

Changing the Landscape of Populonia: Iron-Working in Etruria

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Before the Iron Age, Etruscan technology relied on materials with limited resilience. Bronze weapons could fracture, wooden utensils could splinter, and wattle-and-daub structures could rot away. Everything changed in the 8th century BCE when the ancient inhabitants of Central Italy struck iron and began rapidly developing a metallurgical industry. For the residents of a small region in Northwest Tuscany called Populonia, the discovery of rich iron resources secured their place on the map of Etruria. In order to investigate how ironworking affected the environmental and socio-cultural landscapes of ancient Populonia, this paper will consider the evolution of the region's iron industry and explore connections between its physical effects on nature and its conceptual changes to the community. This paper will thus demonstrate that the iron industry was the primary catalyst for Populonia's political influence, the stabilization of emergent social classes, and the destructive transformations to the environment. Furthermore, the cyclical nature of humans' interactions with and movements within this environment over time show how physical and cultural landscapes are mutually constitutive.

Populonia was the only Etruscan settlement located directly on the coast of Italy, and offered easy access to a variety of natural resources. The nearby Colline Metallifere, or "metal bearing hills," and the island of Elba provided vast quantities of raw metals to the local population. Although iron was the most abundant, these areas also supplied copper, silver, lead, gold, and tin. The hematite iron ore from Elba contains unusually high traces of tungsten and tin, which allow scholars to follow Elban ore along trade routes across the ancient Mediterranean.¹ During the height of Etruscan metallurgical activity, Populonia developed into a hilltop city with a large acropolis overlooking miles of coastline on the Gulf of Baratti. This strategic location helped residents defend the area against attacks by land and sea, which proliferated in the context of contemporary Syracusan and Roman expansion. Moreover, the location on the coast was convenient for the growing iron industry as it provided easy access to overseas markets.

From the records of the ancient Roman authors and the work of archaeologists, it is apparent Populonia's iron industry had significant impacts which reached across the ancient world. Unfortunately, literary records in the Etruscan language are scarce and archaeological evidence of Etruscan cities is limited due to the extensive use of wooden building materials. Nevertheless, through the direct historical approach, a timeline for the metallurgical industry in Populonia emerges. Archaeo-metallurgical activity started on Elba Island as early as 2000 BC, suggesting an early date for the development of smelting technologies in the area.² However, radiocarbon dating for the copper deposits on the island's shores indicates the settlement did not

¹ M. Benvenuti, A. Dini, M. D'Orazio, L. Chiarantini, A. Corretti, and P. Costagliola. "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, no. 3 (2013): 480.

² L. Vigliotti, M. Roveri, and L. Capotondi, "Etruscan Archaeometallurgy Record in Sediments from the Northern Tyrrhenian Sea," *Journal of Archaeological Science* 30, no. 7 (2003): 812

begin actively mining there until the ninth-eighth century BCE.³ Pseudo-Aristotle asserted copper mining began first and iron extraction followed much later.⁴ As this is the only mention of Populonia in his entire work, one can see how closely the city's existence was tied to its metallurgical industry. It is generally accepted the developments of the eighth century BCE had a profound effect on the cultural development of the populations in Italy, resulting in the clear distinction between earlier Villanovan settlements and an Etruscan "civilization."⁵ In Populonia, it is evident the iron industry was the catalyst for this cultural shift.

The height of iron production in Populonia lasted from the seventh to second centuries BCE. The development of an industrial production area, in addition to the change in burial practices and the accumulation of valuable grave goods, discussed later in this paper, is a testament to this "Golden Age" of Populonia. This region was extremely important to Etruria because it was one of two geographical units within their territory which contained significant ore deposits.⁶ It is likely Populonia's widespread economic influence guaranteed its position as one of the original twelve cities in the Etruscan League. This centralization of power is extremely different from the scattered, sparse settlements of the earlier Villanovan period.⁷ Outside of the political realm, the iron industry of Populonia also affected the way in which people moved and settled across the landscape during this time. In the sixth century, the installation of craftsmen's quarters on nearby slopes seems to be contemporaneous with the reduction of activity on the acropolis, meaning the potential for wealth shifted the visible social/architectural layout of the settlement while also modifying social organization.

Even following the advent of the Roman period, Populonia lost none of its significance. In 205 BCE, Livy reported that Populonia played a crucial role in deciding the fate of the Roman Republic by providing Scipio's fleet with iron in the Second Punic War.⁸ Scipio was thus able to arm enough soldiers to invade Carthage and confront Rome's nemesis, Hannibal. In this way, Populonia directly contributed to Roman imperialism and supported the Republic's growing dominance over the Mediterranean. In the first century BCE, Diodorus Siculus goes into more

³ See A. Cartocci, M.E. Fedi, F. Taccetti, M. Benvenuti, L. Chiarantini, and S. Guideri, "Study of a Metallurgical Site in Tuscany (Italy) by Radiocarbon Dating," *Nuclear Instruments & Methods in Physics Research. Section B, Beam Interactions with Materials and Atoms* 259, no. 1 (2007): 386 and see also L. Chiarantini, M. Benvenuti, P. Costagliola, M.E Fedi, S. Guideri, and A. Romualdi, "Copper Production at Baratti (Populonia, Southern Tuscany) in the Early Etruscan Period (9th–8th Centuries BC)," *Journal of Archaeological Science* 36, no. 7 (2009): 1631.

⁴ Pseudo-Aristotle, *On Marvelous Things Heard*, 27.93

⁵ See Mary E. Moser, "The Origins of the Etruscans: New Evidence for an Old Question," in *Etruscan Italy: Etruscan Influences on the Civilizations of Italy from Antiquity to the Modern Era*, edited by John Franklin Hall (Provo, Utah: Museum of Art, Brigham Young University, 1996), 30 and see also Roger David Penhallurick, *Tin in Antiquity: Its Mining and Trade throughout the Ancient World with Particular Reference to Cornwall* (London, Institute of Metals, 1986), 2.

⁶ Claudio Giardino, "Villanovan and Etruscan Mining and Metallurgy," in *The Etruscan World*, ed. Jean MacIntosh Turfa and Ashwini Tambe (London: Taylor & Francis Group, 2013): 724.

⁷ Franco Cambi and Valeria Acconcia, "Hidden urban landscape: Populonia between survey and excavations," in *Hidden Landscapes of Mediterranean Europe: Cultural and Methodological Biases in Pre-and Protohistoric Landscape Studies*, ed. Martijn van Leusen, Giovanna Pizziolo, and Lucia Sarti (Oxford: Archeopres, 2007), 4.

⁸ Livy, *History of Rome*, 28.45

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detail on the collection of ore from Elba, the processes of smelting, and the trade network for iron.⁹ From this record, it seems Populonia gained renown specifically for its vast iron production capabilities and ingenious innovations in industrial practices.

Eventually, however, Populonia's engagement in iron working waned, and the region experienced depopulation. Strabo recounted how people gradually abandoned mines in the country and left the hilltop city of Populonia in favor of the port nearby.¹⁰ Nonetheless, he maintained that the island of Elba was still mined for ore which would be smelted off island, since there were not enough trees on Elba to fuel the high-temperature smelters. Although Populonia was vital to the realization of early imperial ambitions, the expansion of the Roman Empire abroad also spelled its doom. Roman colonies throughout the ancient Mediterranean competed heavily with Populonia's iron industry due to the former's abundant resources and cheap labor, and the Roman Senate eventually banned mining in Italy itself. Despite this, Pliny the Elder implied decades later that Populonia was allowed to continue large-scale production on Elba into the first century CE.¹¹ The last phase of Populonian iron production lasted into the 5th century CE, by which time metalworking was localized and individualized for villas in the area produced and recycled iron for their own consumption.¹² This depopulation of central Populonia over time caused the settlement to largely fade into obscurity by the medieval period.

The demands of the mining, smelting, and iron-working activities in Populonia also had a profound effect on the socio-cultural landscape of the area. Since iron is a more common metal and appears close to the surface, it can be easily removed using open cast mines.¹³ Rather than using deep vein mining techniques of digging deep shafts and carefully preserving particularly valuable metals, the miners only needed to dig large pits in the earth. Slave labor was utilized by the newly wealthy owners of mines in order to contend with the physical demands and harmful pollution which permeated this industry. Signed fragments of pottery uncovered in these areas reveal the vessels' owners were primarily slaves and foreigners, confirming their disproportionate exposure to these dangerous working conditions.¹⁴ From the pits, the raw ore would then have moved to the industrial quarter for smelting. This area of Populonia included a district called La Porcareccia which was dominated by industrial activities and housing for the

⁹ Diodorus Siculus, *Library of History* 5.13.1-2

¹⁰ Strabo, *Geography*, 5.2.6

¹¹ Pliny, *Natural History*, 3.12.2

¹² Dal Parco Al Museum Archeologico di Piombino, "History of Metal-Working at Populonia" signage. Also, this has been theorized during the recent 2021 excavations of the villa at Poggio del Molino where evidence of productive-combustion activity, including numerous lumps of burnt material, metal slag, and a dense amount of coal, has appeared.

¹³ M. Benvenuti, A. Orlando, D. Borrini, L. Chiarantini, P. Costagliola, C. Mazzotta, and V. Rimondi. "Experimental Smelting of Iron Ores from Elba Island (Tuscany, Italy): Results and Implications for the Reconstruction of Ancient Metallurgical Processes and Iron Provenance." *Journal of Archaeological Science* 70 (2016): 4.

¹⁴ Sybille Haynes, *Etruscan Civilization: A Cultural History* (London: British Museum, 2000), 165.

workers (Figure 1). Founded between the sixth and fifth centuries BCE, it was abandoned in the first half of the third century BCE.¹⁵

After sorting and crushing the mined material, the Etruscans used round reduction bloomery furnaces to heat up the metal. The workers would fill the furnaces with charcoal and place layers of hematite on top. On one side, air was introduced with a bellows contraption which fanned the flames higher, driving the temperature of the ore to 1000-1300 degrees Celsius. This would cause the impure portion of the ore, called gangue, to reach its melting point and liquify, collecting as slag and flowing out of the furnace through a hole in its base, leaving only the nearly pure iron behind. As one could imagine, this was not a very desirable job due to the heat of the furnace and the smoky fumes emitted. Over time, a social hierarchy emerged as owners profited off of lucrative trade, free supervisors took control of projects, and enslaved laborers were relegated to the most undesirable jobs. Thus, the iron industry led to the creation of a rigid labor hierarchy.

At the conclusion of the smelting process, one would be left with the desirable bloom of iron. Under the hands of blacksmiths, the iron was repeatedly heated up and pounded with stone hammers in order to remove any of the weaker impurities remaining. Once the iron was purified to satisfaction, the blacksmiths could then treat it to achieve certain physical properties, such as durability, elasticity, or resistance, and shape it into various items, usually weapons or everyday household tools.¹⁶ For instance, Etruscan blacksmiths could apply the technique of pattern welding by layering iron during the forging process.¹⁷ This work required and encouraged specialization, and the resulting social differentiation in craftsmanship quickly led to the emergence of a middle class.

By examining grave goods, archaeologists have been able to determine the metal wares owned by iron workers. For practicality's sake, blades like spear points, swords, axes, and knives were made out of iron due to its inherent hardness and longevity. For the same reasons, domestic tools like kitchen pots, buckets, silverware, and fire grates were produced from iron. Within buildings, iron was used for sturdy connectors, like handles, hinges, and nails (Figure 2). As Etruscan domestic architecture evolved, nails became integral to the support of wooden second stories and they are often the only extant evidence of such structures, which one can see from the excavations at Vetulonia. In general, iron was used for less decorative purposes, but sometimes iron inlay was used on bronze items for a color and contrast.¹⁸ These more complex works could have been made using stone molds for castings, like the ones found at Poggio del Molino.¹⁹

¹⁵ Mauro Cristofani and Marina Martelli, "Scavi: Ricerche archeologiche nella zona 'industriale' di Populonia," *Prospettiva*, no. 16 (1979): 75.

¹⁶ Dal Parco Al Museum Archeologico di Piombino, "From the Mineral to the Metal: The Phases of Ancient Iron Production" signage.

¹⁷ Giardino, "Villanovan and Etruscan Mining and Metallurgy," 723.

¹⁸ *Ibid.*

¹⁹ *Ibid.*, 728.

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Once the final product was completed, the merchants of the Etruscan iron trade network shipped goods from Populonia all over the Mediterranean. Diodorus Siculus indicated the iron blooms from Elba were often exchanged for money or goods, rather than being worked within the city and then sold as finished products.²⁰ Thus, Populonia was a supplier to many merchants, who would then supply the base material to artisans shopping at other trading stations. From grave goods, it appears as though iron funded the import of Baltic amber, Phoenician art, Egyptian ivory, and other luxury items. In terms of ceramic evidence, Populonia seems to have had a special relationship with Athens since many fragments and whole vessels of fine Attic red-figure pottery have been recovered from the local tombs.²¹

Despite the fact that iron bloom constituted a large part of the iron trade, tombs and burials reveal how iron goods were also produced in Populonia. By considering some of the local examples available, one can see how iron influenced and reflected the development of a more stratified society. The Tomba dei Carri is the largest tomb visible in the Necropolis of the San Cerbone outside of Populonia. When it was excavated between 1914-1921, three separate chambers branching off the access corridor were discovered. One of the rooms held the remains of a chariot which sported iron decorations on the bronze plates.²² This iron inlay included processions of walking animals and hunters armed with lances. The size of this tomb and the disposable wealth which permitted the family to bury a large metal chariot indicated the development of an aristocratic class in Populonia during the seventh century BCE. In the Tomb of the Bronze Fans, burials from 630-560 BCE were also richly furnished with a huge quantity of gold jewelry, imported goods, bronze armor, and iron pieces including spits, ferrules, and points for lances.²³ The metal weapons along with the roasting, dining, and drinking equipment indicate the development of a warrior oligarchy during the Archaic Period. The iron spears could invoke the heroic military glory of the deceased and help them retain leadership in the Etruscan afterlife. They could also provide protection as they undertook the dangerous journey through the underworld.

These examples demonstrate the socio-cultural effects of the iron-working industry on the Etruscans. The quantity of burials rich in metal figures, wares, and jewelry indicates the significant increase in the region's wealth over this period due to the success of the iron industry. Thanks to the prestige of metal wares, the necropoli evidence in Populonia shows the emergence of an aristocracy supplemented by a new middle class employed in iron smelting and crafting processes.²⁴ The new burial practices during this period were much different than the cremation urns necessitated by the more egalitarian economic system of their Villanovan predecessors. This socio-cultural shift can be interpreted through the appearance of *aedicula* tombs for family groups surrounded by simpler and more numerous *cassone* tombs for perhaps a new middle

²⁰ Diodorus Siculus, *Library of History*, 5.13.1-2.

²¹ Haynes, *Etruscan Civilization: A Cultural History*, 264.

²² Dal Parco Al Museum Archeologico di Piombino, "Tomba dei Carri" signage.

²³ Haynes, *Etruscan Civilization: A Cultural History*, 104.

²⁴ Giorgia Maria Francesca Di Paola, "Central Place and Liminal Landscape in the Territory of Populonia," *Land (Basel)* 7, no. 3 (2018): 7.

class.²⁵ Furthermore, iron weapons in a burial context show the difference in military technology from the Villanovans. As more tactical weapons, like short swords for close combat, appear alongside the spears and javelins, the tombs reveal the altered militaristic social order of the males. Unlike the earlier symbolic weapons, these more functional implements indicate a changed conception of the Etruscan afterlife. This demonstrates a focus on more relational identities and the importance of social interaction in a civil context in contrast to the more individualistic priorities indicated in earlier burials. Even looking at simple utensils, the role of iron appears intrinsically tied to the success of social interactions, such as in the act of social feasting at a funerary banquet with an iron knife.

Beyond these shifts in social structure and the aforementioned influence on the political landscape, the iron industry of Populonia also had visible physical consequences on the environment. Originally, the iron deposits in this area were created by volcanic intrusions into southern Etruria which formed the natural hills of the Colline Metallifere and the island of Elba. However, the human effect on these natural formations was considerable, as it is estimated Populonia produced four million tons of iron between the fifth and first centuries BCE.²⁶ Having mined the surface of Elba, moved large deposits between the coasts of Elba and Baratti, and left iron byproducts in the soil of Populonia for centuries, the shape of the land changed dramatically. In fact the buildup of slag, especially during the intensive production period from the fourth to second century BCE, was so large that the two nearby necropoli were completely buried by several meters of compacted industrial waste. Once modern construction cleared away the slag, the burials had already been affected and the stratigraphy of the area greatly disrupted. Metal debris had been spread over the whole Baratti Gulf, covering about 220,000 square meters, which posed an ecological risk by threatening the migration of byproducts into the ocean.²⁷

Additionally, this industry contributed to deforestation as huge areas had to be cleared to supply fuel for the smelters. As Wertime states, “over the whole of the Mediterranean one might find minimally 70-90 million tons of slag from antiquity representing the divestiture of at least 50-70 million acres of trees.”²⁸ This deforestation encouraged erosion, as the roots no longer held together the loose soil of the hills and rainwater could easily carry away large quantities of dirt. This erosion, combined with the arsenic in the soil, would have had severe impacts on local flora and fauna surrounding Populonia, heavy metal poisoning harming the health of any living thing in the vicinity of the mines. Harrison, Cattani, and Turfa even suggest the pollution of settlements could have prompted the abandonment of many important Etruscan sites in the sixth century BCE, although more work needs to be done to confirm this hypothesis.²⁹

²⁵ Haynes, *Etruscan Civilization: A Cultural History*, 165.

²⁶ Theodore A. Wertime, “The Furnace versus the Goat: The Pyrotechnologic Industries and Mediterranean Deforestation in Antiquity,” *Journal of Field Archaeology* 10, no. 4 (1983): 451.

²⁷ Cartocci, et al., “Study of a Metallurgical Site in Tuscany (Italy) by Radiocarbon Dating,” 384.

²⁸ Wertime, “The Furnace versus the Goat: The Pyrotechnologic Industries and Mediterranean Deforestation in Antiquity,” 452.

²⁹ Adrian P. Harrison, Ilenia Cattani, and Jean M Turfa, “Metallurgy, Environmental Pollution and the Decline of Etruscan Civilisation.” *Environmental Science and Pollution Research International* 17, no. 1 (2009): 167.

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In conclusion, it is readily apparent that the iron industry of Populonia spurred changes in the political, socio-cultural, and environmental landscapes of this Italian region. Even beyond ancient times, these landscapes remain sensitive and reactive to patterns of human occupation, innovation, destruction, and abandonment. First, the Etruscans expanded the mountain top acropolis, two necropoli, and the iron producing district of ancient Populonia. Di Paola's analysis of landscape archaeology demonstrates how this first center began a new "hierarchical settlement system based on a network of sites and the foundation of new population centers."³⁰ When the wealth from the earth was not worth the effort of exploiting the environment, people abandoned the area because their established social hierarchy broke down. After the majority of the population had gone, nature began to flourish again. However, the promise of wealth through ironworking drew humans back once more. Around the thirteenth century ironworking began again on a large scale, and the powerful Appiani family took control of the area of Populonia. In fact, they completed a fifteenth-century fortress reusing old Etruscan materials just up the mountain from the ancient acropolis. Following this period, iron production tapered off again until the modern population saw more possibilities in the crude slag. It was initially used for roads until industrial exploitation began to destroy the deposit in 1915.³¹ The wars of the twentieth century, like the earlier Punic wars, demanded a supply of iron for weaponry and ancient slag still maintained 40-60% iron content which could be extracted and used.³² Most notably, the Ferromin Company collected vast amounts of ancient slag to refine it further using advanced techniques between 1929 and 1969.³³ This effort removed iron slag from the shores and transformed modern Piombino with into a huge industrial center during World War II.

For Populonia, the discovery of rich iron resources and the development of the metallurgical industry caused major visible and invisible effects on the local community over the millennia. In the realm of conceptualized, socio-cultural shifts, ancient authors, grave goods, tomb architecture, and industrial areas demonstrate an increase in the city's political importance, the growth of disposable wealth, and the rapid stratification of social classes. Furthermore, the human effect on nature was observable in the massive overhaul of the physical landscape through deforestation, discarded by-products, and piled up slag. The cyclical nature of humans' interaction with this environment over time shows how socio-cultural and environmental landscapes of civilization are sensitive and reactive to each other, especially in the case of iron production in Populonia.

³⁰ Di Paola, "Central Place and Liminal Landscape in the Territory of Populonia," 13.

³¹ Olfert Voss, "The Iron Production in Populonia," *First Iron in the Mediterranean: Proceedings of the Populonia/Piombino 1983 Symposium = Il Primo Ferro Nel Mediterraneo: Atti Del Convegno De Populonia/Piombino 1983. PACT (European Study Group on Physical, Chemical, and Mathematical Techniques Applied to Archaeology)* 21 (Strasbourg: Council of Europe, 1988) 91.

³² Cristofani and Martelli, "Scavi: Ricerche archeologiche nella zona 'industriale' di Populonia," 74.

³³ Elena Fani, "Parco Archeologico di Baratti e Populonia," translated by Victor Beard. (Florence, Italy: Museo Galileo - Istituto e Museo di Storia della Scienza. 2008)

<https://brunelleschi.imss.fi.it/itineraries/place/ParcoArcheologicoBarattiPopulonia.html>



Figure 1. Industrial district, Baratti and Populonia Archeological Park, photo by author.



Figure 2. Example of an iron nail, Poggio del Molino, photo by author.