Flint Mining in Northern France and Belgium: a Review

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Abstract: This article proposes an overview of current knowledge on flint mines in France and Belgium. Indeed since 1995 there has been no review of the documentation on this question and on the state of research regarding several themes: status of sites, dating, and product distribution. Several new discoveries in France resulted from preventive archaeology, such as Ressons-sur-Matz, Ri-Rônai, Mesnil-Saint-Loup, Espins or Loisy-en-Brie. Other formerly known quarries were rediscovered or partially explored at Soumont-Saint-Quentin, Flins-sur-Seine and in the region of the Saint-Gond marsh. In Belgium, extraction pits were investigated at Rullen, and in the Mons basin, excavation was undertaken at several sites (Harmignies, Villerot, Mesvin) and productions were studied on others (Flénu, Douvrain). At the major site of Spiennes, new shafts and workshops were excavated, with discoveries of human skeletons in their fillings. Extensive radiocarbon dating was undertaken on several mining sites, but this was still insufficient to characterize all the extraction activity. While the dates indicate a peak of exploitation in the 4th millennium BC, certain mines such as Spiennes were exploited for a very long period, about 2000 years. The choices of production vary: certain mines with a local impact have productions restricted to rather domestic use, whereas others such as Spiennes and Jablines are massively exploited and diffuse at a regional scale, or even at a greater distance, extracting at depth and producing quality products with a high level level of know-how (Spiennes, Jablines). The analysis of the products distribution from these two mining centres shows that finished products circulated over several hundred kilometres.

Keywords: flint mine, France, Belgium, axes, distribution networks, radiocarbon dates

Introduction

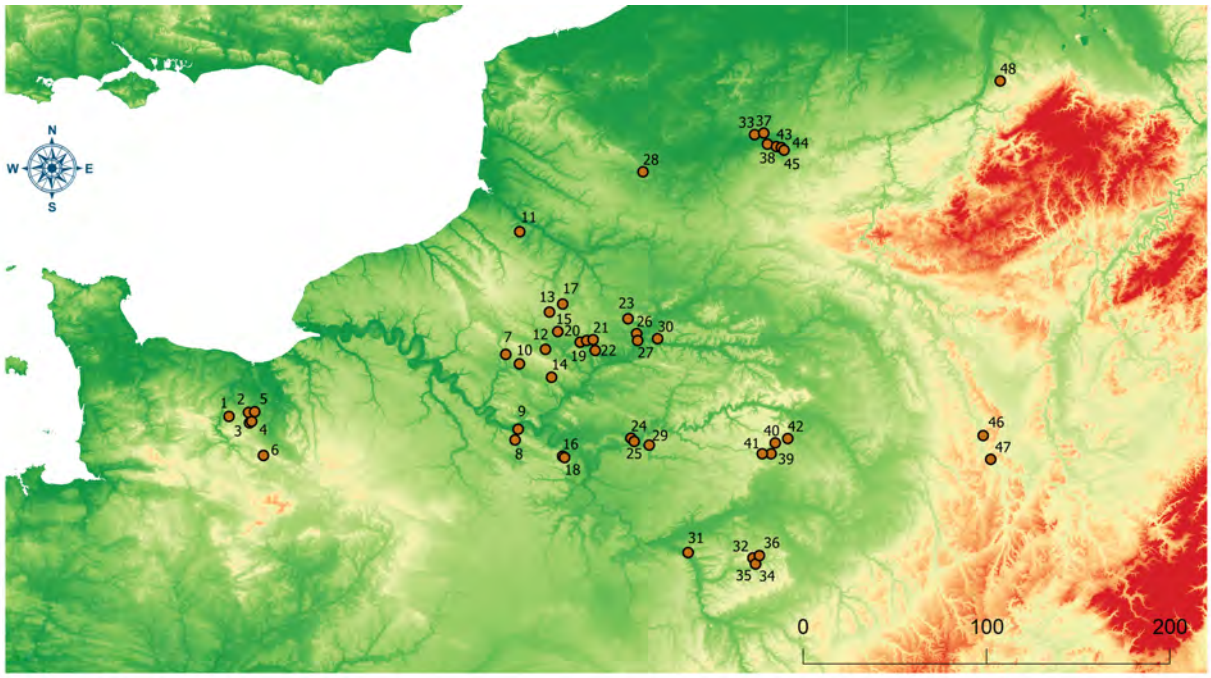
The publication of a voluminous catalogue (in 1980, at the Bochum conference; Weisgerber 1980), providing the scientific community with a detailed state of knowledge on flint mines throughout Europe, marked a turning point in flint-mining research, at last placing it in the position it deserved – at the forefront of technological and socio-economic studies on the European Neolithic. This catalogue was updated in a special volume of *Archaeologia Polona*, published on the occasion of the 7th Flint symposium in 1995 at Krzemionki Opatowskie, Ostrowiec Świętokrzyski district (Lech 1995). The present special volume in honour of Jacek Lech provides us the opportunity to propose a new synthesis of knowledge acquired over the last 20 years on the subject, focusing however on north-western France and Belgium. Nevertheless, the aim of this article is not only to provide an inventory of recent discoveries, but also to address some particular topics, where significant progress has been made, such as the status of mining sites, the dating of mining activity or the distribution networks of specialised productions.

New archaeological data on flint mines

Discoveries and rediscoveries in France

Since the discoveries in the late 1980s of the flint mines at Jablines 'le Haut-Château' (Seine-et-Marne district; Bostyn and Lanchon 1992), during construction of a high-speed railway link, and in the Othe region, during construction of the A5 motorway (de Labriffe *et al.* 1995a, 1995b; de Labriffe and Sidéra 1995a, 1995b), some new flint mines have been added to the corpus of mining sites in France (Fig. 1).

In 2005, a new flint mine exploiting the Campanian level was discovered at Ressons-sur-Matz, Oise district (Beaujard and Bostyn 2008). Unfortunately, no excavation was conducted on this site, and only the information collected during the archaeological diagnostic is available today. The removal of subsoil on a surface of 2000m^2 in addition to trial trenches helped to delimit the extraction area to the north, south and east, while the site continues westward out of the excavated zone. Thirty-eight extraction features were mapped on surface but just one was partially



1. Espins, 2. Bretteville-le-Rabet «La Fordelle», 3. Potigny, 4. Soumont-Saint-Quentin «Les Longrais», 5. Soignolles, 6. Rônai «Le Fresne», 7. Sérifontaine «Champignolles», 8. Maule «Moussets», 9. Flins-sur-Seine «Le Clos»/Aubergenville, 10. Jaméricourt, 11. Hallencourt «Les Bouts du Mont», 12. Frocourt, 13. Auchy-la-Montagne, 14. Méru «Carrière Brébant», 15. Velennes, 16. Sèvres «Le Brimborion», 17. Hardivillers «Les Plantis», 18. Meudon «Bas-Meudon», 19. Etouy, 20. Airion, 21. Lamecourt «Route de Cuignières», 22. Nointel «Bois du Chêne Auger», 23. Ressons-sur-Matz «Le fond Madelon Duriez», 24. Jablines «Le Haut Château», 25. Coupvray «Les Chauds Soleils», 26. Coudun, 27. Margny-lès-Compiègne, 28. Fampoux-pres-Arras, 29. Bouleurs, 30. Saint-Crépin-aux-Bois/Ibouvilliers, 31. Serbonnes «Le Revers de Brossard», 32. Pâlis «le Buisson Gendre», 33. Villerot, 34. Villemaur-sur-Vanne «Le Grand Bois Marot», 35. Villemaur-sur-Vanne «Les Orlets», 36. Mesnil-Saint-Loup «Les Vieilles Vignes», 37. Baudour-Douvrain, 38. Flénu, 39. Coizard-Joches «La Haie Jeanneton», 40. Loisy-en-Brie, 41. Villevenard, 42. Vertus, 43. Mesvin «Sans Pareil», 44. Spiennes Camp à Cayaux, 45. Harmignies, 46. Saint-Mihiel «Côte de Bar», 47. Commercy «Côte de Bucy», 48. Fouron-Saint-Pierre «Rullen».

Fig. 1. Map of the flint mines in France and Belgium. CAD: F. Giligny.

excavated. The shaft is 2.75m deep and the length of the galleries at the bottom is no greater than 2.5m. The archaeological finds from the filling of the shaft consist essentially of waste, particularly with a fragment of bifacial preform. Only one fragment of unworked deer antler was found on the bottom of one gallery and was probably a reserve for the manufacture of mining tools. Even if we cannot extrapolate the evidence from one pit to the entire flint mine, the proximity of the shafts on the surface suggests that this mine is composed of small and relatively shallow shafts. The best comparisons can be found on the flint mines of Nointel and Hardivillers (Oise district; Dijkman 1980; Agache 1959) and the Ressons flint mine seems to match the standard Picardy mining sites exploiting Cretaceous levels through small shafts with chambers or short galleries.

In 2009, another flint mine was discovered at Mesnil-Saint-Loup (Aube district) and the excavations conducted in 2010 on a surface of 8000m^2 revealed more than 560 extraction features which were all mechanically excavated (Hauzeur *et al.* 2010). Various types of features have been found, from simple mining pits (on average 0.90m deep) to deeper shafts (maximum 2.85m deep) with short and more or less radiant exploitation at the bottom. The high density of pits on the surface, some of them adjacent, probably resulted from the low intensity of extraction underground. The lithic remains testify almost exclusively to axe production, even if some cores indicate flake production. This flint mine belongs to the mining complex of the Othe region defined at the time of the A5 motorway excavations (de Labriffe and Thebault 1995), including the flint mines of Villemaur-sur-Vanne 'les Orlets' and 'Le Grand Bois Marot' (de Labriffe *et al.* 1995a, 1995b) and the mine of Palis 'le Buisson Gendre' (de Labriffe and Sidéra 1995a). It shares many common characteristics, such as the morphological diversity of the features, the low intensity of exploitation of the flint levels and the high density of pits on surface.

Recently, another new flint mine was found at Loisy-en-Brie (Marne district) during the construction of a house (Martineau *et al.* 2014). The extraction features are also shallow pits or small shafts with a few short galleries. Sometimes the features are several metres wide but no more than one metre deep, because the flint levels in the Campanian chalk outcrop here.

A new flint mine was discovered at Ri-Rônai (Orne district) in advance of construction of the A88 motorway between Caen and Sées. A surface area of 2.2ha was investigated and 550 features were identified (Ghesquière *et al.* 2012). Five main types of feature

were encountered: single pits that were not deep but sometimes several metres wide, shafts with chambers or with complete exploitation at the bottom all around the shaft, approximately 1.2m deep, deeper shafts (2m) of 2/3m diameter on surface, and deeper shafts (4m), sometimes with two extraction levels. In these cases the level of raw material is completely exploited and additional galleries are sometimes dug and extend the existing ones. Raw material included in the Jurassic chalk levels comes in the form of regular and very compact spheres that do not offer a suitable angle for knapping. It is necessary to break these spheres into two, then use each half independently. The main production conducted on the mine is also axe blade production, carried out on the half spheres or on large flakes.

The last flint mine discovery that may be mentioned, is that of Espins 'Foupendant' (Calvados district), made during an archaeological diagnostic (Charraud 2015) when thirty three extraction features were discovered. Four of them, mechanically excavated, are simple pits which depth can reach 3.3m. The Cinglais flint exploited in these shafts has been searched exclusively for blade production performed by indirect percussion. Two radiocarbon dates obtained on charcoal from the filling of one of the shafts, allow to situate the mining activity in the early Neolithic, which is perfectly consistent with the lithic remains found. This makes it one of the oldest flint mining sites in France.

Furthermore, some formerly recorded flint mines were the subject of new research. In 2008, the flint mine of Soumont-Saint-Quentin (Calvados district) was re-investigated and more than 50 features were observed (Ghesquière *et al.* 2008). Only 9 have been partially excavated. Jurassic flint was extracted by means of simple pits or shafts with galleries about 2m deep. The aim was to obtain nodules for the production of regular blades and tranchets. The comparisons with the mine of Espins, which is located about fifteen kilometres to the west, lead the authors to attribute also this flint mine to the early Neolithic.

In the Saint-Gond marshes region, a research project directed by Rémi Martineau enabled a complete review of all the old documentation (Martineau *et al.* 2014). The information on flint mining sites was largely under-exploited, as previous work had focused mainly on the hypogea cemeteries. The re-analysis of these old data confirmed and documented the flint mines of Villevenard 'La Craïère', Coizard 'La Haie Jeanneton' and Vert-la-Gravelle/Toulon-la-Montage, as well as Vertus 'Grandval' located around 10km to the north. All these flint mines exploited the same Campanian level of flint in the Cretaceous chalk. This level forms a discontinuous outcrop, the depth of which seems to vary from one mine to another. Dating of these sites is not firmly established for the moment, as only one date is available (others are in progress), but the close relationship between the flint mines and the collective tombs suggests at least one operating phase during the Late/Final Neolithic.

Finally, we can mention a collective research project directed by François Giligny on the flint mine of Flins-sur-Seine (Yvelines district), first identified by surface collections of abundant lithic artefacts, especially flaked axes. The comparison of aerial photographs and geophysical surveys confirmed the existence of extraction features (Giligny and Bostyn 2016), but none have been excavated. The important work of recording, mapping and production analysis has clarified the different stages of the operational sequence of axe production, which are strictly comparable to those known from the flint mine of Jablines where the same tertiary raw material has been exploited. Moreover, the terms of distribution of finished or semi-finished products, especially towards western France, was clarified. This research enlarged to all raw material available locally or imported from distant regions (Britain, Italy for example), highlighted the dynamism of axe blade distribution networks, with the river Seine acting as an important axis for travel and circulation.

All these flint mines (excluding Flins), although working at different geological horizons (Cretaceous and Jurassic), have a number of common characteristics, specific types of shallow features, often pits or shafts with chambers or small galleries. The consequence is a considerable surface density of shafts, which enables optimal exploitation of the resources. The deepest shafts, present on all sites, are probably tests to identify other exploitable flint levels. In fact, the labour involved in digging these features is not excessive and would not have required a high level of expertise.

Twenty years of flint mines discoveries in Belgium

In Belgium research has continued over the last twenty years, almost exclusively in the Mons Basin. No further investigation has improved our knowledge on mining sites formerly identified in Brabant and Hesbaye.

In Voeren near the Dutch border, chipping floors were spotted at the end of the 19th century at Rullen-Haut, Rullen-Bas, Sint-Pieters-Voeren 'Vrouwenbos' (a place comprising Fouron Saint-Pierre 'Bois Communal' and 'Bois des Sapins') as well as Remersdael 'Rodebos' and 'Hoogbos' but no extraction feature had ever been identified and excavated there. The survey of the laying of a gas pipeline in 1998 confirmed the presence of a flint extraction site south of the hamlet of Rullen (village of Sint-Pieters-Voeren). Two flint extraction

pits, a test pit and several flint knapping waste areas were unearthed. Both pits have a funnel-shaped profile. They have a diameter of 5.2m and 7.2m and a depth of 1.7 and 3.2m (Creemers *et al.* 1998). The exploited flint occurs as a flint nodules accumulation layer from the weathering of upper Maastrichtian chalk. Flint also occurs in secondary position in slope deposits where it is mixed with the Oligocene sand. It was exploited in both stratigraphic positions, especially on the slopes of a dry valley where flint is near the surface. One of the features (ST5) could be dated to the Late Neolithic (IRPA–1273: 4580 ± 40 BP). According to two radiocarbon dates from the chipping floors, the exploitation could have been active during the Bronze Age (Lv–1858: 3770 ± 80 BP and Lv–1138: 3570 ± 70 BP). Flint was worked on site for obtaining laminar products and axe-heads. The extraction features, knapping workshops and productions are reminiscent of low scale intermittent exploitation. The lithic study indicates that the assemblage is technologically unsophisticated and that knappers did not have a very high level of know-how (Creemers *et al.* 1998; Vermeersch *et al.* 2005).

In the Mons Basin, excavations have focused primarily on the mining site of Spiennes, where research and preventive excavations were conducted from 1997 until now by the Walloon Public Service and the Society of Prehistoric Research in Hainaut. Also, a critical review of mining sites of the Mons Basin has been drawn up based on existing literature and surveys (Collin 2016).

If we already know that the existence of flint mines in Strépy 'Carrière Denuit' and Obourg 'Carrière Roland' must be rejected (de Heinzelin *et al.* 1993), we must now do the same for Saint-Symphorien 'Le Cerneau / Les Phosphates' and Ghlin 'Le Moulineau', as there is no convincing evidence for the mining character of these sites. The presence of a mining site at Obourg cannot however be excluded. Indeed, a fortuitous discovery in a place called 'The Village' has raised the question of mining activity in this locality. Mining tools made of red deer antler dated between 4600 and 4500 BC were discovered at depth of 2m (Jadin *et al.* 2008). However, no lithic material was recovered and the mining context could not been confirmed by any archaeological excavation.

A small-scale preventive operation was undertaken in 2004 in Harmignies at a place called 'La Fosse' (Collet *et al.* 2004). The stripping of a surface of 1800m² revealed a single mining feature partially destroyed by modern quarrying activity, as well as a shallow pit containing flint knapping waste. The extraction feature was just under 2m deep and included three short galleries about 60cm high. One is dug into the chalk, and the other two at the boundary between the chalk and indurated sands present in the dissolution pipe located at the top of the chalk. Exploited flint comes from the base of the dissolution pipe, where flint accumulations have been identified. The knapping waste on the site, especially from the shallow pit, indicates the production of axe-heads and flakes but also the good level of expertise of the knappers. Three deer antler tools have enabled us to date the structure between 3100 and 2900 BC.

A potential mining site was identified at Villerot 'Lambiez'. Artefacts either present a fresh cortex or reflect acquisition in dissolved chalk levels. The matrices have the typical characteristics of local flint. The presence of shallow extraction pits in the area where the flint outcrops cannot be excluded. The tranchets tools, particularly numerous, might have been used for extraction (Van Assche and Dufrasnes 2009). The lithics recovered from survey suggest an activity during the Middle Neolithic. The few fragments of polished axe-heads are made of Douvrain type flint. However, artefacts made of Villerot flint such as tranchets and flake tools were identified within a 10km area around Villerot 'Lambiez', on the surface of the settlements of Sirault 'Notre-Dame de la Délivrance' (Middle Neolithic), Harchies 'Rieu' and Harchies 'L'étang de Préau'.

At Mesvin 'Sans Pareil' archaeological survey has confirmed the presence of an extraction feature near the area excavated in 1957 (Collet and Woodbury 2008). The productions of the site remain to be characterized. On the same plateau, the existence of mines in Ciply at a place called 'Trou des Sarrasins' is unverifiable. The area was completely destroyed in the 19th century by the faience and phosphatic chalk industries (Cornet 1947: 45).

At Flénu, on the plateau of 'L'Ostenne', several 10 metres deep extraction features have been observed in the past (Briart and Cornet 1872). Survey in advance of road development has confirmed the mining status of the site (Leblois and Pacyna 1994) and ongoing research has specified an activity oriented to the production of Turonian axe-heads, generally small in size and with a narrow butt. It has to be noted that the density of features is very uneven on the 40 hectares covered by the site.

At Douvrain, the exact position of the extraction features remains unknown. However, the study of a large collection at the Royal Belgian Institute of Natural Sciences originating from chipping floors discovered in this hamlet has confirmed the presence of flint mines in this locality. This is a coherent assemblage consisting of several hundred axe rough-outs, associated with a few flint extraction picks. In this vast collection, a significant variability of raw material was observed, including the type called 'Ghlin flint'. Current studies

indicate that Douvrain axe-heads are distributed as far as 45km, including Final Neolithic contexts (Gillet *et al.* 2015).

At Spiennes, three shafts of 9 and 10m depth have been investigated thoroughly since 1997. These excavations complement the data available in this sector and reveal a complex stratigraphy, reflecting long-lasting filling processes as well as interruptions in backfilling. This is evidence for seasonal organization of mining activities on the site (Collet *et al.* 2016). These excavations have provided new environmental data (Collet and Van Neer 2002; Defgnée and Collet 2003). Human skeletons were also found in the fills of these features (Collet and Toussaint 1998; Lavachery *et al.* 2015). Various preventive excavations in the vicinity of deep shafts and in two other places at the 'Camp-à-Cayaux' and along the valley of the river La Trouille, combined with systematic surveys conducted by François Gosselin, helped clarify the extent of the mining areas and better define the site's size (Collet *et al.* 2008). Chipping floor excavations were also carried out at 'Camp-à-Cayaux' and 'Petit-Spiennes'. The study of the raw material economy shows a drastic selection practiced from the extraction phase and confirms a whole activity oriented towards the production of axe-heads and blades (Collet *et al.* 2014; Collet *et al.* 2016). These new excavations, as well as the analysis of results from older excavations, helped to increase significantly the number of dates available for the site. There are now forty dates for the three mining areas and for the ditched enclosure (Collet *et al.* 2016).

Socioeconomic and cultural contexts of mining

While fieldwork in France over recent years is mainly related to preventive archaeology, several research projects, some of which involve both France and Belgium, have enabled work to be completed on areas surrounding mining sites, in a wide range of domains.[1] We shall return here to three particular domains: progress in the dating of the mining phenomenon in France and in Belgium, a reflection on the status of the mining sites and an approach to the question of the diffusion of mining products.

An intense development of the extraction activity at the end of the 5th millennium and at the beginning of the 4th: an illusion from radiocarbon dates or a reality?

With a few rare exceptions, the mining sites yield very few artefacts other than lithic products. This constantly raises the question of chronology and especially the attribution of mining sites to a specific cultural group. A link can sometimes be established with nearby settlement sites, as is the case with the Jablines mine and settlements in the Marne valley such as Vignely 'Noue Fenard', to which we can associate several graves containing polished axes (Bostyn 2015), or with Spiennes where a Michelsberg enclosure was built (Vanmontfort *et al.* 2008). But in certain areas, such as the 'Pays d'Othe', the evidence is very incomplete and such relations cannot be established. Thus use of radiocarbon dates is an essential solution, even if the method is not entirely satisfactory, due to error margins for all dates, even using AMS, and the problem of plateaus on the calibration curve. Over the last 20 years, archaeological operations have nevertheless provided large series of dates which complete the data acquired in the 1990s. In France, the most significant series come from excavations of the mines at Ri-Rônai (Ghesquière *et al.* 2012) and Mesnil-Saint-Loup (Hauzeur *et al.* 2010; Bostyn *et al.* 2018). These large series of dates (52 at Ri-Rônai and 30 at Mesnil-Saint-Loup), are particularly interesting because they relate to vast sites, occasionally with complete transects of the mine, as at Ri-Rônai (or Jablines). This improves the representativeness of the sample.

At Spiennes, where preventive and research excavation has been continuous for 20 years, 32 dates have been obtained for the various exploited sectors. The interest here is that, thanks to intensive re-examination of information obtained in 150 years of research on this site (Collet *et al.* 2008), the dated samples concern varied contexts and all the investigated sectors of the mining site. Furthermore, the last excavations at Petit-Spiennes, some of which are still in progress, offered the opportunity to obtain several dates on the same shaft but from different phases, from its exploitation then from its abandonment. This approach enables one to estimate the length of time involved in the complete filling of rather deep shafts, the stratigraphy of which already testifies to a long and complex history.

The compilation of radiocarbon dates available[2] (fig 2) adds up to 93 dates for the sites of Spiennes (32), Harmignies (3), Obourg (2), Rullen (1), Ri-Rônai (28)[3],

[1] We should mention here the Programme collectif de recherches sur le Néolithique de l'Ouest parisien (Giligny and Bostyn 2016), which was especially focused on the Flins-sur-Seine flint mine, the Programme collectif de recherches sur la géoarchéologie du silex dans le nord-ouest de la France (Allard *et al.* 2005), the French-German ANR DFG project on the Michelsberg directed by J.-P. Demoule and F. Lüth (Aubry *et al.* 2014), the JADE ANR project directed by Pierre Petrequin (Giligny *et al.* 2012), the cooperation program with RBINS and IAE PAN (Collet *et al.*, 2008); the Spiennes flint mining site dating project and the study of human remains conducted by the public Service of Wallonia in collaboration with the Royal Belgian Institute of Natural Sciences and AWEM (Toussaint *et al.* 2010), as well as doctoral research on productions from flint mines in the Mons Basin and their diffusion (Collin, in progress).

[2] Six dates have been excluded: one from Saint-Mihiel, one from Jablines, one from Nointel, two from Bretteville-le-Rabet, due to their high standard deviations (+– 190 or more), and a date with old wood effect from Mesvin.

[3] A total of 52 dates were made on the Ri-Rônai mine, but some of

Jablines (20), St-Mihiel (2), Ressons (1), Sèvres (1) and Hallencourt (1), which we can compare to the 60 dates from the 'Pays d'Othe' and the Yonne (Serbonnes – 14, Palis 4, Villemaur-sur-Vanne 'Bois Marot' – 4, Villemaur-sur-Vanne 'Les Orlets' – 8 and Mesnil-Saint-Loup – 30). These dates indicate that the beginning of the exploitation of certain sites may have started in the middle of the 5th millennium BC, as at Obourg 'Le Village', and more certainly from the end of the 5th millennium BC, as at Mesvin. At Villemaur-sur-Vanne, the majority of the extraction features are also connected with this phase and the radiocarbon dating is coherent with one of the rare finds from the features, in this particular case a complete pottery vessel attributed to the beginning of the regional Middle Neolithic II (de Labriffe *et al.* 1995b). But intensive mining activity is clearly dated to the first quarter of the 4th millennium on the majority of sites (Ri, Jablines, Spiennes 'Camp à Cayaux' and 'Petit-Spiennes', Mesnil-Saint-Loup). Nevertheless, in the sector of Petit-Spiennes, the main exploitation phase takes place during the second half of the 4th millennium, which is also the time when activity seems to develop at Rullen, Harmignies, Palis and Serbonnes. Lastly, even if it appears less intense, the extraction of raw material continues on the mines, sometimes right up to the end of the Neolithic.

If we compiled all the available dates for France and Belgium according to the same principles as those implemented by Tim Kerig and his collaborators on the scale of Europe (Kerig *et al.* 2015), it is likely we would obtain a curve rather close to theirs (op cit, Fig. 2), at least for the second part of the Neolithic from 4200 BC, with a very marked peak around 4000 BC. The parallel evolution of the curves of fluctuation in mining activities and population density suggests quite strong links between demography and mining, with increases and reductions in lithic production reflecting actual economic cycles. However, although this cumulative approach effectively highlights broad evolutionary trends, it does mask regional disparities. First of all, as regards the early Neolithic of regions concerned by this study (between 5100 and 4750 cal BC), while we observe a considerable increase in the number of sites and thus probably in population, together with an intensification of long distances exchange networks (Allard 2005; Bostyn and Denis 2016), the indications of mining remain so far particularly tenuous (cf. above). There are still very few radiocarbon dates confirming the presence of mining features during the early Neolithic.

Besides, we can probably see in the increase of mining activities at the end of the 5th millennium BC,

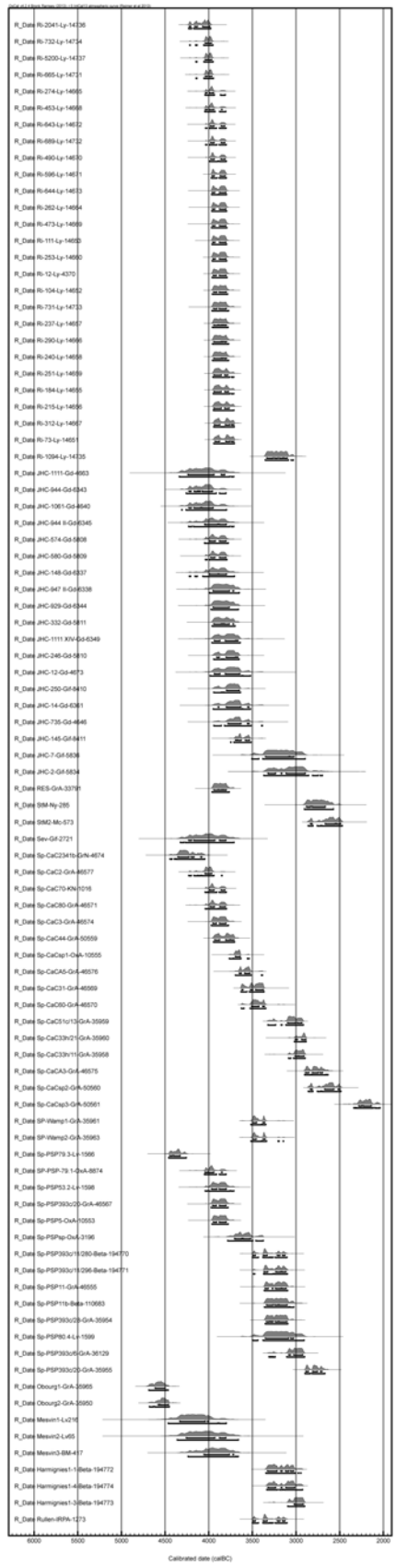


Fig. 2. Radiocarbon dates from flint mines (except Pays d'Othe), ordered chronologically by site. After Bostyn and Lanchon 1992; Collet *et al.* 2004; Vermeersch *et al.* 2005; Beaujard and Bostyn 2008; Jadin *et al.* 2008; Toussaint *et al.* 2010; Ghesquière *et al.* 2012; Collet *et al.* 2016.

these have yet to be published. The whole set of dates is coherent, according to oral information kindly provided by Emmanuel Ghesquière and Cyril Marcigny, to whom we express our gratitude here.

accompanied by massive production of axes blades, the reflection of an evolution of economic activities. The forest clearance attested by palaeo-environmental studies could indicate not only forest exploitation linked to a high demand for timber used for buildings and fences, but also an evolution in the management of fields and pastures.

Furthermore, we cannot avoid the question of the representativeness of the series of dates available today. They may appear numerous, but they only date small parts of the mining sites, which always cover vast surface areas but have never been very extensively explored. So, it is very likely that the durations of mining exploitation would be considerably extended if these sites were more exhaustively investigated, as at Spiennes where various sectors of the site were studied and where the exploitation covers about two millennia.

To conclude on the question of radiocarbon dates, the available data in our study area show very intense mining activity throughout 4th millennium BC, marked however by some variability between the mining sites, resulting from the conjunction of various factors. The small number of dates testifying to mining activity in the 3rd millennium is probably more attributable to a deficit of data than an actual population decline – a decline which is in fact contradicted by the numerous discoveries in recent years of settlement sites in northern France (Joseph *et al.* 2011).

Spatial structure of territories: towards a hierarchy between mining sites?

In the various research projects, particular attention was paid to the theme of the location of flint mines within territories and their impact on the socio-economic structure of Neolithic populations.

To consider the mining phenomenon as a whole is not a satisfactory approach, as we have seen previously: mining sites have not all been operating simultaneously. Moreover, other factors such as the characteristics of the material used and the means used for its acquisition need to be considered. There are significant differences in the morphology of the extraction features and in particular in the depth of the shafts.

At a macro-regional scale, the various mining sites of the Mons Basin are distinguished by the investment in the acquisition of flint blanks (dissolution pipe versus deep mines), their flagship products (blades, axe-heads, flake tools) and, as a corollary, their distribution. Two trends in acquisition-production strategies stand out. The first, as at Villerot and Harmignies, is to limit investment in terms of raw material acquisition, which results in a production that, even if it can be of high standard (Harmignies 'La Fosse'), is restricted and anecdotal in terms of socio-economic impact. On the contrary, the significant investment in the form of deep shafts at Spiennes and Flénu is explained by the choice to exploit specific flint seams, in line with defined productions. Besides the quality of the raw material, richness of the seams and morphometry of blocks are essential. This is not the raw material as such which was sought, but blanks conducive to mass production of axe-heads and regular blades. This enables one to determine which extraction sites had a structural economic function: Douvrain, Flénu and Spiennes. This correlation between investment in the acquisition and production of blanks and the importance of the site in exchange networks peaked with the deep shafts of the Camp-à-Cayaux at Spiennes. Regular slabs of 500kg were quarried there to a depth of 16m, despite the presence of shallower seams of exploitable nodules. Spiennes is also the only site of the Mons Basin where the production of long blades is attested, and this is particularly well documented in the 'Camp-à-Cayaux'.

In the northwest of France, similar observations can be made between mining sites. The Bartonian Tertiary flint worked at the Jablines mine comes in the form of slabs, certainly less voluminous than those of Spiennes, but larger than the nodules from the Cretaceous horizons. In addition, their tabular morphology is a major asset for the production of bifacial pieces that naturally fit into the initial volumes, while the more irregular morphology and less suitable Cretaceous nodules require a prior trimming of blocks with an inevitable loss of volume. The search for high-quality raw material at Jablines is attested by features over 7m deep, requiring a significant investment not only for sinking the shaft but also for digging galleries that also reach out more than 7m horizontally. On the other hand, the extraction features that exploited the Cretaceous horizons are mostly around 2–3m deep, and are sometimes simple pits. Underground features are rarely extensive, consisting of alveoli and a few small, shallow galleries. The use life of these structures is rather short. Furthermore, in addition to providing the raw material for axe production, the shafts probably supplied the vast majority of the raw material used for the domestic productions, most of which come from Chasséen settlement contexts (Augereau *et al.* 2016). Lastly, in the well-documented areas such as the middle Oise valley, there is good evidence for links at local level between flint mines, plateau and valley enclosures and open settlements, all spread over an area of about 20km in diameter (Aubry *et al.* 2014). The flint mines seem well integrated into the spatial structure of the territories and the axe-heads produced on these mines did not circulate over long distances, remaining in use in a local context.

Thus one can see a hierarchy between mines with a high level of investment in the methods of acquisition at depth of quality raw materials and shallower mines apparently dedicated to the supply of material for domestic productions. So one last factor is also involved in the territorial organization, directly related to the quality of the productions in mining contexts: the destination of products. This can either be local, regional or extra-regional.

Production and distribution of mining products: the middle Neolithic case (Chasséen, Michelsberg, Spiere)

The distribution of productions from mines has been studied through different research projects, but work has mostly focused on the middle Neolithic, due to the high number of settlements, some of which have been recently excavated, providing large and varied lithic assemblages which have been exhaustively studied. The remainder of the artefacts come from enclosure sites, providing a homogeneous type of context for study. Given the ranking proposed above, it seemed important to estimate the respective influence of the mines of Spiennes and Jablines on the lithic economy of settlements, and to evaluate the influence of these large mining complexes (Bostyn and Collet 2011). The research conducted on the flint mine of Flins-sur-Seine, the second one exploiting Bartonian flint, provided the opportunity to carry out a detailed study of the operating sequences and the distribution of Bartonian axes to the west (Giligny *et al.* 2012). Others projects are now underway, notably an inventory of flint resources in the Mons basin, supplemented by a study of the distribution of mining tools between the middle Neolithic and the final Neolithic (Collin in progress).

Focusing on the mining complex of Spiennes, various studies (Colman 1957; Hubert 1969; Collet 2012) have shown that there were two main productions: axe-heads, the largest of which are 28cm long, and long blades (up to 20cm) from blade cores with posterior crest preparation. There are also chisels. On the flint mine of Jablines, only the production of axe-heads is attested, with the largest reaching 30 cm in length. The distribution of the Spiennes flint takes on various forms, depending on the distance from the mine. Except for the Petit-Spiennes enclosure where all flint artefacts come from the mine, two settlements located within a distance of 20km provide a contrasting picture. At Thieusies 'Ferme de l'Hosté', specific products like axe-heads, chisels and blades are brought in as semi-finished products and about 80% of the assemblage is Spiennes flint. The picture is slightly different for the Neufvilles settlement, located 17km from Spiennes, where specific mined products are very rare (less than 15%). There are no flint axes and only a few blades possibly come from Spiennes. The assemblages from sites located at 20–60km distance, such as Spiere, Ottenburg/Grez-Doiceau and Schorisse, show that the mining site of Spiennes plays a definite role in raw material procurement strategies. This can be partially linked to the deficit of raw material near these settlements, especially in Brabant. For sites located at 60–80km distance, Spiennes flint is found in much lower quantities and above all, beside finished products like polished axes and blades, there are flakes or flake tools whose size and presence of cortex confirm that they do not originate from re-shaping axes. Over 80km, up to 150km, there are only finished products (blades and axes) from the specialised productions, but they appear to be rare. However, Spiennes type flint (or light grey Belgian flint) has been reported on the Michelsberg site of Koslar (Germany), where Rijckholt flint predominates, although this remains to be clarified (Hamard 1993; Schön 2008). If confirmed, this would provide additional evidence for a privileged distribution of Spiennes flint in the Michelsberg area.

As regards the Bartonian flint, the situation is more difficult to understand because of the potentially simultaneous working of the flint mines at Jablines and Flins. Also there is very probably a third mine at Lhery (Marne), although this has not yet been formally identified. Therefore, we will only take into account sites located over 40km from these three mines. It is interesting to note that the data are quite similar, because on all the sites located between 40 and 70km, such as Boury-en-Vexin, Catenoy, Bercy, Maison-Alfort, next to the blades and axe-heads which arrived as finished products, there are some flakes and flake tools. Over 70–80km, only finished products are found. We must insist on the fact that the type of imported product differs according to the site's cultural background. At Louviers (Eure) for example (Giligny 2005), a site belonging to the Chasséen culture, axes and two roughouts were imported and they represent two third of this type of tool. Further east, at Mairy (Ardennes), where Spiennes flint is abundant despite the distance from the mine, Bartonian flint axes are rare and represent only 6% of the whole assemblage. Bartonian blades are present here even though they form a minority in the assemblage (6.5% of waste, 5.3% of blade tools). Over 100km to the north, Bartonian artefacts become uncommon but are still present: they indeed occur on the Belgian sites of Spiere, Ottenburg/Grez-Doiceau and Kemmelberg (Collet and Collin unpublished). To the south-east, Bartonian flint was not distributed, strongly suggesting that this was due to a cultural frontier.

Conclusion

The wealth of knowledge both from new excavations and from research projects targeting specific problems enables us to put into perspective all the information

from the mining sites and the settlements. Differences appear between materials selected for productions that required a particular level of know-how (large blades and large axes) and materials used for a production of medium-sized axes or simple flakes in domestic contexts. The investment involved in the search for these materials is shown by the digging of deep shafts and is highlighted by the distribution of finished products over long distances, up to 200km. Thus the status of the different mining sites varies. While mines with small extraction features participate in the structuring of territories on a local scale, mines with deep shafts exert an influence that crosses the borders of the cultural entities. If the subject is enlarged to include sandstone and other rocks, comparable situations can be observed, in which certain materials such as jadeites or dolerites circulated over long distances while others clearly had a more local impact.

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