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# Smithing in a priory in Limousin 13rd-16th c. (Lavinadière, Corrèze, France)

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**Abstract :** *The priory of Lavinadière was the possession of the order of the Latin Canons of the Holy Sepulchre. The study of the clergy house site started in the middle of the 1990s and excavations have been undertaken there on a regular basis since 2003. Smithing activities in the priory were recorded in the filling of a ditch dating from the middle ages. For the early post-medieval times (16th century) a smithy was excavated, located on the northern external side of the stone buildings.*

*The residues from the two periods of activity were studied. Hearth bottoms were measured, weighed and metallographic examination undertaken. They form two different groups. The distribution of hammerscales in the smithy was examined leading to hypotheses on space management. They were sorted by type and their microstructure studied.*

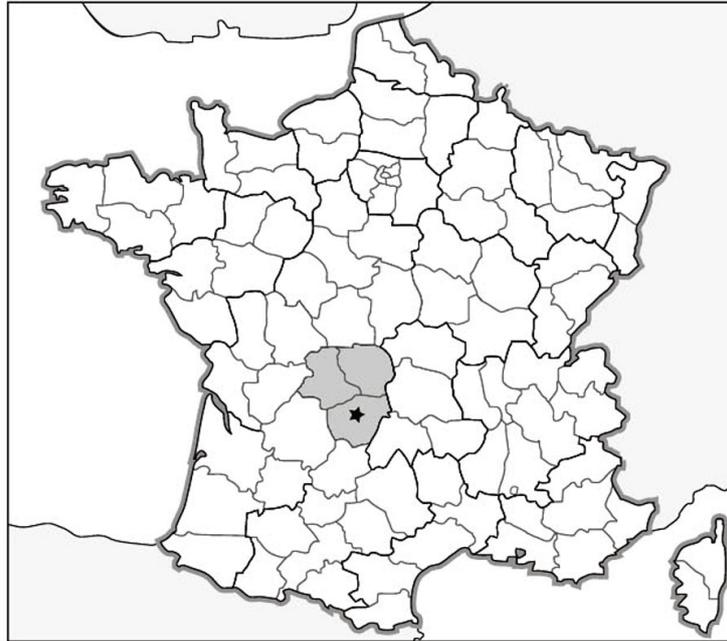
*The metallurgical activity in the priory seems to have been a small scale one focused on the making of small objects and on their repair.*

**Keywords :** smithy, medieval, early post-medieval, hearth bottoms, hammerscales, priory

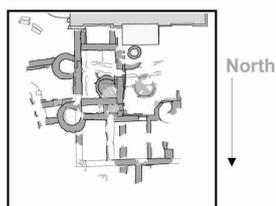
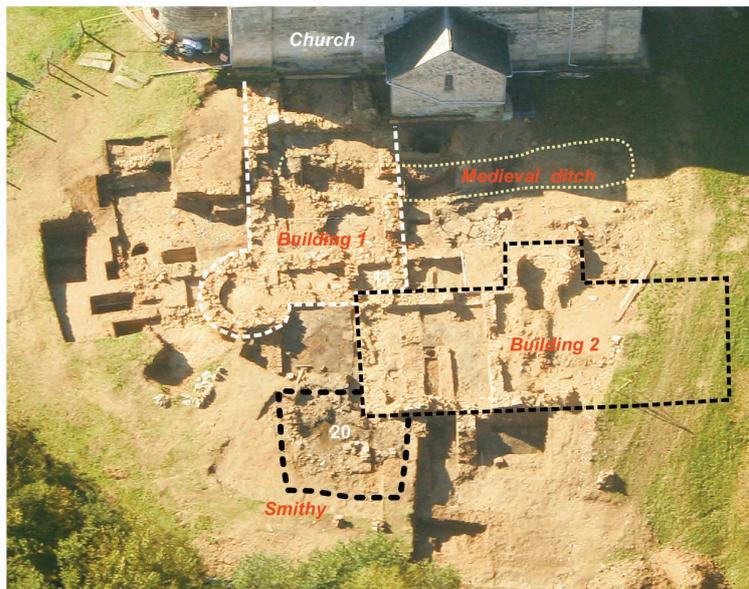
The priory of Lavinadière (fig.1) was the possession of the order of the Latin Canons of the Holy Sepulchre, an order created at the beginning of the 12th century. After the order was suppressed in 1489, it became the property of the Hospitaller order of Saint John of Jerusalem until the beginning of 17th century, when it is recorded abandoned. The study of the clergy house site began in the middle of the 1990s and excavations have been undertaken there on a regular basis since 2003 by Patrice Conte (Conte, 2003).

The priory and his church are located at the top of a hill with a river and a mill downslope, 300 metres away. As the metallurgical activity is located in the priory buildings, the use of hydraulic power is unlikely. These buildings were erected on the northern side of the church (fig. 2). The 13th century priory, surrounded by a ditch, extended to the East outside the excavated area. During the 14th century the ditch was filled. At the end of the 15th century or at the beginning of the 16th century, when the priory's owners changed, a new smaller priory was built over the previous one. The site was recorded abandoned in the beginning of the 17th century and the walls were dismantled later on.

Metallurgical activity has been recorded for two different periods. At first, metallurgical wastes were discovered in the filling of the ditch dating from the early stage of the occupation. The workshop itself has not been discovered yet and may — as suggested by electromagnetic survey (Martinaud and Madani, 1999)



**Fig. 1** : location of Lavinadière.



**Fig. 2** : aerial view of the excavation, showing the remains of the priory. The two buildings are those of the 16th century priory. The ditch pre-dates these buildings and was filled in the 14th century (photo A. Fradet).

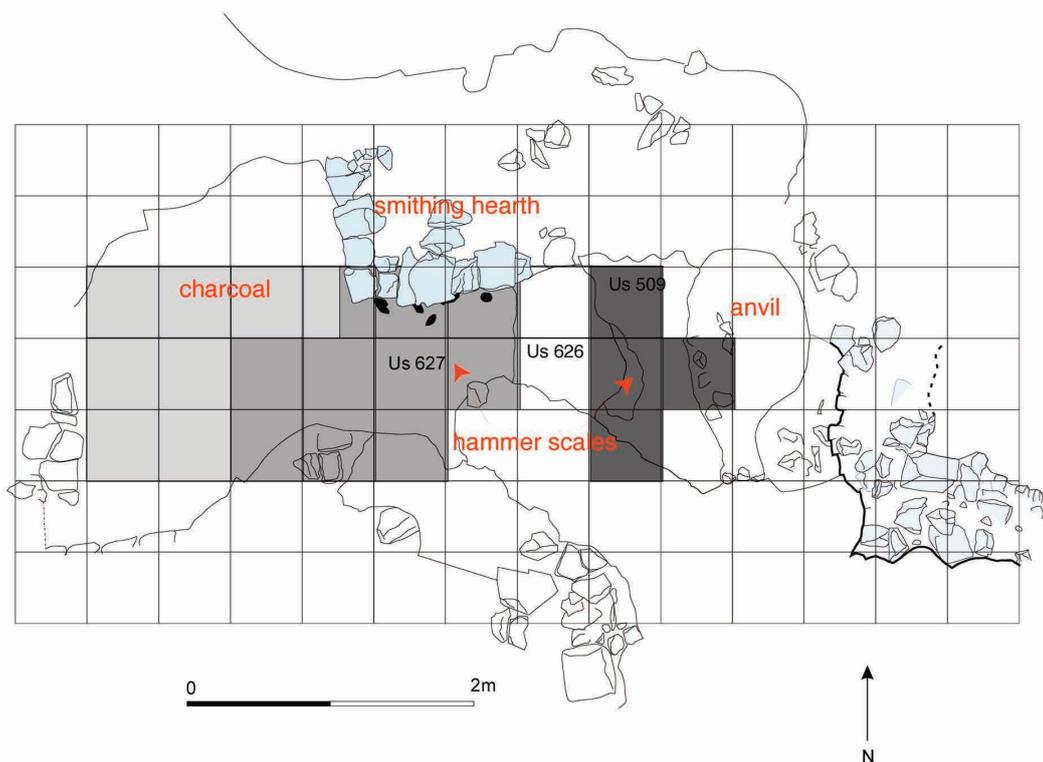
— be located eastwards, outside the excavated area. Secondly, a smithy dating from the 16th century was excavated along the northern external side of the buildings.

### **1. The 16th century smithy : layout and work space management.**

The smithy area was well preserved (fig. 3) even if its periphery was disturbed by the dismantling of the surrounding walls. Its hearth was set on a platform of stones, which displayed burned areas. As vitrified clay was found with the slags, there must have been a clay superstructure. Occupation layers on the southern and the western sides of the stone platform were black, composed of charcoal and hammerscales. To check the density of hammerscales and determine the organisation of the working area, the workshop's occupation layers were sampled with a 0.5 m wide grid and sieved for the charcoal and the hammer scales (2 mm sieve). It appears that almost no hammerscales were recorded on the western side of the hearth platform, while charcoal was very found there in great quantities (fig.4). A charcoal storage area was probably placed in this part of the workshop. On the other side of the hearth, the hammerscale layer was interrupted by the ghost structure, probably that of an anvil. From these observations, it can be inferred that the smith's working place was located south of the hearth, facing north. The charcoal storage was positioned to his left and the anvil to his right. Such a layout allowed him to take the iron out of the fire with his left hand and hammer it with his right one. The area north of the hearth may have been that of the bellows.



**Fig. 3** : *The 16th century workshop after the removal of the smithing residues. The masonry of the smithing hearth is well preserved (photo P. Conte).*



**Fig. 4 :** Layout of the 16th century smithy. Light grey : no hammerscales, medium grey: medium density of hammerscales, dark grey: high density of hammerscales.

## 2. The metallurgical wastes

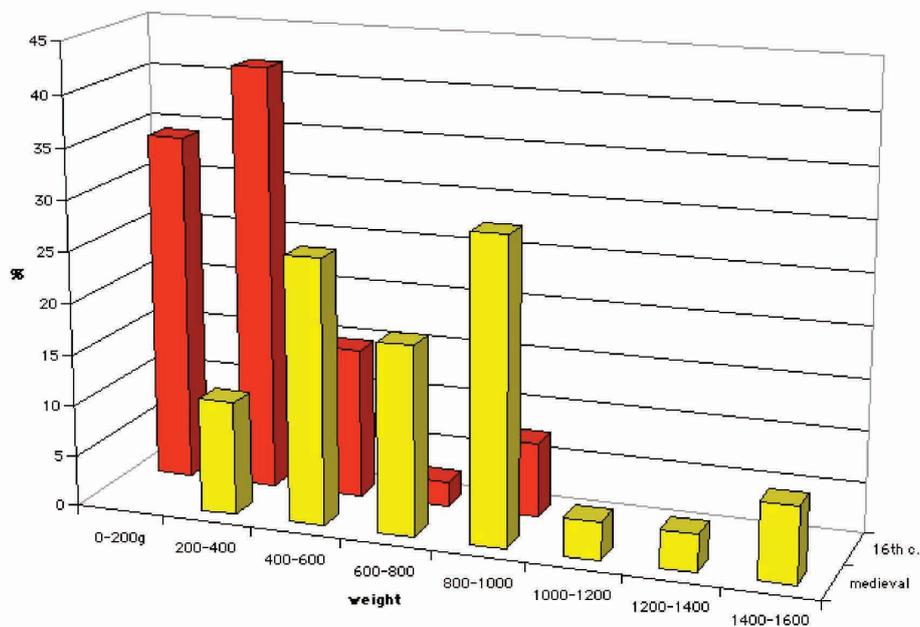
All the recorded wastes were smithing slags. No trace of smelting was discovered in Lavinadière and in its immediate surroundings. The wastes from the medieval period collected in the ditch were hearth bottoms weighing 22.6 kg in total. Almost no vitrified clay was found with them (only 180 g). As they were in the ditch as secondary deposit, one can imagine that the metallurgical wastes were sorted before being discarded. The 16th century wastes were discovered mostly in the workshop itself and in the layers from the same period around it. They were of various types. Slags weighed 34 kg, one half of them being fragments of hearth bottoms, the other half being 47 full ones. Vitrified clay was very profuse: 752 pieces weighing 21.680 kg were found among the wastes. Hammerscales, preserved in situ, and a few heavily corroded iron scraps were also recorded. The typology and crystalline composition of these residues was analysed, which provided data on the technology of the two smithies.

### 2.1. Hearth bottoms

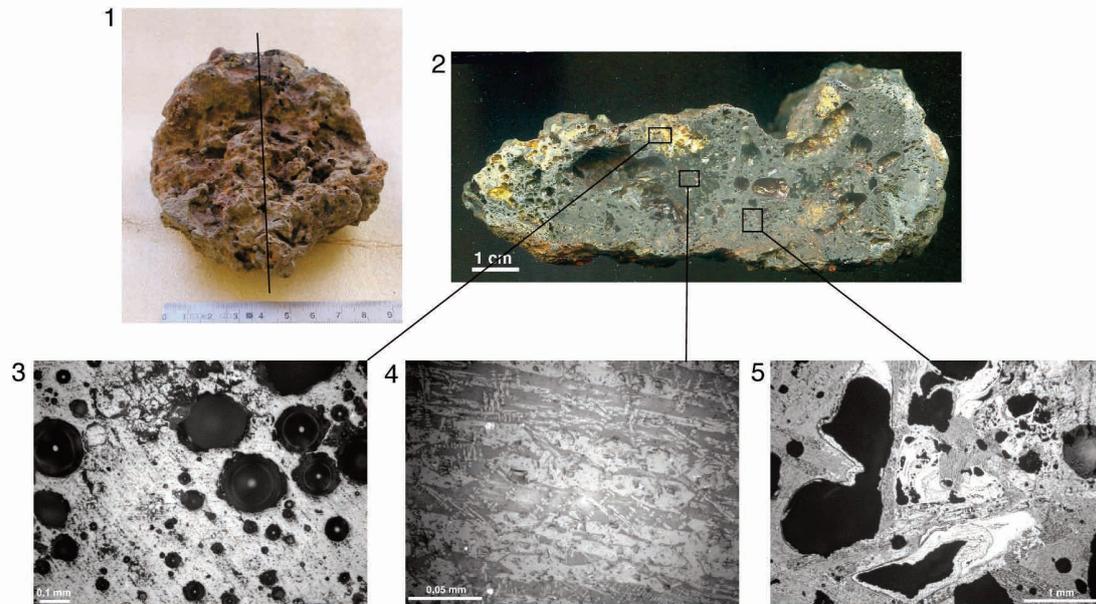
Medieval and 16th century hearth bottoms look different : the first ones were almost hemispherical with an orange surface, the others were of various shapes and were flat and grey. Some of the early post-medieval ones showed a right angle probably matching the shape of the hearth clay superstructure, meaning that the bellow nose was set in the angle of the hearth. All full hearth bottoms

were measured and weighed. The medieval pieces were bigger and heavier than their 16th-century counterparts (fig. 5). Seventeen smithing bottoms of the two periods were cut out and some were ground before metallographic examination to check if structural differences could account for the differences in colour, and more generally to evaluate what kind of smithing activity was performed in Lavinadière.

Metallographic examinations show that medieval and early post-medieval smithing bottoms have some characteristics in common. First, they contain very little metal. Metal appears as orange dots in the section of the slag and is completely corroded. At microscopic level, some of these tiny fragments, most often almost millimetric, are angular (fig. 6, n°5). They seem to be very small parts of a pre-shaped piece of metal lost during reheating. On the whole, the corroded metal represents less than 5% of the smithing bottoms. Secondly, all the studied slags show occasional vitrified rock inclusions on their side and at their top (fig. 6, n°2 and n°3). These rocks are too large to be linked to the use of a flux, as the flux is generally sand. This phenomenon has also been noticed by Dunikowski (Dunikowski et al., 1996, p. 108) but no explanation was put forward in this paper. The lateral rock inclusions may have been parts of the lining of the furnace, but this presence at the top of the hearth bottom would imply partial destruction of the lining during smithing, when the slag is still hot. Analysing of lining structure could be a means to check this hypothesis. Differences between medieval and 16th-century hearth bottoms appear mostly through their cristallographic structure. Medieval hearth bottoms are mostly made of olivine/fayalite and wustite in glass (fig. 7), whereas early post-medieval ones do not contain much wustite, and relatively numerous hammerscales and olivine / fayalite in glass.

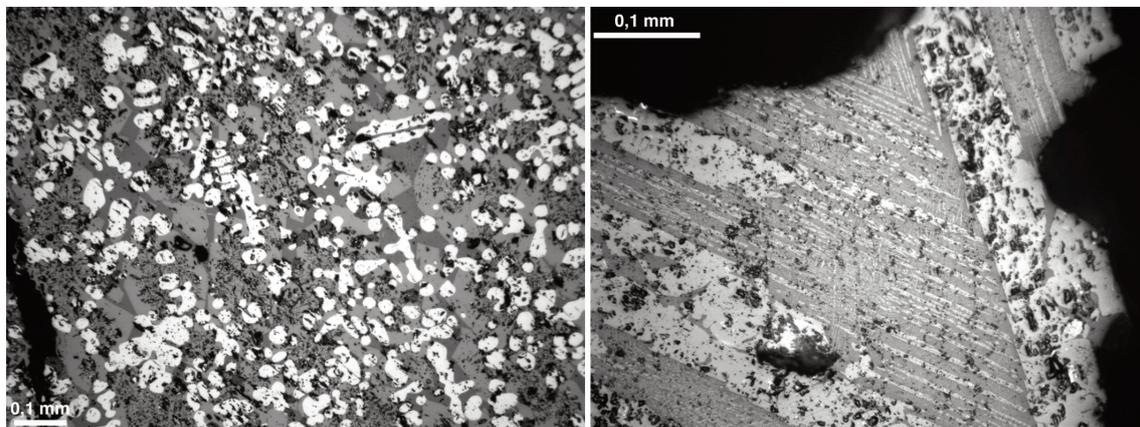


**Fig. 5** : Weight of the full hearth bottoms, based on 27 medieval and 47 modern objects.



**Fig. 6** : Metallography of a 16th century hearth bottom.

1. general view of the slag and cutting line
2. general view of the section
3. vitrified rock inclusion.
4. olivine, and some dendrites of wustite in a glassy matrix
5. corroded metal fragments.



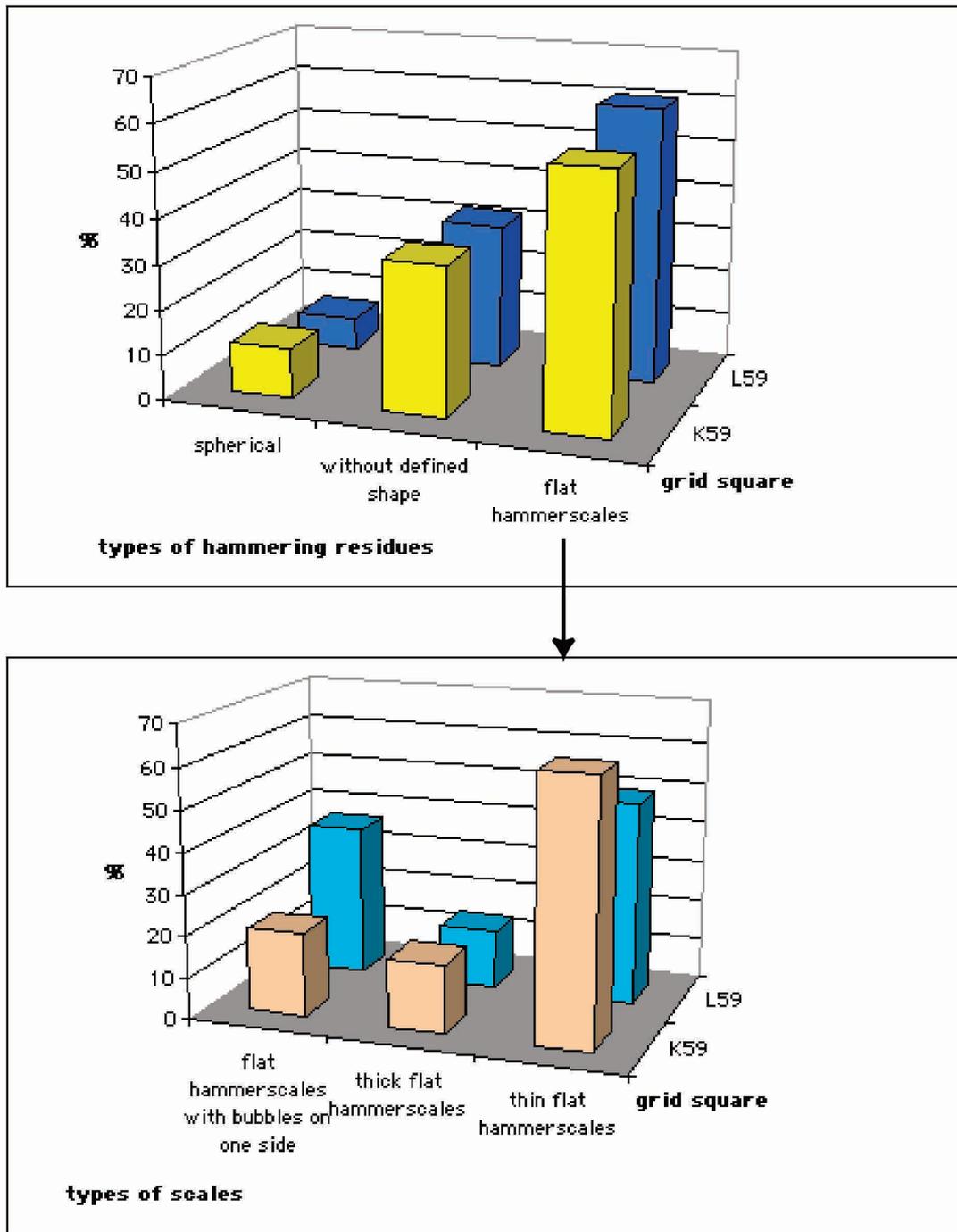
**Fig.7** : left, microstructure of a medieval hearth bottom with wustite dendrites and olivine / fayalite in a glassy matrix; right, microstructure of an early post-medieval heath bottom showing well preserved flat hammerscales.

## 2.2. Hammerscales

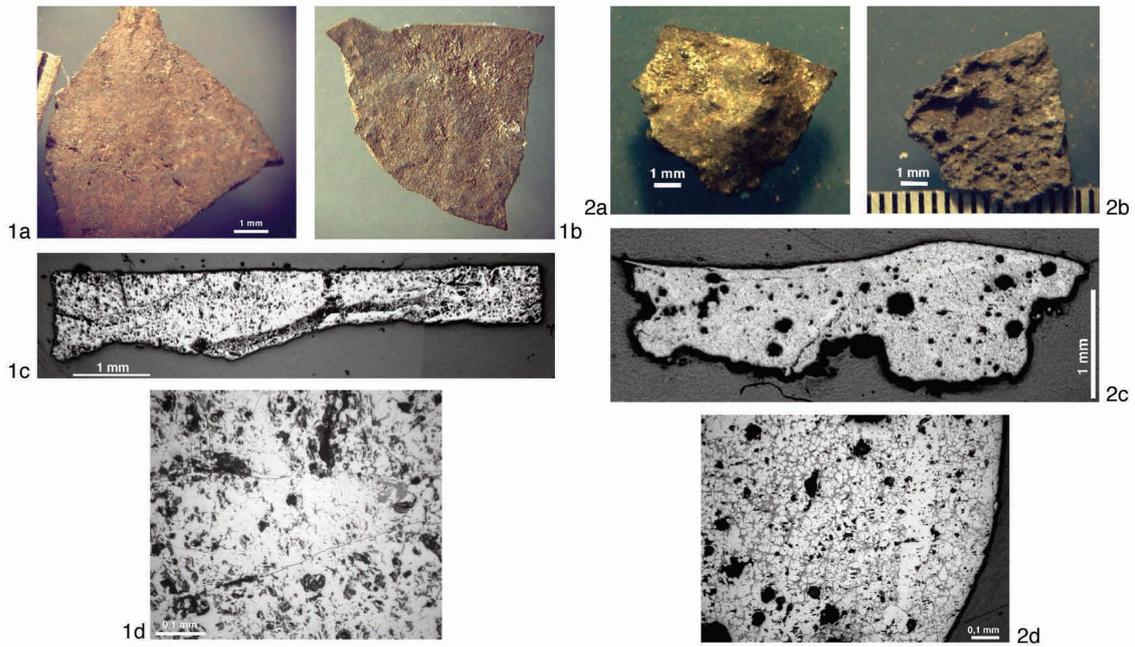
As the 16th-century smithy was the only one excavated of the two identified, the hammerscales study concerned only that period of metallurgical activity on the site. For the best statistical representativeness of the different hammerscale types, typology was undertaken for hammerscales from the smithy area near the anvil, where they were the most abundant. The hammerscales collected in the two squares of the grid where they were the more numerous were sorted. Three major types of those hammering residues were distinguished (fig. 8) : flat hammerscales, spherical ones, and residues without any defined shape. Eschenlohr (Eschenlohr, 2007, p. 65) identified a fourth type, rusted hammerscales, but at Lavinadière these hammerscales were not recorded as a type because binocular examination showed that they were small scales stuck together by iron hydroxydes probably as a result of the cold corrosion of iron fragments on the floor of the workshop. Flat hammerscales were the most numerous (60%). They were divided into three sub-types, according to their morphology. About 55% of them were thin plain flat hammerscale, but almost 25% showed bubbles on one side, which may be linked to a liquid state (Dunikowski et al., 1996, p. 102). The third sub-type, thick flat hammerscales were less numerous. It should be noticed that the distribution of the hammerscales into the different types was almost the same for the two grid squares studied. This emphasizes the representativeness of our sample. Metallographic examinations of these residues were undertaken to characterize their crystallographic structure and further interpret their formation process.

Three to five samples of each type and sub-type of hammerscales were ground and observed by means of optical microscopy. Hammerscales without a specific shape were made of various materials, some made of vitrified clay, others of wustite and magnetite in a glassy matrix. Flat hammerscales could be divided in two groups with distinct crystallographic structures. Thin flat hammerscales were made of massive magnetite (fig. 9, 1d) and the other sub-types of flat hammerscales of magnetite and globular wustite in a glassy matrix (fig. 9, 2d). The glassy matrix, made of silicates may result from the use of flux or from losses of clay of the hearth wall or the tuyere. But, in any case it was not very abundant (less than 10% of the total volume). As half of the flat hammerscales were thin flat hammerscales, it can be inferred that if flux was used, it was only occasionally and in small quantities. The spherical hammerscales (fig. 10) were mostly hollow and formed of magnetite in a glassy matrix. No fayalite was observed in these hammerscales. As fayalitic spherical hammerscales are mostly linked to early phases of hammering, mostly the compacting of the bloom with ejection of smelting slags entrapped in the iron block (Leblanc, 2002, Dumasy et al., 2010), it seems that this technique was not used in the Lavinadière priory. These spherical hammerscales were created on the iron surface by liquefaction of the iron oxides during welding, as shown by Dungworth and Wilkes (Dungworth and Wilkes 2009, p. 44). The proportion in weight of spherical hammerscales (between 5% and 10%) is similar to that obtained in experimental welding (Dungworth and Wilkes 2009, tab. 3) and may indicate a usual use of welding.

Tiny balls of metal were found inside some hammerscales. One of them, droplet shaped and full, contained two balls of hypereutectoid steel and a third, totally

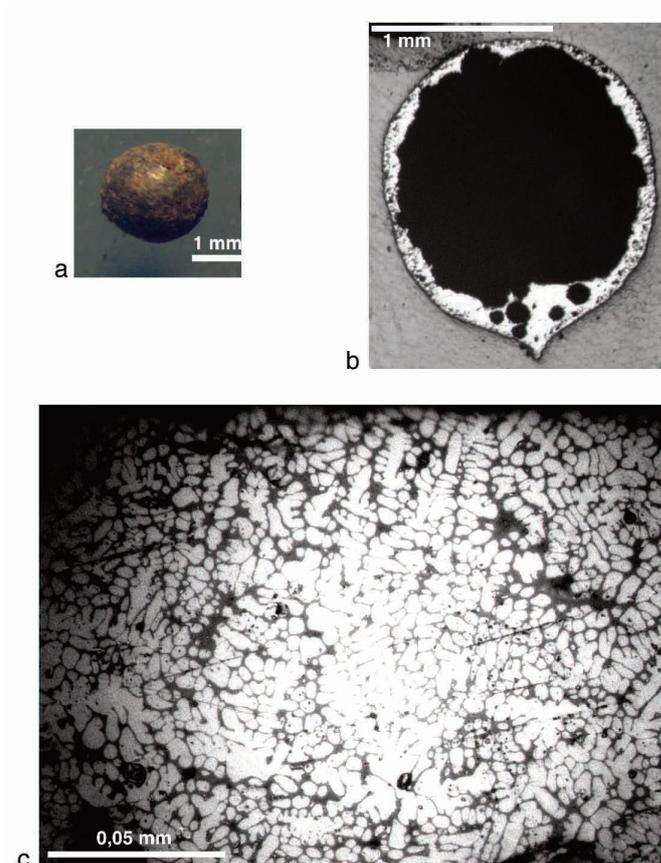


**Fig. 8** : Ratio of the different types of hammerscales in the 16th century smithy, by weight.



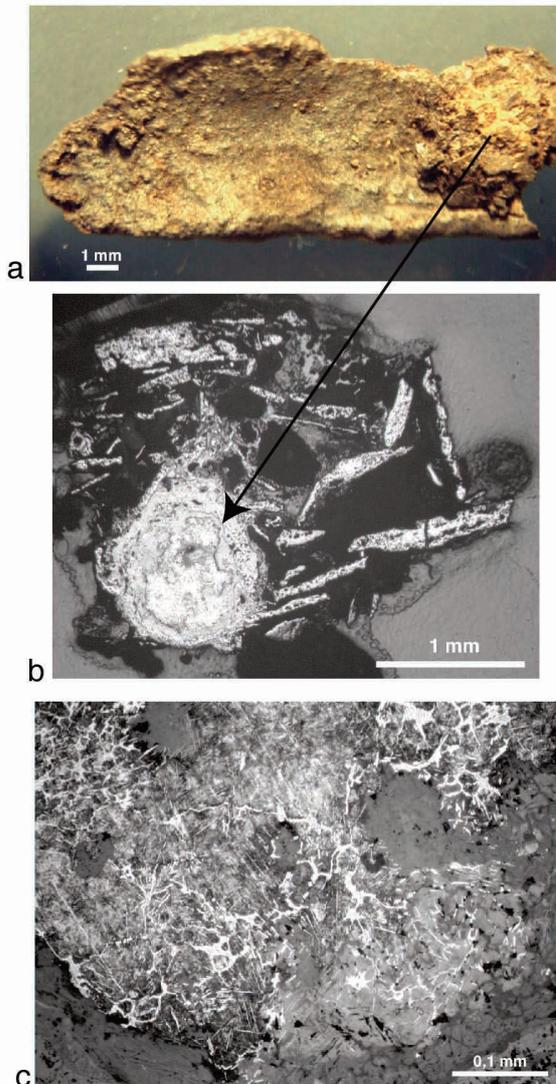
**Fig. 9 :**

1. Flat thin hammerscale; 1a and 1b: view of the two sides of the hammerscale; 1c: general view of the section; 1d: microstructure showing massive magnetite  
 2. Flat hammerscale with bubbles; 2a and 2b: view of the two sides of the hammerscale; 2c: general view of the section; 2d: microstructure showing globules of magnetite in a glassy matrix.



**Fig. 10 :** Globular hammerscale; b: general view of the section, showing its hollowness; c: microstructure showing globules of magnetite and forming wustite dendrites in a glassy matrix.

corroded, perhaps of ferritic iron. They were between 0.05 and 0.1 mm in diameter. A 0.08 mm wide ball of white cast iron was found in a thick flat hammerscale. A bigger spherical fragment of metal, partially corroded, was stuck by oxidation on one of the flat hammerscales studied (fig. 11). It was made of hypereutectoid steel. Fine cementite needles and martensite are proof of fast cooling of the metal. The shape of all these metal parts show that the surface of the piece of metal forged was partially in fusion in the hearth.



**Fig. 11** : a: hammerscale with corroded metal stuck over it; b: section showing a metallic ball surrounded by fragments of flat hammerscales; c: micrography showing corrosion (grey) containing needles of cementite (white). In metallic areas cementite appears in martensite, a sign of the high speed cooling of hypereutectoid iron.

### 3. Discussion

One specificity of the site is that metal is ill preserved due to acidic soil. A high level of corrosion was seen in the iron debris and in the iron entrapped in the hearth bottoms. Therefore the study of the workshops mostly relies on metallurgical wastes. In the 16th-century smithy, the very small prills of metal discovered were highly carburized, but their representativeness of the metal processed is far from certain.

The very small amount of metal found in the hearth bottoms studied show that the medieval and the early post-medieval workshop smithed both objects out of already compacted iron, such as ingots. As hammerscales, whether round or

flat, contained very little glassy phase, it can be inferred that the 16th century smith used very little flux, but the proportion of spherical hammerscales to flat ones shows that welding was probably commonly used.

The small size of the early post-medieval hearth bottoms and the presence of hammerscales in them instead of wustite probably accounts for a much longer process in the medieval smithy than in the early post-medieval one. Long duration of the work implies that the hearth was maintained at smithing temperature for enough time to let hammerscales fall in the hearth react with the glassy matrix and turn into wustite (Dunikowski et al., 1996, p. 106). This is consistent with the fact that medieval hearth bottoms are bigger than 16th century ones. The hypothesis of a more intensive metallurgical activity during medieval times than in the following period will have to be checked when the medieval smithy is discovered.

On the whole, smithing in Lavinadière priory, seems to have been a small scale activity during early post-medieval times. The smiths developed rather basic skills on pieces of metal probably purchased. The question of the production of this metal is not solved: was it iron or steel obtained from pig iron manufactured by the « new » blast furnace process or wrought iron from the old process? The provenance of this metal could be searched for instance by resorting to history through records of iron purchase.

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