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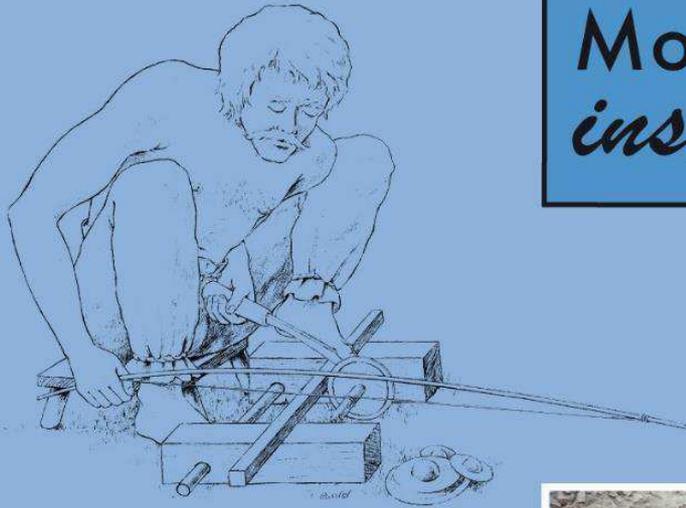
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Table of contents

Early Iron in Europe – an introduction and overview <i>Thilo Rehren, Brigitte Cech</i>	7
The production of <i>ferrum Noricum</i> at Hüttenberg, Austria – the results of archaeological excavations carried out from 2003 to 2010 at the site Semlach/Eisner <i>Brigitte Cech</i>	11
Early iron production in Germany - a short review <i>Guntram Gassmann, Andreas Schäfer</i>	21
Early iron production in the Central German Highlands. Current research in the Lahn Valley at Wetzlar-Dalheim (Lahn-Dill-District, Hessen) <i>Andreas Schäfer</i>	33
The Siegerland as an iron production area during the first millennium BC: A regional approach to a famous mining region <i>Thomas Stöllner in collaboration with Jennifer Garner, Guntram Gassmann, Klaus Röttger, Ursula Tegmeier, Ünsal Yalçın, Manuel Zeiler</i>	43
Heeten revisited – Germanic iron production in the Netherlands (150-350 AD) <i>Patrice de Rijk, Ineke Joosten</i>	65
The Roman bloomery workshop of “Roche Brune” (Pezé-le-Robert, Sarthe, France) <i>Florian Sarreste</i>	81
Tentative chemical characterization of a Roman smelting workshop (Oulches, France): from the ore to the finished product <i>Marie-Pierre Coustures, Nadine Dieudonné-Glad, Philippe Dillmann, Didier Béziat</i>	93
Levroux “Les Arènes” (Indre – France): organization and specialization of post-reduction activities in an open agglomeration of the Late Iron Age (2 nd century – beginning of the 1 st century BC) <i>Marion Berranger, Philippe Fluzin</i>	117
Organization of Forging Activities in Northern Paris Basin Agglomerations (France) during the Final La Tène <i>Sylvain Bauvais, Philippe Fluzin</i>	133
An aspect of the Celtic iron trade: the “Spitzbarren”. The deposit from Bellmund (canton Bern, Switzerland) <i>Marianne Senn, Maren Kraack, Alexander Flisch, Adrian Wichser, Michael Obrist</i>	147
Ironworking in Roman Switzerland: An interpretation of the archaeological evidence <i>Vincent Serneels</i>	161
Iron production in Lombardy from the 2 nd century BC until the 6 th century AD <i>Costanza Cucini, Marco Tizzoni</i>	173
The Aithale Project: Men, Earth and Sea in the Tuscan Archipelago (Italy) in Antiquity. Perspectives, aims and first results <i>Alessandro Corretti, Laura Chiarantini, Marco Benvenuti, Franco Cambi</i>	181
Fragments of iron slags in pottery mortars from Este <i>Irene Calliari, Katya Brunelli, Emilio Ramous, Catarina Canovaro</i>	197
Iron and the Parisi – socio-economic and ritual aspects of the iron industry in Roman East Yorkshire, UK <i>Peter Halkon</i>	203

Table of Content

Roman military control on iron-making in South Wales <i>Tim Young</i>	215
Waste heaps as a potential indicator of regional iron production and organisation: An example from south-east Roman Britain <i>Jeremy Hodgkinson</i>	227
Iron Bloomery in South and Central Norway, 300 BC – 500 AD <i>Jan Henning Larsen, Bernt Rundberget</i>	231
Norwegian Roman Age blooms and their origin. Properties and processes shared with ' <i>ferrum Noricum</i> '? <i>Arne Espelund</i>	249
A Roman Iron Age bloomery site in Gästrikland, Sweden. Evidence of a widespread trade? <i>Eva Hjärthner-Holdar, Svante Forenius, Annika Willim</i>	261
The reconstruction of smithing activities through an ethnoarchaeological and archaeometric approach on metallic wastes <i>Raphaëlle Soulignac, Vincent Serneels</i>	277
Steelmaking in a bloomery furnace: behaviour of manganese. Research on the <i>Ferrum Noricum</i> process <i>Edmond Truffaut</i>	285
Colour plates	299

Organization of Forging Activities in Northern Paris Basin Agglomerations (France) during the Final La Tène

Sylvain Bauvais, Philippe Fluzin

Abstract

During the last three centuries BC, deep changes took place in the social and political organization of the temperate North European society. In the north of France, new sites appeared, containing more concentrated craft activities. In the beginning, we may speak of open agglomerations or of villages; subsequently, the appearance of the *Oppida* is interpreted as a stronger diversification of the inhabited space, which becomes ever more complex. When considering the forging activities of five of the Northern Paris Basin agglomerations, there is no evidence of profound changes in the organization of the iron-making activities between the open agglomerations and *Oppida*. Craftsmen seem to be equally specialized, and relations of inter-dependency between workshops, when they exist, seem to be exclusively related to access to raw materials. Thus, economic and political factors seem to be more engaged in the determination of a specific form of structuration than an evolution of the conception of the organization of the crafts.

Key words: La Tène, France, Paris Basin, Agglomerations, Iron Metallurgy, Forging Activity, Organization of Production, Specialization.

1. Research object and methodology

According to definitions agreed upon in the academic world, open agglomerations represent a new phenomenon which emerged in the Northern Paris Basin during the second part of the middle La Tène (LT C1 – around 250 BC). They are characterized by a stronger centralization of the population and a convergence of craft activities (Buchenschutz and Krausz 2001). They also represent a first step between farms with an agricultural vocation and cities at least partially detached from food-producing. During the La Tène D1 (around 150 BC), *Oppida* (fortified agglomerations) appear, either from open agglomerations, or *ex-nihilo* (Buchenschutz 1990, 2000; Brun 1995, 1999; Brun et al. 2000). They possess a more complex structuring, close to the one of Mediterranean cities. Also according to the existing literature, they were the seats of political, religious

and economic power – centralists of resources and currency issuers.

Considering these premises, we will try to follow the different organization forms of the iron industry according to these two types of sites and try to see if changes of spatial and functional structuring accompanied an evolution in the crafts organization of iron metallurgy, especially in terms of specialization.

For answering these questions, we developed a methodology based on archaeometric data and on spatial distribution studies (Bauvais 2000, 2007; Bauvais and Fluzin 2007). We will thus first carry out metallographic analyses of forge waste (slags and iron scraps) in order to position each activity inside a global succession of the iron and steel making process (from primary reduction to object finishing) and to define more specific *chaînes opératoires* (knowledge, level of complexity, degree of specialization) (Fluzin 1994; Serneels 1998; Fluzin et al. 2002; Serneels and Perret 2003).

These results, combined with a spatial analysis of each site, allow the identification of the internal organization of these agglomerations and, on a wider scale, their regional function.

2. Corpus

Nine agglomerations are known in the Northern Paris Basin to include evidence of forging activities during the final La Tène (Figs. 1 and 2). Five of them are studied in this article (Fig. 3):

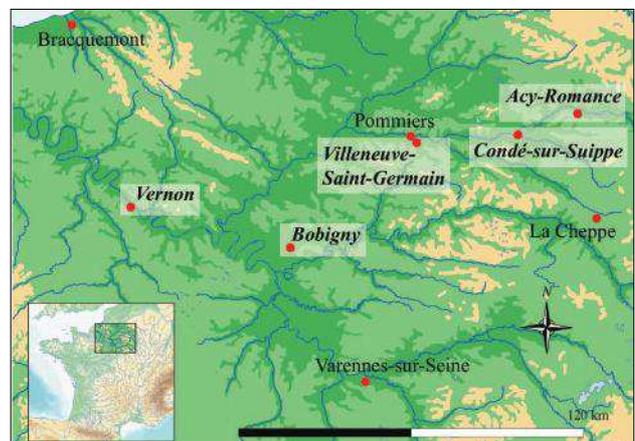


Fig. 1: Localization of the studied sites.

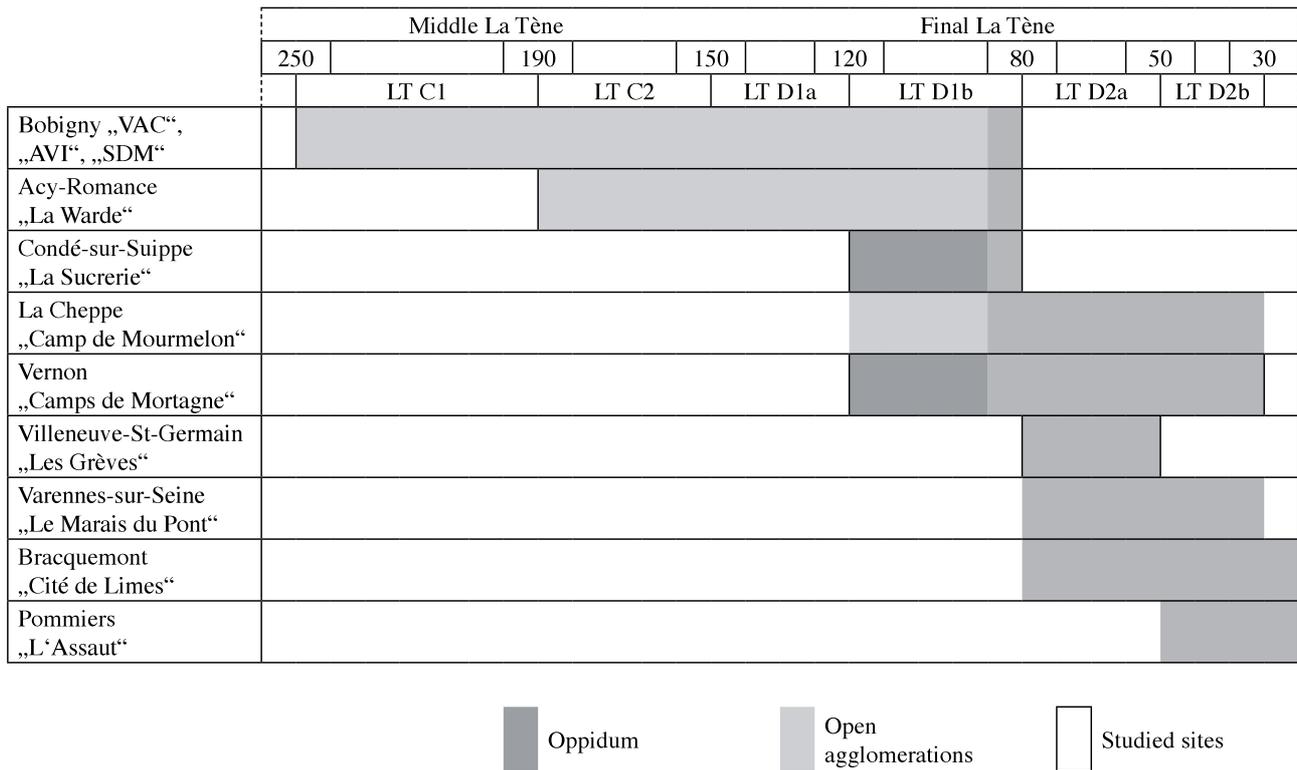


Fig. 2: Chronological table.

2.1. Open agglomeration of Acy-Romance (Ardennes) – La Tène C2-D1 (around 190-80 BC)

The site reveals on an extension of about 8 ha the settlement of an open agglomeration occupying the summit and the east side of a calcareous plateau dominating the valley of the Aisne River (Lambot 2002).

This village is organized according to a preconceived plan taking into account the topography of the place. It seems to have developed from a religious space (Lambot and Méniel 2000). The rest of the settlement is organized in districts or ‘islets’ around three blanks, interpreted as courtyards. The interpretation of these sectors as spaces of a socio-professional nature remains subject of debates. However, the study of the distribution of faunistic vestiges provides evidence of a differential occupation according to ‘islets’. One of these zones is interpreted as a district of metallurgist craftsmen (smiths and braziers). This interpretation is also a subject of questions, because it is based on very limited data. Indeed, the zone presents the most significant differences in terms of altitude of the entire site and reveals the strongest erosion. Only a polylobed pit and two silos present enough volume to have trapped a significant quantity of artefacts. Only 3.5 kg of slags are present.

2.2. Open agglomeration of Bobigny (Seine-Saint-Denis department) – La Tène C2-D1 (around 190-80 BC)

The site is a set of three plots of land aggregated on about 20 hectares off the western side of the municipality of Bobigny. These three plots of land are “La Vache à l’Aise” (6800 m²), “L’Hôpital Avicenne” (env. 4900 m²) and “Le Stade de la Motte” (1100 m²) (Le Béchenec and Marion 1999; Le Béchenec 2001, 2002; Marion et al. 2005a, 2005b). The three parcels which compose it are slightly distant from each other (300-800 m), but the chronological overlapping, the homogeneity of the artefacts, and similarities in the meat-based consumption lead us to interpret them as a unique site. Excavations covered only 0.4% of the probable extension of the settlement (30 hectares). Approximately 61 kg of forging slags were collected from all the excavated spaces.

2.3. Oppidum of Condé-sur-Suipe (Aisne) – La Tène D1b (around 120-80 BC)

This is a vast fortification of more than 170 hectares, settled on an alluvial terrace, in a meander of the Aisne River. The enclosure seems to have blocked the meander

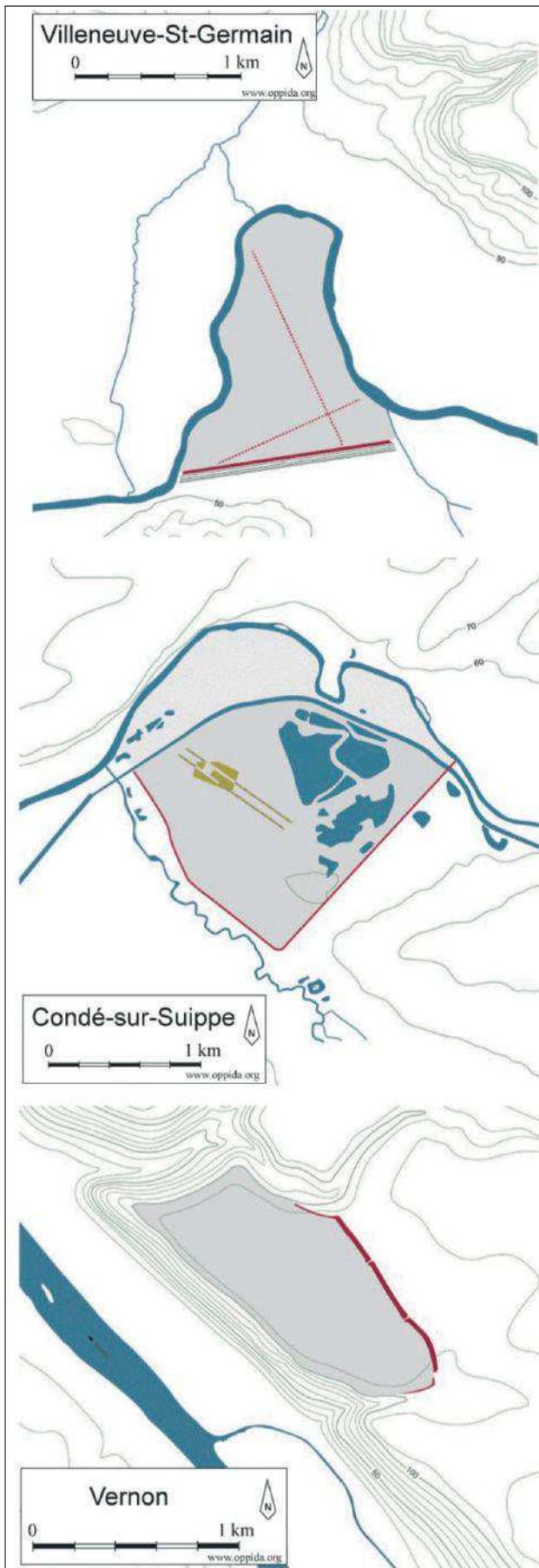


Fig. 3: Plan of the Oppida studied in the present paper.

by a right-angled rampart. The study of the entire corpus of artefacts (fibulae, currency, ceramics), reveals a short-term and synchronous occupation on the totality of the *Oppidum*. The extent of the excavations allowed an understanding of the organization of the agglomeration over approximately 4 ha, a coverage which makes it the most important investigated surface for this type of site in Europe. The present study addresses only the 2.5 ha excavated in 1987 (Pion et al. 1997; Bauvais 2000).

The sector is centred on several forging workshops, but also shows evidence of the activities of bronze smelters and precious metals working. The metal industry is thus the primary activity of this district and maybe even of the entire *Oppidum*. Vestiges on the ground are of great readability. Their study revealed dwelling structures and circulation axes, but also coherent spaces and sub-spaces splitting the craft area. A total of 42 kg of forging slags is attested in this sector.

2.4. Oppidum of Vernon “Le Camp de Mortagne” (Eure) – La Tène D1b-D2 (around 80-30 BC)

The site extends over approximately 78 ha. Its position on the edge of a mountain spur indicates its unmistakable defensive character. The access to the spur is blocked by a massive bank, the excavations of which revealed a structure of the *muris gallicus* type. Excavations, on approximately 400 m², also showed the presence of a ditch parallel to the fortification, completing the defensive structure (Dechezleprêtre and Fourny-Dargère 1999; Dechezleprêtre 2002). The collapse of the door sealed a small forging workshop located between the wall and the ditch, at the south side of the gate.

This workshop is implanted in a 5 m wide cramped space between the fortification and the ditch. At a distance of about a metre from the wall, two post-holes, as well as a stony alignment linking them, could represent the foundations of the superstructure. This allows us to imagine a simple canopy possessing two load-bearing posts and two smaller ones on the opposite side, maybe simple pickets. The ground level is partially preserved and covered on its quasi-totality by a layer of charcoal, burnt clay and of a large quantity of hammer-scales. On the ground, two forging hearths are preserved. Bowl-shaped, from 30 to 40 cm in diameter, they are about 15 cm deep. All in all, 4.5 kg of slags were collected from hollowed structures.

2.5. Oppidum of Villeneuve-Saint-Germain (Aisne) – La Tène D2a (around 80-50 BC)

This site is the first *oppidum* of the *Suessiones*. It is located on the bottom of the valley, inside an Aisne river meander covering a surface of 70 hectares. This meander is blocked by a rectilinear *muris gallicus* type rampart strengthened by a double ditch. Excavations carried out

Types of activity		Sequences of work	Know-how and training		Periodicity	Activities waste	Minimum tools required	Activity structure		
Reduction of the iron ore		Ore seeking	From weak to high	Know-how will be a function of the volume of the production and the type of ore used	Average	Sterile	Tools for extraction	Pits or extraction wells		
		Ore extraction			Weak					
		Ore preparation			Average				Stones for crushing of the ore	Roasting hearth for the ore, washing area of the ore
		Reduction of the ore			Average				Great quantity of slags in only one sequence, walls of furnace, ore	Powerful ventilation system (in the case of a forced ventilation)
Refining		Of crude mass of iron	From average to high	Proportional to the claimed quality of purification and inversely proportional to the initial compaction of the mass	Average	Slag cakes comprising many metal fragments, small flowed slags, "gromps", slag prills, walls	Wood mallet and block. Powerful ventilation system	Re-used reduction furnace or specific hearth		
		Of coarsely compacted piece	From average to high		Average	Slag cakes with few metal fragments, slag prills and flat hammer-scales, walls	Stones comprising traces of launched and passive percussions	Specific hearth		
		Corroyage of homogenisation	Very high		Very regular	Slag cakes (high proportion of clay-sand: additions for weldings), slag prills, flat hammer-scales, walls	Tools for hammering and powerful anvil in order to obtain flat surfaces (metal hammer, anvil made in stone or in metal), Tools of cutting out of metal before folds (chisel). Powerful ventilation system			
Production of objects	Simple	Heating and hammering, cutting, polishing, sharpening	From weak to high	Know-how will be a function of the thickness of worked metal and of the iron/carbon alloy	Weak	Produce little waste (flat hammer-scales, falls of cuttings, formless slags, nonsystematic slag cakes)	Stones comprising traces of launched and passive percussions, polisher out of stone and sharpener. Cutting tools made of metal (chisel), simple ventilation system.	Do not necessarily claim a place nor a specific hearth		
	Complex	Heating and hammering, welding, damas, polishing, sharpening	From high to very high		From regular to very regular	Slag cakes of different types according to the production (additions), falls metal, slag prills, flat hammer-scales, walls	Tools for hammering and powerful anvil in order to obtain necessary shapes (metal hammer, anvil made in stone or in metal), metal tong, polisher out of stone and sharpener. Cutting tool made of metal (chisel)	Forging hearth		
	Thermochemical treatment	Quenching, tempering, annealing, cementation, decarburization, carbonitriding	From high to very high		From regular to very regular	Specific slags (traces of addition and mixtures), bones and burned horns...	Powerful ventilation system	Specific hearth, quenching box, crucible		
Maintenance and recycling	Maintenance of the tools (agricultural and domestic)	Heating and hammering, polishing, sharpening	Weak		Weak	Produce very little waste (flat hammer-scales and slag according to the intensity)	Stones comprising traces of launched and passive percussions, polisher out of stone and sharpener, simple ventilation system.	Do not necessarily claim a place nor a specific hearth		
	Repair and simple recycling	Heating and hammering, cutting, polishing, sharpening	Weak		Weak	Produce little waste (flat hammer-scales, falls of cuttings, possibly formless slags, slag cakes according to the intensity)	Stones comprising traces of launched and passive percussions, polisher out of stone and sharpener. Cutting tools made of metal (chisel), simple ventilation system.			
	Repair and complex recycling	Heating and hammering, cutting, welding, polishing, sharpening	Moyens à élevés		From average to regular	Slag cakes (high proportion of clay-sand: additions for weldings), falls of cuttings, slag prills, flat hammer-scales	Tools for hammering and powerful anvil (metal hammer, and anvil made in stone or in metal), metal tong, polisher and sharpener. Cutting tools made in metal (chisel), powerful ventilation system.	Forging hearth		
	Recycling by reagglomeration of fragments	Agglomeration of metal in a reducing atmosphere	High	High	From regular to very regular	Very metallic and very oxidized bottom-hearth slags	Powerful ventilation system	Adapted forging Hearth, specific hearth		

Activity which claims in an intrinsic way a specialization
 Activity which according to the intensity can be the subject of a specialization
 Domestic activity (can nevertheless be the subject of a specialization)

Fig. 4: Summary table of skills necessary for iron working.

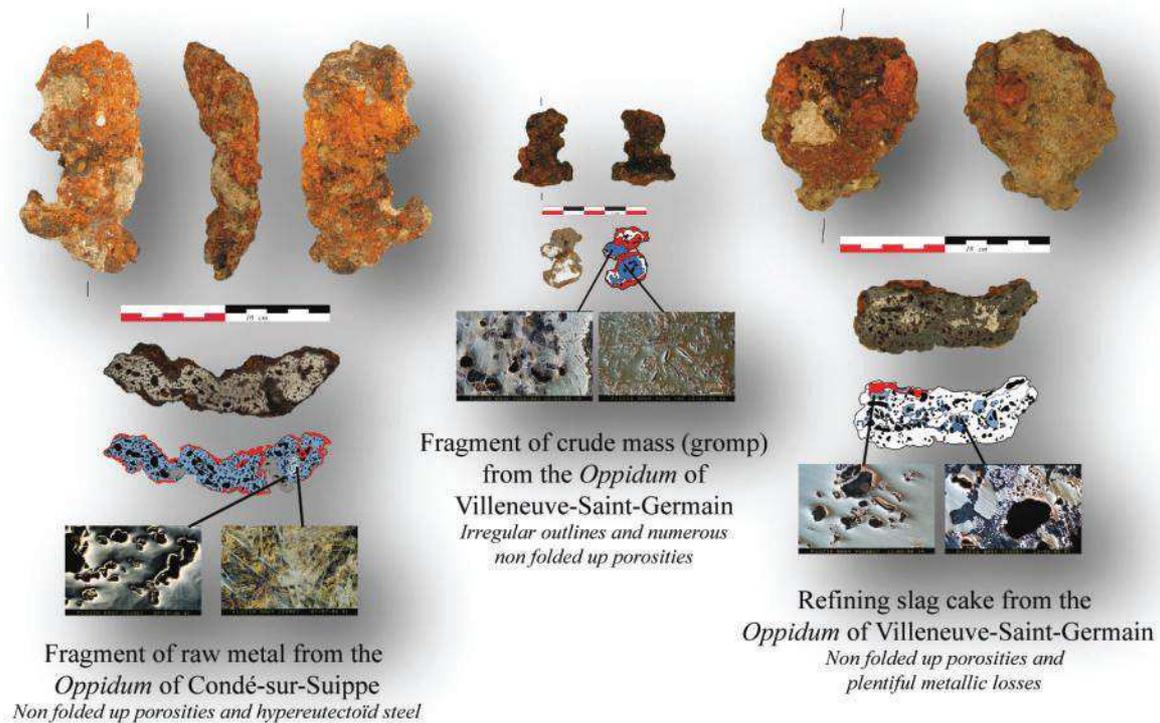


Fig. 5: Examples of evidence of crude mass refining.

since 1973 on approximately 2.3 hectares allowed bringing to light a very structured housing environment for which the readability and the extension of the plan are exceptional (Demoule and Ilett 1979; Robert and Constantin 1980; Dubouloz and Coudart 1981; Constantin et al. 1982; Debord 1982, 1993; Robert and Hénon 1994; Debord 1995). The internal space is strongly structured and seems to be articulated around four ditches converging in a cross, which separate four spatial entities of different surfaces. These spaces were interpreted as having specific functions (housing environment, crafts sector). Craft activities seem to be preferentially located in the western half of the investigated space. They comprise an important monetary production (Suession potins and currencies made of precious metals), copper-alloy working, tanning activities, large-scale textile activities and pottery production. Iron metallurgy was the object of a steady activity, judging by the 74 kg of forging slags collected.

The site of Varennes-sur-Seine (Yonne department – around 80-30 BC) is still under study by C. Dunikowski and S. Cabboi, but we shall make reference to the data already available (Séguier 1996, 2002; Dunikowski et al. 2007).

3. Analysis results

These results originate from a PhD thesis concerning 88 sites related to the iron industry in the Northern Paris Basin (Bauvais 2007). The analysis protocol is based on archaeological (macrographic) and archaeometric studies

(micrographic) of production wastes discovered in workshop contexts (slags, falls of metal and semi-products) (Fluzin et al. 2000; Fluzin 2002; Anderson et al. 2003). A first morpho-metrological sorting allows characterizing different types of wastes and consequently the main lines of the work (reduction, post-reduction). Subsequently, a finer typology allows sampling for analysis. It is from these results that the hypotheses are produced, by considering the selected and analyzed samples to be representative of their entire typo-morphological family.

3.1. A wide range of technical practices reaching expert know-how

All the sites share a first basic level of activity involving simple processes which only require a basic knowledge. In the present article, we will aim our argument toward more specific practices, which demand more significant specializations. First of all, it is important to define the levels of difficulty existing in the large range of processes that can be involved in a forging activity. Figure 4 summarizes these interpretations.

Following the list and the logic of *chaîne opératoire*, the activity of crude mass refining is the first process requiring an important know-how in forging activity. This activity is attested in the *Oppida* of Condé-sur-Suipe and Villeneuve-Saint-Germain with the presence of refining slag-cakes and fragments of crude metal mass (gromps) (Fig. 5) (Nozek 1994; Bauvais and Fluzin 2007).

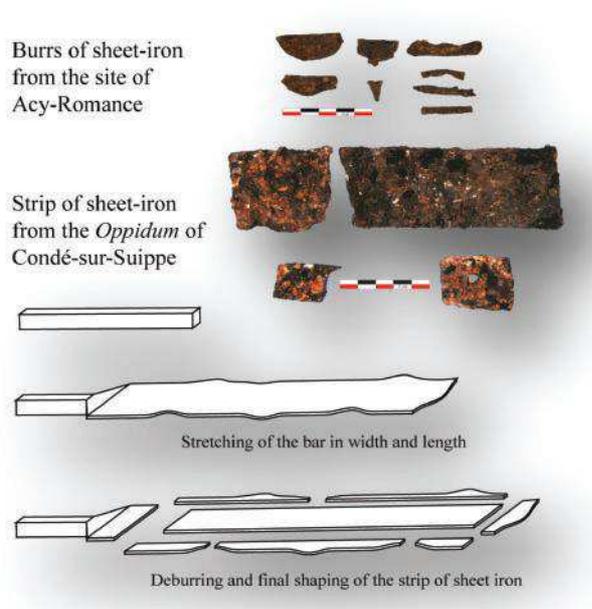


Fig. 6: Obtaining of a strip of sheet-iron from an iron bar.

Fragments of cast iron accidentally brought inside the product of reduction seem to be also linked to this activity. Details from the study of the agglomeration of Varennes-sur-Seine (Dunikowski et al. 2007) indicate that this activity is represented just as much as in the open agglomeration of Levroux (Indre department – around 190-80 BC) (Berranger and Fluzin 2009), for an extra-regional comparison.

This very complex practice is a clue of an important knowledge possessed by the craftsmen working at these sites. ‘Losing’ the least material possible requires a high level of know-how. This difficulty is even more evident at Condé-sur-Suippe, Villeneuve-Saint-Germain and Levroux, due to the very high level of carbon contained in the worked metal, because it makes it harder and more brittle.

The manufacturing and shaping of sheet-iron is maybe the most difficult process in the forging activity, depending on the thickness of the object. It requires great know-how to stretch the metal without breaking it and to have sufficiently purified the metal beforehand so that it does not weaken. This activity is attested at the sites of Condé-sur-Suippe, Bobigny “Stade de la Motte” and Acy-Romance, by fragments of sheet-iron in the process of manufacturing or by off-cuts from the final shaping of strips (Figs. 6 and 7) (Berranger et al. 2007).

Nonetheless, this difficulty is even more important when it is combined with a succession of gestures which form complex chains of the process. At Bobigny “Stade de la Motte”, wastes left after the manufacturing of several swords and scabbards made of sheet-iron show an exceptional know-how, so much so that these parts of weaponry can be included among the steel-making cutting edge products of this time (Fig. 8) (Lejars 1994, 1996; Rapin 2000, Bauvais 2007; Berranger et al. 2007).



Fig. 7: Off-cuts from final shaping of strips from Bobigny “Stade de la Motte”.

They combine refining techniques of the metal with successive foldings, with the aim of homogenizing the metal, but also creating an effect of pseudo-damask (Pleiner 1983, 1993; Senn-Bischofberger 2005; Pleiner 2006). A scabbard is made in very thin sheet-irons (less than 1 mm), and the global assembling by means of frets and of a chape is, in this period, of silversmith’s quality. At Acy-Romance, sheet-irons were also worked with the aim of making fixing-rivets for fine repairs of metal-plates or defensive parts of armament (Fig. 9).



Fig. 8: Assemblage of metal-scrap from the site of Bobigny (SDM). Socket bar, scraps of scabbard, burrs of sheet-iron, cuts of bars.

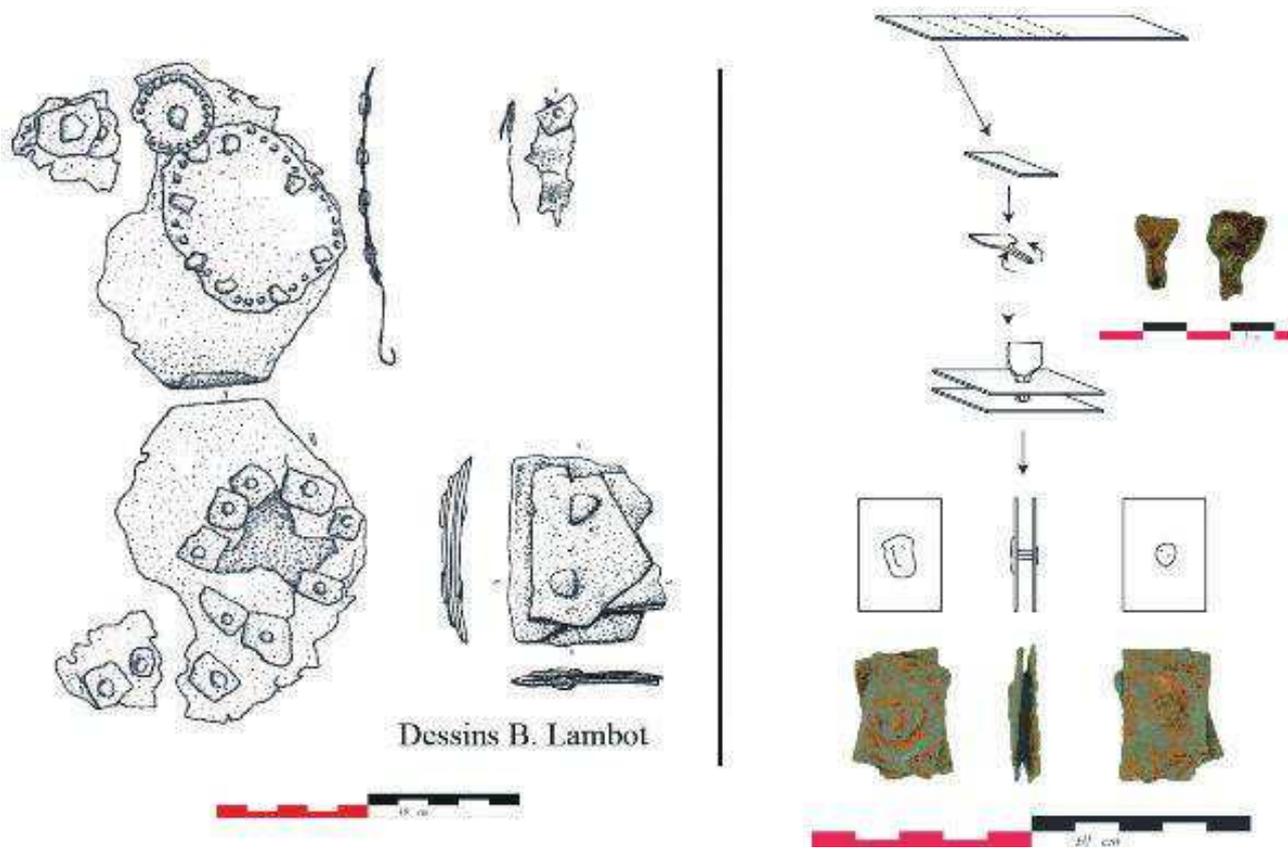
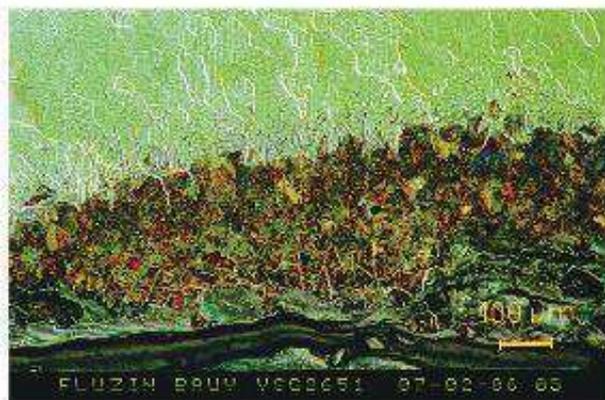
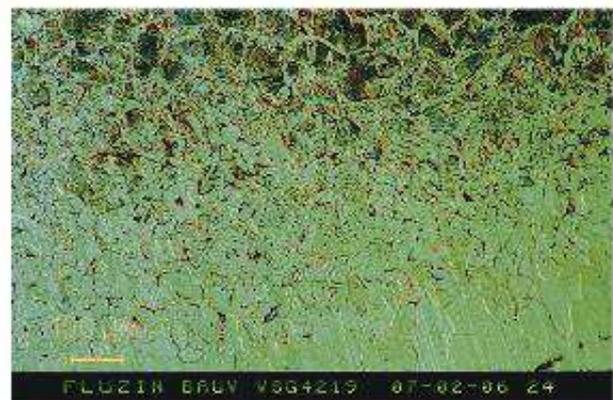


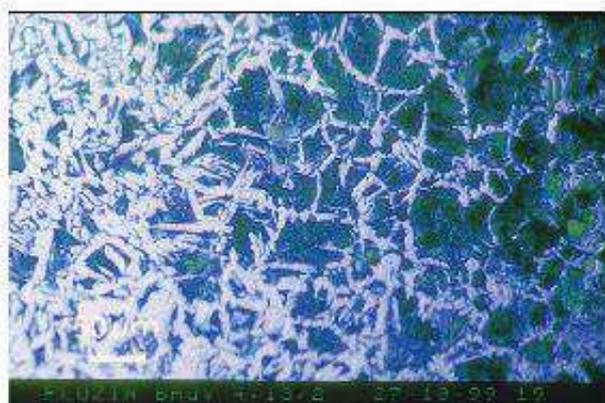
Fig. 9: Obtaining of a rivet.



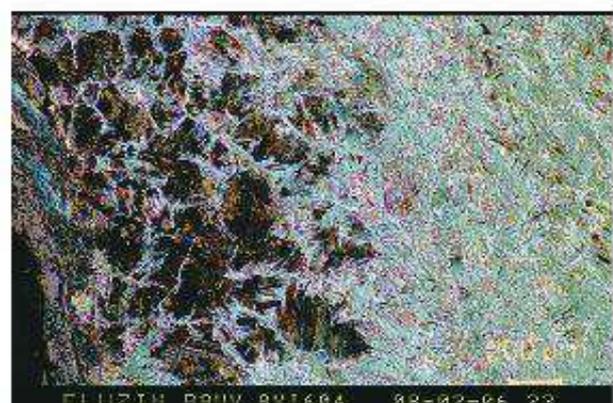
Villeneuve-Saint-Germain: Iron scrap



Villeneuve-Saint-Germain: Chisel



Condé-sur-Suippe: Socket-bar



Bobigny «Avicenne»: Iron scrap

Fig. 10: Evidence of case-hardening practices. Micrography on etched metal. Transition from steel on periphery to a ferritic core.

At Condé-sur-Suippe, this succession of technical processes can also appear in connection to other metallic or organic materials (Bauvais 2000). The presence in the same waste of traces of copper and ferrous alloy seems to indicate that both materials were involved in a succession of technical processes. Furthermore, the concomitance between forging wastes and wood-working tools, as well as a horseshoe-shaped hearth, could also permit envisaging the production of metal tyres, as well as their fixation on their wooden armature.

The mastery of the processes is also attested by steel-working in all the studied sites. As we have already pointed out, the metal refined on sites practising this activity is very often carburized or strongly carburized (eutectoid or hypereutectoid). This feature can explain the carbon content of certain analyzed objects, but a part of them seem to be products of a practice of voluntary carburization (Fig. 10). This practice is attested at Acy-Romance, Bobigny “la Vache à l’Aise” and Condé-sur-Suippe by the presence of organic wastes, horns and bones in workshop contexts. The same practice is also attested in the agglomeration of Levroux (Krausz 1993).

Referring to this first comparison, no difference is really visible between the open agglomerations and the *Oppida* in terms of the level of know-how involved. However, it is important to note that the *Oppidum* of Condé-sur-Suippe is the only one which seems to include all the elements emphasized as characteristic of an important level of know-how.

3.2. Recurrences are detectable in the location of the activities

Since the excavations of Bohemian *Oppida* (Drda 1994; Drda and Rybova 1994, 1997), of Manching (Jacobi 1974; Sievers 2000; Lorenz 2005) and of Bibracte (Pernot 1999; Pernot et al. 2002; Berranger 2009), the knowledge of the internal organization of the first European cities became more extensive, and, for the purposes of the present paper, it provides a good basis of comparison. The setting-up of the craft workshops – especially of metallurgical ones – presents a certain number of recurrent features, which represent crucial arguments on the reasoned organization of these sites. What about *Oppida* from the Northern Paris Basin, and in what ways are these sites distinct from open agglomerations?

If we make reference to the works of Drda in Bohemia (Zavist and Stradonice) and to the results obtained at the *Oppidum* of Bibracte (“la Côme Chaudron” and “la Porte du Rebut”), a preferential localization is revealed, along axes of communication and especially near gates of fortified sites.

In the Paris Basin, this feature is recurrent on numerous sites. At Condé-sur-Suippe, the excavation coverage shows two wide parallel streets, connected on a part of their plans by an empty quadrangular space, interpreted as a courtyard (Pion et al. 1997). Iron and steel-making work-

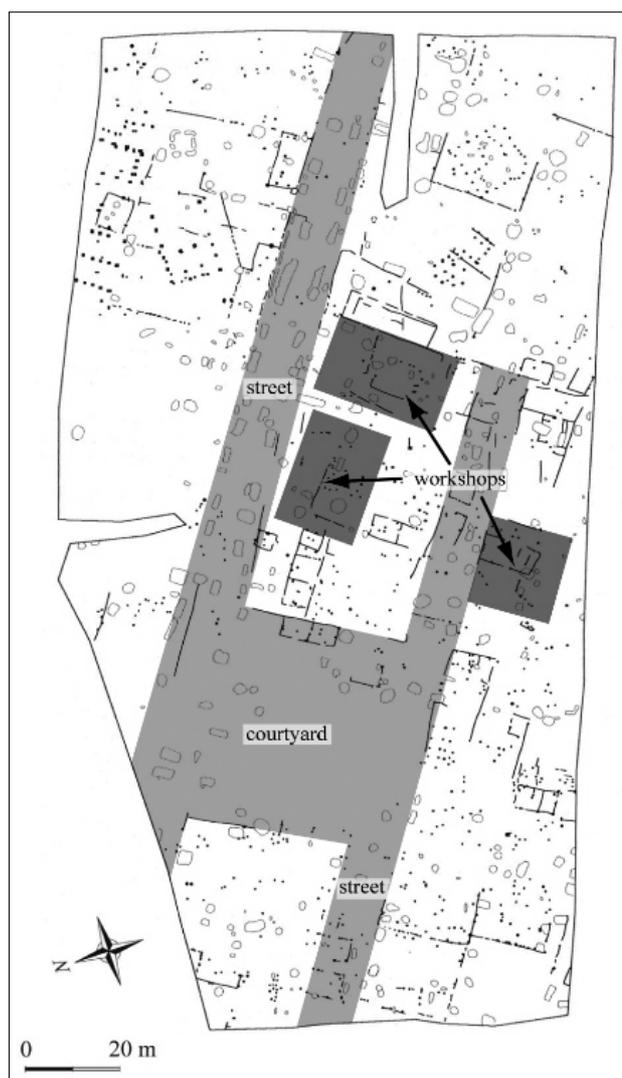


Fig. 11: Localization of forging workshops at Condé-sur-Suippe.

shops are located in the space formed between these three communication axes, as close as possible to raw material supplies and finished products outlets (Bauvais 2000; Bauvais and Fluzin 2007) (Fig. 11). In this sector, the open space could represent a ‘marketplace’ in which products elaborated in neighbouring workshops were exchanged. Even if the space cleaned up at Villeneuve-Saint-Germain is not as clear and easily interpretable as at Condé-sur-Suippe, ditches in cross – which represent the main spatial characteristic of the site – can be interpreted as axes of communication (Fig. 12). According to successive interpretations, paths could have been located above the ditches, composed of a wooden floor and surmounted by a superstructure, or could have been located on both sides of covered ditches, which would have multiple functions, of which that of trading workshops. With excavations having already been carried out in the majority of the locations along this cross, the most important workshops appear to be located along these axes, in the same conditions as at

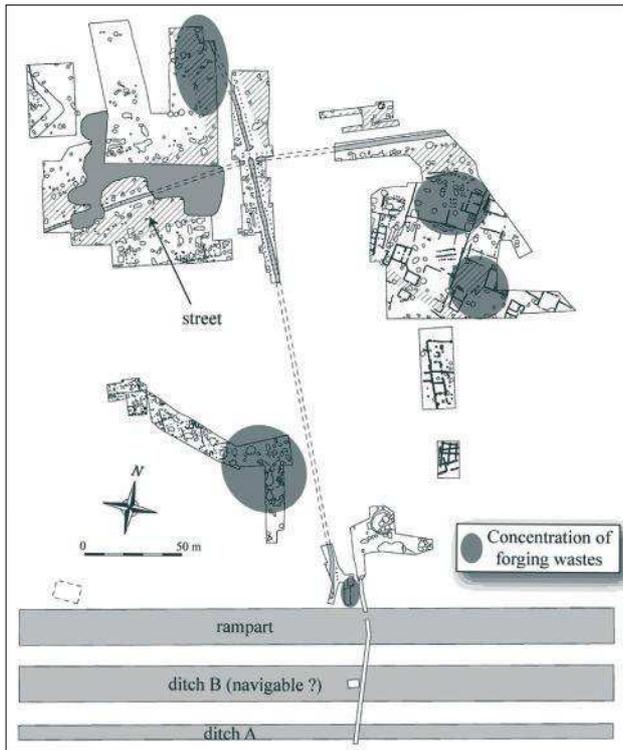


Fig. 12: Localization of forging workshops at Villeneuve-Saint-Germain.

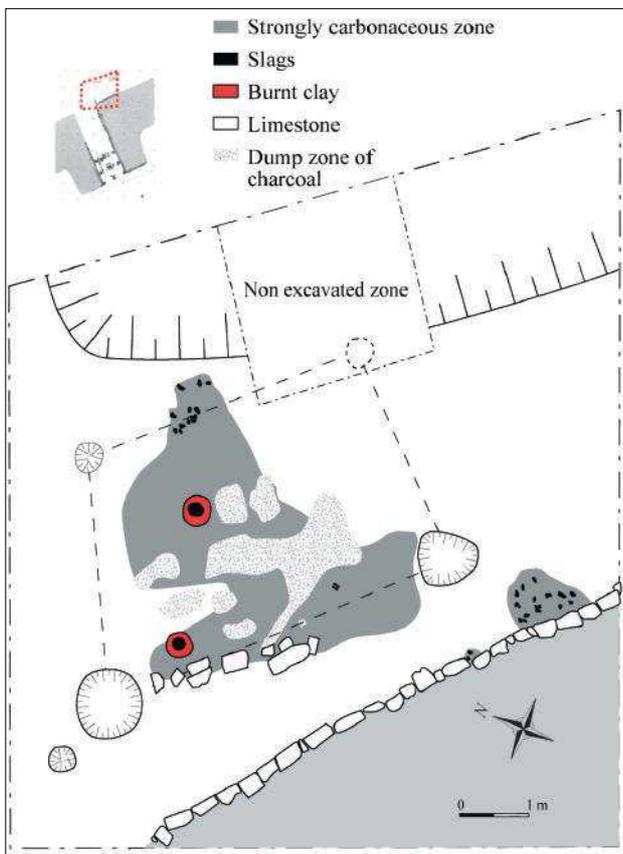


Fig. 13: Plan of the forging-workshop at the north gate of Vernon's Oppidum (Bauvais 2007, modified after Dechezleprêtre 2002). The workshop's ground is preserved, as well as small circular forging-hearths.

Condé. For the sites of Bobigny and Varennes-sur-Seine, the knowledge of their extension and structuring does not allow speaking about major communication axes. However, at Bobigny "Stade de la Motte", a wide road lined with ditches could justify the location of the workshop (Le Béchennec and Marion 1999).

As for the workshops' location in the vicinity of doors, the phenomenon also seems to repeat. The most evident case is the forging workshop of Vernon's *Oppidum*, placed between the North door and the enclosure ditch (Fig. 13). Its locating along the rampart, the accumulations of waste in heaps placed against the first stony assizes, the waste disposal in the filling of the ditch, and the fact that the destruction of the wall covered the workshop are good indications that its activity is contemporary with the functioning of the fortification and of the gate. Consequently, it cannot be either a workshop involved in the construction of the *mur*, or a forge of dismantling. At Villeneuve-Saint-Germain, Jean Debord tried to find the location of a door in the southern area of the site, in the aligning of the south ditch (Debord 1995). Excavations did not allow confirming these hypotheses; however, strong accumulations of slags show that such an activity was practised along the *mur*, maybe at a gate close to the survey.

The concomitance with the other craft activities is also an omnipresent scenario at the studied sites. We have already mentioned it in the context of Condé-sur-Suipe, with copper alloys and wood working activities, but it is necessary to add to them coin-minting, gold-work, inlay work and butchery. This phenomenon repeats systematically in all the agglomerations that were excavated to an extent that allows obtaining sufficient information. It is moreover the main argument employed in the literature when referring to specialized craft-districts and, thus, when speaking about an urban or proto-urban phenomenon.

Sometimes, remains of certain activities are located inside dwelling districts. They seem to be linked to activities practiced by craftsmen outside of their workshop, for momentary activities, orders or constructions. This means that their activities could have been flexible and also itinerant inside their own settlements.

Once again, the location of the various activities does not result in obvious differences between opened agglomerations and *Oppida*, except for aspects related to the physical structure of sites (fortifications).

3.3. Distribution of technical clues shows the existence of specialized workshops

If we combine the elements found during technological analyses and those stemming from spatial analyses, it becomes evident that certain workshops were specialized.

On the site of Condé-sur-Suipe, three different workshops were brought to light (Fig. 14) (Bauvais 2000). The first presents evidence of work on crude masses of metal and on voluminous objects. The second indicates the

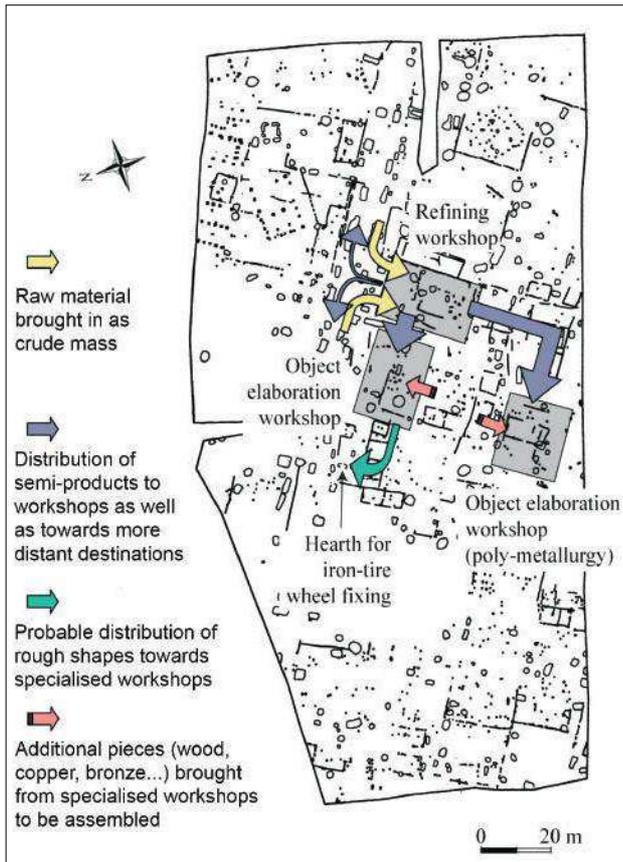


Fig. 14: Organization of production at Condé-sur-Suippe.

working of flat products (sheet-iron, blades, ferrule, iron tyres), and the third can be related to non-specialized activities, also involving work on copper alloys. Other clues are spread over the entire site, without providing evidence for the existence of other workshops.

At Villeneuve-Saint-Germain, the preservation of the site does not allow identifying workshop structures; however, concentrations of material show the existence of specialized spaces (Fig. 15). On the western part of the north ditch, a zone consisting of wide and disparate structures contains all the indications of the activity of raw iron mass compaction (gromps, refining slag-cakes). In the northern part of the 'residential' area located in the south region of the east ditch, the indications of production are more limited, but denote a shaping activity of relatively voluminous objects. This is indicated by slag-cakes of significant volume, containing already compacted fragments of metal and wide and thick hammer-scales. Two other concentrations are characterized by small fayalitic and clay-sandy slag-cakes related to activities of finishing or shaping of small objects.

At Varennes-sur-Seine, because of the ground erosion, the spatial distribution of iron and steel-making wastes is the only evidence allowing us to determine a possible internal structuring (Dunikowski et al. 2007). Thus, at least four different workshops can be distinguished. Two groups

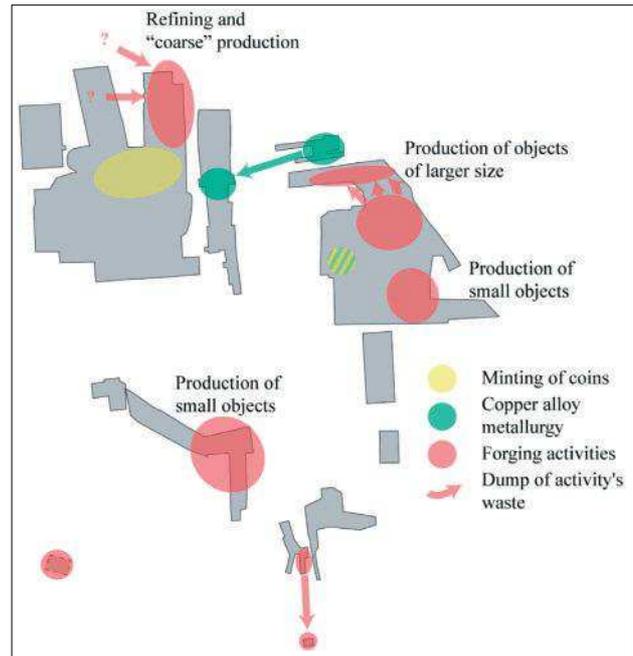


Fig. 15: Localization of specialized area at Villeneuve-Saint-Germain.

of considerable importance are probably dedicated to the same activities, a more modest forging place is associated with a copper-alloy workshop, and, finally, another area presenting evidence of craft activities is still insufficiently known, because, to date, it was only partially investigated. In spite of that, archaeometric analyses, the variety of wastes, and the coherence of the corpus of these zones could allow us to hypothesize that all the stages of post-reduction, like refining, elaboration of objects, finishing, and perhaps recovering and recycling, were present at this location.

For the north gate workshop of Vernon's *Oppidum*, the existing evidence presents a good coherence, indicating a workshop specialized in the working of small objects, as in the "Porte du Rebut" workshop at Bibracte (Pernot 1999). At this site, we encounter very small slag-cakes, and very little metal lost inside the slag-cakes. This indicates that a work of well refined metal was performed using short heating-times during the process. Also, the shape of the two forging-hearths (small and circular) excludes the work of voluminous objects.

In the open agglomeration of Acy-Romance, additional problems arise as a result of the preservation of the site. Too little material has been collected to carry out a characterization of a specialized area, and, as a matter of fact, a distribution analysis.

The analysis of the workshops at Bobigny is more complex because of the space separating the zones and the strong diachrony existing between workshops. However, only the parcel "Stade de la Motte" seems to be indicative of a specialization toward a specific production (swords and scabbards). The others are particularly non-specialized

and concentrated on the final phases of the elaboration of objects.

Difficulties in the interpretation of the specialization of the workshops of both the open agglomerations of Bobigny and Acy-Romance do not allow presenting a pertinent difference from the spatial organization of the *Oppida*. However, the open agglomeration of Varennes-sur-Seine, even if all the analyses are not yet completely performed, presents a similar organisation to that of the *Oppida*. The open agglomeration of Levroux can also be seen as an example of the specialization of forging activities (Berranger and Fluzin 2009). Consequently, even there, the differentiation between the two types of agglomerations does not find relevant arguments as regards the iron metallurgy.

3.4. Technical affiliations show an interdependence of certain workshops

A superior organization stage could be envisaged in terms of the interdependence between workshops, depending on their production and the position they occupied in the *chaîne opératoire*. These affiliations could allow bringing to light functional links between workshops of the same site, in particular according to the refining degree of the worked metal.

At Villeneuve-Saint-Germain, Condé-sur-Suippe and possibly at Varennes-sur-Seine, in districts with well-attested specialized workshops, the fact that some of them acquired crude masses of iron while others only worked well refined metal, seems to indicate that the first type of workshops provided the second with at least part of their raw materials. In other words, the presence of refining workshops illustrates the existence of technical links between them and other workshops.

This interdependency can also be seen through a larger convergence between several crafts towards a common finished product. This is the case at Condé-sur-Suippe with the presence of wood-working and other metal-working clues. Several hypotheses can be considered for this workshop, such as the assembling of barrels or buckets, the manufacturing of wheels with iron tyres, the production of carts and manufacturing of tools (assembling and riveting). Specializations would then be directed not toward a particular material, but toward a type of product, just like the specialisation of the work of a cartwright or a cutler.

At other sites, either the data available are too limited, or the practices too poorly specialized to prove or imply a dependency or interdependency.

On the one hand, we are confronted with the heterogeneity of the accessible data, and this report obtained at Condé-sur-Suippe cannot be credibly extrapolated to all *Oppida*.

On the other hand, the interdependence between workshops according to the compaction quality of the acquired metal intervenes only in sites which practice refining, whether it is opened agglomerations or *Oppida*. Consequently, this established fact seems to indicate that such

interdependence is related more to raw material supplying than to a particular organization of the agglomerations.

4. Conclusion

There is no blatant difference between the information obtained for *Oppida* and for open agglomerations of the Northern Paris Basin, neither in terms of the know-how involved, nor in terms of the location of the activities and the specialization of the workshops. While interdependence between workshops is not attested for the observed open agglomerations, the partial data obtained to date for these sites do not allow drawing a certain conclusion regarding this aspect. However, if we widen the comparison to other open agglomerations in the north of France, the sites of Varennes-sur-Seine and Levroux seem to present these interdependences.

Thus, the transition and the coexistence between open agglomerations and *Oppida* does not seem to really affect the organization of the activities taking place at these sites. This might indicate that the most important developments had already taken place during the times of the foundation of the first agglomerations, and were perhaps only accelerated during La Tène D, at the time of the emergence of *Oppida*.

To conclude, according to the micro-regional context of iron and steel-making under discussion here, it seems

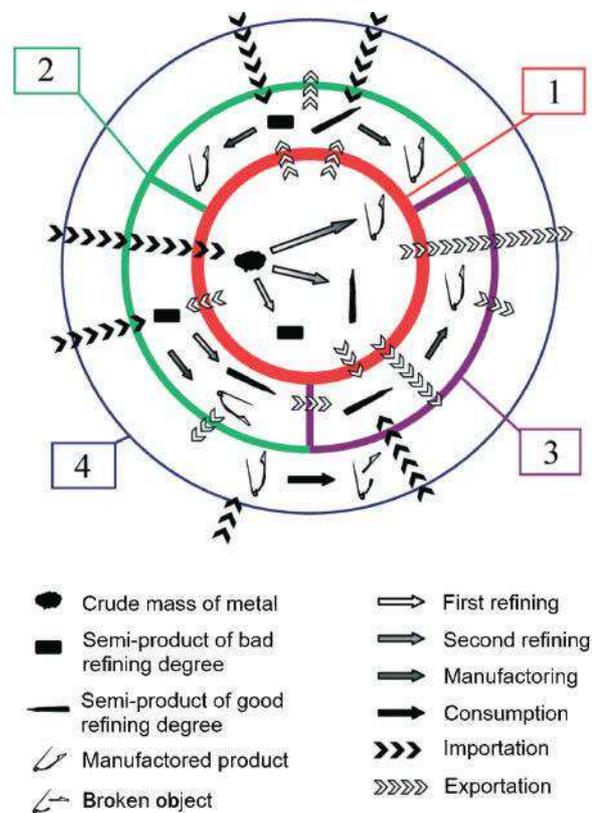


Fig. 16: Integration inside networks of acquisition/redistribution of the metal (Bauvais and Fluzin 2007). Schematic representation of possible relations between each level within a micro-region.

that Aisne's *Oppida* (Condé-sur-Suippe and Villeneuve-Saint-Germain) acquired semi-finished products of a low refining degree and transformed them into finished objects (Level 1 in the network of acquisition/redistribution of the raw material – Fig. 16) (Bauvais 2007; Bauvais and Fluzin 2007). These sites appear to be the only ones in their regional context (of a weak reduction activity) practicing this work. No other site, even considering open agglomerations as well, shows this activity. *Oppida* were consequently at the head of a monopoly of the imports and of the transformation of the crude metal (Bauvais 2007). More to the south (Sénonais – Pays d'Othe), the open agglomeration of Varennes-sur-Seine seems to assume the same function, this time in a zone of important primary production (Dunikowski et al. 2007). This way, access to raw materials appears as a better explanation for the differences in the sites' production roles than the type of agglomeration.

The period under consideration is one which saw a profound change taking place in society, in particular in terms of the new forms of political organization (transition to a state organization form) (Brun 1995, 1999). This more complex structuring materialized more in the regional organization of the political and economic space than in the internal development of agglomerations. It was the position of these sites in the regional network of acquisition/redistribution of material which created specificities in the internal layout of craft districts rather than deep changes in the conception of the craftsmen's organization.

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