Lead ingots from a shipwreck off Poompuhar, Tamil Nadu, East Coast of India: evidence for overseas trade and their significance

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Various types of lead ingots have been reported from a number of shipwrecks from different parts of the world. In 1991 exploration of a wreck off Poompuhar, Tamil Nadu, East Coast of India, at a depth of 19 m yielded a gun, rudder gudgeon, gunpowder boxes and a variety of lead ingots. The most significant ingots are those marked W: Blackett and D with a crown symbol on the obverse and 1791, 1792 and some merchant marks on the reverse. These are similar to Blackett lead ingots found in England, the Netherlands and Sumatra. Pb-isotopic analysis has revealed their source as the North Pennine lead mines of England. Further, the lead used was of high purity ~93%. Records show that Blackett was a well-known lead-exporting company in England since 1694. The wreck off Poompuhar may be a Toni type cargo ship carrying traded lead ingots of different manufacturers.

Key words: shipwreck; Poompuhar; lead ingot; isotopic; trace metal analysis; Blackett.

Introduction

Ings have played a major role in the history of trade. Metal ingots made of gold, silver, copper, zinc and lead are the only surviving evidence of raw metal trade with the exception of iron ore and can provide clues for dating shipwrecks. Ingots with a stamp or seal of a company and year of manufacture are very valuable as they provide authentic information with respect to metal trade. Metal ingots generally remain intact over centuries and hence are of greater utility as compared to many wooden and other artefacts. Metal objects found on land or underwater are of great interest to archaeologists in search of knowledge of origin, use and metallurgical process of ancient times.

In India, for the first time, in 1991 a large number of lead ingots have been noticed from a wreck off Poompuhar, Tamil Nadu on the east coast of India. It is true that metals like gold, silver, copper, zinc and to some extent lead were traded in ancient times but in later periods, particularly, lead was the main metal carried by vessels as paying ballast and cargo. Further, based on compositional and isotopic data we can often trace the source of metal used for the manufacture of the lead ingots and discuss the implications for overseas trade.

Context

Poompuhar, a port town from the 3rd century BC to the 3rd century AD (Soundar Rajan, 1994) is situated at the confluence of the River Kaveri and the Bay of Bengal on the east cost of India (Fig. 1). The Marine Archaeology Centre of the National Institute of Oceanography has carried out underwater explorations in Poompuhar waters since 1989 to locate remains of port installations. Successive investigations (Vora, 1987; Rao, 1991; Rao & Rao, 1991; Sila Tripati et al., 1996) in the intertidal zone as well as offshore in 5 to 8 m water depth revealed a number of ring wells (baked clay rings were used in wells in coastal India to protect from soil erosion), early historical pottery and brick structures. A shipwreck was also found during the exploration in 19 m water depth (Gaur et al., 1997). The shipwreck (hereafter referred as wreck) is located around 3.5 km from the shore, on a seabed comprised of coarse sand. No rock is known to outcrop in the whole study area. The wreck is distributed in two parts, located close to each other and separated...
Figure 1. The location of the shipwreck. (Drawing: S. B. Chitari.)
The ship was about 50 m in length, 15 m in width and 100 to 150 tons. Metal detector survey confirms that about 75% of the ship is buried in the sediment. As lead is heavier the vessel must have buried faster to the bottom soon after the break-up of the ship into two pieces. The wreck lies north-east to south-west. Echo sounder survey indicates that the height of the wreck above the seabed is about 2.5 to 3 m. An iron gun measuring 2.1 m long and three boxes (possibly gunpowder boxes) (Fig. 2) are lying on the eastern side, and lead ingots and other parts of the wreck lying on the southern side. Two circles about 1 m diameter were noticed between two parts of the wreck (Fig. 3), probably these could be the hatches of cargo holds. The gun is fixed on an iron platform, which makes it difficult to lift. These objects are covered with a 5 cm-thick barnacle layer.

About 10 m to the north of the wreck a 1.27 m-long copper alloy rudder gudgeon of 69.8 kg (153.56 lb) was found along with nine rudder copper nails and a rudder pintle. In the rudder gudgeon there is provision for 14 nails, whereas only nine were found. These copper nails were of two types, measuring 22, 21, 20, 18, or 16 cm in length and weighing 600, 450 or 400 gm (Fig. 4, Fig. 5). The wreck and the associated antiquities are dispersed over an area of around 50 m radius. The airlifting operation carried out near the gun up to 1 m subsurface depth confirmed that the ship had a wooden deck. Wooden planks of 17 to 15 cm thickness were used in the construction of the ship. As the considerable part of the wreck is buried in the sediment it is difficult to determine the method of construction of the ship. However, three square portholes of the deck (Fig. 6) were noticed during the airlifting. The exposed wooden planks are

Figure 2. Gunpowder boxes noticed near the gun. (Scale: 50 cm with 10 cm divisions) (Photo: S. N. Bandodker.)

Figure 3. Two circles observed between two parts of the wreck. (Scale: 25 cm with 5 cm divisions) (Photo: S. N. Bandodker.)

Figure 4. Rudder gudgeon along with rudder pintle and nails found in the wreck. (Photo: Sheikh Ali Karim.)
severely affected by woodborer molluscs, while buried planks are intact (Fig. 7). The major part of the exposed portion of wreck is also covered with fishing nets because the area is a rich fishing ground. The visibility in the working area is good. Around 50 lead ingots were noticed and it is believed that more are buried in the seabed (Fig. 8). However, only 18 ingots were retrieved, out of which 13 are at the National Institute of Oceanography (NIO), Goa, and five have been given to the Department of Archaeology, Government of Tamil Nadu.

**Materials and methods**

**Cleaning and conservation of lead ingots**

Lying underwater for a long duration the ingots were overgrown with marine substances. These growths were removed carefully with a wire brush and precautions were taken not to disfigure any hidden marks that were underneath during cleaning. After careful cleaning of the ingots, it was decided to preserve them after chemical treatment. The ingots were thoroughly washed in fresh water, followed by 3% solution of ammonia and mild detergent (T-POL). This treatment effectively further removed the hard dirt and marine substance coatings on the ingots. Later ~40% (V/V=volume/volume) hydrochloric acid was applied on ingots to dissolve carbonate growth qualitatively. Most of the marine growth was successfully removed by that treatment. Therefore, 40% (V/V) hydrochloric acid appears to be effective in removing the carbonate depositions on marine artefacts. It should be ensured that the traces of acid solution are removed by repeated washes using distilled water after each treatment. To neutralise the action of acid, reagent...
like NaOH, KOH (10% to 20% (V/V) solutions) were also applied after three to four times of acid treatment. Finally the ingots were washed with distilled water and dried. The above described treatment was continued until the ingots were completely cleaned exposing the finer details like symbols and signs.

Description

Based on physical features the ingots are classified into four categories based on their shapes, weight and markings.

1 Long oval boat-shaped ingots with inscription W: BLACKETT on one side and the dates 1791 and 1792 on reverse side, with other distinct symbols which are SS, VEIC (United East India Company) inside a heart, WB, IH, F (Fig. 9a, b; Fig. 12, no. 1–2, 5–8, 10–11). There are eight of these, having different weights ranging from 66.6 kg (146.52 lb), 68.2 kg (150.4 lb), 68.5 kg (150.7 lb), 71.8 kg (157.96 lb), to 72.4 kg (159.28 lb).

2 Long oval-shaped with a D below a crown symbol. A smaller crown symbol on the reverse side along with other symbols such as VEIC inside a heart and XXX is distinct (Fig. 10a, b; Fig. 12, no. 12–13). There are two examples, which weigh 63.8 kg (140.36 lb) and 64.4 kg (141.68 lb).

3 Square-ended, flat-bottomed, without inscription or symbol on obverse while on reverse VEIC inside a heart, IB, I and H symbols are distinct (Fig. 11a, b; Fig. 12, no. 3 and 9). There are two examples, which weigh 61.8 kg (135.96 lb) and 65.6 kg (144.32 lb).

4 Round-ended, semicircular bottom, boat-shaped without any inscription or symbol on obverse. The heart symbol is stamped on the reverse. There is one example, weighing 73.2 kg (161.4 lb) (Fig. 12, no. 4).

Over-stampings are not recorded on these types of ingots. More stampings were noticed on the W: Blackett group of ingots. The reverse symbols such as SS, E, F, H, I, B, WB on these ingots are probably merchant marks. The symbols and seals on all these ingots are shown in Fig. 12.

Analysis of lead ingots

Trace metal analysis

Analyses of the lead ingots were carried out to identify the provenance and composition. The
ingots were scraped using a surgical blade. The accurately weighed aliquot (0.1–0.4 mg) was digested in 5 ml of hot concentrated nitric acid. The heating was continued to near complete dryness and the remnant was dissolved and made up to volume using 0.1 M nitric acid. The solution was analysed either on a PE-5000 flame AAS or PE, Plasma-400 sequential ICP-AES facility and the analytical results are presented in Table 1. The results of trace metals having close to blank signals are given as ‘not detected’ (ND). Only those elements having unambiguous signals with at least five times above the blank values only are quantified.

**Isotopic analysis**

The Pb-isotopic ratios can be used to trace the provenance of the lead used in manufacturing the ingots. These isotopes were analysed at the National Geophysical Research Laboratory (NGRI), Hyderabad, with MS-facility. Following the pre-treatment of the sample powder, form natural isotope of lead (\(^{204}\text{Pb},^{206}\text{Pb},^{207}\text{Pb}\) and \(^{208}\text{Pb}\)) were measured on a VG 354 Thermal Ionisation Mass-Spectrometer, in a sequential Peak-jumping mode. Replicate analyses were carried out. The analytical errors measured on SRM-981
reference standard were used to access the accuracy of isotopic results, which were well within the acceptable range (Table 2).

Results of analysis

From the composition it appears that W: Blackett used very high purity lead for manufacturing ingots as evident in high Pb (93%) and very low Zn (8 ppm), Ni (6 ppm) and Cu (130 ppm) composition. The other ingots (Rectangular and D type) have slightly lower levels of Pb (~92%) and high Zn (~200 ppm), Ni (~8 ppm), Mn (~10 ppm) and Cu (>200 ppm). These compositional ranges suggest that W: Blackett was different to any other contemporary manufacturer, indicating the technological edge of W: Blackett over others during the 18th century.

The Pb-isotopic ratios ($^{206}$Pb/$^{204}$Pb, $^{207}$Pb/$^{204}$Pb, $^{208}$Pb/$^{204}$Pb) of ingots closely compare with those of north Pennine and other British ore fields (Parnell & Swainbank, 1984; Rohl & Needham, 1984).
1998). This observation in turn suggests that, irrespective of the placement of the manufacturing units, the raw material for the lead ingots seems to have derived from the same English mines. The various initials may denote batch numbers typically 400 ingots to a ‘mark’. W: Blackett denotes the company of Sir William Blackett, of Durham, England. They had a number of mills around Alston and between there and Newcastle-on-Tyne, when the North Pennines had grown to be the major English lead producer by the late 18th and 19th century.

From the available records (Raistrick & Jennings, 1965), the inscription W: Blackett refers to a successful 18th century English industrialist, Sir William Blackett. Though the pre-1700 records about the Blackett industrial concern are not properly documented, it appears that the Blackett and Blackett-Beaumont concern had a history of more than 100 years before 1800, particularly in lead mining. By 1694 Blackett acquired the estate of Allendale and began to develop the mines with modern methods. In 1696 Blackett leased more mines in Weardale, and in 1698 expanded his
Figure 12. Figure showing all the thirteen types of lead ingots found in the wreck. (Drawing: S. B. Chitari.)
mining activity to the south of the Derwent valley. Ryton mill was sold to the Blackett family in the early 18th century. The Blacketts had several mills in Allendale, Allenheads, Rookhope and Dukesfield for extraction of lead. Most of their mining activity was concentrated in Allenheads, Coalecleugh, Burtree Pasture, Killhope, Breconsike, Boltsburn, all in the North Pennine ore field (Raistrick & Jennings, 1965). By around 1780 the Dutch East India Company’s influence in India had diminished with the rise of the English East India Company, which dominated the later overseas trade.

During the period of British dominance W: Blackett company was supplying lead to many European and Far East countries and their ingots become the most widely recognised from wrecks. Blackett ingots have been reported from several places. Later period Blackett Locke ingots have been excavated underwater off Australia (Lynn Willies, pers. comm.). Blackett Locke was a nineteenth subsidiary from near Newcastle, but details of these ingots are not available. The English East Indiaman Vansittart was wrecked on 23 August

Table 1. Compositional values of various ingots

<table>
<thead>
<tr>
<th>Sample no</th>
<th>Sample</th>
<th>Pb</th>
<th>Ni</th>
<th>Zn</th>
<th>Cr</th>
<th>Cd</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>W: Blackett (1)</td>
<td>93.0</td>
<td>NA</td>
<td>8</td>
<td>&lt;10</td>
<td>130</td>
<td>72</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>W: Blackett (2)</td>
<td>97.8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>37</td>
<td>107</td>
<td>ND</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>Top Plain</td>
<td>93.9</td>
<td>NA</td>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>333</td>
<td>93</td>
<td>3</td>
<td>123</td>
</tr>
<tr>
<td>4</td>
<td>Square ended</td>
<td>92.1</td>
<td>7</td>
<td>171</td>
<td>NA</td>
<td>NA</td>
<td>209</td>
<td>NA</td>
<td>11</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td>D with Crown</td>
<td>92.2</td>
<td>10</td>
<td>286</td>
<td>NA</td>
<td>NA</td>
<td>361</td>
<td>NA</td>
<td>9</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Sample nos 1–3 were analysed on AAS, and 4–5 were analysed on ICP-AES. Pb in wt.%, and all other elements are in PPM. NA=Not analysed, ND=Not detected.

Table 2. The results of isotopic analysis

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sample 206/204</th>
<th>207/204</th>
<th>208/204</th>
</tr>
</thead>
<tbody>
<tr>
<td>W: Blackett</td>
<td>18.408</td>
<td>15.624</td>
<td>38.434</td>
</tr>
<tr>
<td>D with Crown</td>
<td>18.352</td>
<td>15.568</td>
<td>38.249</td>
</tr>
<tr>
<td>SRM 981 standard</td>
<td>16.925±44</td>
<td>15.469±35</td>
<td>36.615±96</td>
</tr>
</tbody>
</table>

Figure 13. Lead ingots and a roll of sheet lead from Eurogeul 19. (Photo: Thijs Maarleveld.)
1789 on a reef in the Straits of Gaspar (between the two Indonesian islands of Banka and Billiton), east of Sumatra (A. J. Farrington, pers. comm). Blackett ingots dated 1787 have been reported from this wreck, discovered in 1975, which was also carrying a large quantity of silver for trade at Canton in China. A Blackett lead ingot in the collections of the British Museum, London, came from the English East Indiaman Henry Addington, wrecked off the Isle of Wight in 1798 (Craddock & Hook, 1997). Five lead ingots with W: Blackett on the concave side and H, WB and 1821 stamped on the flat side, along with a roll of sheet lead, were found at Eurogeul 19.5 km off the port of Rotterdam in 23 m water depth on the coast of the Netherlands (Fig. 13). The weight of these lead ingots varies from 69 kg (151.8 lb) to 71 kg (156.2 lb) (Maarleveld, 1995). The lead ingots discovered from the Netherlands, Sumatra and Poompuhar appear to have been manufactured by W: Blackett Company. The Peak District Mining Museum has one Blackett lead ingot, which was donated by Martin Woodward of the Isle of Wight Maritime Museum. It was found in Poole Harbour, Dorset, and its weight is 71 kg (156.2 lb). It appears that until the 19th century lead was imported by the Dutch to meet their own requirements (Willies, 1969, 1985) as well as for re-exporting.

Not much is known about the crowned D stamped type of ingot, there are no clues as to their source and they may well be the product of a different company and different ore field. So far as other symbols are concerned, the dates are useful, always with the provision that the date mark was sometimes of several years earlier than the wreck. It is certain that the marks were put on at the mill, probably while the metal was still hot (Willies, 1991). It appears that D with a crown type lead ingots might have produced by some companies in the British Isles. During the 18th century there were a number of companies and lead producing centres around the north and west of England, north and central Wales and Scotland, all supplying lead for international trade. Similar ingots have also been found elsewhere.

The British Library archived documents of all English East Indiamen voyaging from London to Asia between 1600 and 1833 do not mention any wrecks in Indian waters between 1790 and 1800. However, the French captured seven ships; Princess Royal (1793), Triton and Friendship (1796), Raymond and Woodcot (1798) at Tellicherry, (?) Kent (1800), and Princess Charlotte (1804) at Vizagapatnam in the Bay of Bengal. Information on the loss of East Indiamen is not available in Poompuhar and Tranquebar region of Tamil Nadu. In light of these records, the wreck found off Poompuhar may not be of British origin even though it carried British lead ingots. Therefore, it is speculated that, the wreck may be a local Toni type vessel carrying traded ingots (A. J. Farrington, pers. comm). The different type of ingots having other manufacturing inscriptions in addition to W: Blackett provides the support for this speculation. Tranquebar (about 12 km south of Poompuhar) was ruled by the Danes between 1624 and 1845 and 12 Danish ships are known to have called at Tranquebar port. However, there is no mention of their return to home. Moreover, several naval battles were fought at Tranquebar between the Danish, Dutch, English and French (Nagawsami, 1987).

The lead ingots vary in their dimension, weight and shapes. It appears that different types of casting moulds including iron and possibly clay were used for making the ingots and flat upper surface on which marks had been stamped either immediately after casting and in some cases at a later date. In all these ingots there are no over-filling rims for indicating overfilling of the mould or handles to help with easy manipulation. As there are no handles, it is very difficult to handle the rounded, heavy and steep sided shapes of ingots.

Conclusions

The wreck is well preserved and needs to be excavated thoroughly. The years stamped on the ingots, 1791 and 1792, were of course the dates of manufacturing, and the vessel might have wrecked some years later. Having several years represented within one cargo and pre-dating the year of loss, is also illustrated by the ingots recovered from the wreck of the Albion (1765), which bore dates of 1763 and 1764 (Redknap, 1990). Further, the stamps have been shown to be associated with production at the smelter. Only the rudder gudgeon and the lead ingots have been retrieved, and other remains of the wreck and cargo remain in situ. Though the rudder braces (gudgeon and rudder nails) vary in size depending on their place on the sternpost and on the rudder itself, preliminary indications are that it is similar to that found on the 366-ton American China trader Rapid (1811) and may come from a vessel of equivalent or larger size.
M. McCarthy, pers. comm). Excavation would throw more light on the wreck as well as international metal trade. The finding of lead ingots confirms that there was trade contact between the W: Blackett Company and India but merchant marks suggest this was through middlemen and not direct. Off the Tamil Nadu coast much archaeological material has been found but the present wreck is the first so far reported from the east coast of India.

Research (Eiseman, 1980; Larn, 1985; Gomez, 1986; Raban, 1999) shows that since 1500 BC there is not much change in the size, shape and weight of lead ingots throughout the world. It appears that metal ingots have been cast through the ages on the basis of metal value. Isotopic analysis revealed the probable source of the lead and trace metal analysis helped to ascertain the quality of the lead. During the 18th century there were frequent wars between European powers in Indian waters in this region, probably this cargo ship might have sunk in the wars. Ships needed ballast and it appears that the vessels during the return journey from European countries instead of coming empty used to bring lead which was relatively cheap, heavy, durable and with a ready market. Similarly, during the 17th and 18th centuries, ships returning from the Far East to Europe were loaded with tin as ballast even though it was cheap and plentifully available from the south west of Britain (Ken, 1965). The size and carrying capacity of the ill-fated vessel indicates that it could be a local Toni type of cargo ship. East Indiamen were much larger in size and carrying capacity during the 18th century.

Lead was used during the 18th century for various purposes such as minting coins, water pipes, ballast for ships, sheet, sheathing for hulls, anchor stocks, seals, stamps, tablets, musket balls and lead shot cartridges. Even India was a producer of lead, but in the 18th century lead was imported, probably for its good quality. While India was a major producer of lead in the ancient world (Willies, 1989), the purpose of production was for silver. This required a high smelting temperature, despite subsequent purposes. Impure lead may have been carried through non-silver bearing. Lead produced in several parts of England was pure, soft and very good for sheet casting. By the 18th century, indeed long before, Indian production was at low ebb. Probably, easily got deposits were well below the water table and in any case, the East India Company as the colonial power would have preferred cargoes of cheap English lead of very good quality.

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