The FAHMA Project: The first multidisciplinary study of the early medieval silver mining district at Melle (France)

Projekt FAHMA: První interdisciplinární studium raně středověkého hornického okrsku v Melle (Francie)

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Abstract: The only production site of silver that is known to have minted deniers from the 8th century is the silver-rich galena deposit at Melle (Deux-Sèvres, France). The site of Melle constitutes an extraordinary place to study medieval mining and metallurgy. In 2009 the FAHMA Project (Filière de l'Argent au Haut Moyen Age) funded by the French ANR (Agence Nationale de la Recherche) was launched. Elementary and isotopic analyses of the artefacts that result from the treatment of the ore to produce silver (ore, lead, slags and coins) will be carried out. The combination of the skills and knowledge of the researchers involved in this project is expected to contribute greatly to the understanding of early medieval silver metallurgy and could constitute a basis for future investigations of other mines.

Key words: Early Middle Ages, silver mining and smelting, geochemical analytic

THE FAHMA PROJECT

FAHMA is the French acronym for "Filière de l'Argent au Haut Moyen Age", which can be translated as "Silver processing during the early Middle Ages". This project has begun in October 2009 and will be funded by the ANR, the French National Research Agency, until the end of 2012. The FAHMA project involves specialists working on a wide range of subjects surrounding silver and its production during the early Middle Ages: mining and metallurgical archaeology, history of technology, analytical chemistry, history and numismatics. The combined skills and knowledges of these researchers is to offer a better understanding of silver processing during the early Middle Ages, through the study and analysis of the different kinds of artefacts resulting from its production at Melle (France): silver itself, ore, vitreous slags, smoothers and lead artefacts. All of these objects contain geochemical information that can be determined and interpreted. Keeping in mind the limitations inherent to each, their combine study should provide a new interpretation of the organisation of mining exploitation and its evolution.

The geochemical fingerprint of the ore and that of the silver, as well as different metallurgical by-products deriving from the transformation, can be compared using two different approaches: elementary analysis and lead isotope analysis. Elementary analysis is performed by various methods depending on the nature of the artefact to be characterized. This approach aims at determining the concentration of the different chemical elements composing the object. The concentration of the major elements that constitute the bulk of the object has to be determined in relation to the characteristics of the sample. Minor and trace elements are contained in this matrix as impurities; ancient craftsmen and metallurgists were not aware of their presence in the material they worked. The determination of their concentration is nonetheless primordial as these elements are those giving indications as to provenance. The determination of the ratio between the different natural isotopes of lead (^{204}Pb, ^{206}Pb, ^{207}Pb and ^{208}Pb) can also reval very useful information allowing to link ore with silver if the

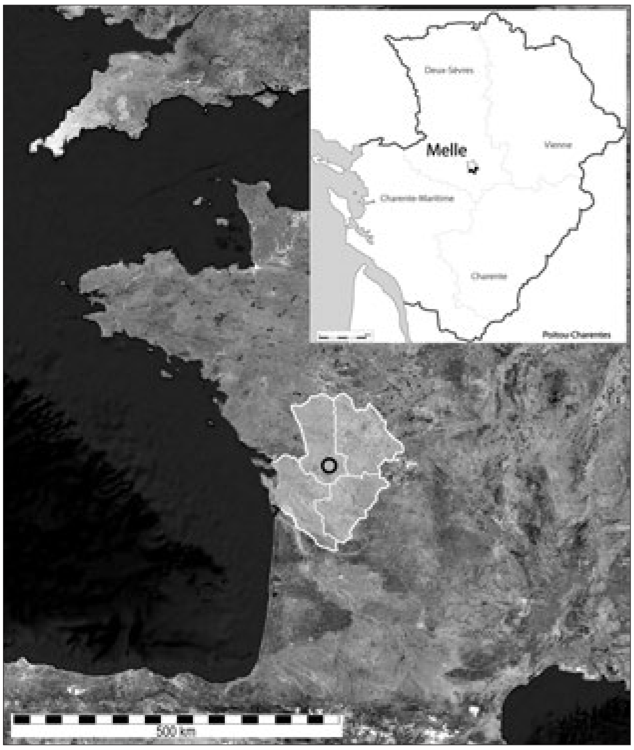

Fig. 1. Localization of Melle and the Poitou-Charentes region.
Obr. 1. Naleziště Melle na mapce Francie a v rámci regionu Poitou-Charentes.

latter has been produced from galena. All of these isotopes except for ^{204}Pb derive from the radiogenic decay of uranium and thorium. Their relative concentration in rocks therefore depends on the age of the ore deposit. The values of the ratios between the different lead isotopes can be used to separate ores from different origins. These ratios remain unchanged during the processes put into effect to obtain silver from the galena, so their comparison is a relevant way to separate ores and metals of different origin. However, it has to be kept in mind that ore or metals mixing from various sources, or the adding of lead of different origin during metallurgical processes can lead to a mix in the lead isotope ratio fingerprint that would minimize the interest of such an approach.

Some of the artefacts resulting from the transformation of ore into silver are precious archaeological samples, and should not be damaged by the analysis. This requires the use of specific methods, non destructive, or at least causing damage not visible to the naked eye. In the case of archaeological vitreous materials like smoothers and silver coins, this can be achieved by the use of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). For other samples such as galena or slags, part of this material can be destroyed for analytical purposes, and other methods can be used.

The FAHMA project puts emphasis on the analyses. The coupling of elementary and lead-isotope analysis appears nowadays to be the most promising approach for the investigation of the provenance of silver and for its linking

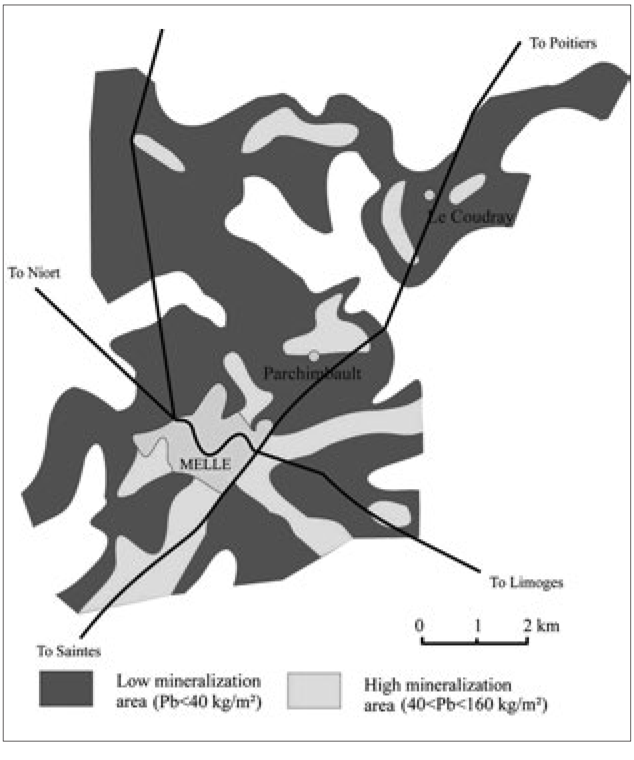

Fig. 2. Density map of the mineralization at Melle (from Coiteux 1982).
Obr. 2. Mapa mineralizace v Melle (podle Coiteux 1982).

with its by-products. So far, no study has implemented a systematic coupling of these two kinds of analysis on a wide range of samples; this is the aim of the FAHMA project: modern analytical methods are to be applied to ores and vitreous materials, as well as lead artefacts and silver coins in a non destructive way, so that their fingerprint can be determined without causing visible damage to the objects.

The early medieval silver-mining district of Melle appears to be the ideal candidate for such a multidisciplinary project. Firstly, the area has been studied both from a geochemical and archaeological point of view; ore samples can be collected from those mining networks that have been preserved, slag samples from previously identified smelteries, and lead samples and coins from archaeological excavations. Furthermore, Melle was not only a major silver production site during early Middle Ages: it was also one of the most prolific mints of the Carolingian period. A large number of silver coins bearing the name of Melle struck during the early Middle Ages, most of them from museums or public collections, but also from hoards or archaeological excavations, can therefore also be taken into account.

The FAHMA project aims to gather all available data concerning silver mining and metallurgy in the early Middle Ages, and in particular about the mining district of Melle. Analyses will then be performed to determine the chemical fingerprint of the various artefacts resulting from the production of silver, and combined with previous results in order to provide an overview of silver processing at Melle during early Middle Ages and the spread of this silver in the Carolingian empire.

THE EARLY MEDIEVAL MINING DISTRICT AT MELLE

1. The mining area at Melle

Nowadays, Melle is a small town of four thousand inhabitants located in the Poitou-Charentes region in France (Fig. 1). Between the 6th and the 10th centuries, one of the major production centers of silver in Western Europe was located there (Téreygeol 2007). In a time when silver was overwhelmingly minted, especially from the 8th to the 10th century, Melle was one of the main minting centers of Carolingian Western Europe, although it was not a major city. Coins bearing the name of Melle are known from the 8th to the 12th century; more than ten thousand such silver coins have been reported so far. By contrast, only four hundred are known for the same period bearing the name of Paris. The coins from Melle are particularly numerous in the hoards of Charlemagne (768–814), Louis the Pious (814–840) and Charles the Bald (840–877). Archaeological remains as well as mentions in early medieval capitularies, and the sheer number of coins bearing its name undoubtedly make Melle a central point in the production and the diffusion not only of silver, but also of the by-products of its processing that could be used for other purposes, such as lead and smoothers.

The first modern mentions of the silver mine at Melle date back to the 19th century. Mining networks were identified and other traces of the mining activity were reported during this period (Rondier 1870). From the 1950's to the 1980's, an important survey took place, aiming to estimate the interest of reopening the silver mines of Melle, which provided a better understanding of the geology of the area (Coiteux 1982, Marcoux 1986). Regular extraction of core samples following a grid was carried out as a basis for the mapping of the density of the mineralizations (Fig. 2). Luckily, no further exploitation of the mines was undertaken at Melle so that medieval site and galleries remain unaltered. The information provided by the geologists is however quite valuable to the archaeologist, and form a realiable basis for prospection and the understanding of the exploitation in medieval times.

The silver-rich mineralization at Melle is only a few meters below the surface, five to six meters deep, which makes mining possible using early medieval techniques. The silver is mainly found in galena ore, which is a lead sulphur (PbS). The average content of galena in the rock is 1 to 2 %, but it can reach 10 % or more in the richest areas; those are the ones that have been exploited by ancient miners. The ratio Ag/Pb in the galena is 1 to 3 ‰. The comparison of the archaeological survey with the geological data reveals that the areas excavated by medieval miners were not exclusively the richest, and that some high-density mineralization areas have been neglected. The silver content of the galena could not be determined by early medieval miners with any precision; they therefore exploited the most accessible areas.

2. From ore to silver at Melle

The treatment transforming galena ore to silver usable for coin minting requires several steps. They take place underground, in the mining galleries, and then outside in dressing-ore areas and smeltries. The complete process has been studied in detail since 1996 (Téreygeol 2001). Traces of mining activities give indications recording the organization of underground activity in the mining networks. The shape of the galleries, the ovoïd coal faces, the charcoal residues and the characteristics of the barren rocks remaining underground reveal that the digging was achieved using fire-attack. Logs were placed along the part of the wall containing the mineralization; the presence of water and the differential dilatation of the rocks when heated lead to the cracking of a superficial layer. After the decrease of temperature and renewal of the surrounding atmosphere, the miners hammered down the rock that had not been eliminated by the fire. This process of fire-setting followed by hammering had to be repeated to dig galleries following the mineralization. The use of fire-setting requires huge quantities of wood; the mining activity at Melle entailed massive deforestation, and lack of wood was most likely the reason why the exploitation stopped (Téreygeol et Dubois 2003).

In the networks at Melle, air-shafts were dug regularly so the air could circulate. The smoke resulting from the fire-setting had to be evacuated as fast as possible in order to facilitate the hammering work of the miners, and to prevent the whole network from being smoked in. Remains of crushing stations in the galleries prove that a first sorting was carried out underground between galena rock and the rest. Only the rocks that contained silver-rich mineralization were taken out of the mine. Part of the mineralurgical activities therefore took place underground.

The fire-setting used to extract galena left charcoals residues underground. Those can be used for radiocarbon dating. This revealed that mining at Melle took place not only during the Carolingian period, for which coins in the name of this city are known, but also during the Merovingian period: underground mining activity would have begun as early as the 6th century and ended in the late 10th century (Téreygeol 2001).

After the fire-setting and the first underground selection, the rocks containing silver-rich galena were transported on the surface. The next step was the dressing of the ore. Ore dressing areas have been identified at Melle and one of them has been excavated. This operation required water, but the ore dressing areas are not placed close to a source of water. It seems that instead of transporting the ore to the water, ancient metallurgists preferred to bring water to the dressing sites. Several steps were necessary in order to separate the ore from organic residues and barren rock pieces (Téreygeol 2002).

After the dressing the ore was smelted. The mining area at Melle revealed surprisingly low quantities of slag. This, combined with the limited number of metallurgical structures discovered suggests that a reprocessing of slags took place at some point. This would also explain the presence in early medieval context of lead-rich vitreous objects known as "smoothers". Some of those smoothers have been analyzed, and have revealed a lead isotope fingerprint similar to that of the ore and silver from Melle. The precise use of these objects and the reason why some have been discovered at places as remote from Melle as Novgorod in Russia has yet to be satisfactorily explained (Gratuze et al. 2003).

The last step after smelting was the refining of the argentiferous lead that would finally be used for coin minting. Coins in the name of Melle are very numerous in the Carolingian period, especially during the reigns of Charlemagne (768–814) and Charles the Bald (840–877), and until the end of the 12th century, even though mining is thought to have ceased after the late 10th century. This raises the question of the actual location of the mint of Melle. The site of the Saint-Savinien church in the contemporary town center, where a motte-and-bailey stood in medieval time, is the likeliest. The most valuable remain from coin minting is a die, that has been unearthed alongside with other significant artefacts in this area in the 19th century (Rondier 1870, Breuillac 1909).

The dynamism of the research surrounding the mining and metallurgical activity at Melle lead to a diversification of the activities linked with this site. A part of the medieval underground mining network has been adapted for tourism. On the same site, archaeometallurgical experimentations on ancient processes also takes place on site every summer, and has since 2000. These experiments first concerned only the processes which were in use at Melle for mining, ore and silver treatment; nowadays, they include other metals and a wider range of metallurgical activities (Téreygeol 2008). The artefacts created then using ancient processes are compared with archaeological objects and studied in laboratories in order to improve our knowledge of historical mining and metallurgy.

COLLECTING SAMPLES: GALENAS AND SLAGS

1. Galena sampling

After gathering the previous geological, archaeological and analytical data, the first step in the FAHMA project is to collect samples in Melle, focusing on two kinds of artefacts: galena and slags. Galena is the lead sulphur ore containing silver that medieval miners extracted from these deposit. Five major mining networks have been surveyed at Melle: La Noblette, Loubeau, Semme, rue des

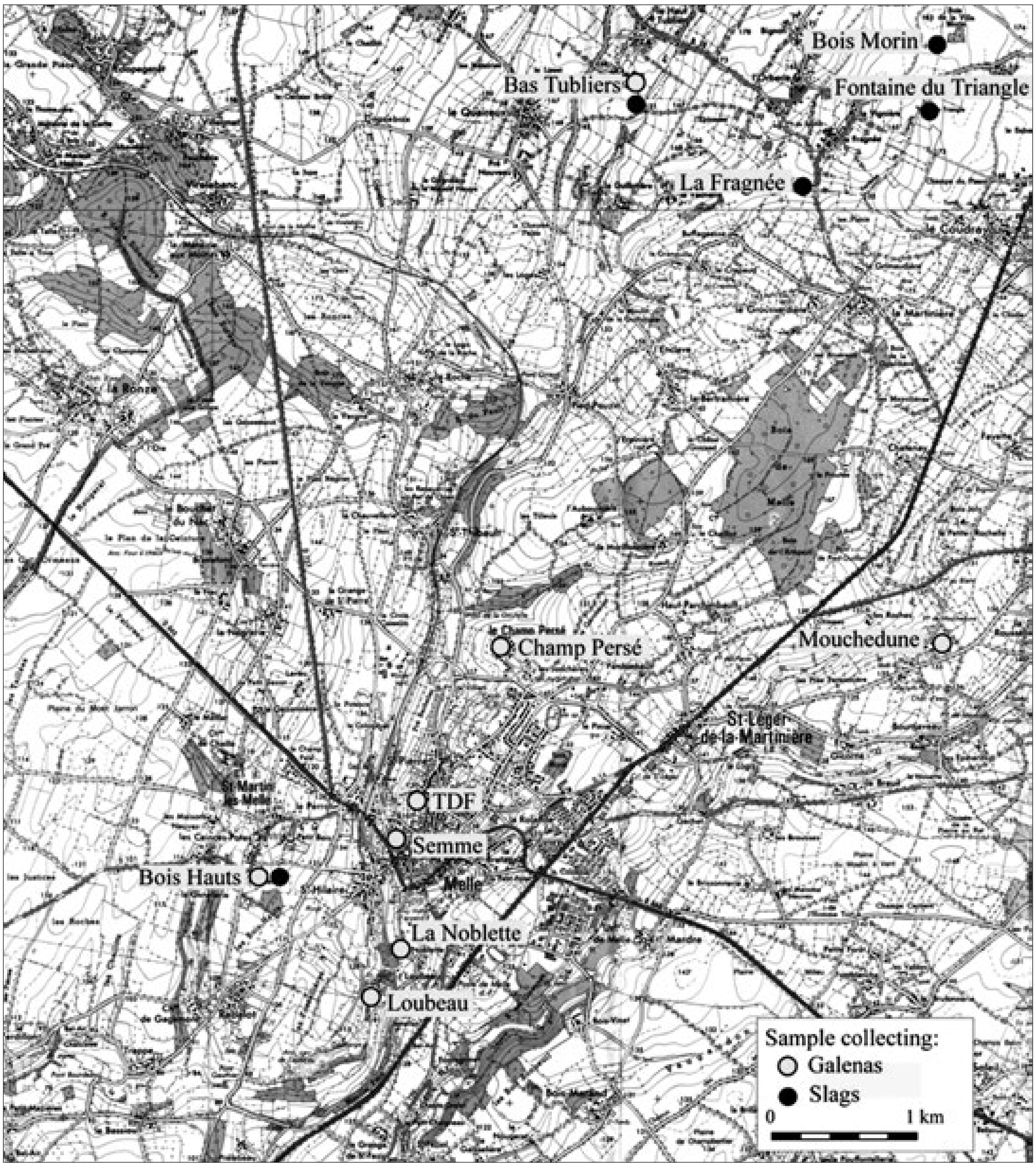

Fig. 3. Map of the sites where galena and slag samples have been collected at Melle.

Obr. 3. Mapa se zanesenými nálezy rud a strusek v okolí Melle.

Mines and TDF, which were in use alongside with smaller exploitations. La Noblette is the one to have been adapted for tourism, and the site of the archaeometallurgical experimentations taking place each summer. This network, as well as that of Loubeau, is located not far south of the modern town of Melle. Both networks have been used as quarries, so that all trace of the oldest mining activities have been obliterated. The entrance to La Noblette and Loubeau can be seen as a cross-section of the networks, due to the removal of stone during the exploitation of the quarries. The three other main networks (Semme, rue des Mines and TDF) are located right under the modern town of Melle. Galena samples could be taken from all of these major networks except for that of the rue des Mines, as it is inaccessible.

The different networks, and among them the numerous working places yield variable amounts of galena. Furthermore, the samples sought for analytical purposes by the FAHMA project are precisely those that were prized by medieval miners. Whatever ulterior transformations and pollution also have bearing on the availability of ore samples. In addition to the galena fragments taken from these four major networks, a few pieces of ore were also collected from mining areas on geological outcrop or on dump remains: Bas Tubliers, Champ Persé and Mouchedune. Another sample comes from the recent excavation of a ventilation pit at the yet unaccessible network of Bois Haut. The location of the sites where galena samples have been collected appears in Fig. 3.

Overall, forty galena samples have been collected at Melle in March 2010. For most of the networks, one to four fragments only have been found. In two cases however, the galena was available in much larger quantities: La Noblette (12 samples) and TDF (15). The emphasis will be put here on the TDF network, as this area especially representative of the mining activity at Melle.

The TDF network was discovered quite recently, during the 1960's, but it has been explored from the 1980's only. The network has the advantage of not having suffered damage from further modification, and has been preserved from pollution after the end of its exploitation. TDF has been extensively studied from an archaeological point of view by F. Téreygeol. The entrance of the network has been opened only for archaeological excavation, so there has been no modification since its discovery.

The map of the TDF network appears in Fig. 4. This network can be divided into eleven parts, corresponding to different periods of exploitation. The archaeological survey indicates that the earliest exploitation took place in part I, and the latest in part XI. It is however impossible to determine whether the exploitation of older parts was sometimes resumed at a later date. The presence of charcoal residues in the TDF network allowed the radiocarbon dating of thirteen samples; this revealed that exploitation had started in the 7th century, and lasted until the 10th century. This period corresponds to the minting of the Merovingian and Carolingian deniers of Melle, so it seems reasonable to infer a link between the TDF galena samples and these silver coins from a geochemical point of view.

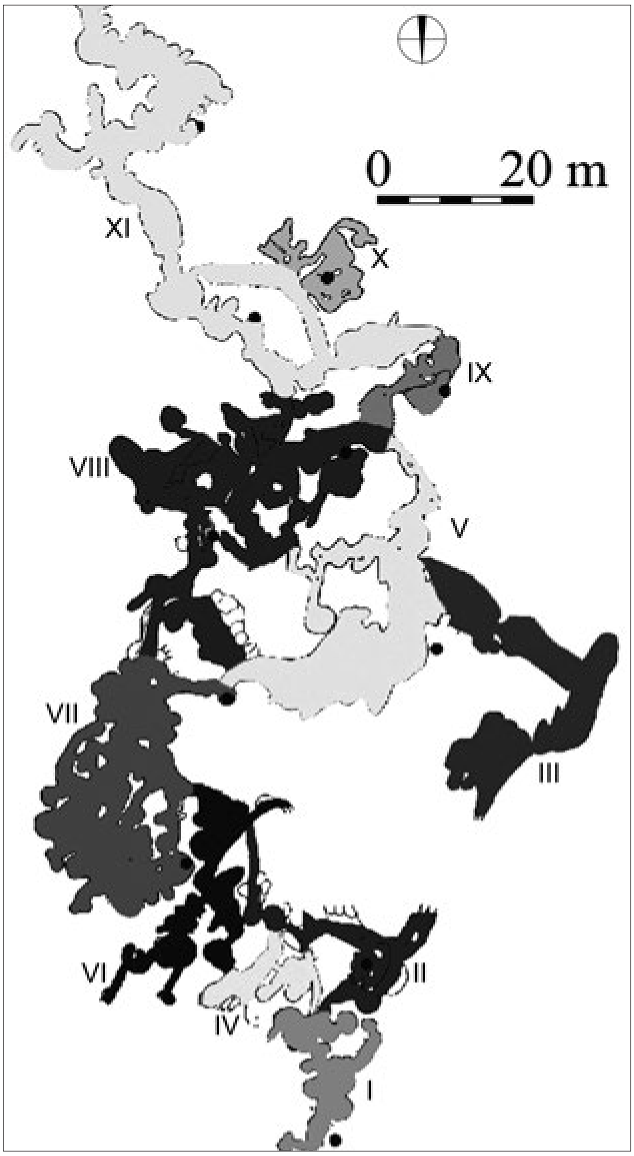

Fig. 4. Map of the TDF network with a separation of the eleven phases of exploitation.

Obr. 4. Mapka s vynesením celkem 11 chronologických fází exploatace rud v Melle.

Fifteen galena samples have been taken in the TDF network for the FAHMA project. One piece of galena has been taken from each of the eleven parts of the network, except for part IX (2 samples), part XI (3) and part VII (2). Elementary and lead isotope analyses of the samples are scheduled for 2011. The results will undoubtedly give interesting indications regarding the variability of the geochemical fingerprint of galena ore within a single network as well as for each of its sections. The same approach will then be used for the Loubeau network, from which numerous samples have also been taken. The results obtained for

TDF and Loubeau will be compared in order to study the variability of the values between different networks; other networks for which the number of galenas sampled was smaller will also be added to this overview.

2. Slag sampling

At Melle, mineralurgical and metallurgical activities at Melle took place alongside with silver mining, so as to produce silver and ultimately coins. Five metallurgical areas have been identified, one of which was excavated in 1975. As previously mentioned, suprinsingly small quantities of slag have been discovered at Melle. However, pedestrian prospection combined with bibliographical research reveals the presence in the area corresponding to identified smeltries of vitreous slags, that can be linked to the medieval metallurgical processes. There are two main slag deposit areas in Melle: the first is close to a pond at La Fragnée, and the second to the spring of the Fontaine du Triangle. The archaeological excavation of the latter site confirmed the presomptions of smeltry activity (Téreygeol 2003). Pedestrian field prospection was undertaken in March 2010 both at La Fragnée and at La Fontaine du Triangle (localization in Fig. 3) in order to collect slag samples. This resulted in fifteen samplings in the area of La Fragnée and nine at the Fontaine du Triangle. Pedestrian prospection yielded similar artefacts at Bois Morin (8 samples), Bas Tubliers (3) and Bois Hauts (3) as well.

The analysis of the slags in the FAHMA project is to follow the same process as for galena samples. Both chemical elementary analysis and lead isotope analysis should be carried out within the end of year 2011. These results will then be compared in order to estimate the variability of the composition of the slags produced by a single smeltery. The data obtained for all the areas of metallurgical activity for which slag samples have been collected will also be compared, and all these results confronted with the values obtained from the galena samples in order to study the link that existed between underground mining activity and surface metallurgical processes. This campaign of analysis should help understand the organization of the chain of activities from the mining to minting at Melle during the early Middle Ages and possibly to establish and follow links between the mining network and the surface sites.

COIN ANALYSIS: RESULST AND PROSPECTS

1. Silver production and coin minting at Melle

As previously stated, the exploitation of the silver mines of Melle began during the 6th century and ended in the late 10th. Mining started at Melle at a time when gold currency dominated the Merovingian monetary economy (Grierson et Blackburn 1986, Lafaurie 1974). Progressively, silver was added to the gold *solidi* circulating in Gaul, until around 675 when the debased gold coinage was replaced by the silver *denarius*, more convenient for everyday transactions. Silver then became the dominant metal in currency, and remained overwhelmingly so until the 13th century.

The importance of Melle in the transition from gold to silver during the last third of the 7th century, and in the following period of almost exclusively silver currency is hard to estimate (Téreygeol 2010). All that can be said thus far is that this silver mining district is the only one that has been well preserved in Western Europe for early

Fig. 5. Illustration of the main coin types from Melle.

Obr. 5. Denáry ražené v Melle. Foto autor.

medieval period. The coins bearing the name of this small city indicate that minting would have taken place where the ore was extracted and the silver produced; their exceptional numbers, and the mentions of Melle amongst the few mints listed in the Edict of Pîtres in 864, suggests that it was a major center of coin production during the second half of the 8th century and all of the 9th century, at the very least. The main coin types attributed to Melle for the Carolingian period presented in the next paragraphs and illustrated in Fig. 5.

The earliest coins attrributed to Melle are gold *solidi* from the Merovingian period, before 675. Their alloy, which is gold-based, cannot evidence any link between them and any kind of metal production, as only silver was ever extracted there. The first silver coins that can be attributed to Melle are Merovingian silver *denari*, minted sometime between c. 675 and c. 750 (Clairand et Téreygeol 2009). The name of Melle is however incomplete on these coins; they only bear the letters M and E ligatured on one of their faces, and the attribution is therefore not entirely certain.

The entire name of Melle only appears on silver coins in the beginning of the Carolingian period. The earliest bear MEDOLVS as the reverse legend, and the name of Charlemagne (king 768–800, imperator 800–814) on the obverse. This first type was minted until the reform of the winter 793/4. Although this legend can easily be read on a significant part of these Charlemagne coins, some of are less certain. This problem also concerns the half-*denari* or obols struck on only side with the name of Melle (Schiesser 2009). Due to the absence of the name of a ruler, it cannot be reliably known whether they were minted by Charlemagne during the years 768–793/4, earlier under Pippin the Short (751–768) or even before during the late Merovingian period.

The reform decided by Charlemagne in the winter 793/4 did not only concern coinage, but also weights and measures in general. At the same time, the standardization of the obverse and reverse types of the *denari*, instigated by Pippin the Short, was reinforced. On all of the Carolingian territory, coins struck after 793/4 bear the royal title CARLVSREXFR *(Carlus Rex Francorum)* on the obverse, and the mint name – spelled METVLLO in the case of Melle – on the reverse.

The name of Melle changed between 814 and 822, under Charlemagne's successor Louis the Pious, to METALLVM. Later, between 822 and 840, the coins struck by Louis the Pious ceased to bear the name of their mint of origin. The death of Louis the Pious was followed by years of instability between his heirs Lothar, Louis II, Charles the Bald and Pippin II of Aquitaine. In 843 the Frankish Empire was divided into three parts attributed to the first three. This separation gave birth to the kingdom known as *Francia Occidentialis*, which roughly corresponds to contemporary France. This kingdom was mainly under the authority of Charles the Bald, but a part of it was claimed by Pippin II of Aquitaine. Coins of Melle are known for both these rulers. The name of the city reads METVLLO on all coins of Pippin, and some Charles the Bald's. Some of his coinage from Melle also bore the legend META/LLVM in two lines on the reverse. Most of the coins dating from this reign however are *Karolus Monogram* coins with the legends CARLVSREXFR and METVLLO, similar in every way to those minted by Charlemagne around 800. This type is known from hoard evidence to have been in circulation until the death of Charles the Bald in 877, but also later, under rulers bearing other name, and until Charles the Simple in the early 10th century. The question of the attribution of the *Karolus Monogram* coins from Melle to a ruler or a minting period remains unsovled: coins minted by Charlemagne can not be satisfactorily distinguished from those of Charles the Bald or of any later ruler purely according to numismatic criteria.

The *Karolus Monogram* coins from Melle ceased to be minted at the same time as a new type of coinage appeared there. The name of Melle changes once more: the reverse of these coins is MET/ALO in two lines. These new METALO coins were minted from the first half of the 10th century to the late 12th century. This coinage is known as the "immobilized type" as it coincides with a time when silver was no longer produced in Melle.

2. Silver coins from Melle: analytical data and prospects

The FAHMA project aims to provide new analytical data on the ancient coins of Melle through numerous elementary and isotopic analysis on various samples collected there, as well as on other archaeological artefacts and coins from museums and collections. However, previous analyses have been carried out that should not be neglected. Previous work has included analyses related to the early medieval silver production at Melle. Knowledge of these is necessary to define orientations for future characterizations.

As to lead isotope analysis, two major studies have to be taken into account. The oldest was published in 1990 (Barrandon et Dumas 1990). Ore samples from Melle, but also from other silver mines from the same area – and for which exploitation is only attested for later periods – were characterized. A definition of the isotopic fingerprint of the Melle area was reached, and compared with that of other silver exploitations. The lead-isotope fingerprint of twenty-seven Carolingian coins from Melle, from other Aquitanian mints, and from cities further away was determined. The results confirmed that the coins bearing the name of Melle contained silver extracted there. Aquitanian mints like Bourges also seem to have used silver from Melle, although Limoges apparently did not. The analyses show no similarities between the fingerprint of Melle and that of coins from cities located outside of the kingdom of Aquitaine such as Arles or Lyon.

New lead isotope results concerning coins and ores from Melle were subsequently published by F. Téreygeol and al. (Téreygeol, Hoelzl, Horn 2005). Merovingian coins have also been analayzed that could be associated from a geochemical point of view with the mine of Melle, confirming the hypothesis of an exploitation as early as the 7th century. All five of those Merovingian coins attributed to Melle could be linked with the medieval mine. The results obtained for the thirteen METALO coins dating from the 10th to the 12th century, which could have been minted after the silver exploitation at Melle ended, are not so simple to interpret. Some coins can undoubtedly be linked to the galena ore from Melle, but not all. There does not seem to be a clear separation of the coins into two groups which might suggest a mix of metals of different origin and an evolution in the provenance of silver during the emission period of the METALO coins. This study, as well as Barrandon and Dumas' work, can be regarded as a preliminary for a larger and more systematic investigation of the lead isotope ratio of archaeological artefacts and ancient coins from Melle attempted in the FAHMA project.

The determination of trace elements provides a valuable complement of information to the lead isotope ratios as to metal provenance. This approach has only recently been developed for the early medieval coinage of Melle, but so far the results obtained seem promising. The development of the LA-ICP-MS method for the analysis of ancient silver coins began in 2005, on the basis of Carolingian coins (Sarah, Gratuze, Barrandon 2007). Within the next five years, more than 800 of these were analyzed, among which a large number from Melle. So far, elementary analysis has been carried out on 73 coins in the name of Melle from the Cabinet des Médailles of the Bibliothèque nationale de France, 51 from the Musée Bernard d'Agesci at Niort, 10 from the Monnaie de Paris, 11 from the Bressuire hoard and 5 from the archaeological excavations at Paule in Britain. As a basis for comparison, other contemporary issues were characterized; most of the data has been published, but some of it is yet unavailable (Sarah 2009). It is however already apparent that coins from Melle apparently tend to contain less gold and zinc than contemporary issues from other mints. An example of this is presented in Fig. 6, a gold versus zinc graphic for the coins of Charlemagne minted before the reform of 793/4. It has also been shown that these two elements can be used to separate *Karolus Monogram* coins from Melle and from other mints when their minting period is uncertain (Sarah 2010). The combined study of the silver fineness of the coins and of their gold and zinc content seems very promising for the dating of such coins.

The coins minted in Melle after the *Karolus Monogram* type coins are the "immobilized type" coins, with a METALO legend on the reverse. No elementary analysis results have yet been published, and very little isotopic data is available however. The recent work of R. Janvier on the Chanteloup hoard, exclusively composed of 2500 of these METALO coins, provides new elements that could help to date them more precisely. Two further hoards containing METALO coins, alongside with also other types, suggesting a date of c. 1050 to c. 1100, will be available for analysis in 2011. The FAHMA project seems a unique occasion to combine numismatic study and analysis, so as to reach a better understanding of the METALO coinage.

The corpus is not yet complete; coins from other hoards and museums should be analyzed before the end of the FAHMA project. Even the study of trace element patterns by itself seems very effective as far as the silver from Melle is concerned. The comparison of results obtained for coins, ores, slags and archaeological lead artefacts provides further elements. The relatively precise dating of some coins allowed by traditional numismatic study could then constitute the basis of a study of the evolution of underground exploitation and surface metallurgical activities.

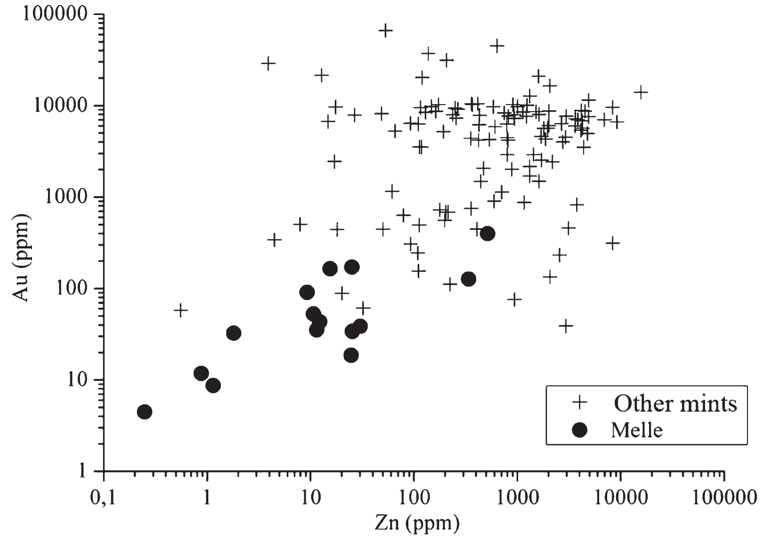

Fig. 6. Gold content versus zinc content for Carolingian silver coins of Charlemagne struck at Melle and at other mints between 768 and 793/4.

Obr. 6. Graf znázorňující podíly zlata a zinku v karolínských stříbrných mincích ražených v Melle i jiných mincovnách v letech 768–793/4.

As far as coinage is concerned, the project aims to carry out lead isotope analysis as often as possible, especially for those coins that revealed interesting trends in their trace elements content. The combination of elementary and isotopic analyses seems to be a most effective method to identify the provenance of ancient silver, and the case of Melle is especially interesting in that respect as artefacts for each stage of the transformation from ore to coined silver, be they voluntary or by-products, are available for study.

CONCLUSION

The FAHMA project is only at its beginning, and two more years yet remain to carry out. Although the analysis of archaeological lead objects and smoothers has not been detailed in this paper, results concerning these objects are also expected to provide a better understanding of the use and the diffusion of the by-products of silver production during early Middle Ages. The first year of the FAHMA project was spent collecting data new and old in preparation for further research and future analyses. Galena ore and slag have been sampled at Melle and archaeological lead objects have been collected for a complete characterization. In the second year of the project in 2011, the emphasis will be put on lead isotope analyses: this part of the project seems very promising for the understanding of the exploitation and processing of silver at Melle during early Middle Ages.

SOUHRN

V raném středověku bylo v karolínské západní Evropě hlavním mincovním kovem stříbro. Dosud však nebylo přesně vědecky definováno ani množství ani jeho zdroje. Dosud jediným známým střediskem produkce stříbra v 8. století je ložisko stříbrem bohatého galenitu v Melle (Deux-Sèvres, Francie). V ekonomice raně středověké francké říše hrálo stříbro z Melle významnou roli, přestože nejde o hlavní centrum státu. Poněvadž zde nejsou stopy významnější exploatace z pozdějších období, je komplex karolínských montánních památek pro svou zachovalost významnou studijní lokalitou. V roce 2009 byl tak zahájen projekt FAHMA (Filière de l'Argent au Haut Moyen Age), pod záštitou francouzské ANR (Agence Nationale de la Recherche). Výzkum raně středověkého stříbrorudného centra v Melle soustřeďuje specialisty v oborech montánní archeologie, archeometalurgie, analytická chemie, výzkum původu, mincovnictví a obchod. V rámci výzkumu se provádějí prvkové a isotopové analýzy artefaktů a meziproduktů, které jsou výsledkem zpracování zdejších rud (strusky, olovo, mince a pod.). Kombinací práce a znalostí výzkumného týmu by mělo být dosaženo značné úrovně poznání raně středověké metalurgie a vytvoření základů pro budoucí výzkum podobných lokalit. Tento příspěvek si klade za cíl představit projekt FAHMA, jeho dosavadní výsledky a výhled do dalších dvou let jeho řešení.

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