

## Assaying ores at Sainte-Marie-aux-Mines (Alsace, France) in the 16<sup>th</sup> century: diffusion and role of a technical innovation

Prubířství v Sainte-Marie-aux-Mines (Alsasko, Francie) v 16. století: šíření a úloha technických inovací

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**Abstract:** Sainte-Marie-aux-Mines was from the 10<sup>th</sup> to the 17<sup>th</sup> century the most important mining district in the Vosges, at the extreme west of the “Germanic mining province”. It suggests that it was the place of a privileged step in technical transfers in mining and metallurgical industries from east to west in the late Middle Ages. This can be verified concerning ores assaying techniques on small scale in the 16<sup>th</sup> century. In fact, all historical and archaeological sources collected in this regard, although limited, form a unique collection in France. We shall analyze the chronology of that transfer and the way this technique has been integrated in Sainte-Marie, between mines and smelting works.

**Key words:** assaying ores, Vosges, Sainte-Marie-aux-Mines, 16<sup>th</sup> century

### INTRODUCTION

The research focuses on ores assaying techniques and is based on the study of historical and archaeological sources (PhD in progress about “History and archaeology of ores assaying technics in Europe, 12<sup>th</sup>–18<sup>th</sup>” at the Mulhouse Université de Haute Alsace, CRESAT, under Pierre Fluck and Florian Téreygeol direction). The bases of as-

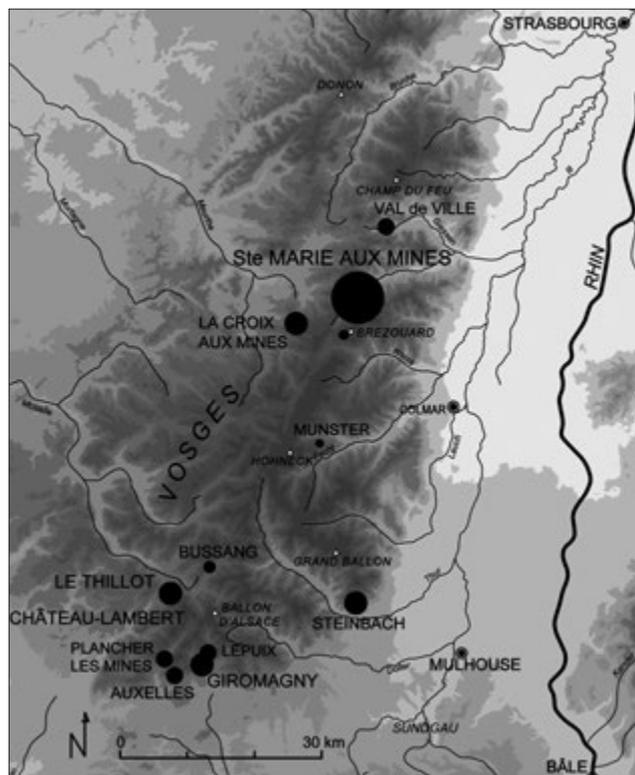


Fig. 1. The non-ferrous mining districts in the Vosges.

Obr. 1. Hornické revíry s historickou těžbou polymetalických rud ve Vogézách.

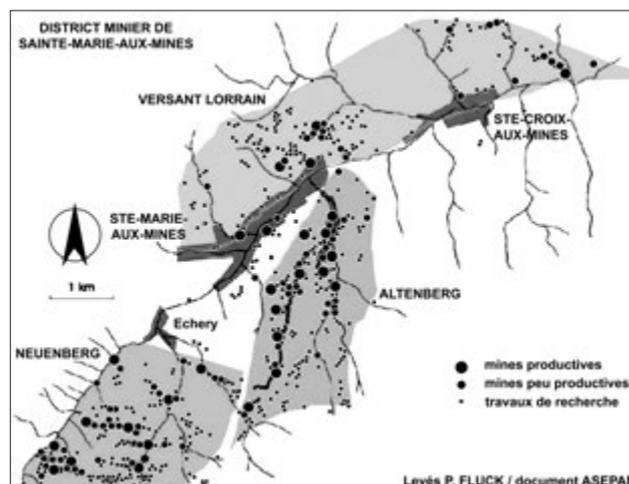


Fig. 2. The three mining sectors in Sainte-Marie-aux-Mines: Altenberg, Neuenberg and Versant lorrain. The border between the Ri-beaupierre's seigniory and the Lorraine crosses the town south of the Versant lorrain.

Obr. 2. Tři důlní sektory v Sainte-Marie-aux-Mines: Altenberg, Neuenberg a Versant lorrain.

saying techniques on a small scale were apparently worked out in central Europe from the end of the 13<sup>th</sup> century or the beginning of the 14<sup>th</sup> century (Dallmann et Gühne 1993, Labuda 1997). Then the technique was perfected and stabilized at the beginning of the 16<sup>th</sup> century. The study of technical treatises on assaying, from Agricola's *De Re Metallica* (1556) to the treatise by Christoph Andreas Schlüter (1738), the one by Lazarus Ercker (1574) or the long series of *Probierrbüchlein*, published from the very beginning of the 16<sup>th</sup> century, shows that the way to assay the ores didn't evolve a lot until the end of the 18<sup>th</sup> century and the emergence of wet assaying techniques. However, it's interesting to observe the way

these dry assaying techniques have spread. In fact, this step of metal production is apart from the rest of the mining and metallurgical operations. It's a laboratory work which is on the border between craft and science and which is not technically necessary to the production. That's why we study the way it was adopted into a mining district like Sainte-Marie-aux-Mines, well off the great mining districts of central Europe.

Sainte-Marie-aux-Mines is the first lode silver mining district of present French territory, and thus the most important in the Vosges (Fig. 1). These mountains twins of the Black Forest (Schwarzwald) but west of the Rhine, have several mining centres hardly exploited in the 16th century for silver, lead and copper. Among the most important, Giromagny, Steinbach are exploited by the Habsbourg; Le Thillot and La Croix-aux-Mines by the duke of Lorraine; others like Château-Lambert were in Franche-Comté (also in the Habsbourg's territory in the 16th century).

Sainte-Marie-aux-Mines at the 16th century was on the border between Lorraine and the Ribeaupierre seigneurie, protected by the Habsbourg since the 1486 treatise. The two powers fought for the three mining sectors (Fig. 2): the Altenberg, with a network of veins whose orientation is north/south to north-east/south-west, produced mainly galena, with an amount of silver around 1 ‰. It is entirely on the Alsatian side. The Neuenberg, exploited from the middle of the 16th century, has seven veins with an orientation from east to west or east-south-east to west-north-west. Ores are a lot richer: silver ores and arsenic-tetrahedrites which can reach 1 % silver. They need the lead from Altenberg to be worked by the liquation process. The Neuenberg is totally situated on the Alsatian side of Sainte-Marie-aux-Mines. The third mining sector, the Lorraine side, is less extended in terms of lode's length but gives particularly rich ores (antimoniferous tetrahedrites), with an amount of silver of up to 10 ‰. It is almost entirely on the left side of the valley. The duke of Lorraine used lead from La-Croix-aux-Mines, just on the other side of the Vosges crest.

#### TECHNICAL INNOVATIONS IN SAINTE-MARIE-AUX-MINES

The first traces of exploitation date back to the 10th century on the Altenberg. This sector was mined intermittently during the second half of the Middle Ages in the form of little exploitations but without any important interruption (Archaeological collective research program in progress about "Mining and metallurgical works on the Altenberg, 10th–16th century" directed by Pierre Fluck). Then, Sainte-Marie, like every other European mining sectors, was the object of particular interest at the end of the Middle Ages, in time of silver shortage. So mines were progressively restarted under lords impulse. The activity increased quickly and Sainte-Marie became an important mining town, with up to 3,000 miners in 1550. Like elsewhere

in Europe, the end of the 16th century saw the decline of the activity which ended in Sainte-Marie in 1637.

The technical innovations that took place over this period are located on the field or in records. The use of water-powered bellows in a smelting understructure at the bottom of the Altenberg is proved from the second half of the 13th century (Fluck 2008). The first washing and manual stamping lets traces in the beginning of the 15th century near the mines, in altitude (Fluck 2009). Water-powered stamping was used in the beginning of the 16th century (illustrated by the Saint-Dié Graduel dated nearly 1513); historical sources indicate the construction of the first *Sayerhütte* (liquation process) in 1551 in the Black Forest mountains and in 1558 in Le Bonhomme, nearby Sainte-Marie, both to process ores from the Neuenberg (Westermann 1993). The apparition of these new techniques fit into a general evolution of the whole German mining area and were most probably the result of exchanges from east to west and west to east at different times. Small scale assaying techniques are also clearly the result of a technical transfer initiated by the Habsbourg administration in the first decades of the 16th century.

#### THE ASSAYER OFFICE

The historical sources we used about Sainte-Marie are principally kept by the Archives départementales du Haut-Rhin in Colmar (Adhr), the Landesarchiv in Innsbrück and the Archives du Palais Princier in Monaco (Arch. Monaco). They are mainly written productions of the Ensisheim Chamber: mining rules, rules for smelting works, technical reports of activity sent to the chamber by the *Bergrichter* once or twice a year, assay office inventories made when an assayer was renewed, assayers nomination papers, letters between the *Bergrichter* and the Habsbourg administration. Unfortunately, we have not found any assayer's office register or account.

Assaying appeared in the new Archduke's smelting work of Echery between Altenberg and Neuenberg in 1533 (Tiroler Landesarchiv – Handschrift 5152). The order was given by the Habsbourg power: in 1530, a group of expert came in Echery to choose the best place to build the smelting work. Among them, several officers from the Schwaz mining district. Thus the foundry organization was clearly

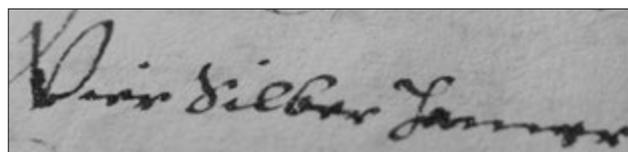


Fig. 3. Adhr 1C8571 (detail), inventory of utensils given to George Vallandt, new assayer, by his predecessor, Wolfgang Haid, January 9, 1574. We can see that the ink was dried with powdered ore.

Obr. 3. Výřez z inventáře prubíře Geoga Vallandta, který mu předal jeho předchůdce Wolfgang Haid 9. ledna 1574. Inkoust byl zasypán pudrem.

based on German mining districts and the appearance of an assayer in Sainte-Marie-aux-Mines must be seen in this context. Then there were two assayers in Sainte-Marie: one on the Lorraine side, one on the Alsatian side. On the Alsatian side, in 1533, Hans Eber was in charge as “*hüttschreiber, artzikauffer unnd probierer*”. Jobst Haylman took his place in 1535 as “*Hütshreiber, Erzkauffer und probierer*” (Adhr, 1C8566). Batt Rorer took over from him in March 1537. His nomination paper mentions only the office of “*Probierer*” (Adhr, 1C8568). The office seemed to be renewed without any interruption until the end of the activity in 1637. On the Lorraine side, we have only one name for the moment: Valtin Kaufman had the assayer post from 1553 to 1590 (Grandemange 1991).

The assayer was a mainstay of the Habsbourg mining administration. He had the statute of officer, took the oath when he was appointed. In fact, he was a specialist whose know-how plays an important role in several steps of the silver production line. Thus, the assayer often had several functions including, as we have seen, clerk. Concerning metallurgy, assaying and refining were often the office of the same man (For example, Joergen Vallandt, “*Silberprener und Probierer*”, Adhr 1979, 1C8571, 9.01.1574. Fig. 4, 5). We find also offices holding this two tasks and cupellation. Valtin Kaufman ended his carrier as a foundry director, still analyzing ores. Concerning the activity of assay, all metallurgical steps which took place in the foundry need it to control them: assay of ores, assay of work lead and red copper, assay of smelting scraps, assay of silver from the cupellation.

If we limit ourselves to ores assaying, several aims were pursued. The main one was the management of ores purchasing by the smelting work of the archduke to miners. In fact, some concessionaires didn't have their own smelting work. The ore price could be decided according to the ore appearance or the assay result. The 1533 rule encouraged to assay all ores to avoid any dispute. However, it is difficult to say that ores were systemically assayed in every transaction. In fact in the 1570's, reports by Habsbourg advisers recommend to assay particularly rich ores (Arch. Monaco, T956/2, n<sup>o</sup>7, 1572). In 1602, the technical report of activity by the *Bergrichter* Wilhelm Prechter mentions that copper ores were usually sold according to their aspect (Adhr 1979).

The assayer also had to share ores according to their characteristics and to put them together for smelting with the aim to extract the maximum of metal. Finally, assaying also had a role in prospecting new deposits. Even if it is not often mentioned in our sources, it seems certain that all ores found in this context were always assayed in order to decide to continue the work or not.

## METHOD OF SAMPLING

Sampling is practically absent in technical treatises of the 16<sup>th</sup> century. So indications about this issue are very



Fig. 4. The assayer in the *Schwazer Bergbuch*, Bochum ms. (Bartels, Bingener, Slotta 2006: *Das Schwazer Bergbuch*, 3 Bde, DBM).

Obr. 4. Prubíř v knize *Das Schwazer Bergbuch* (Bartels, Bingener, Slotta 2006).



Fig. 5. The refiner in the *Schwazer Bergbuch*, Bochum ms. (Bartels, Bingener, Slotta 2006: *Das Schwazer Bergbuch*, 3 Bde, DBM).

Obr. 5. Přepalovač hertovního stříbra v knize *Das Schwazer Bergbuch* (Bartels, Bingener, Slotta 2006).

welcome in records. The method of sampling has a process planned in details from 1533: the assayer had to separate the ore from the gangue at the mine, then to take a sample in a bag and bring it to the foundry. There, he had to crush it and make three samples, one for the seller, one to assay and one kept by the assayer in case of dispute. So the entire work from the raw ore to the silver button was made by the assayer himself. In 1602, Prechter's report says on the contrary that sampling was made at the delivery on fine ores, prepared by the miner. Moreover, two assays were made by two different assayers, and results were compared and had to be close enough to be accepted. So the lord has left a part of responsibility and also a leeway, making the assay more neutral. The process was more complex after seventy years of mining activity in Sainte-Marie. Is this evolution due to the increase of mining

sites and the acquired experience since the beginning of the 16<sup>th</sup> century? Perhaps the diversity of ores exploited from the 1550's played a role in this change, or it may have been a response to miners' demands.

Thus, how essential was assaying for an exploitation? Was it a simple copy from the German model? In 1571, Neuenberg miners' demands concerning an assayer who didn't mastered his job lead us to think that the role of assaying in the business between miners and foundries was vital. According to them, every working sites of the sector would close in the year if the assayer was not renewed (Arch. Monaco T956/2, n°33, 1571). In spite of that, the activity still continued in the 1570's, although it was a bad period for many reasons. The way ores prices were decided in crisis time, during the three first decades of the 17<sup>th</sup> century,



Fig. 6. The carreau Patris before the excavation. Photo Author.  
Obr. 6. Terén zkoumané lokality Patris před exkavací. Foto autor.

shows that assaying was not a binding indicator and its influence on prices was shared with other, and sometimes more important, parameters (Fluck 2000). Nevertheless, the permanence of the assay office and the obvious frequent recourse to it show that assaying ores is an integral part of the silver line production in Sainte-Marie-aux-Mines in the 16<sup>th</sup> century. Its process was codified and it played both an economic and technical role.

## ARCHAEOLOGICAL SOURCES

Approaching ores assaying techniques from the point of view of the history of metallurgical techniques brings very little information from texts. Then we have to turn to archaeological remains still present in Sainte-Marie. Despite the relative importance of 16<sup>th</sup> century sites, assay traces are meager and have nothing to do with the number of ceramics found in central Europe. We located five sites for the moment (Echery smelting work, Fertrupt-laverie, Fertrupt-Fassler, Fertrupt-Cerisiers, carreau Patris) all dated from the 16<sup>th</sup> century, delivering poor findings (four scorifiers and some crucibles pieces, Fig. 7, 8). A little triangular crucible was also found in the centre of the town,



Fig. 7. The four scorifiers found in Sainte-Marie-aux-Mines. Up left: Fertrupt-Fassler, 2006; Up right: Echery foundry, 2007; down left: Fertrupt-laverie, 1989; down right: carreau Patris, 2009. Photo Author.

Obr. 7. Struskovací střepey nalezené v lokalitě Sainte-Marie-aux-Mines. Foto autor.

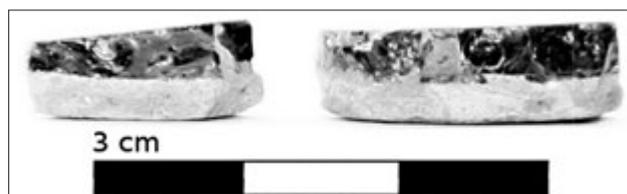


Fig. 8. Crucible fragments. Carreau Patris 2009. Photo Author.  
Obr. 8. Fragmenty nistějoviny. Patris 2009. Foto autor.

but it can correspond both to ores assaying or silver-smith's trade.

Nevertheless it allows two comments: the first about the sites localization. Echery is the archduke's foundry, where the assayer's office was located according to written documents. So it's the normal place for ores assaying. Moreover, we can suggest the possibility that it was the only place where assaying took place. In fact, assay might be exclusively managed by the lordship since in 1572, mining shareholders complained about the bad job of the Alsatian side assayer, Michael Reysländer, and they couldn't go to ask another assayer. Several reports by *Bergrichter Vogel* or councillors from the Ensisheim chamber support shareholders' request to appeal to the Lorraine side assayer (Arch. Monaco T956/2, n°33, 1571; Arch. Monaco T956, n°1, 1572; PestArchiv, XIV, 325, n°8, 1572). So the other sites pose a problem. Fertrupt-laverie (an ore washing place; Fluck 1989) and Fertrupt-Fassler (a house; Gauthier 2007) are difficult to interpret since they are not metallurgical sites although they are situated in a very

active zone near several smelting works. Among those is the Fertrupt-Cerisiers site, whose excavation permitted to discover crucible fragments (Fluck 2010). It raises an issue about isolated practice of assaying, that the last site reinforces: the carreau Patris is a mining bank established on a 11<sup>th</sup> century dump in the upper part of the Saint-Philippe small valley (Fig. 6). There was a miners house, a smithy and an assaying place since one scorifer and crucible pieces were found (Fig. 7, 8). It is difficult to explain the presence of these findings with chance on this platform in altitude, in the centre of mines worked in the 16<sup>th</sup> century, and showing several elements testifying of a metallurgical activity. So archaeological evidence could prove that assaying was also done in private foundries, indeed sometimes at the mine exit.

As to the findings, they show the import of small scale assaying techniques worked out in central Europe at the end of the Middle Ages. For the 16<sup>th</sup> century, Sainte-Marie-aux-Mines is for the moment the most occidental place where this kind of metallurgical ceramic was found, and the only one in France. We can notice the standardization of scorifiers forms, made with a fine white clay throwed, about 5 centimeters diameter, all glazed, surely to avoid the attack of the ceramic by the lead bath. Crucible fragments are in a similar clay, of very fine thickness (about 4 mm) covered by a black vitreous slag of similar thickness. Thus we know that assaying techniques on a small scale described in the treatises was imported from central Europe. But it's not enough to characterize assaying techniques in Sainte-Marie and their role into the foundry or near the mine.

#### ASSAYING IN THE OTHER VOSGES MINING DISTRICTS

Here are the elements we have so far concerning ores assaying presence in Sainte-Marie-aux-Mines. To understand what the assayer place was, as well as the assay role in mining exploitation on the mining district scale, we have compared this situation with other Vosges mining districts. The result is particularly interesting because it singles out Sainte-Marie as the place where assaying techniques arrived in the Vosges among the rare districts where an assayer was instituted in the 16<sup>th</sup> century. In fact, ores from Le Thillot (in the Lorraine dukedom) were smelted in Wisembach and assayed in Sainte-Marie during the first ten years of exploitation between 1550 and 1560 (Oral com. Francis Pierre). In Giromagny, the first assayer mention dates from 1564 (Liebelin 1987). So it seems that small scale assaying ores techniques were imported from central Europe in the Vosges *via* Sainte-Marie-aux-Mines at the beginning of the 1530's.

The comparison with nearby La Croix-aux-Mines mining district, in Lorraine, is also surprising. No assaying traces could be found there. The Lorraine Duke's foundry in Wisembach, in activity during all the century, was

studied by Georges Rech thanks to very well preserved accounts from 1542 to 1597 (Rech 1992). No assayer mention, and nothing to think that assays were made. In the same way, Heinrich Gross pictures in 1529 does not show assaying whereas every mine and metallurgy operations and jobs are drawn (Brugerolles et al. 1992). This absence is surprising since we think that Sainte-Marie ores were smelted in Wisembach in the beginning of the century, when there was no smelting work in Sainte-Marie. What are the reasons for this absence? There were so many exchanges between the two valleys that it is impossible to imagine that assaying techniques never crossed the mountains. So assays for La Croix must have been made by the Lorraine side assayer in Sainte-Marie. Or perhaps the ores were sufficiently known to not need assays, and prices were decided according to their appearance or the smelting result. But again, we must not forget that this absence in our sources concerns only the very centralized organization of different administrations and not the whole mining activity.

#### CONCLUSION

Assaying integration to the metals production line in a mining district can depend on many factors. Sainte-Marie-aux-Mines was apparently the first place where the Habsbourg administration named an assayer in the Vosges. He was an important person among the rare experts present in the locality. The role of ores assaying grew in importance and became essential in the mining district exploitation. Nevertheless, some evidence points to the practice of assaying in private foundries and at the mine bank, perhaps by miners themselves. In this case, why wouldn't the art of assaying ores have preceded the official assayer? What falls within public field or private field and the relations between these two spheres is not obvious. The problem has not been studied a lot, surely because of the rare private records for this period. So only archaeological findings can bring indications, unfortunately difficult to date accurately. The follow-up to this work will try to make these issues clear and to define the conditions that make systematic assaying necessary and that lead to the creation of an assayers' office. One aspect was the possibility to engage an efficient specialist. In fact, techniques concerned required a rare know-how, particular skills and a good knowledge of ores and smelting processes to be able to assay all ores which were brought. Apparently, this kind of expert were present at Sainte-Marie-aux-Mines in the 16<sup>th</sup> century. But miners' demands we spoke about show that this perfect image of the assayer, often derived from the treatises, does not always still correspond to reality. Michael Reysländer, yet originating from Schwaz, did not master the job well enough. It could be interesting to appreciate the quality of assays carried out in Sainte-Marie thanks to new archaeological remains or archives.

## SOUHRN

Význam historického hornického revíru Sainte-Marie-aux-Mines ve francouzských Vogézách je z hlediska poznání středověké těžby polymetalických rud a produkce stříbra obecně znám. Výzkum za posledních třicet let přinesl mnoho nových vědomostí o technologiích a jejich inovacích přinejmenším od 10. století. Studie se zaměřuje na rané novověké stopy prubírství v lokalitě Echery, kdy nejmodernější prubírské technologie a postupy se do regionu dostaly po roce 1533 s habsburskou správou. Prubíř byl v hornictví a hutnictví velmi významným činitelem, přičemž nežádka byli prubíři zároveň důlními podnikateli, spolujaviteli měř či hutí. Prubíř vedle jiných úkonů spoluurčoval ceny rudy, technologie výroby koncentráту i hutnění konkrétních typů vsázek a byl pomocníkem horních úředníků včetně soudce na horách. Přínosné jsou ve studiu a poznávání metod a postupů prubířů archivní fondy, které mnohdy obsahují více informací, než známé tituly dobové odborné literatury, poněvadž se vztahují ke konkrétním událostem. Následné kroky výzkumu, tedy detekce vlastních prubírských pracovišť na jednotlivých lokalitách, zmiňovaných v pramenech, je již úkol terénní archeologie. Podle dosavadních nálezů se ukazuje, že prubírské provozy či dílny se nacházely na více jednotlivých dolech, propůjčených nájemcům. Výzkum paleometalurgických nálezů, zejména strusek a slitků naznačuje existenci spíše menších dílniček, což koresponduje s dobovou naučnou literaturou. Srovnávacím studiem s jinými lokalitami Vogéz se také ukazuje, že jednotliví prubíři byli činní jen na několika málo provozech. To je odrazem silné centralizace tohoto řemesla a odpovídá to obecným trendům habsburské správy i v mnoha jiných oblastech výrobní činnosti.

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