Subsidiary Industries and Cross-Craft Production in the Roman Mining Landscapes of Southwest Iberia

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Introduction

Studies of the economic role of mining and other large-scale extractive industries, such as quarrying, often focus on the big-picture questions: how much was extracted and where did it go? Recently, however, closer attention to the archaeology of mining landscapes themselves has allowed scholars to consider the impacts of Roman imperial mining on local economic organization. In this paper, I examine one facet of local mining economies by looking at the role of subsidiary industries and cross-craft production in Roman mining landscapes in southwest Iberia. Artifacts recovered from Roman mines of the early imperial period – including Riotinto and Aljustrel – show that potters, smiths, carpenters, and basket-weavers supplied the tools necessary for underground mining across this region. Through an exploration of esparto-grass weaving and the production of water-lifting devices, I suggest that the increased scale of mining stimulated pre-existing local industries, but also brought about the importation of technological traditions for use in novel ways. Ultimately, I argue that better understanding these and other local industries in mining landscapes can help us move beyond a top-down understanding of Roman imperial mining. This approach sheds light on the integration of the Roman economy at multiple scales, from the local to the global, as well as the lived experience of laborers and craftspeople in mining landscapes.

Subsidiary Industries and Cross-Craft Production in Roman Economies

Subsidiary industries comprise the varied types of craft production that are carried out alongside and in support of dominant industries. Cross-craft production is the sharing of tools, equipment, ideas, labor, technologies, and other resources across industries.[1] In Mediterranean archaeology, these two related topics have rarely been explored in non-urban landscapes and industries centered outside the city. The one exception to this is research on the production of amphorae alongside viticulture and oleiculture in Roman agricultural landscapes, such as the production of Dressel 20/23 amphorae as containers for Baetican olive oil.[2] In studies of near-industrial production and extraction (including Roman mining and quarrying), economic questions typically focus on the dominant industry. Accordingly, scholarship on the organization of labor, production, and the economy in mining landscapes has often overlooked the essential role that smaller-scale and less-visible industries played in the quotidian operation of mines. The various stages of mining – from prospection, to opening shafts and galleries, to smelting, to transporting

Published in: Frank Hulek – Sophia Nomicos (Eds.), Ancient Mining Landscapes, Panel 4.2, Archaeology and Economy in the Ancient World 25 (Heidelberg, Propylaeum 2022) 113–128. DOI: *https://doi.org/10.11588/propylaeum.896.c11650*

ores – required contributions from specialists in multiple professions beyond mining. Although these supporting industries were subsidiary to mining itself, they were indispensable to its operation.

The study of interactions among craftspeople in urban landscapes has recently received a great deal of attention. This is especially true in cities like Rome and Pompeii, for which there is abundant evidence of production. Among the results of this work is our increased understanding of how cross-craft production and economic interconnections benefitted craftsmen and workshops in urban landscapes and promoted social ties among laborers. In her analysis of Roman tanning, for instance, Sarah Bond asserts that leather production served as an "economic hub" in the wider animal processing industry, with activities ranging from butchery, to glue production, to fur processing, to cobbling.[3] Workers needed to communicate and share resources across these industries to acquire animals and their by-products. This type of cooperation has also been noted in Pompeii, where workshops for dyeing and fulling textiles often clustered nearby one another to facilitate interaction.[4] Significantly, interactions across varied industries included not just the sharing of material resources, but also the exchange of organizational strategies, technologies, and economic practices.[5] The dynamics of craftspeople and interactions among industries can and should also be studied in rural and industrial landscapes, as well as in contexts where dominant, imperial industries were integrated with small-scale, private industries.[6] An analysis of mining tools and equipment in the mining landscapes of southwest Iberia provides one productive way forward.

Roman Imperial Mining in Southwest Iberia

The landscapes of the Iberian Peninsula were famous in antiquity for their abundant metals, and scholars have long recognized the contribution of this region to the Roman imperial economy.[7] Environmental studies have further confirmed the large scale of mining in Iberia and the pollution it produced in classical antiquity.[8] Because of the scale of mining and its contribution to the Roman imperial economy, Iberia is a particularly apt location in which to explore the role of subsidiary industries in Roman mining. Here, I focus on evidence from mines in the geological region of the Iberian Pyrite Belt in southwest Iberia. A metal-rich swath of land roughly 200 km long and 30 kilometers wide, the Iberian Pyrite Belt stretched from Seville in the east to the Atlantic coast of the Alentejo region in southern Portugal in the west.[9] Across this region, mining took place from early in prehistory and was further catalyzed by Phoenician, Punic, and later Roman demand.[10] Under Roman administration, extraction was accomplished through underground mining, where copper as well as lesser quantities of silver and other ores were extracted through the excavation of vertical shafts and horizontal galleries, sometimes many stories deep. In the 1st and 2nd centuries AD, these mines provided ores that went into copper-based coinage minted in Rome and other objects.[11] Red pigments – a

Fig. 1: View of the contemporary mining landscape of Riotinto, Spain in 2013.

byproduct of smelting – were used across the empire, including Egypt and Italy.[12] Two of the best-studied mines in the region include Riotinto (Huelva, Spain) and Aljustrel or Roman *Vipasca* (Baixo Alentejo, Portugal), locales where contemporary mining allowed for the collection of many pieces of Roman equipment from Roman mines (fig. 1).[13]

Equipment and Industry in Southwest Iberia

Material evidence recovered from the mines in southwest Iberia demonstrates that many industries contributed to the production of mining equipment used in the various stages of underground mining.[14] Deep shafts and galleries required loggers and carpenters to provide wooden scaffolding and ladders, which have been recovered from Aljustrel and other sites. Iron chisels, picks, and other excavation equipment were cast by smiths and fitted with wooden handles. As they were used in the mines, such tools were frequently sharpened or repaired. Evidence of these tools remains in the form of metal picks, wooden mallets, and tongs, while the discovery of whetstones in the vicinity of mines provides evidence for the maintenance of metal equipment (fig. 2). Fiber or metal buckets and baskets as well as hemp or esparto ropes were used to create pulley systems for bringing ore to the surface. Flooded mines had to be drained, which was often accomplished using mechanical water-lifting devices such as the Archimedean screw or water wheel. Miners required specialized footwear and clothing woven from textiles or cut from leather. Finally, ceramic oil lamps or wooden torches were made to

Fig. 2: Sandstone used as a whetstone for sharpening iron mining tools (Museo de Huelva).

illuminate the dark, dusty underground passageways as miners worked. While multiple subsidiary industries were involved in the production of equipment, I will focus on two types of equipment and the contexts in which they were crafted: esparto grass objects and mechanical water-lifting devices. A closer look at the production of this equipment demonstrates the varied technological traditions and laborers across subsidiary industries who contributed to and benefitted from local mining economies.

Esparto Grass Production: A Local Industry Intensified

Esparto grass is a perennial plant used for basketry and textiles that grows in semiarid Mediterranean environments. The esparto species native to Iberia is known for its quality and durability.[15] Products woven from this plant were produced in parts of Iberia as early as the Neolithic period, most famously for the intricate, polychrome baskets and sandals from the Cueva de los Murciélagos near Granada.[16] Similar products are still made for artisanal purposes today.[17] Ancient examples of esparto objects demonstrate that the sophisticated technical skills required to craft esparto long-predated Roman presence in the region. Though esparto grows naturally in Iberia, it was likely being grown and harvested at increasing levels – and potentially even cultivated – by the Iron Age, as the industry grew in response to Phoenician and Punic economic demand.[18]

Under Roman rule, esparto grass became an essential component of subterranean mining equipment. It was used to produce safety coverings and clothing, including helmets, tunics, and sandals, ropes and baskets for lifting ore out of shafts, and canteens for water. Many examples survive from the Republican-period lead and silver mines in southeast Iberia around Cartagena (Roman *Carthago Nova*), a location where esparto production was especially prolific and of a particularly high quality (fig. 3).[19] Similar

Fig. 3: Esparto grass and wood basket from *Carthago Nova* (Museo Arqueológico Municipal de Cartagena).

types of equipment were also used in the mines of southwest Iberia during the early empire, as demonstrated by examples recovered intact from the underground mines of Aljustrel (fig. 4, fig. 5). Fragmentary pieces of equipment have also survived from the mines at Riotinto, such as bronze frames onto which baskets were once woven (fig. 6).[20] These pieces, while incomplete, attest to collaboration between esparto grass weavers and smiths to produce finished items. Similarly, many of the earlier baskets from *Carthago Nova* are made with wooden framing, making it necessary to have carpentry skills and a suitable supply of wood for this industry as well.

The production of esparto objects is a laborious, multistage process that involves cultivating, harvesting, alternately drying and soaking the raw materials, and pounding the leaves so they are supple and suitable for working. In his *Historia Naturalis,* Pliny the Elder (*HN* 19.7–8) suggests that this was a seasonal activity. Ethnographic research on contemporary communities shows that esparto is often a craft done alongside pastoralism and subsistence agriculture.[21] Later, the weaving of the products themselves requires the kinds of tactile skills developed through gradual exposure to the craft, often from a young age in household contexts. The importance of hands-on experience and knowledge of the local landscape in the production of esparto objects indicate that local people – including, perhaps, women and children – were likely the ones producing the esparto equipment for mining. Therefore, the existing skills of local people in and

Fig. 4: Esparto grass helmet from Aljustrel (Museu Geológico de Lisboa).

Fig. 5: Esparto grass basket from Aljustrel (Museu Geológico de Lisboa).

Fig. 6: Bronze ring, once part of an esparto grass basket from Riotinto (Museo de Huelva).

around mining landscapes were redeployed within the Roman imperial economic system, making this local industry and the technical knowledge involved essential to the economies of Roman mining. The production of specialized esparto products must have brought local crafters into interaction with miners, overseers, and other craftspeople through the making and distribution of this equipment. Esparto crafters, who perhaps engaged in agriculture and pastoralism on a seasonal basis or also produced esparto goods for use outside of mining, then, became an essential part of the social and economic networks in mining landscapes.

Water-Lifting Devices: Innovative Implementation of Hellenistic Technologies

As with esparto grass equipment, the water-lifting devices recovered from mines in southwest Iberia also show the ways that cooperation across industries and among different sectors of the mining community was key to the success of mining. By contrast, however, the creation and use of water-lifting devices in mines shows the interaction of both foreign and local knowledge. The large-scale of Roman mining in the Iberian Pyrite Belt, combined with the region's distinctive geology, meant that shafts and galleries often had to be extended below the water table. Efficient methods for removing underground water were devised for extraction to continue. This could be accomplished through the construction of inclined galleries and evacuation channels or simply by bailing water out by hand. However, water-lifting equipment made the process more efficient. The various types of water lifting devices that have been discovered in Roman-era mines of southwest Iberia include bucket-chains, Archimedean screws, and water wheels or *norias,* among others.[22] The origins of many of these water-lifting devices can be traced to the Hellenistic East. Many were invented – or at least first described – by Hellenistic scientists and inventors in Alexandria in the 3rd century BC. These machines saw many of their first practical applications, improvements, and wide use in agriculture, urban water management, as well as mining in the Roman West.[23] While the exact mechanism of transfer of this knowledge is still up for debate, it may have circulated among the educated in technical texts or have been brought to Iberia by trained engineers who either traveled with the Roman army or migrated themselves as specialists for hire.[24]

The adaptation of these technologies for the practical needs of mining operations, however, involved not only the import of outside technologies, but also the use of local resources and multiple local industries for their production and implementation. Water wheels were commonly used in the Iberian Pyrite Belt in the 1st and 2nd centuries AD at locales including Riotinto, São Domingos, and Tharsis. At Riotinto, the remains of more than 50 water wheels have been uncovered, mostly in the process of 19th and 20th century opencast mining. Because so many were recovered intact and have been thoroughly published, this is an excellent corpus of objects with which to examine the practices involved in their production. Wheels typically reached diameters of between 3.6 and 4.6 meters and had between 22 and 27 buckets.[25] They were constructed with a combination of timber and bronze elements for the axis, spokes, and buckets (fig. 7). In one water wheel that has been extensively studied, now in the Museo de Huelva, multiple different species of wood were used, including walnut, pine, and fir. Local timber was sourced selectively: the hard walnut wood was employed to make the buckets, an element that needed to be more durable than other components.[26] Thus, even though the design of water wheels can be traced to technological traditions outside Iberia, their construction relied on loggers, carpenters, and smiths to fashion and repair their components. Even in state-owned woodlands of the Roman Empire, most logging was carried out by private hands.[27] Thus, there is reason to believe that this demand, while created by the imperial mining industry, still relied heavily on local economies and laborers to provide this essential service.

Once the components of wheels were finished, they were inscribed with numbers to aid in quick assembly after they were transported through the underground mines in pieces to their destination. Traces of these numbers have been preserved on surviving pieces from Riotinto.[28] The relatively uniform size of wheels would also have facilitated the repair of broken elements so that entire devices would not have to be replaced when single elements failed. The arrangement of multiple wheels together at Riotinto is also

Fig. 7: Wooden buckets for water wheels from Riotinto (Museo de Huelva).

significant because this type of complex system is not used with water wheels outside of mining. In the South Lode of Riotinto, for instance, eight Roman water wheel pairs were discovered, which together raised water over 29 meters to the surface (fig. 8).[29] Thus, although engineers were using a technology common to other industries such as urban water infrastructure, construction, and milling, they were innovative in their implementation of it according to the demands of the local landscape and the scale of the specific industry. Commonalities among the design of water wheels found across the Iberian Pyrite Belt further suggest that their design was adapted to the particular circumstances of mining.[30] Ultimately, the implementation of waterwheels and other water-lifting devices served to bring technical knowledge from outside of Iberia, make innovative use of that knowledge in mining, and utilize local resources, skills, and labor.

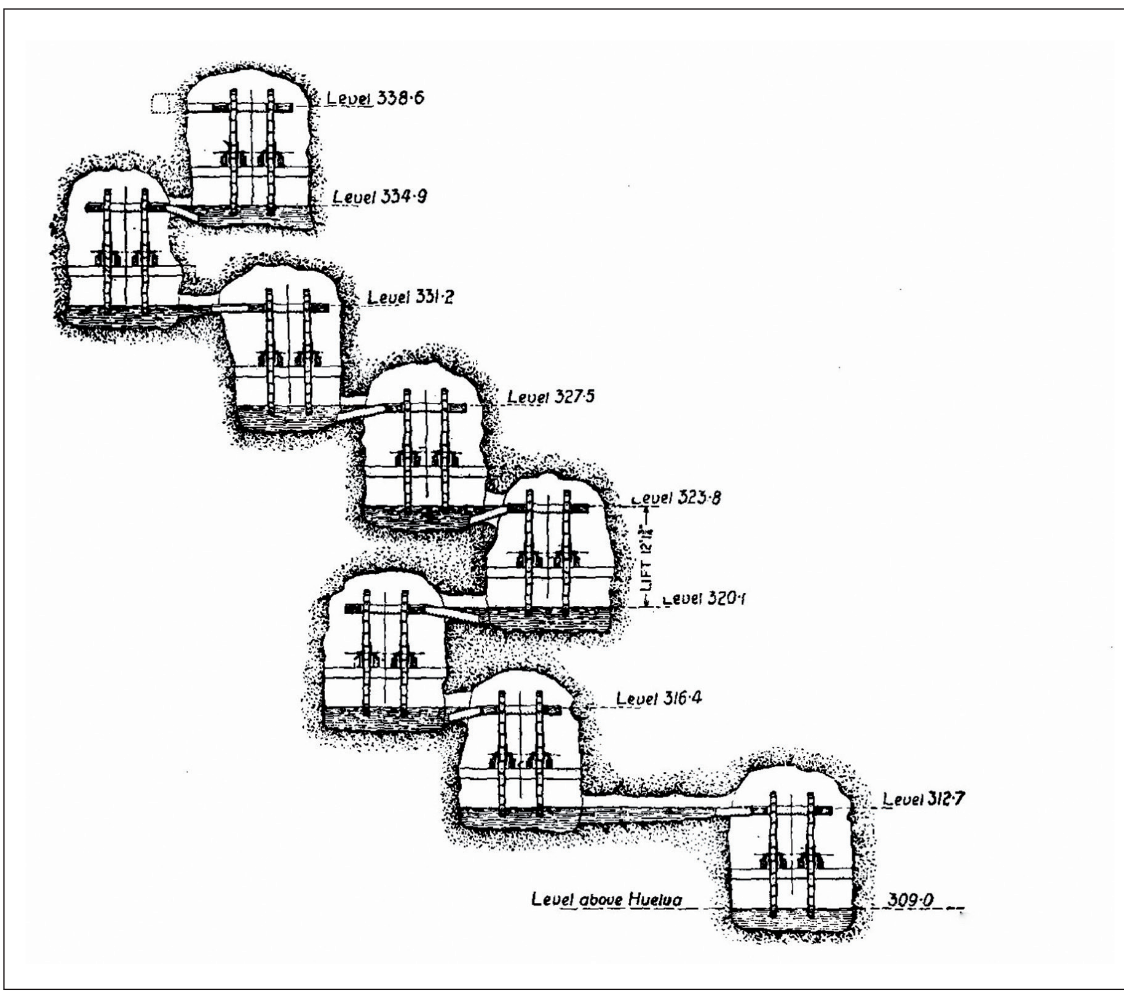

Fig. 8: Reconstruction drawing of a system of eight pairs of water wheels from Riotinto.

Conclusions and Further Considerations

Further study of the subsidiary industries that supported imperial mines in Roman Iberia will illuminate details about the significant role that local production had in imperial extraction. While this discussion has been limited to those industries most closely linked with mining economies, many other industries should be taken into account. For instance, the agricultural sector was especially key, as food produced locally and farther afield was needed to sustain populations of specialized laborers engaged in mining.[31] For now, this specific look at the crafting of tools and other equipment used in underground mining in the Iberian Pyrite Belt has shown the variety of ways that laborers and craftspeople living in and around mining landscapes sustained the operation of the copper and silver mines of the early empire. Subsidiary industries – ranging from esparto grass weaving, to potting, to carpentry – became essential to local economies and supported the work of large-scale mining. Many of these industries were inextricably linked to one another and engaged in cross-craft production, dependent on the sharing of equipment, materials, and technologies. Roman extraction, then, incited the formation of social and economic ties across varied subsidiary industries. These processes altered local economic organization and, ultimately, sustained and supported large-scale Roman imperial mining in southwest Iberia.

Notes

[1] Miller 2007, 237–246; Shimada 2007.

[2] E.g.: Blázquez Martínez 1992; Remesal Rodríguez 1998; Bourgeon 2017.

[3] Bond 2016, 97 f.

[4] Flohr 2013a, Flohr 2013b.

[5] Murphy 2015.

[6] For more on the organization of the mining industry in this period, see Hirt 2010.

[7] E.g., Davies 1935; Domergue 1990; Edmondson 1987; Orejas et al. 1999; Wilson 2007.

[8] Hong et al. 1996, Hong et al. 1994; Rosman et al. 1997; McConnell et al. 2018.

[9] García Palomero 2004; Gibbons – Morena 2002, 483–487.

[10] Rothenberg – Blanco-Freijeiro 1981; Hunt Ortiz 2004; Gosner 2016.

[11] Klein et al. 2004, 478 f.

[12] Mazzocchin 2008, 692; Walton – Trentleman 2009, 858.

[13] For information about the long-term history of the mines, including more recent periods, and the history of collecting, see: Delgado Domínguez 2012; Harvey 1981; Salkield 1987. The Vipasca tablets are among the other famous finds from Aljustrel, see: Domergue 1983; Edmondson 1987, 244–249; Orejas 2002.

[14] The artifacts discussed here are now preserved in museum collections in Spain and Portugal, including the Museo de Huelva, the Museo Minero de Riotinto, the Museu Geológico de Lisboa, the Museu Nacional de Arqueologia (Lisbon), and the Museu Municipal de Arqueologia de Aljustrel.

[15] Fajarado et al. 2015.
[16] Cacho Quesada et al. 1996.
[17] Alfaro Giner 1984.
[18] Buxó 2008, 152.
[19] Bañón Cifuentes 2010.
[20] Palmer 1927, 305.
[21] Fajardo et al. 2015, 372.
[22] Blair et al. 2006; Simms – Dalley 2009; Oleson 1984.
[23] Wilson 2002, 17–28; Oleson 2000; Oleson 1984.
[24] On technical knowledge transfer with reference to water-lifting devices, see: Schneider 2008, Oleson 1984.
[25] Manzano Beltrán et al. 2010, 350.
[26] Manzano Beltrán et al. 2010, 363–365.
[27] Harris 2017; Meiggs 1982.
[28] Ojeda Calvo 1999, 30–33.
[29] Delgado Domínguez – Regalado Ortega 2010; Palmer 1927, 303; Schneider 2008, 165.
[30] Manzano Beltrán et al. 2010, 375 f.; Domergue et al. 1999.
[31] On agriculture around the Roman copper mines at Wadi Faynan, see, Friedman 2013. For a specific look at southwest Iberia, see: Pérez Macías 2014.

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Fig. 1–7: by the author. – Fig. 8: Palmer 1927, 303.

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