Searching for the Ancient Harbours of the Erythraean Sea

An Analytical Investigation

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ABSTRACT

This research study seeks to determine the possible locations of a selection of undiscovered ancient harbours of the *Periplus Maris Erythraean* (PME) and Ptolemy's *Geography*. This investigation of ancient ports also provides insight into the local resources, the harbour's role in navigation and the organisation and scale of trade within wider networks. The research is centred on the region of the "Erythraean Sea", encompassing regions of the Red Sea, Arabian Gulf and Indian Ocean, through a study of the ancient harbours and their function. Although we know these harbours existed, there are still gaps, principally due to their unknown location, and so this is a significant issue to address in the field of maritime archaeology. In the data analysis, I focus specifically on the region of the African coast of the Red Sea, down along the Horn of Africa and the coast of Tanzania, in East Africa. This narrowing of focus for the mapping of distances and possible location of unknown harbours was a result of time restrictions and varying accuracy of the statistical data across the wider research region.

The study employs a largely quantitative methodological approach creating a database with PME's distances, Ptolemy's coordinates, Modern coordinates (known and probable locations) and general descriptions of the sites. In recording the findings, the aim is to attempt to locate the ports and harbours within the study-area from all the evidence at hand, in terms of ancient sources, archaeological data, and the analysed distances. Moreover, it seeks to understand the methods adopted by the two primary ancient authors of this study, Ptolemy and the author of the *Periplus Maris Erythraean*, and attempt to search for parallels between the two, which both rely heavily on maritime data and the estimation of distances for their work.

Results from the research study map the possible locations of unknown harbours along the East African coast, determined from an array of data sources. The study-topic of this research is on-going, and the location of some of these sites is extremely hard to establish and requires further investigation. Nonetheless, the study provides a comprehensive and holistic insight into the nature and scale of Indo-Roman trade, the networks it operated, its significance during the period, and the potential location of some undiscovered ancient harbours.

CHAPTER 1

"Harbours and Indo-Roman Trade"

1.1. Aims and Research Questions

1.1.1. PROPOSED RESEARCH

Apart from the archaeological evidence we now have for ancient harbours, the majority of our understanding of Early Historic trade ports and harbours on coastlines of the Red Sea, Arabian Gulf and India, comes from Greco-Roman sources, notably the *Periplus Maris Erythraeai* (PME, 1st century AD) and Ptolemy's *Geography* (2nd century AD). My key aim will be to locate harbours mentioned in the two aforementioned sources that have not yet been discovered.

The activity coined as "Indo-Roman trade" consists of "a small episode within the much broader history of Indian Ocean activity" (Tomber 2008:15). It mainly developed as a result of interest in the East for its rich natural resources and manufactured products. This did not only include ostentatious 'luxury products' (i.e. gems, silks), but also products such as pepper and aromatics, which became widely used for medicinal, culinary and religious functions, and, ultimately, a necessity to the Roman lifestyle.

Ancient textual sources list various ports of trade and their location (e.g. Quseir al-Qadim and Adulis, in the Red Sea region), the roles they played, the people involved, and the goods being exchanged. However, the radical change in landscape over time has meant that some of the coastal sites of this date within the study region are difficult to identify. Due to the impact of siltation and progradation, some sites are now silted-up. Others are situated much further inland, submerged, built over, or their location is simply unknown. A clear example of this is indicated by the recent discovery at Pattanam, western India, and its relation to the ancient port of trade, Muziris (Tomber 2008). Similar patterns are apparent on a global-scale at several harbour sites located on river systems and along the coast. Understanding the dynamic environment is crucial to obtain a fuller understanding of human maritime activity and how people in the past used and engaged with their surroundings. In addition, the archaeology in these regions appears to lack a monumental characteristic, which can sometimes make interpretations rather less clear-cut, but can also yield much information about nature and scale. An example of this can be seen at Quseir al-Qadim, with its basic buildings and no traces of monumental architecture (Peacock & Blue 2006). However, it is its environmental setting, the harbour structures, and the numerous artefacts and distinctive signatures, which provided invaluable archaeological evidence and allowed the positive identification of the ancient port of trade, Myos Hormos.

1.1.2. AIMS

The crucial aim of this research project will be to attempt to determine the possible locations of a selection of undiscovered ancient harbours of the PME and Ptolemy's *Geography*, as well as looking to provide insight into the local resources, the harbour's role in navigation and the organisation and scale of trade within wider networks. The research will be centred on the region of the *Maris Erythraean,* or "Erythraean Sea", encompassing regions of the Red Sea, Arabian Gulf and Indian Ocean (fig.1), through the study of the ancient harbours and the role they played. In my analysis, I will be narrowing my focus specifically to the region of the African coast of the Red Sea, down along the Horn of Africa as far as the coast of Tanzania, in East Africa. This narrowing of focus for the mapping of distances and possible location of unknown harbours is important due to time restrictions governing the research study and varying accuracy of the statistical data across the wider research region. The sharper focus will provide a more in-depth analysis of information about these harbours and correlate findings.

Although we know these harbours existed, there are still considerable gaps, principally due to their unknown location, and so this is a very significant issue to tackle. Furthermore, this scope will enhance our understanding of the nature of sea trade in the Red Sea-Indian Ocean, or “Indo-Roman Trade”, during the Early Historic Period (300 BC-AD 500).

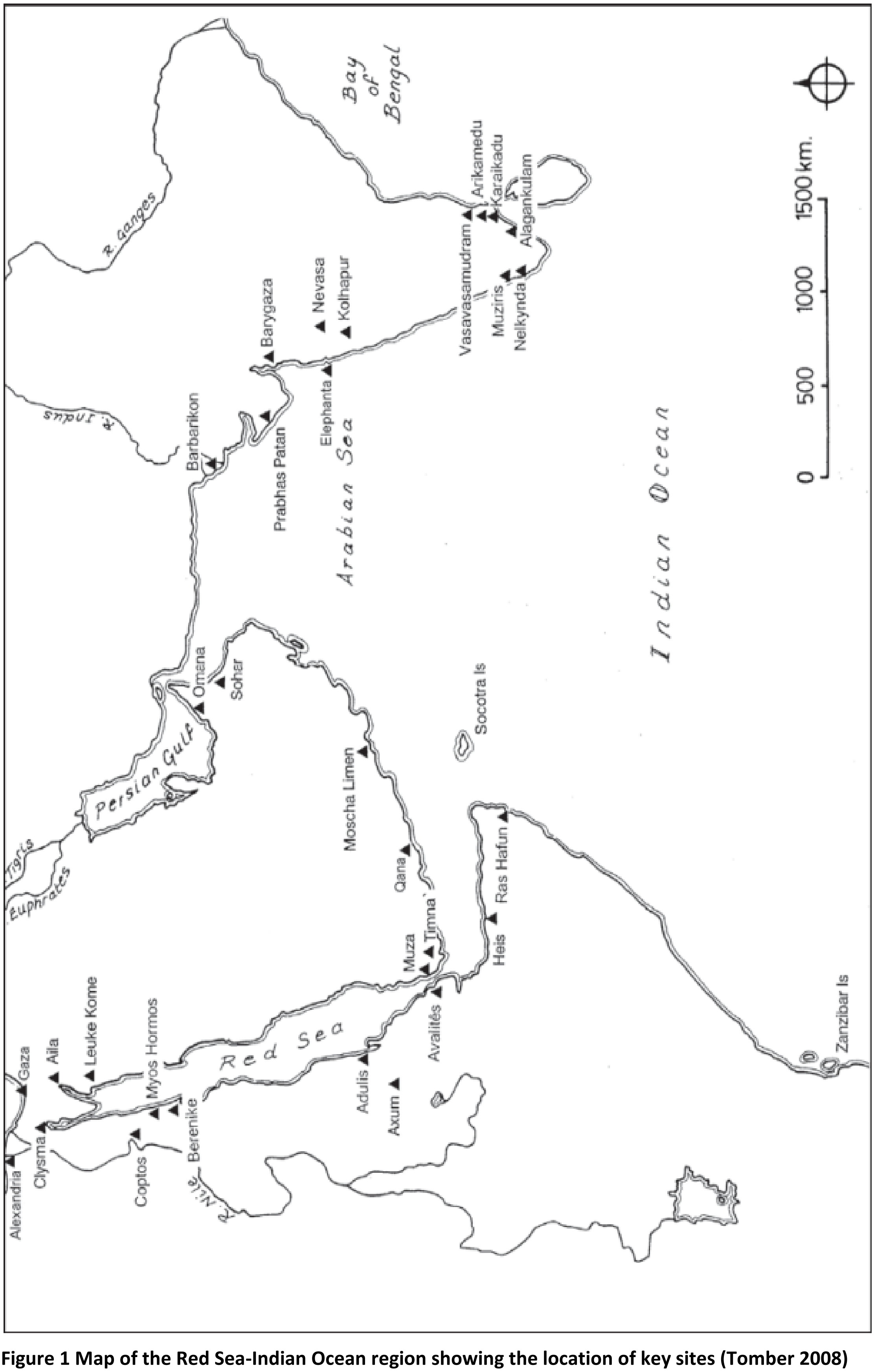


Figure 1 Map of the Red Sea-Indian Ocean region showing the location of key sites (Tomber 2008)

In order to overcome the gaps within this area of research, this project will aim to take on a comparative, essentially desk-based approach, by examining the available evidence from the ancient harbours through both ancient and modern secondary sources: notably literary and cartographic, by closely analysing distances (in *stades* – see chapter 4 - and travel time between ports) and coordinates from ancient sources, maps and modern satellite images, in conjunction with mathematical formulas, such as spherical geometry. In terms of landscape change over time, attention will focus on the character of the maritime conditions of the region and its topographic and geomorphological features, by studying and comparing maps of different periods, both ancient and current, and analysing them through the Geographic Information System (GIS). It is also important to determine the available shelter provided for shipping from the determined harbours.

This will enable the potential locating of ancient sites designated as ports of trade in the ancient texts which have not yet been discovered, and will subsequently provide a more holistic representation of the nature of maritime Indo-Roman trade, the networks in which it operated, and its significance during the period.

1.1.3. SIGNIFICANCE

The selected area of study is highly significant due to its large scope and many gaps, particularly as parts of this region have undergone vast geomorphological changes. Thus, the integration of ancient sources with modern publications and recent archaeological investigations, in conjunction with scientific techniques, such as spherical geometry, Google-Earth and GIS, will undoubtedly add to current work being undertaken in locating such harbours and address gaps in our knowledge of this period.

1.2. Context and Scale

1.2.1. HARBOUR ARCHAEOLOGY

Until recently, harbour archaeology "has long been the poor relation of shipwreck archaeology" (Peacock & Blue 2006). This has been largely due to its lack of romanticism in comparison with shipwreck archaeology. Moreover, various significant harbour sites are currently silted up, built over, destroyed, or currently still in use as ports of trade. Nonetheless, the subject has recently been developed by recent investigations (e.g. Peacock & Blue 2006; Sidebotham et al. 2008; Chami 2002) and become a more serious subject, attracting much interest. Harbour and port sites are now being studied and investigated thoroughly and have been widely published.

Small vessels can be anchored and unloaded relatively quickly and so it was not vital to provide artificial harbourworks for these (Greene 1986:29). However, in the case of large vessels, it was favourable to have harbours sheltered from storms and waves using moles, with vertical deep water quays. This was particularly true for those ships transporting heavy cargoes that require loading, unloading and storage to be carried out with care. The first to create large-scale moles and artificial basins for larger ships were the Greeks. However, it was the Romans who advanced this technology, by using concrete that would be placed under water (*ibid*). The provision of shelter, natural or artificial, is crucial for port development and local maritime trade (Hoyle 1967:2).

In the context of the study-area, the key port sites involved in the Roman trade with the east were Rome, Alexandria, Adulis and Muziris (Peacock & Blue 2007). In the Red Sea region, Myos Hormos and Berenike ports were critical (Peacock & Blue 2006; Sidebotham 1986:48–71), serving as important points of transhipment between ancient Rome and Egypt on one side, and the Red Sea and Indian Ocean regions, on the other (Begley & De Puma 1991:4), and having considerably easy access to the river Nile. In Egypt, commodities were transported to Myos Hormos, and then to Coptos, an important trade-town located on the Nile valley and then up the river to Alexandria, to be transported across the Mediterranean (Agius 2005:257). During this period, a well-organised maritime trading system had also been established in East Africa, which was served by coastal settlements and is described in ancient sources, such as the PME and Ptolemy's *Geography.* However, the maritime trade in this region had no centralising power or dominant export (Seland 2010:41). Rhapta was the last and principal port on the Swahili coast, known as Azania by the PME and Ptolemy, and Zanj by Arab Geographers (Chami 1999:237). It served as a good means of penetrating into the hinterland and became the Roman outpost on the Indian Ocean (Coquery-Vidrovitch 2005:41).

RED SEA ANCHORAGES

These comprise the following: Island Anchorages; Reef Anchorages; Sharms ("narrow, deep, often winding and push several kilometres inland or into the fringing reef", Davies & Morgan 2002:46 – compared to *rias* in Spain, Portugal, SW Britain) and Marsas ("natural bays, sometimes creeks leading off them, formed by a headland [*ras* in Arabic] or projection of the frining reef", *ibid;* fig.2). Khor (sharm or marsa if they constitute the 'estuary' of a wadi). In addition, the term *khor* "can be substituted for either *sharm* or *marsa* if these constitute the 'estuary' of a wadi". However, it is important to note that these terms are not always used correctly on western charts. Most of the harbours are located in *marsas* which have been developed, typically with excellent holding and good shelter. *Ras* anchorages are most frequent in the Gulf of Suez, though some are found in the southern Red Sea. They do not provide much protection from the wind, though some from the sea, but not much from swell (*ibid*).

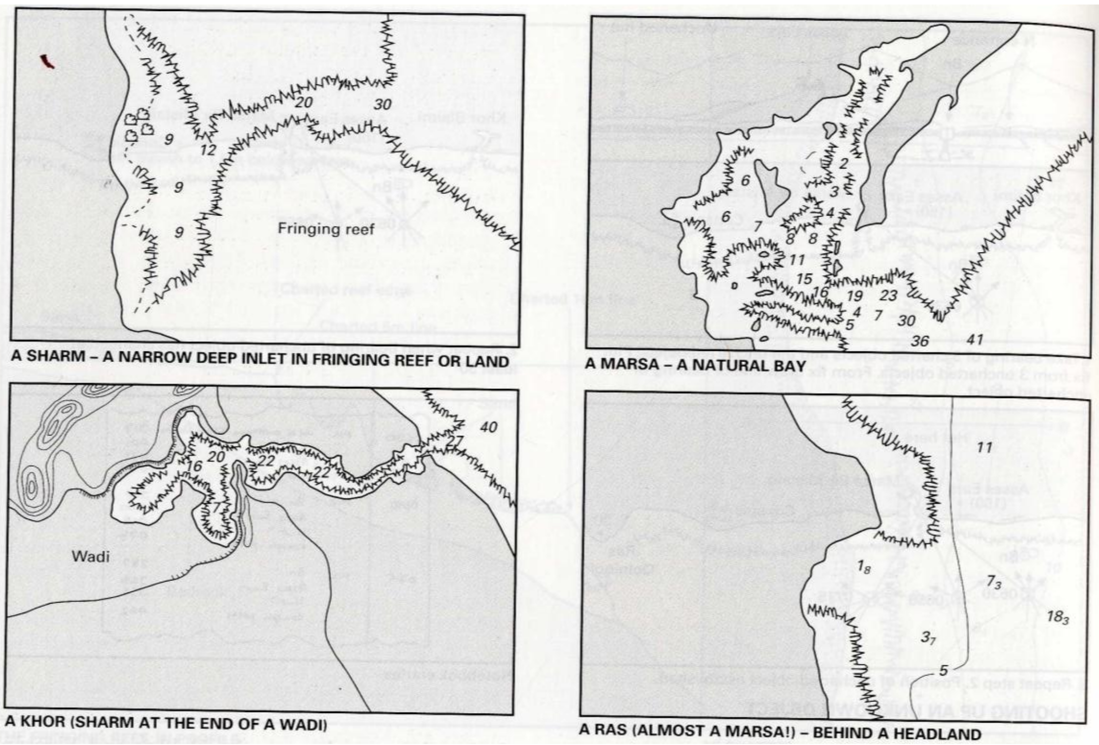


Figure 2 Figure Showing the different types of anchorages (sharm, marsa, khor, and ras) - Morgan & Davies 2002:44

1.2.2. GEOLOGY AND GEOMORPHOLOGY

The coastlines of the study-region are extremely dynamic and prone to tectonic activity, processes of erosion and deposition, and transgressions and regressions of relative sea level (RSL) (Bailey 2009). This has resulted in geological and geomorphological change over time, which can dramatically change the coastline and the position of certain important features. Moreover, such dynamic environments mean that humans have had to continually adapt and have thus developed a close relationship with the sea, for long-distance trade, as well as local marine resources. Therefore, for maritime communities, such adaptations to their surroundings have always been an essential factor for their survival and development (*ibid*).

EGYPT

Context of the region and geomorphological changes

Egypt lies in northeast Africa, with a cover-area measuring approximately 1,002,000 square kilometres (Sidebotham 2008:21;fig.3). In the post-glacial global warming, at the end of the Pleistocene, the geomorphological changes led to more humid periods in Egypt from around 10,000bp to around 3500bp. Small water supplies developed in the desert, which were able to sustain human and animal life, that the inhabitants were then able to exploit (Byrnes 2007). The fertile Nile served as a vital geographical feature, playing a major part in Egyptian economic life due to the annual flooding of the valley (referred to as the 'Black Land' by the Nile-centric Egyptians), which covered it with a layer of fertile silt and clay, acting as natural fertilisers. The Nile River separates Egypt into two sections, comprising two deserts (known as the *'Red Land'* by the valley inhabitants): the Western Desert (Sahara) and the Eastern Desert (Sidebotham 2008:21).

RED SEA

Scale of the region

This resulted in the now long, narrow, mostly enclosed sea, edged by mountains (Davies & Morgan 2002:34), with a length of about 2,250 kilometres, a width, at its greatest, of approximately 335 kilometres, and a maximum recorded depth of 2,850 meters (ibid; Sidebotham 2008:22). Most of the western shore consists of raised coral platform, whereas the eastern shore is mostly formed of higher, rocky cliffs. Its only natural outlet is at the 29 kilometer-wide strait of Bab el-Mandeb ('Gate of Tears'), between Yemen and Djibouti, into the Indian Ocean.

Geology of the region and natural harbours

The Red Sea coast is desert, with few good locations for large natural harbours, known as *marsas* (anchorages), which "eventually and temporarily metamorphosed into harbours" and "were formed when seaward ends of valleys were flooding by rising sea levels at the end of the Ice Age (about twelve thousand years ago)" (Sidebotham 2008:22-23).

EASTERN DESERT

Scale of the region

In contrast to the Western Desert, which has a semi-circle of oases that provided refuge, the Eastern Desert (fig.3) offered rich natural stone and mineral resources, hence Egyptians have always quarried and mined in this region (Byrnes 2007). The Eastern Desert comprises approximately 22% of Egypt's surface area (Moneim 2005:416), extending from the eastern limits of the Nile Delta down into the Sudan, between the Nile and the Red Sea. It has a total cover-area of 222,000 square kilometres, measuring c.1100 kilometres from north to south and c.225 kilometres from east to west, (Morrow and Morrow 2002:11).

Geology of the region and natural trade routes

Wadis (valleys of an occasional watercourse) intersect the mountains and the plateau of the Eastern Desert. The majority are orientated east to west (e.g. Wadi Hammamat), though some are from south to north (e.g. Wadi Qena). To the north, the

Wadi Araba connects the Nile to the Red Sea. These wadis offered natural routes for travellers, merchants, military personnel and industrial workers (Byrnes 2007). The Eastern Desert is dominated by the Red Sea Mountains which extend from the latitude of Cairo down to the Egyptian-Sudanese border and beyond.

Figure 3 Map showing Egypt, the Eastern Desert, and the Red Sea coast, with the topography of the region http://mapsof.net/red_sea/static-maps/jpg/red-sea-topographic-map-fr [accessed 08/10]

EAST AFRICAN COAST

<u>Context of the region and geomorphological changes</u>

It is shaped by the tectonic processes which caused the Great Rift Valley. The East African coast stretches along approximately 3000 miles from Somalia in the north to Mozambique in the south, encompassing offshore islands,e.g. Zanzibar (fig.4).

<u>Geology of the region and natural harbours</u>

The geology of the region influenced the development of trade routes as the Horn of Africa consists of mainly desert and semi-desert regions, and the region of the Great Lakes is heavily forested marshland. Therefore, seaborne trade was advantageous along the coastline of East Africa rather than trade routes across difficult inland terrain. During the open season the harbours along the East African coastline were relatively hospitable and the routes were good for navigation (Schlichter 1891).

Figure 4 Mapshowing the horn of african down to Tanzania in East Africa, with the topography of the region http://www.lib.utexas.edu/maps/africa.html

1.2.3. ROUTES, ORGANISATION AND SCALE

Winds and their role in Seaborne Trade

The dynamic maritime trade was facilitated by the direction and duration of the monsoon winds in both the Red Sea and the Indian Ocean (fig.5). They played a predominant role in seaborne trade, largely dictating the practicality and timing of seafaring activity. It determined the routes of merchant ships and their sailing seasons, ensuring the success of long-distance trade between the Egyptian Red Sea and the coast of India (Tripati & Raut 2006:864). These winds blow in southwest direction from June-November (summer monsoon) and in northeast direction from December–May (winter monsoon) (*ibid*). However, navigation was still a challenging task, as "the direction of travel had to be carefully oriented and co-ordinated with the movement and velocity of the monsoon and dates for sailing adjusted according to the location of the ports" (De Romanis & Tchernia 1997:25).

Figure 5 Map depicting the wind seasonality in the Red Sea-Indian Ocean region

(http://www.saudiaramcoworld.com/issue/200506/queen.of.the.india.trade.htm)

Roman merchant ships going to India took two major routes: either to the north-western coast, to the major ports of Barbarikon and Barygaza (*ibid*:75–6), or directly across the Indian Ocean to the ports of Muziris and Nelkynda, situated on the Malabar Coast of south-west India (Casson 1989:83; Young 2001:30). In terms of the cargo, the exported commodities arrived at Alexandria and from there were shipped up the Nile to Coptos in river craft, stopping at several ports en route. Goods were then brought back by camel or donkey across the desert to Myos Hormos or Berenike. As the journey to India took approximately two months, the ships reached the Indian coast by September and then remained there for approximately two further months, as the northeast monsoons on the west coast did not begin until late November (Casson 1984; McGrail 2001:258). Pliny states that Roman vessels departed from India in December or early January, taking the same route in reverse, and arrived in Egypt in March or April (NH6.26.106). This stationing period in India encouraged an establishment of interaction between the Roman merchants and seamen and the Indian people, improving their trade business and allowing cultural exchange. The entire voyage, to India and back, could be completed under a year (Casson 1984:190–1; McGrail 2001:258). Accordingly, it is clear that trade routes and sailing seasons were largely dictated by the wind and this had a prominent effect on the volume of trade (Blue 2009:3). Trading ranged from the basic barter of goods to more sophisticated market exchanges, with circuits of trade partly being dependent on navigational technology (De Romanis & Tchernia 1997:24).

1.3.4. ITEMS OF TRADE OF THE EASTERN COMMERCE

Items of trade and basic staple foodstuffs (such as olive oil, wine and *garum* [fish sauce]), were easily transportable and objects of considerable demand. The African trade route, from the Red Sea down to Rhapta, predominantly yielded basic ivory, tortoise-shell, frankincense, myrrh, and various grades of cassia. Next, Arabia yielded frankincense, myrrh, and aloe. The widest spread of goods came from India and included native spices, drugs, aromatics, gems, textiles, ivory, pearls, tortoise-shell (Casson 1989:15,table1).

Trade Region	**Items of trade**
Africa (Red Sea-Rhapta)	ivory, tortoise-shell, frankincense, myrrh, & cassia* * in reality of Southeast Asian origin, but its sale to the merchants of Roman Egypt occurred in certain "far-side" ports
Arabia	frankincense, myrrh, aloe
India	native spices, drugs, aromatics (costus, bdellium, *lykion*, nard, malabathron, pepper); gems (turquoise, lapis lazuli, onyx, diamonds, sapphires, "transparent gems"); textiles (cotton cloth and garments, and silk cloth and yarn from China); ivory, pearls, and tortoiseshell

Table 1 Table showing the items of traded on route (based on Casson 1989:15)

Luxuria:

It is important to be cautious when using the term 'luxury goods' and calling Rome's trade with the east 'luxury trade' (Young 2001:14). Nonetheless, they did trade 'luxuria' which included items for production of clothing and adornment; decorative materials; perfumes, unguents, and ointments; culinary items; and exotic items (i.e. tigers and ostriches), though in smaller numbers (*ibid*:15). All these items were transported at great cost over long and difficult trade routes and priced accordingly. They were considerably expensive and were aimed for the wealthier populace.

Religious goods:

In Roman religious practice, as well as Hellenistic and Near Eastern cultures, incenses (i.e. frankincense and myrrh) were burnt in honour of gods at temples and funerals. These items were relatively expensive (*ibid*:16).

Medicinal goods:

These consisted of myrrh and oil of myrrh, cinnamon and cassia, nard, malabathron. They were particularly valued as they were considered 'antidotes' to poison (*ibid*:17). However, they were often imported for different purposes (i.e. as 'luxury' or religious goods). For Indian products that were considered rare and valued in the West, and vice versa, their price and value would have increased (Whittaker 1998: 14), as 'geographical distance brings social prestige' (Parker 2002: 59).

By improving our knowledge of these objects and contextualising them, we obtain a more holistic understanding of their significance beyond their rarity.

1.3.5. NATURAL RESOURCES

Certain products are difficult to source, as it can be difficult to distinguish between growing-regions. Frankincense is an example of this, as it is native to both Yemen and Somalia. Cinnamon is another example; it is thought to come from the Malabar Coast and Sri Lanka, along with *cassia*, also from Southeast Asia and southern China (Dalby 2000 38; Cappers 2006:10-11).

In contrast, other products (e.g. pepper) have more exact growing-regions and are thus easier to source. Two major species of pepper were available from India, which included the long pepper, *piper longum,* from the north-east, and the black pepper (fig.6), *Piper nigrum,* from the south-west. White pepper is also mentioned in documents. Long pepper (the hotter of the two) was preferred, especially for medicinal use (Dalby 2000:90). Pliny (*NH 12.26-9)* describes black pepper as the cheapest. Currently, only black pepper has been identified archaeologically (Cappers 2006:114-19). Pepper also had the advantage of being cheap where it was produced, but then exported and sold for a high price. Most of the remains recovered come from the Eastern Desert of Egypt, due to its remarkable preservation conditions, which has facilitated archaeo-botanical research.

Figure 6 Pot with 7.5kg of Malabar black pepper at Berenike [www.athirady.com]

Textiles and glass beads (fig.7) were found distributed along the trade routes in India, East Africa and Egypt. Ivory was used throughout the ancient world for decoration, and travelled long distances while remaining in good condition. Rhinoceros horns were valued medicinally, and were also regarded as a powerful aphrodisiac by the Romans. This item has been found at ports throughout the Indo-Roman trade route, and was light to transport. Tortoise-shell was another readily available product throughout the Erythraen Sea. Similar to ivory, it was used for decorative purposes in both the West and the East (Tomber 2008; Young 2001).

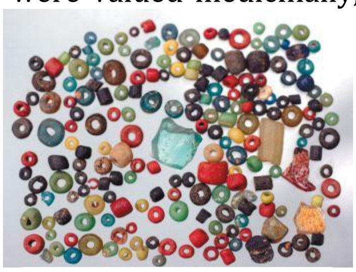


Figure 7 Glass beds and semi-precious stones found in Pattsnam [www.athirady.com]

1.3.6. EVIDENCE FOR IMPORTED SOURCES

Coinage: Coins are the most easily identifiable, abundant and widely published Roman finds in India (Tomber 2009:42). They are particularly useful for interpreting trade patterns. For instance, most of the Roman coins (especially gold and silver) in India occurred as hoards in the south, especially the south-west (Meyer 2007:61), which could possibly reflect a more monetarised economy in this region. During the Early Historic period, indigenous coinage in base metals was common (far less in precious metals) and a coin culture was doubtless present (Tomber 2008:24). Also, defacement (for decorative purposes or as a means of eliminating coinage from circulation, either in India or to avert its return to the West) and imitation (counterfeits or Indian *bullae*, moulded discs of ceramic or lead*)* of Roman coinage occurred and are relevant to understanding coin usage in India (*ibid*:36-37).

Pottery: According to Roberta, due to its abundance, this class of material is less observable and more challenging to identify, particularly with recovered sherds (*ibid*:38). After coinage, it is the second most frequent and significant Roman artefact type found in India's archaeological record, being most extensively used to document Indo-Roman trade (*ibid*). It was of diverse function and origin, being widely distributed and particularly comprised of amphorae sherds (*terra sigillata*) and a variety of bronze objects. Through recent excavations on the Egyptian Red coast, Indian pottery has been acknowledged in the Roman world, and complimentarily, various Roman amphorae have also been located throughout the Indian Ocean (e.g. Red Sea amphora, fig. 10). However, an interesting realisation was made by Tomber, who found that many of the amphorae in India that had previously been thought to be Roman, were in fact of Mesopotamian origin (Tomber 2007). In ten cases, the assemblage contained only Mesopotamian sherds, and Roman pottery was absent. The Mesopotamian vessels belong to a type known as 'torpedo jars' (used for wine) which have not previously been identified in India (fig.11). Other types of Roman pottery occur around the Indian Ocean, and include fine wares (e.g. *sigillata* from Western and Eastern Mediterranean) and coarse table wares (specially from Egypt) (Tomber 2008:43). Sandy Red Ware and Aksumite Coarse Wares, of East African origin, also occur along the Red Sea sites, such as Myos Hormos and Berenike.

1.3.6.1 EASTERN DESERT WARE

Eastern Desert Ware (EDW) found in the Eastern Desert (fig.9), between the Nile and the Red Sea, in southern Egypt and northern Sudan is a newly identified corpus of quite small, hand-made vessels with a notable surface treatment, mostly dating from the 4th-6th centuries (Barnard 2002,2004; Sidebotham et al. 2008). These vessels are thought to have been produced natively and used by the indigenous, nomadic inhabitants of this region. Examples of these have been found at Berenike (fig.8), which was considered by ancient authors such as Strabo and Pliny the Elder to be the most important Graeco-Roman port on the Egyptian Red Sea coast. The ports along this coast, which was originally built for the import of African elephants for military purposes, were then integrated into the long-distance maritime trade routes to and from East Africa, Arabia Felix (modern Yemen) and India (Barnard 2004). Overland journey routes via Edfu or Qift also played an important role. The infrastructure consisted of routes being laid out in the desert to link the mines, quarries and harbours in the Eastern Desert with the Nile Valley region (*ibid*). Along these routes, at regular intervals between locations and with cairns as landmarks, artificial way-stations (hydreumata), which offered travellers water and shelter (Sidebotham et al. 2008).

Figure 8 Examples of Eastern Desert Ware from Berenike (EDW 17 and 48) and Wadi Sikait (Mons Smaragdus, EDW 232 and 234). Photographs by H. Barnard, courtesy of the Berenike Project and the Mons Smaragdus Conservation Project. https://openaccess.

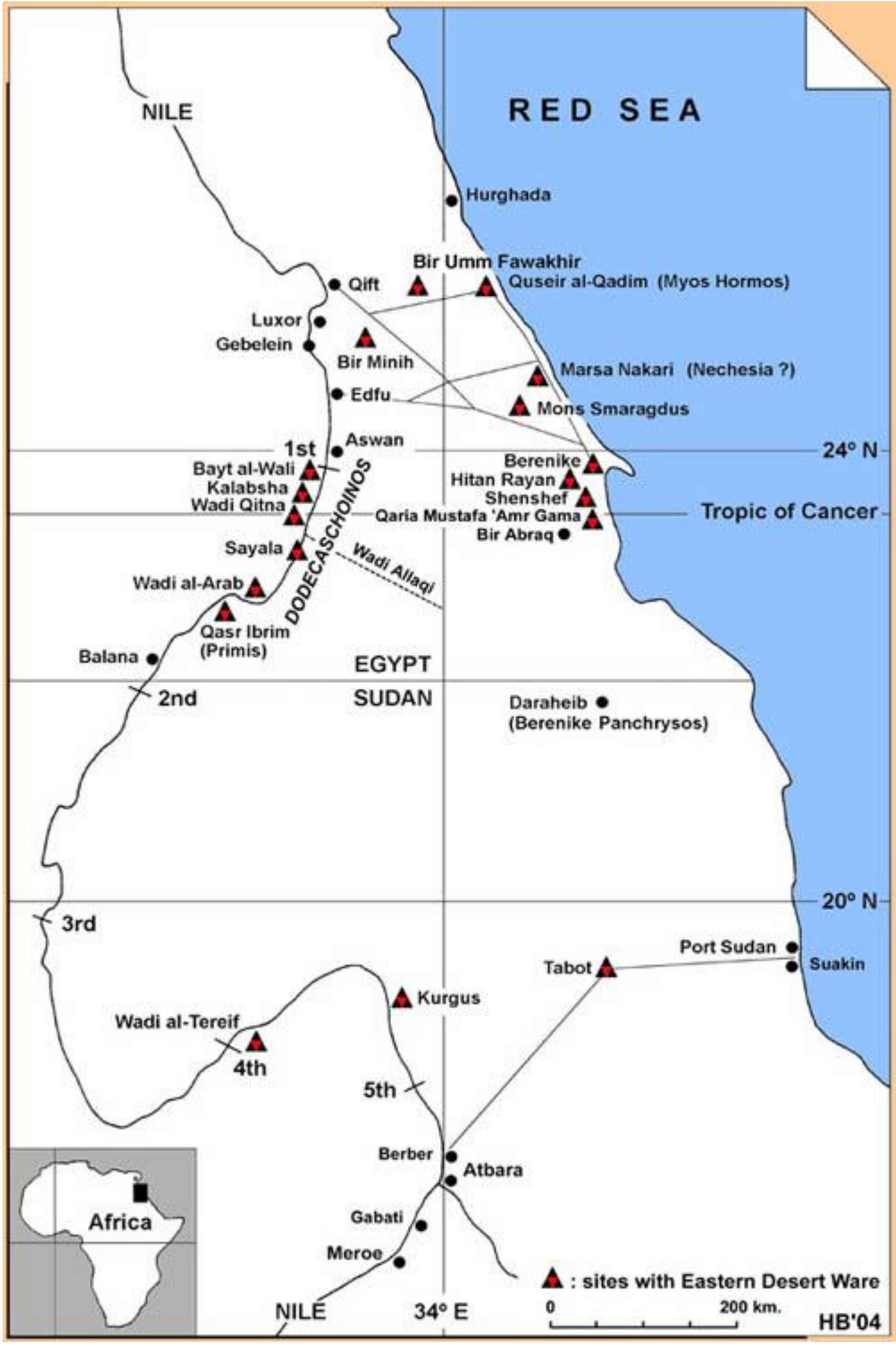


Figure 9 Map indicating sites with Eastern Desert Ware found in Egypt

http://www.barnard.nl/EDWdata/map.html

1.3.6.2. AMPHORAE

Amphorae are more complex pottery-types, as their location of production can be harder to identify, as they can be locally produced or imported (from numerous different source areas, with various different vessel forms and shapes).

Classification of Roman Amphorae

Roman amphorae come in different types, shapes, and forms, and can be from a variety of sources and dates (fig.10). The 'Roman amphorae: a digital resource' (http://ads.ahds.ac.uk/catalogue/archive/ampho-ra_ahrb_2005/index.cfm), compiled by Williams and Keay, is the most up-to-date resource for the study and classification of Roman Amphorae (Tomber 2009:45). During the Roman period, amphorae were widely distributed and transported as the primary items of cargo onboard a ship, for trading purposes. Their primary function was to transport products such as wine, oil and *garum* (i.e. fish sauce produced from salt and decomposed fish), which formed the staple diet of the Roman lifestyle. Epigraphic evidence, such as stamps and inscriptions were extremely common and can tell us about the origin of the location of production, the name of the manufacturer, or the content. Generally, stamps are positioned on the handle, though sometimes they are found on the rim and neck. These stamps indicate the agricultural estate on which the amphorae were manufactured. Inscriptions, or *tituli picti,* are generally located on the neck and

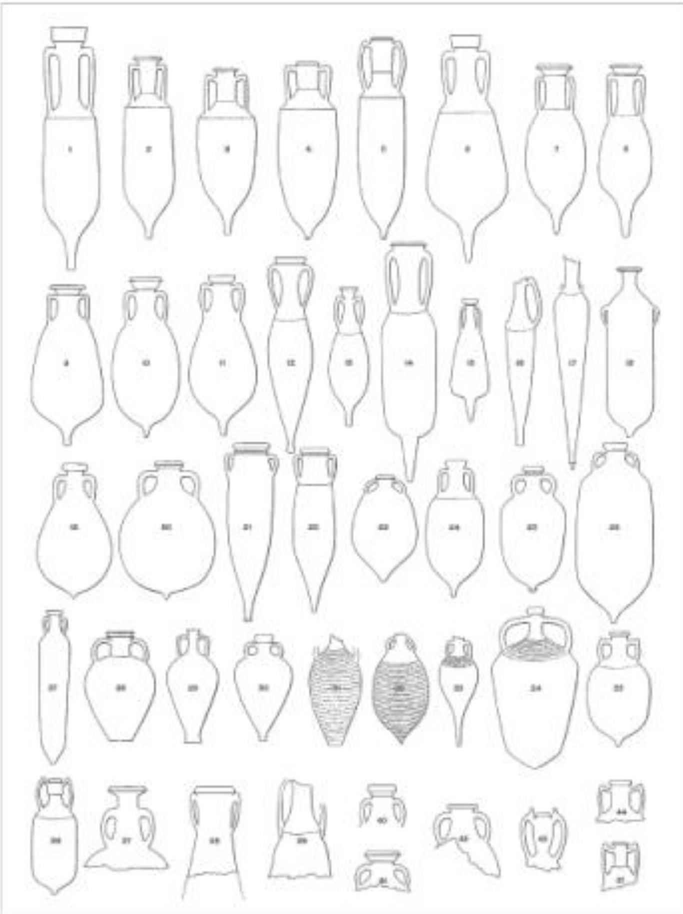


Figure 10 Typology of 43 Dressel Amphorae based on H. Dressel 1899 (in Tomber 2009)

shoulder of a vessel, and can provide us with information about the empty weight of the vessel, the weight of its contents, as well as details about the contents. Potentially they can also yield information on the source area and on shipping and customs operations (*ibid*:46).

The characteristic shape of the imported amphorae found in the Indian archaeological context, are the Dressel's Forms 2–4, which consist of three vessels joined in overall body form by a double-rod handle, a peg base, and a carinated shoulder (*ibid*), and its rim can be a rounded or flattened bead. This amphora-type was the most widely reproduced during the early Roman period, being produced in most provinces, from Britain to Egypt and Syria, and the most widespread in India, being used primarily as a wine container. Its distinctive shape and its function developed from a Greek wine amphora, known as Koan amphora, from the Greek island of Kos, dating from the 4th century BC-1st century AD (Whitbread 1995:81). Analysing the distinctive fabrics, forms, and styles of amphorae can potentially yield valuable information on the source area, the amphora-type, and dating. Though when only body sherds are present on-site, the task becomes more challenging and, thus, it is important to have good stratigraphic contexts (*ibid:*47).

1.3.6. **WIDESPREAD EXCHANGE-NETWORKS**

There were prosperous international trade routes that connected coastal harbours with inland sites. Tomber (2008) argues that 'two levels of exchange may have existed at trading sites – one for locals and another for foreigners (*ibid*:172). Some imports have been found predominantly at sites connected with the trade. For example, Indian pottery finds in Egypt have, so far, been restricted to port sites, pointing to their use on ships. Indian products, such as pepper and gems, are found at port sites and in other regions indicating their use in both "terminal and transit trade" (*ibid*:171). Such finds reflect how imported pottery can yield a wide range of dating and sourcing information, and show distribution patterns of trade.

CHAPTER 2

"Data Sources"

2.1. ANCIENT LITERARY SOURCES

The prime literary data source for my research project will be the ancient merchants' handbook "*Periplus Maris Erythraean*" (PME), written by an unknown Greco-Egyptian merchant living in Egypt, thought to date sometime between the first and mid-third centuries AD (Tomber 2008:21), although the actual date is subject to longstanding debate. It was a practical guide for merchants travelling from the Red Sea to India, providing a detailed description of the ports on route, the maritime environment, the resources available, the products traded and the different peoples. Much of this guide was a first-hand account of many of the places described (table2). This is apparent through the nature of his account, which is direct and meticulous, as well as a passage where he states that he himself travelled the journey, "we set a course (...) we put on extra speed" (PME 20:7.14-15, in Casson 1989:8). This detailed account will act as a valuable resource for my study, as it contains quantitative data in terms of distances between ports and waiting-stations. It has been shown to be a reliable source for locating ancient sites (*ibid*), as can be seen through excavations at Myos Hormos (Peacock 1993; Peacock & Blue 2006) and Adulis (Peacock & Blue 2007) confirming their actual locations at Quseir al-Qadim (Myos Hormos) and Diodorus Island and Oreine/Dese (Adulis). I will be using translated versions of this text, from Schoff (1912), Huntingford (1980) and Casson (1989).

Ports:	Chapters:	Main route described:	Reliability:
Myos Hormos - Opônê	1-14	Egypt - Horn of Africa	Firsthand
East Africa - Rhapta	15-18	Arabia - East Africa	Secondhand
Leukê Kômê - Kanê	19-28	Egypt - Arabia	Firsthand
Socotra and Moscha	29-32	Internal Hadramawt	Secondhand
Parthian ports	33-37	Persian Gulf - India	Secondhand
Barbarikon - Barygaza	38-49	Egypt - India	Firsthand
Akabaru - Tyndis	50-54	Coastal	Secondhand
Muziris - Nelkynda	54-57	Egypt - India	Firsthand
Balita - Sôptama	58-60	Coastal	Secondhand
Kamara - Ganges / Chrysê	61-63	Costal / India - S.E. Asia	Secondhand

Table 2 First and Secondhand Data in the PME (Seland 2010:15)

I will also use other sources (table3), though not as reliable as the PME, which will provide extra useful information on the subject, such as Pliny the Elder (AD 23-79) *Natural History (NH)* (a 37-book Latin encyclopaedia) and Strabo's (c.64/3 BC-AD23) *Geografia* (a 17-book in Greek). Pliny was renowned for his scientific methods, although some of his secondary sources were at times contradictory, which has led to questioning of the reliability of the certain parts. He perceptively describes the locations involved in the Indian Ocean trade, which included the Red Sea-India route, as well as the natural regional commodities. His approach appears to transmit a wariness of the impact that Eastern trade was having on Roman society (Thapar 1997:15-16; Tchernia 1997b:252). In comparison, Strabo, although he travelled in Egypt, Yemen and Ethiopia, also bases the majority of his work on secondary information. Many of the descriptions were acquired from historians of Alexander the Great, Mark Antony and Augustus (Tomber 2008:22), as well as earlier writers, namely Agatharchides of Cnidus' *On the Erythraean Sea* (before 100 BC), whose work is preserved by Strabo, Diodorus and Photius (Cohen 2006:13). Agatharchides had also obtained his information from earlier writers (Burstein 1989:13,22,29-33) and serves as a valuable summary of the results of Ptolemaic exploration. His book, which has survived almost intact, was a geographical piece covering the Horn of Africa and the lands around the Red Sea, with important descriptions of the routes and distances between locations, such as ports and towns, as well as the people inhabiting these places (*ibid*). His work was influential on many other ancient geographers, such as Diodorus Siculus, Strabo, Pliny the Elder, Aelian (Claudius Aelianus,), who quoted material from this book. Diodorus Siculus (1st century BC), a Greek historian, through such influences wrote his *Bibliotheca historica* ("Historical Library"), including geographical themes and descriptions in relation the history and culture of regions such as ancient Egypt, Mesopotamia, India, Scythia, Arabia, and North Africa.

For a more a holistic approach, Indian literary sources are referred to, which differ considerably in tradition from the other sources mentioned. The thematic anthologies of Tamil poems, form South India, such as the *Sangam poems* (written by merchants, potters and carpenters), focused on relations and conflicts (Champakalashmi 2006:175-80). Other texts, such as the Sanskrit *Arthastra,* describes matters such as the internal organisation of the state and its relationship with external contacts. Other relevant stories include the post-*Sangam* Tamil epics, such as the *Cilappatikaram* (Zvelebil 1974:132).

The ports listed along the African Red Sea coast from N-S in different ancient sources:

PME	Ptolemy 5.4.15-16	Strabo 16.4.5	Pliny 6.167-71	Agatharchides	Diodorus 3.39.1
Myos Hormos	Arsinoe	Philotera	Arsinoe	Arsinoe	Arsinoe
Berenike	Clysma/ Clysina Castle	Arsinoe	Philoteriae	Myos Hormos (Aphrodite)	Aphrodite's Harbour
Ptolemais Theron	Myos Hormos	Myos Hormos	Myos Hormos	Ptolemais Theron	
Adulis	Philotera	Berenike	Berenice Trogalytika		
	Leukos Limen	Ptolemais Theron	Berenice Panchrysos		
	Nechesia	Berenike Sabae (Epi Dire)	Berenice Epi Dires		
	Berenike		Ptolemais Theron		
	Adulis				

Table 3 Comparison of various ports listed in different ancient sources

NB: For discussion of the different locations of Hellenistic settlements within the study-region see Cohen (2006).

2.2. TOPONYMICAL EVIDENCE

Toponymical evidence is also extremely useful for the identifying the potential location of unknown sites. In relation to southern Arabian's historical geography and toponyms preserved in ancient texts such as that of Strabo, Pliny and Ptolemy, A. Sprenger and H. von Wissmann have dominated the subject (Potts 1996:58v). Regardless of the problematic political situation in Yemen, through sources such as Admiralty charts these two scholars were able to identify several locations without field-work, and according to Potts 1966, "eventually, progress in this field may be expected to determine the identification of many more of the toponyms listed here as unlocated." Their reliability must be approached with caution, but they are nevertheless extremely useful.

In contrast, east African toponyms recorded in ancient texts such as that of PME, Ptolemy and Cosmas Indicopleutes have been less used as sources for modern positioning of unlocated ancient harbours (though see Chitick 1976). This has been largely due to recent military conflicts in the region of lower Red Sea and Horn Africa, notably Eritrea and Somalia. This has complicated accessibility to the potential archaeology in those regions. Therefore, much of the research in this area in terms of identifying the position of unlocated ancient harbours has been carried out using a comparative approach, through analysing distances and using modern maps and admiralty/ pilot charts to determine the suitability of particular harbours and inlets. This approach has been applied by experts on PME such as Schoff (1912), Huntingford (1980), Casson (1989) and Groom (1995). I will use a combination of the aforementioned approaches to improve the reliability and accuracy of my results.

2.3. CARTOGRAPHY

Maps are an extremely useful data source, particularly in this area of research, as they often have direct links with texts, visually reflecting the ideas and knowledge of past people, and showing how they perceived time and space. For example, Claudius Ptolemy (c.AD 100-170), an Alexandrian Greek mathematician, astronomer and geographer, contributed to the foundation of spherical trigonometry and incorporated it into astronomical and terrestrial observations. He accepted that the earth was spherical and presented his arguments in the *Almagest* (1.4). He created a two-sphere system whereby the celestial sphere formed the outer circle, rotating daily around the earth, which was centred within the second sphere. The sun travels the path west to east of a great circle (*ecliptic*) on the celestial sphere (Darcy & Flynn 2008; Berggren & Jones 2000a:10; Diller 2006-2007*).* These observations became "the foundation of all astronomical science" (Bunbury & Beazley 1926:620). Through his astronomical work, Ptolemy then began his mapping of the known world, *oikoumene,* in his book *Geography,* which will be my prime cartographic source. His earth-centred method of the universe involved dividing a sphere into 360° by parallels of latitude and meridians of longitude, thus creating a grid on which he positioned a number of locations (fig.11). His databank included approximately 8000 localities within their assumed longitudes and latitudes (in his *Handy Tables*, a revision of the

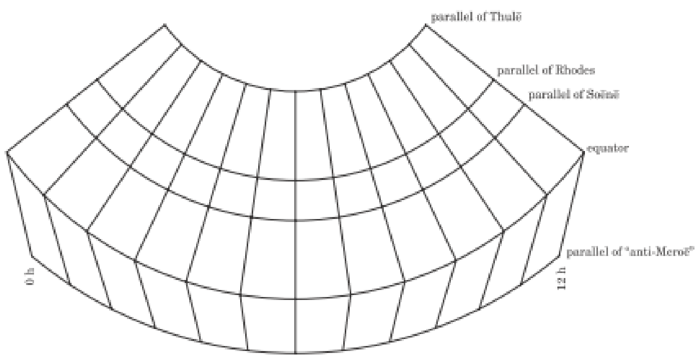


Figure 11 Graticule of Ptolemy's First Projection showing the parallels and meridians (Berggren & Jones 2001:36)

Almagest, he included a "Table of Important Cities", which are essentially those chosen in the *Geography*, Berggren & Jones 2001a:19). From observations of the longest hours of daylight it was possible to calculate the latitude of certain sites with considerable accuracy. The relative longitude were determined by the difference in local time using the hour of an astronomical event, i.e. a lunar eclipse. Although there are inaccuracies in his calculations, he was very knowledgeable about the East and his work has provided us with valuable information, reflecting the development of trade centres (emporia) and networks, during the first and second centuries AD (Casson 1995).

The *Geography* (fig.12) was written in the mid second century B.C., but was lost to scholars for over a century and then rediscovered around the fifteenth century. The original maps are unknown and probably never accompanied Ptolemy's manuscripts, as his aim was to provide a method for drawing maps, not to actually create them (Berggren and Jones 2001:45). Numerous reconstructions and copies exist, as Renaissance mapmakers utilised his work to create their own maps, serving as an influential model for mapmakers (Harley & Woodward 1987). Ptolemy's maps were relied upon until their improvement during the Age of Exploration (Tomber 2008:29).

Figure 12 Claudius Ptolemy (150 AD)'s map from his *Geographia*

Ptolemy's work was influenced by an array of sources, notably the work of his predecessors Marinus of Tyre (ca. 70-130 A.D.), Poseidonius, Eratosthenes (fl. 240-200 B.C.), Hipparchus and Aristotle (384-322 B.C.) adopting their concepts and methods (Royster 2004). Marinus was the 'founder of mathematical geography' (Cancik & Schneider 2010), improving the construction of maps and developing a system of nautical charts. The only surviving records of his work are in fact those found in Ptolemy's commentaries. Ptolemy adopted thousands of sites' geographical locations from the work of this early geographer.

A follower of Ptolemy was the author known as Cosmas Indicopleutes (i.e. Indian traveller), an Alexandrian merchant who visited India. However, in his *Christian Topography* he refutes the idea of a spherical world and through his theological approach presents religious notions in his maps. His accounts describe with relative accuracy of his journeys to the Mediterranean, the Nile Valley, Sinai, Palestine, the Persian Gulf, Ethiopia, Eritrea and Socotra (*ibid*:23).

Eratosthenes of Cyrene (276-195 BC), an ingenious librarian, developed a system for calculating the measurement of the Earth's circumference, using geometry and the Sun (Engels 1985; Walkup 2010:1). Before this, using mathematical geography, Eratosthenes attempted to create the earliest scientifically made world map (*ibid*). It appeared in his *Geography*, which was regarded very highly (Dicks 1971:389). There is a 19th century reproduction of the Eratosthenes' map of the world (Siebold 1998).

Versions of Ptolemy's *Geography* include: Muller (1883-1901), Nobbe 1843-45; Stevenson 1991; Breggren & Jones; digital publication by Stückelberger & Graßhof 2006.

For a Roman approach to mapmaking, we have the *Tabula Peutingeriana,* a graphic document charting and depicting how Romans perceived the known world, including India (appendix E) and the Far East. This *itinerarium pictum,* painted itinerary, presented an assemblage of places and distances along established routes (Dilke1985:112). This distinctive document was for individuals travelling to unknown locations, rather than for trade and official purposes, like the *periploi* documents (Salway 2001:59). yet, this 5th century AD Roman map exists only as a 12th century reproduction.

2.4. FIELD ARCHAEOLOGY: Papyri and Ostraka

The following sources will be used as secondary data, drawn from research of archaeologists in the field. Texts include papyri and ostraka (writing on potsherds), which have been found well preserved in the Eastern Desert of Egypt, and have yielded information about lists of foodstuff and items of trade, which were linked with ports and sea routes (Bagnall et al. 2000:8). An example of this is the group of 90 linked ostraca from Coptos, known as the Nicanor archive, consisting of receipts for a family shipping firm working between Coptos and the Red Sea ports of Berenike and Myos Hormos between 6 BC and AD 68/69. Recently, a group of ostraka has also been excavated from a rubbish dump at Berenike (Sidebotham & Wendrich 2000). Most of these acted as passes for the Berenike customs station, allowing the bearer to enter with itemised goods.

A legal text, known as 'the Muziris papyrus', covers both sides (neither complete) of the papyrus and describes facets of Eastern trade (Tomber 2008:25). The front, *recto*, describes a contract of a maritime loan accounting for a voyage from Alexandria to Muziris. It offers thorough guidance about the transport of products on this sea route. The back, *verso*, catalogues the price of a ship's cargo, after the 25% tax was deducted *(ibid)*.

Epigraphic evidence is also useful, and includes inscriptions, coins and graffiti. Coins are possibly the most frequently cited artefact-type involved in Indo-Roman trade (Tomber 2008:30). They are an important source of information, due to their reliable identification and distribution. However, their interpretation can sometimes be problematic. Graffiti and inscriptions also yield valuable information. The Pithom Stele, for example, offers valuable information about the ancient Red Sea hunting-station Ptolemais Theron, the canal linking the Nile and the Red Sea, and also the founding of the ports of Philoteras and Arsinoe (Cohen 2006:15). On a smaller scale, they can be found on pottery, providing insights into ownership and origin, date, function, and sometimes even ethnicity. On a larger scale, Nabataean activity in Egypt during the Roman period is evidenced through Nabataean cave inscriptions and graffiti found in the Eastern Desert (Sidebotham 1986:94).

2.5. RECENT PUBLICATIONS AND TECHNIQUES

Scientific and statistical techniques, such as spherical geometry, Google Earth, and GIS, will be used to update the research and strengthen the quality of my illustrations and interpretations. My research will use topographical images and coordinates, which can then be integrated into Google Earth or GIS to create maps and be studied in further detail. Various charts will be studied, which include topographic, admiralty and pilot charts. An example is "The Red Sea Pilot (Morgan & Davies 2002), which lists and describes the ports and anchorages on the Red Sea coasts, with useful information on the regional environmental conditions, such as winds, sea-state, level of shelter and hazards.

For recent publications on the study-topic, for the general context of the region:

Red Sea & Indo-Roman Trade: Desanges (1978); Miller (1969, 1998); Raschke (1978); Warmington (1995); Wheeler (1955); Young (2001); Sidebotham(1986-2002); Sidebotham & Wendrich (1995-2000); Sidebotham et al. (2002,2008); Cohen (2006); Peacock & Blue (2006,2007); Tomber 2008; *Journal of Egyptian Archaeology, International Journal of Maritime Archaeology (IJMA); Journal of Arabian Studies; Journal of Indian Ocean*

For East Africa: Chami (1994-2002); Chittick (1977-79;) *Azania: Archaeological Research in Africa, in Journal of the British Insitute in Eastern Africa*

These are just to name a few, as many will be referred to in specific context. Archaeological excavation and surface survey in the Red Sea region have provided and continue to provide crucial information about numerous ancient sites, such as Myos Hormos, Berenike and Adulis. Moreover, survey work in the Eastern Desert and in-depth ceramic analysis from different sites along the many roads has strengthened our understanding of the context of the area.

2.5. RECENT ARCHAEOLOGICAL INVESTIGATIONS

In the study of harbours, it is crucial to also consider social and economical questions, such as "Why were ports positioned where they were, in relation to geography, population, manufacture or political need? Who paid for them and why? What governed their success and how were ports used?" (Rickman 1988:257). These questions can be answered by drawing on a range of archaeological sources. For instance, ancient textual sources list various ports of trade and their locations (e.g. Quseir al-Qadim and Adulis, in the Red Sea region), the roles they played, the people involved, and the goods being exchanged.

2.5.1 Sources on Material Culture and Trade

Recent excavations in Egypt have advanced our knowledge of the thriving Indo-Roman trade. In Egypt, Ptolemy (*Geog*.4.5.8) lists six harbours in the Red Sea region, from north to south, as Clysma, Myos Hormos, Philoteras, Leukos Limen/Albus Portus, Nechesia and Berenike. By the late 1980s, Clysma and Berenike had been located (Sidebotham 1992). Due to further excavations and advances in our understanding of landscape, the modern site of Quseir al-Qadim has recently been confirmed as the ancient port of trade Myos Hormos (see Peacock and Blue 2006; fig.13). Furthermore, the site of the ancient port of Adulis has recently been investigated through intensive fieldwork which revealed the two harbours of Diodorus Island and Oreine, Eritrea (see Peacock & Blue 2007).

Figure 13 Amphora foundation of the jetty hard in the silted lagoon at Myos Hormos (Blue 2007)

2.5.2. Quantitative Data on Trade in the Region

The trade in frankincense and myrrh can be indirectly attested through ballast, which provides key quantitative evidence often absent in the archaeological record. Excavations at Quseir al-Qadim and Berenike revealed basalt blocks, which were identified as having been brought there as ships' ballast (Peacock et al 2007). A detailed scientific analysis of these finds demonstrated that about 70% of these came from Kane/Qana' (Bir Ali) and about 30% from Aden, the two major emporia in the Gulf involved in this trade.

2.5.3. Sources on the Geography and Coastline

The radical change in landscape over time, due to the impact of siltation and progradation, has meant that most of the coastal sites of this date within these regions are now either silted-up, situated much further inland or their location simply unknown (e.g. Adulis, Ptolemais Theron, Muziris). At Pattanam (Muziris), the effect on landscape can clearly be seen. Descriptions of Muziris abound in early Tamil Sangam literature:

"Here lies the thriving town of Muchiri, where the beautiful large ships of the Yavana come, bringing gold, splashing the white foam on the waters of the Periyar and then return, laden with pepper".

Akananuru (149.7-11), an anthology of early Tamil poems in the Sangam collection *Ettuttokai*.

This key port of trade was in a region near the delta of the Periyar, the longest river in Keral (fig.14). Recently, a geo-archaeological study conducted by Shajan K. Paul (2010) has revealed that "the Periyar had shifted its course from the Paravur area towards north-west to its present position" (*ibid* - www.athirady.com).

Therefore, understanding the dynamic environment is crucial to obtaining a greater understanding of human maritime activity and how people in the past used and engaged with their surroundings. In addition, new collection strategies and analytical techniques have improved the sourcing of findings, such as pottery (Tomber 2007) and archaeobotanic remains (Cappers 2006), that provide evidence on goods traded and, ultimately, on their utilised trade routes and their significance. According to Tomber (2007), Pattanam can be correlated to other sites within the Indian Ocean, such as "sites on the Red Sea, the embarkation point for Roman trade, as well as stopping off sites on the journey, in Yemen and Oman, and other sites in India" (www.athirady.com).

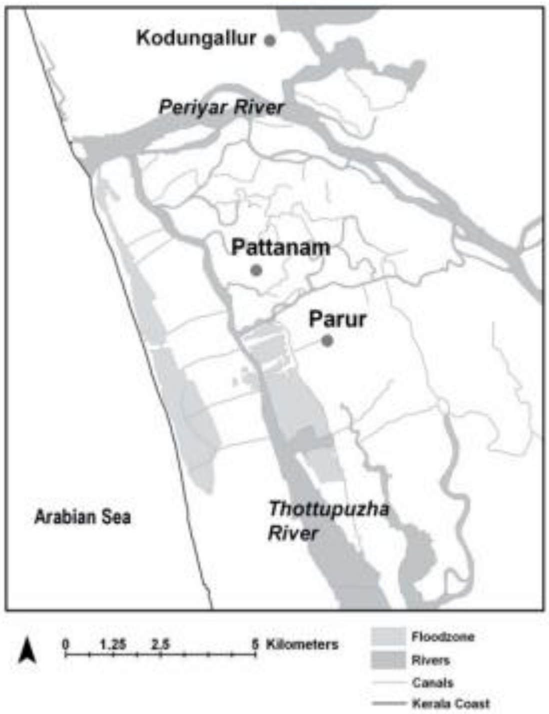


Figure 14 Map of Malabar coast, Kerala [www.athirady.com]

CHAPTER 3

"How to Locate Unidentified Ancient Harbours"

3.1. Methodological Approach

Investigative techniques relating to locating unidentified ancient harbours have evolved over the years, particularly with the development and increasing availability of new technologies and our advanced understanding of the archaeological landscape. Several recent investigations, such as Myos Hormos, Berenike, Adulis and Pattanam, have proven extremely fruitful and added to our knowledge of these ports and their involvement in Indo-Roman trade across the Erythraean Sea. However, there are still many gaps and extensive work that needs to be done.

Through interdisciplinary approaches, this maritime-oriented research aims to draw on evidence from archaeology, geography/cartography and literature that will help to locate or identify the ancient Indo-Roman ports mentioned in ancient sources, such as the PME and Ptolemy's *Geography.* The methodological approach that I will use is based on essentially desk-based, secondary research methods, as it is not within the scope of this study to carry out new research on-site/ in the field . It aims to be scientific and adopt a mainly quantitative approach in its design and analysis of data, through the use of spherical geometry, GIS mapping, and observing features on satellite images on google-earth. It will also look at supporting qualitative and statistical evidence from different archaeological sites in the areas of interest, examining items of trade. Primarily, the ports of trade will be determined by referring to measurements used in the PME rather than collecting new data from fieldwork. In drawing on field data, sites will be where the presence of Roman activity and settlement can be observed as evidence of Indo-Roman seaborne trade routes in the study region.

Attempts to locate ancient harbours and ports from ancient Graeco-Roman sources will be carried out using a number of methods. Firstly, I will identify the ports of trade, through historical, documentary and cartographic research (see chapter 2 for data sources), namely the PME and Ptolemy's *Geography*. By collating the numerous strands of evidence, from their lists and descriptions, this will enable me to establish the different sites and understand their context and significance.

Next, the data collected from these sources will be used to create a database record in a spreadsheet table of the ports of trade and other important features en-route, such as inland towns, islands, mountains and anchorages. This database will indicate the distances between each site as mentioned in the PME (in stadia or travel time); Ptolemy's coordinates, as well as modern coordinates for the respective known or probably locations; and descriptions of the type of site and harbour, its available shelter, and hazards.

Subsequently, mathematical calculations will be made in order to analyse distances and coordinates. Spherical geometry will be used to convert Ptolemy's coordinates into distances (in metres). Then, in order to determine a value for the *stade*, Ptolemy's calculated distances will be divided by the distances given in the PME (see chapter 4 and 5 for discussion and calculations). Moreover, an exercise of stripping all ancient sources (e.g. Agatharchides, Strabo, Pliny) for distances between sites will enable me to ascertain the reliability of the data and help narrow down possible locations. A database will also be created for the anchorages found along the African Red Sea coast, in order to analyse their significance in the context of this study.

The known and unknown locations will be established in a google earth map, with their distances. After that, I will examine topography and geomorphology of the study region and analyse changes in the landscape, through google-earth for a general overview; and satellite images and published data for a more specific and quantitative spatial analysis (which will be processed and modelled within a GIS framework, using ArcGIS 9.3, and plotted on google-earth). This will enable a more in-depth spatial analysis of the data, where I can measure actual distances, observe actual elevations and topographic features, and create high-resolution images.

Topographical and geophysical surveys will be used as they allow the mapping of the sites and can indicate sub-surface anomalies, in terms of the nature and extent of the underlying bedrock (Earl & Glazier 2006:34–42). Targeted excavations will be integrated within such investigations, to assess the effects of siltation and progradation.

From the collected data, an exercise of comparing ancient descriptions and distances/coordinates with modern ones and satellite images will be undertaken, which should potentially yield valuable information on possible harbour locations. This will be collated with other useful sources, such as modern admiralty and pilot charts, and wind/tidal information. The final stage will be to ultimately attempt to draw conclusions and suggest further work.

A limitation in this approach to locating unidentified ancient harbours is the reliance on secondary research methods rather than excavation in the field. A potential problem is that toponyms of harbours or features have altered over time. Some location names have been replicated in different places, such as Ptolemy's Sabathra and Sabrata, which are the same city (Sabratah, Libya), or have been corrupted due to transcription errors.

Nonetheless, due to the advanced technology we now have, combined with all the literary sources readily available, it is possible to develop a reliable hypothesis that can later lead to further research, and, ultimately, be tested in the field.

CHAPTER 4

"Maps and Distances"

This research project encompasses many different fields of study, and, thus, it is important to understand the different concepts within the subject, from astronomy to mathematics, geography to cartography, and their links with archaeology. Therefore, I have provided a clear, comprehensive overview of these relevant concepts in order to develop a better grasp of the material and its significance. PME and Ptolemy's *Geography* are my two primary sources for drawing values for determining distances, positioning harbour locations, and map-making.

4.1. EARLY CARTOGRAPHY

Maps are the fundamental tools of geography. In order to produce and understand a map efficiently, principles and techniques of cartography are implemented. Although early attempts at maps were considerably limited due to the lack of familiarity with anything that was not local, there are some early surviving examples, notably the Catal Hyük wall painting in Anatolia and the Babylonian maps engraved on clay tablets (O'Connor & Robertston 2002).

The first Greek thought to have created a map was Anaximander (610 - 456 BC), though no surviving maps exist. Dikaiarch (or Dicaearchus) of Messina (350-290/85 BC), a Greek geographer, cartographer and mathematician was one of the first to introduce geographical coordinates into map-making. Subsequently, Eratosthenes and Strabo created the first maps of the whole known world (Lahanas 2005).

When addressing Ptolemy's mapping work, it is crucial to account for the fact that the notions of maps and map-making in the past differed greatly from that of today, in not only the techniques at their disposal but also their approach towards the subject (Cronin 1905:429).

4.2. COASTING DISTANCES

Due to the scarcity of material on terrestrial road distances, coasting distances were the best means of determining relative positions. It seems clear that Ptolemy did not have much access to road itineraries, such as the *Antonine Itineraries*, for if he had he could not have made the internal errors apparent in his calculations. With coasting distances, "the first concept is that the locations along a given piece of coast are spaced at equal distances; a notion that probably arose from statements of day's sailing between ports" (Flinders-Petrie 1917). As Ptolemy's distances tend to only be stated to the nearest 10', and never less than 5', it is to be assumed that any distances within such limits should be seen as equal (Flinders-Petrie 1917).

4.3. SO WHAT IS A "STADE"?

The Roman measuring system developed from the ancient Greek methods and units of distance, which were primarily based on the Egyptian techniques. In classical geography, measured linear distances between sites were commonly expressed in stades, the standard unit of terrestrial distance (Berggren & Jones 2001:14). However, as there was no International Bureau of Standards in the ancient world, it is probable that measures such as the stade fluctuated slightly from region to region (Dicks 1960:46). Thus, there is much disagreement amongst scholars with regards to the actual length of the stade. According to Herodotus, one stade is equal to 600 feet. However, there were several different lengths of "feet", depending on the country of origin and time period. The scholar Lehmann-Haupt believes that there were approximately six different stades (*ibid*:43).

In contrast, astronomer and historian Rawlins believes that "1 stade = 185 meters (almost exactly 1/10 nautical mile*)* is well established" (Rawlins 1982:211). Although this is debatable, the 185 meter stade is in fact the most commonly accepted figure for the length of the stade (Rawlins 1982:211; Walkup 2010:12)**.** Frequently, when determining which value of the stade to use, an effective method is to compare how the stade equates to other ancient units of length. An array of references from different authors from the first century CE onward state the following: 1 Roman mile equates to 8 stades; 1 Roman mile equates to 5000 Roman feet (each just short of the

English foot); thus, if 1 Roman foot is equal to approximately 11.65 English inches, then one Roman mile is equal to approximately 1479 meters. Finally, 1/8 of this Roman mile gives the length of 1 stade as approximately 184.8 meters (Walkup 2010:11-12). This length of 185 metres corresponds to one of Lehmann-Haupt's six stades. He refers to this stade as the "Italian" (or "Attic") stade (Dicks 1960 1960:42-44).

Conversely, according to Schoff (1912:54), three stades were in use in the Roman world during the time, namely the Phileterian of 525 to the degree, the Olympic of 600, and that of Eratosthenes, of 700. He believes that "the stadium of the Periplus seems to be that of Erastothenes. Generally speaking, 10 stadia of the Periplus to the English statute mile would be a fair calculation" (*ibid*). However, it is important to note that all distances are approximations and generally given in round numbers. Consequently, the value chosen for the length of the stade affects the interpretation of ancient texts. I will adopt a different value of a stade based on my calculations from the data collated in chapter 5.

4.3.1. STADE VALUE FOR THE EARTH'S CIRCUMFERENCE

The stade was the unit of measurement used to calculate the Earth's circumference. Different authors used different values, which affected their degree of accuracy. Marinus used a zero meridian at the Isles of the Blessed (Canary Islands or Cape Verde Islands) for measurements of longitude, and the parallel of Rhodes for measurements of latitude (Berggren & Jones 2001). Marinus' estimation of the parallel of Rhodes was of 90,000 stades, and, thus, he calculated the value for the earth's circumference to be 33,300 km (approximately 17% less than the actual value, though both numbers are dependent on the stade value chosen).

Erastothenes' estimation of the Earth's circumference was 252,000 stades, which was much closer to the actual value of 249,020 stades. Subsequently, Poseidonius calculated the Earth's circumference to be approximately 180,000 stades (around one sixth of its actual measure). Interestingly, Ptolemy opted for Poseidonius' less accurate value for his estimation of the Earth's circumference. He adopted Hipparchus' method of dividing the equator and other great circles into 360 degrees, which resulted in making every degree only 500 stades, whereas Erastothenes and Hipparchos made every degree 700 stades. The true computation is 600 stades to every degree (Tozer 1897:341).

As mentioned, Hipparchus divided the equator of the earth into 360 degrees and 60 minutes. These values were approved by Ptolemy, who noted that much of what was known from travellers and texts was to be taken with caution in regards to their accuracy, which reflects how "Ptolemy's aims and methods were rigorous and scientific, but his materials were not equal to the demands he placed on them" (Whitfield 1998, 11).

4.4. HOW MANY STADES IN A "RUN"?

According to Casson, a "run" (*dromoi*) equates to a day's sail (1989:278). Different authors assign different values to a run, or day's sail. When analysing these seaborne distances, it is essential to know the start and finish positions of a journey, as well as any stops made en route, as this affects the total timings for the distance covered, "the duration of voyages is rarely measured with accuracy greater than half a day. When a voyage was recorded as taking '2–3 days', a compromise figure of 2 1/2 days may be used." (Whitewright 2010:5). Moreover, the weather conditions and sea-state were also very influential factors when estimating measurements of travel. Strabo (13.163.613) attributes a value of 700 stades for an average day's sail, whereas Aristeides (48.111) states 1200 stades in a day's sail, though this was with strong winds (cf.Pritchett 1982:238).

Above all, it is important to distinguish whether 'a day's sail' means 12 hour or 24 hour time-periods. Determining this is extremely important as it has a direct effect on the expected 24-hour speeds and distances. A possible solution for this would be to determine whether the journey was undertaken in a daylight period, or a day and night period, by calculating the given distances back around the expected performance (persn. comm. J. Whitewright 2010). Then by analysing a range of data for different voyages from historic records, it is possible to calculate a more reliable average measurement for a day's sail.

Marcianus of Herakleia, author of a *Periplous* (Muller, *GGM* 1.567-568), comes across inconsistencies in units of distance between locations within the *periplorum scriptores.* Marcianus claims that there is a general consensus that a ship could cover 700 stades in day's sail, with favourable weather conditions, and even 900 stades in optimum conditions. Whereas, Pseudo-Sylax (Pritchett 1982:238) calculates a day's sail to be 500 stade. Marinos, in Ptolemy's *Geography* (1.17.5), is quoted as achieving only 400-500 stades, but this under particularly unfavourable weather conditions.

Herodotus states a very generous, but acceptable, estimation for the distance travelled in four days and nights, with a steady wind astern, with an average of 1300 stades for a day and night's sail. However, his calculations are critiqued by Bunbury (1883:176-177), who explains that "it is no doubt possible that a Greek merchant vessel should, under favourable circumstances, accomplish as much as 700 stadia (70 G. miles) in a day, and 600 in the night; but it was great mistake to take this as the distance performed *on average*. The ordinary estimate of later geographers is 500 stadia a day, and the same for a night". Land and sea voyages were seldom made in a straight line, as there were many deviations along the way (*ibid*:26-27). Thus, it is important to determine the nature and extent of the deviation, the weather conditions, and to reduce the number of stades in order to achieve a straight course.

Therefore, if we assume a stade to be 180 m (see chapter 5 for method of determination), this would equate to the following distances travelled in a 'day's sail': Marcianus' 700 stades = 126 km; Pseudo-Sylax' 500 stades = 90km; and Herodotus (day and night)' 1300 stades = 234km. From this, we can observe that Herodotus' day and night distance travelled is around double the distance of the other two values, which implies that, on average, a standard day's run is determined on a 12 hour-period basis.

In favourable conditions, a ship should generally achieve at 4 knots around 96 nautical miles in a day's sail, i.e. 178 km, which equates to approximately 990 stades in a 24 hour-period (pers. comm. J. Whitewright:2010). At a very fast speed of 6 knots, 1483 stades (267km) could be achieved in a 24 hour-period. On this basis, it appears that all the authors have made considerably accurate estimations, the point to note being that they are dealing with different vessels sailing at different speeds under different environmental conditions. This is where the issue lies, as these ancient authors did not always specify these important factors in their journey accounts.

Another important point to consider is that many of these estimations of distance covered in a day's sail were highly dependent on the regions and their conditions, as well as the type of vessel used. For example, in the Mediterranean basin, it would be correct to consider the 500 stade figure as an acceptable average. However, when dealing with the Red Sea region, the monsoon winds can be extremely advantageous when sailing down the Red Sea during favourable months, hence, facilitating the sail and increasing the distance-time travelled. Ships sailing down the Red Sea should be able to, using the monsoon winds, achieve on average approximately 750 stades in a day's sail (pers.comm. J. Whitewright:2010).

Whitewight's article on "The Potential Performance of Ancient Mediterranean Sailing Rigs" (2010) provides a valuable and detailed insight into the relative performance of vessels, by analysing factors such as speed, distance-travelled, and time-taken in various different voyages, with close consideration to regional weather and sea conditions. For example, with a journey down the Red Sea, under favourable weather conditions, approximately 10 nautical miles (c.185 km) could be achieved in a day's sail. For the entire stretch of the Red Sea, the total distance-time covered from Suez to Djibouti by a lateen/settee rig, was 940 nautical miles in 9 days at approximately 3 knots (de Monfried, 1935:270 in Whitewright 2010:12). From Suez to Bab el-Mandeb 1200 nautical miles can be achieved at an average of 6 knots, which equates to 8.3 days. Hence, 9 days seems to be a reasonable estimation, although this was probably not always the case, depending on factors such as wind strength. Moreover, although there is some disagreement on this, ships would have almost certainly taken advantage of night sailing, thus, reducing the number of stops and time-taken to reach their final destination. In reality, it was easier to navigate by night, guided by the stars, and also safer, as often anchoring can be dangerous due to reefs and corals, etc. Moreover, it was time-effective and more economic.

Based on the evidence, it seems acceptable to calculate the distance travelled in a day's sail as approximately 72 nautical miles (12 hours x 6 knots), and, thus, for a night and day's sail (24 x 6 knots) equals around 144 nautical miles. Moreover, even with these established figures, it is important to attempt to collate as much information as possible from a given journey in order to fill in the gaps and reach more accurate and reliable conclusions.

4.5. PTOLEMY'S COORDINATES

4.5.1. Ptolemy's Work: Case-Studies on Reconstructions

Several authors have attempted recent reconstructions of Ptolemy's maps. For example, Strang (1998) adopted an empirical approach as a method of interpreting Ptolemy's early cartographic practices, focusing on the regions of Great Britain and Ireland. Lacroix (1998) takes on an interesting approach by acknowledging the idea that a great extent of the map's data derives from native travellers and merchants. He attempts to interpret the different names through the medium of the native languages of commerce, e. g. Swahili. This has proven fruitful, providing meaningful interpretations for many of the African place-names in Ptolemy's map. Berggren & A. Jones (2000b), a reconstruction of Gallia using Ptolemy's coordinates. In Manoledakis & Livieratos (2007), coordinate-based digital techniques have been implemented in order to position Ptolemy's Aegae, by using control points from the vicinity that are confirmed as common in the *Geography* and modern maps to allow comparison. Darcy & Flynn (2008) attempt to adjust Ptolemy's coordinates closer to the actual modern positions by effectively using two mathematical equations based on degrees of error of the latitudinal and longitudinal points.

From the ratio of the given part of the circumference to the great circle, the value of the stade can be calculated from the known number of stades in the circuit of the whole earth. According to Bunbury, "every degree, it is accepted, has 500 stadia" (Bunbury 1883:28). As mentioned earlier, this concept was accepted by Ptolemy, rather than the actual value of 600, which in turn affected all his coordinate values. He positions the equator at a significant distance from its actual geographical position. Latitudes were far simpler to measure with accuracy than longitudes in the past (Beggren & Jones 2001). However, Ptolemy's calculation for the *oikoumene*'s longitudinal value is more accurate than his latitudinal value, as the latitudes were approximately 25% less due to his adoption of a smaller figure for the Earth's circumference (Rawlins 1979-2007). Although, he chose a prime meridian which made all his eastern longitudes approximately seven degrees less than their actual value (Imperial Gazeteer of India,v.2:78).

It is still uncertain the exact process used by Ptolemy to work out the point coordinates in his *Geography*. It is supposed that certain points were identified using in-situ latitudinal and longitudinal observations, and that the remainder were determined by a "sort of step by step relative determination of coordinates starting from known positions of close points" (Manoledakis & Livieratos 2007:34). This seems to be also indicated by Ptolemy in his discussions (19.3). Hence, the analytical approach of the coordinates should involve looking at both the raw data from Ptolemy's *Geography* and a process of map-making based on relative point coordinates (coordinate differences), to then compare to modern positions.

4.5.1. Ancient Sources: A Positive Approach

Ancient scientists lacked the equipment and techniques we have today. However, it is important to remember that they did not regard accuracy and precision in the same way we do (Dicks 1960:43-45; Walkup 2010:13), and, thus, "any attempt to force a spurious accuracy on to ancient measurements and translate them into mathematically exact modern equivalents is bound to have misleading results" (Dicks 1960:43-45). Therefore, in ancient standards, the estimations made were surprisingly close and it is important to approach these with an open mind.

Ptolemy's *Geography* and the PME, in conjunction with many other ancient and modern sources and authors, provide us with invaluable information from which we can find relationships and attempt to calculate and reconstruct the distances travelled along trade routes between the ancient harbours with as much precision as possible. As mentioned, there is a vast range of material available: coordinates and distances for ancient objects such as cities (coastal and inland), mountains, rivers, lakes, capes, bays, etc; descriptions of these places, tribe names, items of trade, difficulties encountered, geographic and climatic conditions, etc; and all the archaeological data available. This will enable the realistic estimation of the probable localisation and discovery of the lost ancient trading harbours known to these ancient authors.

CHAPTER 5

“Ancient Harbours of the Erythraean Sea”

Data Collection and Analysis

A database has been created with PME's distances, Ptolemy's co-ordinates, and modern co-ordinates in order to analyse the distances between the ancient harbours and interrogate the validity of these measurements within the context of the Red Sea-Indian Ocean region, or “Erythraean Sea” - fig.15 (see database tables in appendix A for information on harbours, distances, coordinates, and descriptions).

5.1. TOPOGRAPHY OF THE ERYTHRAEAN SEA

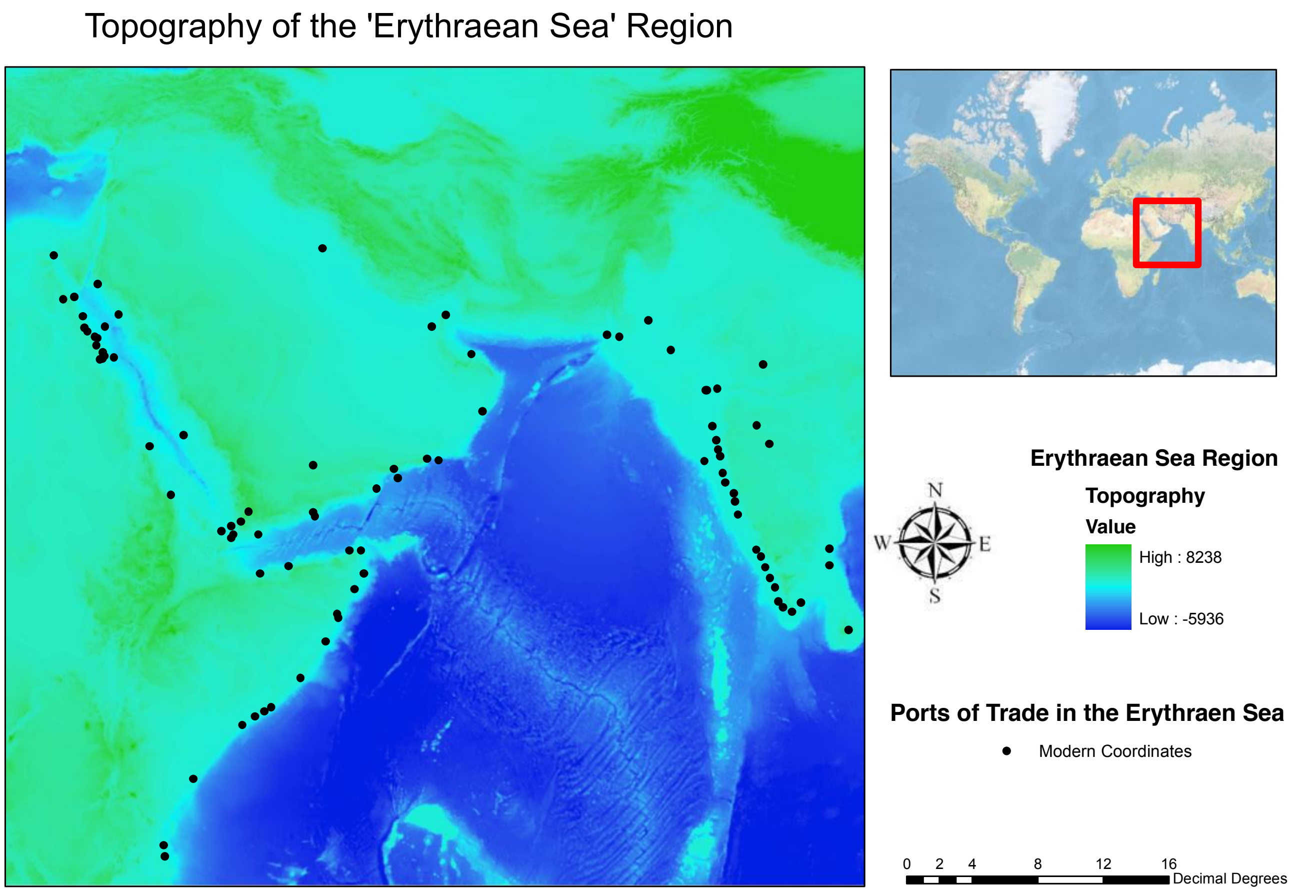


Figure 15 GIS map showing the topography of the Erythraean Sea (by author)

5.3. COORDINATES AND DISTANCES

To determine the actual distances between two locations from Ptolemy's coordinates, the method of spherical geometry was adopted.

Spherical Geometry

To calculate the distance between two sites from Ptolemy's coordinates, the method of spherical geometry was adopted (see formula below). Spherical Geometry utilises the 'haversine' formula to calculate great-circle distances between two given points, i.e. the shortest distance over the earth's surface, resulting in an 'as-the-crow-flies' distance between the points (ignoring any hills) [http://www.movable-type.co.uk/scripts/latlong.html: accessed 08/10].

Haversine Formula:

R = earth's radius (mean radius = 6,371km)
$\Delta lat = lat_2 - lat_1$
$\Delta long = long_2 - long_1$
$a = \sin^2(\Delta lat/2) + \cos(lat_1).\cos(lat_2).\sin^2(\Delta long/2)$
$c = 2.atan2(\sqrt{a}, \sqrt{(1-a)})$
$d = R.c$

NB: angles must be in radians to pass to trig functions.

Next, an attempt has been made to find a parallel between Ptolemy and PME's adopted value for the stades. There are no sources which state that Ptolemy was aware of, or used the PME's work. However, what we do know is that Ptolemy's information was primary obtained from and based on maritime data, which he clearly states in chapter 1 of his *Geography,* and communication from an array of travellers and merchants. Hence, it seems very plausible that he in fact did come across PME's work, particularly in relation to his information on the coastlines.

Both authors had a more in-depth, first-hand knowledge and understanding of the sites located within the Red Sea region, as they were far more familiar with this region. Thus, for more reliable and accurate results to be obtained, calculations and comparisons will be made with reference to sites in this region, particularly recently discovered sites with exact coordinate positions and distances between them.

5.4. SEARCHING FOR PARALLELS: Ptolemy & Periplus

Course	Ptolemy's Coordinates		Ptolemy's Distances (*D*) - m	PME distance (stades - *s*)	Stade value D/s - m
	Latitude	Latitude			
Myos Hormos - Berenike	26°45'	64°15'	324800	1800	180.4
Berenike - Ptolemais Theron	23°50'	64°5'	848600	4000	212.15
Ptolemais Theron - Adulis	16°25'	66°	539100	3000	179.7
Adulis - Avalites	11°40'	67°	847300	4800 (4000 + 800)	176.5
Avalites - Malao	8°25'	74°	240000	800	300*
Malao - Mundu	6°30'	75°	335900	2 runs	
Mundu - Mosyllon	7°	78°	248200	2 or 3 runs	
Mosyllon - Cape Elephas	9°	79°	276100	> 2 runs	
Cape Elephas - Spice Port/Tabai	7°30'	81°	276800	N/A	
Spice Port & Tabai - Opone	6°	83°	294800	400	737*
Opone - Rhapta	4°15'	81°	917400	25 runs total (see below)	
Small and Great Bluffs	3°	70°	994300	6 runs	
Small and Great Beach	1°S	78°	497000	6 runs	
Sarapion	3°S	74°	177900	7 runs	
Nikon	4°15'S	73°			
Pyraloi Islands & Canal	N/A	N/A		2 night and day runs (=4 runs)	
Menuthias Island	12°30'	85°S	240000	2 runs from island	
Rhapta	73°50'S	8°25'			

Table 4 Calculating common distances between data in Ptolemy's Geography and the PME (*Anomalies)

As can be seen from the table above (table4), by dividing Ptolemy's distances by PME's distances, we can attempt to find a parallel between the PME and Ptolemy's work and attempt to determine a common value of a stade used by these two authors. If we look at the more reliable distances between known locations, e.g. Myos Hormos to Berenike, the figure obtained is one stade equating to c. 180 m. This is considerably consistent between the other sites along the Red Sea, which range from 176.5 to 212.5. Anomalies and inaccuracies emerge the further away we venture past the straits (Bab el-Mandeb) and where runs become the measurement used to describe distances, rather than stades. This opens the dilemma regarding the value of a run (or day's sail), which is measurement/ estimation of time and has been discussed in detail in chapter 4.

If we analyse the runs from these results:

A. Malao – Mundu: 2 runs: 335900/180 stades = 1866/2 runs = 933/day

B. Mundu – Mosyllon: 2 or 3 runs: 248200/180 = 1379/2 or 3 = 459.7 – 689.5/day

C. Mosyllon – Cape Elephas: over 2 runs: 276100/180 = 1533.9/2 = up to 766.95/day

From these calculations, there is a clear variation in the number of stades achieved per day, ranging from 933 – 459.7 stades. If we look more closely at where each place is positioned on the map (fig.16), we can see a correlation between the region and the time-distance travelled. For instance, Malao and Mundu sailing is performed with relative ease, travelling at a good speed and distance. However, as one progresses eastward along the horn of Africa, the journey becomes increasingly more difficult due to regional environmental conditions, such as wind and currents (appendixD).

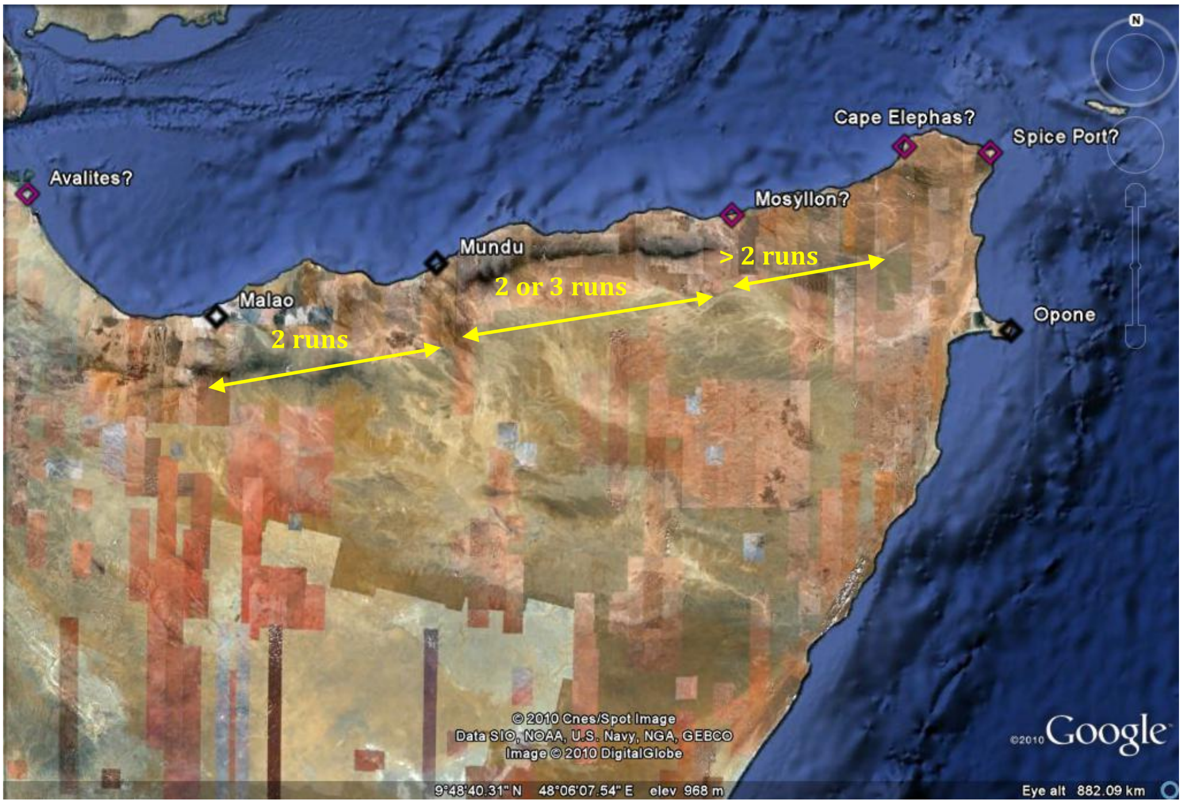


Figure 16 Distance travelled (in runs) from Malao to Cape Elephas

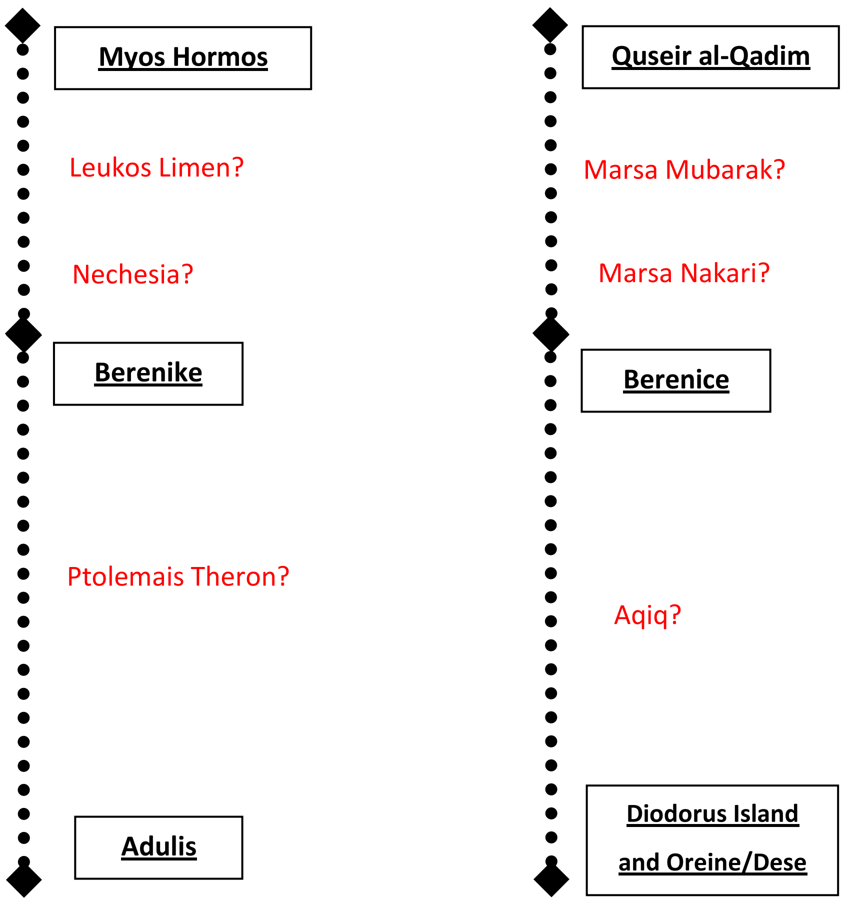
5.5. Known Distances: Distances from Identified Sites

Ancient Name	Modern Name	Ptol. Lat.	Ptol. Long.	Actual Lat.	Actual Long.
Myos Hormos	Quseir al-Qadim	26°45'	64°15'	26°06′	34°17′
Berenike	Berenice	23°50'	64°5'	23°55'	35°30'
Adulis	Diodorus Island and Oreine/Dese	11°40'	67°	15°14'	39°39'

Ancient Name	Ptol. distance (m)	Actual distance (m)	PME distance (s)	PME distance (s*180 = m)
Myos Hormos - Berenike	324800	272000	1800	324000
Berenike - Adulis	1388000	1059000	7000 (4000 + 3000)	126000

Table 5 Using distances from known sites to attempt to identify unknown sites

From the excavated sites, we know that the distance from Quseir al-Qadim (Myos Hormos) to Berenice is exactly 300 km to the north (Peacock & Blue 2006). This is considerably close to the PME's value of 324km, and Ptolemy's value of 324.8km (table5), thus serving as considerably reliable sources to use when analysing distances. Below is a schematic diagram: looking at known sites and probable sites found en-route to try to find their location using known distances (fig.17;see chap.6).



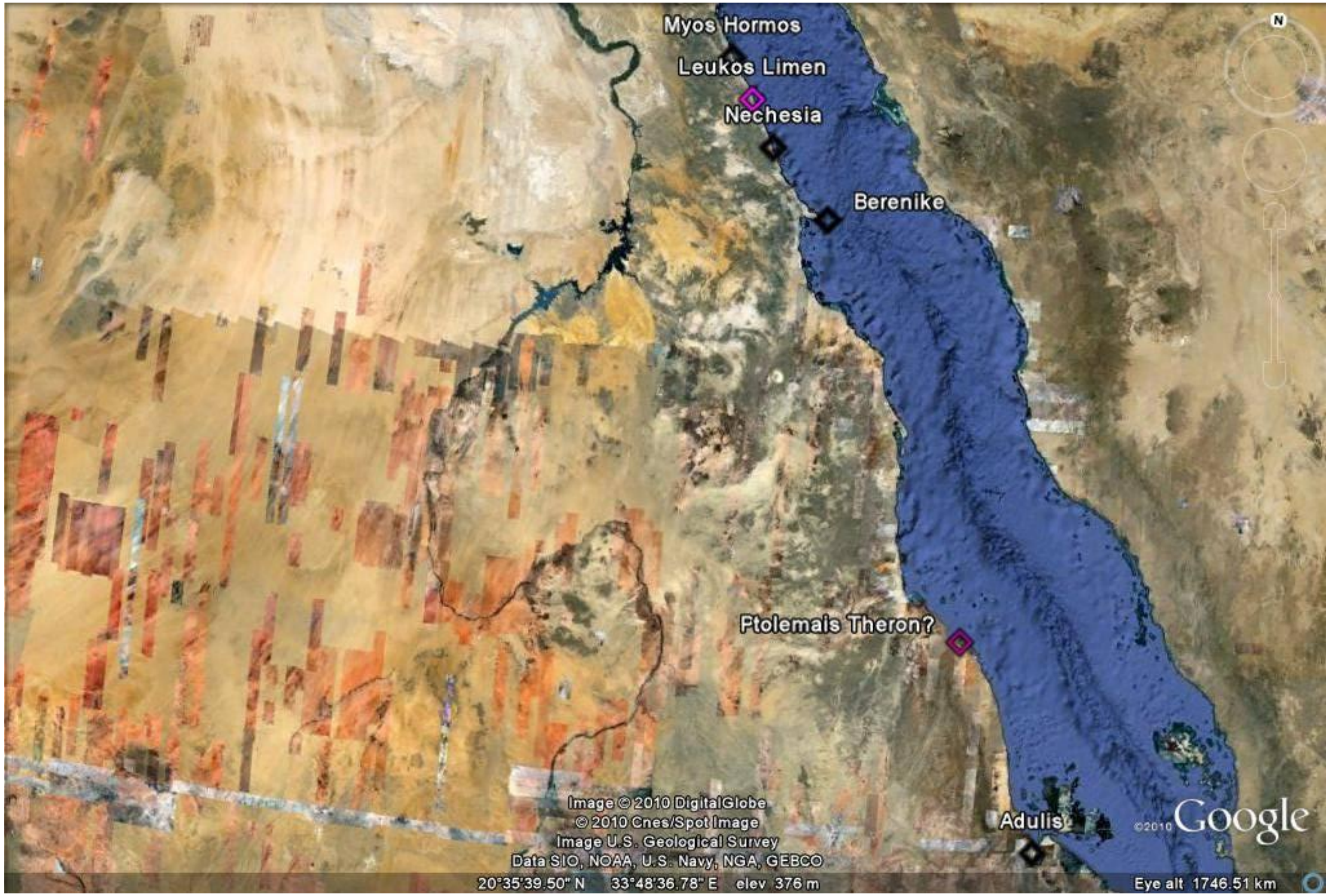


Figure 17 Known (in black) and unknown (in pink) sites along the African Red Sea coast

5.7. Errors and Distortions

To enter all the values into GIS, all the coordinates were converted into decimals using a formula in Microsoft Excel. Maps were created using ArcMap9.3. (fig.) to observe the error differences between Modern and Ptolemy's coordinates and the general shift pattern (fig.18). As can be seen, particularly due to errors in the longitudinal values, Ptolemy's coordinates are all shifted too far east.

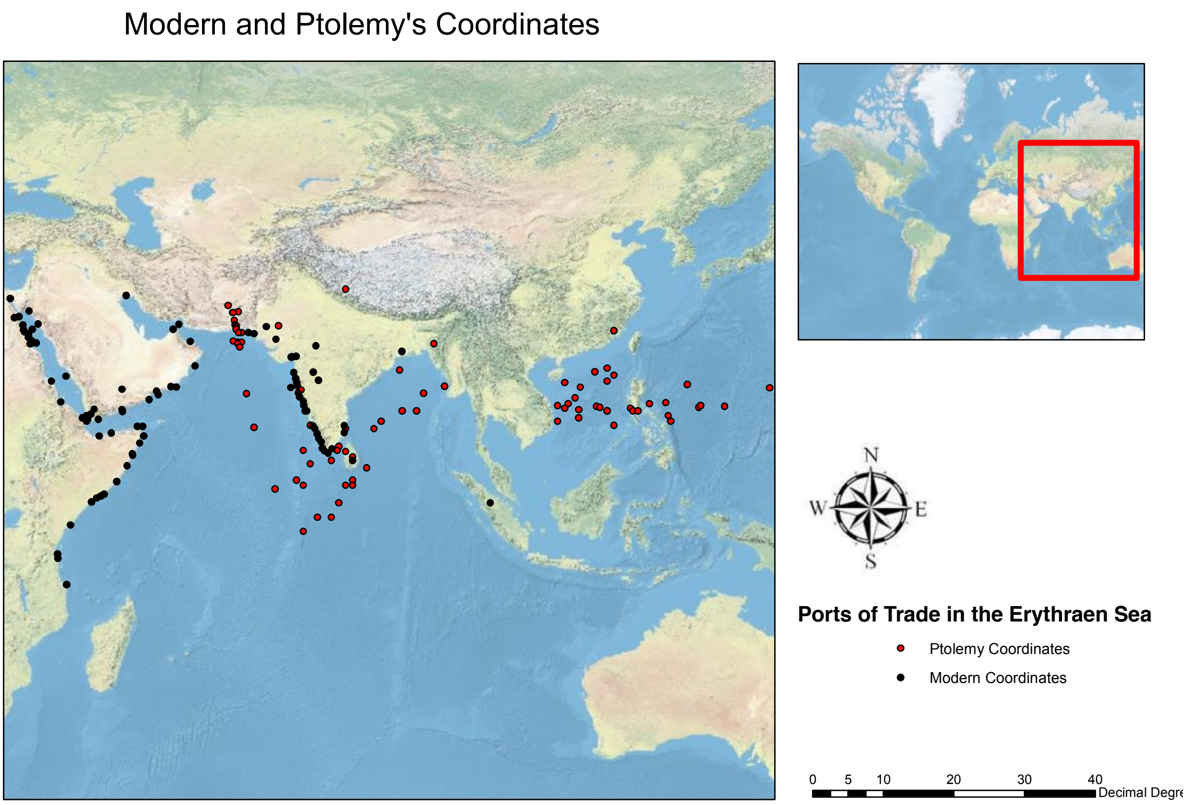


Figure 18 Modern and Ptolemy's coordinates to show the general shift pattern

From the data collected on coordinates, error differences were determined between Ptolemy's latitudinal and longitudinal figures, and the actual values (known and probable). An average error was then calculated using a formula in Microsoft Excel. However, as these values were not constant, dependent on the region, the data was separated into different groups: NW Red Sea Ports (Egyptian coast), SW Red Sea Ports (from Ptolemais Theron down to the Courses of Azania), Rhapta & Islands (including Prasum Promontory), Arabian Ports, and Indian Ports. Hence, figures for average error in the coordinates of each group-region were determined (see appendix 2; fig.19).

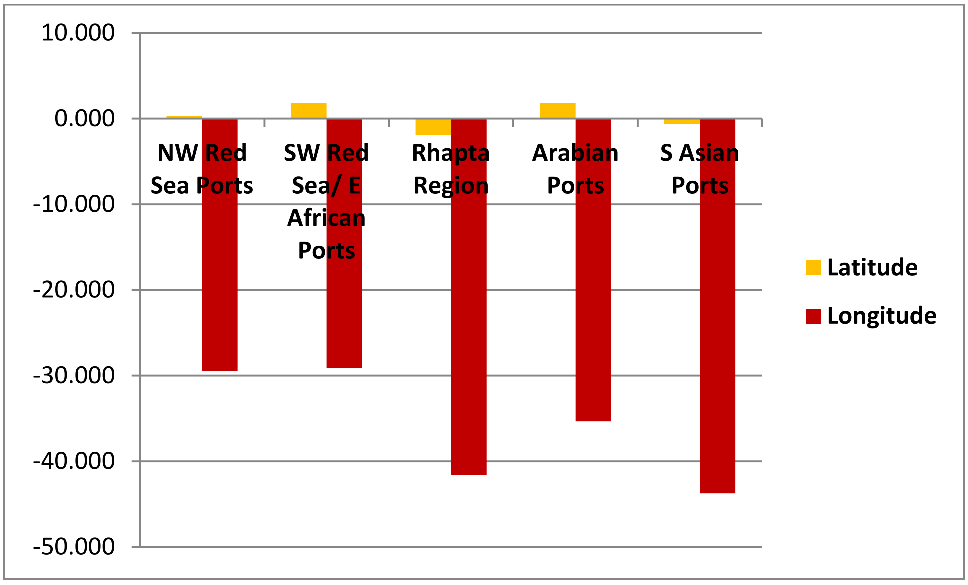


Figure 19 Graph showing the average error difference, divided into group-regions, between Ptolemy's coordinates and Modern coordinates (known and probable)

These results clearly reflect how, as we progress further east or south, the calculated longitudinal values become more distorted and more errors exist, particularly in the region of Rhapta and Southern Asia.

Ptolemy's representation of the Red Sea coasts of his Libye (equating to modern Africa) appears to be the most accurate in comparison to the other regions. To an extent, in making their itineraries, experience and the calculation of the time taken to reach places where food and water could be obtained, must have enabled the traders to give the distances between the different points of their routes with reasonable accuracy.

However, as can be seen, this level of accuracy decreases around the Horn of Africa (Berggren & Jones 2001:22). Furthermore, huge distortions become apparent when dealing with Asia. It seems that the further east one progresses, the more unfamiliar and inaccurate he becomes with his estimations. The clearest distortion is the north-south compression of the Indian subcontinent and the exaggeration of the estimated size of Tabrobane, which equates to modern Sri Lanka (*ibid*).

According to Isaksen (2010), "statistical analysis of the coordinates assigned to localities demonstrates clearly that ostensible precision (whether to the nearest 1/12, 1/6, 1/4, 1/3 or 1/2 degree) varies considerably by region and is locally heterogeneous"(fig.20). All coordinate are assigned to a degree or a fraction of a degree, and there is a complete mixture of levels of precision within the geography. Ptolemy was aware of his limitations, and designed his *Geography* as a living document, encouraging it to be added to, amended and improved as knowledge advanced. However, it is hard to determine where these insertions and accretions occur.

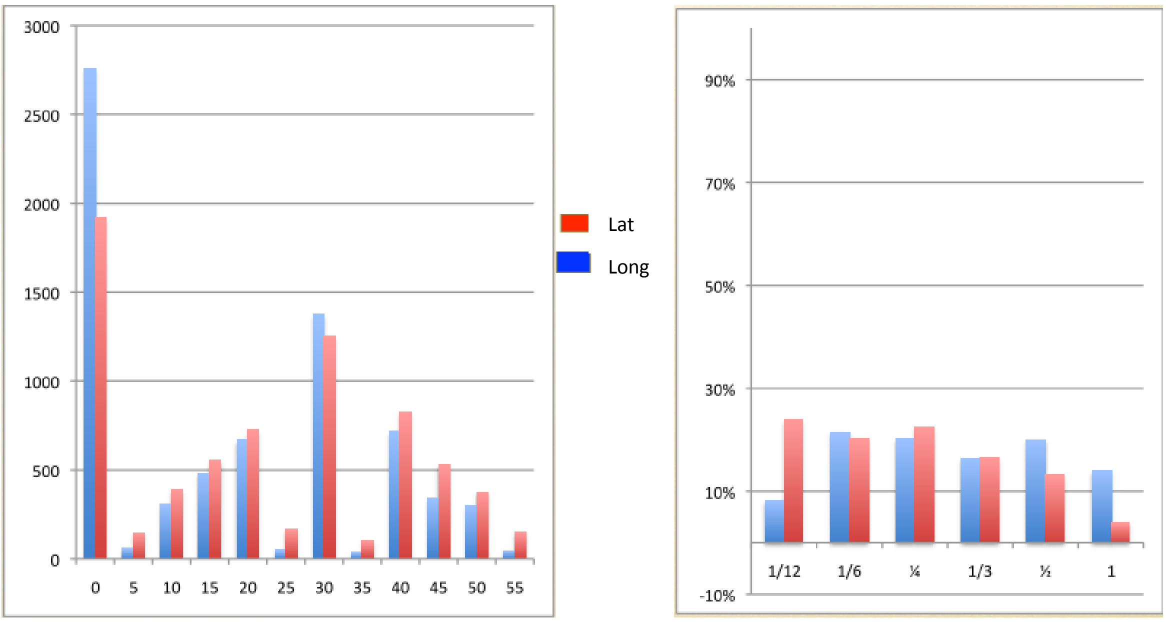


Figure 20 Level of precision of the latitudinal and longitudinal values for the globe in Ptolemy's *Geography* (L. Isaksen 2010 - http://www.digitalclassicist.org/wip/wip2010-01li.pdf)

From the chart it can be observed that the majority of the longitudinal data was allocated to the nearest 1/3 or 1/2 of a degree. Similar observations can be made in relation to the latitudinal values, though they are far less extreme.

Fundamentally, the data analysis based on Ptolemy's coordinates will always be subject to margins of error and subjectivity because the coordinates cannot be corrected by linear or polynomial transformations. Isaksen argues that this is due to the fact that there are mixed levels of precision in the point data, so presumably a point assigned to the nearest twelfth of a degree can be next to a point assigned to the nearest degree, and that Ptolemy constructed the distances for his map from locations 'believed' to be at particular latitudes and longitudes (pers.com. L. Isaksen 2010).

Nonetheless, we do know that some of his data was intended to be considerably precise, even if only relative to other, roughly located sites (Isaksen 2008), and, as long as we are aware of the discrepancies from the outset, it can act as a useful tool for identifying sites and help determine the general region of their location.

Through an in-depth evaluation of all the evidence, known and probable locations have been determined for the ancient harbours and topographical features mentioned in the ancient texts, and their coordinates then integrated into GIS to map the sites of the study-area (see fig.21). In the following chapter, a detailed and focused discussion (restricted to the region of the African shore of the Red Sea and East Africa) will explain how and why these positions were established.

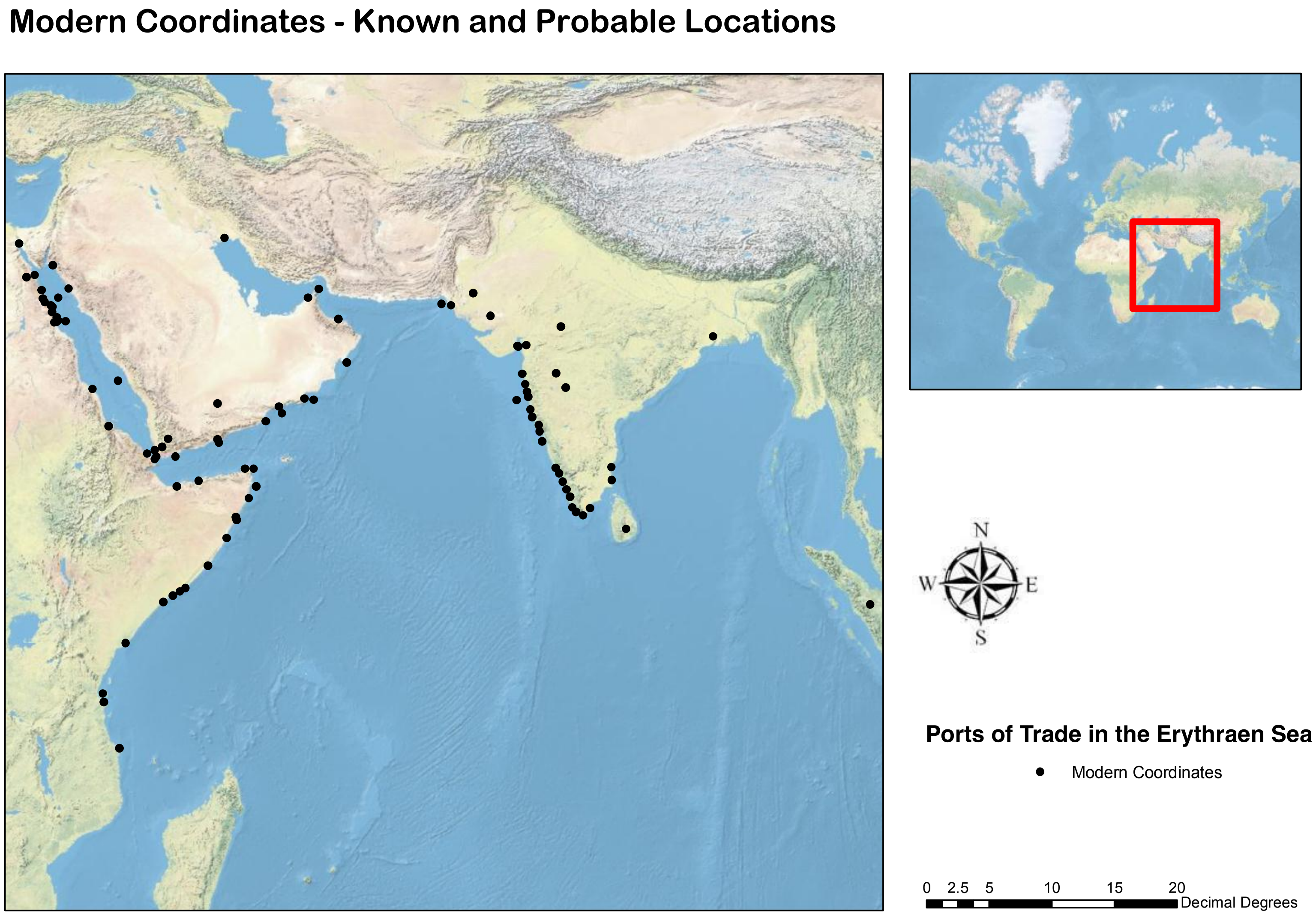


Figure 21 Map showing the modern coordinates of known and probable locations of the ports of trade

CHAPTER 6 – "POSSIBLE SOLUTIONS"

DISCUSSION & SUGGESTIONS

This chapter aims to discuss the sites found en-route along the African Red Sea coast, the Horn of Africa and the coast of Azania (Tanzania) in East Africa. The scope has been restricted to these areas, due to the time constraints and the extensive amount of information available on all ports of Indo-Roman trade. The study will act as an investigative catalogue for known and probable sites, with an assessment of ancient and archaeological sources. Known sites have been only briefly discussed, as the work undertaken on them has already been published. The main discussion will focus on the unidentified sites, to enable an understanding of the general coastal area, their role and nature, and evaluate the available evidence in order to attempt to make reliable suggestions for their probably locations. Furthermore, the study will consider anchorages found along the way, as they too played an important role in this thriving trade.

5.1. ANCHORAGES

The anchorages listed here are those found close to the sites of interest (fig.22), which are grouped together and recommended in modern pilots (e.g. Davies & Morgan 2002). They have been recorded into a database, with their coordinates, descriptions and potential archaeology (see table in appendix C). Natural conditions in the area of the Red Sea, particularly in a coralline environment, mean that there is limited evidence, due to difficult preservation. Nonetheless, these anchorages often possess cairns, wrecks or foundations of settlements, which suggest occupation in the area. Islands and mountains are also listed as they too served as anchorages and/or landmarks. The best anchorages are likely to be included in Ptolemy's *Geography*, and he probably recorded them as people would have perceived the coast as a series of anchorage nodes where they could stop to re-supply.

There is a need to investigate the approaches to key anchorages, islands and mountains en-route, even if they were simply used as stopping-points for water and food, as this will undoubtedly add to our knowledge of trade.

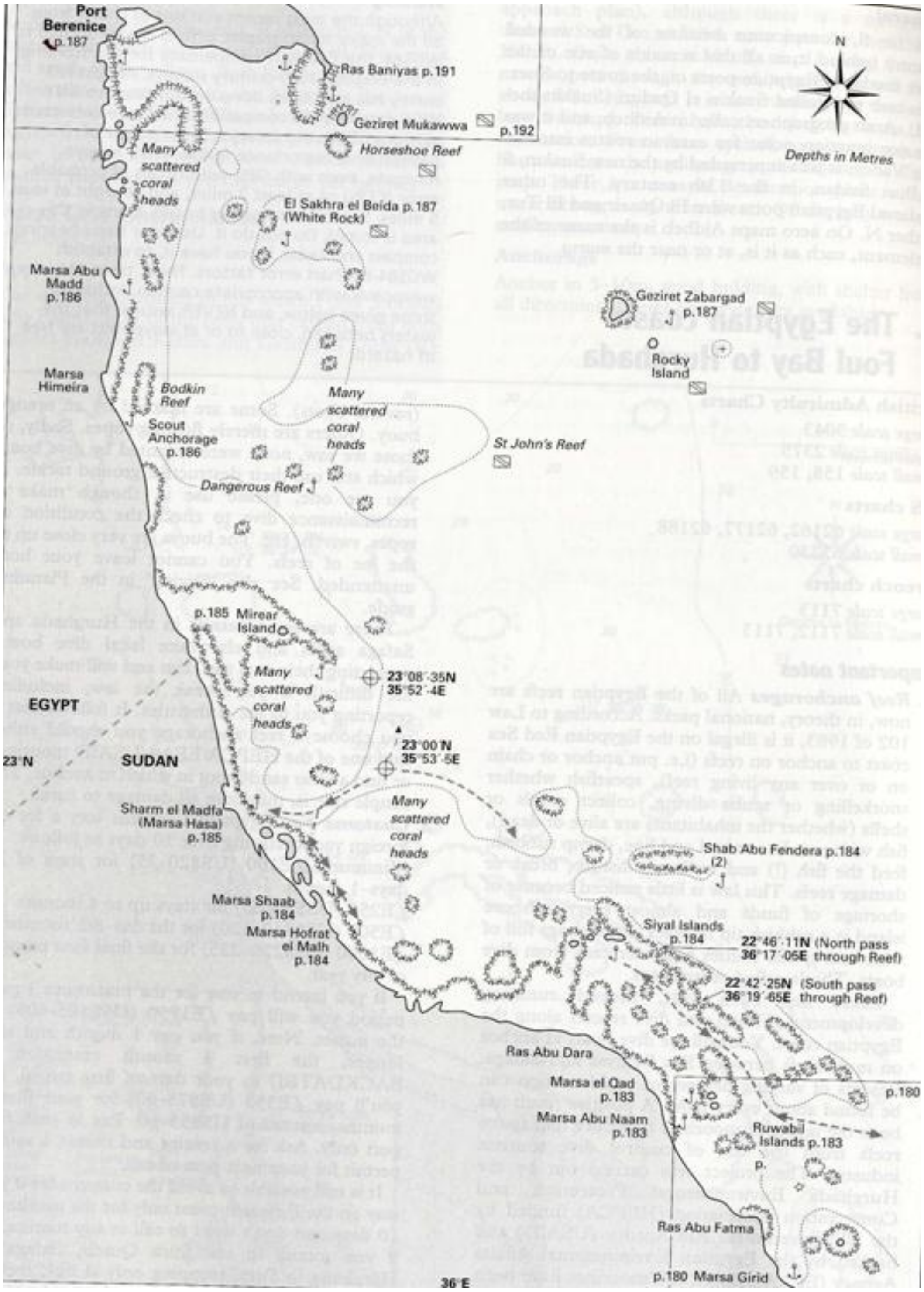


Figure 22 Chart showing Foul Bay anchorages - from Marsa Girid to Ras Banas

(Red Sea Pilot 2002:182)

5.2. KNOWN AND PROBABLE LOCATIONS

"RED SEA PORTS"

The major emporia along the Red Sea coast were Arsinoe/Clysma (Suez), Myos Hormos (Quseir al-Qadim) and Berenike (Berenice) in Egypt; Ptolemais Theron (Aqiq?) in Sudan; and Adulis (Island of Diodorus and Oreine/Dese) in Eritrea (fig.23). In the 1930s, Clysma was excavated (Bruyère 1966), whereas Ptolemais Theron's location is yet to be identified. The other three ports have recently been archaeologically investigated and their exact location has been identified (Peacock & Peacock 2007:32).

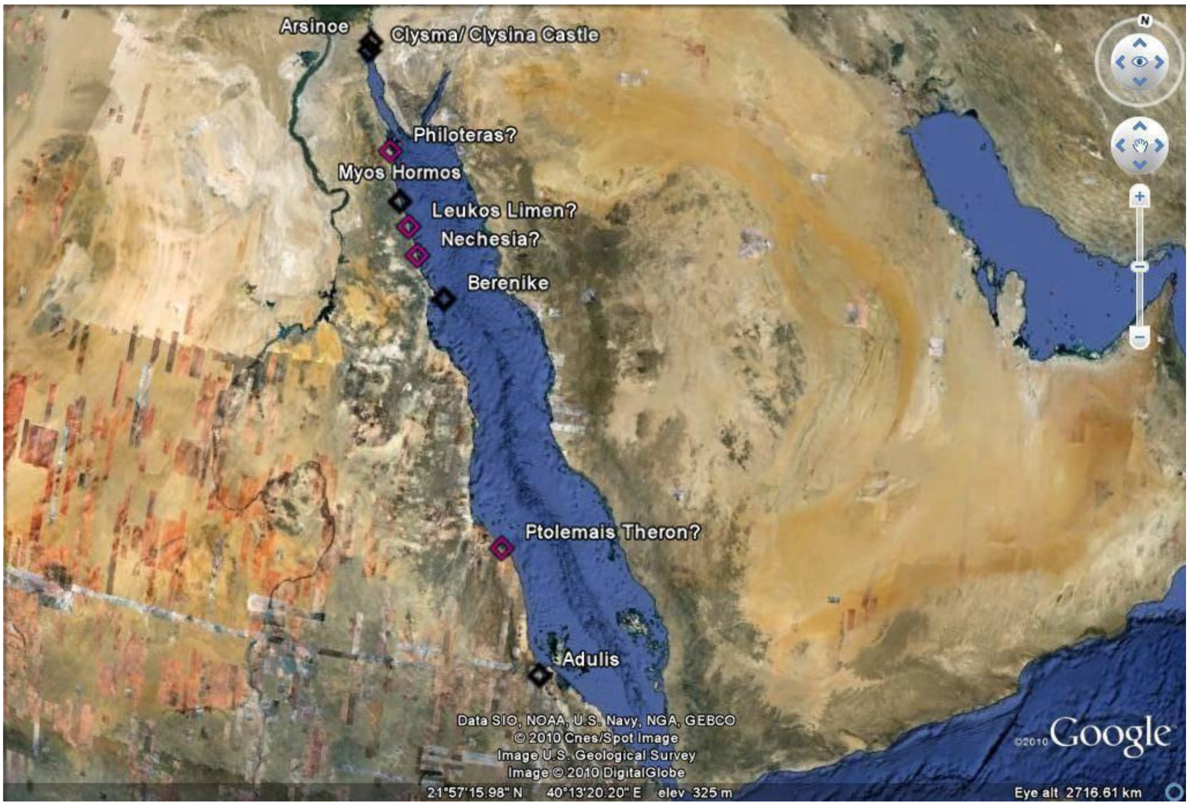


Figure 23 Identified (in black) and unidentified (pink) sites along the African Red Sea coast from Arsinoe/ Clysma to Adulis

ARSINOE/CLYSMA

Known location: Suez, Egypt

The place known as Arsinoe and Clysma (al-Qulzum in Arabic) is located in modern Suez, Egypt. The ancient port infrastructure associated with the canal mouth at Suez – Roman Clysma, Arab al-Qulzu – was surveyed and recorded by Bourdon in the 1920s, revealing extensive structures, comprising major concrete quay structures, and a putative lock system at the canal mouth (Cooper 200?:203-204;fig.24). In antiquity, this port played a considerable role in the Red Sea-Indian Ocean trade (Facey 2004:7; Lindsay 2006: 101). The products from the East African trade were taken to one of the three major Roman ports on the Red Sea: Arsinoe, Berenike or Myos Hormos (O'Leary 2001:72). Over-time, Arsinoe was overshadowed by the rising importance of Myos Hormos. (Freeman 2003:72). The site was partially excavated in the 1930s by French archaeologists (Sidebotham et al. 2008:158; see Bruyère 1966). However, much of the port side has been lost to development (Cooper 2009:204).

Despite the seasonality of the canal, which was essentially out of sync with India's trade (Cooper 2009:205), this ancient port played an important role in Red Sea maritime activity and ships did sail this far north up the Gulf of Suez (pers.com. L.Blue 2010). However, Cooper suggests that the port of Clysma/al-Qulzum was essentially involved in a more localised nature of trade within the Red Sea, perhaps with a military-strategic dimension (2009:205). This is a site that requires further excavation (pers.com. L. Blue 2010).

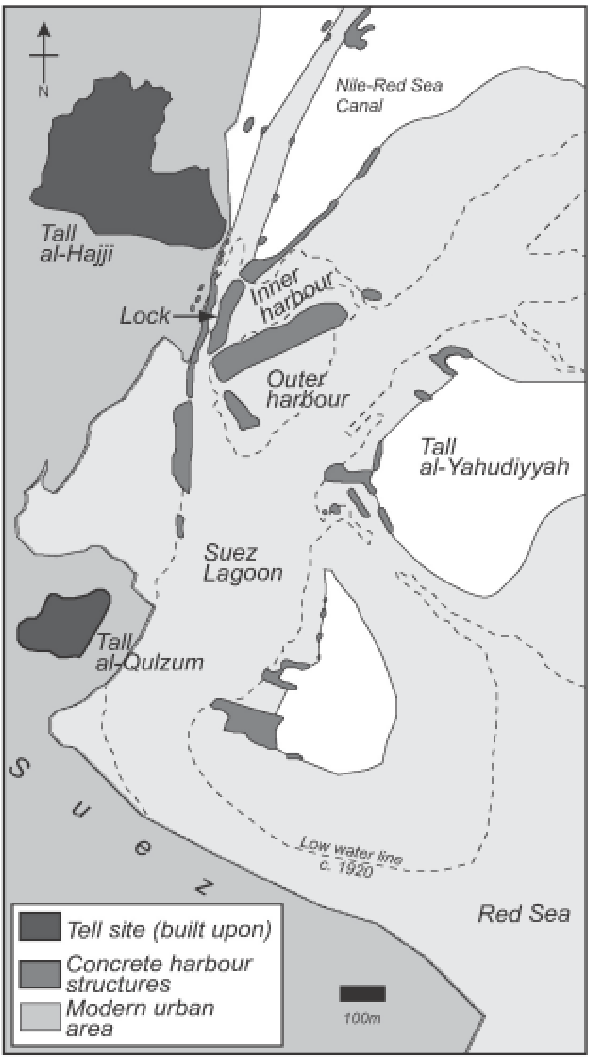


Figure 24 Remains of canal mouth and harbour at Suez as recorded by Bourdon 1925 (Cooper 2009:203)

PHILOTERAS

Possible location: Wadi Safaga, Wadi Gawasis, or Abu Shar at el-Gouna

Favoured location: Wadi Safaga, Egypt

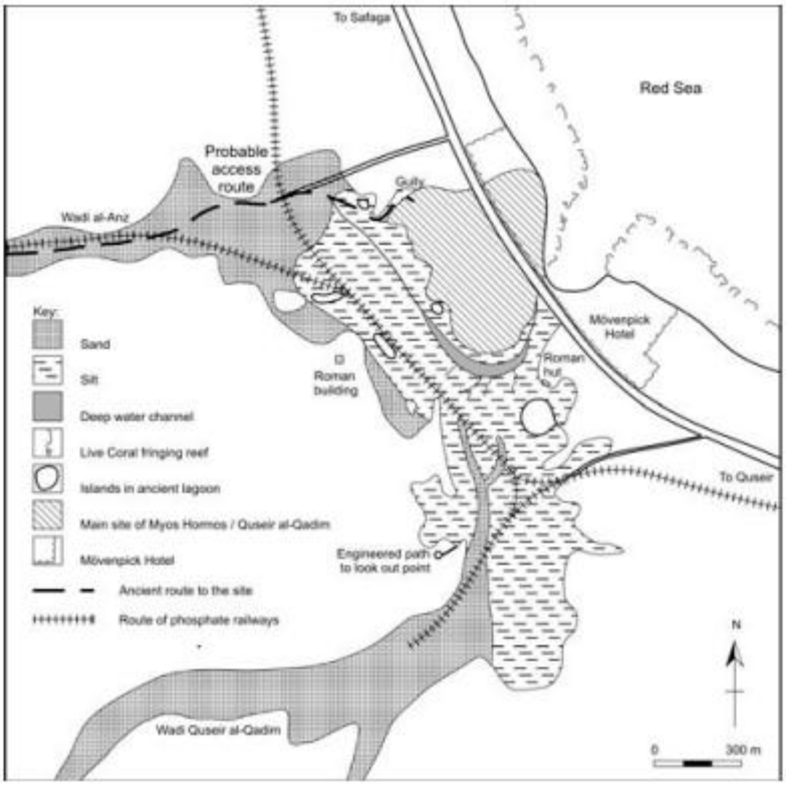
Philoteras, named after the sister of Ptolemy II, was an official Ptolemaic foundation (Bard 1999:835-836; Sidebotham et al. 2008:168), which was likely active into the Roman times. It is reported in ancient texts such as Ptolemy, Strabo and Pliny. The identification of this port is uncertain. Possible suggestions are Wadi Safaga, Wadi Gawasis, or Abu Shar at el-Gouna. However, the majority of archaeologists and scholars favour its location in the vicinity of the modern port of Safaga (Sidebotham 2008:168).

MYOS HORMOS:

Known location: Quseir al-Qadim, Egypt

Quseir al-Qadim is around 8 km north of the modern town of Quseir. As a result of recent work (see Peacock & Blue 2006), it has been established that the ancient settlement was silted on a peninsula, formed by a coral reef running north-south, which enclosed to the west a lagoon, which was linked to the sea by a narrow channel to the south of the settlement (fig.25). Both the lagoon and the channel are now silted up. Excavations have revealed substantial evidence of harbour installations in the lagoon, and port is thought to have been active from the Ptolemaic period to around the third century AD, when it was abandoned (*ibid*:136; see also Blue 2007; Whitewright 2007; Sidebotham et al. 2008).

Figure 25 *Above:* Aerial photograph showing the view of Quseir al-Qadim and the silted lagoon taken from the north of the site; *Below:* site-plan of Quseir al-Qadim (in Blue 2007:2)



LEUKOS LIMEN/ ALBUS PORTUS («White Harbour»)

Possible locations: Marsa Mubarak

Favoured: Marsa Mubarak, Egypt

It was previously thought to equate to the modern site of Quseir al-Qadim. However, recent archaeological investigations undertaken by the University of Southampton have proven Quseir al-Qadim to in fact equate to the ancient port-town of Myos Hormos (Peacock & Blue 2006).

Data from Ancient Sources: Leukos Limen is known in Latin as 'Albus Portus', which means 'White Harbour'. Ptolemy's is the only attestation of this port, but mentions nothing of its foundation (Sidebotham 1986:53). He places this ancient port between Myos Hormos and Nechesia (Sidebotham et al. 2008:168).

Strabo does not include Leukos Limen in his list of Red Sea ports, which could imply that the port was not active in his day, and was founded at a later stage.

Leukos Limen played a far smaller role in comparison to its larger neighbouring port-towns, Myos Hormos and Berenike. Although it did not have the best natural harbour, its primary advantage lay in the fact that it was "the terminus of the shortest route from the Nile valley emporium of Coptos" (Sidebotham 1986:57).

Data from archaeological investigation: Important finds, such as the Tiberian graffiti on the Coptos-Quseir road, have provided a valuable insight into governmental organisation in the area. The graffiti primarily lists the names of Roman troops, which seems to imply the government's involvement in the facilitation and supervision of Rome's trade within the Erythraean Sea region. This route was significant in the transportation of commodities exchanged between Coptos, Leukos Limen and the Arabian and Indian ports served by Leukos Limen (Sidebotham 1955).

Figure 26 Suggested location for Leukos Limen at Marsa Mubarak, Egypt

A survey of the region between Marsa Nakari and Berenike revealed a number of ephemeral sites, such as cairns, burials, settlements and shell middens along the coast (Sidebotham 2002). Reports of cairns and middens in the Port Ghalib (a developed harbour previously known as Marsa Imbarak) area were in some cases associated with Roman and late Roman pottery, but it is in the region of Marsa Mubarak (25^0.32'N, 34^0.38".5'E), south of Port Ghalib that more substantial evidence of a Roman port have been noticed (pers.com. R. Thomas, discussing in progress research; fig.26). Red Sea pilots have reported the presence of white ruined buildings on the North of Marsa Mubarak also noticed on old geological maps (Davies & Morgan 1995; Morgan & Davies 2002), now a military area and partially covered with a halted hotel development. Roman pottery and white stone walls have been observed in-situ, with pottery found as far north as the Three Corners Hotel (just to the north), but require further and future investigation (pers.com. R. Thomas). Interestingly there are limestone/marble quarries in Wadis Imbarak and Mubarak (Floyer 1893), as well as natural outcrops of gypsum in the area, building materials most likely used in this settlement, that may explain the naming of Leuke Kome (or "white village"). The distance of this Roman settlement placed next to this useful anchorage, from Quseir al-Qadim (Myos Hormos), matches the distance stated in Ptolemy's Geography, strongly suggesting this was Leukos Limen.

NECHESIA

Possible locations: Marsa Nakari

Favoured: Marsa Nakari, Egypt

Nechesia, an ancient port-town recorded in Ptolemy's *Geography,* is thought to equate to the modern site of Marsa Nakari, in the south of Egypt, around 19 km south of Marsa 'Alam, along the Red Sea coast (fig.27&28). From pottery evidence, it is known that the port-town was active during the Roman period (*ca.* 30 BC - 600 AD) (Sidebotham et al. 2008).

Figure 27 Marsa Nakari (http://www.barnard.nl/desert/nakari.html)

Data from Ancient Sources: As with Leukos Limen, the only ancient source which mentions this ancient port is Ptolemy in his *Geography.*

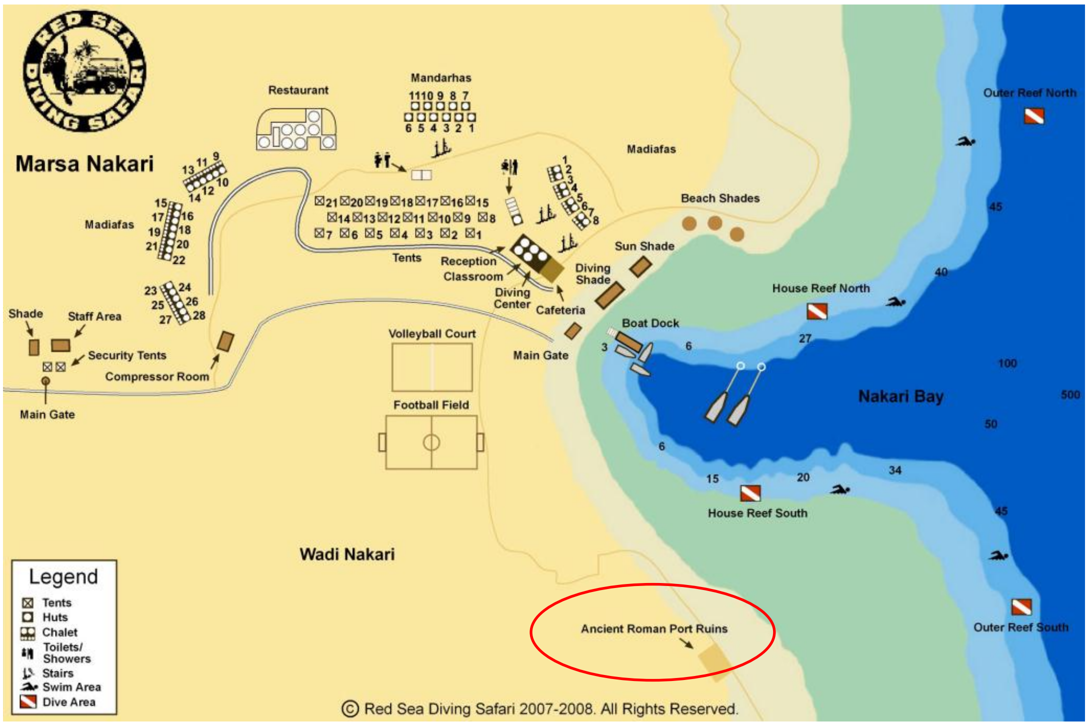


Figure 28 Map of Marsa Nakari (http://www.redsea-divingsafari.com/media/media_docs/Nakari%20Map.pdf)

Data from archaeological investigation: It is generally agreed that the ancient port-town of Nechesia equates to modern Marsa Nakari, on the Red Sea coast at 24^0.52’N, 35^0.01’E (Seeger et al. 2006). Marsa Nakari is a low bluff by the sea, with two inlets on either side, forming a natural harbour. At the site there are outlines of buildings and walls in the sands, and extensive ruins have been found on the south side of the site (*ibid*:77). Ruins have also been discovered on the hill to the south of Nakari. Moreover, around four or five looted graves have been located and excavated by Seeger on an island in Nakari, as well as graves west of the site on the highway.

Before recent excavations, several earlier travellers visited the site and their observations strengthen the positioning of Nechesia at Marsa Nakari. Wilkinson (1835) considered Nechesia to equate to Marsa Nakari. Murray (1925) was open to the suggestion that these ruins could be linked to Nechesia, though he favoured Marsa Mubarak. Meredith (1953) agreed that Marsa Nakari was potentially Nechesia. Recently, excavations were undertaken in 1999, 2001, and 2002, led by Seeger, from Northern Arizona University. Evidence for early and Roman activity was found at the site (fig.29). Archaeological surveys have also been undertaken by Sidebotham et al. in 1977 and 2000, yielding evidence for an ancient road which connected Marsa Nakari to Edfu (ancient Apollonopolis Magna), with several stations along the way dating from Ptolemaic times and later. Thus, trade was clearly active in the area during that time.

Figure 29 Pottery Sherd (3rd-6th century AD) - http://www.barnard.nl/EDWdata/75EDW75.html - Marsa Nakari Project, late Roman deposit in the center of town

BERENIKE

Known location: Berenice (Umm el-Khetef), Egypt

Berenike is located in Berenice, in Egypt, approximately 300 km (200 m) east of Aswan and 800 km (500 m) south of Suez (fig.30). More specifically, it is on the west coast of the Red Sea, in the Bay of Umm-el-Ketef, just south of the large peninsula Ras Banas (Lepte Acra?).

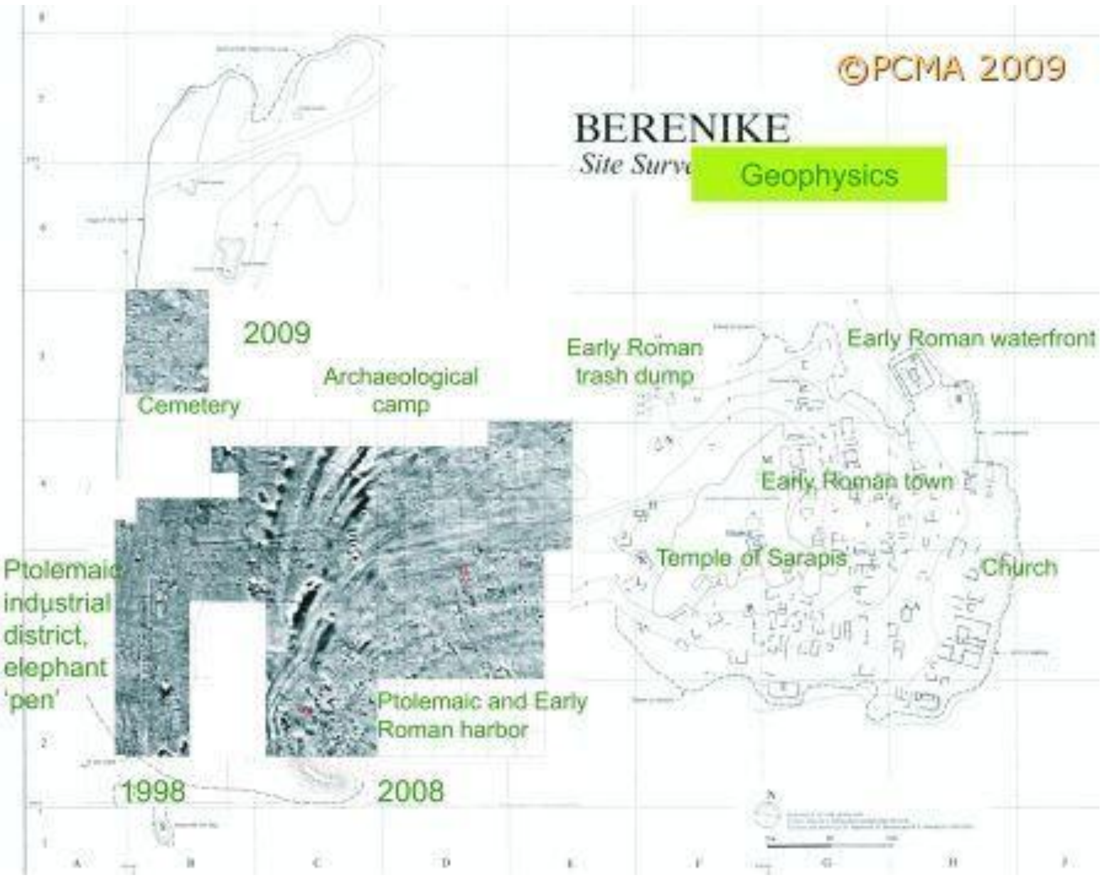


Figure 30 Survey Plan of the Site (2000) showing superimposed magnetic map: combined results of geophysical prospection in 1998, 2008, and 2009 (after Berenike Project archives and T. Herbich)
http://www.centrumarcheologii.uw.edu.pl/index.php?id=253&L=0

The Berenike Project is a multi-disciplinary archaeological research project studying the remains of Berenike, the most important harbour on the Red Sea coast between the third century BC and the sixth century AD. From here trade was conducted, in Ptolemaic and Roman times, between Rome, Alexandria, Arabia Felix, the East African coast and the Indian sub-continent. It has been excavated extensively by a Dutch-American team (Sidebotham & Wendrich, 1994-2001), and more recently by a Polish – American team in 2008 and 2009 (http://www.archbase.com/berenike/english1.html).

The majority of the structures at Berenike were constructed using semi-fossilised coral and are now covered by wind-blown sand. The site is situated on a headland with a silted lagoon to the south of the town, which would have been the ancient harbour of Berenike (Peacock & Blue:135; fig.31&32).

Figure 31 Headland with silted lagoon, where the ancient harbour was located http://www.barnard.nl/desert/berenike.html

Figure 32 Ruins at the site of Berenike, on the Red Sea shore http://www.archbase.com/berenike/english4.html

Figure 33 An assortment of ostraka recovered from a trash-dump, in Greek and Latin writing, which consisted of receipts for potable water for the Roman garrison; and a wooden stylus for writing http://www.centrumarcheologii.uw.edu.pl/index.php?id=253&L=0

PTOLEMAIS THERON

Possible locations: Aqiq, Suakin, Marsa Maqdam, Trinkitat

Favoured: Aqiq, Sudan

The exact location of the ancient port of Ptolemais Theron has not yet been determined, but strong indications seem to point more towards the vicinity of Suakin and Aqiq (McGrail 2004:52; Huntingford 1980). Other suggested locations include Marsa Maqdam and Trinkitat. The generally accepted position for Ptolemais Theron is the region of Aqiq (fig.34), in Sudan, due to Crowfoot's findings of Graeco-Roman moulding embedded in a later structure (Casson 1989:101; Bustein 1989). This site was later re-examined in 2004 and briefly in 2006 (Seeger et al. 2006), and then visited by Blue in 2007 (pers.comm. L. Blue:2010).

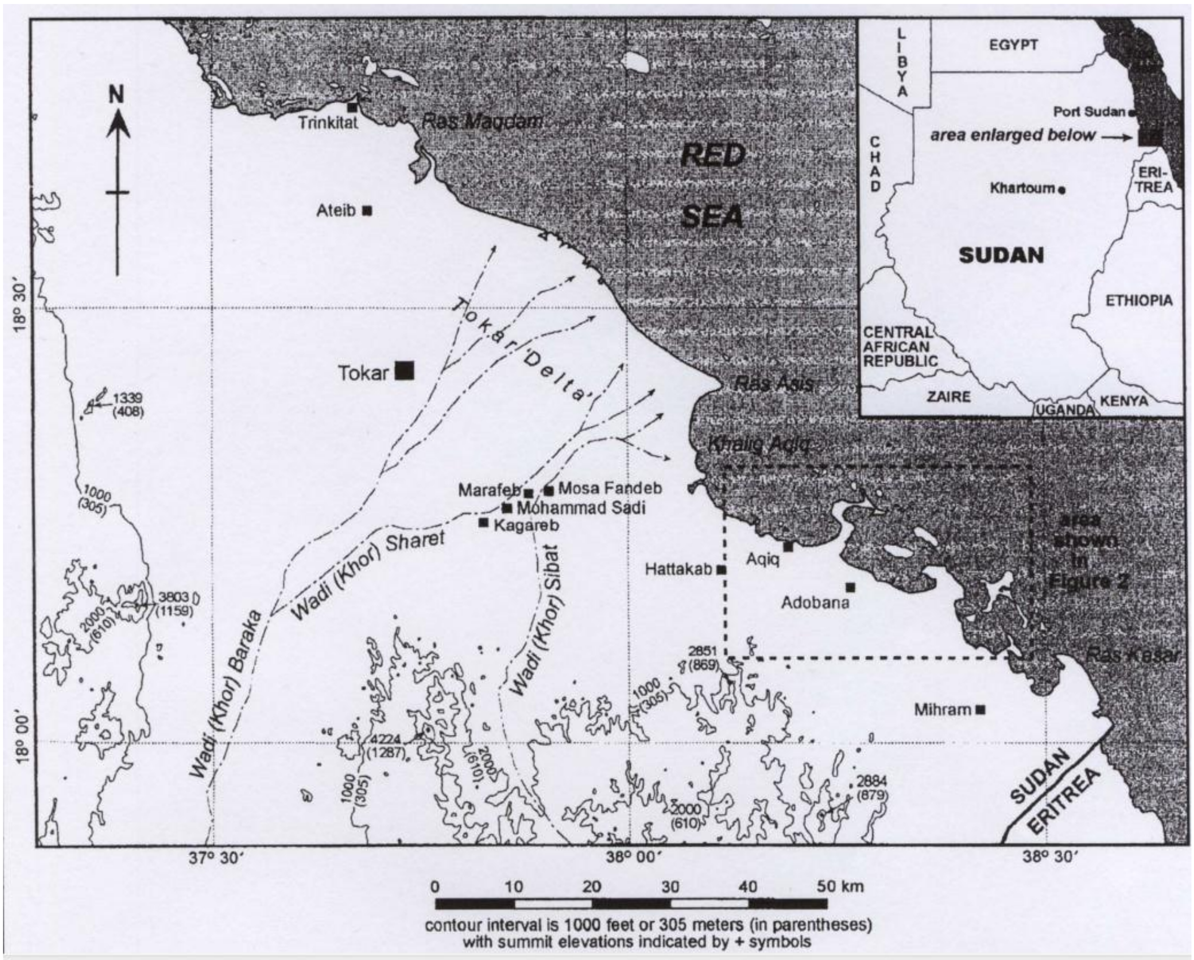


Figure 34 Map showing regions of Aqiq and Adobana (Seeger et al. 2006:8)

Data from Ancient Sources: The PME (Casson 1989:51) informs us that Ptolemais Theron was located 4000 stades from Berenike and 4000 stades north of Adulis. Assuming the length of a stade to be 180 m, 4000 stades would be 720 km. If we measure on google earth, it leads to the bay of Aqiq.

Strabo (*Geog.*16.4.7), informs us that this port served as an elephant-hunting station used by Eumedes, who was sent there by Ptolemy II Philadelphus (286-246 BC), King of Ptolemaic Egypt, and that is was only one of a series of similar elephant-hunting stations along the Red Sea coast of Africa. Other ancient authors, such as the PME and Agatharchides (5.86a) also describe it as a place where elephant-hunting took place. Pliny (N.H. 6.168) notes that Ptolemais was close to Lake Monoleus. In addition, Strabo describes the region, "secretly enclosed a kind of peninsula with a ditch and a wall..." (*Geog.*16.4.7). Therefore, the site was doubtless on a peninsula. However, by the time of the PME, it appears to have declined in importance, as it is described as having "no harbor, and can only be reached by small boats" (ch.3). By then it was a source of ivory and tortoise shell rather than elephants. However, it would have been impossible to load elephants onto small boats so the implication is that the harbour had silted up and it might be even more silted today. In other words we should look for a peninsula and adjacent silted harbour.

Data from archaeological investigation: The Pithom Stele is a Ptolemaic inscription which was discovered in the Egyptian Nile Delta and is linked with Ptolemy II's Nile-Red Sea canal constructing in the region. It places the date of the foundation of Ptolemais Theron between 270 and 264BC (Sidebotham et al. 2008:167). Moreover, the stele mentions other daily activities at the port in addition to elephant-hunting, such as cultivating the hinterland and animal husbandary (Naville 1885:18,line24).

The majority of scholars position Ptolemais Theron in the region between approximately 18˚ and 19˚ North latitude (Desanges 1978:273-274; Seeger et al. 2006:9). Several travellers have observed and analysed the area, which include Reil (1869:370-371), Crowfoot (1911:529-534), Hibbert (1935,1936) and de Monfreid (1974:102-110) (cf.Casson 1989:101). Ancient remains of structures, i.e. standing stones and graves, were observed at or in the vicinity of Aqiq.

A likely location within the Aqiq region is positioned at 18˚11'18.38"N, 38˚21'58.86"E (Peacock & Blue 2007:136). Through satellite images, a peninsula with a unique signature can be observed, giving the appearance of blocks, which could potentially be house foundations. It is not likely to be a natural feature, as it is not consistent in the nearby landscape. Beside these possible foundations is what might potentially have been silting along the coast (fig.35). Considerable landscape change has taken place in this area, as can be observed below. The system of fossilised sand dunes supports the argument for progradation and dune advancement within the region.

Figure 35 Photographs of the region of Aqiq, showing siltation, progradation and dune advancement (Photos by L. Blue)

Locating the site and studying material from it would shed valuable new light on the origins of trade with the east and improve our limited understanding of Ptolemaic material culture in the Red Sea region. The role it played en-route to India is not stated in ancient sources, though it is generally described as a hunting-station. However, Strabo (*Geog.* 2.5.12) mentions that a small number of ships sailed to India to bring back commodities. It seems likely that such vessels would stop at Ptolemais Theron, even if just for water and supplies.

Recently, fluted column fragments have been found on Bahdur (or Ibn Abbas) Island, which is situated in the *khor* Nwarat, approximately 15 km offshore, near the village of Aqiq (http://www.barnard.nl/desert/ptolemais.html; de Monfreid 1974:102-108; Seeger et al. 2006), and, thus, the survey boundary was expanded to include adjacent islands, which were found to preserve evidence for architectural remains and ancient activity (*ibid*:14). The survey also revealed a concentration of architectural remains (e.g. walls built of ashlars, and fluted columns) at the modern village of Adobana (18o10.72'N/38o15.90'E). Looking at Google Earth, it appears to be limited to the coastal 500 m, where a colour change to brown sediment can be observed. The column fragments (fig.36) possibly represent an extramural building, such as a rural temple, or may have come from Ptolemais Theron.

Figure 36 Ashlers and fluted columns found at the modern village of Adobana (Photos by L. Blue)

From the evidence at hand, it is likely that Ptolemais Theron may have been positioned in this region of Aqiq. However, it is 3 km inland from the Red Sea coast and there is no sign of a fossil peninsula showing on the satellite image. However, this could be as a result of a combination of tectonic activity, the rise of the relative sea-level (RSL) and processes of erosion, as “it is situated on an alluvial plain that is subject to occasional wadi floods. Large quantities of water-borne sediments have covered most of the area, undoubtedly burying many ancient remains there” (*ibid*:11).

ADULIS

Known location: Diodorus Island & Oreine/ Dese, Eritrea

The port of Adulis was one of the major ports in antiquity, and is best known for its role in Aksumite trade (fourth - seventh centuries AD). This is portrayed in the work of Cosmas Indicopleustes, ‘*Christian* Topography’, which contains a sketch-map of Adulis a short distance from the coast, and linked with Aksum (Wolska-Conus 1968). However, it also played a major role during the first century AD in the Red Sea-Indian Ocean trade, and was described as a “legally limited port” in the PME (PME 4; Casson 1989). It offered a good harbour en-route to India and was a source for luxuries (e.g. ivory, tortoiseshell and rhinoceros horn). The location of the ancient port of Adulis has recently been identified (see Peacock & Blue 2006), in the Bay of Zula on the western shore of the southern Red Sea, around 7 km from the coast and connected to the sea by the wadi bed of the River Haddas, which is now dry (*ibid:*39). This indicates coastal change in the area. The fieldwork revealed the two harbours of Diodorus Island and Oreine. The weather conditions were favourable here, and when they worsened, vessels would anchor in the lee of the the adjacent Galala Hills. This shifted to the offshore island of Diodorus following raids from the mainland. Moreover, Oreine offered an ideal lagoonal harbour and an nearby settlement in the centrally located valley of Dese (*ibid:*137).

The East African coast is situated within the monsoon wind zone, of the western Indian Ocean, which can facilitate and restrict movement along the coast depending on direction force and currents. There were several ports along the coast.

“FAR-SIDE PORTS"

The PME describes the ports along the coasts of modern Djibouti and Somalia, which includes Somaliland, and denominates them the “far-side ports”(fig.37). This relates to the other side of the straits (i.e. Bab el-Mandeb), to the south of the Red Sea stretch. These ports are also mentioned by Ptolemy.

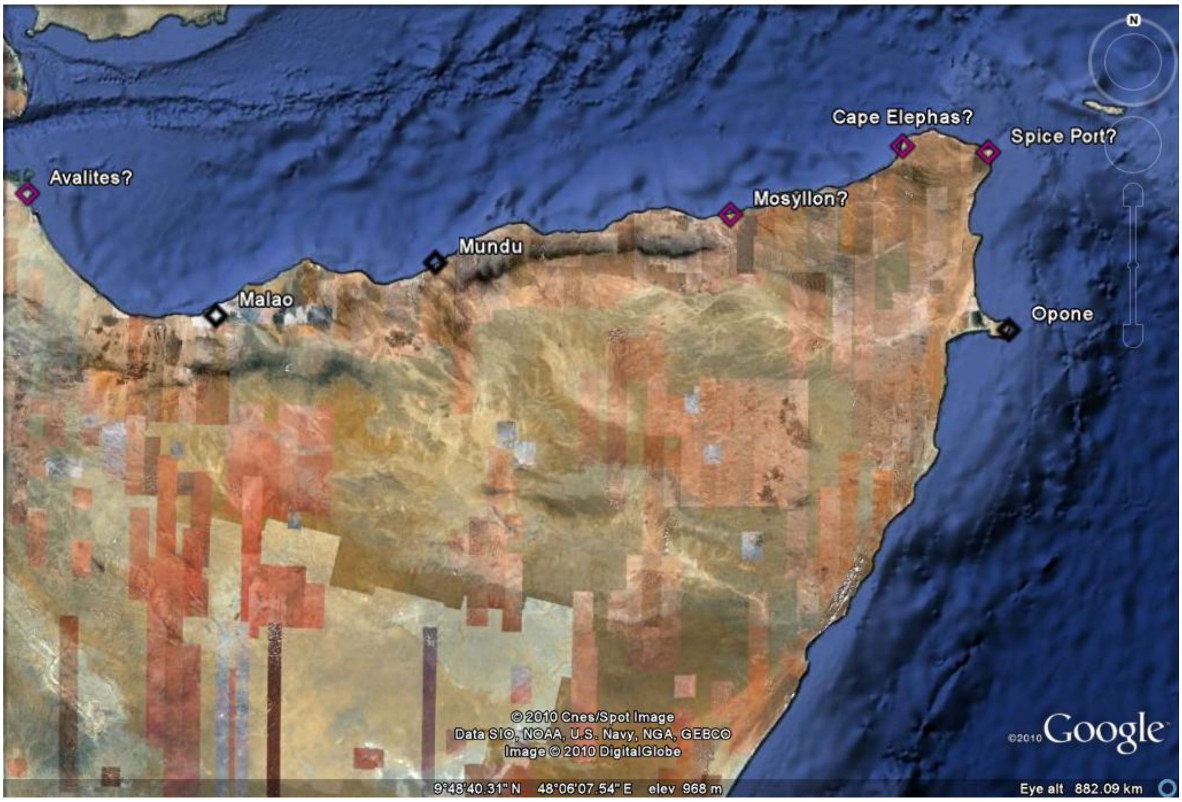


Figure 37 Map showing the "Far-Side Ports" along the Horn of Africa

[http://www.reliefweb.int/mapc/afr_ne/reg/hornofafrica.html:2009 - accessed:08/10]

AVALITES

Possible locations: Assab, Saylac/Zeila

Favoured: Saylac/ Zeila, Somaliland

Avalites is the first of the “far-side ports”. A suggested location for Avalites is at the modern port of Assab, just north of the strait Bab el Mandeb, in Eritrea (McGrail 2004:52; Sprenger 1857:329), as the PME(5-7) describes it as being in the narrowest point between Africa and Arabia. It has a good harbour, but the distance does not equate with the information given in the PME. Rather, the evidence at hand appears to point more favourably towards Saylac/Zeila, in Somaliland.

Data from Ancient Sources: The PME(5) states that, from Adulis, "After about 800 hundred stadia comes another, very deep, bay near whose mouth, on the right, a great amount of sand has accumulated; under this, deeply buried, obsidian is found, a natural local creation in that spot alone". Then from this deep bay to Avalites: “By now the Arabian Gulf (Red Sea) trends eastward and at Avalites is at its narrowest. After about 4000 stades on an eastward heading along the same coast, come the rest of the ports of trade of the Barbaroi, those called “far-side”, lying in a row and offering, by way of anchorages and roadsteads, suitable mooring when the occasion calls. The first is called Avalites; at it the crossing from Arabia to the other side is shortest. At this place there is a small port of trade, namely Avalites, where rafts and small craft put in(...)” (PME 7). Therefore, the total given distance from Adulis to Avalites is 4800 stades. If using the calculated value in chapter 5 (stade=c.180), then the distance between Adulis and Avalites was approximately 864 km.

Saylac or Zeila has been suggested as a possible location for Avalites (Pankhurst 2004; Peacock & Blue 2007). It is positioned 800 km from Adulis. The port of Malao was said to be 800 stades from Avalites (144 km). This port is universally accepted as equating to modern Berbera (Fabricius 1883:124; Schoff 1995:79). The distance from Assab to Berbera is approximately 400 km (around 2,000 stades). Conversely, the distance from Zeila to Berbera is approximately 200 km (around 1,000 stades). Based on these figures, Zeila appears to be more favourable. As Avalites is said to have been the first of the "far-side"’ ports, it seems plausible to locate it in Somaliland. This argument is strengthened “if we assume that the author was referring, not to the narrows of the Bab el Mandeb, but to the narrowest point of crossing the Gulf of Aden to Arabia" (Peacock & Blue 2006:139). Ptolemy (4.7) positions Avalites "after the strait in the Red Sea" (Stevenson 1932:107). Moreover, its ancient name is conserved by the village Abalit, situated on the north shore of the bay. (Schoff 1912).

Data from archaeological investigations: No related archaeological remains have been discovered at Saylac/Zeila. However, a bay (fig.38), which is currently silted, exists and may have been a harbour during the Roman period. More archaeological investigations are needed in the regions of Saylac/Zeila. A brief survey in 2003-4 in this region, and Assab, found no evidence of pots, so there is need for a more systematic and detailed survey of these sites (pers. comm. L. Blue:2010). The port of Zeila was where much of the trade between Arabia and the Gulf of Aden was conducted (Pankhurst 2004:20). Medieval authors, such as Ibn Hwqat, the Arab geographer, describe Zeila as a point of embarkation for Christian Abyssinian slaves who were taken across the Red Sea to the great Yemeni slave depot at Zabid (*ibid*).

Figure 38 Silted bay at Saylac, Somaliland

Another possibility is at Saad al-Diin (fig.39), approximately 6 km north of Saylac, where Curle (1937) recorded an Islamic settlement. Beneath these Islamic remains, could potentially be remains dating to the Roman period, which would imply that Avalites had been located on an island (Peacock & Blue 2007:138).

Figure 39 Island of Saad al-Diin as a possible suggestion for Avalites (Curle 1937; Peacock & Blue 2007)

MALAO

Known location: Berbera, Somaliland

Malao (PME 8) has been identified with considerable certainty at modern Berbera, on the Somalian coast (Fabricius 1883:124; Schoff 1995:79), due to the author's description of the harbour as "sheltered by a promontory extending out from the east", which conforms exactly to the promontory at Berbera (Schoff 1912:79; Casson 1989:120; fig.40).

Figure 40 Promontory of Berbera, Somaliland

MUNDU

Known location: Bandar Heis, Somaliland

Mundu (PME 9) has been identified with the modern site of Heis (Xiis), in Somalia (Chittick 1979; Casson 1989:122; Desanges 1993:16-17; Schoff 1995:81). This identification is primarily based on the evidence of sherds of Roman pottery and glass found in the area (Chittick 1979), and the description of vessels mooring safely on an "island that lies very near the shore" (PME 9).

Figure 41 Bandar Heis, Somaliland

MOSYLLON

Possible locations: Bandar Cassim, Elayu, Candala, Ras Antarah

Favoured: Bandar Cassim, Somaliland, Horn of Africa

Data from ancient sources: The text from the PME does not provide detailed enough clues in its description to help in locating the site, other than distances mentioned from Mundu (Heis), as heading eastward, "after two, perhaps three, runs near a promontory (...) on a beach with a poor harbor" (PME 10), and from there, heading westward, after a two-run journey we reach Cape Elephas (Ras Filuch?).

In relation to the extent of trade, Mosyllon possibly played the most significant role amongst the "far-side ports", particularly in the frankincense trade, as the PME 10 states that larger ships were employed there due to the amounts of cassia available (Seland 2010:40). The favoured suggestion is at Bandar Cassim (Schoff 1912:81; Casson 1989:127), which measured on Google Earth lies c.138 nautical miles east of Heis and c.88 n.m. west of Ras Filuch, and fits relatively well with the distances provided in the text. Other possibilities are Elayu, c.123 n.m. from Heis and c.104 n.m. from Ras Filuch (assuming Mosyllon was closer to Mundu), or Candala, c.181 n.m. from Heis and c.46 n.m. from Ras Filuch (assuming it was closer to Cape Elephas). It has also been placed at the promontory Ras Hantara. Moreover, Mosyllon is described as only providing a beach with poor anchorage, which fits well with all aforementioned locations, and the general topography of the region (see fig.42).

Data from archaeological investigations: Work has been undertaken at a port-side east of Heis on the northern-coast, where a vast assemblage of different types of cairns was excavated (Chittick 1977b:5). No occupation site was revealed, but one of the two small cairns revealed fragments of Roman glass (dating from around the 4th century A.D.). Other artefacts include high-quality mille fiori glass, which support the wealth of the incense trade. Dates range from 1st to 5th century A.D. It is thought that this site could perhaps equate to the PME's ancient port of Mosyllon (*ibid*).

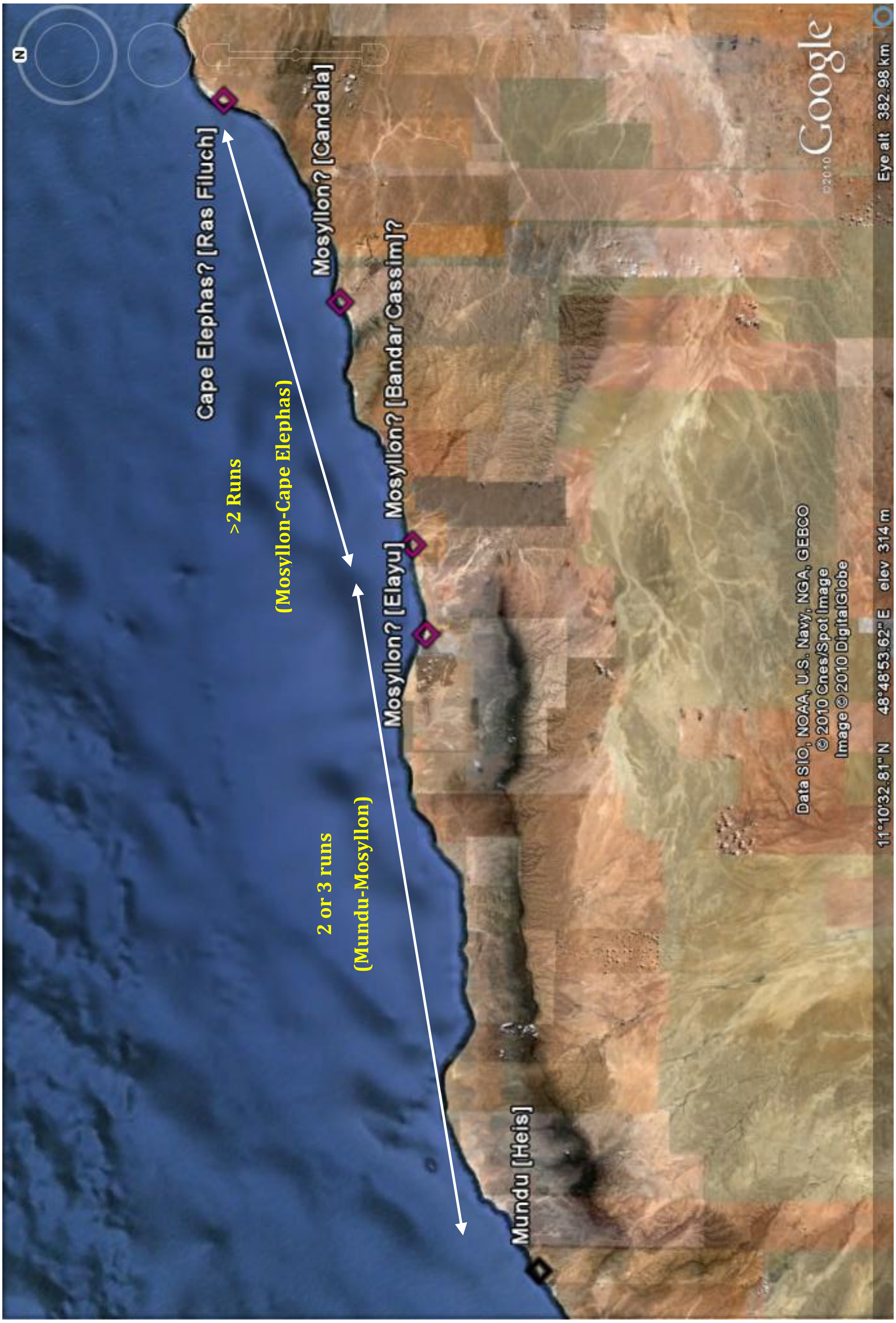


Figure 42 Attempting to locate Mosyllon showing distance travelled (in runs) in the PME

CAPE ELEPHAS

Possible locations: Ras Filuch

Favoured: Ras Filuch/ El-Fil, Somalia

Data from ancient sources: As aforementioned, after sailing over 2 runs eastward along the coast from Mosyllon, we reach "the so-called Neiloptolemaiu, Tapatege, a small laurel grove, Cape Elephas" (PME 11). This must equate to Ras Filuch, on the Horn of Africa (Casson 1989:127-128), with a promontory, as the name indicates, of an elephant-like shape (as can be clearly seen in fig.43). This is not only its ancient name, but also in its modern one, as *fil* means "elephant". Strabo (16.774) also reports similar features along this part of the coast, such as "a river land [*potamia*] called Neilos", "Laurel Harbour (*limên*)"and "Elephas, the mountain that juts into the sea", as well as stating that frankincense is one of the natural items produced in the region. It is listed in Ptolemy's *Geography* as Elephas Mountains (Ptol. 7.7).

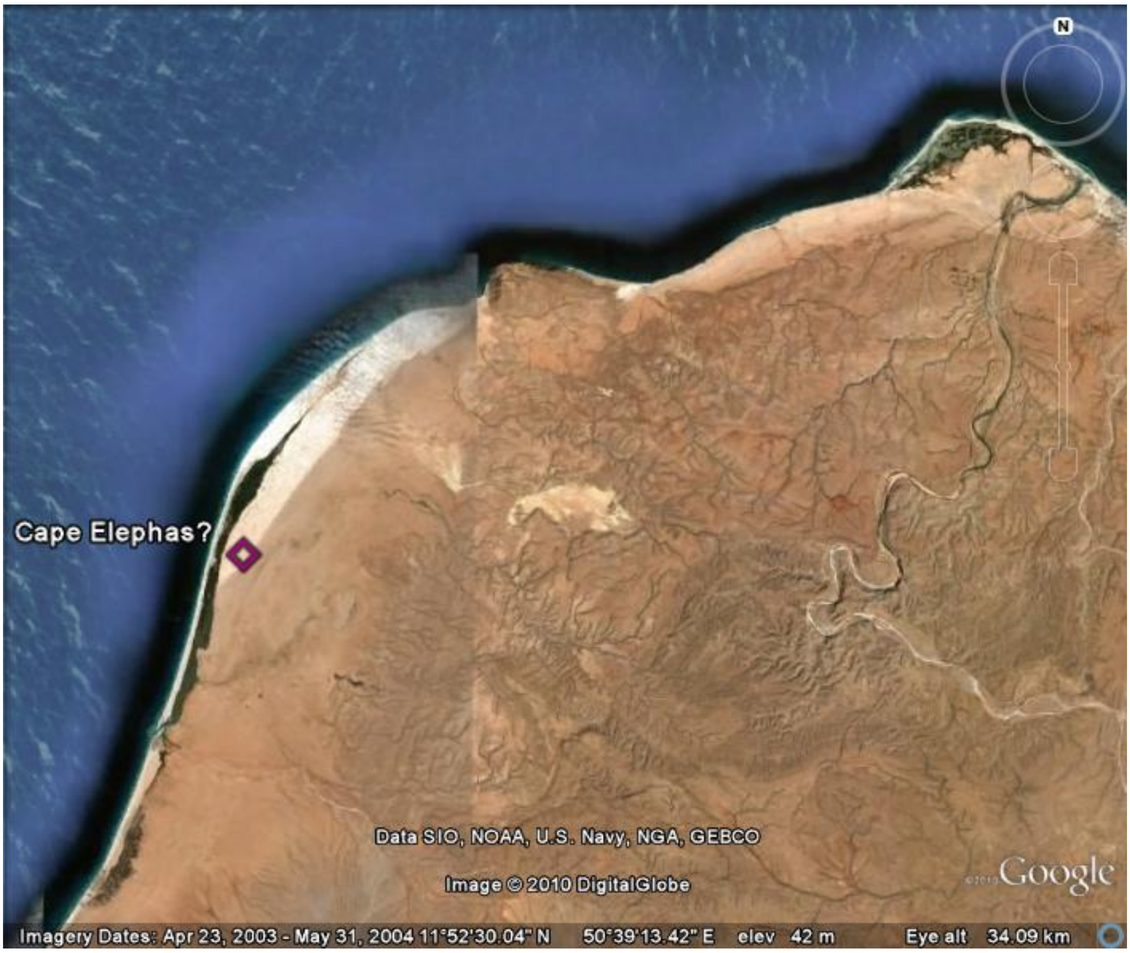


Figure 43 Probable location of Cape Elephas at Ras Filuch, Somalia

SPICE PORT & TABAI

Possible locations: Cape Guardafui - Chori Hordio,Ras Shenaghef,Guardafui,Tohen

Favoured: Cape Guardafui (Spice Port) & Chori Hordio (Tabai), Somalia

The location of the Spice Port (*Aromaton Emporion*) remains unidentified. However, it is believed to be located at Cape Guardafui, now called Ras Asir, on the eastern edge of the Horn of Africa (Desanges 1978:83-84; Casson 1989:129; fig.44). This seems the most likely location, based on ancient descriptions, the modern geography, and local archaeological finds.

Data from ancient sources: Beyond Cape Elephas, "with the coast by now trending to the south, is the Spice Port and a promontory, the last along the coast of the country of the Barbaroi towards the east, a precipitous one. The harbour, an open roadstead, is dangerous at times, because the site is exposed to the north. A local indication of a coming storm is when the depths become rather turbid and change color; when this happens, all take refuge at the big promontory, a site that offers shelter, called Tabai. The port of trade [i.e. Spice Port] likewise offers a market for the aforementioned" (PME 12). Cape Guardafui was where Strabo's and Pliny's knowledge of eastern Africa ended, described as the last promontory of this coast (cf.Bunbury ii 63,429,551; Casson 1989:129). It is also listed in Ptolemy's *Geograph* (Ptol. 4.7.3) as Aromata promontory and emporium.

Figure 44 The Spice Port remains unidentified, and could possibly be located at Cape Guardafui

Data from archaeological investigations: Fragments of ungrazed pottery have been discovered at the modern village of Damo (fig.45), approximately three miles west of Cape Guardafui and believed to be of Roman origin (Chittick 1976:124, 1981:188; Chittick 1979:275). Moreover, the harbour is exposed to the north, yet sheltered from the winds from the south, as can be observed below.

Figure 45 Modern village of Damo, Somalia

The promontory called Tabai is also mentioned in the PME. The Spice Port and Tabai must have been located considerably close to each other, for quick refuge during storm. According to Casson (1986), the PME supplies certain clues, "it is a large promontory, this promontory is located on the route from the Spice Port and Guardafui to Ras Hafun [Opone] some 400 stades before Ras Hafun" (*ibid*:181). The fact they were seeking refuge gives another clue. This would have been related to an outbound voyage southward, which can only be achieved during the north-east monsoon (Casson 1980:27-29), so protection would have to be against winds from the north. Based on these observations, Guillain (1859:99-100 in Casson 1980:181) suggested a port on a bay called Chori Hordio, north of Ras Hafun. Recent investigations conducted by Chittick (1976) have revealed ancient remains (e.g. pottery from the third and second century BC), hence confirming Guillain's claim.

OPONE

Known location: Ras Hafun, Somalia (universal agreement)

The location for Opone (fig.46) is universally accepted to be the in Ras Hafun, which descends from its ancient form (see Chittick 1977a, 1979; Smith & Wright 1988). It is on a peninsula that "justs out prominently some 85 nautical miles south of Guardafui" (Casson 1986:180), with an excellent harbour on the southern shore. The earliest archaeological evidence for trade on the East African coast has been found at this site, such as ancient pottery of Egyptian, Roman and Persian origin, spanning from the first century BC to the fourth century AD.

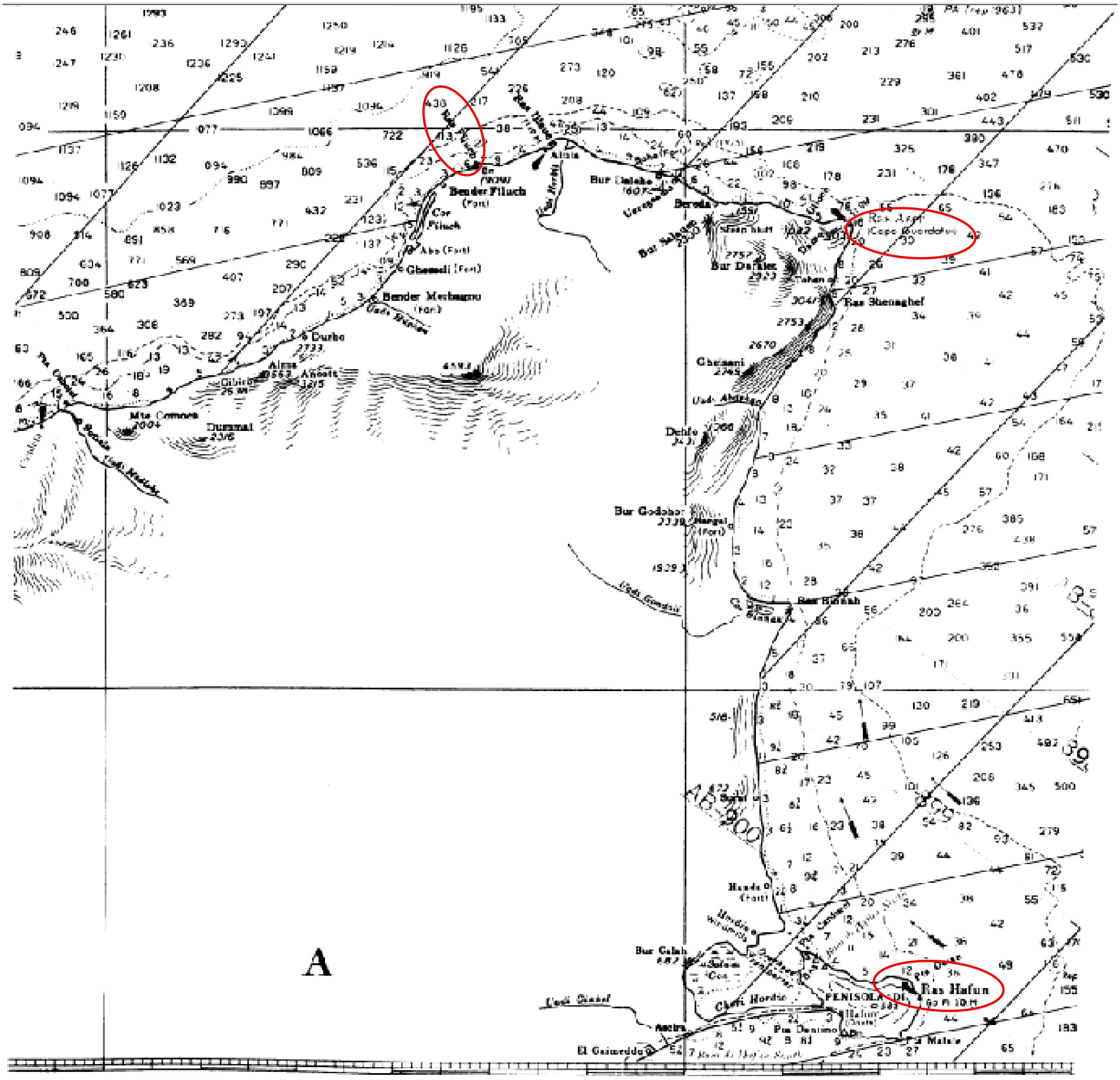


Figure 46 The Horn of Africa - showing Ras Filuch on the top left, Ras Asir/Cape Guardafui on the top right, and Ras Hafun on the bottom right [from U.S. Defense Mapping Agency, Hydrographic/Topographic, Chart No. 620000 (in Casson 1986:18)]

“PORTS OF AZANIA”

Beyond Opone (Ras Hafun), the entire Eastern African coast down to Rhapta (Rufiji Delta, in Tanzania) is called "Azania" (fig.47) and belongs as colony to the Yemenite merged kingdom of Saba (Sheba) and Himyar. The distinction between the ‘Other Berberia’/'Far-Side Ports' and Azania is very clear political distinction.

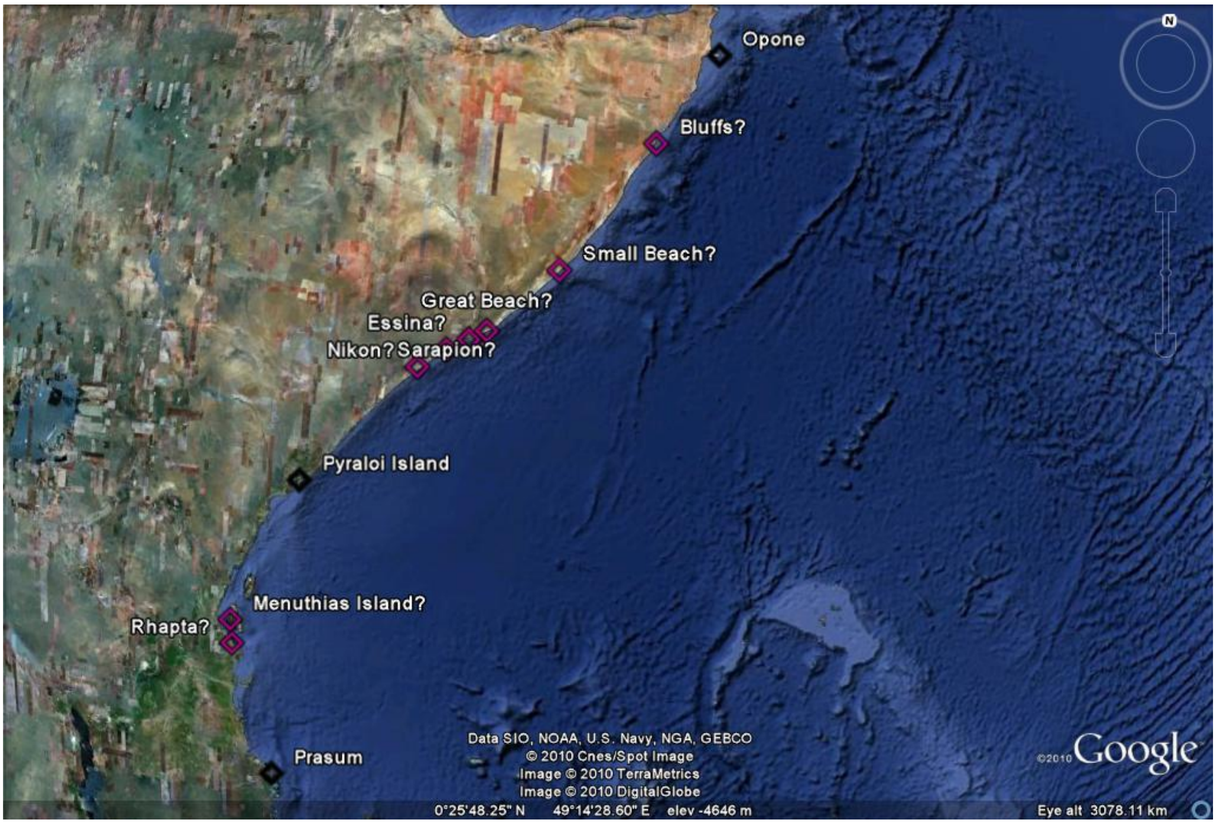


Figure 47 Map showing the Ports of Azania - from Ras Hafun to Cape Delgado

SMALL AND GREAT BLUFFS

Possible locations: El Hazin coast: Ras Hafun to El Fosc, or Ras Hafun to Ras el Khayl

Favoured: Has Hafun to El Fosc, Somalia, E. Africa

Data from Ancient Sources: These are described in the PME 15, "beyond Opone, with the coast trending more to the south, first come what are called the Small and Great Bluffs of Azania..., six runs by now due southwest", and equate to Ptolemy's Apocopa.

Data from archaeological investigations: According to Schoff (1912), the bluffs of Azania equate to the rocky coast known as El Hazin (fig.48), ending at Ras el Khayl (7°44'N, 49°52'E). Based on first-hand observations, Guillain (in Casson 1989:136-137) positions the Bluffs between Ras Mabber, 9°28'N, 50°51'E, and Ras el-Khayl. In contrast, also based on first-hand observations, Chittick (1976:120) argues that the Small and Great Bluffs begin at Ras Hafun [Opone] and stretch southwards to El Foc, 7°10'N, south of Ras el-Khayl. Both agree on the general area and describe the rocky coast, with steep cliffs plunging into the sea (i.e. the 'bluffs').

Figure 48 The Bluffs (El Hazin Coast)

SMALL AND GREAT BEACHES

Possible locations Sif el Tauil coast**:** from El Fosc to Warsheikh, or to Ras Aswad

Favoured: from El Fosc to Warsheikh, Somalia, E. Africa

Data from Ancient Sources: Following the Bluffs, come "the Small and Great Beaches for another six [runs]" (PME 15). They are listed by Ptolemy (4.7). Schoff (1912) equates to the beaches to Sif et-Taouil coast, ending at Ras Aswad (4°30'N, 47°55'E). Guillain (in Casson 1989:137) locates the Beaches between Ras el-Khayl and just slightly north of Ras M'routi (i.e. one degree short of Warsheik, 2°18'N, 45°48'E). He describes the great coast known as Sif et-Taouil. In contrast, Chittick (1976:120) claims it to extend from El Fosc until Warsheik itself. From Ras Hafun to Warsheik, the total distance is c.600 nautical miles, which fits well with the ancient accounts (Casson 1989:137;fig.49).

COURSES OF AZANIA (Essina, Sarapion, Nikon)

Possible locations: Mogdashu, Merka, Warsheik, Barawa or Gonderscia

Favoured: Mogdashu (Essina), Merka (Sarapion), Barawa (Nikon), Somalia, E. Africa

Data from Ancient Sources: These, according to Schoff (1912), are the strips of desert coast below the equator. The topography as described in the ancient texts seems to fit with the African coastline (fig.49). The Arabs divide it into two parts, Barr Zanj, preserving its ancient name, and Banadir, i.e. 'coast of harbours' (Freeman-Greville 1962:4; Chittick 1976:18-20). Suggestions for Sarapion are Merka, Warsheik or Modgdishu (though it is possible that Essina is Modgdishu) and for Nikon are Barawa or Gonderscia (see Casson 1989:138-139).

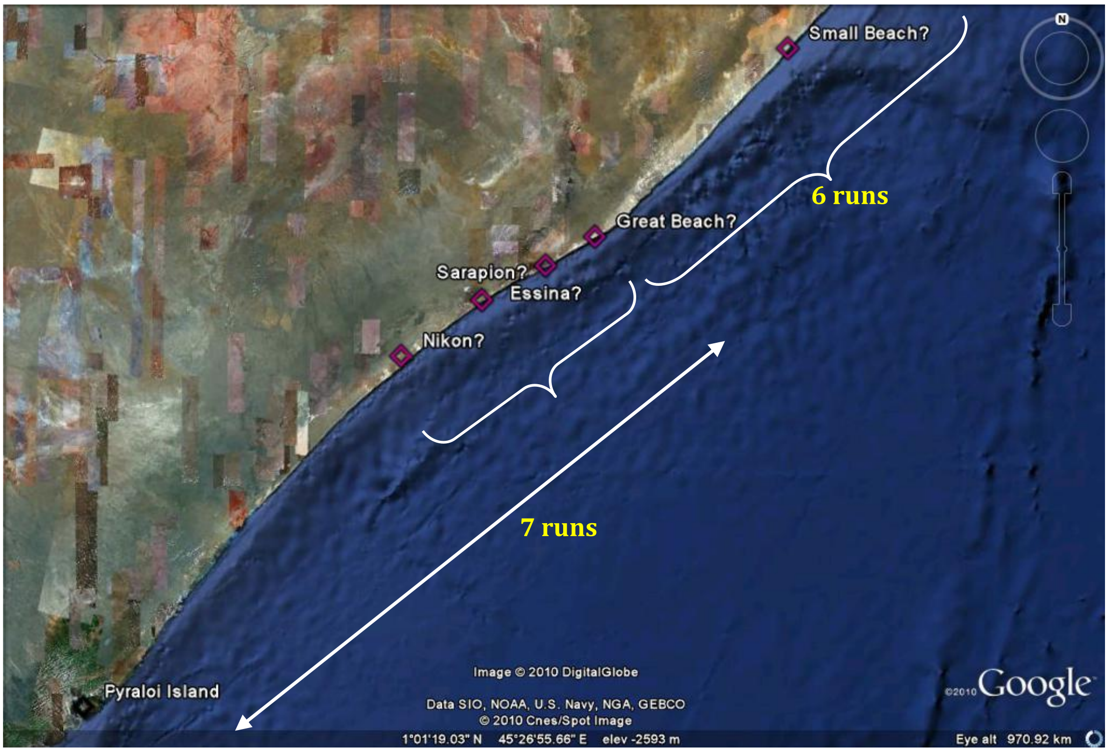


Figure 49 Map showing the distances travelled (in runs) from the Beaches, along the Courses of Azania (Essina, Sarapion, Nikon) to the Pyraloi Island

PYRALOI ISLANDS & CANAL

Possible locations: Lamu Archipelago

Favoured: Lamu Archipelago: Patta, Mandra and Lamu, Kenya, E. Africa

Data from Ancient Sources: It is generally agreed that the Pyraloi Islands, "islands of fire", which are described in the PME 15, 7 runs from the end of the Great Beach, equate to the Lamu Archipelago (comprising Patta, Mandra and Lamu; fig.49), as they are the first islands encountered along the coast south of Ras Hafun [Opone]. Furthermore, the islands are divided from the mainland by a waterway passage, which can be defined as the "canal" of the PME (Schoff 1912:94; Casson 1989:139). The distance from Ras Hafun to the Lamu Archipelago is c.970 nautical miles and c.725 n.m. from Warsheikh.

MENOUTHIAS ISLAND

Possible locations: Pemba, Zanzibar, Mafia/ Monfiyeh

Favoured: Zanzibar, Tanzanian coast, E. Africa

Data from Ancient Sources: The author of the PME describes Menuthias Island as having rivers, crocodiles and "sewn boats and dugout canoes that are used for fishing and for catching turtles. The inhabitants of this island also have their own way of going after these with baskets." (PME 15; Casson 1989:59-60). The PME describes the Menuthias Island as being 300 stades (c. 54 km) from the mainland. Pemba or Zanzibar are both likely candidates. Casson (1989:140) argues for Pemba or Zanzibar, though he is more inclined towards Pemba. In contrast, from Ptolemy's *Geography*, Menuthias equates to Madagascar, as it was positioned east of Prason [Cape Delgado?], which was a promontory south of Rhapton, which was itself south of Rhapta (Freeman-Greville 1962: 4).

Data from archaeological investigations: Generally, Menuthias is thought to equate to either modern Pemba or Zanzibar. Pemba, the first island located south of Manda (approximately 5° south), is a possible suggestion and is argued strongly by Casson (1989:19) and Datoo (1970:68). However, based on the topography, the island of Zanzibar (approximately 6° south) seems to be more favourable (Fabricius1883; Muller 1855; fig.50). A central argument for Zanzibar is that it alone possesses what can be defined as rivers, which conforms to the PME's description. A further possibility, if we look at toponyms, is that of modern Monfiyeh (about 8°S.), which carries the modern version of the island's name, though this is the least likely. According to Schoff 1912, the author of the PME was perhaps unfamiliar with this coast and, hence, included accounts from other seafarers and travellers, lumping three islands into one. Or another option is that he did visit these places, which is implied by descriptions of the local fishing-baskets, etc., and a scribe corrupted or omitted some of the data related to this passage (*ibid*).

Figure 50 Identifying Rhapta is dependent on identifying Menouthias Island. This map shows the possible locations for these two sites: 1. Menuthias Island: Pemba (A), Zanzibar (B), Mafia (C); 2. Rhapta: at the mouth of Pangani River (A), Dar es-Salaam (B), at the mouth of Rufiji Delta (C) - it also lists the coordinates from Ptolemy's *Geography* and the runs in the PME

RHAPTA

Possible locations: at the mouth of the Rufiji Delta, or Pagani River, or Dar es-Salaam

Favoured: at the mouth of the Rufiji River, Tanzania, E. Africa

The region of Rhapta played a major role in the trade in Eastern Equatorial Africa (Schlichter 1891: 524). The identification of the port-town of Rhapta is dependent on the correct identification of the Menuthias Island. The location of these two places has perplexed scholars for years. Generally, the most favoured location for Rhapta is in modern Tanzania (ancient Azania), at the mouth of the Rufiji River.

Data from Ancient Sources: Both the PME and Ptolemy describe the Azanian emporium, Rhapta, as the final market-place to the south known in the Roman world. The PME describes the journey to Rhapta: "Two runs beyond this island [Menuthias] comes the very last port of trade on the coast of Azania, called Rhapta ["sewn"], a name derived from the aforementioned sewn boats, where there are great quantities of ivory and tortoise shell." (PME 16; Casson 1989:61)

Ptolemy, in his *Geography* (4.7), places it as 8°25'S, 73°50' and implies that he supposed a daily value of 400-500 stades (72-90 km). Although the PME and Ptolemy's *Geography* provide valuable information, with useful distances that fit well with the East African coast, they give two distinct positions for Rhapta. One is placed inland on an estuary (the metropolis?), whilst the other is placed on the mainland (the promontory?) opposite Menuthias (Zanzibar or Pemba?). Ptolemy (4.7) described Rhapta as a metropolis, positioned at 8°25'S and 1° inland, by a major river with a similar name, Rhaptus, at 7°S, 72°30' (Huntingford 1980, Casson 1989; Chami 1999). The only two possible rivers are the mouth of the Rufiji Delta (7°49'S, 39°27'E) and the mouth of the Pangani/Ruvu River (5°26'S, 39°1'E) (Datoo 1970:69; Raschke 1978:933). Kirwan (1986:102) argues for Dar es Salaam as the location for Rhapta (*ibid*:99-104), based on the assumption that Menuthias equates to Pemba and stating that it has a good harbour. Other suggestions for Rhapta's location include: at the end of the deep creeks located at the back of the Lamu archipelago, or one of the earlier mouths of the River Tana (Horton et al. 2000:36).

According to the PME, ivory was the main article of export at all trading places on the coast, and that it was procured abundantly (Schlichter 1891: 517). The traders of

Muza, in Arabia, were greatly involved in this ivory trade. Pliny also makes reference to large amounts of ivory being procured in this region of Africa (*NH*, 8.10.11).

Data from archaeological investigations: Rhapta is the last port of trade on the Eastern coast of Africa, and its name, which is not indigenous, derives from its sewn boats. Traders would go there with their sewn boats to interact and exchange goods with the local inhabitants. Based on this, it is possible that Rhapta did not have a fixed location, which perhaps moved over time.

According to Datoo (1970), through analysis of the ancient the sources, the topography and metereological conditions, "it is shown that it is not possible to identify a site but merely to delimit a locality, which is deduced to lie between the mouths of the Pangani and Rufiji rivers", and that is more probable to be located in the northern section. Similarly, Chittick, the first director of Tanganyaka Antiquities, who has been carrying out invaluable archaeological research on the coast of Tanzania, was of the opinion that "it remains possible that all traces of Rhapta have been washed away or buried" (1982:58), following an unsuccessful early survey of the Rufiji Delta, which yielded no archaeological clues indicative of connections with Mediterranean trade.

Since 1993, recent archaeological investigations on the Tanzanian coast have focused on this district of Rufiji and the off-shore islands including Zanzibar and Mafia, where interesting archaeological features have been revealed. The discovery of 20 sites of the Early Iron Working tradition suggests the presence of abundant settlements in the region during the 1st to the 5th century A.D. (see Chami and Msemwa 1997). In addition, these sites have also revealed remains of trade goods imported to East Africa, such as pottery, glass fragments and beads, originating from the Mediterranean world, the Middle East and India (see Chami 1999, Chami 2001 a, b, and c; Chami 2002). These objects were discovered close to an off-shore site of Kivina and Mkukutu, near Kibiti. All this evidence supports accounts reported in Graeco-Roman documents in that Azania "was the southernmost territory known and commercially linked to the Mediterranean trade" (Chami 1999:240). Therefore, from the evidence of very high population densities and commercial activity in the lower Rufiji basin, it can be assumed that Rhapta "must have been in the Rufiji region, according to Ptolemy, at latitude 8° south, near a major river" (Chami 2001:16).

PRASUM

Possible locations: Cape Delgado, Cape Verde

Favoured: Cape Delgado [Mozambique, East Africa]

The furthest point of navigation known to the Ptolemy was the promontory of Prasum (Ptol.1.7.2). Although it cannot be identified with absolute certainty, the favourable location is Cape Delgado, in modern Mozambique (Schoff 1912:94; Wainwright 1947:145; Harley & Woodward 1987:179; Horton et al. 2000:36).

CONCLUSION

This research set out to attempt to position the locations of unidentified ancient ports in the Erythraean Sea during the Early Historic Period, based on the evidence at hand from an array of different data sources. Taking into account restrictions of time and firsthand investigations, this research was successful in meeting its aims and has provided a comprehensive and holistic insight into critical aspects of this complex subject, including the nature and scale of maritime Indo-Roman trade, the networks in which it operated, and its significance during the period.

An appraisal of the evidence from ancient harbours located along the coastlines of the Red Sea-Indian Ocean reflects the active role that each region played within a thriving maritime commerce. Harbours were instrumental in the development of this trade and maritime activity, acting as "an interface between land and sea and a conduit for the transfer and storage of goods" (Blue 2007:265). Indo-Roman trade was not a unified system, because the trade routes were divided both spatially and temporally, depending on the commodities exchanged in the different regions. The variable role of the different regions was mostly influenced by internal political and economic factors that consequently impacted, on a wider scale, on their international relations (e.g. Salles 1998:48). The research study successfully provided further insight into trade at the ancient harbours in the study region by looking at material remains found at these sites and mapping the ancient seaborne trade routes. Ptolemy's work is a subject that in itself deserves further pursuit, particularly in terms of its possible correlation with the PME. It would be interesting to investigate the comparisons between the two in more depth, as they have proven to be extremely useful and fruitful for aiding in the locating of ancient sites and filling in gaps in our knowledge, particularly when used in conjunction with modern tools and supporting archaeological evidence. It is unfortunate that Ptolemy's work, for example, is not more than a catalogue with listed locations, providing a more detailed description or discussion of these places and the sources of data he used. The task of correcting Ptolemy's coordinates is a fascinating, yet complex one, that deserves further investigation.

Another point of consideration is that these sites are constantly threatened by rapid modern development and destructive natural processes along the coast, which will eventually destroy potential surviving remains, and so we may never find their location (Talbert 2000:1171). Therefore, there is an urgent need for future fieldwork in this entire region, to ensure that these valuable coastal settlements can be identified, recorded and protected.

The study-topic of this research is an on-going one, as there are still several gaps, principally due to the unknown location of various of these sites that can at times be extremely hard to establish. Thus, it is a significant issue to address in the field of maritime archaeology, particularly as our understanding of these types of sites advances and patterns can be correlated within a wider scope.

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APPENDICES

Appendix A: PME Ports, Distances and Descriptions

Course	Modern name	PME distance (stades)	Site Type	Harbour description	Shelter	Hazards
AFRICA						
Myos Hormos - Berenike	Quseir al-Qadim (Egypt)	1800	inlet	first port of trade - key Egyptian port for departure		
Berenike - Ptolemais Theron	Berenice - Umm el-khetef (Egypt)	4000	inlet?	port of trade		
Ptolemais Theron - Adulis	Aqiq? Suaqin?	3000		small port of trade - "Ptolemais of the Hunts"	has no harbour, offers refuge only to small craft	
Adulis - a deep bay	Diodorus Island and Oreine/Dese (Egypt)	800		there is a market		
a deep bay - Avalites	Hauachil Bay (Baia di Ouachil)	4000				
Avalites - Malao	Assab? Saylac/Zeila (Somaliland)? Saad al Din island?	800	anchorage	small port of trade		
Malao - Mundu	Berbera (Somaliland)	2 runs	anchorage	better port of trade	open roadstead sheltered by a projection/ promontory extending from the east	
Mundu - Mosyllon	Heis (Somaliland coast) - accepted	2 or 3 runs	anchorage	port of trade	vessels moor fairly safely at the island that lies very near the shore	
Mosyllon - Cape Elephas	very uncertain... Bandar Kasim (Somaliland)? Mait B. Kasim? Ras Hantara?	> 2 runs	anchorage	small port of trade	lies on a beach with a poor harbour	
Cape Elephas - Tabai	modern Ras el Fil, or Filuk? (40 miles west of Cape Guardafui)	N/A	mangrove	small laurel grove - produces incense		
Tabai & Spice port - Opone	modern Cape Guardafui, or Ras Asir? present village of Olok? Village of Damo?	400	harbour, open road stead	"Spice Port" & a promontory	well protected against winds from the south - big promontory (Tabai) offers shelter	dangerous at times - as site exposed to the north
Opone - Rhapta	Ras Hafun - universal agreement	23 runs = 6+6+7+4 (see below)			excellent harbour	
Small and Great Bluffs of Azania	from Hafun to El Fosc? Coast of El Hazin, ending at Ras el Kyl?	6 runs				
Small and Great Beach	From El Fosc to Warsheikh? Sif el Tauil ending at Ras Aswad?	6 runs				
Courses of Azania (Sarapion, then Nikon)	Nikon (Gonderscia? Barawa?), Sarapion (Warsheik? Mogdishu?)	7 runs				

Table 6 PME Ports along the African Red Sea coast and East Africa, with their distances and descriptions (continued on next page) -

[In Blue: the port referred to in the respective descriptions; in red: uncertain site location]

Pyraloi Islands & Channel	Lamu Archipelago - Patta, Mandra and Lamu	2 night and day runs to island (=4 runs)				
Menuthias island	Zanzibar most favoured - other option is Pemba - Mafia least likely	2 runs beyond the island				
Rhapta	At the mouth of Rufiji river? Dar es Salaam? (depends on identification of Menuthias island)		metropolis	last port of trade on coast of Azania		

ARABIA

Myos Hormos - **Leuke Kome**	**Al Wajh?** - Aynunah? - El Haura?	2 or 3 runs				
Berenike - **Leuke Kome**	**Aynunah?** Al Wajh? Meda'in Salih?	200	harbour with a fort	"White Village"		
Berenike - **Muza**	**Mocha?** Mauza'? Maushij?, Yemen	12000	anchorage	"a legally limited port of trade"	offers a good roadstead for mooring because of the anchorages with sandy bottom all around	no harbour
Saue	a site 22km south of **modern Ta'izz?**	3 days	inland city			
Saphar	Zufar	9 days	inland metropolis			
channel (shuts sea into strait)	Bab el-Mandeb "Gate of Tears"	300				
passage/ strait	**Shayk Sa'id?** Khawr Gjurayah? villaga of Dhubab?	60				
Muza - **Okelis**	Aden - universally ageed - However, location unknown of Roman settlement?	360 (+ 3 days?) -- 300stadia? (Casson)		A natural cove & harbour (watering station/stopping point)		
Okelis - **Eudaimon Arabia**	Qana - Well-known site, but no harbour discovered - cape Husn Ghurab?	1200	bay (beginning of gulf formed by receding of shore)	A proper harbour, with better water supply than Okelis		
Eudaimon Arabia - **Kane**	**Sikha Island** (Yemen)	2000	bay			
islands: Orneon (of Birds) and Trullas	**Barraqah Island** (Yemen)	120 stadia from Kane (Schoff)	desert islands			
Sachalites	between Aden & Fartaque? or between Fartaque cape and cape Merbat?	beyond Kane (Schoff)	bay			

Table 7 PME Ports along the Arabian coast, with their distances and descriptions **(continued on next page)**

Kane - **Syagros**	Ras Fartak	not given - 2500? (Casson)	mighty headland on the bay (landmark)	Harbour, fortress, storehouse for frankincense		
Omana	Qamar Bay, Yemen	600	bay			
High mountains	Jabal Qamar, Oman	500	rocky and sheer high mountains		caves	
Syagros - **Moscha Limen**	inlet Khor Ruri, Omar	total 1100 (600 + 500)		Designated Port of trade (for loading frankincense)		
Moscha Limen - **Asichon**	**Ras Hasik?**, Oman	1500 (2600 from Syagros)				
Isles of Zenobios	now called Kuria Muria islands, Oman					
Isle of Sarapis	Masirah island, Oman	2000				
Isles of Kalaios	**Jazair Daymaniyat islands**, north-west of Muscat, Oman?	"stretch for almost 2000 stades"	islands			
Moscha Limen - **Apologos**	**Al-Ubulla** (Basra), Iraq?			"legally limited port of trade"		
Apologos - **Omana**	**Umm al-Qaywayn, UAE?** Chah Bahar, Iran? Jiwani bay, Pakistan?	after 6 runs (3000 stades)		Persian port of trade		
Omana - **Horaia**	**Sonmiani Bay**, Pakistan	not given		small port of trade		
Skythia				seaboard		
Minnagar (Skythia's capital)	difficult to identify			metropolis		

ASIA/INDIA

Horaia - **Barbarikon/ Barbarike**	extensive changes which have occured in the river sind - hard to identify (in present Karachi?)	not given - in the indus estuary		Important Parthian port of trade	good harbour	
Eirinon	Rann of Kutch		bay		hidden from view, to the north	frequently, with shore nowhere in sight, vessels run aground & often wreck
Barake	hard to identify, due to changes in coastline - consensus is Gulf of Kutch - Purakkad?		rocky and sharp/ steep gulf, embracing 7 islands	promontory		those closed inside basin, are destroyed - waves, violent eddies, whirpools

Table 8 PME Ports along the Indian coast, with their distances and descriptions (continued on next page)

Barygaza	Barygaza itself (Broach, Gujarat) - Barygaza bay (Gulf of Cambay)	~300 up from mouth of river Mais				difficult anchoring - extreme ebb-and-flood tides
Papike	Kuda Point	3000 stades		promontory (near Astakapra)		difficult mooring - surrounding current & bottom, rough and rocky, cuts anchor cables
Baiones (island)	Piram Island		island			
Ozene	modern Ujjain			port of trade		
Paithana	modern Paithan	20 days south from Barugaza	very large city	trading centre		
Tagara	Ter	over 10 days east	very large city	trading centre		
Damirica	Greek term for Southern India	total 7000				
Akabaru	Unidentified - Khabirum by Idrisi?			local port (of Dachinabades region)		
Suppara	Sopara, near Vasai (Bassein) - (stood near the modern town of Bassein, north of Mumbai)			local port (of Dachinabades region)		
Kalliena	Kalyana, near Mumbai			local port (of Dachinabades region)		
Semylla - Mandagora	Chaul			local port (of Dachinabades region)		
Mandagora - Palaipatmai	Bankot			local port (of Dachinabades region)		
Palaipatmai - Melizeigara	Dabhol			local port (of Dachinabades region)	a good harbour	
Melizeigara - Byzantion	Jaigarh			local port (of Dachinabades region)		
Byzantion - Toparon (?)	Vi jayadurg - Vizadrog			local port (of Dachinabades region)		
Toparon (?) - Tyrannosboas?	Devgarh?			local port (of Dachinabades region)		
Tyrannosboas (?) - Naura	Malvan?			local port (of Dachinabades region)		
Sesekreienai Islands	Vengurla Rocks (also called Burnt Island)		island			presence of pirates
Isle of Aigidioi	Goa		island			presence of pirates
Isle of the Kaineitoi	Oyster Rocks		island			presence of pirates
White Island	Pigeon I.					presence of pirates

Naura - Tyndis	*Mangalore - Cannanore - Cranganore?*	7000 from Barugaza (Sch)		first ports of trade of Limyrike		
Tyndis - Muziris	Ponnani - Tanur?	500		first ports of trade of Limyrike		
Muziris - Nelkynda	Pattanam (almost definately)	500		active ones during PME		
Nelkynda/ Bakare	Kottayam? Nakkida?		inlet anchorage	active ones during PME		
Red Mountain	Varkkallai					
Balita	*Vilinjam/ Varkkallai?*		village	first stopping place	a good harbour	
Komar	Cape Comorin? - now buried under sand			stopping-place (small settlement and port)		
Kolchoi	Korkai on the river Tambraparni in Tiruneveli?			port of the Pandya kingdom celebrated for its pearls		pearl fishing
Kamara	Karikal? Puhar or Poompuhar?			most important ports of trade in region of Argaru		
Poduke	Arikamedu near Pondichery? - near Madras (at Saidapat) - Sopatinam - Sea port of Naliyakkodan?			most important ports of trade in region of Argaru		
Sopatma	Madras? - Marakkanam? Near Chennai?			most important ports of trade in region of Argaru		
Ganges	Tamra-lipti, modern Tamluk?			port/ town		
Chryse	Sumatra?		island			
Thina	China		inland city			
Beyond Unknown						

Appendix B: Ptolemy & PME: Coordinates

Ptolemy/ PME_Name	Modern name	Ptolemy		Decimals		Actual		Decimals		Error Difference		Average Error	
		Lat.	Long.	X	Y	Lat.	Long.	X	Y	Latitude	Longitude		
Arsinoe	Clysma/ Suez, Egypt	28°50'	63°20'	28.833	63.333	29°59	32°31'	29.833	32.516	1.000	-30.817		
Clysina castle	Clysma/Suez, Egypt	28°50'	63°20'	28.833	63.333	29°59	32°31'	29.833	32.516	1.000	-30.817		
Drepanum promontory	**Ras Zeit?, Egypt**	27°50'	64°	27.833	64.000	27°49'	33°35'	27.150	33.083	-0.683	-30.917		
Sapphire Island	**Shaker Island?, Egypt**	28°	64°50'	28.000	64.833	18°52'	40°25'	18.866	40.416	-9.134	-24.417		
Philoteras	**Abu Shar at el Gouna?** vicinity of Safaga?, Egypt	27°50'	64°5'	27.833	64.083	27°17'	33°44'	27.298	33.745	-0.535	-30.338		
Myos Hormos	Quseir al-Qadim, Egypt	26°45'	64°15'	26.750	64.250	26°06'	34°17'	26.100	34.283	-0.650	-29.967		
Aeas mountains	Ras Toronbi, Egypt	26°10'	64°20'	26.166	64.333	25.41.5	34.38	25.415	34.380	-0.751	-29.953		
Leukos Limen/ Albus Portus	**Marsa Mubarak?, Egypt**	26°	64°30'	26.000	64.500	25.30.5?	35.38.5?	25.501	35.635	-0.499	-28.865		
Acabe mountains	Ras Samadai (Gebel Abu Diyab), Egypt	25°45	64°30'	25.750	64.500	25°11'	34°13'	25.183	34.550	-0.567	-29.950		
Nechesia	**Marsa Nakari?**, Egypt	25°30'	64°30'	25.500	64.500	24.52	35.01	24.866	35.016	-0.634	-29.484		
Veneris Island	**Gezirat Wadi Gimal?**, Egypt	25°	65°15'	25.000	65.250	24.35	35.1	24.350	35.100	-0.650	-30.150		
Samaragdus Mountains	**Ras Bagdadi (Nugrus Mountains)**, Egypt	25°	64°50'	25.000	64.833	24°46'	35° 9'	24.766	35.150	-0.234	-29.683		
Lepte acra	Ras Banas, Egypt	23°40	64°40'	23.666	64.666	23.53.5	35.47	23.916	35.500	0.250	-29.166		
Berenike	Berenice, Egypt	23°50'	64°5'	23.833	64.083	23°55'	35°30'	23.535	35.470	-0.298	-28.613		
Agathonis Island	Geziret Zabargad, Egypt	23°40'	65°15'	23.666	65.250	23°36'	36°11'	23.600	36.183	-0.066	-29.067		
Pentadactylus mountains	**Gebel el Farayid,** Egypt	23°30'	64°45'	23.500	64.750	23°30'	35°19'	23.500	35.316	0.000	-29.434		
Bazium promontory	**Foul Bay,** Egypt	23°	65°	23.000	65.000	23°41'	35°37'	23.683	35.616	0.683	-29.384	0.317	-29.472

Table 9 [NW Red Sea Ports] showing common locations mentioned in both Ptolemy and the PME with their respective coordinates. The error difference and average error has then been calculated between Ptolemy and actual modern coordinates [in red: uncertain site locations]. The average error has been categorised into group-regions (see chapter 5)

Ptolemais Theron	**Aqiq?** Suaqin?, Sudan	16°25'	66°	16.416	66.000	18°11'	38°21'	18.183	38.350	1.767	-27.650		
Adulis	Diodorus Island and Oreine/Dese, Eritrea	11°40'	67°	11.666	67.000	15°14'	39°39'	15.233	39.650	3.567	-27.350		
Avalites	**Saylac/Zeila (Somaliland)?** Assab? Saad al Din island?, Somaliland	8°25'	74°	8.416	74.000	13° 1'	42°43'	13.017	42.716	4.601	-31.284		
Malao	Berbera, Somaliland	6°30'	75°	6.500	75.000	10°25'	45°5'	10.416	45.083	3.916	-29.917		
Mundu	Heis, Somaliland - accepted	7°	78°	7.000	78.000	10°52'	46°50'	10.866	46.833	3.866	-31.167		
Mosyllon	very uncertain... **Bandar Kasim?** Mait B. Kasim? Ras Hantara?, Somaliland	9°	79°	9.000	79.000	11°17'	49° 9'	10.416	51.416	1.416	-27.584		
Cape Elephas	**Ras el Fil, or Filuk?** (40 miles west of Cape Guardafui), Somalia	7°30'	81°	7.500	81.000	11°50'	50°32	11.833	50.533	4.333	-30.467		
Tabai & Spice port	**Cape Guardafui** (Ras Asir)? present village of Olok? Village of Damo?	6°	83°	6.000	83.000	11°49'	51°15	11.816	51.250	5.816	-31.750		
Opone	Ras Hafun - universal agreement	4°15'	81°	4.250	81.000	10°25'	51°25'	10.416	51.416	6.166	-29.584		
Zingis promontory	**Ras Mabber?**, Somalia	3°30'	81°	3.500	81.000	9°28	50°51'	9.466	50.850	5.966	-30.150		
Phalangis mountains	**Eyl?**, Somalia	3°30'	80°	3.500	80.000	7°58'	49°48'	7.966	49.800	4.466	-30.200		
Small and Great Bluffs	**Coast of El Hazin, from Hafun to El Fosc?** from Hafun to Ras el Khayl?, Somalia	3°	70°	3.000	70.000	7°44'	49°52	7.733	49.866	4.733	-20.134		
Austri Cornu promontory	Southern Horn - **Ras Asswad?**	1°	79°	1.000	79.000	6°17'	49° 5'	6.283	49.083	5.283	-29.917		
Small Beach	**Sif el Tauil: From El Fosc to Warsheikh?** From Ras el Khil to Ras Aswad? , Somalia	1°S	78°	1.000	78.000	4° 4'	47°34'	4.066	47.566	3.066	-30.434		
Great Beach	**Sif el Tauil: From El Fosc to Warsheikh?** From to Ras Aswad?, Somalia [Warsheikh]	2°S	76°	2.000	76.000	2°17'	45°47'	2.283	45.783	0.283	-30.217		
Courses of Azania (Essina)	**Mogdashu?**, Somalia	3°30'S	74°	3.000	74.000	2° 1'	45°21'	2.016	45.350	-0.984	-28.650		
Courses of Azania (Sarapion)	**Merka?** Warsheik? Mogdishu? , Somalia	3°S	74°	3.000	74.000	1°42'	44°46'	1.700	44.766	-1.300	-29.234		
Courses of Azania (Nikon)	**Barawa?** Gonderscia?	4°15'S	73°	4.250	73.000	1°11'	44° 1'	1.183	44.016	-3.067	-28.984	2.994	-29.149

Pyraloi Islands & Canal	Lamu Archipelago - Patta, Mandra and Lamu, Kenya					2°6'S	41°1'	2.103	41.021				
Menuthias island	**Zanzibar** most favoured - other option is Pemba - Mafia least likely, Tanzania	12°30'S	85°	12.500	85.000	6°9'S	39°12'	6.165	39.203	-6.335	-45.797		
Rhapta	**At the mouth of Rufiji river? Dar es Salaam?, Tanzania** (depends on identification of Menuthias island)	8°25'S	73°50'	8.416	78.833	6°49'S	39°12'	6.831	39.269	-1.585	-39.564		
Prasum	Cape Delgado, Tanzania/ Mozambique	8°15'S	80°00'	8.250	80.000	10°30'S	40°30'	10.500	40.500	2.250	-39.500	-1.890	-41.620

Table 10 [Above: SW Red Sea/ E African Ports] - [Below: Rhapta Region] Table showing common locations mentioned in both Ptolemy and the PME with their respective coordinates. The error difference and average error has then been calculated between Ptolemy and actual modern coordinates [in red: uncertain site locations]. The average error has been categorised into group-regions (see chapter 5)

Leuke Kome	**Al Wajh?** - Aynunah? - El Haura?					26° 14'?	36° 28'?	26.233	36.466				
Egra	**Aynunah?** Al Wajh? Meda'in Salih?	26°	70°30	26.000	70.500	28° 5'?	35° 11'?	28.083	35.183	2.083	-35.317		
Muza	**Mocha?** Mauza'? Maushij?, Yemen	14°	74°30'	14.000	74.500	13°19'?	43°20'?	13.316	43.333	-0.684	-31.167		
Saue	a site 22km south of **modern Ta'izz?**	16°55'?	73°40'?	16.916	73.666	13°35'?	43°55'?	13.583	43.916				
Saphar	Zufar	14°?	88°?	14.000	88.000	14°12'?	44°24'?	14.200	44.400	0.200	-43.600		
passage/ strait	Bab el-Mandeb "Gate of Tears"					12°35'	43°12'	12.583	43.333				
Okelis	**Shayk Sa'id?** Khawr Gjurayah? villaga of Dhubab?	12°	75°	12.000	75.000	12°48'?	43°28'?	12.800	43.466	0.800	-31.534		
Eudaimon Arabia	Aden - universally ageed - However, location unknown of Roman settlement?	11°30'	80°	11.500	80.000	12°48'?	45°0'?	12.800	45.000	1.300	-35.000		
Kane	Qana - Well-known site, but no harbour discovered - cape Husn Ghurab?	11°30'	84°	11.500	84.000	14°10'?	48°20'?	14.166	48.333	2.666	-35.667		
Orneon Island (of birds)	**Sikha Island** (Yemen)					13°55'?	48°22'?	13.916	13.950				
Island of Trullas	**Barraqah Island** (Yemen)	84°	12°40	84.000	12.666	13°57'?	48°27'?	13.916	48.450				
Sachalites	between Aden & Fartaque? or between Fartaque cape and cape Merbat?												
Syagros	Ras Fartak	14°	90°	14.000	90.000	15°36'	52°20'	15.600	52.200	1.600	-37.800		
Omana	Qamar Bay, Yemen					16°15'	53°30'	16.250	53.500				
High mountains	Jabal Qamar, Oman					16°48'	53°15'	16.800	53.250				
Moscha Limen	inlet Khor Ruri, Omar					17° 1'	54° 4'	17.033	48.333				
Asichon	**Ras Hasik?**, Oman					17°25'?	55°16'?	17.416	55.266				
Isles of Zenobios	now called Kuria Muria islands, Oman	16°30'	91°00'	16.500	91.000	17°20'	56°	17.333	56.000	0.833	-35.000		
Isle of Sarapis	Masirah island, Oman	17°30'	94°	17.500	94.000	20°20'	58°40'	20.333	58.666	2.833	-35.334		
Isles of Kalaios	**Jazair Daymaniyat islands**, north-west of Muscat, Oman?					23°48'?	58°0'?	23.800	58.000				
Apologos	**Al-Ubulla** (Basra), Iraq?	31°10?	80°?	31.166	80.000	30°15'?	48°54'?	30.250	48.900				
Asabon promontory	**Jabal Sibi** (Ra's Musandam), Oman	23°30'	92°30'	23.500	92.500	26°12'	56°25'	26.200	56.416	2.700	-36.084		
Ommana	**Umm al-Qaywayn, UAE?** Chah Bahar, Iran? Jiwani bay, Pakistan?	19°45'?	87°40'?	19.750	87.666	25°30'	55°34'	25.500	55.566	5.750	-32.100		
Horaia	**Sonmiani Bay**, Pakistan					25°0'?	66°15'?	25.000	66.250			1.826	-35.328

Table 11 [Arabian Ports] Table showing common locations mentioned in both Ptolemy and the PME with their respective coordinates. The error difference and average error has then been calculated between Ptolemy and actual modern coordinates [in red: uncertain site locations

Binagara	difficult to identify	25°20'	118°	25.333	118.000								
Barbarei	extensive changes which have occured in the river sind - hard to identify - present **Karachi**, Pakistan?					24°53'	67° 1'	24.883	67.017				
Eirinon	Rann of Kutch, Gujarat, India					24°4'	70°10'	24.066	70.166				
Papike	Kuda Point, Gujarat, India					21°37'	72°17'	21.616	72.283				
Baiones (island)	Piram Island, Gujarat, India					12°36'	72°2'	21.600	72.350				
Suppara	Sopara, near Vasai (Bassein), , India	15°50'	112°30'	15.833	112.500	19°24'	72°4'	19.416	72.683	3.583	-39.817		
Dunga		15°	111°30'	15.000	111.500								
Symilla	Chaul, India	14°45'	110°	14.750	110.000	18°34'	72°55'	18.566	72.916	3.816	-37.084		
Balepatma	Dabhol/ Rajapur, India	14°20'	111°	14.166	113.000	17°35'	73°10'	17.583	73.166	3.417	-39.834		
Mandagora	Bankot, India	14°10'	113°	14.333	111.000	17°59'	73°3'	17.983	73.050	3.650	-37.950		
Milizigeris	Jaigarh, India	12°30'	110°	12.500	110.000	17°17'	73°13'	17.283	72.216	4.783	-37.784		
Byzantium	Vijayadurg, Maharashtra, India	14°40'	113°40'	14.666	133.666	16°33'	73°20'	16.550	73.333	1.884	-60.333		
Nitra emporium	**Cannanore?** *Mangalore? Cranganore?*, India	14°40'	115°30'	14.666	115.500	11°52'	75°22'	11.866	75.366	-2.800	-40.134		
Tindis	**Ponnani?** Tanur?, India	14°30'	116°	14.500	116.000	10°48'	75°56'	10.800	75.933	-3.700	-40.067		
Calecarte promontory		14°	116°40'	14.000	117.000								
Muziris emporium	Pattanam (almost definately), Kerala, India	14°	117°	14.000	117.000	10°9'	76°12'	10.150	76.200	-3.850	-40.800		
Melkynda	Marsa Nakari, Kerala, India	14°20'	120°20'	14.333	120.333	9°35'	76°31'	9.583	76.516	-4.750	-43.817		
Elancor emporium		14°	120°40'	14.000	120.666								
Commaria promontory	Cape Comorin?, Tamil Nadu, India	14°	121°20'	14.000	121.333	8°5'	77°33'	8.083	77.550	-5.917	-43.783		
Colchi emporium	Cape Comorin?, Tamil Nadu, India - now buried under sand	15°	123°	15.000	123.000	8°40'	78°5'	8.666	78.083	-6.334	-44.917		
Cory promontory on Argaricus Bay	on Palk Bay, India	13°20'	125°40'	13.333	125.666							-0.623	-43.766

Table 12 [S Asian Ports] Table showing common locations mentioned in both Ptolemy and the PME with their respective coordinates. The error difference and average error has then been calculated between Ptolemy and actual modern coordinates [in red: uncertain site locations (continued)

Salur emporium		15°10'	125°20'	15.166	125.333								
Chaberis city	**Karikal?** at the mouth of river Chaberus, India	15°45'?	128°20'?	17.750	128.333	10°55'	79°50'	10.916	79.833	-6.834	-48.500		
Sobura emporium		14°30'	130°	14.500	130.000								
Poduca emporium	**Pondichery?** - near Madras (at Saidapat) - Sopatinam - Sea port of Naliyakkodan?	14°45'	130°15'	14.750	130.250	11°56'	79°49'	11.933	79.816	-2.817	-50.434		
Minagara (Paralia)		17°15'	140°	17.250	140.000								
Binagara (Indoscythia)	Brahmanabad (Pakistan)?	25°20'	118°	25.333	118.000	25°52'	68°46'	25.866	68.766				
Barygaza	Barygaza itself (Broach, Gujarat) - Barygaza bay (Gulf of Cambay), India	17°20'	113°15'	17.333	113.250	21°41'	72°59'	21.700	72.983	4.367	-40.267		
Ozene	modern Ujjain, India	20°?	117°?	20.000	117.000	23°10'	75°46'	23.183	75.783	3.183	-41.217		
Minagara (Larica region - Indoscythia)		19°30'	115°15'	19.500	115.250								
Gange regia	Tamra-lipti, modern **Tamluk**?, India	19°15'?	146°?	19.250	146.000	22°17'	87°55'	22.390	87.933	3.140	-58.067		
Tagara	Ter, India	19°	118°	18.166	117.000	18°19'	76° 9'	18.316	76.150	0.150	-40.850		
Betana regia	Paithana, India	18°10'	117°	19.000	118.000	19°28'	75°24'	19.466	75.400	0.466	-42.600		
Baraca	Purakkad, India	18°	111°	18.000	111.000	11° 28'	75° 39'	11.466	75.650	-6.534	-35.350		
Heptanesia island	Vengurla Rocks (also called Burnt Islands), India	13°	113°	13.000	113.000	15°58'	73°28'	15.966	73.466	2.966	-39.534		
Isle of Aigidioi	Goa/ Angediva south of Sadāśivagaḍh, India					15°20'	74°0'	15.333	74.000				
Isle of the Kaineitoi	Oyster Rocks, India					14°49'	74°4'	14.816	74.066				
Leuca	Pigeon Island, India	12°	118°	12.000	118.000	14°1'	74°16'	14.016	74.266	2.016	-43.734		
Red Mountain	Varkkallai, India					8°44'	76°42'	8.733	76.700				
Balita	Vilinjam/ Varkkallai?, India					8° 22'	76° 59'	8.366	76.983				
Promontory in Golden Chersonesus	in peninsula of Malacca? Sumatra?	4°20'	159°	4.333	159.000	1°S	100°30'	1.000	100.500	-3.333	-58.500		
Taprobane (Boreum promontory)	Sri Lanka	12°30	126°	12.500	126.000	7°	81°	7.000	81.000	-5.500	-45.000		

Appendix C: RED SEA ANCHORAGES

The general descriptive information for the different anchorages was gathered from the Red Sea Pilot (Davies & Morgan 2002), whereas the coordinates and archaeological section were drawn from R.I. Thomas' PhD research (2010).

Ancient Site	Modern site	Latitude	Longitude	Site Type	Shelter	Holdings	Hazards	Landmarks	Archaeology
	Sharm el Bahari	25˚52'N	34˚25'E	Inlet	good in NW, wide entrance	hard, due to laid mooring (resort)		loaf hill.	
	Marsa Wizr	25˚47'N	34˚29'5E	Small Bay	protected from all but northerlies	E only, 6m sand, poor against northerlies.	swell		
	Marsa Toronbi	25˚41'5N		Bay	Protection from reef, max 3m	7-10 m, sand and weed, visible in good light	connection between anchorages: 3m	headland	Geology
Leukos Limen	Marsa Mubarak?	25˚32'N	34˚38'5E	Inlet	good	Good, 10 m coral heads			Sea Pilot
	Port Ghalib (Marsa Imbarak)	25˚30'5N	35˚38'5E	Bay/ Inlet	marsa, good, 10m	coral heads in marsa		white ruins on N shore	Ruins and their location (Pilot)
	Marsa Abu Dabbab	25˚20'5N	34˚44'E	Bay	W,N,S	6m, close to reef, swell an issue	Elphinstone Reef an issue, roll and swell, shallow indent		Red Sea Pilot
	Mersa Tarafi	25˚12'5N	34˚48'5E	Bay/ Inlet	N,W,S	Small, 12-15m	small, narrow entrance		Red Sea Pilot
	Marsa Igli (Marsa Zebara)	25˚10'5N	34˚50'5E	Bay/ Inlet		Small, 7-10m			Red Sea Pilot
	Marsa Alam	25˚04'5N	34˚54'E	Bay	N,S,W	poor, 10m	dangerous reefs		Red Sea Pilot
	Marsa Tundaba	24˚57'5N	34˚56'5E	Bay	N,NW excellent shelter from swell	8m sand		headland, hill	2 bluffs south near sea. coral head structures north of marsa.

Table 13 Red Sea Anchorages (continued next page)

Nechesia	Marsa Nakari?	24˚52’N	35.01E	Inlet	Some behind a small *ras*, in calm weather	Wadi Nakari was probably an inlet in the past			extensive ruins on south side, also 2 on hill south of Nakari. 4-5 robbed graves in island in Nakari, and graves west of site on highway.
	Wadi Ghadir	24˚49’N		Inlet		Reasonably good, 7-10m sand	Isolated coral heads	Low headland	11-12 graves, 6 cairns south, 37-40 north.& 37-42 Bedouin graves
	RED SEA HILLS	24˚45’8N							3 wind breaks (...modern?)
Ictheophagi settlements	8.5km S of Abu al-Ghosun	24˚23’4N	35˚15’3E	Open roadstead	Limited shelter from NW	6m, sand and rock			cairns, shell midden
Ictheophagi settlements	Gezirat Siyul	24˚22’5”N	35˚22’5E	Island	W,E and N excellent protection. 7m,lagoon	10-12m			shell middens 100m inland
Ictheophagi settlements	Ras Qulan	24˚17’N	35˚23’E	Headland		7-10m, good	Coral heads, reefs, very poor visibility	2 cairnes	cairns/graves
	Mahabis Islands	24˚18’8N	35˚23’1E	Island	NW,N,NE	6m / 7m			
	Marsa Wadi Lahmi	24˚12’5N	35˚25’5E	Bay	NW	Good holding, protection NW, 6-10m	Shallows patches, narrow, lead line req	low black hills with cairn & bold white stripe	
	Dolphin Reef/ Sataya	24˚09’7N	35˚41’6E	Reef	N,E,W(S)	9m sand	foul from NW approach	wreck at S corner	
	Fury Shoal	24˚10’N	35˚40’E	Reef	protection from NW. 7-12m	shallow reefs	difficult		Wreck site 7m

APPENDIX D: Currents in the Gulf of Aden

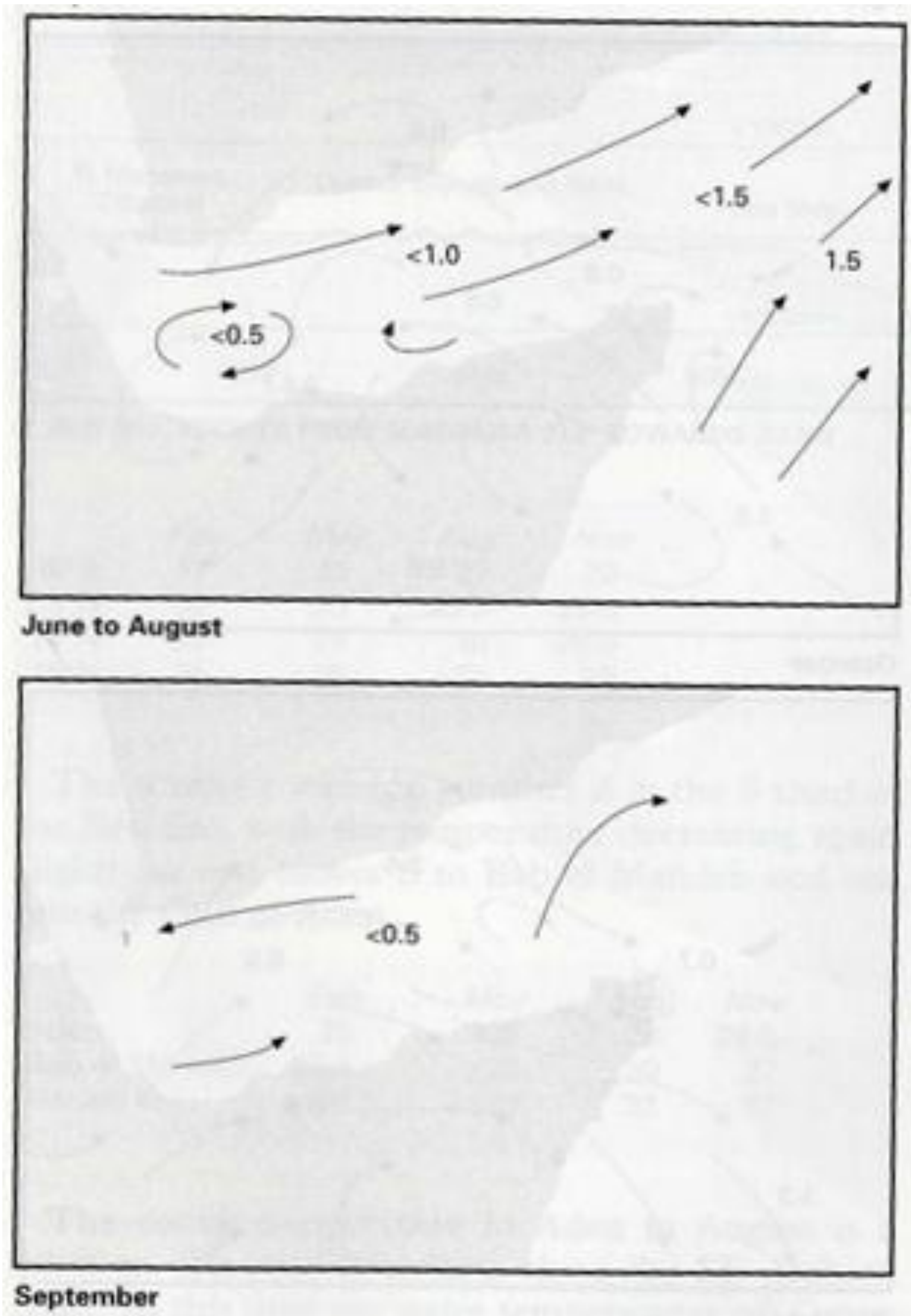

Figure 51 Currents in the Gulf of Aden in June-August, and September (Morgan & Davies 2002:38)

APPENDIX E: *Tabula Peutingeriana* (Peutinger Table)

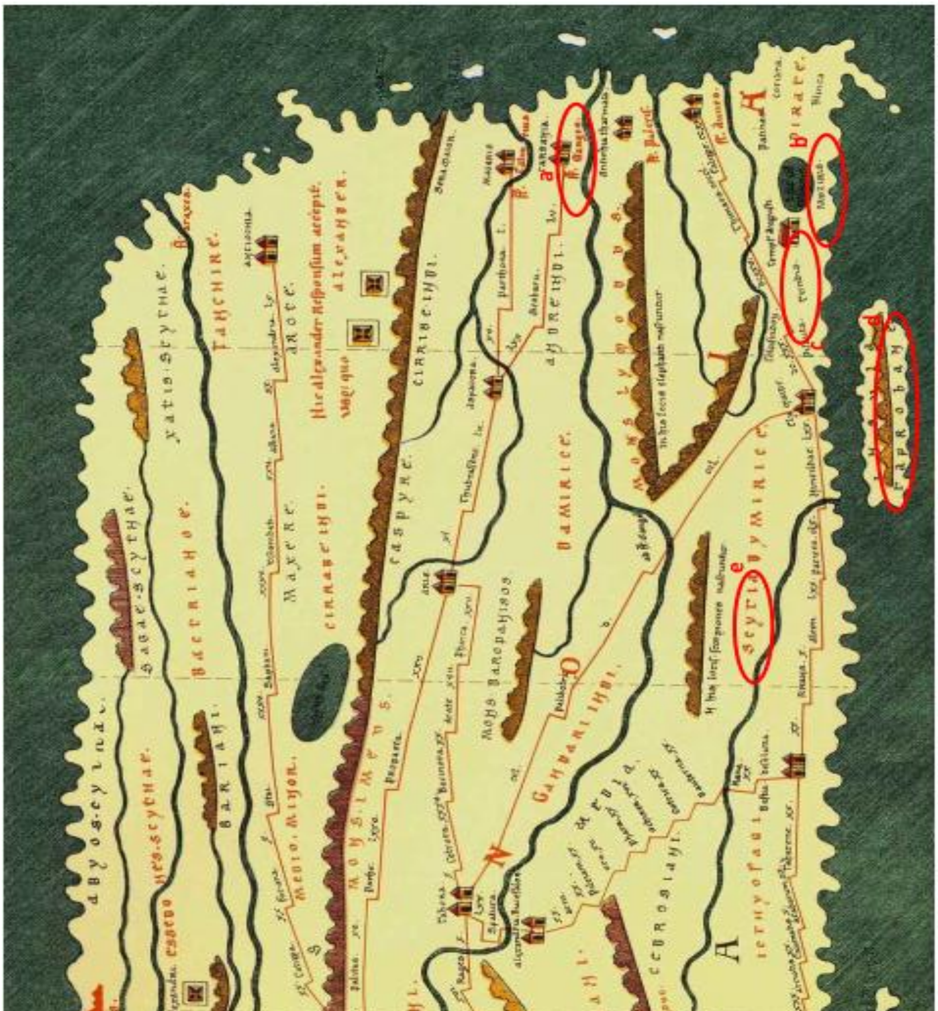

Figure 52 Section of India: Interesting features and relevant sites are circled in red - a: Ganges River; b: Muziris; c: Tundis; d: Tabrobane (Sri Lanka) ; e: Scythia [Millieri, C. 1887/1888]