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Lead isotopic provenance of some coins and other bronze items from an early Swahili site in Ibo Island (northern Mozambique)

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ABSTRACT

Northern Mozambique has traditionally been considered marginal within the Swahili trade of the western Indian Ocean due to the absence of outstanding harbour stone-built towns. However, our research on Ibo island (Quirimbas Archipelago) proves the role played by small coastal villages in the early development of the Indian Ocean trade route. In this paper, we discuss the result of a lead isotope analysis performed on samples of two coins and some fragments of a wire and chain recovered on a Swahili dwelling floor dated to the eleventh/twelfth centuries AD. They were probably cast with copper from mines in present-day Congo-Kinshasa. If so, then they are the most distant findings of copper from these ores to date. Along with other exotica, they point to the Middle Limpopo Valley as their most probable route of arrival in the Quirimbas and insert small local villages such as that on Ibo island within the wider Indian Ocean trade route system.

RÉSUMÉ

Le nord du Mozambique a traditionnellement été considéré comme étant marginal dans le commerce swahili de l'Océan Indien, et ce en raison de l'absence de villes portuaires bâties en pierre. Cependant, nos recherches sur l'île d'Ibo (archipel des Quirimbas) démontrent le rôle joué par les petits villages côtiers dans le développement précoce de la route commerciale de l'océan Indien. Dans cet article, nous présentons les résultats d'analyses isotopiques du plomb effectuées sur deux monnaies et quelques fragments d'un fil et d'une chaîne retrouvés sur le sol d'une habitation swahilie datant des onzième/douzième siècles après J.-C. Ces objets ont probablement été coulés avec du cuivre provenant de mines situées dans l'actuel Congo-Kinshasa. Si tel est le cas, il s'agit des découvertes les plus lointaines à ce jour de cuivre provenant de ces minerais. De même que d'autres objets exotiques, ils suggèrent que la vallée du Moyen Limpopo a servi de voie d'arrivée aux Quirimbas, et ils insèrent de petits villages locaux tels que ceux de l'île d'Ibo dans le réseau de routes commerciales de l'océan Indien.

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Introduction

The history of Sub-Saharan copper-based metallurgy is still poorly known, although recent research is improving our knowledge about copper mining and metal ingots that support the relevance of this activity, especially from the mid-first millennium AD (Killick 2014; Rademakers *et al.* 2018; Bandama 2020; Stephens *et al.* 2020, 2023). However, one of the most striking features of early metallurgy in this part of the world is the lack of evidence for metals other than copper and iron until maritime trade with the Islamic world commenced in the eighth or ninth centuries AD (Killick 2014: 522). Due to a later introduction of tin bronze metallurgy compared to Egypt and the Mediterranean region, the idea that southeast African coastal traders may have learned about bronze from Eurasians and diffused the idea into the region is still dominant (Bandama 2020: 5–6).

The identification and classification based on radiocarbon dates associated with the copper ingots found in the Copperbelt of Central Africa is a good base point from which to understand the exploitation of the area's copper mines and the relevance of the possible trade of this raw material to other regions. However, the great majority of copper objects from archaeological excavations in the southern third of Africa are not ingots and do not have distinctive shapes that could link them to the Copperbelt mines (Stephens *et al.* 2020: 2). Research based on chemical analysis and lead isotope analysis represents the strategy followed in papers concerned with the study of metals to infer the geological provenance of these copper objects (Rademakers *et al.* 2018; Stephens *et al.* 2023). The information acquired from this kind of analysis lets us not only discuss the provenance — and consequently the trade routes — of copper in relation to other materials (pottery, glass beads etc.), but also understand the use of tin/copper alloy as imported objects, recycled ones or evidence of regional production.

Environmental and historical context

The Quirimbas Archipelago consists of around 50 inshore coral platform islands, not all of them inhabited. They are located in northern Mozambique and administratively belong to Cabo Delgado province. Several of them, such as Ibo, Matemo, Quisiva, Vamizi, Quirimba and Medjunbe, support a small population of fishermen, while Ibo and Metundo, which is a private island, host tourist resorts for well-off foreign visitors. Shallow waters and a complex tidal regime, together with the lack of good harbours, make navigation from the African mainland difficult for boats other than the traditional dhows manned by expert sailors. Local climate is warm and arid, except for the rainy season, which runs from December to March/April, and most of the vegetation consists of mangrove and palm trees, along with some mango and papaya trees (Figure 1).

It seems probable that the Quirimbas Archipelago formed part of what in the tenth century AD the Muslim geographer al-Mas'ūdī (1989) described as the land of Zanj. According to him, it stretched between the Land of the Abyssinians to the north and the land of Sofala to the south. There are also indirect references to the Quirimbas and Cabo Delgado areas in other Arabic chronicles. In the twelfth century, for example, al-Idrisi mentions Sayuna as being a certain territory located around seven days' sailing into Sofala. Some authors (e.g. Pollard *et al.* 2018) think that this could

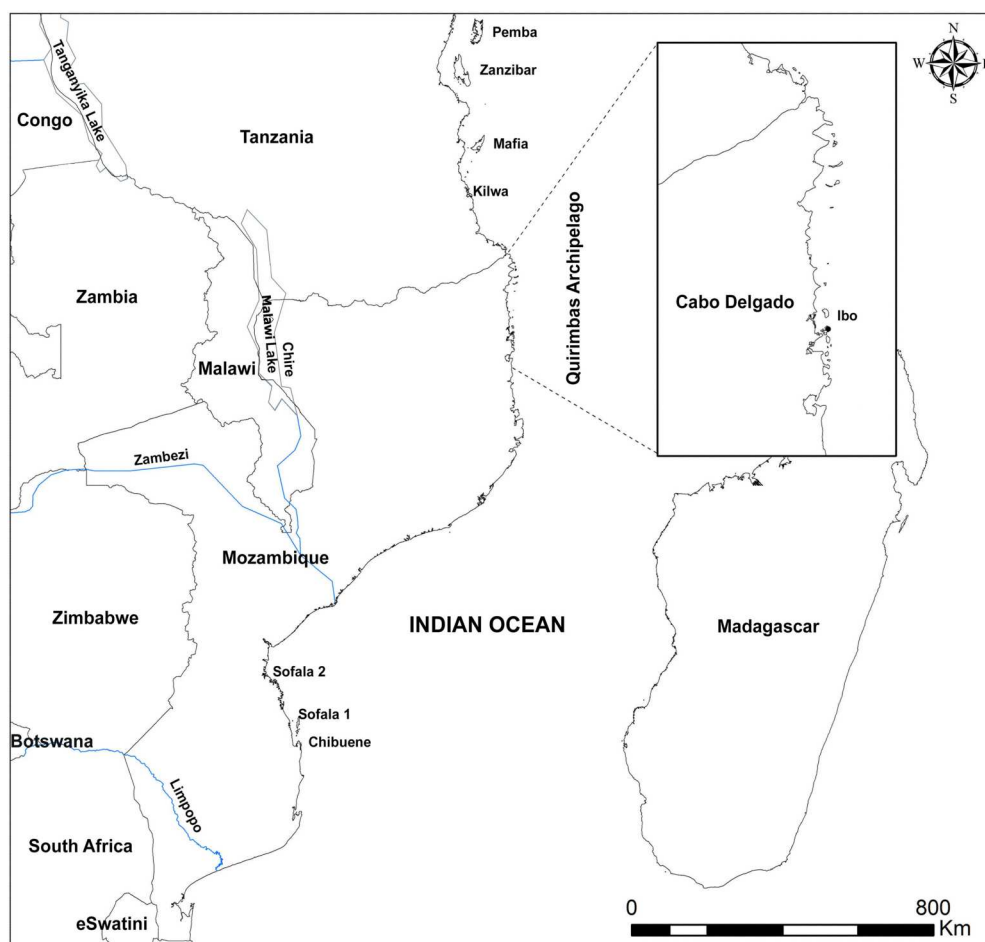


Figure 1. Location of the Quirimbas Archipelago within eastern Africa and the western Indian Ocean.

have been around the Rovuma River, which flows into the Indian Ocean in the Cabo Delgado area, opposite the Quirimbas. Later, the fifteenth-century traveller and writer Ibn Mājid mentions Wamizi island, which was inhabited by Muslim people, among other visible ports along the coast between Kilwa and Sofala. Some scholars identify Wamizi with Vamizi, one of the islands of the Quirimbas Archipelago (Pollard *et al.* 2018). Both the Pate and Kilwa Chronicles also refer to the Quirimbas, although the reliability of the first is questionable, including perhaps the statement that they were part of the territory conquered by that city in the fourteenth century (Chittick 1969). Meanwhile, the Kilwa Chronicle mentions that its deposed ruler, Hassan ibn Suliman, gathered his troops at Quisiva island in 1495 to try and recover his throne (Newitt 1972).

Further information about these islands comes from Portuguese chronicles, which describe them as being active in a local textile industry controlled by Muslim traders and as having close links to the Kilwa sultanate and to Zanzibar. The archipelago was conquered in the late sixteenth century by the Portuguese, who wanted to take control of the gold trade between the Zambezi area and the Kilwa sultanate (Newitt 1995: 23, 190–192).

In 1634 the Portuguese writer Antonio Bocarro used the word Quirimbas for the first time to describe the archipelago (de Mello-Ferrerira 1998: 323) and in 1820 Ibo became an important port of export of slaves headed to the Americas (Rita Ferreira 1982: 300).

Archaeological field campaigns

In 2015, we started an archaeological research project in co-operation with Eduardo Mondlane University of Maputo. Its aim was to investigate the involvement of the Quirimbas Archipelago in the Swahili trade network before the Portuguese arrived there. In 2015, we conducted a field survey on the islands of Quirimba, Matemo and Ibo (Figure 2A). Our findings led us to focus our investigation on Ibo, where we opened several 2 × 2 m test pits in the main square of the Portuguese village (C-100, C-200, and C-300 respectively) (de Torres *et al.* 2016; Ruiz-Gálvez *et al.* 2017; Ruiz-Gálvez 2021) (Figure 2B).

In 2016 we opened a 4-m² test pit that was oriented northwest/southeast that we labelled C-400 next to the seashore and a nineteenth-century Portuguese stronghold (Figure 2B). Its upper levels were disturbed and mixed with handmade Lumbo type sherds together with China and European ceramics. This disturbance was due to the building and use of the stronghold, which had in part dismantled a previous Swahili settlement. Beneath the disturbed level, a sterile layer of sand corresponding to a barren dune running southeast/southwest partially sealed an approximately 20-cm-thick dwelling floor. It consisted of dark, organic soil that was rich in archaeological items and organic rubbish. The test pit was enlarged by another 4 m² and in 2017 transformed to an open area excavation measuring 22 m² in total. The dwelling floor was labelled Stratigraphic Unit (SU) 405. It was surrounded by a 40-cm-wide by 12-cm-thick almost semi-circular structure of cemented litter, made of a sea turtle scapula, large sherds of handmade pottery that fit together and were apparently broken *in situ*, glass and shell beads, wheel-made sherds, several spindle whorls, a few metal items and one very worn-out coin (SU 409). In addition, we recorded an almost square, compact vermilion/ruby-coloured structure with charcoal fragments that we interpreted as a fireplace (SU 408), plus two postholes (SU 410 and 411) that interrupted the semi-circular litter structure (SU 409). We read the whole structure as being a wood or wattle and reeds hut or windscreen measuring around 11 m² in size, the inner frame of which helped to retain the domestic rubbish. Most of the abundant finds of bones, pottery and shells came from inside the area delimited by SU 409, being otherwise very scarce outside it (SU 407) (Figure 3).

Local pottery belongs to the Lumbo tradition (Duarte 1993.) Shapes are predominantly hemispherical and the most frequent decoration combines comb- or roulette-impressed patterns delimited by incisions or by bands of parallel lines of comb impressions (Ruiz-Gálvez 2020; Ruiz-Gálvez *et al.* in prep.) (Figure 4 above).

Among the imported ceramics we note the following:

IBO16-740: a glazed monochrome blue-green coloured potsherd with the glaze covering both the interior and exterior of the sherd of Sasanian tradition, type TURQ JR5 from the Persian Gulf (Priestman 2013: 555–556, Plate 64);

IBO16-707: a fragment of bowl with green glazed decoration at the interior. This likely belongs to the Monochrome Green Glazed Ware type from southern Iran (Priestman 2013: 596 Plate 101);

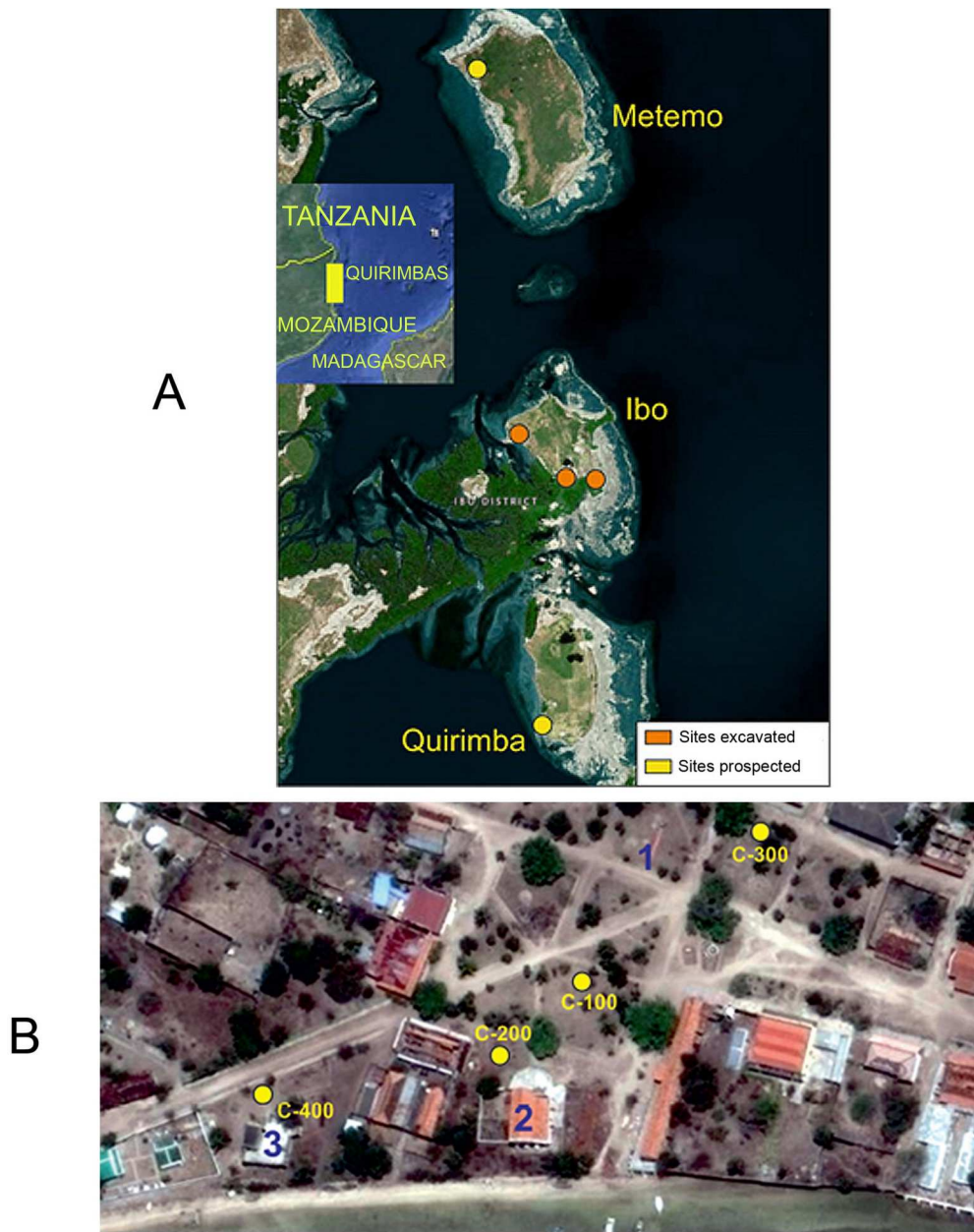


Figure 2. Location of archaeological research within the Quirimbas Archipelago: A) on Matemo, Quirimba and Ibo; B) Location of the test pits and excavations on Ibo: 1) Ibo main square; 2) Portuguese church; 3) Portuguese stronghold. Archaeological interventions: C-100, C-200 (sterile), C-300 and C-400.

IBO 16-633 and IBO17-314: two thin-walled potsherds of pale yellow-brown colour and a mould-made floral or geometric pattern. They may correspond either to the Moulded Eggshell Ware from southern Iraq or to the White Moulded Ware known from southern Iran. (Priestman 2013: 505-510, Plates 25-28);

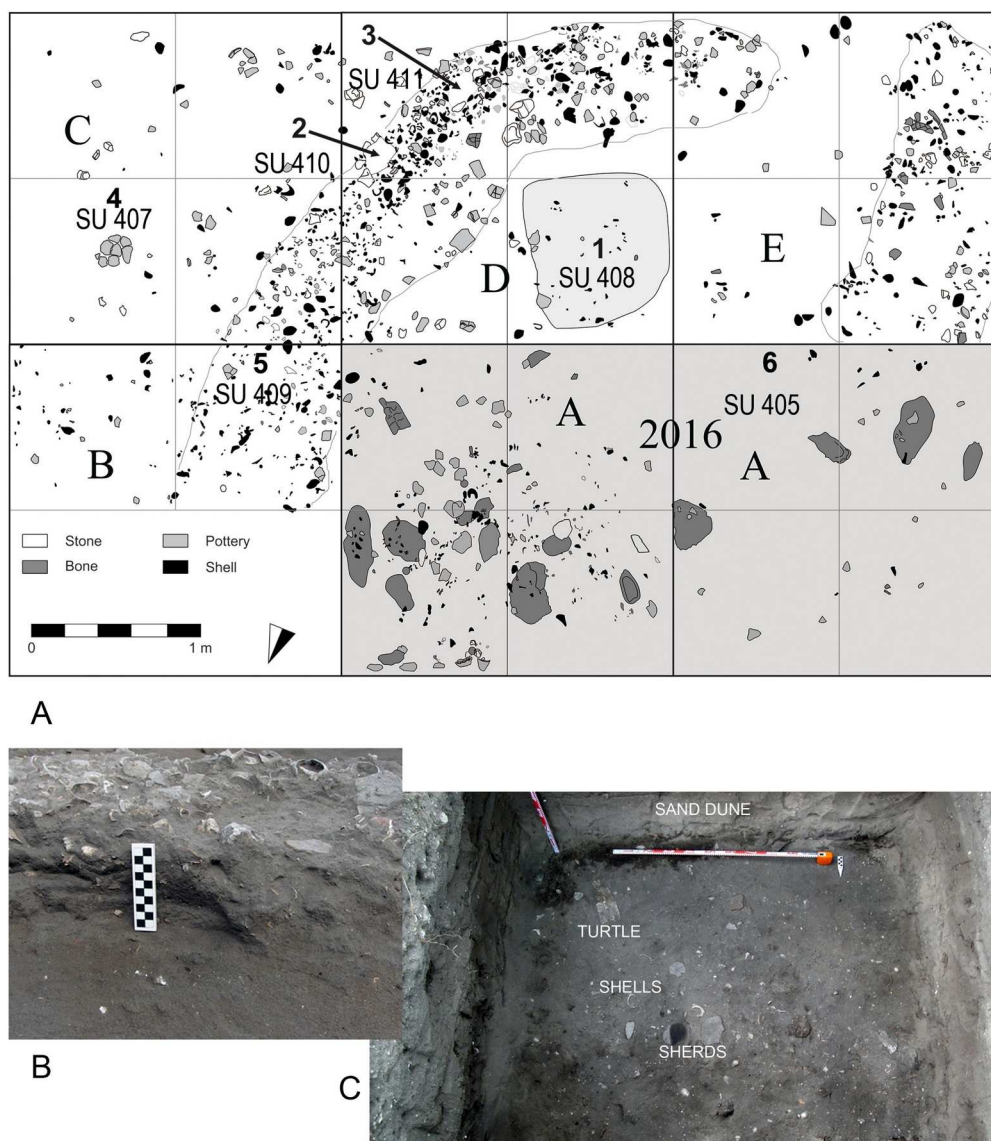


Figure 3. Ibo: the Swahili hut found in the main square: A) plan of the excavated contexts: 1) almost square hearth (SU 408); 2 and 3) negative imprint of postholes (SU 410, SU 411); 4) area outside the hut (SU 407); 5) cemented litter (SU 409); 6) living floor (SU 405); B) photograph of the cemented trash; C) photograph of the 2016 excavation with the dwelling floor and part of the sand dune respectively at the rear and on the right.

IBO17–220: a sherd of the Monochrome Mustard Sgraffiato type, Graf LY produced in southern Iran (Priestman 2013: 594, Plate 100);

IBO17–313: an emerald-green glazed sherd that could either belong to the TURQ T type from the Persian Gulf (Priestman 2013: 555–556, Plate 66) or to an Early Monochrome Green Sgraffiato type GRAF.EG of southern Iran (Priestman 2013: 580–581, Plate 88). Three other glazed sherds could not, unfortunately, be identified. One of

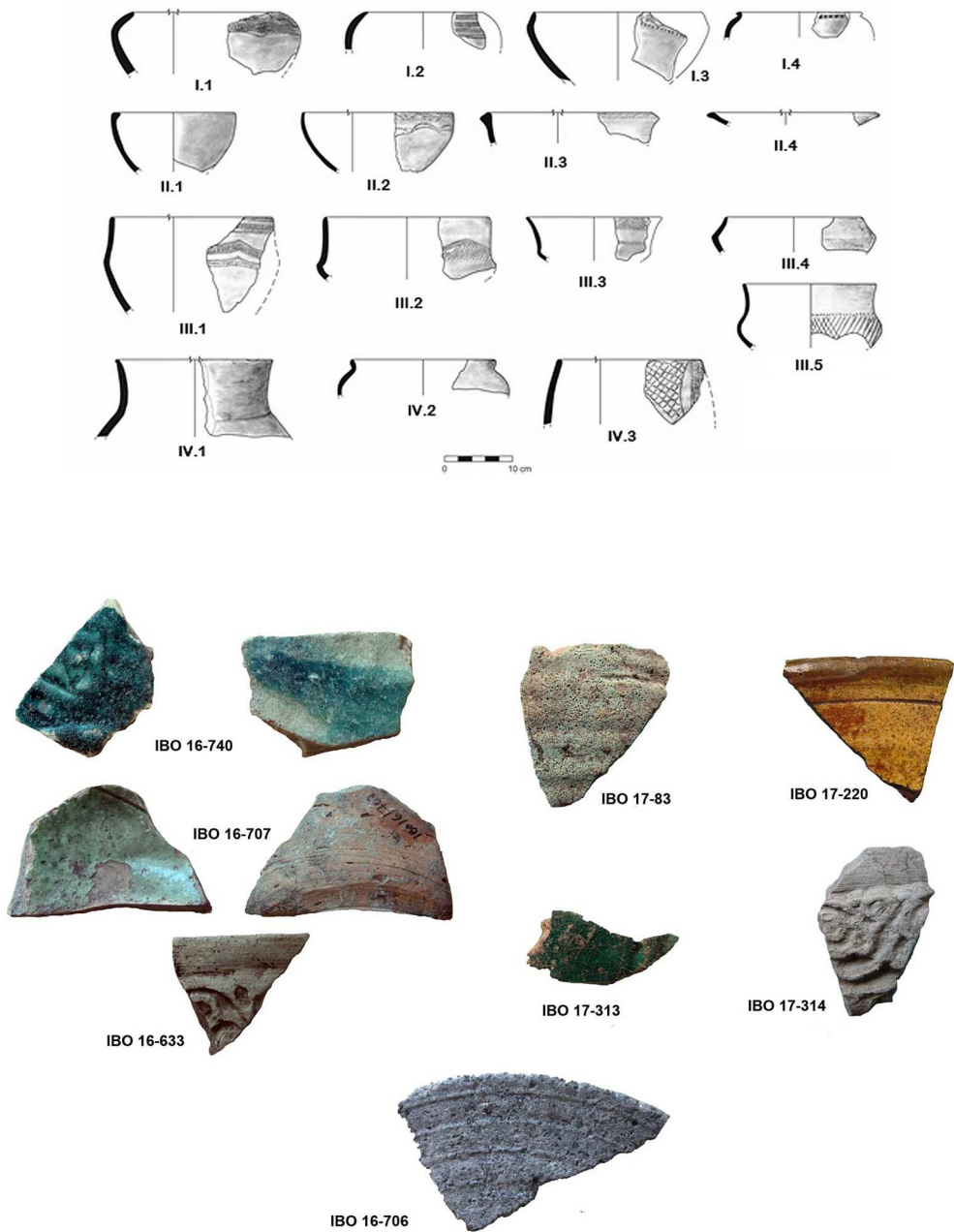


Figure 4. Ibo: examples of recovered ceramics: top) main shapes and decorations of handmade local pottery; bottom) wheel-made ceramic imports and a fragment of soft-stone ware.

them, IBO17-83, has a green glazed colour at the exterior, but is poorly preserved. The other two are glazed monochrome brown colour interior and exterior (Figure 4 below).

Plumbic and alkaline compositions identified by archaeometric analysis in most of these glazes are technologically compatible with the so-called Samarra glazes produced

in the Lower Mesopotamian area (García-Heras *et al.* 2019, 2021: 299; Ruiz-Gálvez 2020; Agua 2022 *et al.*).

Also noteworthy is a plain fragment of a soft-stone ware, probably a lid, recovered from SU 405 and labelled IBO 16–706. Its geological composition includes coesite, inesite and leuchtenbergite (García-Heras *et al.* 2019). Analysis suggests a twelve-century date and an origin in either Iran or Oman. Soft-stone quarries were also exploited at that time at Vohémar in Madagascar (Sitivikis *et al.* 2018; Pradines 2019: 123) (Figure 4 below).

Glass beads occurred in both the disturbed upper levels and the lower Swahili dwelling area. Analysis of a small sample of them allowed us to distinguish a first group of mineral soda alumina glass produced somewhere on the western coast of India, a second group of vegetal-soda glass from Central Asia and a third group of shell beads of local production. One soda silicate bead with zinc oxide coming from the upper disturbed levels was of modern European manufacture (García-Heras *et al.* 2021).

We recovered two coins by sieving sediment from the dwelling floor (SU 405 grids A and D), while as noted previously a third formed part of the cemented trash of SU 409. A metal chain was also found in SU 409 grid D and other metallic fragments in a variety of areas (SU 401 surface; SU404 interface to SU 405, SU 405 grids A and E, SU 407 grids C–D and SU 410, a posthole) (Figures 3, 5 and 8) (Ruiz-Gálvez *et al.* 2017; Ruiz-Gálvez 2020).

Two AMS radiocarbon dates calibrating respectively at two-sigma to cal. AD 1011–1164 (D-AMS-022046, 1330 ± 28 BP) and cal. AD 1062–1212 (GrM-14830, 1265 ± 20 BP) were obtained from two samples of marine tortoise scapulae; both were calibrated using OxCal 4.3.2 (Bronk Ramsey 2017) and the r5 marine calibration curve (Reimer *et al.* 2013). Dating of two other samples on terrestrial mammal bones sent to the same Teledyne Direct AMS and Groningen radiocarbon laboratories proved unsuccessful.

Material and methods

Coins and metal description

The three coins found are in very poor condition due to the sandy environment from which they were recovered, which is rich in salt, rendering any inscription on them undecipherable (Figure 5). In 2016 the Mozambican Heritage Authorities permitted the temporary export of coin 1 (SU 405A) for study. The Coins and Medals Department of the Spanish Archaeological Museum (*Gabinete de Monedas y Medallas del Museo Arqueológico Nacional*) examined it but could not determine which was its obverse side and which its reverse. However, it was possible to read the letter Lam (ل), likely the last letter of a word or phrase, on one of the sides. On the other hand, the die-axis from when the coin was struck is visible on both sides. The coin has a diameter of 15 mm, but no information exists regarding its weight.

Coin 2 (SU 405D) is 15 mm in diameter, although a fragment is missing, and currently weighs 0.54 grams. Both the obverse and reverse sides are illegible and there are no visible die traces (Figure 6 top).

Coin 3 (SU 409D) is 15 mm in diameter and currently weighs 0.72 grams. There is a sign on one of its sides, perhaps an Arabic character, as well as a tiny hole pierced next to one rim, so it could have been worn as a pendant or personal possession. There are no visible die traces (Figure 6 bottom).



Figure 5. Ibo: coins found at the C-400 site.

Photographs of the three coins were sent to Dr John Perkins, of Flinders University, Australia, an expert on Swahili coins, for his assessment on identification. However, as they were corroded and illegible, he could not assist us.

Coins 2 and 3 were also temporarily exported for analysis and samples of them were taken for lead isotope analysis. A third sample was extracted from the wire or chain fragment.

Three-dimensional scan model of the coins

A three-dimensional scan model of coins 2 and 3 was generated in an attempt to see their surfaces a little better. Both coins were photographed with a CANON EOS camera. A ZEISS Stemi 305 microscope was used to obtain more detailed information about the coin surfaces. In addition, they were scanned with a DAVID three-dimensional SLS-2 Scanner using a small scale coupled to the size of the pieces for a more accurate analysis. As other recent publications have shown (e.g. Friess 2012; Kolobova *et al.* 2019), by applying these kinds of micro-photogrammetric technologies, researchers are able to

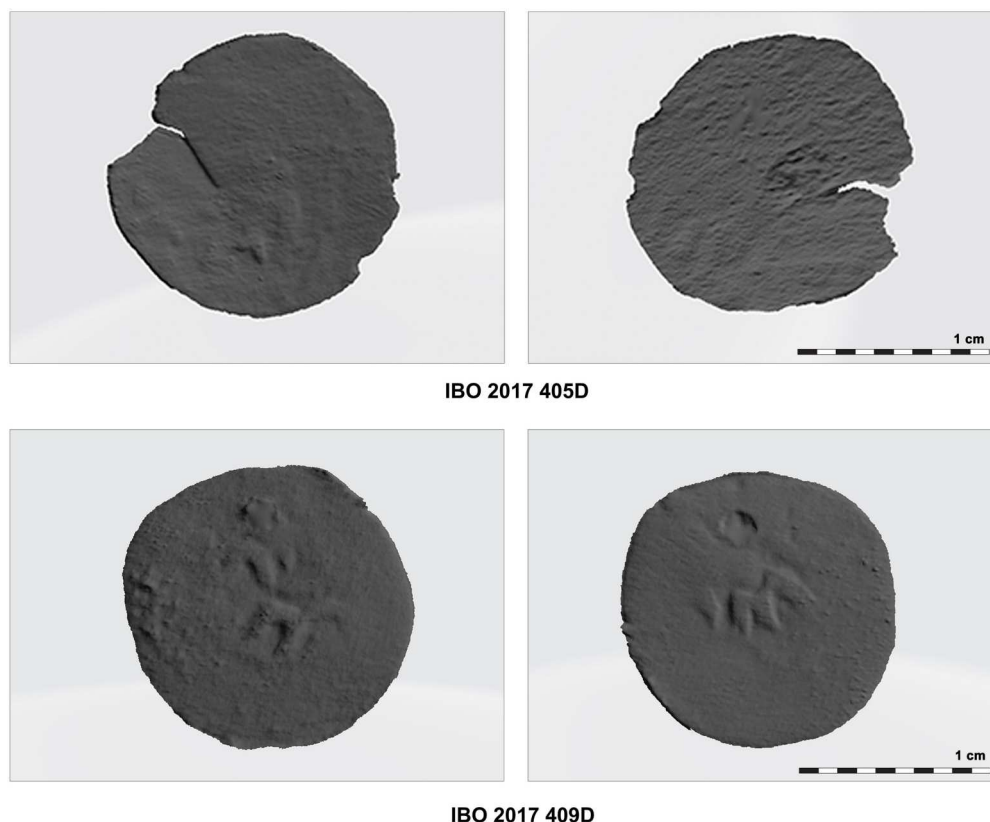


Figure 6. Ibo: scans of the obverse and reverse faces of coin 2 from SU 405 (top) and coin 3 from SU 409 (bottom).

obtain more exact images of the three-dimensional forms of archaeological items and obtain important results as well (see also Courtenay *et al.* 2019; Maté-González *et al.* 2019).

As shown in the figures, the scans made on both coins have provided a different insight into the metal surfaces and therefore new results. On the one hand, coin IBO17 405D shows silhouettes on both sides that could be used to search for similarities with other numismatic pieces. Additionally, it exhibits some scraping marks on one of the edges. However, its other side is more affected and eroded, leaving us unable to ascertain any particular form that could help in our research. Nonetheless, the zoomed photographs taken with the camera show that the coin surface has been highly affected with erosion reaching the point that the metal has lost its protective layer of oxide to expose the original material beneath.

Although the images obtained by the camera and the microscope are very precise, some of the reliefs showed by the DAVID 3D-scan are unique. In any archaeological analysis it is therefore important to contemplate the possibilities that these three-dimensional models may be able to provide better results.

Elemental analysis

Two coins (SU 405D and SU 409D) and the fragment of a chain or wire ornament (SU405E n°12) were initially analysed by x-ray fluorescence (XRF) with Olympus Innov-X Systems Delta Premium equipment from University College London (Table 1). The other seven fragments and the chain (SU 405E n°12) were analysed with INNOV-X Alpha equipment from the National Archaeological Museum in Madrid (Table 2). Two analyses were performed on each item, the first on the surface (patina) and the second after cleaning on a small area but without reaching the metal core, due to the advanced corrosion process in all the items. Table 2 shows only the post-cleaning results as these are more representative of the original composition. The chain (SU 405E n°12) was analysed using both pieces of equipment and the results obtained are in full agreement with each other.

The composition of the two coins shows differences from that of the rest of the items. While the coins used an alloy with very low amounts of tin (~1.5% Sn) and lead (5–7% Pb), the wires and chain links contain a higher quantity of tin (5–11% Sn; average of 7.5%) and almost no lead in the alloy (0.2–0.3% Pb). After this elemental analysis we classified these metal items, following the proposal of Pollard *et al.* (2018: 115–120), as tin bronze in the case of the chain links and wire fragments and leaded bronze (Sn, Pb both >1%) in that of the coins.

The minor and trace elements identified also differ, with nickel, zinc and antimony present in the coins but falling below the limit of detection in the other artefacts. Arsenic and silver are nearly absent in both groups, with the former detected in a few items but always in a very low proportion (<0.1%).

A comparative study of the coins using the analysis published by Perkins (2013: Appendix B) made at the British Museum Research laboratory using XRF reveals that the new coins from Ibo cannot be assigned to any of the known individual Swahili rulers (Perkins 2013: 170, Table 5). The bivariate plot (Figure 7) comparing the tin and lead in the alloy shows both coins from Ibo in a separate position, while the closest coins with low amounts of tin in the alloy are BMRL 2 and 17 (both of al-Hasan Ibn Sulaiman A). Moreover, these coins show a trace element composition that is different from that of the other coins in their group in that it is without nickel, arsenic or antimony. Arsenic is an element that characterises all the coins analysed by Perkins (2013), but this element is completely absent in the Ibo coins (Figure 7C).

The plot comparing nickel and antimony (Figure 7B) shows the Ibo coins in a separate position with BMRL 19 and 38 as the closest coins (from al-Hasan Ibn Sulaiman A and Ali Ibn al-Hasan A). However, although the low proportion of tin is found only in the

Table 1. Elemental analysis of coins and chain links from Ibo using pXRF (Innov-X Systems Delta Premium). Values in weight %. LOD = Limit of detection.

Object	Fe	Ni	Cu	Zn	As	Ag	Sn	Sb	Pb	Bi
Coin SU405D – patina	0.59	0.23	87.6	0.19	<LOD	<LOD	1.68	0.14	9.57	<LOD
Coin SU405D – clean	0.40	0.22	90.0	0.20	<LOD	<LOD	1.37	0.14	7.59	<LOD
Coin SU409D – patina	0.61	0.14	91.9	0.30	<LOD	<LOD	1.63	0.30	4.95	0.05
Coin SU409D – clean	0.60	0.13	91.7	0.30	<LOD	<LOD	1.54	0.30	5.33	0.04
Chain SU405E 12 – patina	0.3	<LOD	92.3	<LOD	<LOD	<LOD	7.16	<LOD	0.25	<LOD
Chain SU405E 12 – clean	0.25	<LOD	92.5	<LOD	<LOD	<LOD	7.06	<LOD	0.21	<LOD

Table 2. Elemental analysis of chain links and wire samples from Ibo using pXRF (innov-X Alpha equipment) of metal fragments from Ibo. Values in weight %. LOD = Limit of detection.

Analysis	Object	ID	Mass (g)	Fe	Ni	Cu	Zn	As	Ag	Sn	Sb	Pb	Bi
PA27571	Chain link	IB016-SU401	0.041	0.31	<LOD	88.0	<LOD	0.1	<LOD	11.3	<LOD	0.3	<LOD
PA27572	Chain link	IB016-SU404	0.064	0.37	<LOD	92.1	<LOD	0.09	<LOD	7.24	<LOD	0.25	<LOD
PA27573	Chain link	IB017-SU410	0.088	0.27	<LOD	91.4	<LOD	<LOD	<LOD	7.96	<LOD	0.22	<LOD
PA27574	Wire	IB017-SU410	0.054	0.58	<LOD	92.7	<LOD	<LOD	<LOD	6.21	<LOD	0.48	<LOD
PA27575	Chain link	IB016-SU405A	0.16	0.37	<LOD	92.9	<LOD	<LOD	<LOD	6.41	<LOD	0.20	<LOD
PA27576	Wire	IB017-SU405E 14	0.075	0.4	<LOD	91.7	<LOD	<LOD	<LOD	7.65	<LOD	0.20	<LOD
PA27577	Chain	IB017-SU405E 12	1.76	0.5	<LOD	92.8	<LOD	0.08	<LOD	6.42	<LOD	0.19	<LOD
PA27578	Wire	IB017-SU407C-D	0.087	0.57	<LOD	93.6	<LOD	0.08	<LOD	5.54	<LOD	0.19	<LOD

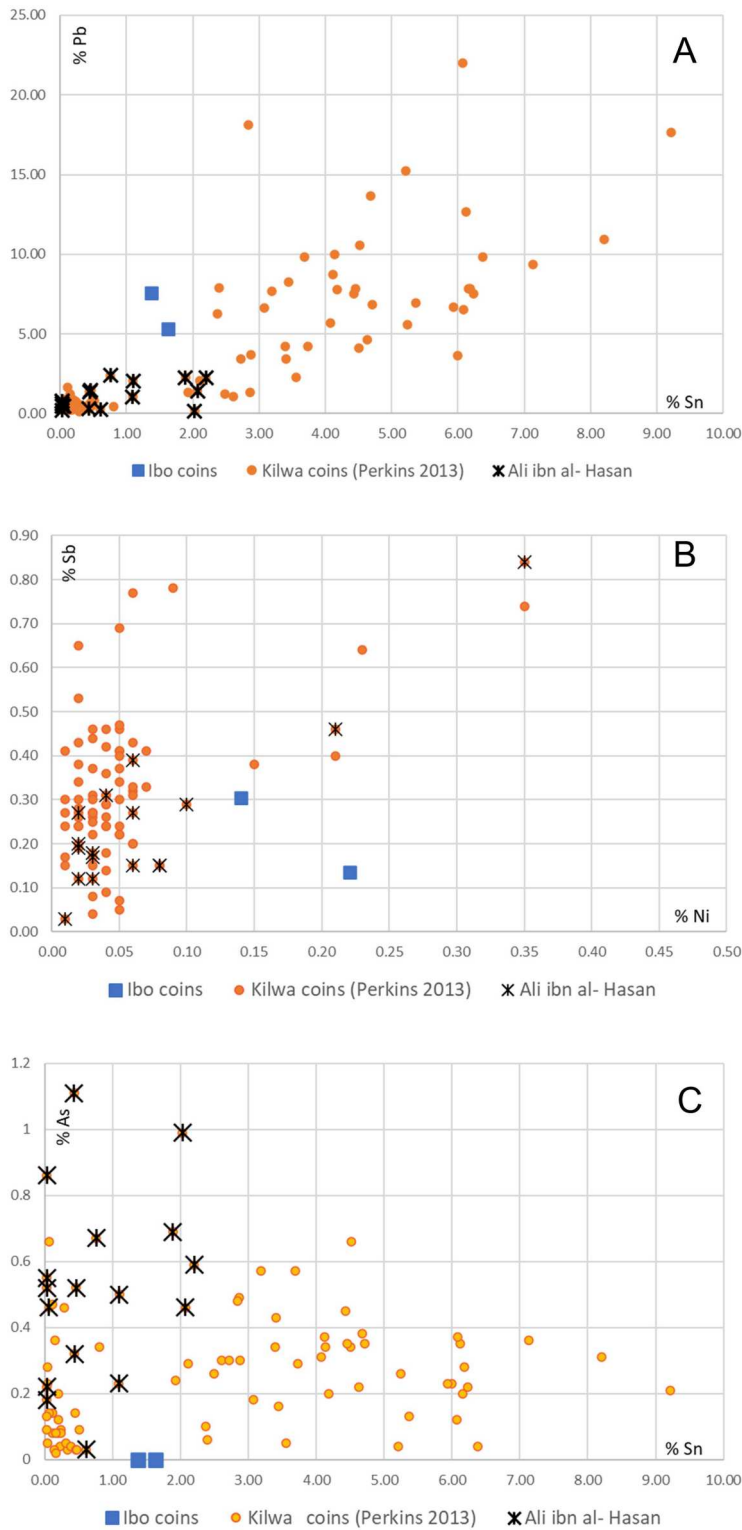


Figure 7. Composition of the Ibo coins (SU 405D and SU 409D) compared with those from Kilwa studied by Perkins (2013): A) tin versus lead; B) nickel versus antimony; C) tin versus arsenic.

coins of the first group (that linked to Ali Ibn al-Hasan) and arsenic is the main impurity, their high lead content and the absence of arsenic in the Ibo coins are the main differences between these early coins, which date to the twelfth century AD (Perkins 2013: 228, Table 6). The fact that the XRF analyses were performed on mineralised samples could result in a certain deviation in the real proportions of lead and tin. Both elements usually have a surface enrichment as can be seen in our XRF analysis, mainly in lead: from 9.5% to 7.5% Pb in coin 405D and from 5.3 to 5% in coin 409D. However, the percentage of lead is too high to fall to the levels of the Ali ibn al-Hasan coins, with the highest value at 2.4% Pb (BMRL 1715).

In any case, analysis of the metal alloy indicates that the Ibo coins could be in an intermediate position between the two chronological groups defined by Perkins (2013), with low tin levels typical of the early group and higher lead values typical of the second group. Given that all the coins analysed by Perkins (2013) contain an average amount of arsenic ranging from 0.2 to 0.7%, and that this is even higher in the earlier group, the absence of arsenic in the Ibo coins could be associated with a change in the copper resources at this intermediate moment. However, we do not have any analytical references of earlier coins that could better match the chronology of the Ibo site (eleventh-twelfth centuries AD).

Provenance by Lead Isotope Analysis

Samples from two coins (SU 405D and SU 409D) and from the chain (SU 404) (Figure 8) were also sent to the Geochronology Service (SGIker) at the University of the Basque Country, Spain, where they were dissolved and prepared for measurements using a multi-collector inductively-coupled plasma mass spectrometer (MC-ICP-MS) (see Rodríguez *et al.* 2020 for details of the analytical description). The results (Table 3) were

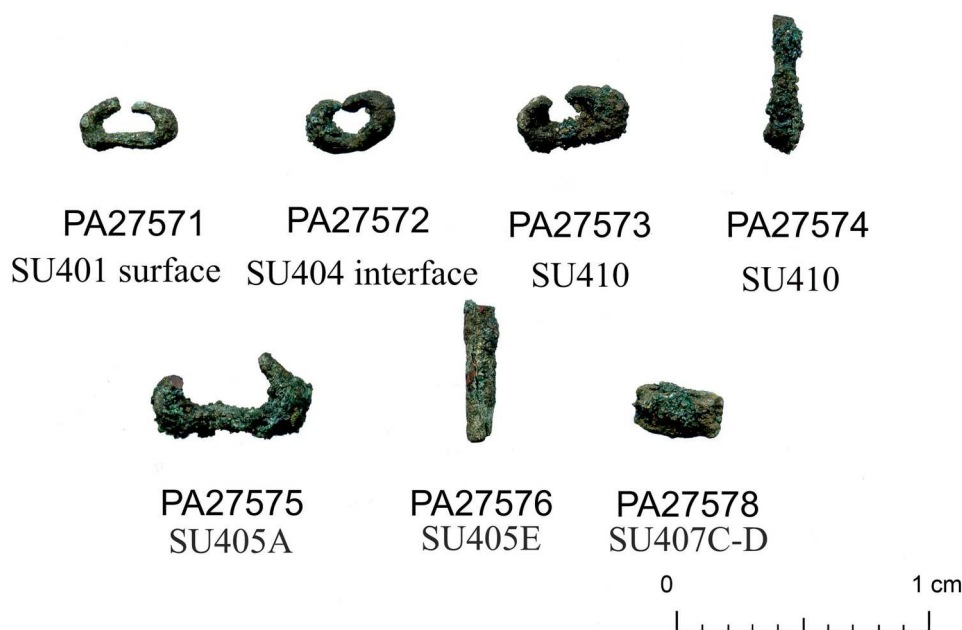


Figure 8. Fragments of bronze chain found in different areas of the Ibo C-400 site.

compared with geological data from African resources obtained from recent papers (Kříbek *et al.* 2016; Rademakers *et al.* 2018, 2019; Bolhar *et al.* 2020; Stephens *et al.* 2023) and the database offered by Killick *et al.* (2020), as well as a recent compilation of geological data from Eurasian ores by Tomzyk (2022). We also compared the lead isotope analysis data obtained with other second-millennium archaeological items published in those papers as references of the real metals in use at that time in Africa.

Results

The three archaeological lead isotope results are concentrated in a short range of values when compared with the wider distribution of the African geological data (Figure 9). This wide range reflects the wider span of geological time of formation of these deposits (3300–400 mya) (Killick *et al.* 2020: 95). Most of the sources are not compatible with the data from Ibo. This is confirmed by the distribution of the lead isotope analysis performed on the copper ingots (Stephens *et al.* 2023) and metals from other African sites, such as those in the Niara Basin of Congo-Brazzaville (Rademakers *et al.* 2018), the Upemba Depression of Congo-Kinshasa (Rademakers *et al.* 2019), the Tsodilo Hills of Botswana (Stephens *et al.* 2020) and bronzes from sites in South Africa (Molofsky *et al.* 2014). Most of this archaeological copper matches the lead isotope ratios of ores from the Copperbelt ore deposits of Katanga, Congo-Kinshasa. This is formed of several mining districts, each with different isotopic fields, some of which are not yet

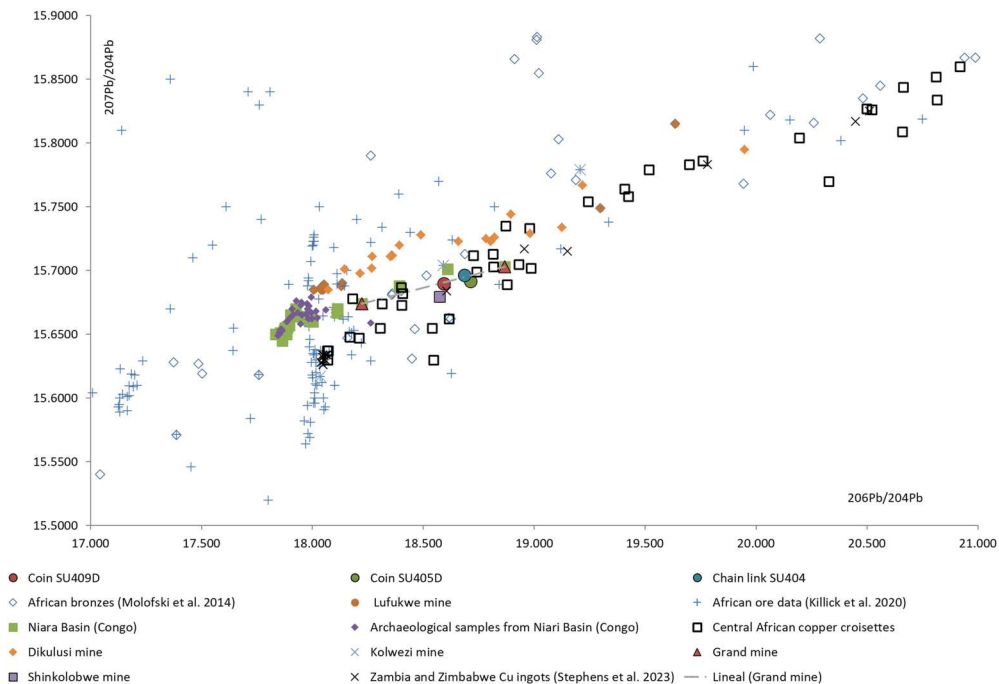


Figure 9. Results of the lead isotope analysis of Ibo metal artefacts (coins SU 405D and SU 409D, chain link SU 404) compared with those of the main copper ores from different African regions (Killick *et al.* 2020) and copper ingots and metals from Africa.

Table 3. Lead isotope analysis of metal artefacts from Ibo using MC-ICP-MS.

Sample	$^{206}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{207}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{208}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{208}\text{Pb}/^{206}\text{Pb}$	Error (2SE)	$^{207}\text{Pb}/^{206}\text{Pb}$	Error (2SE)
Coin SU405D	18.7154	0.0008	15.6912	0.0007	39.2227	0.0021	2.09570	0.00005	0.83841	0.00001
Coin SU409D	18.5937	0.0008	15.6895	0.0007	38.8535	0.0019	2.08960	0.00004	0.84380	0.00001
Chain link SU404	18.6867	0.0009	15.6960	0.0008	39.0071	0.0022	2.08743	0.00004	0.83996	0.00001

fully characterised. For example, the Grand Mine in Boko Songho has seen only two lead isotope analyses with extreme values of 18.2 and 18.9 in their $^{206}\text{Pb}/^{204}\text{Pb}$ ratios (Figure 9) (Rademakers *et al.* 2018).

Although we cannot match the Ibo metals with sources on the Copperbelt at this time, some options are open for future research. The closest ore to the coin SU 409D is the galena from the Shinkolobwe mine in the Congo Basin (Willet and Sayre 2006: Table 1). This coincidence is important because both coins are leaded bronzes and in this case the lead isotope analysis results could be related to the lead. However, chain SU 404 is made of bronze with only 0.2% Pb and the analysis reflects a similar provenance to that of the coins. Thus, the Cu-Fe-Pb-Zn sulphides from the Congo Basin could explain the common provenance for all three objects. The Shinkolobwe mine confirms that using lead isotope analysis results from geological samples is actually very limited and emphasises the need for more research to understand pre-European metal production in Africa (Killick *et al.* 2020).

Other options should also be considered. The first of these is a possible provenance of the metal from the Islamic world, the second the use of recycled metal from a variety of origins. The option of metal coming from the Islamic regions of North Africa and Asia can be rejected based on the different alloys used. After Craddock (1979), the most striking feature of Islamic metalwork is the general replacement of bronze by brass, except for making mirrors. Craddock (1979: 75) summarised his research with this sentence:

‘The Islamic brasses dealt with in this paper date from the tenth to the sixteenth centuries A.D., and the alloys for cast and sheet work were fairly static through this period, yet clearly, they are in some respects radically different from their Late Roman precursors of some 500 years previous.’

New research in recent years in all regions of the medieval Islamic world, including the Iberian Peninsula (La Niece *et al.* 2012; Gener *et al.* 2014; Orfanou *et al.* 2018; Bottaini *et al.* 2022), has confirmed this general trend, with zinc as the main alloyed element and copper-tin bronze being an exception.

Although both coins contain a small amount of zinc (0.2%) and the low percentage of tin could suggest recycled metal, the composition of the wire and chain excludes the use of Islamic metal, whether fresh or locally recycled. Both the coins and the wire are located in the same isotopic region, although certain differences in the representation of minor elements could suggest a different provenance for copper. In any case, if lead provenance is identified in the coins and copper in the wire, this suggests that we are dealing with a region from which both metals could be obtained. Once again, Cu-Fe-Pb-Zn sulphides from some areas in the Copperbelt of Congo-Kinshasa could eventually be considered as future options for research.

The recycled metal option needs an end point in the theoretical mixing line located in a region with values of $^{208}\text{Pb}/^{204}\text{Pb}$ higher than 39.2 (Figure 10) but lower than 0.838 in the $^{207}\text{Pb}/^{206}\text{Pb}$ ratio (Figure 11). This does not fit any consistent isotopic field in the Tomzyck (2022) database, although it does match isolated data from Mitterberg (Austria), certain mines in Morocco and southern Iberia and one sample each from Yahyali Town (Turkey) and Masirah Island (Oman). In other words, there is no realistic evidence to support the use of mixed metal.

The lead isotope and the elemental analyses of the Ibo metals are thus not sufficiently conclusive as regards provenance and the copper trade. We must therefore await future research to confirm whether African copper was used in the early Swahili period.

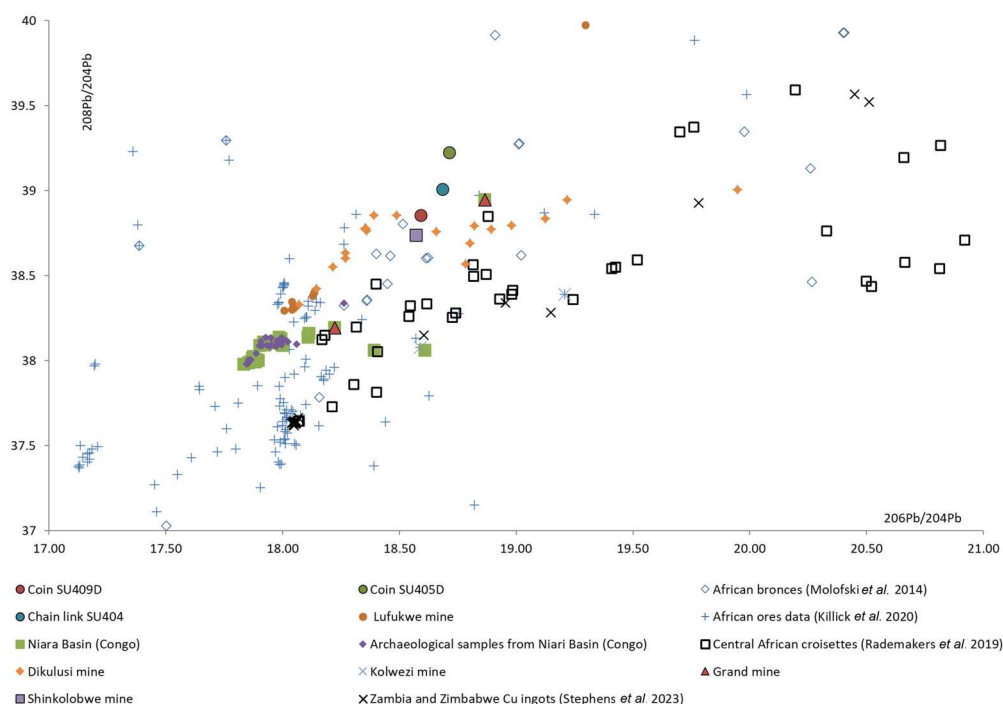


Figure 10. Results of the lead isotope analysis of Ibo metal artefacts compared with the same data as in Figure 9 but using different isotopic ratios to show changes in the relative position of the isotopic fields.

Origin of the copper ores and trade connections

Despite their poor condition and the fact that we cannot claim that our coins belong to a Swahili mintage, a link can be established with Swahili coins in general and, more specifically, the copper coins struck at Kilwa in particular, since the Quirimbas were networked into the gold trade that connected the Limpopo and Zambezi areas of southern Africa to that Swahili city. Lead isotope analysis of our two coins shows that they were minted in leaded bronze instead of copper as is frequently affirmed of Swahili coins (Wynne-Jones and Fleisher 2012: 5; Perkins *et al.* 2014: 11). On the other hand, Mapunda (2018: 308–310) stresses the difficulty of distinguishing copper from bronze when dealing with very weathered archaeological items, as is the case with both our coins and most Kilwa coins. This holds true especially when these coins, as in our case, have a very low tin content.

As mentioned earlier, despite their bad condition and illegibility, our coins share common characteristics with those minted at Kilwa. Most of the Kilwa copper coins analysed by Perkins (2013) are also corroded due to the salty environment of the dunes and soils in which they were found. Those that are well-preserved weigh between 0.5 and 3.0 g and measure 19–22 mm in diameter, although the average weight of those from Songo Mnara is lower (Fleisher and Wynne-Jones 2010: 495; Wynne-Jones and Fleisher 2012: Table 3; Perkins 2015.) Our coins are smaller and lighter than these, yet this could be due to their poor preservation, while at least one may have traces of a die (coin 1 – SU405A), as also happens with the Kilwa coins.

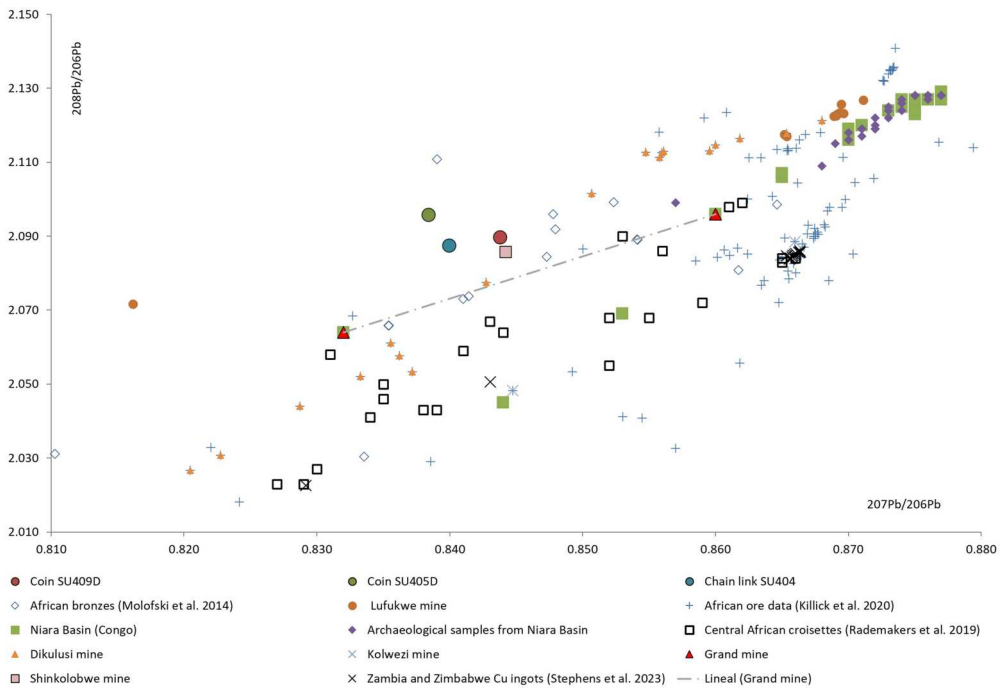


Figure 11. Results of the lead isotope analysis of Ibo metal artefacts compared with the same data as in Figures 9 and 10 but using different isotopic ratios.

Pierced coins like the one from Ibo are known from several Swahili towns, including Songo Mnara. In Wynne-Jones and Fleisher's (2012: 32–33) view, these could have been worn as ornaments and talismans. As at Songo Mnara, our three coins come from a domestic context (Wynne-Jones and Fleisher 2012: 28, 32) and could thus have been used both as a local means of exchange and as personal possessions with symbolic and protective connotations.

Lately, Mapunda (2018: 309) has objected to the consensus on the foreign origin of African copper (Arabia, India or China) since there are copper ores in the inner African continent, from Uganda to Congo-Kinshasa, some of which were certainly exploited from the early first millennium AD. More recently, archaeological research and archaeometallurgical analyses have documented the early exploitation by local miners and nearby crafters of malachite and azurite from the Lolwe Hill mine of eastern South Africa between the tenth and thirteenth centuries, including production of ingots and other items within a domestic context (Moffett 2020: 7–8; Moffett *et al.* 2020) (Figure 12).

Moffett (2020: 6) points to other possible early sources of copper, among them the Copperbelt region of northern Zambia and Katanga. Their ores are known to have been extracted since at least the mid-first millennium AD, with trade networks expanding thereafter, probably in association with the emergence of centralised polities, as suggested by mortuary evidence from graves of the mid-eighth- to thirteenth-century Kisalian culture in the Upemba Depression, many of which are rich in copper items (Figure 12) (de Maret 2013). Indeed, Katangan-sourced ingots in the form of crosses,

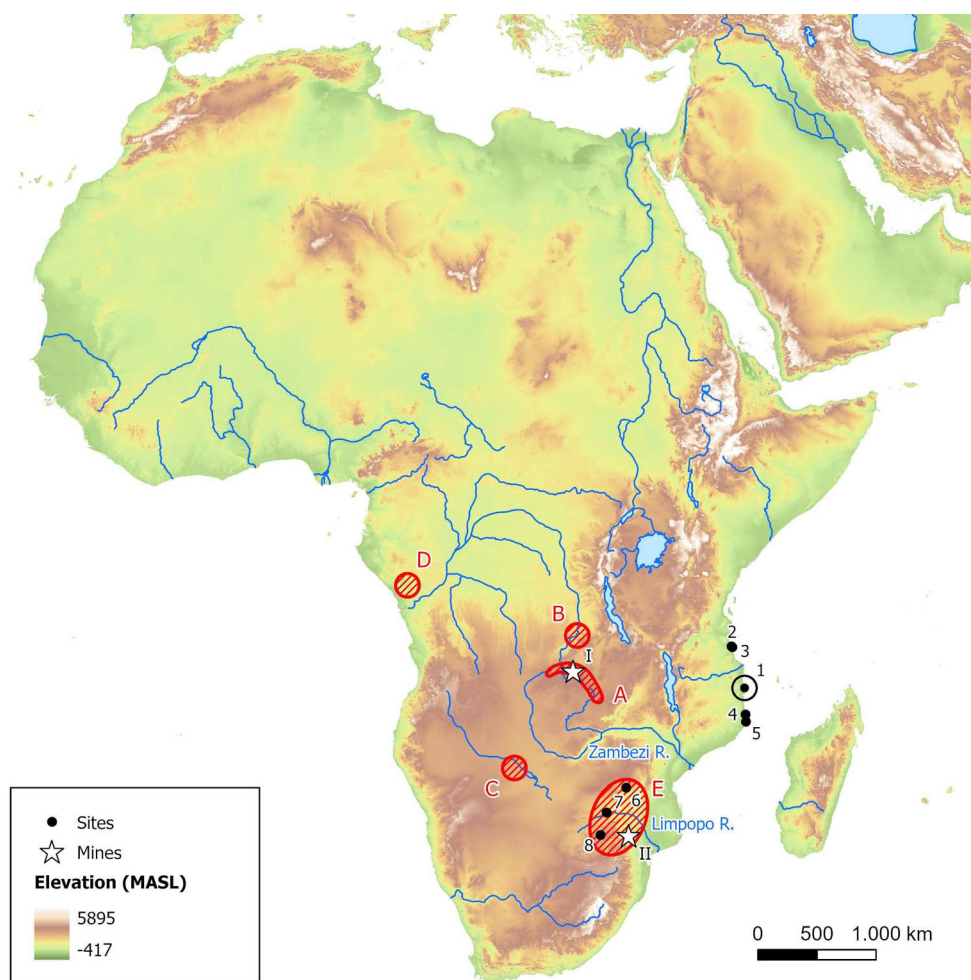


Figure 12. Map of sites, mines and key regions mentioned in the text. Sites are shown as dots and numbered: 1) Ibo; 2) Kilwa 3) Songo Mnara 4) Mozambique Island 5) Somana 6) Great Zimbabwe 7) Mapungubwe 8) Mapela. Mines are shown as stars and numbered: I) Shinkolobwe; II) Lolwe Hill; Other areas are shaded and labelled: A) Copperbelt; B) Upemba Depression; C) Tsodilo Hills; D) Niari Basin; E) Middle Limpopo Valley.

the so-called *croisettes*, subsequently spread as far south as Great Zimbabwe (Swan 2007: 102), with the distribution of the HIH type,¹ which dates from the mid-ninth to fourteenth centuries and is found from western Katanga to Zimbabwe and Mozambique, pointing to a route along the middle section of the Limpopo Valley (Nikis *et al.* 2017: 899). This is interesting because the archaeometallurgical analyses performed on a gold bead that we recovered in an excavation on Ibo island suggests Great Zimbabwe as the most probable origin for its gold (Ruiz-Gálvez *et al.* 2021). This underlines the role that the Quirimbas Archipelago is likely to have played as a port of call in the Middle Limpopo gold route to the Kilwa sultanate (Figure 12). Moreover, while our lead isotope results do not yield conclusive results on the origin of the copper from which the coins we have found at Ibo were cast, one possible origin to be considered

is precisely the Copperbelt mining district of Katanga where Cu-Fe-Pb-Zn sulphide ores are present.

In the Middle Limpopo valley, very important political entities controlled the long-distance trade in both gold and ivory. Among them were polities focused on the sites of Mapela (c. 1055–1450), Mapungubwe (c. 1220–1300) and Great Zimbabwe (c. 1300–1450) (Chirikure *et al.* 2014). There is agreement that the gold moving north along the East African coast from Sofala (first located in the Barazuto Archipelago of southern Mozambique and later in the Bay of Beira of central Mozambique), which was mentioned in the tenth century by al-Mas'ūdī (1989), was in fact extracted from gold belts located on the Zimbabwe Plateau (Huffman 2009: 50), with Sofala being just one outpost of the Kilwa sultanate for acquiring gold and other commodities from the African interior (Figure 12).

With the growing importance of Kilwa as the main African partner of the Indian Ocean trading system from the twelfth century onward the international demand for gold increased. Mapela lies 20 km from a rich gold belt and, although no gold items have been recovered in excavation there as yet, a great number and variety of imported glass beads along with bronze and copper objects attest to its role in long-distance trade (Chirikure *et al.* 2013: 359, 2014). Later, according to Huffman (2009: 50–53) the Mapungubwe state expanded north and took over control of some gold-producing areas, a role assumed by Great Zimbabwe after Mapungubwe's collapse c. 1300.

Through this long period of trade contacts with Swahili traders, gold, tin, bronze and brass were introduced to southern area in the early second millennium (Bandama *et al.* 2016: 174). Most of the copper and bronze items used in Botswana, Zimbabwe and South Africa come partly from local ores (Bandama *et al.* 2018: 541), but they were also imported from the Copperbelt, at least between the mid-ninth and fourteenth centuries, as suggested by the dispersal of the HHH *croisette* ingots discussed above (Bandama *et al.* 2016: 178).

A possible second route runs through the Zambezi River, crossing Zambia and Malawi to the coast, perhaps to the island of Mozambique. Located a hundred kilometres to the north was the outpost of Somana, where Duarte (1993: 61–65) reported the ruins of several Swahili stone buildings, some of which were imposing, with carved decorations and a wall, dating to the twelfth to fifteenth centuries. Alternatively, we might envisage an even more northerly route, perhaps over the Quirimbas Archipelago, to Kilwa. However, the rise of the islands of Somana and Mozambique as trade centres connected with Kilwa only began in the fourteenth century (Duarte and Meneses 1996: 558), i.e. later than our Ibo C–400 site.

Conclusions

Although we were unable conclusively to identify the coins found at Ibo, their context is undoubtedly Swahili and shows that the beginning of the Swahili culture along the coast of northern Mozambique took place in small, local villages, such as Ibo, that profited from their location and were immediately linked to the broader Indian Ocean world system from around one thousand years ago.

Coins and other foreign items, such as wheel-made glazed and unglazed ceramics from Iraq and Iran and glass beads from western India and Central Asia, recovered at site C–400 do not constitute the only proof of the role played by Ibo in Indian Ocean trade networks. Other fragments of imported ceramics were collected in two test pits

(C-100 and C-300; Figure 2) in the main square of the island. Although no archaeological structures could be identified at these sites, in both cases glazed wheel-made imports appeared in their deeper levels together with Lumbo impressed pottery, while Chinese and European ceramics appear simultaneously with local red Sancul pottery in their upper levels. A sherd of Monochrome Yellow Sgraffiato and another of the Campleve type, both coming from southern Iran (Priestman 2013: 593–594, Plate 99 and 585–586, Plate 92), were respectively found in SU 104–3 and 103–2 at C-100. Two AMS radio-carbon dates on short-lived samples date these levels to cal. AD 995–1265 (Ruiz-Gálvez 2020; García Heras *et al.* 2021: 312–313 and Figure 13A).

Lead isotope analyses open up the question of the possible involvement of the copper mining districts of Katanga in southern Congo-Kinshasa in Swahili-oriented trade routes, an issue that needs to be further explored on the basis of more extensive isotopic sampling. In the meantime, however, two extraordinary beads, one of gold and the other of carnelian, from an AMS-dated context of cal. AD 971–1149 in test-pit C-300 in the main square of the Portuguese village of Ibo point to the Middle Limpopo area as the most probable route from which gold — and perhaps also copper — arrived at Ibo, given that the elemental composition of the gold is compatible with that of sources on the Zimbabwe Plateau (Ruiz-Gálvez *et al.* 2021.) As for the carnelian bead, its archaeometric characterisation suggests a provenance in western India (Ruiz-Gálvez 2020; García-Heras *et al.* 2023; cf. Insoll and Khan 2001). In similar vein we note that Stephens *et al.*'s (2020) lead isotope analysis of 20 copper objects from the Divuyu and Nqoma sites of northwestern Botswana's Tsodilo Hills, which date to between AD 650 and 1200, were all cast from copper obtained from ores in Katanga more than 1050 km to the north (Figure 12).

The Quirimbas Archipelago would be located even further away than this if our hypothesis about the coins, wire and chain fragments recovered at Ibo having been cast using copper from Congolese Copperbelt ores is correct. Additionally, we note here that the wire fragments from possible bangles recovered at Ibo resemble others, also in bronze, from stonewalled sites such as Great Zimbabwe and Little Mapela in Zimbabwe that were also involved in long-distance exchange both within Africa and beyond the continent (Bandama *et al.* 2016: Fig. 2(6) and 14; 2018: Fig. 4). Because of the high social value placed on copper and bronze objects in Africa and the likelihood that the copper used to make those found at Ibo came from as far away as Congo-Kinshasa, the Ibo coins and bracelets must have been perceived as significant personal objects. At the same time, our analyses show that the coins and the chain fragment discussed here were made from a low tin bronze, not unalloyed copper. Although it is not easy to distinguish between copper and bronze at a glance (Moffett 2021: 11), microscopic analyses of objects from second-millennium archaeological contexts in southern Africa prove the existence of many bronze objects there (Miller 2010). The metals and coins found at Ibo were part of complex trade networks that developed along the African coast of the Indian Ocean in the early second millennium AD, involving rich resources of highly valuable materials, such as ivory, gold and copper.

Note

1. A type of ingot with two arms at each side and an elongated body as defined in the typology published by de Maret (1995) attending to the shape of the arms and the central body.

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