

Copper ingots from the western Mediterranean Sea: chemical characterisation and provenance studies through lead- and copper isotope analyses

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The present study is part of a wide-ranging research project on copper used for Roman Imperial coinage, of which the goals are:

1. to trace the quality of copper used for low-denomination coinage and its changes over the course of the Empire;
2. to detect more precisely the copper sources exploited by the Romans;
3. to reconstruct the structure of the copper supply during the relevant period, and
4. to summarize the Romans' knowledge in producing sufficiently pure copper.

During the study we increasingly found it necessary to include material other than copper coins from official mints, as these materials may potentially function as important links between raw material sources and final products. Recently we began to gather information on copper ores from defined ore districts relevant for the Roman period (e.g., from S Spain), and to analyse Roman copper ingots which need to be treated as the connecting link between the ores and the final copper products.¹

Most of the known Roman copper ingots come from the shores of Languedoc-Roussillon² (figs. 1-2). Most are exhibited or stored in various museums. Here we will present the sampling and analysis of a selection of such ingots from the Musée des Docks Romains, Marseille (1 ingot sampled); Musée de l'Ephèbe, Cap d'Agde (12 sampled); Musée Paul Valéry, Sète (1 sampled); Musée de Frontignan (2 sampled); and Musée du Biterrois, Béziers (9 sampled). Included also are ingots from two shipwrecks (*Lavezzi 1* and *Sud-Lavezzi 2*) partly or fully excavated in the strait of Bonifacio south of Corsica that provided literally tons of copper ingots; ingots of the first are stored at the Museum of Bastia, ingots of the latter in Marseille at the Fort Saint-Jean, the headquarters of the Département des Recherches Archéologiques Subaquatiques et Sous-Marines (DRASSM), the French public institution that carried out excavation of *Sud-Lavezzi 2*. In addition, we extended our study to copper ingots of the *Pecio del Cobre* wreck near Cádiz; the location of that wreck is a clear indication of the Spanish origin of the ingots it contained.

In the case of *Lavezzi 1* and *Sud-Lavezzi 2*, the variety of goods excavated indicates a Spanish source for the whole cargo. The underwater finds made along the coast of Languedoc-Roussillon, on the other hand, raise real questions about the sources of their copper. Most of the ingots are either isolated finds or come from pillaged sites for which important information is lost.³ Yet the similarities that can be observed on the majority are strong arguments for their source in S Spain, which was a major metal-producing region in Roman times.⁴ This is despite some recent attempts to link the copper ingots found in Languedoc-Roussillon to the French district of the Cévennes.⁵ Archaeologists hope that lead isotope analysis can fix the broad source of the metal when the archaeological context does not provide good data and possibly even give some pointers towards the particular mining district where the metal originated.

1 Recent underwater findings at Maguelone (France) gave the occasion to conduct the first isotopic study on copper ingots to trace the source of the metal, with good results: Rico *et al.* 2006.

2 Here we must also mention the 4 ingots, typologically very close to those studied in this paper, that were uncovered in the pillaged Sicilian wreck of *Terrasini A* (Purpura 1974, 50-52). Like the three copper ingots found in the *Port-Vendres 2* wreck and two isolated finds off Les saintes-Maries-de-la-Mer, these ingots are not included in the present study.

3 The copper ingot collections of the museums of Cap d'Agde, Béziers, Frontignan and Bastia partly or totally derive from authorized research by local divers active in the 1960-1970s, such as A. Bouscaras, the GRASPA underwater archeology group, and the archaeological society of Béziers. Some pieces lacks museum inventory number and it has been difficult to identify their exact provenance. A very few have not been described until now.

4 Domergue 1990, 194 and 206-7.

5 Maréchal 1985 and 1995; see discussion in Domergue and Rico 2002, 394-95.