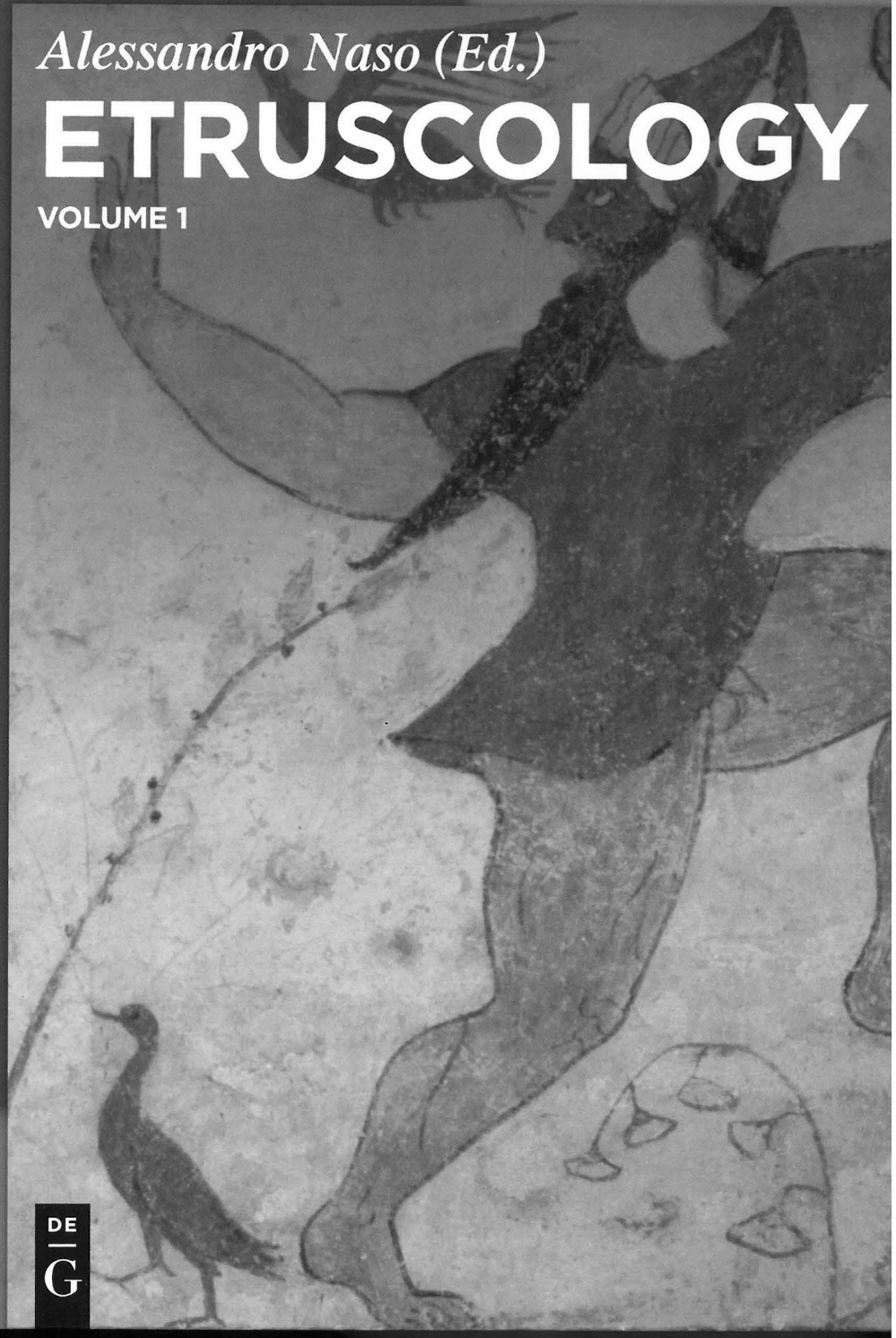
*Alessandro Naso (Ed.)*

# ETRUSCOLOGY

VOLUME 1



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# Etruscology

Volume 1

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—. 1996b. "Problemi di archeologia mineraria nel Lazio. Il caso dei Monti della Tolfa." *Archeologia Medievale* 23:739–53.
—. 2000. "Architettura costruita e paesaggio rurale in Etruria meridionale. Un contributo dal territorio cerite." In *L'architettura funeraria a Populonia tra IX e VI secolo a.C.*, edited by A. Zifferero, 193–250. Florence: All'Insegna del Giglio.
—. 2002. "Attività estrattive e metallurgiche nell'area tirrenica: Alcune osservazioni sui rapporti tra Etruria e Sardegna." In *Etruria e Sardegna centro-settentrionale tra l'età del bronzo finale e l'arcaismo,* Atti del XXI Convegno di Studi Etruschi ed Italici, Sassari, Alghero, Oristano, Torralba, 13–17.10.1998, 179–212. Pisa-Rome: Istituti Editoriali e Poligrafici Internazionali.
—. 2008. "Intervento in discussione." In *Preistoria e protostoria in Etruria. Paesaggi reali e paesaggi mentali*, edited by N. Negroni Catacchio, 94–96. Ricerche e scavi 8. Milan: Centro Studi di Preistoria e Archeologia.
—. 2009. "Attività minerarie e trasferimento dei saperi metallurgici nell'alto Tirreno. Conoscenze attuali e prospettive di ricerca." In *Materiali da costruzione e produzione del ferro. Studi sull'economia populoniese fra periodo etrusco e romanizzazione*, edited by F. Cambi, F. Cavari, and C. Mascione, 149–56. Bari: Edipuglia.

Alessandro Corretti

# 26 The mines on the island of Elba

**Abstract:** The metal resources of the island of Elba have always been a relevant factor in the history of the surrounding communities, down to recent times. Copper outcrops, though present on the island, were too small to support a significant output, while the iron mines in eastern Elba were renowned for their plenty and continued to be worked until 1981, supplying the entire Tyrrhenian Sea area and beyond with iron. Control, exploitation, and trade of Elban iron influenced local settlements and the environment and, on a wider scale, the economy and international politics. Most archaeological evidence on the ancient mines was lost during modern exploitation. Chronological, technical, and quantitative information on iron production on Elba can no longer be retrieved by direct observation. It is therefore necessary to turn to indirect evidence. The appearance of Elban iron ore (when a reliable attribution is possible) in dated contexts yields chronological hints, together with the establishment of iron workshops at Populonia and the surrounding areas. A structured and continuous exploitation seems traceable only to the late seventh century, possibly in connection with foreign (Greek? Phoenician?) initiatives. The hypothesis of Populonian control of the mines from the beginning is sensible but lacks positive evidence, as does the suggestion of pan-Etruscan (mainly Caeretan) management. The "industrial building" at Populonia implies a continuous input of Elban ore from the sixth century. Sixth–fifth century materials on Elba indicate a shift of settlement toward the mining zone. After the Syracusan incursions in 453–452 a system of hilltop fortresses was established probably by Populonia to protect the mines and the related settlements. Romanization beginning in the early third century provoked a dramatic change in the area's iron industry. An impressive amount of smelting activity (which caused increased exploitation of the Elba mines, possibly using slaves) covered the shores of Elba and the mainland with slag heaps amounting on the island to more than 100,000 tons, dating from the late third to the first centuries. The location of the workshops aims at the fullest exploitation of wood resources. Diodorus Siculus gives a vivid picture of this intensive activity, which involved the whole Tyrrhenian area. By the first century, mining and smelting were greatly reduced and limited to local needs. On Elba, ironworking sites gave way to luxurious *villae*. The memory of the glorious times survived in the works of geographers (Pliny the Elder) and poets (Rutilius Namatianius).

**Keywords:** Elba, copper, iron, mines, smelting

## 1 A geomorphological sketch

In a schematic geomorphological description, Elba may be divided into three zones. On the west, the huge granite spur of Monte Capanne, which rises 1,019 m above sea level, is covered with extensive forests and contains several granite quarries, some of which were active in Roman and medieval times. The center of the island (from Marina di Campo to Portoferraio) lies between two isthmuses and is formed by a system of low rises and hills with alluvial plains. The eastern zone stretches from Capo Vita on the north to Monte Calamita on the south and is divided in two by the isthmus of Mola. It consists of a range of steep, rocky cliffs where almost all the iron deposits on the island occur. A reconstruction of the geological evolution through a

sequence of five units ("Trevisan's complexes") was proposed in the 1950s and has recently been discussed and updated.[1]

## 2 Mines and metals

We deal here only with metals exploited in the ancient world, which for Elba means copper and iron.[2] A general reappraisal of mineral deposits on the island was published in 1991[3] and is still the main reference.[4]

Copper exists on Elba as native metal, oxide, carbonate, and sulfide. Small cupriferous veins occur all over the island, but Elba bears no major copper resources. Suggestions by nineteenth century mining engineers[5] to reopen an "ancient" copper mine at Santa Lucia had no actual consequences. In fact, no copper has been excavated on the island in modern times. From west to east, copper is found at Pomonte Ogliera – Punta Massellone, Le Tombe – Fetovaia, Acquacalda, Monte Perone, Santa Lucia – Colle Reciso – Monte Orello, Volterraio, Monte Calamita, and Cima del Monte.[6] Other records of veins of native copper or chalcopyrite mention Maciarello[7] and several sites around Pomonte (Buca del Rame ["Copper's Cave"], San Bartolomeo).

Iron is found as oxides (hematite and magnetite), sulfides (pyrite), and hydroxides (limonite, goethite) and occurs almost exclusively in the eastern part of the island (Fig. 26.1a). A peculiar clay (*bolo*) was also collected in the iron mines and was used as a medicine;[8] healthful effects were credited to a mineral spring below the iron mountain at Rio Marina.[9]

Beginning in 1853, several iron mines were opened or re-opened from Rio Albano to Monte Calamita;[10] before that, only the high-quality hematite deposits of Rio Albano and Rio Marina had been exploited.[11]

1 A summary in Tanelli et al. 2001, 239–41.
2 For an insignificant amount of tin near San Piero in Campo, Tanelli 1989, 1414; on lead ores observed near Rio Marina see Giardino 1995, 119.
3 Benvenuti, Guideri, and Mascaro 1991, 122–64.
4 Update in Tanelli et al. 2001.
5 Simonin 1858, 567; Jervis 1862, 60–61.
6 Benvenuti, Guideri, and Mascaro 1991.
7 Though Zecchini 2001, 193 reports iron concretions in and around the cave.
8 Pini 1777, 44.
9 The "*Acqua Marziale di Rio*": Buzzegoli 1762; Pini 1777, 44–48; Jervis 1862, 45.
10 Fabri 1887, 11–12; see also Benvenuti, Guideri, and Mascaro 1991.
11 Fabri 1887, 11–12; Tanelli et al. 2001, 243.



## 3 History of research

Ancient authors (e.g. *Mir. ausc.* 93) already realized that mineral exploitation on the island had a long and complex history, but reliable evidence of ancient mining on Elba began to be collected and discussed only in the eighteenth and nineteenth centuries.[12] True historical interest grew beside utilitarian aims. In fact, tracing the exploitation of a mine back to remote times legitimated new investment:[13] veins of ore exploited by the "ancients" could be followed with modern mining methods, yielding a successful enterprise.[14] But while investigations on the mainland actually led to the recognition of ancient and medieval excavations,[15] on Elba ancient workings remained largely unknown, due to uninterrupted activity in the mine of Rio, which was carried out through open-pit digging beginning in the sixteenth century, and later also with gunpowder.[16] Old galleries were occasionally brought to light, but none of them were conserved or scientifically documented.[17] These caves are simply referred to as "ancient"; sometimes an approximate length (1/4 mile) is given.[18] The ancient dumps near the mines were also exploited[19] without any archaeological control.[20] Other information derives from objects found among the slag heaps occasionally excavated on Elba, again with almost no scientific recording of data.[21]

The growing importance of the iron mines of Elba in nineteenth- and twentieth-century Italy was both economic and symbolic, connecting the future of the new nation to its glorious past.[22] In 1938, when all the mineral resources of Italy were put under intense exploitation, a comprehensive volume traced the history of the mines of Elba "since the Etruscans."[23]

The recovery of slag at Populonia in the first decades of the twentieth century[24] stimulated new multidisciplinary investigation of the mineral resources of ancient Etruria.[25] While evidence on the mainland since then has been the object of renewed

12 Mainly Pini 1777; see n. 17 below.
13 Vitali 1992; Francovich 1994.
14 Haupt 1847, 187–88.
15 E.g. Haupt 1847, 188–89; Simonin 1858, 561–62; a summary in Francovich 1994; Zifferero 2002.
16 Pini 1777, 51–52.
17 Scanty information occurs in Buzzegoli 1762, 17–18; Pini 1777, 59; Colt Hoare 1819, 18 (summary in Vanagolli 1998, 48 n. 15; Corretti and Benvenuti 2001, 128–29).
18 Colt Hoare 1819, 18.
19 Recorded *e.g.* by Pini 1777, 34, 60, and sketched in his plan of the mine.
20 Cocchi 1865, 9; Mellini 1879.
21 Jervis 1862, 39–40; Mellini 1879; Fedeli 1983, 177–78.
22 On the mining industry in nineteenth and early twentieth century Italy see Pistolesi 2011.
23 Miniere e ferro 1938.
24 D'Achiardi 1927; Minto 1943; Pistolesi 2006.
25 Benvenuti, Guideri, and Mascaro 1991, 10 n. 4; Giardino 1995, 131 n. 49; Corretti and Benvenuti 2001, 128 n. 2.

interest, the iron mines of Elba—which were still active at that time—have received less attention.

The discovery in the 1960s on the island of Ischia of a fragment of hematite[26] stimulated new interest in ancient metal exploitation in Elba and Etruria. In fact, excavations on Ischia were bringing about the recognition of the role of the Pithekoussan community (which did not comprise Euboeans only) as the starting point of Greek colonization and trade in the West. The evidence from Ischia revealed a connection between the mineral resources of central Italy (including Elba mines) and Greek expansion in the Tyrrhenian Sea.[27] Meetings,[28] exhibitions,[29] and reappraisals[30] were therefore focused on *Etruria Mineraria*. Excavations at Populonia brought to light a building of the sixth–early third centuries, where Elban iron ore was smelted and worked.[31] Excavations[32] and surveys[33] were also carried out on Elba, extending to the Middle Ages,[34] which allowed a careful reexamination of archaeological data published in local contributions.[35]

Research carried out in recent decades at and around Populonia by a multi-institutional team has been widening our knowledge of ancient Populonia,[36] and throwing light on the phase of copper metallurgy that preceded iron exploitation.[37]

On Elba, a late Republican (third–first centuries) ironworking site was discovered at Cavo (Rio Marina) in 1999;[38] a mold of the hearth is displayed in the Antiquarium of Rio nell'Elba, along with slag, ore, and tuyère fragments from other Roman and medieval ironworking sites.

Mineral exploitation and human settlement on the island of Elba from antiquity to the Middle Ages are currently being investigated by a multidisciplinary team (the "Aithale project").[39]

26 Corretti and Benvenuti 2001, 134 n. 37, with previous literature.
27 Main literature in Corretti and Benvenuti 2001, 134–35; for Ischia Nijboer 1998, 165–66.
28 E.g. Istituto di Studi Etruschi ed Italici 1981; First Iron 1988.
29 Albore Livadie 1985; Pancrazzi 1985.
30 Fedeli 1983, 177–78; update in Fedeli 1993; Romualdi 1993.
31 Martelli 1981; Nijboer 1998, 190–91; Bonamici 2007.
32 Relevant for the present issue are two Classical and Late Etruscan hill forts at Monte Castello and Castiglione di San Martino (Maggiani 1981; 2008; Pancrazzi 1985).
33 Corretti 1997; Cambi 2004.
34 Excavation of an iron workshop at Monte Serra (Rio nell'Elba): Martin 1994.
35 Zecchini 1978, 2001.
36 See the series *Materiali per Populonia*; an update on ancient quarries and mines around Populonia and on Elba in Cambi, Cavari, and Mascione 2009.
37 Chiarantini et al. 2009; Chiarantini and Benvenuti 2009.
38 Firmati, Arrighi, and Principe 2006; Corretti and Firmati 2011; Maggiani 2015, 365.
39 See Alderighi et al. 2012; Cambi, Corretti, and Pagliantini 2015.



# 4 Scattered remarks on metal exploitation and production on Elba

## 4.1 Copper

The literary allusion to copper mining occurring in remote times (*Mir. ausc.* 93) is paralleled by the archaeological evidence. In fact, the presence of people of the Eneolithic culture of Rinaldone in the heart of the mining area of Elba (Grotta di San Giuseppe, Rio Marina)[40] testifies to their precocious interest in the metal resources of the island, with pride of place, of course, going to copper.

Human presence intensified from the Late Bronze to the Early Iron Age, according to several bronze hoards from the island,[41] which were found in close relationship with copper outcrops (Fig. 26.1a), though the latter are of minor extent.[42]

Bronze objects and burial rites show parallels both with the mainland and with Sardinia and Corsica,[43] suggesting that people traveling between the islands and the Italian peninsula played a major role in the spread of metallurgical knowledge in Elba.

Even the smallest chalcopyrite outcrop would not escape the expert eye of prospectors acquainted with copper metallurgy in Sardinia or the Campigliese; indeed, analyses on bronze objects from Cima del Monte testify for their Sardinian origin.[44] The small amount of available metal suggests that copper exploitation on Elba played only a supplementary role beside other activities.[45]

This scheme is reflected in the Pseudo-Aristotelian text *Mir. ausc.* 93.[46] The chronological sequence starts with copper production for local needs, followed by a considerable pause and, finally, by the *paradoxon* (tale of marvels) of iron exploitation in the same mine. Actually, copper veins do occur on Elba among iron ore deposits (e.g. at Monte Calamita or Rio), though never in large amounts. The Pseudo-Aristotelian idea of a "real" copper mine is therefore influenced by the later, impressive appearance of iron mines and possibly by the abundance of copper in *Etruria Mineraria* as a whole. It has been suggested that Etruria controlled and took advantage of Elba's copper resources, while iron production was directly managed by Populonia.[47] Self-suffi-

40 Cremonesi 2001; Ducci 2001, 2007.
41 Delpino 1981; Fedeli 1983, 179–80; Camporeale 1985, 46–47; Giardino 1995, 119–22; Ducci 2001, 221–22; Cygielman et al. 2015, 281 n. 61.
42 Delpino 1981, 270–76; Corretti and Pancrazzi 2001, 270–76.
43 Evidence in Delpino 1981, 272; Giardino 1995, 122; Zifferero 2002; Milletti 2012; Cygielman et al. 2015.
44 Milletti 2012, 210–11; 245–46; on the analyses on bronze objects from Cima del Monte Alderighi et al. 2013, 80–81.
45 A pattern well described in Nijboer 1998, 136, 189.
46 Corretti 2004, 272–73.
47 Colonna 1981.

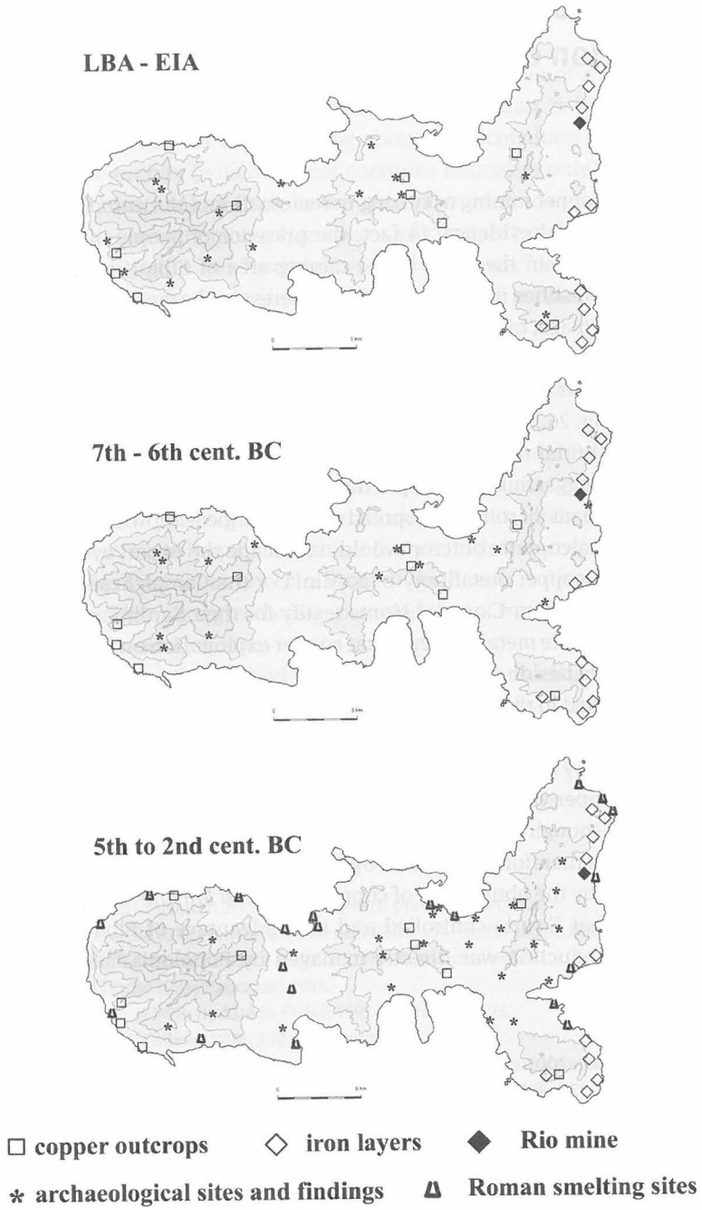


**Fig. 26.1:** Map of the metal resources on the island of Elba



ciency based on Elba's copper outcrops makes sense only if it referred to the needs of the inhabitants of the island; it seems therefore possible that the heavily abridged Pseudo-Aristotelian paragraph distinguished between a (remote) time when Elban people directly managed the copper on the island, retrieving enough of it to satisfy their needs, and the time of the author of the tale (Timaeus?), when iron mining was the bulk of mineral production on the island, under Populonian rule. Two features should be noted: the long time between the exhaustion of the copper mine and the reopening of the iron mine; and no mention of the inexhaustibility of iron mines (a major theme in later ancient literature), even though the tale would offer an appropriate context.

## 4.2 Iron

### 4.2.1 The Etruscan period

Since ancient mines and dumps at Rio have been lost in modern exploitation, indirect information is needed to date the initial phases of iron production.

Tracing back the first appearance of (true) Elban hematite in reliable archaeological contexts is a sensible method, though ore provenance should always be controlled through specific analyses. Recent research has discovered that high tin and tungsten contents mark the hematite from Elba, thus yielding a tool for tracing the diffusion of Elban iron ore.[48] Elban hematite has recently been discovered in reliably Palaeolithic contexts near Livorno and near Lake Bilancino (Florence), of course not for metallurgical use.[49] Ore from the lowest levels in the "industrial building" at Populonia dates to the first half of the sixth century.[50] Hematite from Pisa[51] and San Piero a Grado[52] comes from late seventh–early sixth century contexts; a slightly lower chronology is suggested for the iron ore at Rondelli–Follonica.[53] On Ischia the ore from "Scarico Gosetti" comes from a disturbed context, and the slag found in an eighth-century layer in the necropolis of Lacco Ameno cannot be linked with certainty to Elban ore.[54]

Iron objects from Populonia testify to the spread of iron technology in the area[55] and to the exploitation of local resources (possibly including the ore deposits of Monte Valerio, on the mainland). Iron was not common in the early phases of the necropolis

48 Benvenuti et al. 2013.
49 Sammartino 2009, 49 fig. 5; Aranguren et al. in press.
50 Bonamici 2007; Bonamici 2015, 411.
51 Bonamici 1989; Bonamici 2015, 411, 414–15 for further references.
52 Bruni 2001.
53 Aranguren et al. 2004.
54 Corretti and Benvenuti 2001, 134–35, 142–43.
55 Fedeli 1983, 178; Nijboer 1998, 190–91.

of Populonia,[56] but it was used for ornamental purposes (iron inlay in bronze sheet) as late as the middle of the seventh century.[57] Other parts of Italy (e.g. Calabria) were more precocious, adopting iron for utilitarian purposes as early as the ninth century.[58] The existence of large iron ore deposits on Elba does not seem to have stimulated an autonomous early transition to iron-based metallurgy in the area.[59] External influence may therefore be traced through several distinct—possibly interconnected—paths, involving Greek (Euboean-Pithekoussan), Phoenician, and Sardinian prospectors and traders, in the context of a well-developed local copper-based metallurgy.[60]

The stratigraphy of Porto Baratti at Populonia, where slag accumulated for centuries, may enlighten the early phases of iron exploitation. At the bottom of a cliff running along the seaside,[61] large slag cakes deriving from copper smelting were recorded, dating to the ninth–eighth centuries.[62] Atop this layer, some iron slag appeared mixed with copper slag, earth, and charcoal, with a $C^{14}$ chronology from the eighth and seventh centuries. Copper slag disappears, and iron slag becomes more frequent in the upper layers.[63] These data will be verified through further investigations in other portions of the slag deposit at Porto Baratti.

Even admitting a late-eighth-century date for the "discovery" of the iron deposits of Rio,[64] positive evidence of systematic exploitation is consistently later.[65]

The status of the iron mines in these early phases is obscure. Evidence of a structured community on Elba—able to manage the local metal resources—is elusive. Populonia is said to manage the "new" iron mine in *Mir. ausc.* 93;[66] garment accessories from seventh–sixth century tombs at Madonna del Monte (Monte Capanne, Elba) point to Populonian settlers.[67] However, political control of the island (and of the mines) by Populonia at this early time needs stronger evidence.[68] It is certain that in the early sixth century, Populonia created an industrial complex for ironworking at Baratti, which presupposes a continuous supply of iron ore.

56 Acconcia and Milletti 2009, 144.
57 Corretti and Benvenuti 2001, 134 n. 4.
58 Nijboer 1998, 160–61; Corretti and Benvenuti 2001, 130.
59 Corretti and Benvenuti 2001, 132; Acconcia and Milletti 2009, 143.
60 Corretti and Benvenuti 2001, 139–40; Zifferero 2002, 2009; Acconcia and Milletti 2009, 143; Milletti 2012, 237 ff.; Cygielman et al. 2015, 289–90.
61 Acconcia and Cambi 2009; Chiarantini et al. 2009.
62 Chiarantini et al. 2009, 1632.
63 Chiarantini et al. 2009, 1633.
64 Corretti and Benvenuti 2001, 135, n. 42.
65 Not before the late seventh or sixth century: Nijboer 1998, 165; Acconcia and Cambi 2009, 171; Cambi 2009, 224; Chiarantini and Benvenuti 2009, 208.
66 Corretti 2004.
67 Maggiani 2006, 440–43.
68 But see Acconcia and Milletti 2009, 144.



Several sparse hints thus converge to indicate a Populonian initiative in improving iron production at least as early as the sixth century. This may be due, of course, to internal developments at Populonia that moved the balance of the local economy toward a manufacturing industry, (and iron production ad Populonia and elsewhere in Etruria has been recently connected to aristocratic groups since the first half of the sixth century)[69], but external influence should not be excluded. It is worth noting that the beginning of regular iron production coincides with the acme of Phocaean and Ionian *emporia* in the West. This is the time of the first known mention of Elba in Greek sources—by Hecataeus of Miletus. Phocaeans in particular were credited with "opening" the sea routes of the western Mediterranean (Hdt. 1.163), and it is tempting to connect the location of Elban iron mines—almost directly on the sea—to the high grade of Elban hematite (which made the raw ore trade profitable),[70] and the traces of Ionian (Phocaean?) influence in the material culture of Archaic Populonia.[71]

We cannot guess at the amount of iron worked.[72] The quantity of slag dated with certainty to the Archaic period (from Populonia "Edificio Industriale," Rondelli, and a few other sites in the neighborhood, but not yet Elba)[73] appears significantly smaller (on the order of hundreds of tons) than the huge heaps from Roman times (hundreds of thousands of tons).[74] Though small, in the sixth–fifth centuries, several ironworking sites were already spread along the Tyrrhenian Sea. We do not know how much they relied on Elban iron and/or other sources of iron,[75] and only analyses of ore and slag will give an answer. This is the case, for example, of the iron ore found in a fifth-century context at Genoa and at Aleria (Corsica), which is generally identified as Elban hematite without specific analyses.[76]

There is a shift of the human settlement on Elba towards the eastern, iron-mining area in the sixth and fifth centuries (Fig. 26.1b–c). An Archaic bronze statuette of an offerer,[77] together with some of the Classical tombs so far discovered on Elba, attest to a moderate local wealth, possibly connected to iron mines.[78] From the second half of the fifth century, a system of hilltop fortresses was established on the island, probably

69 Bonamici 2015, 415–6.
70 Nijboer 1998, 165.
71 Corretti and Benvenuti 2001, 141 nos. 83, 84; Maras 2015.
72 For a calculation of ore excavated before the nineteenth century see Fabri 1887, 1–2; Cipriani and Tanelli 1983, 254.
73 Zifferero 2002; Ponta 2006, 285–86.
74 Corretti and Benvenuti 2001, 142. Estimates of the amount of iron slag at Populonia vary dramatically: for a concise discussion see Nijboer 1998, 191 n. 305; Pistolesi 2006.
75 Aranguren et al. 2004; according to Nijboer 1998, 162–65, local bog iron ore was treated at Satricum.
76 Corretti and Benvenuti 2001, 142–43.
77 Albore Livadie 1985.
78 Maggiani 1981; Corretti and Pancrazzi 2001; Maggiani 2006; Rafanelli 2007, 69–70.

under Populonian control[79] and mainly in the most populous, central-eastern part of the island. This suggests an increased importance of iron exploitation, which became a strategic resource in a wider Tyrrhenian area. At Populonia, smelting and refining activities were carried out in the "industrial quarter" from the sixth to the early third centuries[80] and near the Baratti shore, where recent excavations have brought to light smithing forges dating from the fourth to the second centuries.[81]

The iron mines of Elba may have been the real target of the double naval expedition by Syracuse in 453–452 (Diod. Sic. 11.88.4–5), though Diodorus refers only to the repression of Etruscan piracy.[82] The number of ships (sixty) and the distance from Sicily long remained unparalleled in Syracusan history. This highlights the importance attributed by the Sicilian *polis* to the direct control of Elba and its iron mines, a resource almost totally lacking in Sicily. A further expedition under Dionysius the Elder in 384 supports this view. The anecdote of the Sicilian merchant (in Arist. *Pol.* 1259a)—the first documented attempt at an iron monopoly, under Dionysius the Elder—gives the figure of fifty talents to indicate the value of the iron purchased. This number has been seen as the amount of iron annually bought by Syracuse,[83] thus giving a figure for the annual output of the main source of iron ore, the Elba mines. This statement should be reexamined, however. Traces of Syracusans on Elba are scanty but suggestive: the *Portus Longus* (*Peutinger Table* 2.4–5)—Porto Longone, later Porto Azzurro—mirrors Greek place names in northeastern Sicily;[84] the myth of the Argonauts on Elba has also been connected with Corinthian (i.e., Syracusan) traditions;[85] the "*Hellenes hoi ten neson oikountes...*" mentioned by *Mir. ausc.* 105 (Timaeus?) were perhaps the descendants of the Syracusan garrison.[86]

### 4.2.2 The Roman period

Traces of a change in the iron industry at Populonia after the Roman conquest (early third century) may be seen in the abandonment of the "industrial quarter" at Baratti[87] and in the establishment of several large ironworking sites on the Tyrrhenian coast[88] and on Elba. Since these slag heaps were almost totally destroyed during slag-retrieval

79 Cambi 2004; Maggiani 2008; Corretti 2011; Cambi, Di Paola, and Pagliantini 2013; Maggiani 2015.
80 Bonamici 2007; 2015.
81 Cambi 2009, 173.
82 Colonna 1981.
83 Pais 1893, 347–48 n. 3; Corretti 2004, 274–75.
84 Corretti 2009, with previous literature.
85 Most recently Corretti 2005, with previous literature.
86 Colonna 1981; Corretti, Cambi, and Pagliantini 2015.
87 Acconcia and Cambi 2009, 172–73.
88 Ponta 2006, 286–87.



operations in the 1930s and later,[89] only an approximate date (early second–early first century) can be given for this massive ironworking phase.[90]

More than 100,000 tons of slag were recovered on Elba;[91] on the mainland, the ironworking site at Poggetti Butelli near Follonica is estimated to have held around 500,000 tons, while the amount of slag at Populonia is debated but seems to be consistently larger.[92]

This means that iron ore excavation on Elba underwent a dramatic increase under Roman rule, possibly through greater use of slave manpower. A clear explanation for this change continues to elude us, although it seems likely that Populonian control of the Elba mines weakened,[93] and private enterprises (*publicani*) made free use of the mineral and forest resources of the island and the mainland. Possibly, one of these entrepreneurs was that Aulus Vettius who scratched his name inside a third century BCE black glazed bowl that was found in the sea at Cavo, near the iron mines and in front of an ironworking site.[94]

Tomb assemblages in the Hellenistic-Roman cemeteries of Elba suggest that both slaves and freedmen were employed in the mines and related jobs.[95] New ironworking sites were created up and down Elba's coast (Fig. 26.1c),[96] even at the western end.[97] These factories were located on the sea, near an anchorage for ore transport facilities. They relied on water from small streams flowing nearby, and usually had a valley behind them that furnished charcoal for metallurgical furnaces. Roof tiles, amphorae, and ceramics found among the slag during the surveys and the excavation at San Bennato and San Giovanni[98] hint at permanent settlements.

The location of these ironworking sites aimed at the fullest exploitation of the island's forests. In fact, the only factor limiting the amount of iron that could be produced was the quantity of available wood and charcoal. Woods in the area were severely damaged by this large-scale manufacture, which impressed the ancient writers. Diodorus Siculus (5.13.1–2) devotes the entire chapter on Elba to the ironworking process, describing the large amount of iron available and exploited, the crushing

89 Corretti 1997; Baiocco et al. 1990; Pistolesi 2006; Pistolesi 2013.
90 Follonica: Baiocco et al. 1990; territory of Populonia: Cambi 2009, 227; Elba: Maggiani 1981; Corretti 1997; Zecchini 2001, 127–38; Corretti and Firmati 2011; Alderighi et al. 2012.
91 Corretti 1997; Zecchini 2001, 127–38; Pistolesi 2013. Estimates are based on records collected in person in the late 1950s by the Swedish researcher John Nihlen, who interviewed workers involved in slag retrieval operations.
92 Pistolesi 2006, 22–23.
93 Corretti 2004, 284.
94 Maggiani 2015, 362–3
95 Rafanelli 2007; Firmati 2009.
96 And/or older ones were enlarged (archaeomagnetism suggests a date of between 550 and 350 BCE for the early furnace at Cavo: Firmati, Arrighi, and Principe 2006).
97 Pomonte and Patresi: Corretti 1997.
98 Firmati, Arrighi, and Principe 2006; Corretti and Firmati 2011; Alderighi et al. 2012.

and smelting of ore, the technical properties of the furnaces, and the fact that the metallurgical treatment was limited to smelting, producing unrefined iron in the form of large "sponges." A complex network of factories and trading points that spread across the Tyrrhenian Sea but was centered on Puteoli (Pozzuoli), brought Elban iron—in the form of finished objects—almost everywhere. This system distributed the environmental[99] and economic problems connected with charcoal production to a wider area, since every step of the ironworking process (from smelting to refining to forging and shaping) was located in a different place.

The establishment of this operational chain dates at least to the Second Punic War, when Scipio (in 205) asked his Etruscan allies for the raw materials to build and arm a fleet for his expedition to Africa. Populonia gave iron, while weapons and implements—possibly made of the very same iron—were presented by Arretium (Livy 28.45.15–16).[100]

Analyses of slag from Roman ironworking sites on Elba confirm that the metallurgical treatment of iron ore was limited to smelting.[101] At Populonia, coastal excavation has brought to light some refining forges dating to the fourth–beginning of the second centuries, while a huge accumulation of smelting slag occurs immediately after.[102] The impact of mining and metallurgy on the Italian environment, the fear of further slave rebellions after Spartacus, and attention to sparing the resources of Italy for future needs moved the Senate to promulgate a *senatusconsultum*[103] in the first century forbidding mineral exploitation in Italy. At the same time, several authors mention the iron mines of Elba for the *paradoxon* of their inexhaustibility. Elba was Italian soil, but Strabo (5.2.6) saw active Elban iron mines (though ironworking on the island had ceased), with the ore laded directly from the mine and brought to Populonia for smelting. Elban iron mines were not definitively closed, possibly because iron had a special status for strategic reasons, or because they really were supposed to be nearly inexhaustible.[104]

### 4.2.3 Epilogue

We do not know how long the Elban iron mines remained active after Strabo's observation. Excavations at Baratti-Populonia clearly show an end to large-scale metallurgical activity by the middle of the first century[105] and a transition to a modest production system based on *villae* that was aimed at local needs.[106] The routes of the iron trade—at least those that led to the Roman army—no longer crossed the waters of Elba, but followed the Rhône toward the German *limes*.[107] It is suggestive that steel implements used in Vetulonia were purchased in Noricum in the first century CE.[108] Though Virgil (*Aen.* 10.173), Silius Italicus (6.613–16), and Pliny the Elder (*HN* 3.81, 34.142) still mention the iron mines, they refer to past ages, or use a literary *topos* associating Elba with *ferri metalla* even though these were no longer being worked. Rutilius Namatianus (1.351–66) praises the poor, honest, and fertile iron of Elba as the symbol of an old world that had collapsed under the blows of the barbarians or had been weakened by the Christians. The mines had entered legend.

99 Williams 2009.
100 Most recently Corretti 2009; Maggiani 2015.
101 Alderighi et al. 2012.
102 Cambi 2009, 224.
103 Corretti 2004; Cambi 2009, 226–27; Camporeale 2013.
104 Camporeale 1985, 34; Corretti 2004, 282–84; Cambi 2009, 228–29.
105 Acconcia and Cambi 2009.



## References


Acconcia, V., and F. Cambi. 2009. "Lo scavo della spiaggia di Baratti a Populonia." In Cambi, Cavari and Mascione 2009, 171–79.

Acconcia, V., and M. Milletti. 2009. "Pratiche metallurgiche e circolazione di saperi all'origine di Populonia." In Cambi, Cavari and Mascione 2009, 141–47.

Albore Livadie, C. 1985. "Isola d'Elba." In Camporeale 1985, 84, no. 301. Milan: Electa.

Alderighi, L., M. Benvenuti, F. Cambi, L. Chiarantini, C. X. H. Chiesa, A. Corretti, A. Dini, M. Firmati, L. Pagliantini, C. Principe, L. Quaglia, and L. Zito. 2012. "Aithale. Ricerche e scavi all'isola d'Elba. Produzione siderurgica e territorio insulare nell'antichità." *AnnScPisa, Classe di Lettere e Filosofia* ser. 5, vol. 4(2): 169–88.

Alderighi, L., M. Benvenuti, A. Buracchi, L. Chiarantini, A. Dini, M,. Firmati, C. Milanesi, L. Pagliantini, and L. Quaglia. 2013. "Elba centrorientale: gli insediamenti antichi di Monte Moncione e Cima del Monte." *Notiziario della Soprintendenza per i Beni Archeologici della Toscana:* 67–81.

Aranguren, B., F. Cavulli, M. d'Orazio, S. Grimaldi, L. Longo, A. Revedin, and F. Santaniello. 2015 "Territorial Exploitation in the Tyrrhenian Gravettian Italy. The case-study of Bilancino (Tuscany)." *Quaternary International* 359–360: 442–51.

Aranguren, B., G. Ciampoltrini, L. Cortesi, G. Giachi, M. Firmati, P. Pallecchi, P. Rendini, and P. Tesi. 2004. "Attività metallurgica negli insediamenti costieri dell'Etruria centrale fra VI e V secolo a.C." In *L'artisanat métallurgique dans les sociétés anciennes en Méditerranée Occidentale. Techniques, lieux et formes de production*, edited by A. Lehoërff, 323–39. Rome: École Française.

*Atti Bastia- Aléria - Piombino - Populonia. La Corsica e Populonia.* Atti del XXVIII Convegno di Studi Etruschi ed Italici, Bastia, Aléria, Piombino, Populonia 25–29.10.2011. Rome: Giorgio Bretschneider

*Atti Firenze III. L'Etruria Mineraria.* Atti del XII Convegno di Studi Etruschi ed Italici, Florence, Populonia, Piombino, 16–20.6.1979. Florence: Olschki.


106 Cambi 2009, 228–29.
107 Domergue et al. 2003.
108 Egger 1961, 27.

Baiocco, G., F. Bucci, L. Ferretti, N. Geri, R. Magagnini, and L. Verdini. 1990. *Metallurgia antica e medievale nel golfo di Follonica*. Follonica: Comitato pro ex ILVA.
Benvenuti, M., A. Dini, M. D'Orazio, L. Chiarantini, A. Corretti, and P. Costagliola. 2013. "The Tungsten and Tin Signature of Iron Ores from Elba Island (Italy). A Tool for Provenance Studies of Iron Production in the Mediterranean Region." *Archaeometry* 55(3): 479–506.
Benvenuti, M., S. Guideri, and I. Mascaro. 1991. *Inventario del patrimonio minerario e mineralogico in Toscana. Aspetti naturalistici e storico-archeologici*. Florence: Edizioni Regione Toscana.
Bonamici, M. 1989. "Contributo a Pisa arcaica." In *Atti del Secondo Congresso Internazionale Etrusco*, Florence 26.5–2.6.1985, 2: 1135–47. Rome: Giorgio Bretschneider.
—. 2007. "Nuove ricerche nel quartiere industriale di Populonia." *AnnMuseoFaina* 14: 431–54.
—. 2015. "Ricerche nel quartiere industriale di Populonia." In *Atti Bastia – Aléria – Piombino – Populonia*, 409–57.
Bruni, S. 2001. "Ad Gradus Arnenses. Il distretto della foce del ramo settentrionale del delta dell'Arno in età antica." In *Tombolo. Territorio della Basilica di San Piero a Grado*, edited by S. Sodi, 83–99. Pisa: Felici Editore.
Buzzegoli, A. 1762. *Dell'acqua marziale di Rio. Trattato*. Florence: Andrea Bonducci.
Cambi, F. 2004. "Populonia e l'isola d'Elba. Territorio e viabilità delle fortezze d'altura." In *Materiali per Populonia 3*, edited by M. L. Gualandi and C. Mascione, 291–307. Florence: All'Insegna del Giglio.
—. 2009. "Conclusioni. Populonia. Ferro, territorio e bacini di approvvigionamento fra il periodo etrusco e il periodo romano." In Cambi, Cavari and Mascione 2009, 221–30.
Cambi, F., A. Corretti, and L. Pagliantini. 2015. "AITHALE. Per una ripresa della ricerca archeologica all'Isola d'Elba." In *Atti Bastia – Aléria – Piombino – Populonia*, 375–94.
Cambi, F., G. Di Paola, and L. Pagliantini. 2013. "Populonia e la romanizzazione dell'Etruria Settentrionale." In *Mura di legno, mura di terra, mura di pietra. Fortificazioni nel Mediterraneo antico*, edited by G. Bartoloni and L. M. Michetti, Atti del convegno internazionale, Rome 7–9.5.2012. *ScAnt* 19: 387–410.
Cambi, F., F. Cavari, and C. Mascione, eds. 2009. *Materiali da costruzione e produzione del ferro. Studi sull'economia populoniese fra periodo etrusco e romanizzazione*. Bari: Edipuglia.
Camporeale, G. ed. 1985. *L'Etruria Mineraria*, exhibition catalogue. Milan: Electa.
—. 2013. "Ancora sul decreto di divieto dell'attività estrattiva nell'Italia antica (Plin., Nat. Hist. III 24, 138; XXXIII 21, 78)." In *Δόσις δ'ολίγη τε φίλη τε. Studi per Antonella Romualdi*, edited by S. Bruni and G. C. Cianferoni, 193–206. Florence: Polistampa.
Chiarantini, L., and M. Benvenuti. 2009. "I bacini di approvvigionamento dei minerali metalliferi e le tecnologie produttive del rame e del ferro." In Cambi, Cavari and Mascione 2009, 203–12.
Chiarantini, L., M. Benvenuti, P. Costagliola, M. E. Fedi, S. Guideri, and A. Romualdi. 2009. "Copper Production at Baratti (Populonia, Southern Tuscany) in the Early Etruscan Period (9th–8th century BC)." *Journal of Archaeological Science* 36: 1626–36.
Cipriani, C., and G. Tanelli. 1983. "Le risorse minerarie della Toscana. Note storiche ed economiche." *AttiMemColombaria* 48: 241–83.
Cocchi, I. 1865. *Di alcuni resti umani e degli oggetti di umana industria dei tempi preistorici raccolti in Toscana dal professore Igino Cocchi*. Memorie della Società Italiana di Scienze Naturali 1.
Colonna, G. 1981. "Presenze greca e etrusco-meridionale nell'Etruria mineraria." *Atti Firenze III*: 431–52.
Colt Hoare, R. 1819. *A Classical Tour through Italy and Sicily*. London: J. Mawman.
Corretti, A. 1997. "La metallurgia del ferro all'isola d'Elba nel periodo classico e medievale." In *L'Ambiente geomineralogico e la Storia mineraria dell'Isola d'Elba*, Atti dei Convegni, Rio nell'Elba 1996, 67–82. Quaderni de "I fiori della Terra" 1.



—. 2004. "Per un riesame delle fonti greche e latine sull'isola d'Elba nell'antichità." In *Materiali per Populonia 3*, edited by M. L. Gualandi and C. Mascione, 269–89. Florence: All'Insegna del Giglio.
—. 2005. "Per un riesame delle fonti greche e latine sull'isola d'Elba nell'antichità. Gli Argonauti." In *Materiali per Populonia 4*, edited by A. Camilli and M. L. Gualandi, 231–58. Florence: All'Insegna del Giglio.
—. 2009. "Siderurgia in ambito elbano e populoniese. Un contributo dalle fonti letterarie." In Cambi, Cavari and Mascione 2009, 133–39.
—. 2011. "Le fortezze d'altura dell'isola d'Elba. Lo stato della questione." *Aristonothos* 8: 347–70.
Corretti, A., and M. Benvenuti. 2001. "The Beginning of Iron Metallurgy in Tuscany, with special reference to Etruria Mineraria." In *The Origins of Iron Metallurgy*. Proceedings of the First International Colloquium on the Archaeology of Africa and the Mediterranean Basin, Geneva, 4–7.6. 1999, 127–45. Sydney: Meditarch.
Corretti, A., and M. Firmati. 2011. "Metallurgia antica e medievale all'isola d'Elba: vecchi dati e nuove acquisizioni." In *Archeometallurgia. Dalla conoscenza alla fruizione*, Atti del workshop, Cavallino, 22–25.5.2006, edited by C. Giardino, 229–41. Bari: Edipuglia.
Corretti, A., and O. Pancrazzi. 2001. "L'isola d'Elba." In *Le rotte nel mar Tirreno. Populonia e l'emporio di Aleria in Corsica*, 18–21. Suvereto: Isografiche.
Corretti, A., F. Cambi, and L. Pagliantini. 2015. "'The Finest Harbour'. The Argonauts (and the Others) on the Island of Elba." In *Sanctuaries and the Power of Consumption. Networking and the Formation of Elites in the Archaic Western Mediterranean World*, edited by E. Kistler, B. Öhlinger, M. Mohr and M. Hoernes, 263–273. Wiesbaden: Harrassowitz.
Cremonesi, G. 2001. *La grotta sepolcrale eneolitica di San Giuseppe all'Isola d'Elba*. Origines 17. Florence: Istituto Italiano di Preistoria e Protostoria.
Cygielman, M., F. Lo Schiavo, M. Milletti, and L. Pagnini, 2015. "Populonia e Vetulonia fra Corsica e Sardegna." In *Atti Bastia - Aléria - Piombino - Populonia*, 273–315.
D'Achiardi, G. 1927. "L'industria mineraria e metallurgica in Toscana al tempo degli Etruschi." *La Miniera Italiana* 113: 65–68.
Delpino, F. 1981. "Aspetti e problemi della prima età del ferro nell'Etruria settentrionale marittima." In *Atti Firenze III*, 165–98.
Domergue, C., L. Benquet, P.-M. Decombeix, J.-M. Fabre, A. Gorgues, C. Rico, and F. Tollon. 2003. "La guerre des Gaules et le débuts de la sidérurgie romaine en Montagne Noire." *Pallas* 63: 241–47.
Ducci, S. 2001. "La più antica storia." In *Elba. Territorio e civiltà di un'isola*, edited by R. Rosolani and M. Ferrari, 214–22. Genoa: R S Studio.
—. 2007. "La necropoli eneolitica della grotta di San Giuseppe (fine III – inizi II millennio a.C.)." In *La terra di Rio. Guida al museo archeologico del distretto minerario, al paesaggio e alla storia dell'Elba nordorientale*, edited by M. Firmati and L. Paoli, 47–55. Rio nell'Elba: Museo Archeologico del Distretto Minerario.
Egger, R. 1961. *Die Stadt auf den Magdalensberg: Ein Grosshandelplatz. Die ältesten Aufzeichnungen des Metallwarenhandels auf dem Boden Österreichs*. Österreichische Akademie der Wissenschaften, Phil.-Hist. Kl., Denkschriften 79. Graz: Böhlau.
Fabri, A. 1887. *Relazione sulle miniere di ferro dell'Isola d'Elba*. Rome: Tipografia Nazionale.
Fedeli, F. 1983. *Populonia. Storia e territorio*. Florence: All'Insegna del Giglio.
—. 1993. "L'età del Ferro." In *Populonia e il suo territorio. Profilo storico-archeologico*, edited by F. Fedeli Bernardini, A. Galiberti, and A. Romualdi, 76–91. Florence: All'Insegna del Giglio.
Firmati, M. 2009. "L'arcipelago Toscano e la romanizzazione. Il contributo delle ultime ricerche." In Cambi, Cavari and Mascione 2009, 187–93.

Firmati, M., S. Arrighi, and C. Principe. 2006. "L'impianto metallurgico tardo repubblicano di San Bennato all'Isola d'Elba." *Agogè* 3: 301–12.
First Iron 1988. *The First Iron in the Mediterranean/Il primo ferro nel Mediterraneo,* Proceedings of Symposium. Strasbourg: European Study Group on Physical, Chemical, Biological and Mathematical Techniques Applied to Archaeology.
Francovich, R. 1994. "Introduzione." In *Le ragione di un parco alle radici dell'archeologia mineraria,* edited by R. Francovich, 11–52. Venice: Marsilio.
Giardino, C. 1995. *Il Mediterraneo Occidentale fra XIV e VIII secolo a.C. Cerchie minerarie e metallurgiche / The Western Mediterranean between the 14th and 8th Centuries B.C. Mining and Metallurgical Spheres.* BAR IntSer 612. Oxford: Archaeopress.
Haupt, Th. 1847. *Delle miniere e della loro industria in Toscana: Trattato.* Florence: Le Monnier.
Jervis, W. P. 1862. *The Mineral Resources of Central Italy.* London: Stanford.
Maggiani, A. 1981. "Nuove evidenze archeologiche all'isola d'Elba. I rinvenimenti di età classica ed ellenistica." In *Atti Firenze III,* 173–92.
—. 2006. "Rotte e tappe nel Tirreno settentrionale." In *Gli Etruschi da Genova ad Ampurias.* Atti del XXIV Convegno di Studi Etruschi ed Italici, Marseille, Lattes 26.9.–1.10.2002, 435–53. Pisa, Rome: Serra.
—. 2008. "Oppida e Castella. La difesa del territorio." In *La città murata in Etruria.* Atti del XXV Convegno di Studi Etruschi ed Italici, Chianciano Terme, Sarteano, Chiusi 2005, 355–71. Pisa, Rome: Serra.
—. 2015. "L'Elba in età ellenistica." In *Atti Bastia-Aléria – Piombino – Populonia,* 357–73.
Maras, D. 2015. "Populus ex Insula Corsica. Ancora sulla fondazione di Populonia." *Atti Bastia-Aléria – Piombino – Populonia,* 47–60.
Martelli, M. 1981. "Scavi di edifici nella zona industriale di Populonia." In *Atti Firenze III,* 161–72.
Martin, S. 1994. "Trial Excavation on Monte Serra, Elba. A Medieval Iron Workshop." *Archeologia medievale* 21: 233–50.
Mellini, V. 1879. "Ricerche sulla prima età del ferro nell'Isola d'Elba." *BPI* 5:84–89.
Milletti, M. 2012. *Cimeli d'identità. Tra Etruria e Sardegna nella prima età del ferro.* Rome: Officina edizioni.
Miniere e ferro 1938. *Miniere e ferro dell'Elba dagli Etruschi ai nostri giorni. Mostra autarchica del minerale elbano.* Rome: Palombi.
Minto, A. 1943. *Populonia.* Florence: Istituto di Studi Etruschi.
Nijboer, A. J. 1998. *From Household Production to Workshops. Archaeological Evidence for Economic Transformations, Pre-Monetary Exchange and Urbanization in Central Italy from 800 to 400 B.C.E.* Groningen: University of Groningen.
Pais, E. 1893. "Gli elementi sicelioti nella più antica storia di Roma." *Studi Storici* 2: 145–84, 315–57.
Pancrazzi, O. 1985. "Castiglione di San Martino." In Camporeale 1985, 117–19. Milan: Electa.
Pini, E. 1777. *Osservazioni mineralogiche su la miniera di ferro di Rio ed altre parti dell'Isola d'Elba.* Milan: Giuseppe Marelli.
Pistolesi, C. 2006. *La miniera di Baratti.* Pisa: Felici Editore.
—. 2011. *L'età delle miniere. L'industria mineraria italiana dall'Unità alla seconda guerra mondiale.* Venturina, LI: Edizioni Archivinform.
—. 2013. *Ferro autarchico. L'uso delle antiche scorie ferrifere di Baratti, Poggio Butelli e dell'isola d'Elba nella siderurgia del Novecento.* Venturina, LI: Archivinform.
Ponta, E. 2006. "Metallurgia, territorio e viabilità. Il comprensorio del golfo di Follonica nel periodo romano." *Agogè* 3: 285–304.
Rafanelli, S. 2007. "La 'pax syracusana'. L'Isola d'Elba dal V agli inizi del III secolo a.C." In *La terra di Rio. Guida al museo archeologico del distretto minerario, al paesaggio e alla storia dell'Elba nordorientale,* edited by M. Firmati and L. Paoli, 69–72. Rio nell'Elba: Museo Archeologico del Distretto Minerario.



Romualdi, A. 1993. "La polis nel periodo arcaico e l'attività di lavorazione del ferro." In *Populonia e il suo territorio. Profilo storico-archeologico,* edited by F. Fedeli Bernardini, A. Galiberti, and A. Romualdi, 102–17. Florence: All'Insegna del Giglio.
Sammartino, F. 2009. "Il sito epigravettiano di Villa Padula – le Sughere (Livorno)." *Quaderni del Museo di Storia Naturale di Livorno* 43–55: 22.
Simonin, L. 1858. "De l'exploitation des mines et de la métallurgie en Toscane pendant l'antiquité et le moyen age." *Annales des Mines* ser. 5, vol. 14: 557–615.
Tanelli, G. 1989. "I depositi metalliferi dell'Etruria e le attività estrattive degli Etruschi." In *Atti del Secondo Congresso Internazionale Etrusco,* Florence 26.5–2.6.1985, 1409–17. Rome: L'Erma di Bretschneider.
Tanelli, G., M. Benvenuti, P. Costagliola, A. Dini, P. Lattanzi, C. Maineri, I. Mascaro, and G. Ruggieri. 2001. "The Iron Mineral Deposits of Elba Island: State of the Art." *Ofioliti* 26: 239–48.
Vanagolli, G. 1998. *Statuta Rivi. Il volto di un'antica comunità elbana attraverso i suoi ordinamenti.* Rome: Le Opere e i Giorni.
Vitali, S. 1992. "'Sulle tracce degli antichi'. Aspetti della ricerca mineraria in Toscana fra Sette e Ottocento." *Archeologia Medievale* 19: 675–89.
Williams, J. 2009. "The Environmental Effects of Populonia's Metallurgical Industry. Current Evidence and Future perspectives." *Etruscan Studies* 12:131–52.
Zecchini, M. 1978. *Gli Etruschi all'isola d'Elba.* Portoferraio: Ente Valorizzazione Elba.
—. 2001. *Isola d'Elba. Le origini.* Lucca: Edizioni San Marco Litotipo.
Zifferero, A. 2002. "Attività estrattive e metallurgiche nell'area tirrenica. Alcune osservazioni sui rapporti tra Etruria e Sardegna." In *Etruria e Sardegna centro-settentrionale tra l'età del Bronzo finale e l'arcaismo.* Atti del XXI Convegno di Studi etruschi ed italici, Sassari, Alghero, Oristano, Torralba, 13–17.10.1998, 179–212. Pisa, Rome: Serra.
—. 2009. "Attività minerarie e trasferimento dei saperi metallurgici nell'alto Tirreno: conoscenze attuali e prospettive di ricerca." In Cambi, Cavari and Mascione 2009, 149–56.