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MINING IN SOUTH-WEST GAUL AT THE CROSSROADS OF THE CELTIC AND MEDITERRANEAN WORLDS. THE CASE OF THE MINING AREA OF THE ARIZE MOUNTAINS (CENTRAL PYRENEES) DURING THE FOURTH AND THIRD CENTURIES BC

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Summary. This paper presents new data about the silver-bearing copper mining area of the Arize (Central Pyrenees) during the fourth and third centuries BC. The identification of amphorae sherds from Magna Graecia and the Strait of Gibraltar region sheds new light on this metal production and confirms a systematic exploration of the ores before the end of the third century BC. At a regional scale, the existence of several mines operating between the fourth and third centuries BC also suggests a production that exceeded the local needs. Parallels can be drawn between this important raw metal production and the socio-economic changes observed in Celtic Europe in the same period. We also point out the need for further in-depth study of the economic situation of this region, lying at a crossroads between the Celtic and Mediterranean worlds.

INTRODUCTION

The fourth and third centuries BC represent a period of significant change in Celtic Europe, which is the subject of renewed research attention (Brun 2007; Buchsenschutz *et al.* 2012; Marion 2013). The third century in particular has been identified as a major stage of economic development. The emergence of trade-oriented artisanal agglomerations from the Atlantic seaboard to Central Europe is an expression of this development (Fichtl *et al.* 2019).

At the same time, archaeological research into mining activities carried out in the last decade between the Pyrenees and the Montagne Noire (Fig. 1) has renewed the data on the relevant chronology. The ranges of radiocarbon dates have led on several occasions to the discovery of a phase of activity covering the fourth and third centuries cal BC, hitherto unknown (Girard *et al.* 2010; Beyrie *et al.* 2011; Beyrie 2015; Maintenant and Munoz 2017; Py-Saragaglia

et al. 2017). In the Arize Mountain district,¹ recent radiocarbon dating has also evidenced this early stage of mining (Meunier *et al.* 2017). The new identification of amphorae sherds consistent with this existing chronology adds another dimension to this activity and its context. These data allow a reassessment of regional mining and open up prospects for the long-distance relationships in which the trafficking of metal took place. This also helps, thanks to the structural relationship between the mines and their socio-economic context (see Shennan 2010; Stöllner 2012; 2015), clarify the ongoing changes of this period as expressed in the archaeological record, which in turn herald the deeper transformations clearly identified for the second century BC onwards.

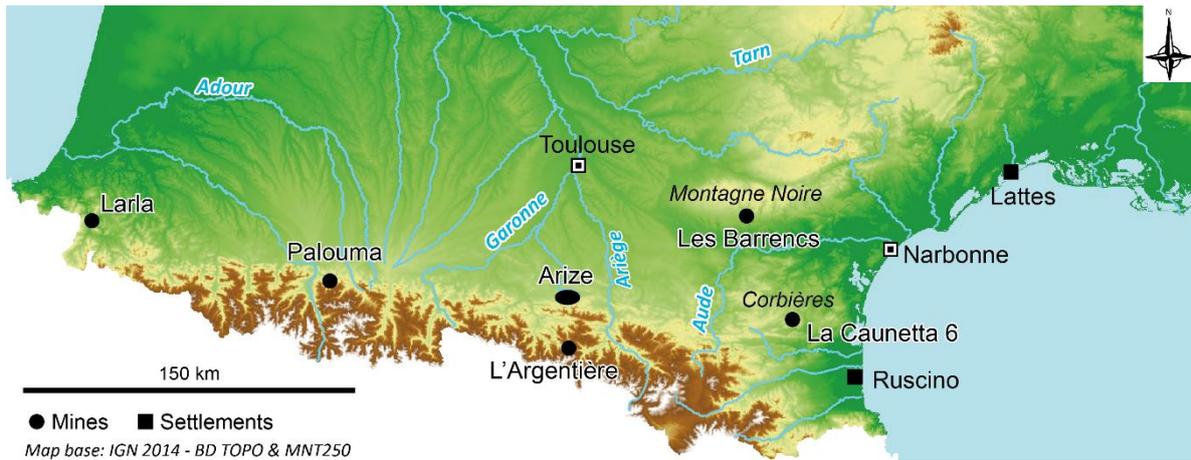


Fig. 1: Localisation of the main sites cited in the text.

THE CU-AG ARIZE DISTRICT: THE NEW CHRONOLOGY

The Arize Mountain range, in the central part of the northern Pyrenees, is a small chain separated from the primary Axial Zone. A thin strip of Devonian limestone terrain extending 20 km east-west bears the polymetallic ores that are the object of mining. The most common ore is an argentiferous tetrahedrite – $(\text{Cu}, \text{Fe}, \text{Ag})_{12}(\text{Sb}, \text{As})_4\text{S}_{13}$, but some proportions of chalcopyrite, pyrite and galena are also identified. The gangue is mainly barite, but some calcite is also recorded (Meunier *et al.* 2017, 240). Thirteen old mines are known (Fig. 2), and we can access the underground portions of six of them (Dubois and Guilbaut 1982; Meunier *et al.* 2017, 226–7).

¹ The term ‘district’ is used here with the meaning of a group of mines located in the same circumscribed area, with no assumption of their administrative composition.

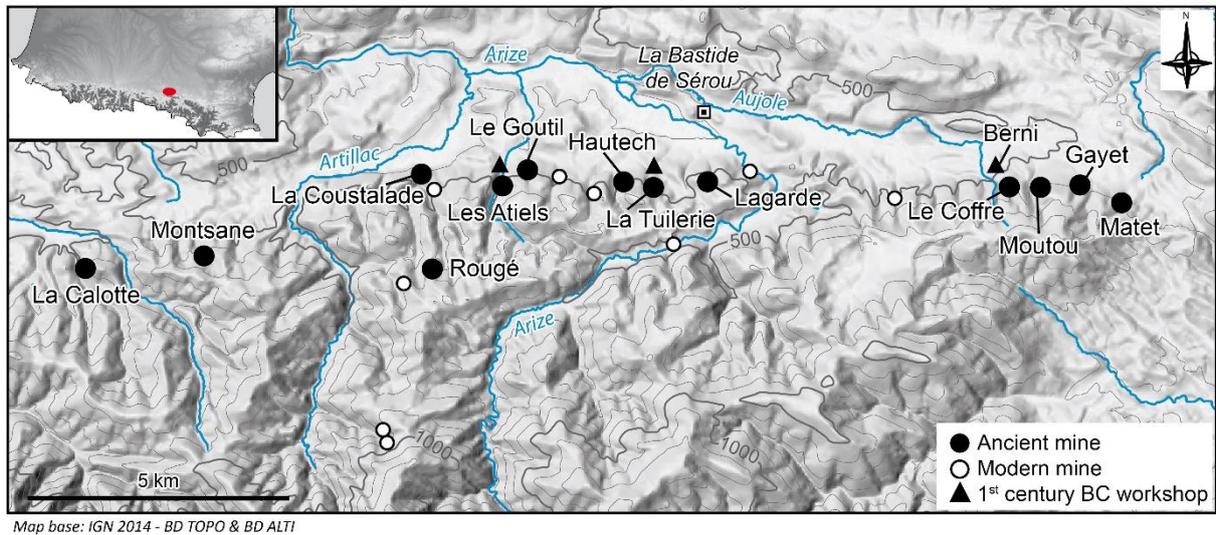


Fig. 2: The Arize mining area.

The previous data

Field surveys in and around the mines have yielded numerous amphorae sherds, mostly of the Dressel 1 type, and more specifically of the A variant (Fig. 3). This type and variant represent the main transport container for Roman wine between the end of the second and the end of the first centuries BC. Most of the production centres for these amphorae were located in Italy, but other provinces were also involved, such as *Hispania Tarraconensis* and *Ulterior* (Hesnard *et al.* 1989; Sáez Romero and Díaz Rodríguez 2007). Ancient Gaul proved to be one of the first outlets for Roman wine, and most sites in this territory regularly produce considerable quantities of Dressel 1A and 1B amphorae (Olmer 2008; Loughton 2014, 419–25). The mining and metallurgical contexts are no exception, as shown by their recurrent and sometimes massive presence at the mining sites of the Corbières area, the Montagne Noire or the south of the Massif Central, but also in the ironmaking and smelting workshop sites like Les Martys and Canigou (Tchernia 1986, 92–3; Benquet 2016). Their presence provides greater visibility for the widespread expansion of mining activity during the Late Republican period (Domergue 1994).

In the Arize district, the few small excavations carried out near the entrances of the mining networks have yielded amphorae sherds of the same type (including also some Dr 1B and 1C, and scarce late Greco-Italic), a few sherds of Campanian B and other common protohistoric ceramics. Associated with mining waste, this material is contemporary with an exploitation phase during the Late Republican period and testifies to the miners' daily life, whose still unknown habitats must have been nearby (Meunier *et al.* 2017). New data obtained in the doctoral research of one of the authors have refined the historical perspectives of this district (Meunier 2018). The Late Republican stage of mining can no longer be considered as the main period of work and even less as the origin of the systematic procurement of local ores.

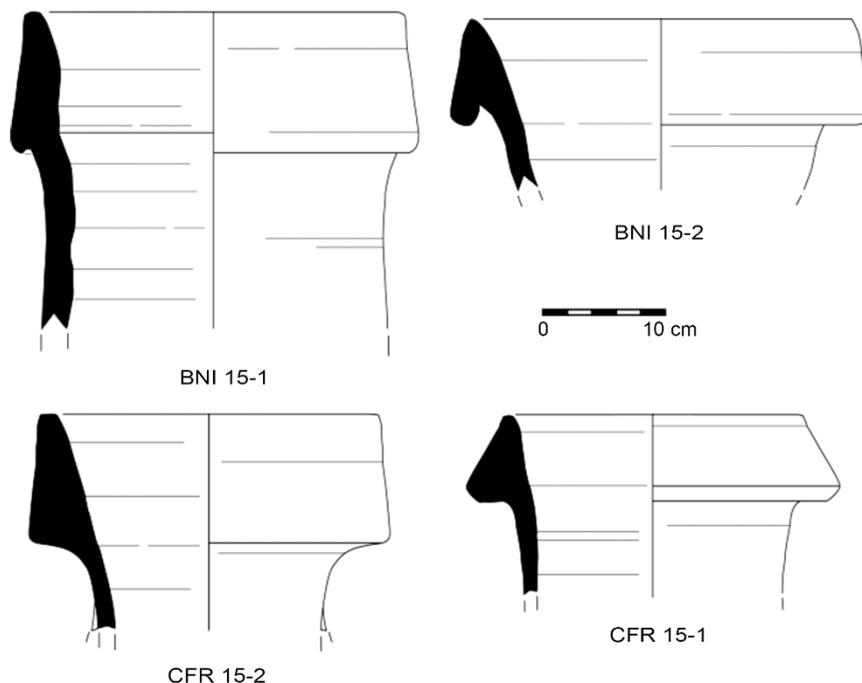


Fig. 3: Various examples of Dressel 1 amphorae from the Arize mining area (scales in centimetres).

New radiocarbon dating

The silver-bearing copper ore of the Arize mountains is embedded in very hard massive limestone. Fire-setting was therefore mainly used for extraction. The very large volume of charcoal produced during this process make it possible to directly date the phases of mining, when discovered in significant stratigraphic units. Archaeological soundings were carried out in five mines. Their location was chosen according to the structure of the networks both to get as close as possible to the opening of the mine and to evaluate the rate of progress inside it.

The stratigraphy made it possible to distinguish phases of activity, marked by thin and hardened floor-surfaces, and phases of use of the galleries as storage spaces for mining waste, as the activity had progressed in the galleries. The charcoals used for dating, selected by anthracologists,² were preferably chosen from stratigraphic units composing the floors of the galleries wherever possible. Levels corresponding to renewed mining activity could also be identified and dated. When there was no other option, the charcoals came from a fill level, providing a *terminus ante quem* for the cutting of the gallery in question.

These data (Table 1 and Fig. 4) show that mining activity began clearly earlier than the Late Republican period. The dates 2, 3 and 4 (Table 1) from Rougé, 6 from Hautech and 8 from La Coustalade reveal that the period between the mid-fourth and end of the third centuries cal BC appear as an important mining stage. Date 1 from Rougé even proposes the first half of the fourth century cal BC. This activity was in fact part of a native Latenian context, clearly prior to the Roman presence in the region. On the other hand, the dates 9 (La Coustalade) and 10 (Les Atiels), in accordance with the chronology of the omnipresent Dr 1, confirm the recommencing of mining during the Late Republican period. The later mining phase of the

² Raquel Cunill and Vanessa Py, Géode.

fourteenth century AD that had been identified by C. Dubois (1996, 39) in Le Goutil was confirmed (Table 1, 11), and the same phenomenon also appears in the Rougé (Table 1, 5) and Hautech mines (Table 1, 7).

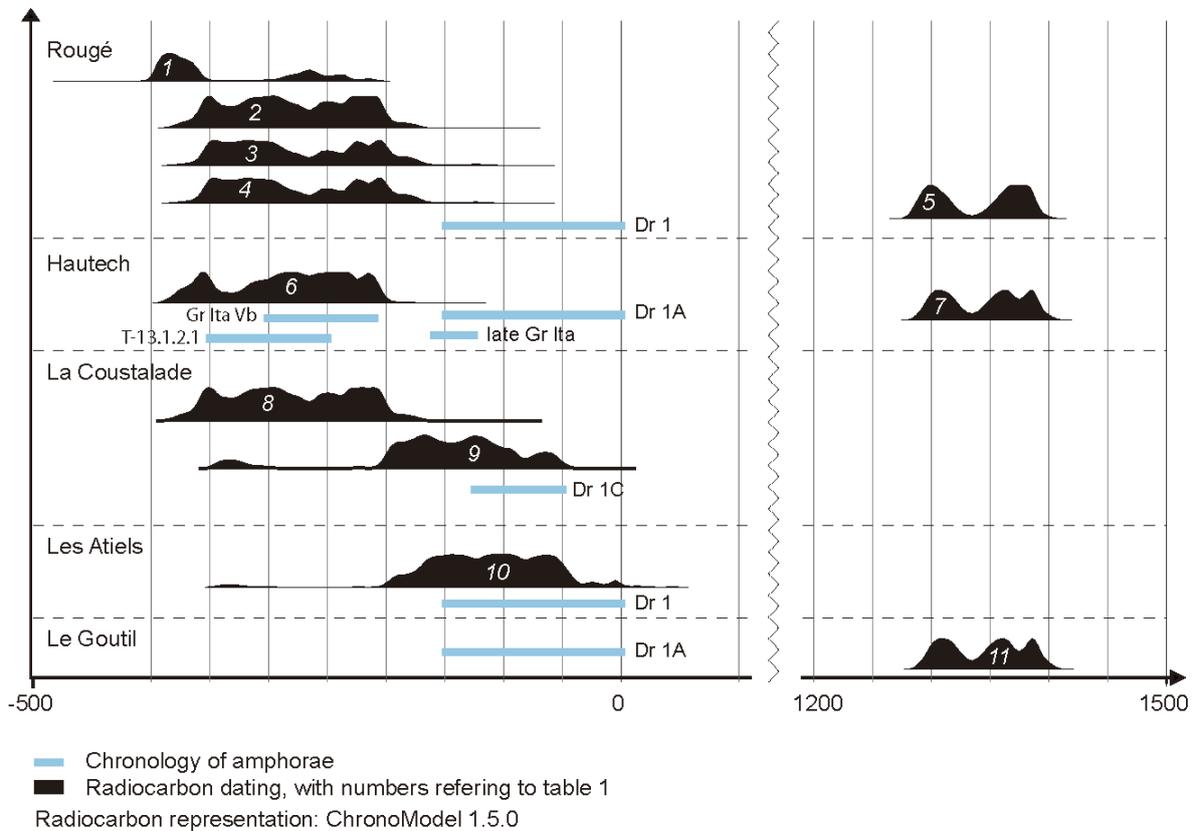


Fig. 4: Synthesis of radiocarbon dates compared with amphorae chronology in the Arize mines.

Laboratory code	Conventional radiocarbon age	Calibrated age	Stratigraphic context	Element dated
Mine of Rougé				
Poz-83887	2285±30 BP	405–362 cal BC (65.5%) 295–229 cal BC (29%) 219–213 cal BC (0.9%)	Soil of gallery	Small beech branch with bark
Poz-83888	2205±30 BP	370–196 cal BC (95.4%)	Intermediate local fire-setting	Small branch with bark
Poz-83890	2190±30 BP	361–178 cal BC (95.4%)	Fill-level composed of fire-setting debris	Small beech branch with bark
Poz-84530	2190±30 BP	361–178 cal BC (95.4%)	Soil level above fire-setting debris	Identification not possible
Poz-95126	645±30 BP	1281–1328 cal AD (42.2%) 1341–1396 cal AD (53.2%)	Late fire-setting debris	Hazelnut branch
Mine of Hautech9				
Poz-92446	2225±30 BP	380–203 cal BC (95.4%)	Soil of gallery	Identification not possible

ETH-55854	627±30 BP	1289–1398 cal AD (95.4%)	Fire-setting debris	Small beech branch
Mine of La Coustalade				
Poz-92445	2205±30 BP	370–196 cal BC (95.4%)	Fire-setting debris soil of mine entrance	Identification not possible
Beta-414105	2120±30 BP	345–322 cal BC (4.2%) 206–50 cal BC (91.2%)	Fire-setting debris lower recess	Beech bark
Mine of Les Atiels				
Poz-84531	2090±30 BP	202–37 cal BC (93.5%) 30–21 cal BC (0.8%) 11–2 cal BC (1%)	Soil of gallery	Small fir branch
Mine of Le Goutil				
ETH-55853	622±30 BP	1291–1400 cal AD (95.4%)	Fire-setting debris	Small alder branch

Table 1: New radiocarbon dates in the Arize mountain mines (Meunier 2018). Calibration with OxCal v. 4.2.3 using calibration curve IntCal13 (Bronk Ramsey 2009; Reimer *et al.* 2013).

The amphorae, another evidence of the earlier mining stage

As commercial containers, amphorae had a strictly utilitarian function, unlike fine ceramics and certain prestige items: this limits their functional life. Amphorae can therefore become a relatively precise chronological marker, when properly contextualized (Olmer 2012; Loughton 2014, 27–63). For the Arize mountains, the recent revision of the identification of various amphorae sherds from the mining contexts tends to confirm the data for an early operating phase here.

Indeed, two sherds from the Hautech mine (Fig. 9) belong to much older amphorae. The first, coming from the bottom of the Hautech5 complex, is a rim of a Graeco-Italic amphora linked with the wine trade (Empereur and Hesnard 1987; Olcese 2004; Cibecchini and Capelli 2013). It shows a fabric of a petrographic composition similar to that observed among the Magna Graecia amphorae (Fig. 5, A). Its morphology and fabric connect it with the Gr.-Ita. Vb variant, a distinct shape of Graeco-Italic amphora dated around the years 300–215 BC (Cibecchini and Capelli 2013, 437). At that time, in the south-west quarter of Gaul, the bulk of the Mediterranean imports are mainly concentrated on the major coastal centres, such as Lattes and Ruscino (Séjalon 2013). A few examples of this type of early Roman container have been identified around modern Toulouse, but they belong to contexts connected with the long-distance Mediterranean trade (Benquet 2007), with which the mines are not traditionally related.

The second amphora fragment, collected on the ground near the Hautech16-17 complex, is a Western Phoenician amphora rim identified as from a T-13.1.2.1 type (Fig. 5, B), a container produced between the mid-fourth and mid-third centuries BC (Ramón Torres 1995, 241–2). The contents of the T-13.1.2.1 amphorae remain unclear, but the available evidence argues for their having been wine containers or processed foodstuffs. A complete example of this type of amphorae, found elsewhere, is illustrated to highlight its typology (Fig. 5, C). This type of amphorae came mainly from Carthage, but it was also produced among the Phoenician cities from the Strait of Gibraltar region (Martín Ruiz 2010), and this last origin has to be considered here. The economic status of the Phoenician settlements from the Gibraltar region

during the Classical era is still unclear. Nevertheless, many recent discoveries tend to suggest that they were then particularly dynamic centres, as they were engaged from very early on in the long-distance trade of wine and fish products.

The chronology of these two amphorae corresponds to the radiocarbon date no. 6 from Hautech (Fig. 4) and confirms the local activity during this early stage of mining. Taking into account the range of the calibrated radiocarbon dates and the production period of these amphora types, the first half of the third century appears as the most probable period of mining. However, the scarcity of the dated material requires caution until new investigations bring more reliable data.

Beyond the chronological dimension, the presence of such an amphora at a mine in the Pyrenean foothills, around 150 km away from the Mediterranean coast, raises the question of the trade networks involved in the diffusion of these artefacts. The regional data about the contemporary settlements are still very scarce: one cannot ascertain the ancient connections active at the interface of the Celtic and Mediterranean worlds. Nevertheless, the integration of the Arize mines into these networks further highlights the metal production of this sector.

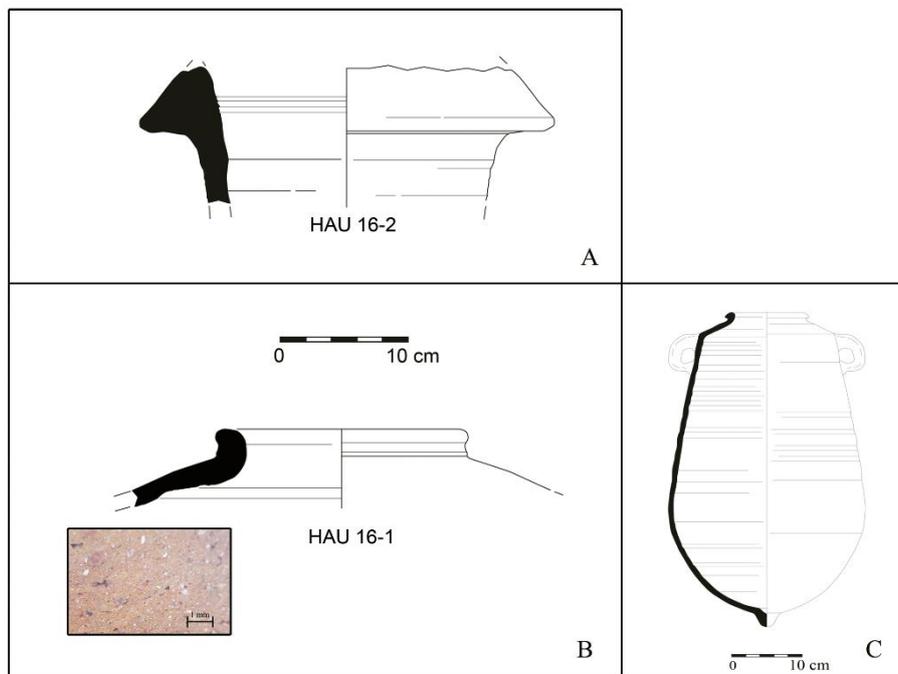


Fig. 5: Rim of a Graeco-Italic amphora from the Hautech mine (A). A fragment of T-13.1.2.1 amphora from the same site, whose origin is illustrated by the fabric image (B; in millimetres); a complete vessel of the same type (C).

REGIONAL METAL PRODUCTION THAT EXCEEDS LOCAL NEEDS

The Arize district between the mid-fourth and the end of the third centuries BC: a systematic exploitation

The small number of radiocarbon dates and their broad range when calibrated do not permit one to accurately trace the pace of activity in this district. However, the appreciation of the reconstructed organisation of the mining activity, taken with the chronological data, demonstrates the importance of this phase.

The Rougé mine followed a sloping vein for over a depth of 41 metres, between +12 and -29 in depth.³ Mining was carried out in a succession of horizontal levels that deepened and ran westwards to follow the slope of the vein (Fig. 6, plan and Fig. 7, a). Small archaeological trial-excavations were undertaken on the -4/-5 and -13/-14 levels (Fig. 6, E1 and E2). The backfill dated at the -14 level (Table 1, 3) could only have been placed there when the miners were working between the -15 and -21 levels, so as not to block the miners' movements. Three-quarters of the mine therefore were empty by the end of the third century, at the latest. The consistent technical practices, observed even in the deepest parts, could also indicate that the bottom of the work was reached soon after, leaving little ore for either late Republican or medieval restarts.

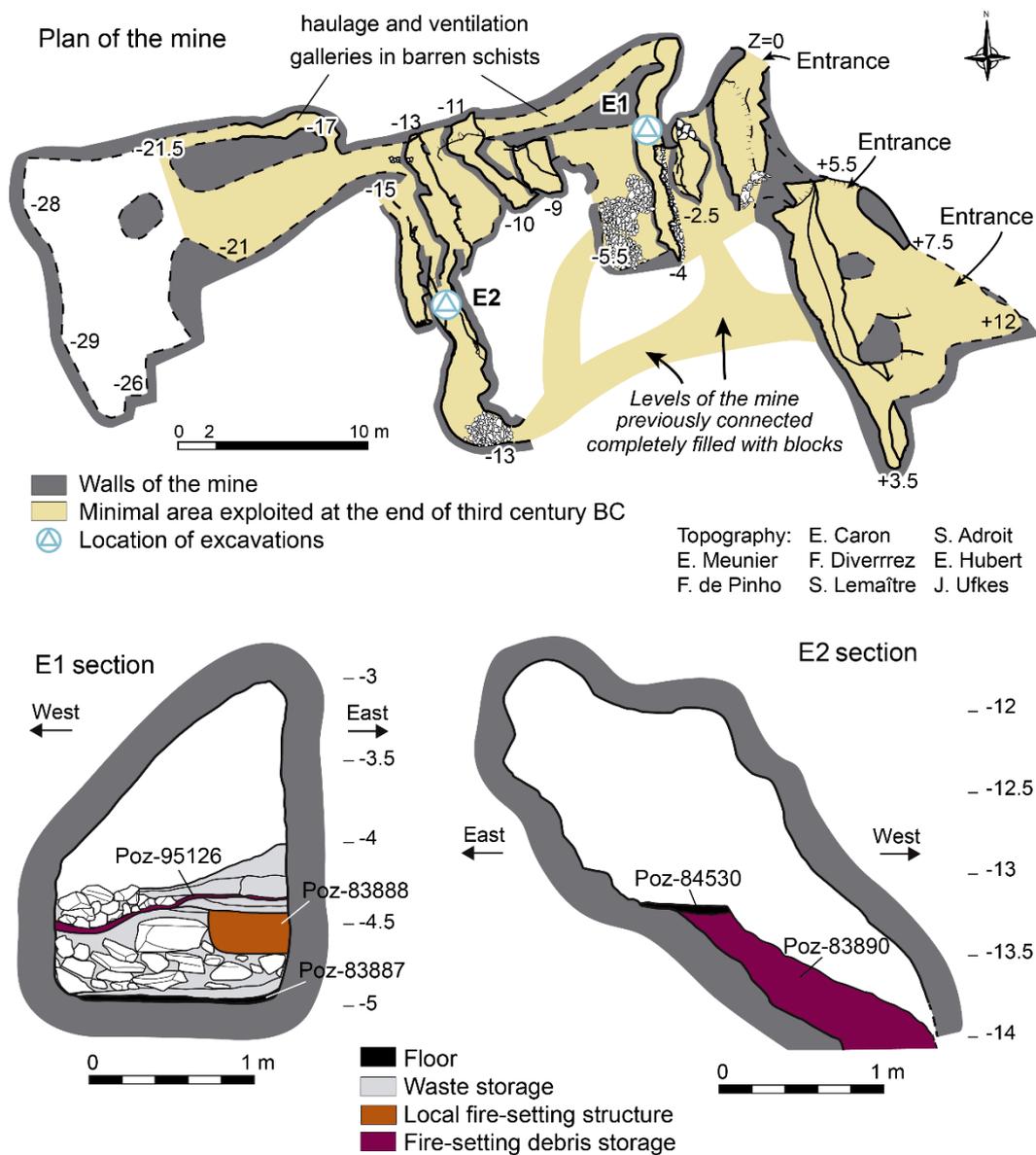
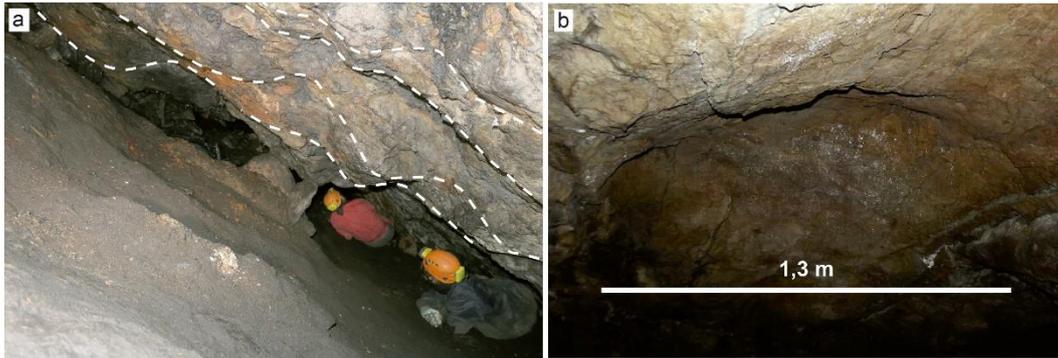


Fig. 6: Rougé mine: plan of the mine (top) and sections of the excavations (bottom).

³ Each depth is expressed in metres in a relative system specific to each mine.



a Northern part of levels -12 to -14, partly filled with wastes, seen from the north.

b A fire-setting dome, level -3.

Fig. 7: Rougé mine: pictures of significant features.

The situation is similar in La Coustalade. The ancient part of this mine (Fig. 8) comprises a sloping double shaft in the south and a single incline underground at the north, connected first by a large pit, and then a further underground communication passage at the bottom (level -10/-11). A recent gallery (beginning of the twentieth century) cuts across the bottom of the ancient mine and continues to the south in search of parallel veins. The chronological gap between the dates obtained near the upper north entrance (level -1, E2; Table 1, 8) and in a recess at level -6.5 (E1; Table 1, 9) is not compatible with the size of the work. To reach the maximum depth of the ancient part of the mine, at 10 to 12 m, over a length of about 20 m at most, did not require two centuries of work. The limits of the main vein were most certainly reached towards the end of the third century BC as well. The recesses at level -6.5 correspond to an attempt to restart the mining between the last quarter of the second century and the mid-first century BC (judging by the presence of a sherd of Dr 1C), which was then aborted due to the poor quality of the ore still present.

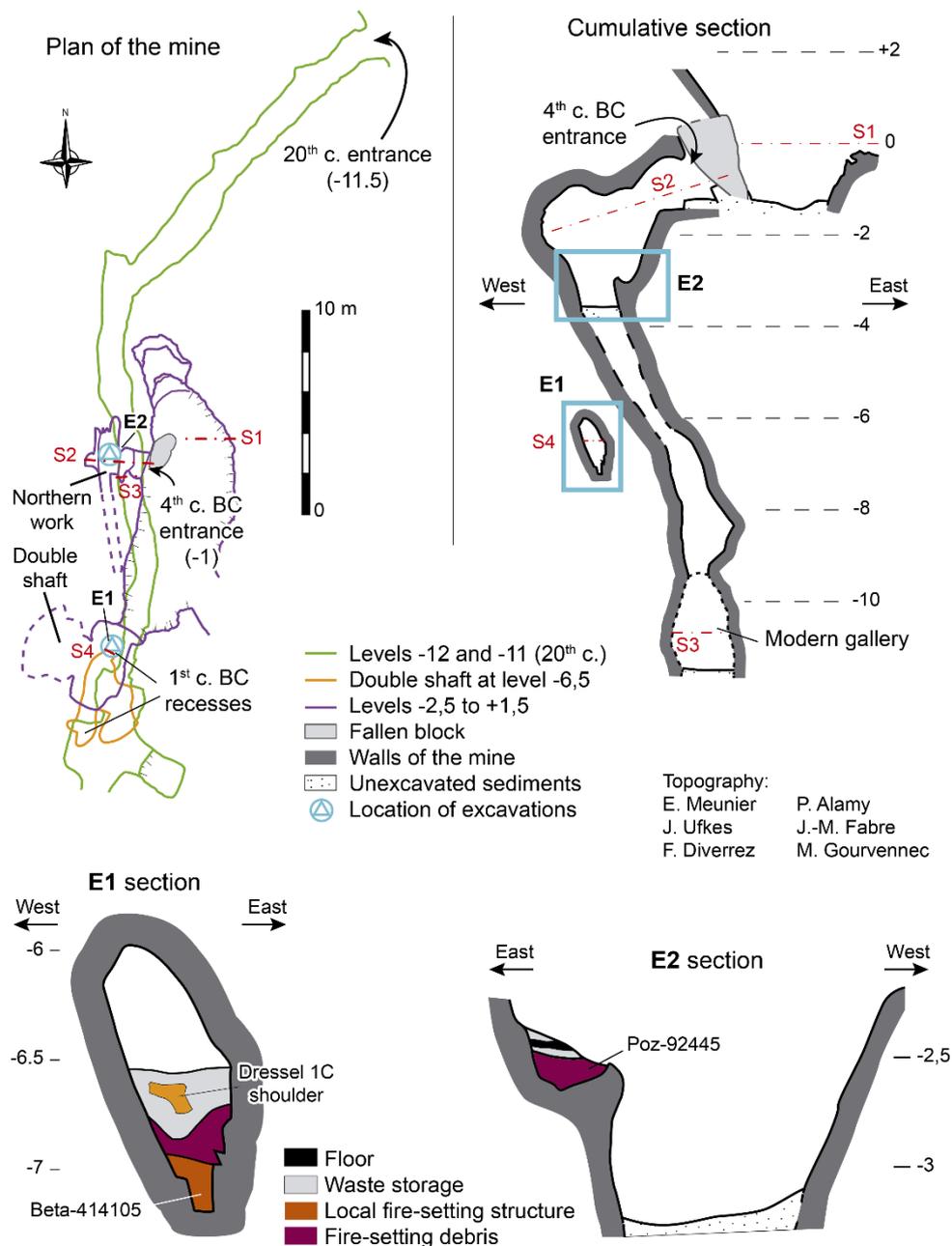


Fig. 8: La Coustalade mine: plan and section of the mine (top) and detailed sections of the excavations (bottom)

For the Hautech complex (Fig. 9), mine 9 is dated by a charcoal from the soil of level -6 (Table 1, 6). Considering its relatively small dimensions, the main exploitation of the lower levels should have been completed around the end of the third century at the latest, as indicated by the calibrated radiocarbon age. The levels -8 to -11, with their completely different profile (fig. 9, bottom), were enlarged during the resumption of activity in the fourteenth century AD. In the Hautech5 complex, that is much more extensive, the fragment of a Graeco-Italic Vb amphora (HAU16-2) presented above comes from a fill at level -38 (fig. 9, top right). This area could be backfilled only when the bottom of the mine had been reached. This leads us to conclude that this complex was also mostly worked out at the end of the third century BC at the latest.

As to when the systematic mining activity could have started in the Hautech complex, the T-13.1.2.1 sherd (HAU16-1), combined with the radiocarbon date for Hautech9, could

allow this to be dated to the mid-fourth century BC, if we consider that the Mediterranean elements arrived there by ways independent of each other. If, however, they were to belong to the same stage of mining, one that was integrated into a broader trade network, which seems more probable, the beginning of the third century BC appears as a stronger option. Such a scenario would not be in contradiction with an earlier recognition of the mineralised outcrops and a first stage of less intensive mining during the fourth century BC.

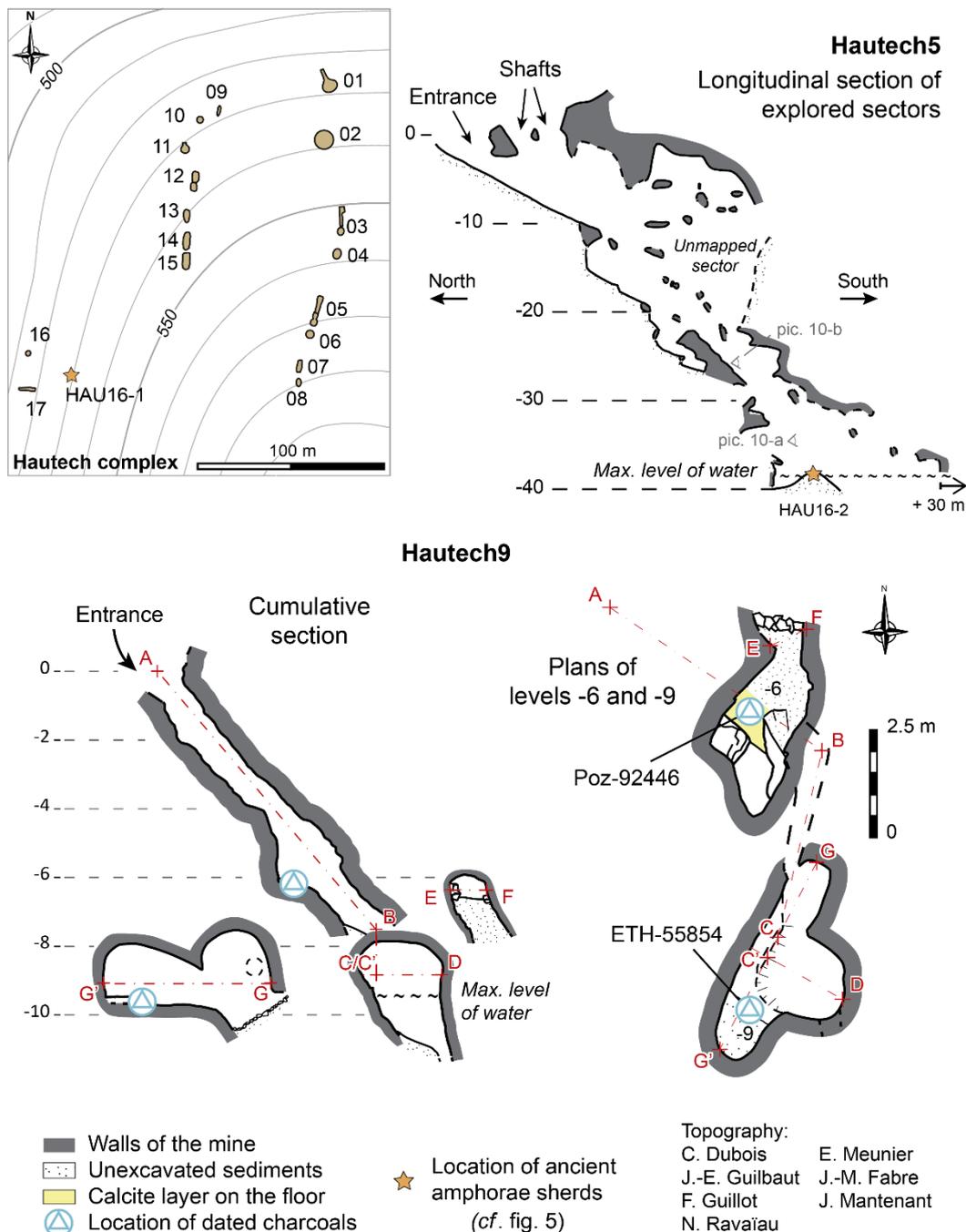
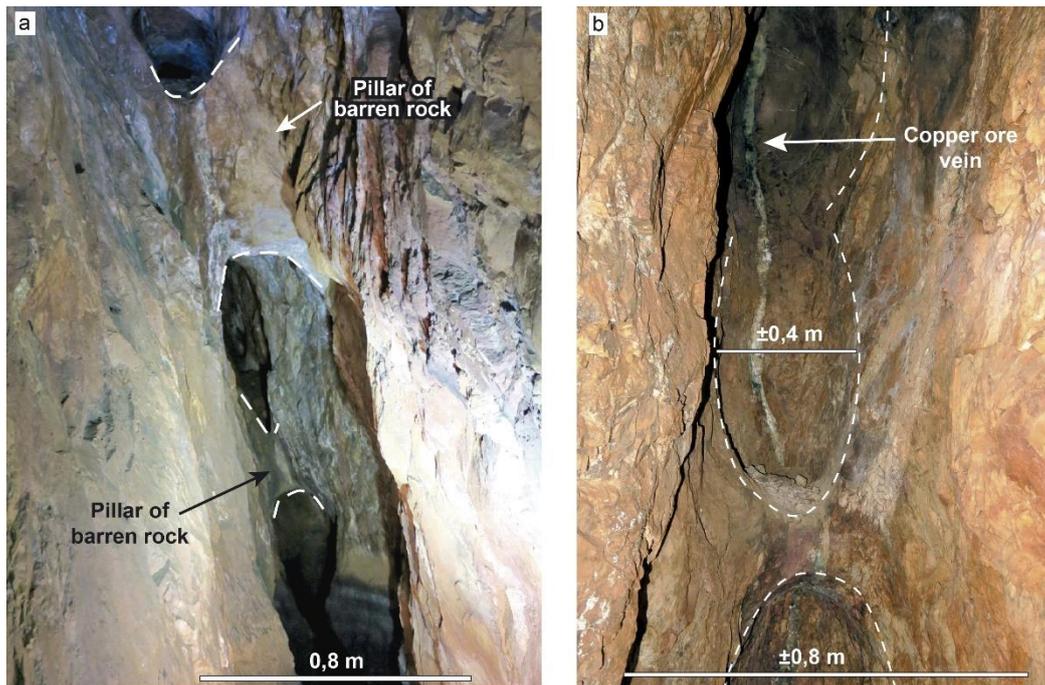


Fig. 9: Hautech complex: general distribution of the mines (top left), longitudinal section of Hautech5 mine (top right) and Hautech9 plan and sections (bottom).

The technical characteristics of the mines with the calibrated dates between the mid-fourth and the end of the third centuries BC are identical in this district. The mines are opened

from the outcrop using fire-setting, forming domes whose diameter does not exceed 1.4 m (Fig. 7, b) and curving smooth walls (Fig. 10, b). The veins were then exploited in successive horizontal and descending levels. Propping up of the ceiling is provided by leaving pillars of sterile or weakly mineralised rock in place (Fig. 10, a). The veins are closely followed, so limiting excavation of the worthless rock as much as possible. This was, however, to the detriment of the ease of circulation: the absence of steps or notches in the sloping parts made the progression difficult and tiring. For mines with vertical workings, such as Hautech5 and La Coustalade, the same type of superimposed levels can be observed, with similar dimensions ranging from 0.8 to 0.9 m high (Fig. 10, b). Some notches in the walls could correspond to the location of wooden structures to assist passage.



Hautech5, levels 33 to 38, to the south. Successive horizontal levels with some pillars.

Hautech5, levels 25 to 27, where miners decided to stop going further south.

Fig. 10: Hautech5 mine: pictures of significant features.

Another common feature of these complexes is the almost general absence of technical devices for haulage, ventilation or mine drainage. The morphology of the ore deposits partly explains this. The mines were naturally well ventilated, often having several entrances on the slopes. As for drainage, only the infiltration of waters from the outside had to be managed at La Coustalade or at Rougé, above the water table. At Hautech, several networks are nowadays flooded during periods of heavy rain and then are naturally emptied. Natural faults can ensure the removal of the water, although the possibility of an as yet unidentified drainage gallery cannot be totally ruled out. Two galleries designed to facilitate ventilation and haulage in the deep levels of Rougé are the only exception here. The miners took advantage of the contact with barren schist, which limited the extent of the ore mineralisation to the north, to open two sloping galleries between the -3 and -12 levels, on the one hand, and the -15 and -21 ones, on the other hand (Fig. 6, plan). There is no doubt that the ease of digging in this soft rock, where iron tools were suitable, must have played a role in this choice.

These technical points are found in common throughout the whole Arize district, for example in the Hautech¹⁰ and 16 networks, but also in the sectors near the entrances to the Goutil mines. The small accessible area of La Tuilerie may also correspond to this pattern. An exception is found in the Les Atiels mine, apparently entirely opened with tools, but this is dated later in the first century BC (Table 1, 10). Regarding the medieval resumption of mining, this seems to be characterized by a mixed use of iron tools and fire-setting, the diameter of the fire domes here being as large as 2 to 4 m.

The homogeneity of the oldest mines testifies to a sharing of know-how at the district level, where the mines were probably exploited more or less simultaneously since several of them were largely emptied by the end of the third century BC. The internal configuration of the mines allowed two or even three teams to work at the same time, suggesting a desire to maximize productivity. They mark the systematic exploitation of the silver-bearing copper ores, which very probably also occurred in the mines that are not accessible today. The third century BC thus appears to be the main period of exploitation in the Arize mountains, probably starting in the second half of the fourth century (or the first half, taking into account the date 1 from Rougé). The scale of the activity, as well as the presence of material usually linked with the Mediterranean trade, shows that the metal was not restricted to the local market.

A regional mining dynamic

The available data show that regional mining was part of a fundamental shift the societies underwent between the fourth and third centuries BC. In some cases, the relevant elements are isolated and do not allow an assessment of the extent of mining. The Argentière silver-bearing lead mine (Fig. 1), largely destroyed by the resumption of the twentieth century work, is one such case. Debris from fire-setting allows us to affirm that these resources were indeed exploited between the fourth and third centuries cal BC (Py-Saragaglia *et al.* 2017, 148). In the extended Corbières district, only the La Caunetta⁶ silver-bearing copper mine is dated to this period (Mantenant and Munoz 2017, 159). The early cases seem isolated. The very frequent Graeco-Italic type and other Roman amphorae recorded during surveys give an image of a main exploitation phase between the middle of the second and the end of the first centuries BC. The relatively limited excavation undertaken in these mines, however, councils caution, as the Late Republican period could be over-represented by the volume of the amphorae remains.

In the Montaigu mountains, the work on the Palouma mine has remained largely unpublished (Girard *et al.* 2010). This underground network can still be visited for over several hundred metres, and many small open-cast mines are visible nearby. Most of the mining work dates back to the second and first centuries BC, but the dated charcoals come from areas far away from the entrances. This suggests that the start of the activity should be placed at an earlier date, to which the open-cast works could also be linked. The scale of the mine, whose set-up is organised to permit long-time exploitation, could be consistent with a beginning as early as the third century BC.

In other mines, the data are more accurate and indicate significant operations. In the Basque Country, the iron reduction workshops at Larla were active as early as the fourth century BC and continued to operate until the second century AD (Beyrie and Kammenthaler 2005, 29). The technique was well controlled from the very beginning and did not change during the whole period of activity (Beyrie 2015, 135). The production is estimated at 2000 tons of iron during

these six centuries (Beyrie 2015, 131–2). Even given the long period of activity, this was one of the main iron production centres of the Northern Basque Country (Beyrie 2015, 135).

In the Montagne Noire, the silver-bearing copper mine of the Barrencs is the clearest example of a large-scale mining site from the fourth century BC. The complex studied, exploiting a near-vertical vein mineralisation, comprises several hundred metres of galleries and other workings, staggered over nearly 100 m of depth (Beyrie *et al.* 2011; Manteau *et al.* 2013; Munteanu *et al.* 2016). This represents only a small part of the complete mine: other filled-in or flooded underground networks are recorded along two mineralised areas of several hundred metres each. Six of the 15 radiocarbon dates of the Les Barrencs mine are from the early fourth to the end of the third centuries BC, and three others range from the mid-fourth century to the end of the second century BC (Beyrie *et al.* 2011, 51; Manteau *et al.* 2013, 39–40). Their location at different levels of the network shows that it had been widely explored well before the Roman takeover of *Gallia Narbonensis*, although activity continued until the Augustean period. Charcoals taken from 80 m below the surface indicate the extensive progress of the work by the end of the third century BC. Technical aspects show that this mine too was highly organised, revealing the presence of specialists in charge of supervising the miners (Munteanu *et al.* 2016, 177–178).

The same level of control has been identified in the gold mines of the Limousin, where complex drainage and timbering techniques, on the one hand, and gold quality control, on the other, show the presence of management personnel and specialists in the organisation of these operations (Cauuet *et al.* 2018, 34–6). This large gold district (with more than 250 mines) was exploited between the fifth century BC and the Augustan period, with an intensification from the third century BC (Cauuet 2004; Toledo I Mur *et al.* 2005; Cauuet *et al.* 2018). Gold production is estimated between 74 and 297 tons over the entire period of operation, which far exceeded local consumption.

Viewed from this broader perspective, the silver-bearing copper mines of the Arize mountains appear as an additional point on the map of important production centres over a regional scale. The diversity of the ores sought shows that the demand for metals was varied and widespread. In particular, the recurrence of the exploitation of polymetallic silver-bearing ores (based on copper or lead) in the areas of the Arize, the Montagne Noire, Montaigu mountain, the Corbières and the south of Ariège should be noted. In a period when indigenous silver coinage appears and develops (Feugère and Py 2011; Callegarin and García Bellido 2012; Callegarin *et al.* 2013), this coincidence is noteworthy, despite the absence of data on numismatic workshops. However, the widespread exploitation of regional metal resources, with its many implications, is above all a manifestation of the changes occurring during this period.

THE MINES AS INDICATORS OF DEEPER SOCIO-ECONOMIC DYNAMICS

The data derived from archaeology on mining also shed light on the socio-economic structures surrounding the mining exploitation. To reach the level of intensive production attained, some prerequisites have to be met by the societies involved in it, beyond the existence of a strong demand for the metals (Stöllner 2010). This makes it possible to deduce some of the main features of the socio-economic pattern in which mining is embedded, as corroborated by data from non-mining contexts.

The first aspect concerns the emergence of groups of specialists in mining communities. Operating a mine to supply a regional or even extra-regional market represents an investment, in the form of maintaining an available, dedicated workforce (Stöllner 2012, 435; Cauuet *et al.* 2018, 34–5). The ensuing specialization can be compared with that of other craftsmen grouped together in the open agglomerations that developed from the third century BC onwards. The blacksmiths, bronze-smiths, goldsmiths or potters in these agglomerations are the counterpart of the miners and metallurgists, and also of the loggers and charcoal burners of the districts producing raw metal. The emergence of large-scale specialized activities is a development that was present as early as the end of the fourth century in the Celtic area. At that time, both the formation of a priesthood and the differentiation between soldiers and the rest of the population demonstrate a tendency towards social complexity (Marion 2007, 111–12; 2013, 366). The management of the relations between these different groups was made possible by a more stratified organization of society, with a rural aristocracy that asserted its power, particularly by seeking control over the means of production (Brun 2001; 2007, 384; Buchsenschutz *et al.* 2012, 324; Colin and Verdin 2013, 240–3; Mennessier-Jouannet 2013, 371).

The diffusion of raw metal beyond the local scale requires the existence of structured networks. The same applies to the manufactured products of the artisanal agglomerations. The sustained relations identified between the members of the La Tène aristocracy throughout Europe, which contributed to the very rapid adoption of technical or artistic innovations over long distances (Buchsenschutz *et al.* 2012, 300–1), certainly favoured economic exchanges. At the same time, in the Mediterranean area, the fourth and third centuries were marked by a clear increase in trade, well identified among the classical Greek cities (Ober 2010). In fact, the archaeological and textual data testify to a strong increase in demand during this period, linked to a phase of economic “growth” in several regions of the ancient Mediterranean (Morris 2004). The need for raw materials, especially metals, intensified, though this remains more difficult to assess (Van Alfen 2016, 289–91). The Phoenician cities of the east and west, as well as southern Italy, participated in this economic expansion (Van Alfen 2016, 293–5), in connection with an extension of trade networks, particularly towards the west of Iberia and eastern Gaul (Bertucchi 1992, 212–15; Muller 1998; Sourisseau 2004; De Sousa and Arruda 2010). The Celtic and Mediterranean dynamics were combined during this period. In this sense, the ancient amphorae of the Arize region should not to be seen as isolated cases. On the contrary, they attest to the extension of these Mediterranean trade networks to south-western Gaul. We expect that further research in contemporary regional sites would bring more data on that topic.

Such an association between intensive mining activity and the strong surrounding socio-economic structure has also been evidenced in the Dürrnberg salt mining centre (Austria). These mines enjoyed their strongest activity between the sixth and mid-fourth centuries BC (Stöllner *et al.* 2003). The fact that no other salt resources were available within 500 km around this rich area (which includes the Hallstatt mines also) increases its relative importance. This position favoured the early formation of a complex system controlled by a small group of people, where inclusion in exchange networks was a key factor (Stöllner *et al.* 2003, 179–84; Stöllner 2010, 306–7). In south-western Gaul and in the same period, the metal resources may not have been considered as strategic as salt was, and so did not induce the same level of very strong demand. The evolution towards a comparable intensive activity, with all the involved prerequisites, occurred later, maybe since the fourth century BC (Les Barrencs, Larla, Arize for the second

half) and more surely during the third century (Limousin, Arize). The global dynamic towards more structured societies and the development of stronger exchange networks (illustrated by the rise of open settlements with craft specialization) seem to have facilitated the emergence of several intensive mining clusters at that time.

Finally, it is essential to realize that mining districts are centres of wealth production anchored in their home territories. Their control was absolutely necessary, especially if they were intended to supply a larger market. A parallel can also be made with artisanal agglomerations as important economic centres. This issue of control over territories and the exploitation of their economic resources echoes the questions raised by the adoption of money. Celtic coinage, inspired by Mediterranean models, appeared precisely during the third century. This too expresses the growing sociopolitical complexity of the period and is intimately linked to the economic sphere (Callegarin *et al.* 2013, 189–90; Hiriart 2019, 430–1). The political entities that were issuing these currencies displayed thereby their control over a certain territory, which had its own resources and was part of exchange networks reflected in the monetary circulation. Although the presence of these first currencies is frequently encountered in artisanal agglomerations (Hiriart 2019), they are currently unknown in the mining context. Future research on the miners' habitats could help to determine the effect that these ventures had in the construction of the local political entities whose names are given by classical sources from the second century onwards.

CONCLUSION

The rise of mining centres able to supply extensive markets between the fourth and the third centuries BC in south-western Gaul plays a full part in the overall dynamic of economic growth and sociopolitical transformation identified during this period. The third century seems to bear witness to most of the evidence for this phenomenon – more chronological data for mines, the rise of open settlements with craft specialization and the emergence of Celtic coinages.

The production of metal, then, responded to a growing demand for raw materials, both regionally and throughout the ancient Mediterranean. The role taken by south-western Gaul in the related trade networks of that time is still unclear. Nevertheless, the documentation presented here calls for a more in-depth study of the economic situation of this region, and its contacts with the Continental, Atlantic, Iberian and Mediterranean areas.

Although many uncertainties remain, the data presented here contribute to the recognition of the third century BC as a phase of active transition in the Celtic world, in parallel with what is observed in the Mediterranean world. This evolution has its roots in the fourth century BC, and further investigations are needed to propose more accurate chronologies of its development. The mining districts constitute fixed points for further research on this period. In particular, discovery of the miners' habitats should help to identify with more precision those involved in production and the way in which they fitted into these exchange networks.

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