**Reconsidering the role of gemstones in the so-called Indo-Roman trade**

**Summary**: With a shift away from more traditional narratives about the outflow of gold and silver from the Roman Empire in exchange for “luxuries” from the East, more scholarly attention has been given to the cultural (as well as economic) significance of this trade. This includes a focus on the ways in which these goods became embedded into various social and religious practices. Potentially this analytical shift has privileged the study of commodities like spices over items like gemstones since the former were often cheaper and more feasible for a wider spectrum of the population to acquire. As such, this paper examines where gemstones sit within these new frameworks for analysing the so-called Indo-Roman trade. Should they be considered peripheral to the trade or did their high value and low bulk mean that their economic significance more than compensated for their modest (in physical terms) volume of import?

**Keywords:** gemstones, Egypt, Roman Empire, India

**Introduction**

Early twentieth century discourse on the so-called Indo-Roman trade frequently framed this exchange as the flow of “luxuries” like gemstones, spices, and silks westwards, and gold and silver eastwards (e.g., Warmington 1928, pp. 271-318; Miller 1969, pp. 216-22).[1] This typically included projecting back mercantilist anxieties onto the Roman world and concerns about a negative balance of trade (De Romanis 2015a). However, a reaction to this idea occurred in the latter twentieth century. Those adopting a more primitivist perspective argued that while this trade could still be labelled as one of “luxuries”, it was, nevertheless, not of great economic consequence and peripheral to the predominantly agrarian Roman economy (e.g., Jones 1974, p. 30; Finley 1999 [1973], pp. 33-34; see also Casson 1989, pp. 38-39, for the outdated idea that Eastern Desert infrastructure was primarily there for mining and quarrying and only of incidental benefit to trade). This view has been itself been challenged in more recent scholarship, with a renewed interest in the importance of this exchange for the Roman economy (on the various elite families who invested in the trade, see Tchernia 2016, pp. 42-48), and its revenue potential for the Roman state (among others, see Wilson 2015; McLaughlin 2019; De Romanis 2020; Cobb & Wilkinson 2022). Moreover, greater emphasis has been given to the cultural significance of this trade and how Indian Ocean imports were embedded into wider Roman social practices, notably medicine, cuisine, funerary and religious rituals (Sidebotham 2011; Cobb 2013).

These conceptual shifts have encouraged a more holistic approach when studying the use of Indian Ocean goods within the Roman world, where the wider population is considered, not just the elites. At the same time, there have been attempts to nuance what luxury meant in varied social settings, with a move away from simplified, blanket applications of the term. To an extent, this has favoured the study of spices and aromatics and their use in religious, funerary, magical, medicinal, and culinary contexts (e.g., Pollard 2013; Purcell 2016; Cobb 2018a; Mayer 2018). This is with good reason, for these goods were consumed by a wide range of people across the Roman Empire, both geographically and across the socio-economic spectrum. They also featured in a diverse range of products (perfumes, ointments, incense compounds) and recipes (food, drink, medicaments) (Cobb 2018a; Cobb 2018b). Indeed, the social and economic significance of spices and aromatics has led some to downplay the relative importance of other higher value imports, like gemstones and silks. Mayer (2018, p. 576) for example, has exclaimed that ‘[if] the cargo of the Hermapollon [a very large merchant vessel] was in any way representative, Roman traders made most of their profit with relatively cheap bulk cargoes and not with a few precious commodities that only the truly rich could afford.’ Similarly, Fitzpatrick (2011, pp. 33-34) has claimed that the ‘bulk of Rome’s trade with the East did not consist of silk and gemstones, but of more mundane if nonetheless quite expensive commodities, such as pepper, spices, incense, and aromatics’, suggesting that items like gems captured the attention of Roman (often Stoic) moralists, leading to their overrepresentation in Latin (and Greek) literature (see also Raschke 1978, pp. 632–65, 677, 767 n.530).

All this begs the question, where do gemstones sit within these new frameworks for analyzing so-called Indo-Roman trade? Where they merely imported in small volumes and of limited economic significance or did their high value and low bulk compensate for any modest scale of import (given that only a small amount of physical space might be required to transport them)? The present chapter interrogates these issues.[2] It is argued that gemstones were not peripheral to this trade, but an important component of the cargoes flowing between the Indian Ocean region, Egypt, and the Mediterranean in the early centuries AD. Even if the volume of gemstones being exchanged may have been more limited compared to other commodities, their relative value meant they were of great economic significance. It is further suggested that the socio-economic and cultural role of gemstones within Roman society (the processes by which they became socially embedded) can also be fruitfully studied, just as has been done with spices and aromatics.

**Methodological challenges and opportunities**

The introduction to this chapter may leave the reader with the impression that gemstones studies have been neglected compared to the study of some other commodities, at least when it comes to the so-called Indo-Roman trade. Indeed, Pérez González (2019, p. 140) has asserted that the focus on spices and aromatics has relegated gemstones to a subordinate position. There may be a grain of truth to this, but more scholarship on the gemstone trade across the Indian Ocean, and the socio-economic and cultural significance of this, is coming to the fore (for example, Evers 2017; Sabaté Morales 2023). This is happening in tandem with a growing understanding of the Antique Indian Ocean as a whole, particularly due to new excavations and survey work at various international sites (including on the Egyptian Red Sea coast), a reassessment of material previously unearthed (some of which is now in museums and private collections), and new papyrological, epigraphic and literary studies. In the case of gemstone studies specifically, increasing archaeometric and gemological analysis has brought to light valuable new data, though, in some respects, this research is in its early stages (Gliozzo et al. 2011, p. 470; Krzemnicki et al. 2019, p. 711). As such, before going on to consider the role of gemstones in the so-called Indo-Roman trade, it is worth briefly considering the challenges faced by those wishing to study their movement across the Mediterranean, Egypt, and wider Indian Ocean world.

*Identification and popularity*

One challenge is identifying which gemstones were traded between the Mediterranean and Indian Ocean worlds (via Egypt and the Red Sea, and Mesopotamia and the Persian Gulf), as well as their relative popularity. A plethora of gemstones and glass beads are referred to in the ancient literary sources, although equating the terminology used by these authors to the hard minerals that we know today can present some issues. The semantic shift from σάπφειρος or *sapphīrus*, meaning lapis lazuli in Graeco-Roman sources, and ὑάκινθος or *hyacinthus* meaning sapphire, to our contemporary terminology is probably one of the most well-known examples (Wendrich et al. 2003, p. 80; Butini et al. 2018, p. 167). In other cases, we have variant names for what are probably the same precious stone, such as for olivine peridot. This stone could be what Strabo (16.4.6) and Pliny (*HN* 37.32.108, 42.126, 52.136) refer to as τόπαζος or *topazus* (deriving from Zabargad/St. John’s Island in the Red Sea), but what the author of the *Periplus Maris Erythraei* (39, 49, 56), henceforth *PME*, calls χρυσόλιθον (*chrysolithon*)(Casson 1989, pp. 74-85, 94; *contra* Seland 2017, 51). Occasionally, there is even some debate over whether something is a gemstone or not (e.g., Schneider 2016, on “land pearls”).

Juxtaposing details from these accounts with information about gemstones found in archaeological contexts, and those contained in museum and private collections, can help us ask further questions about which stones entered Egypt and the wider Roman Empire from the East, as well as those heading in other directions.[3] For example, the high numbers of carnelian, sard and agate stones that have been found at the Egyptian Red Sea port of Berenike, alongside their prevalence in European museum collections, may well indicate their popularity in the Roman Empire, whereas finds of lapis lazuli and sapphires at Berenike and its vicinity is much more limited (Wendrich et al. 2003, pp. 60-61, 80; Gliozzo et al. 2011, p. 486; Pérez González 2019, p. 147). The latter do appear in museum collections, such as the emerald and sapphire bracelet now present in the J. Paul Getty Museum (inv. 83 AM 227.2, c. fourth century AD; see Figure 1), and in archaeological contexts, like the sapphires embedded in a diadem from a female grave in Colonna (Alban Hills) (Butini et al. 2018). However, does the limited presence of sapphires and lapis lazuli at Berenike imply that these stones were imported in less volume? Or that their potentially higher value meant that they were less likely to be recovered from the archaeological record? Or that overland and Persian Gulf networks of exchange were more important for their westward movement, than the Egyptian-Red Sea networks in the early to mid-first millennium AD? All important, if not easily soluble, questions.

In the other direction a high number of emeralds – likely from the Mons Smaragdus area (Wadi Sikait and Gabal Zabara; see Shaw et al. 1999; García-Dils de la Vega et al. 2021; Oller Guzmán 2022) – have been found at Berenike, including in unworked form, suggesting that many were destined for export. Wendrich (et al. 2003, p. 57) had assumed that they may have been traded mainly to parts of northeast Africa, partially due to their apparent low quality (though Surour & Omar 2020, p. 7, have noted that this low opinion may partly be explained by amazonite from the area being misidentified as emerald). However, comments by Late Antique authors about the Blemmyes and Aethiopians suggest that communities in South Asia may also have received these Eastern Desert emeralds (Epiph. *De XII gemmis* 19-21 = *FHN* 305; Olympiodorus, *fragm*. 1.37 (= Phot. *Bib.* cod. 80 p. 62a9-26) = *FHN* 309; Cosmas *Christian Topography* 11.339).[4] In any case, the salient point for our purposes is that the testimony of individual authors, or the presence of gemstone at different archaeological sites, can sometimes give an impressionistic indication of the popularity of specific gemstones, but rarely can we get a more quantified sense of the scale at which they were traded.

*Provenance*

Discerning the sources of different gemstones is also a potentially fraught issue. Ancient authors can often be quite vague, such as Pliny using the term India to designate an origin for particular stones, without further qualification (for example, opal (*HN* 37.21.80–82), onyx and sardonyx, which is said to also come from Arabia (*HN* 37.23.87, 24.90–91), and amethyst, the finest variety from India (*HN* 37.40.121–24), though we know it was also mined in Egypt – Harrell et al. 2006). Texts like the *PME* (39, 56, 61) offer some details about key markets at which certain gemstones could be acquired (such as turquoise, lapis lazuli, onyx, agate, diamonds, and sapphires). But the location of the mines or riverbeds, and the transport networks that brought these stones to various markets, are not always mentioned. This has often meant needing to make inferences about the most plausible sources of different gemstones (particularly based on geology), such as the Narmada River, Deccan Traps and Coimbatore region of South Asia (Francis Jr. 2000, p. 54; Seland 2017, pp. 51-2).

Fortunately, recent developments in gemological analysis offer the potential to gain more detailed indications of the sources of certain gemstones. Especially with the development of non-destructive techniques which can identify trace chemical elements and oxygen isotopic signatures (Giuliani et al. 2000, p. 631, Gliozzo et al. 2011, pp. 470-71; Gilg et al. 2018, p. 150; Krzemnicki et al. 2019, pp. 716, 718); although, in some cases, the lack of ‘characteristic fingerprints (especially trace element content)’ may mean that firmer identifications of particular sources is not always possible, as has been noted with types of chalcedony (Gliozzo et al. 2011, pp. 470, 475). For example, a study from 2000 used the delta-O-18 (*δ* 18O) value of a Gallo-Roman emerald found in Miribel to argue for its origin from the Swat-Mingora region of Pakistan (Giuliani et al. 2000, p. 631), which, if correct, would suggest that Egypt was not the only source of emeralds to be utilised for jewellery in the Roman Empire. A more recent study of fourth century garnets from an elite tumulus at Hagar el‐Beida has proposed a West African or Portuguese origin for these stones (Then-Obłuska et al. 2021, p. 227-42); again, if correct, suggesting that there were additional sources, besides those deriving from South or Southeast Asia (on Southeast Asia as a source of garnets, as well as finds at Arikamedu (a site a few km south of modern Pondicherry), see Gilg et al. 2018, p. 163).

Variant origins for the same class of gemstones and a lack of consensus between different studies, however, should remind us not to take such archaeometric and gemological studies as providing definitive and final answers. This is especially true given the unevenness (extent) of different gemstone databases, upon which scholars draw to make comparisons with their own finds (on this difficulty, see Breeding et al. 2010). For instance, one team analysing basaltic sapphires from a mid-third century grave in the Alban Hills has proposed from X-ray fluorescence spectrometer tests that they derive from Cambodia or Thailand, with the non-basaltic sapphires coming from Sri Lanka (Butini et al. 2018). In contrast, another team studying a basaltic sapphire intaglio found at Pompeii in the House of Gemmarius have argued for a possible Axumite origin for this gemstone (Krzemnicki et al. 2019). These differing conclusions should warn us against making assumptions about trade routes solely from individual gemological studies.

*Trade routes*

Overall, we can say that the growing body of gemological research, alongside archaeological fieldwork, offers increasing insights into the origins and popularity of different gemstones. Nevertheless, it is not simply a question of where the gemstones came from and where they ended up, but how they moved from A to B and in what form. Broad references to the Silk Road (overland routes) or Maritime Silk Road (spanning from the South China Sea, through the Indian Ocean to the Mediterranean and Near East) can offer useful generalisations. However, when drilling down into the specifics, it is evident that various historical actors from numerous societies operated from different nodes (ports, emporia, etc.) and traversed various networks (routes) and not all these regions were evenly connected. In light of these issues, critical engagement with written sources, alongside archaeological and archaeometric analysis, remains vital. An exhaustive account of the movement of gemstones across Afro-Eurasia is not possible here, but a few examples can allow us to appreciate the complexities involved.

The conditions in which gemstones moved – be it in unworked, rough, polished, or even engraved form – is particularly illustrative of the intricacies of the trade. For example, crystal, carnelian, jasper, and banded agate, have been found at Arikamedu in rough form and as studs, beads, and ring stones (Raman 1991, pp. 131-2; Francis Jr. 2004, pp. 503-04), while stone and bead-working, notably with agate and carnelian (not local but imported to the site), is in evidence at Pattanam on the Kerala coast (possible ancient Muziris, or a satellite settlement) (Kelly 2007-8 & 2016). Moreover, at the Egyptian Red Sea port of Berenike many cameo blanks, roughly worked and to be finished at later stages have been found (Sidebotham 2011, p. 238).[5] This might not seem surprising if one were to suppose that unfinished pieces, having been transported over long distances, could be brought to local craftsmen who would then work and engrave these objects into forms that suited specific cultural tastes. Indeed, Chase-Dunn and Hall (1997) have argued that objects travelling along “prestige goods networks” often suffered from what they call “fall off”, meaning that any original cultural or religions meaning was lost by the time they reached their eventual recipients. An idea applied by Pollard (2013, pp. 22-3) to the study of spices and gemstones arriving in the Late Antique Roman Empire, which in some contexts were associated with magic. On this basis, one might suppose that unengraved gemstones were preferred, since more culturally relevant imagery could be applied subsequently. When foreign forms or imagery are present on gemstones, the temptation might be to assume they represent idiosyncratic exotica, or personal possessions of travellers and resident foreigners.

There are reasons, however, to be circumspect. A fair number of engraved gemstones with Graeco-Roman designs have been found in South and Southeast Asia. This includes examples such as a carnelian intaglio with the bust of Augustus found at Arikamedu (possibly the site referred to as Podukē in the *PME*) (Wheeler et al. 1946, p. 101; Malleret 1959, pp. 103-04), and a Sphinx on a seal ring at Pattanam (possibly ancient Muziris) (Cherian et al., 2022). Moreover, in Southeast Asia 11 carved gems have been identified, stylistically dating to the first to third centuries AD. The engravings include representations of Mars, Dionysus, Perseus, Satyrs, and other Graeco-Roman imagery (Borell et al. 2014; Hoppál 2021). In isolation these might be dismissed as chance finds or novelties. But the fact that we also find imitation engraved gemstones produced by local craftsmen, especially in Southeast Asia, should give us pause. It suggests that an appreciation for these form and style, even if any meaning imbued to the imagery may have differed (a phenomenon, that can be observed, for example, with some uses of Roman coins in jewellery and clothing (potentially with ritual significance) in South Asia – see, Darley 2015; Cobb 2022a). Questions might be asked about where the Roman “originals” were engraved and how they reached Southeast Asia, but these issues are not within the scope of the present chapter.

**Volume and value: the role of gemstones in the so-called Indo-Roman** **trade**

Having set out these methodological challenges, we can now explore the economic and cultural significance of gemstones in the so-called Indo-Roman trade. As stated at the outset, despite earlier notions of a luxury trade, in reality a complex array of goods, from foodstuffs, raw materials, crafted wares, and textiles, to plant, animal and mineral products were being exchanged in multiple directions (Cobb 2015, 193-97; Cobb 2018b, 180-271; Seland 2016). Many ships plying the Indian Ocean will have contained mixed cargoes. This not only made economic sense, by spreading risk, but it also helped to ensure that there was suitable ballast and safe stowage (McGrail 1989; Cobb 2015).

This does not mean that merchants never specialised in particular routes and commodities. For example, finds of vesicular basalt at Myos Hormos (modern Quseir al-Qadim) and Berenike can be tied to Pliny’s (*HN* 6.26.104) claim that certain vessels specialised in acquiring and transporting frankincense from southern Arabia to Egypt (see, Peacock et al. 2007, pp. 28-70; Sidebotham 2011, pp. 205, 236; Sidebotham & Zych 2012, p. 139). Additionally, De Romanis (2015b & 2020) has argued that the Hermapollon, the vessel mentioned in the Muziris Papyrus, probably represented an example of one of the very large ships (μέγιστα πλοῖα) focused on trade with southwest India to acquire black pepper.[6] It is worth noting, however, that the author of the *PME* (56) makes it clear that a range of other products, like gemstones, could be acquired at these southwest Indian ports.

Whether the demand for gemstones was a driving force behind the ports to which vessels might sail to, or merely an incidental commodity picked up alongside other goods, has been debated. In the early twentieth century, Schoff (1912, pp. 222-4) thought that the transparent gems said to be available in the *PME* (56) at Muziris and Bakarē-Nelkynda were beryl from the Coimbatore mines. Certainly, thousands of Julio-Claudian denarii have been located in the vicinity of these mines (Cimino 1994, pp. 168-69; Rajan 1996, p. 103; Thapar 1997, p. 26).[7] Indeed, Francis Jr. has gone so far as to speculate on the possibility that melted gold from aurei could have been used by the jewellers of Kodumanam (Kodumanal) (Francis Jr. 2000, p. 53). De Romanis (1997, p. 97) has made the reasonable caveat that the distribution of these Roman coins may partially reflect internal trading networks, as well as a local demand for beryl (see also Selvakumar 2016); as such, it is worth remaining mindful of the importance of local and regional dynamics in the movement of these goods, alongside “global” trade. Nonetheless, excavations at Pattanam (either Muziris or a satellite area) in recent years has confirmed the presence of beryl at the site. It appears to have been one of the most common finds alongside carnelian (Cherian 2011, p. 3), allowing us to consider the possibility that the availability of beryl was an important draw for international merchants.

A similar quandary is raised by the presence of concentrations of second century aurei along the Krishna River valley in Andhra Pradesh (Turner 1989, p. 5; Gurukkal 2016, p. 47). Some early twentieth century scholars had proposed that their presence revealed a shift in demand away from high-value goods, like gemstones, sought after in the Julio-Claudian period, to an increasing desire for cheaper and bulkier products like cotton (Sewell 1904, pp. 593, 599, 601; Banerjee 1921; an idea later adapted by Suresh 2004). But such a sharp chronological division seems doubtful. In any case, the presence of these second century aurei could equally be conjectured to reflect a demand for gemstones coming from the Deccan Traps and Godavari and Krishna rivers valleys. An idea that can be coupled with an apparently increased familiarity with the Bay of Bengal during the second century AD (Marcotte 2016, pp. 174-75). Ultimately, either proposition is speculative and other local factors were almost certainly at play.

*Demand, cost and practicalities*

Even if it is difficult to prove that gemstones, in isolation, were a major driver for merchants to visit specific emporia, the evidence certainly suggests that they were prized and potentially expensive. For example, Pliny comments upon several very expensive hard minerals, like an opal ring costing 2,000,000 sestertii (*HN* 37.21.81-82), and a rock-crystal ladle worth 150,000 sestertii (*HN* 37.10.29). A few of Martial’s *Epigrams* centre around characters who pretend like they can afford fine objects, such as sardonyx and green gemstones, but, in reality, have no hope of buying them (e.g., 9.59; see also 10.80, where the character Eros, weeping because he has no hope of buying items like murrhine vessels (among other finery), is mocked, but those mocking him weep inside too). No doubt the quality of workmanship and other cultural and aesthetic factors will have influenced how much individuals were willing to pay for them. Nevertheless, the disparity in the value of some of these items compared to other Indian Ocean commodities is stark. The opal ring mentioned by Pliny, for example, represent the equivalent of 125,000 Roman pounds of black pepper in Rome’s retail market (see Pliny *HN* 12.14.26-9). That is just over 40 metric tons.

Not all gemstones were equally expensive and factors like quality, shape, transparency, hardness, and colour will have impacted on their price (estimation of both economic and cultural value are always specific to different societies and time periods, they are not static and universal). Unfortunately, Pliny does not provide the same level of comparative information about the cost of different gemstones as he does for spices for AD 70s Rome, but he does reveal that rock-crystal (*crystallum*), diamond (*adamas*) and emerald (*smaragdus*) were some of the most prized commodities within the Roman Empire – they ranked well above gold and silver (*HN* 37.78.204).[8] Other stones like agate, jasper and carnelian are likely to have been less expensive in the Roman world and potentially available to a wider market beyond the super wealthy (a likelihood suggested by their comparative prevalence at Berenike (see above) and in some modern museum collections).[9]

Pseudo-gems made of coloured glass and glass beads will have meet the needs of an even wider market. Pliny’s (*HN* 37.75-76.197-200) advice about how to spot counterfeit stones may well reflect a problem with fraud, but also probably speaks to a market for imitations stones desired by the less well-to-do (Olson 2008, p. 46). Indeed, the popularity of Indo-Pacific beads is arguably indicative of this continued taste for colourful (pseudo-gemstone) jewellery. These beads appear in significant numbers in Late Antique Berenike and seem to have been popular among the Blemmyes of the Southern Eastern Desert and Lower Nubia (Then-Obłuska 2015, 2017 & 2019), as well as being found in western Europe in fifth to sixth century contexts (Pion & Gratuze 2016). Indeed, in the other direction, the author of the *PME* comments on the export of glass beads to sites in East Africa (6-10, 12-13), and raw glass to the western coast of India (49, 56), while in central and western India, blue glass beads and bangles of possible Roman origin have been found at Brahmapuri, Nevasa, and Bhokardan (Gupta et al. 2001, p. 15; Singh 1988, pp. 87-88).

It is clear then that a range of gemstones, as well as glass beads, arrived in the Roman Empire via Egypt and other routes, while items like raw glass, glass wares and beads, and peridot were exported. Unfortunately, we lack the hard data to determine the scale of their exchange. Nonetheless, we can use theoretical modelling to help us at least get a sense of the practicalities involved. Assuming we take at face value Pliny’s (*NH* 6.26.101) hyperbolic statement that goods from India were sold at a 100x their original cost, the opal (embedded in the ring) he mentioned might have cost something like 200 aurei of 20,000 sestertii nearer to the source. In all probability, his statement is a rhetorical exaggeration, meaning that the actual cost for some of the most sought-after gemstones in Indian Ocean emporia may have been even higher. The main point for our purposes, is that a few dozen of the most expensive gemstones like diamonds and sapphires likely cost on the order of 100,000s of sestertii for traders to acquire, subsequently being sold for many multiples of this back in the Roman Empire.

A dozen or so of the most highly esteemed gemstones (at least from a Roman perspective) like beryl, diamond, sapphire could easily fit into an into a merchant’s strong-box, and were no doubt closely guarded. In contrast, stones like carnelian, jasper and agate were likely acquired on a larger scale, and glass beads presumably in even greater volumes. It seems plausible that 100s of gemstones and 1000s of beads could be packed efficiently into a few square metres of space of a cargo-hold. To put this in context, a medium sized ship of 75-150 metric tons capacity, with a length around 15-30 metres, a beam of between 4-9 metres, and a keel to deck depth of around 2-3 metres, would cover an area of roughly 125-250 metres squared (Nakas 2020, 16; on Roman shipping capacities, see also Pomey & Tchernia 1978; Tchernia 2011). By way of comparison, it has been demonstrated elsewhere that an extremely high value of gold and silver can hypothetically be packed into a very small amount of space (potentially taking up less than 1% of a medium to large-sized Graeco-Roman vessel’s cargo capacity) (Gill 1991, pp. 39-40; Cobb 2015, pp. 191-92). The same principal can be applied to very high value, low weight items like pearls and red coral (the latter being exported from the Roman world to South Asia, among other places).

*Volume and value*

For many of the goods traded there was likely an inverse between their value and the aggregate weight and volume of space they occupied. For example, in De Romanis’ (De Romanis 2015b, p. 138; De Romanis 2020) reconstruction of the Muziris Papyrus, ivory is valued 16-17x more highly than black pepper, although in Morelli’s (2011) reconstruction this ratio is only 4 to 1 (the fiscal valuation of the cargo (undertaken for taxation purposes in Egypt) has ivory tusks valued at 100 Egyptian drachmae (equivalent to 100 sestertii) per mina of weight (511 grams), and black pepper at 6 drachmae, under De Romanis’ reconstruction, or 24 drachmae under Morelli’s).[10] Regardless, in both De Romanis’ and Morelli’ reconstructions they have ivory (and possibly tortoiseshell) taking up less than 1% of the Hermapollon’s cargo, with black pepper making up over three-quarters of the load.

Unfortunately, there is no surviving equivalent document to the Muziris Papyrus which can tell us about the value (and weight) of gemstones relative to other cargo on a ship. As noted already, high-quality gems, pearls, red coral, gold and silver likely, on average, took up a very small percentage of cargo capacity (perhaps less than 1%) in those ships operating from the Egyptian Red Sea ports during the Imperial period. In the next rung are the bulkier, but still high value goods like ivory, tortoiseshell and certain medium to high-cost textiles that will have taken up comparatively more space, but probably still a modest amount. And at the other end of the spectrum, products like spices, aromatics, wines, lower quality textiles, and certain raw materials, as well as food and water supplies, probably took up a considerable amount of space.

Fitzpatrick (2011) is correct to have noted that moralising Roman authors were fixated on items like precious gems and pearls. But this is because so much of the *patrimonia* of members of the elite could be caught up (or stored, depending upon one’s perspective) in the purchase of items like gemstones, pearls and silk (e.g., Sen. *QNat*. 1.17.8–9, *Ben* 7.9.4; Juvenal 6.509, 6.464–66; Tac. *Ann*. 3.55). By contrast, most spices and aromatics (especially black pepper and incense) would barely have made a dent in the surplus income of the top 1-2% of the Roman Empire’s population, since there were practical limits on how much could normally be consumed by individuals, and the greatest aggregate consumption likely came from those of middling and “upper poor” socio-economic status (Cobb 2022b).

Thus, it is possible to have a situation where in terms of volume products like black pepper and incense were imported on a considerable scale. And yet at the same time, the highest value gemstones were imported on a much smaller scale, for a more limited market but, nonetheless, represent in value terms a very significant element of the so-called Indo-Roman trade.

**Gemstones and their socio-cultural significance within Roman society**

It has so far been suggested that even if the highest cost gemstones only took up little space on merchant vessels, their value made them highly economically significant. But we have also noted that less costly stones, glass beads and studs may have been used by a wider spectrum of the population. As such, these diverse range of hard minerals could be incorporated into numerous social practices.

Undoubtedly, gemstones were used (by those that could offered them) to display wealth and status. Most obviously, a variety of different forms of jewellery come to mind, with hundreds of gemstones fixed in jewellery having been found at Pompeii (Krzemnicki et al. 2019, p. 712). But there were numerous other ornamental uses, such as their being incorporated into furniture (on jewelled furniture, see Sen. *Ep*. 110.12; on onyx embedded into the feet of a chair, see Mart. *Ep*. 36.12.7), as well as being embedded into objects like cups (e.g., Pliny *HN* 37.6.2, 9-10.2). They could be shown off at banquets, used to attract a suitor and worn to celebrated major life events (on Lollia Paulina wearing 40,000,000 million sestertii worth of emeralds and pearls at her betrothal party to the emperor Caligula, see Pliny *HN* 9.58.117). A phenomenon that is apparent from depictions of gemstones in wall-paintings and descriptions of their physical properties in Graeco-Roman literature, where much emphasis is placed on their sensory (including erotic) appeal (Allen 2019). Seneca the Younger (*Ep*. 86.7) even goes so far as to claim that wealthy and decadent freedmen incorporated gemstones into the adornment of their bathing facilities.

Gemstones could also serve as a store of wealth to be inherited or form part of a dowry. A point that is even begrudgingly admitted by the moralising Pliny (*HN* 13.4.20), who notes that unlike ephemeral perfumes, gemstones (and pearls) are at least more permanent. Indeed, we even have evidence from papyri in Roman Egypt of items like jewellery and clothing, which formed part of dowries, being used as collateral for loans (Thoma 2021). Engraved gemstones served further practical purposes like being employed as personal insignia and seal rings (Borell et al. 2014, pp. 100, 104; Nagy 2015, p. 208; Pérez González 2019, p. 141), something that was not the sole preserve of the elite, since iron rings with glass stones (among other materials) could also be worn by the less wealthy (Reinhold 1971, p. 284; Croom 2004).

However, the use of gemstones went beyond social display, personal identification, and a means of preserving personal wealth. These varied gemstones and glass materials also featured as part of religious dedications (see, for example, Philostr. *VA*. 1.10.1, 2.40.3; see also a dedication by the *flaminica* and *sacerdos* Vibia Modesta in the community of Italica (Baetica) – Sabaté Morales 2023, pp. 137-41) or even as *fabri ocularii* in statues (Pérez González 2019, p. 147). Again, these items might also act as stores of public resources, such as when Marcus Aurelius auctioned off Hadrian’s “holy cabinet” of gemstones which he had placed in the Forum of Trajan. This was done to raise additional funds for the Marcomannic wars, in order to avoid burdening the provincials with further taxation (*SHA Marcus Aurelius* 17.1-5).

Furthermore, gemstones, jewellery, and amulets were viewed as having potential magical and medicinal associations in the Roman world, belying the reductive moniker “luxury” (Pollard 2013, p. 2; Seland 2017, p. 51; Pérez González 2019, p. 140). The purported magical and apotropaic quality of gemstones (often embedded in pendants and rings) is expressed in numerous written sources, most notably the list of “recipes” or formulas in the magical papyri (Nagy 2002, pp. 170-79).[11] Moreover, they also feature in fictional novels, such as the *Aethiopica* of Heliodorus. In this text, a major plot point concerns how the heroine Chariclea was saved from death by the fire-resisting properties of the pantarbe (“all-fear”) ring, with its magical qualities being enhanced by the Aethiopian hieroglyphics engraved on it (Lefteratou 2019, p. 14; see also Philostr. *VA* 3.46-47, where details about the Indian origin of the fictional pentrabe ring are given in the humorous and fantastical account of Apollonius of Tyana’s life and deeds). In addition to textual sources, thousands of surviving engraved gems have been identified, mainly in museum storerooms rather than from in situ archaeological contexts (e.g., see Figures 2.1 and 2.2). Largely produced in the Eastern Mediterranean, these feature Graeco-Egyptian imagery and, as Nagy (2015, pp. 210-11, 215-20) observes, are typically tied into concerns about success, love, and health rather than what we might call “black magic”.

**Conclusion**

From the preceding discussion, it should hopefully be apparent that gemstones were not merely an incidental commodity picked up alongside more important items of trade, like spices, aromatics, and various types of textiles. Rather, these gemstones were utilised in numerous socio-cultural and religious contexts within the Roman Empire. They not only played a role in social display and personal identification, but also in medicinal, religious, magical, marriage and inheritance practices. It is true, however, that the most expensive gemstones would only ever have formed a tiny portion of a ship’s cargo for those vessels plying the Indian Ocean. This is unsurprising given their potential cost in comparison to other commodities like black pepper, frankincense, and lower-cost textiles. In fact, we can perhaps imagine an inverse scale with some of the highest value, lowest bulk items, like gemstones, pearls, red coral and gold and silver, taking up little space, but representing a significant portion of the value in the overall cargo (for outbound and inbound journeys), with bulkier items like raw materials and spices taking up more space, but having a lower relational value. Lower cost gemstones and glass beads were also traded, the latter almost certainly on a more significant scale and finding a wider market in the Roman world (as elsewhere).

**Notes**

[1]: The label Indo-Roman perhaps belies the multidirectional nature of the networks linking the Mediterranean, northeast Africa, Arabia, South Asia and regions beyond, though the term has still proved popular as a geographic and chronological marker. For a critique of the use of the term Indo-Roman trade, see Simmons forthcoming.

[2]: This paper focuses primarily on hard minerals. However, it is worth noting that pearls – in fact an organic material (largely composed of calcium carbonate) – were often considered by many ancient authors as within the same class of material – Pérez González (2019, p. 140). Indeed, many of the conclusions drawn in this paper regarding gemstones are also applicable to (high quality) pearls. For a detailed discussion of the pearl trade in the Roman Empire, see Schörle (2015); Schneider (2019) and Schneider (forthcoming).

[3]: Pérez González (2019, pp. 142-44) has noted that of the 240 gemstones mentioned in book 37 of Pliny’s *Historia Naturalis*, the purported origins of 93 are given, of which 21% are said to come from India specifically, and another 30% coming from the “East”; a ratio which he asserts roughly accords with Roman gemstones contained in 10 major museums collections.

[4]: The indigenous peoples of the southern Eastern Desert, known as Blemmyes in many Late Antique sources, and referred to as *barbaroi* in various ostraka deriving from Roman fortlets (praesidia) that lined the routes between Koptos, Myos Hormos and Berenike in the first to third centuries AD, were an important presence in the region. And by the fourth century AD they were likely in control of much of its territory, including the port of Berenike and the mines of the Mons Smaragdus area. On these indigenous nomads (and texts mentioning them), see Cuvigny (2005), (2006), (2012) and (2022). On Late Antique archaeological evidence from the Mons Smaragdus area and possible links to the Blemmyes, see Oller Guzmán (2022, pp. 374-381).

[5]: Several houses in Pompeii, potentially linked to gem-cutting activity, have revealed jasper, carnelian and agate, among other stones (Evers 2017, p. 56).

[6]: On the μέγιστα πλοῖα of the *PME* (56), see discussion by De Romanis (1996, pp. 178-80 n. 40; & 2012, pp. 75-77).

[7]: Findspots of Julio-Claudian denarii in this area include: Akhilandapuram, Annamalal, Budinatham, Pennar, Pollachi, and Vellalur, as well as a report on Tiberian aurei found alongside jewellery at the latter site. For details, see Turner 1989. See also, De Romanis (1997, p. 96), who notes the find of a denarius of Tiberius at Sulur.

[8]: In the opposite direction, peridot from Zabargad Island in the Red Sea was also being exported to South Asia according to the author of the *PME* (Barbarikon (39), Barygaza (49), Muziris and Bakarē-Nelkynda (56)).

[9]: For example, of the 74 Roman engraved gemstones (73 intaglios, 1 cameo) contained in the National Archaeological Museum in Lisbon, 21 are of them carnelians, 10 of them are jaspers, and 17 nicolos (this is a type of chalcedony with a bluish to brown top layer and darkish brown bottom layer). On this collection, see Cravinho (2017, pp. 174-75).

[10]: It should be noted that the document known as the Muziris Papyrus, which contains text on both its recto and verso, is quite lacunas and, as such, any reconstruction should be treated with a degree of caution. On the varied interpretations of this document over the last several decades, see Harrauer & Sijpesteijn (1985); Thür (1987); Casson (1990); Rathbone (2000); as well as De Romanis and Morelli (cited above).

[11]: Theophrastus’ work *On Stones* is arguably the first major discussion of hard minerals (for a recent translation, see Amigues 2018) in the Classical world, and one that appears to be largely rational and devoid of allusions to magic (Caley & Richards 1956, p. 10). However, many works subsequent works in Graeco-Roman Antiquity (and beyond) focus on the magical and healing properties of stones.

**References**

Allen, R. (2019). ‘Eye-Like Radiance’: The depiction of gemstones in Roman wall painting. *Arts*, *8* (60), 1-26.

Amigues, S. (2018). [Edition & translation of] Théophraste *Les Pierres* (*Collection des universités de France*). Les Belles Lettres.

Banerjee, G. (1921). *India as Known to the Ancient World*. Oxford University Press.

Borell, B., Bellina, B. & Chaisuwan, B. (2014). Contacts between the Upper Thai-Malay Peninsula and the Mediterranean World. In N. Revire & S. A. Murphy (Eds.), *Before Siam was born: New insights on the art and archaeology of Pre-Modern Thailand and its neighbouring regions* (pp. 98-117). River Books.

Breeding, C. M., Shen, A. H., Eaton-Magaña, S., Rossman, G. R., Shigley, J. E. & Gilbertson, A. (2010). Developments in gemstone analysis techniques and instrumentation during the 2000s. *Gems & Gemology*, *46* (3), 241-257.

Butini, E., Butini, F., Angle, M., Cerino, P., De Angelis, A., Tomei, N. & Altamura, F. (2018). Archaeometric and gemmological analyses of a Roman imperial gold-and-sapphire jewel from Colonna (Rome, Italy). *Measurement*, *128*, 160-69.

Caley, E. R. & Richards, J. F. C. (1956). [Translation & commentary of] Theophrastus *On Stones*. The Ohio State University Press.

Casson, L. (1989). [Translation & commentary of] *Periplus Maris Erythraei*. Princeton University Press.

Casson, L. (1990). New light on maritime loans: P. Vindob G 40822. *ZPE*, *84*, 195-206.

Chase-Dunn, C. & Hall, T. D. (1997). *Rise and Demise*. Westview Press.

Cherian, P. J., Deepak, P. & Saha, S. (2022). The She Sphinx that flew over the Red Sea: Artefact, author, agency and audience. A paper delivered at the *Red Sea X conference*,Rethymno Crete, 6-9 July 2022.

Cimino, R. M. (Ed.), (1994). *Ancient Rome and India: Commercial and cultural contacts between the Roman world and India*. Munshiram Manoharlal Publishers.

Cobb, M. A. (2013). The reception and consumption of Eastern goods in Roman society. *Greece & Rome*, *60* (1), 136-152.

Cobb, M. A. (2015). Balancing the trade: Roman cargo shipments to India. *Oxford Journal of Archaeology*, *34* (2), 185-203.

Cobb, M. A. (2018a). Black pepper consumption in the Roman Empire. *Journal of the Economic and Social History of the Orient*, *61* (4), 519-559.

Cobb, M. A. (2018b). *Rome and the Indian Ocean trade from Augustus to the early third century CE*. Brill.

Cobb, M. A. (2022a). Mediterranean goods in an Indian context: the use of transcultural theory for the study of the ancient Indian Ocean world. In S. Autiero & M. A. Cobb (Eds.), *Globalization and transculturality from Antiquity to the Pre-Modern world* (pp. 165-82). Routledge.

Cobb, M. A. (2022b). Black pepper consumption and the middling in Roman society: Affordability, availability and status. In P. Schneider & J. Trinquier (Eds.), *Le poivre, fragments d'histoire globale : Circulations et consommations, de l'Antiquité à l'époque modern* (pp. 71-92). Hermann.

Cobb, M. A. & Wilkinson, T. (2022). The Roman state and Red Sea trade revenue. In C. Durand, J. Marchand, B. Redon & P. Schneider (Eds.), *Networked spaces: the spatiality of networks in the Red Sea and Western Indian Ocean* (pp. 213-226). Archéologie(s) 8, MOM Éditions.

Cravinho, G. (2017). Roman engraved gems in the National Archaeological Museum in Lisbon. *Studies in Ancient Art and Civilization*, *21*, 173-245.

Cuvigny, H. (2005). *Ostraca de Krokodil : La correspondance militaire et sa circulation*. IFAO.

Cuvigny, H. (Ed.), (2006). *Le route de Myos Hormos : L’arme romaine dans le dsert Oriental d’gypte*, vol. 1 and 2, Second Edition. IFAO.

Cuvigny, H. (Ed.), (2012). *Didymoi : une garnison romaine dans le désert oriental d’Égypte. II – les textes*. IFAO.

Cuvigny, H. (Ed.), (2022). *Blemmyes: New Documents and New Perspectives, including* O.Blem. 1-107. IFAO.

Croom, A. (2004). Personal ornament. In M. Todd (Ed.), *A Companion to Roman Britain* (pp. 288-298). Wiley.

Darley, R. (2015). Self, other and the use and appropriation of Late Roman coins in Peninsular India (4th–7th century CE). In H. P. Ray (Ed.), *Negotiating cultural identity: Landscape in Early Medieval South Asian history* (pp. 60-84). Routledge.

De Romanis, F. (1996). *Cassia, cinnamomo, ossidiana: uomini e merci tra Oceano Indiano e Mediterraneo*. L'Erma Di Bretschneider.

De Romanis, F. (1997). Rome and the *notia* of India: Relations between Rome and southern India from 30 BC to the Flavian period. In F. De Romanis & A. Tchernia (Eds.), *Crossings: Early Mediterranean contacts with India* (pp. 80-160). Manohar publishers.

De Romanis, F. (2012). Playing sudoku on the Verso of the ‘Muziris Papyrus’: Pepper, malabathron and tortoise shell in the cargo of the Hermapollon. *Journal of Ancient Indian History*, *27*, 75-101.

De Romanis, F. (2015a). Introduction. In F. De Romanis & M. Maiuro (Eds.), *Across the ocean: Nine essays on Indo-Mediterranean trade* (pp. 1-9). Brill.

De Romanis, F. (2015b). Comparative perspectives on the pepper trade. In F. De Romanis & M. Maiuro (Eds.), *Across the ocean: Nine essays on Indo-Mediterranean trade* (pp. 127-150). Brill.

De Romanis, F. (2020). *The Indo-Roman pepper trade and the Muziris Papyrus*. Oxford University Press.

Evers, K. G. (2017). *Worlds apart trading together: The organisation of long-distance trade between Rome and India in Antiquity*. Archaeopress.

Finley, M., with a foreword by Morris, I. (1999) [originally published in 1973]. *The Ancient economy*. University of California Press.

Fitzpatrick, M. P. (2011). Provincializing Rome: The Indian Ocean trade network and Roman imperialism. *Journal of World History*, *22* (1), 27-54.

Francis Jr., P. (2000). The stone bead industry of southern India. *BEADS: Journal of the Society of Bead Researchers*, *12*, 49-62.

Francis, Jr. P. (2004). Beads and selected small finds from the 1989–92 excavations. In V. Begley (Ed.), *The ancient port of Arikamedu: New excavations and researches 1989-1992. Volume 2* (pp. 447-604). École française d'Extrême-Orient.

García-Dils de la Vega, S., Oller Guzmán, J., Fernández Abella, D., & Trevín Pita, V. (2021). The emerald mines of Wadi Sikait (Egypt) from a diachronic perspective: Results of the 2020 and 2021 seasons of the Sikait project. *Trabajos de Egiptología. Papers on Ancient Egypt*, *12*, 19-48.

Gilg, H. A., Schmetzer, K. & Schüssler, U. (2018). An early Byzantine engraved almandine from the Garibpet deposit, Telangana state, India: Evidence for garnet trade along the ancient Maritime Silk Road. *Gems & Gemology*, *54* (2), 149-165.

Gill, D. W. J. (1991). Pots and trade: Spacefillers or objets d’art? *Journal of Hellenic Studies*, *111*, 29-47.

Gliozzo, E., N. Grassi, P. Bonnani, C. Meneghini, & Tomei, M. A. (2011). Gemstones from Vigna Barberini at the Palatine Hill (Rome, Italy). *Archaeometry*, *53* (3), 469-89.

Giuliani, G., Chaussidon, M., Schubnel, H.-J., Piat, D. H., Rollion-Bard, C., France-Lanord, C., Giard, D., de Narvaez, D. & Rondeau, B. (2000). Oxygen isotopes and emerald trade routes since Antiquity. *Science*, *287* (5453), 631-633.

Gupta, S., Williams, D. & Peacock, D. (2001). Dressel 2-4 amphorae and Roman trade with India: The evidence from Nevasa. *South Asian Studies*, *17*, 7-18.

Gurukkal, R. (2016). *Rethinking Classical Indo-Roman trade: Political economy of eastern Mediterranean exchange relations*. OUP India.

Harrell, J. A., Sidebotham, S. E., Bagnall, R. S., Marchand, S., Gates, J. E., & Rivard, J. L. (2006). The Ptolemaic to early Roman amethyst quarry at Abu Diyeiba in Egypt’s Eastern Desert. *Bulletin de l’Institut français d’archéologie orientale*, *106*, 127-162.

Harrauer, H. & Sijpesteijn, P. (1985). Ein neues Dokument zu Roms Indienhandel. P. Vindob. G 40822. *AnzWien* *122*, 124-155.

Hoppál, K. (2021). Roman engraved gems from Southeast Asia. *Dissertationes Archaeologicae*, *3* (9), 197-223.

Jones, A. M. H. (1974) *The Roman economy*. Blackwell.

Kelly, G. O. (2007-8) Report on the stone beads, debitage and raw materials from the 2007 and 2008 excavation seasons at Pattanam, Kerala. In P. J. Cherian, V. Selvakumar & K. P. Rajan (Eds.), *Interim Report of the Pattanam Excavations 2007* (pp. 1-28). KHCR.

Kelly, G. O. (2016). Heterodoxy, orthodoxy and communities of practice: Stone bead and ornament production in Early Historic South India (c. 400 BCE-400 CE). *Archaeological Research in Asia*, *6*, 30-50.

Krzemnicki, M. S., Butini, F., Butini, E. & De Carolis, E. (2019). Gemmological analysis of a Roman sapphire intaglio and its possible origin. *The Journal of Gemmology*, *36* (8), 710-24.

Lefteratou, A. (2019). Gemstones, textiles and a princess: Precious commodities in Heliodorus’ *Aethiopica*. *The Classical Journal*, *115* (1), 1-30.

Malleret, L. (1959). Les lapidaires et artisans du verre de Vîrampatnam. *Arts Asiatiques*, *6*, 93-106.

Marcotte, D. (2016). The Indian Ocean from Agatharchides of Cnidus to the *Periplus Maris Erythraei*. In S. Bianchetti, M. R. Cataudella & H.-J. Gehrke, (Eds.), *Brill’s companion to ancient geography: The inhabited world in Greek and Roman tradition* (pp. 163-183). Brill.

Mayer, E. E. (2018). “Tanti non emo, Sexte, Piper”: Pepper prices, Roman consumer culture, and the bulk of Indo-Roman Trade. *Journal of the Social and Economic History of the Orient*, *61* (4), 560-589.

McGrail, S. (1989). The shipment of traded goods and of ballast in antiquity. *Oxford Journal of Archaeology*, *8* (3), 353-358.

McLaughlin, R. (2019). Indian Ocean commerce in context: the economic and revenue significance of eastern trade in the ancient world. In M. A. Cobb (Ed.), *The Indian Ocean trade in Antiquity: Political, cultural and economic impacts* (pp. 117-134). Routledge.

Miller, J. I. (1969). *The spice trade of the Roman Empire 29 B.C. to A.D. 641*. Clarendon Press.

Morelli, F. (2011). Dal Mar Rosso ad Alessandria: II *Verso* (ma ancheil *recto*) del ‘papiro di Muziris’ (SB XVIII 13167). *Tyche*, *26*, 199-233.

Nagy, Á. M. (2002). *Gemmae magicae selectae*. Sept notes sur l’interprétation des gemmes magiques. In A. Mastrocinque (Ed.), *Atti dell’incontro di studio “Gemme gnostiche e cultura ellenistica”, Verona, 22–23 ottobre 1999* (pp. 153-179). Pàtron.

Nagy, Á. M. (2015). Engineering ancient amulets: Magical gems of the Roman Imperial period. In D. Boschung & J. N. Bremmer (Eds.), *The materiality of magic* (pp. 205-240). Brill.

Nakas, I. D. (2020). Ships and harbours of the Hellenistic and Roman Mediterranean: a new approach. *MAGS*, *2020*, 1-25.

Oller Guzmán, J. (2022). From the sea, to the river, through the desert: Some issues regarding the emerald trade network in Roman Egypt. In C. Durand, J. Marchand, B. Redon & P. Schneider (Eds.), *Networked spaces: the spatiality of networks in the Red Sea and Western Indian Ocean* (pp. 365-384). Archéologie(s) 8, MOM Éditions.

Peacock, D., Williams, D., & James, S. (2007). Basalt as ships’ ballast and the Roman incense trade. In D. Peacock & D. Williams (Eds.), *Food for the gods: New light on the ancient incense trade* (pp. 28-70). Oxbow Books.

Pérez González, J. (2019). Gems in ancient Rome: Pliny’s vision. *Scripta Classica Israelica*, *38*, 139-59.

Pion, C. & Gratuze, B. (2016). Indo-Pacific glass beads from the Indian subcontinent in Early Merovingian graves (5th–6th century AD). *Archaeological Research in Asia*, *6*, 51-64.

Pollard, E. (2013). Indian spices and Roman “magic” in Imperial and Late Antique Indomediterranea. *Journal of World History*, *24* (1), 1-23.

Pomey, P. & Tchernia, A. (1978). Le tonnage maximum des navires de commerce romains. *Archaeonautica*, *2*, 233-251.

Purcell, N. (2016). Unnecessary dependences: Illustrating circulation in pre-modern large-scale history. In J. Belich, J. Darwin, M. Frenz & C. Wickham (Eds.), *The prospect of global history* (pp. 65-79). Oxford University Press.

Rajan, K. (1996). Early maritime activities of the Tamils. In H. P. Ray & J.-F. Salles (Eds.), *Tradition and archaeology: Early maritime contacts in the Indian Ocean* (pp. 97-108). Institute of Southeast Asian Studies.

Raman, K. V. (1991). Further evidence of Roman trade from coastal sites in Tamil Nadu. In V. Begley & R. D. De Puma, (Eds.), *Rome and India: The ancient sea trade* (pp. 125-133). University of Wisconsin Press.

Raschke, M. G. (1978). New studies in Roman commerce with the East. *Aufstieg und Niedergang der Römischen Welt*, *9* (2), 604-1378.

Rathbone, D. (2000). The ‘Muziris’ Papyrus (SB XVIII 13167): Financing Roman trade with India. In M. Abd-El-Ghani (Ed.), *Alexandrian studies in honour of Mostafa el Abbadi* (pp. 39-50). Société Archéologie d'Alexandrie.

Reinhold, M. (1971). Usurpation of status and status symbols in the Roman Empire. *Historia: Zeitschrift für Alte Geschichte*, *20* (2/3), 275-302.

Sabaté Morales, A. (2023). Pearls, beryls, and priestesses in the Latin West: pearls and gems as symbols of female power and devotion, as well as impiety and irreverence. In L. Pons Pujol & J. Pérez González (Eds.), De luxuria propagata romana aetate: *Roman luxury in its many forms* (pp. 137-166). Archaeopress.

Schneider, P. (2016). Did Rome engage in pearling in the Red Sea? A re-examination of the two dedications by Publius Iuventius Agathopus. *Zeitschrift für Papyrologie und Epigraphik*, *198*, 131-37.

Schneider, P. (2019). Erythraean pearls in the Roman world: features and aspects of luxury consumption (late second century BCE-second century CE). In M. A. Cobb (Ed.), *The Indian Ocean trade in Antiquity: Political, cultural and economic impacts* (pp. 135-56). Routledge.

Schneider, P. (forthcoming). *Margarita. Perles et nacre, de l’océan Indien à la Méditerranée*. Artois Presses Universités.

Schoff, W. H. (1912). [Translation & Annotation of] *The Periplus of the Erythraean Sea*. Longmans, Green, and Co.

Schörle, K. (2015). Pearls, Power, and Profit: Mercantile Networks and Economic Considerations of the Pearl Trade in the Roman Empire. In F. De Romanis & M. Maiuro (Eds), *Across the Ocean: Nine Essays on Indo-Mediterranean Trade* (pp. 43-54).Leiden.

Seland, E. H. (2016). The Periplus of the Erythraean Sea:A network approach. *Asian Review of World Histories*, *4* (2), 191-205.

Seland, E. H. (2017). Gemstones and mineral products in the Red Sea/Indian Ocean trade of the first millennium. In A. Hilgner, S. Greiff and D. Quast (Eds), *Gemstones in the first millennium AD: Mines, trade, workshops and symbolism* (pp. 45-58). RGZM.

Selvakumar, V. (2016). The routes of Early Historic Tamil Nadu, South India. In M.-F. Boussac, J.-F. Salles & J.-B. Yon (Eds.), *Ports of the ancient Indian Ocean* (pp. 289-321). Primus Books.

Sewell, R. (1904). Roman coins found in India. *Journal of the Royal Asiatic Society of Great Britain and Ireland*, *36* (4), 591-637.

Shaw, I., Bunbury, J., & Jameson, R. (1999). Emerald mining in Roman and Byzantine Egypt. *Journal of Roman Archaeology*, *12*, 203-215.

Sidebotham, S. E. (2011). *Berenike and the ancient maritime spice route*. University of California Press.

Sidebotham, S. E. & Zych, I. (2012). Results of fieldwork at Berenike: A Ptolemaic-Roman port on the Red Sea coast of Egypt, 2008-2010. *Topoi, Supplément* *11*, 133-157.

Simmons, J. (forthcoming). Behind gold for pepper: The players and the game of Indo-Mediterranean trade. *Journal of Global History* Special Issue (Travellers, traders and diaspora in Antiquity: networks and nodes across the Indian Ocean and Eurasian world).

Singh, A. K. (1988). *Indo-Roman trade*. Commonwealth Publishers.

Suresh, S. (2004). *Symbols of trade: Roman and pseudo-Roman objects found in India.* Manohar Publishers.

Surour, A. A. & Omar, S. A. M. (2020). Historiography and FTIR spectral signatures of beryl crystals from some ancient Roman sites in the Eastern Desert of Egypt. *Environmental Earth Sciences*, *79*, 1-15.

Tchernia, A. (2011). L’utilisation des gros tonnages. In W. V. Harris & K. Iara, with contributions from P. Arnaud [and others] (Eds.), *Maritime technology in the ancient economy: Ship-design and navigation* (pp. 83-88). BAR International Series 2152.

Tchernia, A., translated by J. Grieve, with E. Minchin (2016). *The Romans and Trade*. Oxford University Press.

Thapar, R. (1997). Early Mediterranean contact with India: An overview. In F. De Romanis & A. Tchernia (Eds.), *Crossings: Early Mediterranean contacts with India* (pp. 11-40). Manohar publishers.

Then-Obłuska, J. (2015). Cross-cultural bead encounters at the Red Sea port site of Berenike, Egypt. Preliminary assessment (seasons 2009–2012). *Polish Archaeology in the Mediterranean*, *24* (1), 735-777.

Then-Obłuska, J. (2017). Between the Nile and the Ocean: The bead assemblage from Shenshef in the Eastern Desert (4th–6th centuries AD). *Polish Archaeology in the Mediterranean*, *26* (1), 719-747.

Then-Obłuska, J. (2019). *Glass bead trade in northeast Africa: The evidence from Meroitic and post-Meroitic Nubia*. Polish Centre of Mediterranean Archaeology.

Then-Obłuska, J., Gilg, H. A., Schüssler, U. & Wagner, B. (2021). Western connections of northeast Africa: The garnet evidence from Late Antique Nubia, Sudan. *Archaeometry*, *63* (2), 227-246.

Thoma, M. (2021). Material aspects of marriage: Economic transactions between spouses in Roman Egypt. In C.-E. C. Challet (Ed.), *Married life in Greco-Roman Antiquity* (pp. 168-184). Routledge.

Thür, G. (1987). Hypotheken-Urkunde eines Seedarlehens für eine Reise nach Muziris und Apographe für die Tetarte in Alexandria: (zu P. Vindob. G. 40.822). *Tyche*, *2*, 229-245.

Turner, P. J. (1989). *Roman coins from India*. University College London Institute of Archaeology.

Warmington, E. H. (1928). *The commerce between the Roman Empire and India*. Cambridge University Press.

Wendrich, W. Z., Tomber, R. S., Sidebotham, S. E., Harrell, J. A., Cappers, R. T. J. & Bagnall, R. S. (2003). Berenike crossroads: The integration of information. *Journal of the Economic and Social History of the Orient*, *46* (1), 46-87.

Wheeler, R. E. M., Ghosh, A., & Deva, K. (1946). Arikamedu: An Indo-Roman trading station on the east coast of India. *Ancient India: Bulletin of the Archaeological Survey of India*, *2*, 17-124.

Wilson, A. (2015). Red Sea trade and the state. In F. De Romanis & M. Maiuro (Eds.), *Across the ocean: Nine essays on Indo-Mediterranean trade* (pp. 13-32). Brill.