



## Copper metallurgy in ancient Etruria (southern Tuscany, Italy) at the Bronze-Iron Age transition: a lead isotope provenance study

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### ABSTRACT

The Etruscan site of Populonia-Baratti (Southern Tuscany, Italy) became in the first millennium BCE one of the most important iron metalworking sites in the Mediterranean region thanks to the exploitation of nearby Elba Island iron ores. Recent studies, however, have demonstrated that, before iron, copper was smelted therein (9th–8th century BCE). The ancient Hellenistic text *De mirabilibus auscultationibus* by Pseudo-Aristotle states that the ancient inhabitants of Elba Island firstly exploited copper and that, later in, iron was won from the same mines by the inhabitants of Populonia. However, copper occurrences are extremely scanty on the island, while mainland southern Tuscany hosts a number of copper-rich deposits which could have been profitably exploited since Eneolithic. In order to investigate if, and to what extent, copper mining and smelting/working was practiced in this area in Final Bronze Age (FBA) to Early Iron Age (EIA), we have thus compared the lead isotope composition of copper slags found in the Populonia-Baratti area and dated to the 9th–8th century BCE with those of copper-rich ore deposits of southern Tuscany and Elba Island. In addition, few copper-based items from to FBA-EIA hoards of Elba Island have been investigated as well. All copper slag from Baratti-Populonia have lead isotope composition fully comprised within the nearby Campiglia Marittima district, but the ophiolitic copper (either from Tuscan mainland or the neighboring island of Elba) was never worked in this site. Differently, all items from the island of Elba do not show clear genetic relationship neither with Elban nor with the Tuscan mainland copper ores but display a “foreign” Pb signature, suggesting that, even before iron exploitation started, the island of Elba - one of the main crossroads of the Mediterranean Sea - was probably involved in metal trading (rather than metal working) with other regions.

### 1. Introduction

After the abandonment of small coastal settlements during the FBA (12th–10th century BCE), in the Early Iron Age (9th–first half of 8th century BCE) a village was probably established by ancient Villanovan clans at Poggio del Telegrafo, just on the top of Populonia promontory (southern Tuscany, Italy) (Acconcia et al., 2006). This hilltop settlement, dominating the large coastal lagoon connected with the Gulf of Baratti, was easy to defend and permitted to control the trade exchanges with the nearby Elba Island, separated from the Channel of Piombino (Fig. 1), the whole Tuscan Archipelago up to the islands of

Corsica and Sardinia. Although it is likely that these ancestors of the Etruscans chose this site mostly for its strategic position, they were also surely attracted by the large availability of iron, copper, lead, (tin?) and silver from the nearby ore districts of Elba Island and Colline Metallifere - Campiglia Marittima (Fig. 1).

The new village on the top of Populonia promontory (Poggio del Telegrafo) – as it happened in many other areas of ancient Etruria (Bartoloni, 2004) - probably resulted from unification of previously independent political entities in a city with a state organization and centralization of all the political and economic activities. No clear traces of metallurgical activities (slags, ore relics or semi-finished

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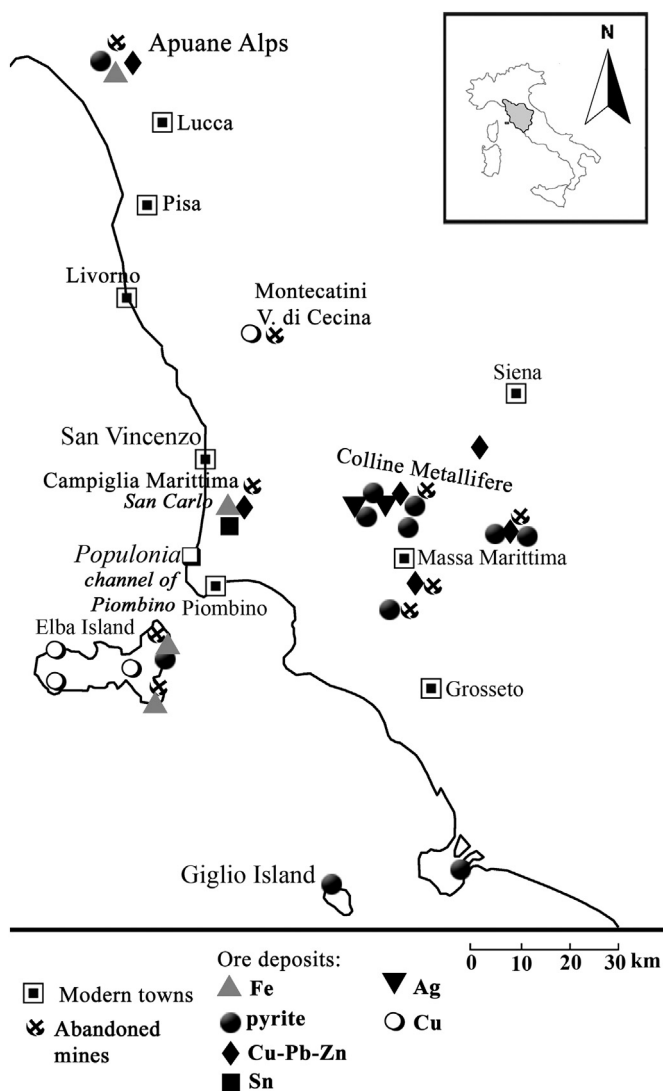


Fig. 1. Sketch map of the distribution of the main copper deposits of Tuscany. (After Tanelli, 1983, simplified.)

objects) belonging to this period have been ever found on the Populonia promontory, with the exception of two clay molds for pins (beginning of the 8th century BCE) that may suggest some bronze-working activities (Fedeli et al., 1993).

At Populonia the first clear evidence of copper production is provided in the slag beach deposit of San Cerbone along the Gulf of Baratti (Fig. 2), where layers of copper slags have been discovered at the bottom of a well-preserved stratigraphic sequence (Chiarantini, 2005). Radiocarbon dating of charcoal fragments associated with copper slag points to an early phase (9th–8th century BCE: Cartocci et al., 2007) of a highly efficient, copper metallurgy (Chiarantini et al., 2009). On the other hand, the close proximity of several FBA-EIA settlements to copper ores both in the island of Elba and the Colline Metallifere - Campiglia Marittima districts has been repeatedly claimed to indicate that these ores were exploited for copper/bronze production (for instance, Zifferero, 2002; Acconcia and Milletti, 2015).

As indicated by radiocarbon dating of the earliest iron slag horizon in the Baratti slag beach deposit (Chiarantini et al., 2009), the shift from copper to iron production took place between the 8th and early 6th century BCE (late Orientalizing period), presumably when Populonia took complete and direct control of iron ore deposits of Elba Island (Maggiani, 2006). It must be said, however, that the exact beginning of iron mining on the island of Elba is still largely undetermined

(Corretti et al., 2014). Accordingly, the earliest phase of iron production identified in the “industrial quarters” of Populonia has been dated to the 6th century BCE (Fedeli et al., 1993). It is not yet clear why iron smelting was not deeply practiced within Elba Island in this period, but metallurgical activity probably moved to the Gulf of Baratti toward Populonia even before the 6th century BCE (cf. Corretti and Benvenuti, 2001; Corretti, 2004a). In addition to classical hypotheses (the reduction, or even exhaustion, of forestal resources on the island), one can suggest that the Etruscan inhabitants from Populonia had already achieved a high metallurgical skill inherited by a long-lasting copper smelting tradition (Chiarantini et al., 2009).

Between the 6th century BCE and 1st century AD, under the Etruscan and subsequent Roman rule, Populonia became one of the most important metalworking sites in the Mediterranean region, particularly for iron production (Corretti and Benvenuti, 2001). In this period the Etruscan merchants from Populonia traded goods with Sardinia and Corsica, southern Etruria and the Aegean region, as testified by the tumulus tombs of the San Cerbone and Casone necropolises, extremely rich in jewels and objects from eastern Mediterranean (Fedeli et al., 1993). As a result of this long-lasting metallurgical activity, heaps of slag and other metallurgical debris have been discharged over a surface of about 220,000 m<sup>2</sup> in the Gulf of Baratti (D’Achiardi, 1929) (Fig. 2). The greatest part of these slag heaps was dismantled in the past century (1922–1959) for re-smelting in modern blast furnaces. The modern excavators, besides bringing to light the monumental tombs of an Etruscan necropolis, also profoundly upset the original stratigraphy of archaeological layers thus destroying most of the evidence (e.g. furnaces) of metalworking activity in this area.

The link between iron smelted at Populonia and Elban iron ores, clearly predictable on the basis of documentary, geographic and archaeological evidence, has been recently confirmed by the Sn-W geochemical anomaly of Elban hematite ores which is still detectable in smelting slags and (rare) iron blooms found at Populonia (Benvenuti et al., 2013, 2016).

But what can we say about the provenance of copper smelted at Populonia? Despite copper deposits on Elba Island are few and of very small size (see next chapter), in a famous, somehow puzzling Hellenistic text (“*De mirabilibus auscultationibus*”, 93) written by Pseudo-Aristotle, it is said that copper (and, later on, iron) was exploited from mines in the island of Elba (see Section 2.2). In principle, one cannot rule out with absolute certainty that the Villanovan inhabitants of Populonia smelted copper mined from the island of Elba.

In order to assess the provenance of copper smelted at Populonia, we have compared the mineralogical, textural and compositional features (including lead isotope composition) of metallurgical wastes from copper production found in the Baratti Gulf with those of copper-rich ore deposits in the targeted areas (i.e., southern Tuscany and Elba Island districts). In addition, we have also analyzed a few copper-based items from FBA-EIA archaeological sites of Elba Island in order to make a comparison with copper ore deposits and establish possible connections (if any).

## 2. The copper deposits of southern Tuscany and Elba island

### 2.1. Ore geology and mineralogy

Almost three millennia of exploitation in Tuscany yielded significant productions of iron, pyrite, base metals, silver, antimony, mercury, gold, as well as industrial minerals and rocks (cf. Cipriani and Tanelli, 1983). The genesis of many of these deposits is associated with volcano-sedimentary, magmatic, metamorphic and geothermal environments of pre-Tethyan and Alpine ages (Lattanzi et al., 1994).

Copper deposits of southern Tuscany are mainly hosted along a belt which extends from the Tyrrhenian coast (at Piombino) towards Siena to the east and only minor copper ore showings are present in Elba Island (Fig. 1).

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