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## THE LEAD INGOTS OF CAPO PASSERO: ROMAN GLOBAL MEDITERRANEAN TRADE

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*Summary. Epigraphic and isotopic analysis of the lead ingots recovered from a shipwreck off Capo Passero (in Sicily) in mid-2006 suggests that the ingots were produced in Spain, in the Cartagena region. The shipwreck is estimated to have occurred around 38 BC, at the beginning of the Hispanic era. This provides further evidence that the Romans were trading lead throughout the Mediterranean Sea.*

### INTRODUCTION

In the summer of 2006, a diver discovered 13 lead ingots of Roman origin in the sea 150 m from the harbour of Capo Passero, in southern Sicily.<sup>1</sup> The ingots, weighing 100 Roman pounds (33 kg), were scattered on the sea floor at a depth of about 7 m along with the remains of a shipwreck, from which it was evident that the ship's hull had been coated in lead for protection. Archaeological and analytical evidence suggests that the ingots are of Spanish origin; in particular, they originate from lead ores extracted in the Cartagena region, indicating that the Romans were trading lead throughout the entire Mediterranean.

### ARCHAEOLOGICAL ANALYSIS

#### *The discovery*

In September 2006, officers of Italy's Carabinieri of the Porto Palo di Siracusa station contacted Sicily's Superintendent of the Sea to report the discovery of old lead ingots just outside the local harbour. The recovery operation was conducted by archaeologists of the Superintendent of the Sea with the cooperation of divers from the Carabinieri Arts Protection task force. The diver who discovered the shipwreck took part in the operation. The site, at c.150 m from the shore, had recently been disturbed, with some of the ingots moved from their original position. The ingots were lying together in a channel 5–6 m wide and 10–15 m long.

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1 The site's discoverer, Mr Dario Lopes, tells the story of his discovery on the web: <http://www.apneamagazine.com/articolo.php/1640>



Figure 1

Four (out of 13) trapezoidal lead ingots discovered off Capo Passero (Sicily) carry the inscription M. OCT.M.L.PAP IL.

Other metallic fragments (a lead lamina coating the ship's hull, and a few nails) have been deliberately left *in situ* in anticipation of a detailed archaeological dig. Thirteen lead ingots of rectangular shape, 45–48 cm long and 12 cm wide at the base with the upper part rounded, were eventually recovered. As mentioned above, each ingot weighs about 100 Roman pounds and belongs to one of three types.

All the ingots are decorated with rectangular cold stamped marks, some with a stylized leaping dolphin on the right (found in several shipwrecks on similar ingots bearing marks of different producers) and a caduceus, possessing both apotropaic and benevolent powers, but also representing a trademark (Domergue 1994; Domergue *et al.* 2006). The trapezoidal section is characteristic of a type produced in Spain, dating to the second/first century BC to first century AD, found in several other shipwrecks in the Mediterranean, such as Port-Vendres 2, Nave di Comacchio, Isola di Mal di Ventre, Madrague de Giens, Bagaud 2, etc. (Poveda Navarro 2000). In Sicily, a number of ingots referred to as 'Spanish' had previously been found in Cianciana, a small centre near the city of Agrigento.<sup>2</sup>

### *Epigraphic analysis*

The first group is composed of four ingots (Fig. 1) with the following mark: (caduceus) **M. OCT.M.L.PAP IL** (dolphin), where OCT was first interpreted as Octavianus (63 BC–AD 14), the future Augustus. However, Octavius was also a rather common name in first century BC Spain, as recorded in several inscriptions from the *Corpus Inscriptionum Latinarum* (CIL) II for Spain.

2 Five ingots carrying the mark 'L. PLANI. L. F.', representing the name of the manufacturer L (ucius), Plani, L (uci) F (ilius) based in south-eastern Spain, are shown at the Regional Archaeological Museum 'Antonino Salinas' in Palermo.



Figure 2

A single (out of 13) trapezoidal lead ingot discovered off Capo Passero (Sicily) carries the inscription CNATELLICNLBVIO.

As to the *cognomen* Papi, the *gens* Papia were renowned as fine wine-makers in the Samnium region between the third century BC and first century AD, as demonstrated by several marks on amphorae, including one found in Levanzo's Cala Minnola in Sicily (Manacorda 1994), and another in the shipwreck of Madrague de Giens (Laubenheimer 1990). Furthermore, a likely manufacturer Papinius C(larissimo) was *propraetorian legate* (*Legatus Propraetore*) in the provinces of Hispania Citerior and is mentioned in CIL II 0.4415. A *Papilianus* is also cited in one instance in CIL II. The L for L(ibertus) would suggest the following reading: *Marcus Octavius Marci Libertus Papil(ianus)?*.

Another single ingot (Fig. 2) is impressed with the following letters: **CNATELLICNLBVIO**, namely Cn.Atelli.cn.L.BULIO, well known in the epigraphic literature thanks to the lead ingots recovered from the Bocche di Bonifacio's Capo di Testa in Sardinia (D'Oriano 1999). The presence of the slave's name (Bulio, later to become Libertus) retained next to *gens Atellii*, rich manufacturers from the Cartagena province in Spain, allows precise dating of this mark, and thus of this class of ingots, to 40–38 BC.

Finally, a third class of eight ingots of slightly reduced size (Fig. 3) carries the following inscription: **MPLANII (dolphin) RV.. IN**, that is Marcus Planius Russinius, belonging to another important family of manufacturers in the region of Cartagena (Sierra Morena), whose production intensified around the first half of the first century BC thanks to the protection of Sextus Pompey. (Sextus Pompeius Magnus Pius, the youngest son of Pompey, led the resistance against Caesar and the Second Triumvirate in Sicily, having escaped to Sicily after the battle of Munda, in Hispania, until the naval battle off Naulochus cape in August 36 BC (Poveda Navarro 2000; Domergue 2005).)

As mentioned above, the trading of these ingots has been established by the discovery in Cianciana (near Agrigento) of an ingot bearing the mark Planii L.F. (a manufacturer of slightly older date, around 88–85 BC) (Domergue 1965; Antolinos Marin 2005).



Figure 3

Eight (out of 13) trapezoidal lead ingots discovered off Capo Passero (Sicily) carry the inscription MPLANII (dolphin) RV.. IN.

Taking all these epigraphic data into consideration the date of the shipwreck is estimated to be around 38 BC *terminus post quem*, although only a thorough archaeological excavation will allow the event to be placed in its historic setting.

#### ISOTOPIC ANALYSIS

Pb isotopic analysis by mass spectrometry is a well established technique in archaeological research for determining the provenance of a lead artefact (de Wannemacker *et al.* 2000). Natural lead consists of four isotopes, namely  $^{204}\text{Pb}$ ,  $^{206}\text{Pb}$ ,  $^{207}\text{Pb}$  and  $^{208}\text{Pb}$ .  $^{204}\text{Pb}$  is not radiogenic and therefore its abundance is constant in time whereas the other isotopes derive from the radioactive decay of nuclides of U and Th. Isotopic abundances of lead are a function of the U-Th concentrations in the parent ore or rock and the age of the system. Hence, every natural lead deposit has a characteristic lead isotopic composition. Since this composition of Pb varies within narrow limits in a given ore and the isotopic composition in the ore passes unchanged through the melting and refining processes into the artefact, comparison of the isotopic composition of Pb in artefacts and ore sources points to the geographical origin of a lead object.

#### *Instrumentation, reagents and standards*

Sample analysis was carried out on an Agilent 7500i ICP-MS (Agilent Technologies, Yokogawa Analytical Systems, Tokyo, Japan), with a quartz double pass spray chamber, thermostatted to 2°C, and fitted with a PolyPro-ST concentric nebulizer (Elemental Scientific Inc., Omaha, USA). High purity de-ionised water (18 MΩ cm<sup>-1</sup> resistivity) (Purelab Ultra, Elga, High Wycombe, UK) and high purity acids (Suprapur grade, Merck, Darmstadt, Germany) were used for sample digestion. A sample of SRM 981 Common Lead Isotopic Standard (NIST,

Gaithersburg, MD, USA) was dissolved in cold nitric acid and was serially diluted to give a final concentration of 10 µg L<sup>-1</sup> (total Pb), and was used as a mass bias correction solution for isotope ratio analysis.

*Sample preparation*

A 10 to 30 mg sample of lead was dissolved in an acid-cleaned glass beaker, heated on a hotplate after the addition of 1 ml of ultra pure water and 1 ml of nitric acid. Once dissolved, the sample was allowed to cool and was made up to 50 ml with ultra pure water in a polypropylene centrifuge tube; the samples were stored refrigerated at 4°C. Prior to analysis, the samples were brought to room temperature (20°C) and further diluted in 1% v/v nitric acid to obtain a nominal lead concentration of 10 µg/L, a level at which the instrument remains in pulse counting thus avoiding any detector errors on the isotope ratio measurements.

*Analytical procedure*

All samples were analysed using the isotope analysis acquisition parameters for isotope ratio analysis; the instrumental operating conditions are reported in Table 1.

For isotope ratio analysis, the number of scans is pre-set to 1000 in the ICP-MS software (Ruiz Encinar *et al.* 2001), so only three parameters can be optimized, the points per peak, the integration time per measurement and the number of replicates. The integration times were set to give similar count rates for the four isotopes studied (<sup>204</sup>Pb, <sup>206</sup>Pb, <sup>207</sup>Pb and <sup>208</sup>Pb) based on their mean isotopic abundances (IUPAC 1991) to obtain a similar measurement precision for each isotope. Three points per peak were chosen as this gives the best precision for quadrupole instruments<sup>10</sup> and five replicates were chosen to give a total analysis time of 327 seconds. Samples were diluted so that all the isotopes were acquired in pulse counting mode, as this ensures that the same integration time is used throughout the measurement. After each sample the common lead isotopic standard was run to correct for any drift in mass bias.

TABLE 1  
Experimental conditions of the ICP-MS analysis

|  |                                     |
|--|-------------------------------------|
| Instrumental Conditions                                  |                                     |
| Rf power   | 1450 W                              |
| Plasma gas flow rate                                     | 15 L min <sup>-1</sup>              |
| Auxiliary gas flow rate                                  | 1.0 L min <sup>-1</sup>             |
| Nebulizer gas flow rate                                  | 1.2 L min <sup>-1</sup>             |
| Sample uptake rate                                       | 0.5 ml min <sup>-1</sup>            |
| Spray chamber temperature                                | 2°C                                 |
| Acquisition Parameters                                   |                                     |
| Isotope ratio analysis (3 points per peak, 5 replicates) |                                     |
| Mass   | Integration time<br>per point (sec) |
| 204  | 19                                  |
| 206  | 1.1                                 |
| 207  | 1.2                                 |
| 208  | 0.5                                 |

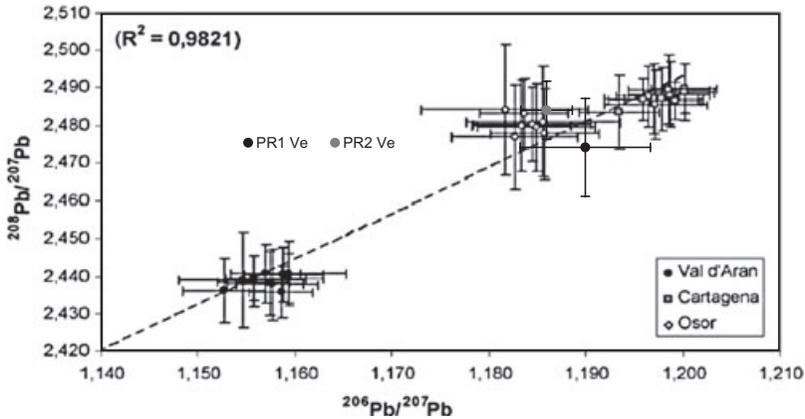


Figure 4

Points and error bars in  $^{208}\text{Pb}/^{207}\text{Pb}$  vs.  $^{206}\text{Pb}/^{207}\text{Pb}$  plot for lead ingot samples found off Capo Passero (Sicily), plotted along with the same ratios for mining samples in Spain (The framework figure is reproduced from Marguí *et al.* 2000, with permission.)

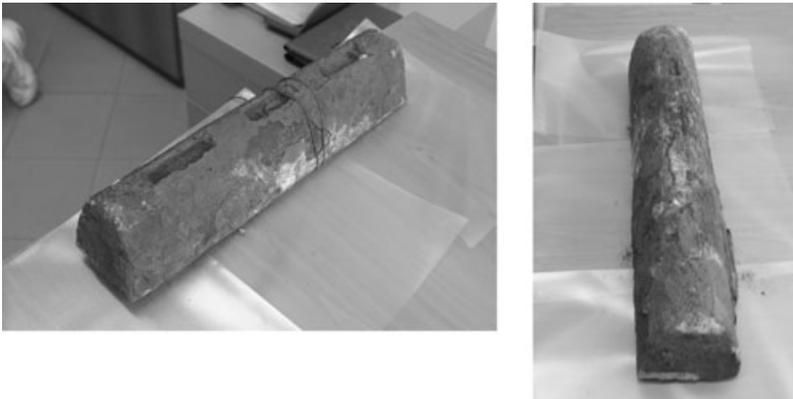


Figure 5

The PR1 (left) and PR2 (right) ingots used for the isotopic analysis.

## RESULTS

Figure 4 shows the ICP-MS results plotted for two samples (PR1 and PR2, Fig. 5) along with data of ore sources in the region of Osor, Vald'Aran and Cartagena, in Spain (Fig. 6) (Marguí *et al.* 2000).

The ingots originate from lead ores in the region of Cartagena, the largest mining zone in Spain. For the relatively straightforward quadrupole ICP-MS technique, isotope ratio precision values of 0.1–0.5% RSD are typical (even if values of 0.05% can be reproduced at sufficiently high count rates). Further studies using the TIMS technique are under way.

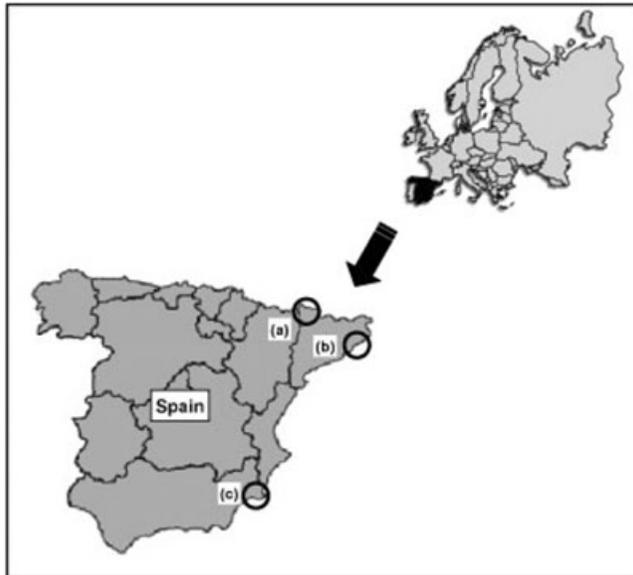


Figure 6

Location of the mining districts studied: Val d’Aran (a), Osor (b), Cartagena (c). (Reproduced from Marguá *et al.* 2000, with permission.)

#### CONCLUSIONS

A Roman ship carrying lead ingots sank around 38 BC in the sea off Capo Passero, in southern Sicily. The ingots were manufactured in Spain, with ores from the Cartagena region. Similar ingots found near Agrigento suggest a wider trade in lead from Spain to Sicily. Hence, at the beginning of the *Pax Romana* in Hispania (the ‘Hispanic era’), the Romans were trading lead throughout the whole of the western Mediterranean. The ingots were produced in the Cartagena mining district in south-western Spain, the most important area in the Mediterranean controlled by the Romans until AD 410 (and by the Carthaginians, from 535–205 BC). Remarkably, so intense was the Roman mining activity that about 70 per cent of the lead in the Greenland ice between 150 BC and AD 50 came from this area (Rosman *et al.* 1997). Lead, an easy to work corrosion-resistant metal, was extensively used in plumbing, architecture and shipbuilding, and as a preservative for food and a wine additive to stop fermentation. Control of Spain’s natural resources was strategic, and the Capo Passero wreck sheds valuable light on the export of lead from the region.

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#### REFERENCES

- ANTOLINOS MARIN, J.A. 2005: Prospección minero-metalúrgica antigua en la Sierra de Cartagena y su territorio adyacente. *Memorias de Arqueología* 13 (1998), 581–602.
- DE WANNEMACKER, G., VANHAECKE, F., MOENS, L., VAN MELEB, A. and THOENB, H. 2000: Lead isotopic and elemental analysis of copper alloy statuettes by double focusing sector field ICP mass spectrometry. *Journal of Analytical Atomic Spectrometry* 15, 323–7.
- DOMERGUE, C. 1965: Les Planii et leur activité industrielle en Espagne sous la République. *Mélanges de la Casa de Velázquez* 1, 9–27.
- DOMERGUE, C. 1994: Production et commerce des métaux dans le monde romain: l'exemple des métaux hispaniques d'après l'épigraphie des lingots. In *Epigrafiya della produzione e della distribuzione* (Rome, EFR 193), 61–91.
- DOMERGUE, C. 2005: B. Q. Cassius Longinus et la gestion des ressources naturelles en Espagne. In *La politique coloniale de César en Espagne, Enjeux des ressources naturelles et coloniales* (Colloque 2005, Université de Laval).
- DOMERGUE, C., QUARATI, P., NESTA, A. and TRINCHERINI, P.R. 2006: Retour sur les lingots de plomb de Comacchio (Ferrara, Italie) en passant par l'archéométrie et l'épigraphie. arXiv.org, arXiv:physics/0605044v2.
- D'ORIANO, R. 1999: *Un carico di lingotti di piombo di età augustea dalle Bocche di Bonifacio*. www.cronacheisolane.it/archeo.7.htm.
- IUPAC COMMISSION ON ATOMIC WEIGHTS AND ISOTOPIC ABUNDANCES 1991: Atomic weights of the elements 1989. *Pure and applied chemistry* 63, 975–90.
- LAUBENHEIMER, F. 1990: *Le temps des amphores* (Paris).

- MANACORDA, D. 1994: Produzione agricola, produzione ceramica e proprietà della terra nella Calabria romana tra Repubblica e Impero. In *Epigrafia della produzione e della distribuzione* (Rome, EFR 193), 3–59.
- MARGUÍ, E., IGLESIAS, M., QUERALT, I. and HIDALGO, M. 2000: Precise and accurate determination of lead isotope ratios in mining wastes by ICP-QMS as a tool to identify their source. *Talanta* 73, 700–9.
- POVEDA NAVARRO, A.M. 2000: Societas Balarica. Una nueva compañía minera romana de Hispania. *Gerión* 18, 293–313.
- ROSMAN, K.J.R., CHISHOLM, W., HONG, S., CANDELONE, J.-P. and BOUTRON, C.F. 1997: Lead from Carthaginian and Roman Spanish Mines Isotopically Identified in Greenland Ice Dated from 600 B.C. to 300 A.D. *Environmental Science & Technology* 31, 3413–16.
- RUIZ ENCINAR, J., GARCIA ALONSO, J.I., SANZ-MEDEL, A., MAIN, S. and TURNER, P. 2001: A comparison between quadrupole, double focusing and multicollector ICP-MS instruments Part I. Evaluation of total combined uncertainty for lead isotope ratio measurements. *Journal of Analytical Atomic Spectrometry* 16, 315.