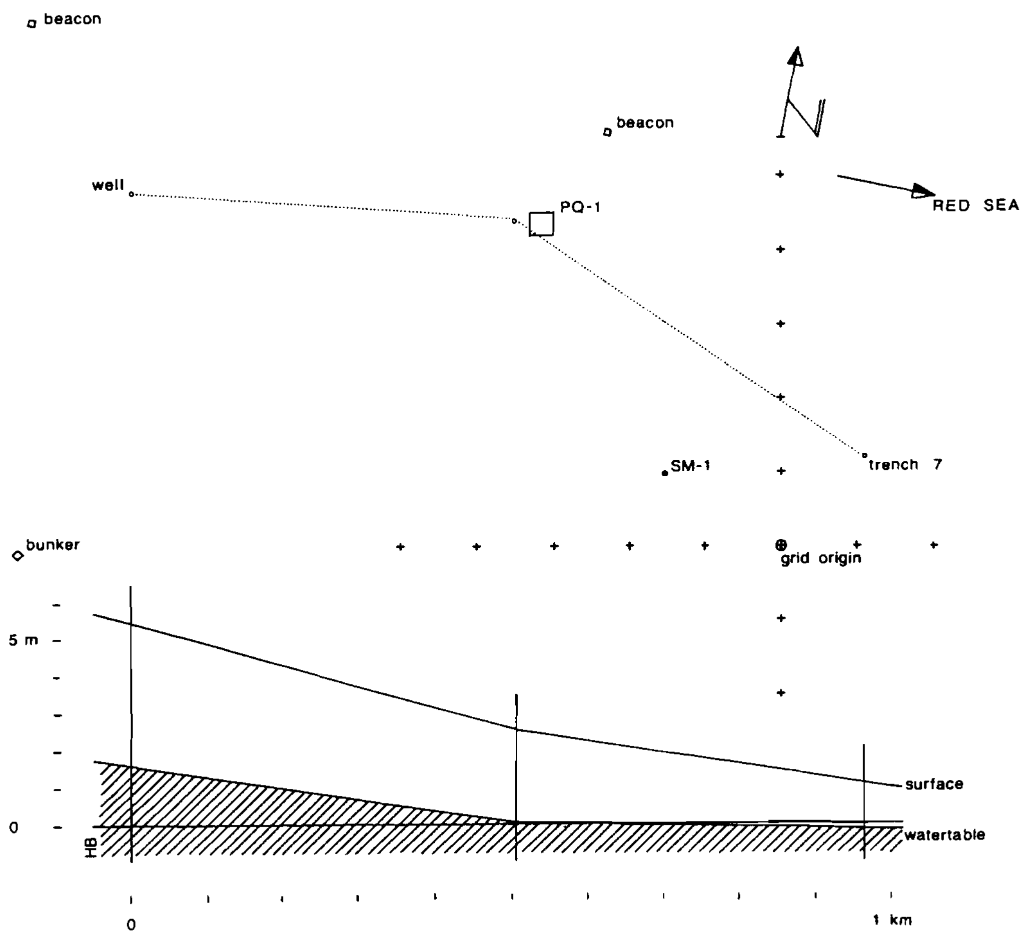

Figure 2-6 The position of SM-1 and the three points where the ground water table was measured (top), and the absolute and relative heights of the water table at these three points (bottom). Drawing by H. Barnard.

From the data now available, it is impossible to say how deep the water table is in Wadi Kalalat or how much that might have changed since antiquity, but judging by the size of the well, *ca.* 32 m in diameter, it must have been rather deep. However, the construction and maintenance of such a large installation would have been a small price to pay for a constant supply of fresh water to the city.

A distinctive feature of the surface layers at Berenike is a 0.1-0.2 m thick and very solid salt crust about 0.3-0.4 m below the sandy surface. Above this salt layer artifacts are affected by salt and below it artifacts are harmed by a higher level of humidity (see Chapter 19). This observation led to the hypothesis that salty ground water was drawn up by capillary forces and evaporated, leaving a layer of salt behind. The fact that the salt crust is continuous over walls, as was seen in trench BE96-8 (see Chapter 3), and the position of the ground water table, compared to the usual maximum capillary rise of 2 m, make it necessary to modify this theory. The very shallow coastal waters east of Berenike lead to a considerable horizontal displacement of the water front during the tidal cycle, even though the vertical tidal movement in the Red Sea is small. Therefore, large areas of wet sand, as well as a number of intertidal pools, are exposed to the sun and the wind during low tide. From these, the water evaporates quickly, allowing the wind to carry the remaining salt crystals inland. Once they have settled, they are washed down with the dew and the occasional rain, leaving a crust where the sand is dried by the sun. The salt eventually contaminates the ground water when it is washed farther down. To demonstrate this mechanism, a clean sheet of glass, 0.4 x 0.6 m, was placed in shell midden number 1 (SM-1, see Figure 2-6) at an angle of about 60° to the horizon. The centre of the sheet was approximately 0.6 m above the ground and pointed directly into the wind. After 24 hours, the sheet was covered with a film of salt, proving that at least part of the salt layer in the ground is aeolian in origin.

The life of the inhabitants of Berenike must have been largely ruled by water: not only because they were living in the desert, where the supply of drinking water must be constantly secured, but also because they were economically dependent on their harbour and the Red Sea. The relationships between the inhabitants of Berenike and the various local water systems were ambiguous. The salt water of the Red Sea, on which the economy of the city depended, forced them to fetch their drinking water some distance from the city. The occasional rivers of fresh water not only refilled the inland reservoirs, but also silted up the harbour and could destroy buildings or even kill livestock and people. Additional research will have to be undertaken to understand more fully this fragilly balanced ecosystem.