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The Neolithic Flint Mines of Les Marais de Saint-Gond and La Côte des Blancs (Marne, France)

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Abstract

The Côte d'Île-de-France, in particular around the Saint-Gond Marshes, is well known for numerous collective burials and notably for its hypogea. Eighteen flint mines have also been excavated there during the nineteenth or at the beginning of the twentieth century, or have more recently been detected by aerial photography. Five mining areas have been identified. The excavation of Vert-la-Gravelle 'La Crayère' concerns one of these sectors. These excavations have discovered three trenches and four shafts for flint exploitation. The flint of Saint-Gond has been geologically and petrographically studied in order to characterise the micro-facies.

In the same region, the presence of these numerous flint mines and 120 hypogea, five gallery graves, eight earthfast polissoirs and hundreds of knapping workshops suggest the presence of a new mining complex in the Saint-Gond Marshes. The study of this sector opens many new perspectives concerning the regional distribution of flint, the quantitative estimation of flint exploitation surface area and the study of territorial organisation.

Keywords: Marne, Saint-Gond, Late Neolithic, flint mines, knapping workshop, hypogeum, aerial photographs.

Résumé

Le secteur sud-est de la Côte d'Île-de-France, et notamment la région des Marais de Saint-Gond, a livré de très nombreuses sépultures collectives en hypogées, mais aussi 18 minières de silex fouillées au XIX^e^ ou au début du XX^e^ siècle. Plusieurs autres minières ont été récemment détectées par photographie aérienne. Cinq secteurs miniers ont été identifiés. L'un d'eux a fait l'objet d'une fouille sur le site de « La Crayère » à Vert-la-Gravelle, où trois tranchées à ciel ouvert et quatre puits pour l'extraction du silex ont été mis au jour. Le silex de Saint-Gond a fait l'objet d'une caractérisation pétrographique détaillée des micro-faciès.

La présence de ces nombreuses minières de silex situées dans une région comprenant plus de 120 hypogées, cinq allées couvertes, huit polissoirs fixes et des centaines d'ateliers de taille permet d'évoquer la présence d'un nouveau complexe minier. L'étude de ce secteur ouvre de nombreuses perspectives concernant la diffusion de ce silex à l'échelle régionale, l'estimation des surfaces d'extraction du silex et l'étude de l'occupation du territoire.

***Mots-clés** : Marne, Saint-Gond, Néolithique récent, mines de silex, atelier de taille, hypogée, photographies aériennes.*

1. INTRODUCTION

In the archaeological community, this region is better known under the name of the Petit Morin Valley (*vallée du Petit Morin*), rather than the Saint-Gond Marshes (*région des Marais de Saint-Gond*). Nevertheless, the Neolithic occupation of this region extended beyond the valley of the Petit Morin River, which originates in the marshes. Most of the Neolithic sites are located on the hills in the northern part of the Saint-Gond Marshes. The area is notable for the numerous hypogea that have been excavated at the end of the nineteenth century and at the beginning of the twentieth.

Numerous flint mines have already been identified in these regions (MARTINEAU *et al.*,

2014). Before this synthesis, very few references were available in the scientific literature concerning the flint mines of the Saint-Gond Marshes. Some data concerning a few of these sites is accessible in the excellent synthesis of Gerd Weisgerber (RODEN, 1999a, 1999b), but many descriptions are not exact, with several minor errors. The flint mines covered a large area, which comprises not only the Saint-Gond Marshes, but also a large part of the south-eastern cuesta of the Île-de-France, and notably the Plateau de la Brie champenoise and the Côte des Blancs areas.

Many of these mines were discovered between 1872 and 1941. Few of them have been excavated; the majority have only been detected by aerial photography. Many have also been verified or detected by walk-over surveys, and one of them has recently been excavated. Close to these flint mines, many other sites (collective burials, knapping workshops, earthfast polissoirs, etc.) have been also discovered, constituting a large mining complex. It appears that the level of flint mining in this region has been largely underestimated until now.

Since 2011, a research programme has developed. Forty-five colleagues are involved in a multidisciplinary research group, focussing upon the Neolithic of the 'Saint-Gond Marshes' and the Côte des Blancs area. This research programme consists of aerial prospection, walk-over surveys, site-mapping, excavations, artefact studies, geological investigations and palaeoenvironmental analyses. These researchers are from several institutions: the National Centre of Scientific Research (CNRS), the Universities of Burgundy/Franche-Comté, Champagne-Ardenne, Lyon and Paris, and the French National Institute for Preventive Research (INRAP).

2. CONTEXTS

2.1. Previous research

The Saint-Gond Marshes are renowned for the numerous important discoveries of Joseph de Baye. Between 1872 and 1886, this young archaeologist discovered more than a hundred hypogea there. Later, more than twenty other hypogea were discovered in this area, notably by Augustin Roland and Pierre Hu, and later by André Leroi-Gourhan, Bernard Chertier and Guy Mazières. More than 150 hypogea have been discovered in the Marne department, distributed in 15 necropolises. These collective graves are commonly dated to the Late Neolithic period (between 3600 and 3000 cal BC).

J. de Baye discovered two flint mines at Coizard 'La Haie Jeanneton' in 1872, and at Vert-la-Gravelle 'La Crayère' in 1873. A. Roland, in 1907, and André Brisson, in 1938, also discovered other flint mines. At that time, archaeologists were not very interested in flint mines. Before the development of lithic technology studies, the abundance of knapping waste in the pits, the absence of beautiful objects, and above all the difficulty of this type of excavation limited interest in such finds. So, unfortunately, these few excavated mines have not been as well documented as the hypogea.

2.2. Archaeological context of the region

An inventory of Neolithic sites, based upon archives and literature searches, completed by new walk-over and aerial surveys, has been carried out in this region. The database now comprises more than 300 Neolithic sites, whether explored or simply identified, notably concentrated in the north of the Saint-Gond Marshes. Such a concentration is very impressive for this period, and constitutes a good framework to study the social and territorial organisation of Neolithic societies in this area. Discoveries in this region include more than 120 hypogea (in 15 hypogeum necropolises), five gallery graves, three settlements, height earthfast polissoirs, several dozen knapping workshops, and at least 18 flint mines (Fig. 1). The map shows the main settlements, hypogea, gallery graves, flint mines and workshops, which are principally concentrated in the northern part of the Saint-Gond Marshes.

Eighteen flint mines have been identified in this area. They are distributed along the south-east of the Côte d'Île-de-France, on the

hill slopes, which provide easy access to the flint outcrops. Five mines have been excavated, and others have been detected by aerial photographs or by pedestrian surveys. Eight zones can be highlighted: Villevenard with five mines, Congy with three mines, Coizard with two mines, Vert-la-Gravelle, on the eastern slope of Toulon hill, with five mines, and Loisy-en-Brie, Givry-lès-Loisy, Vertus and Courjeonnet, with one flint mine each. Many other potential sites have been detected but have not yet been confirmed as flint mines through surveys or excavations.

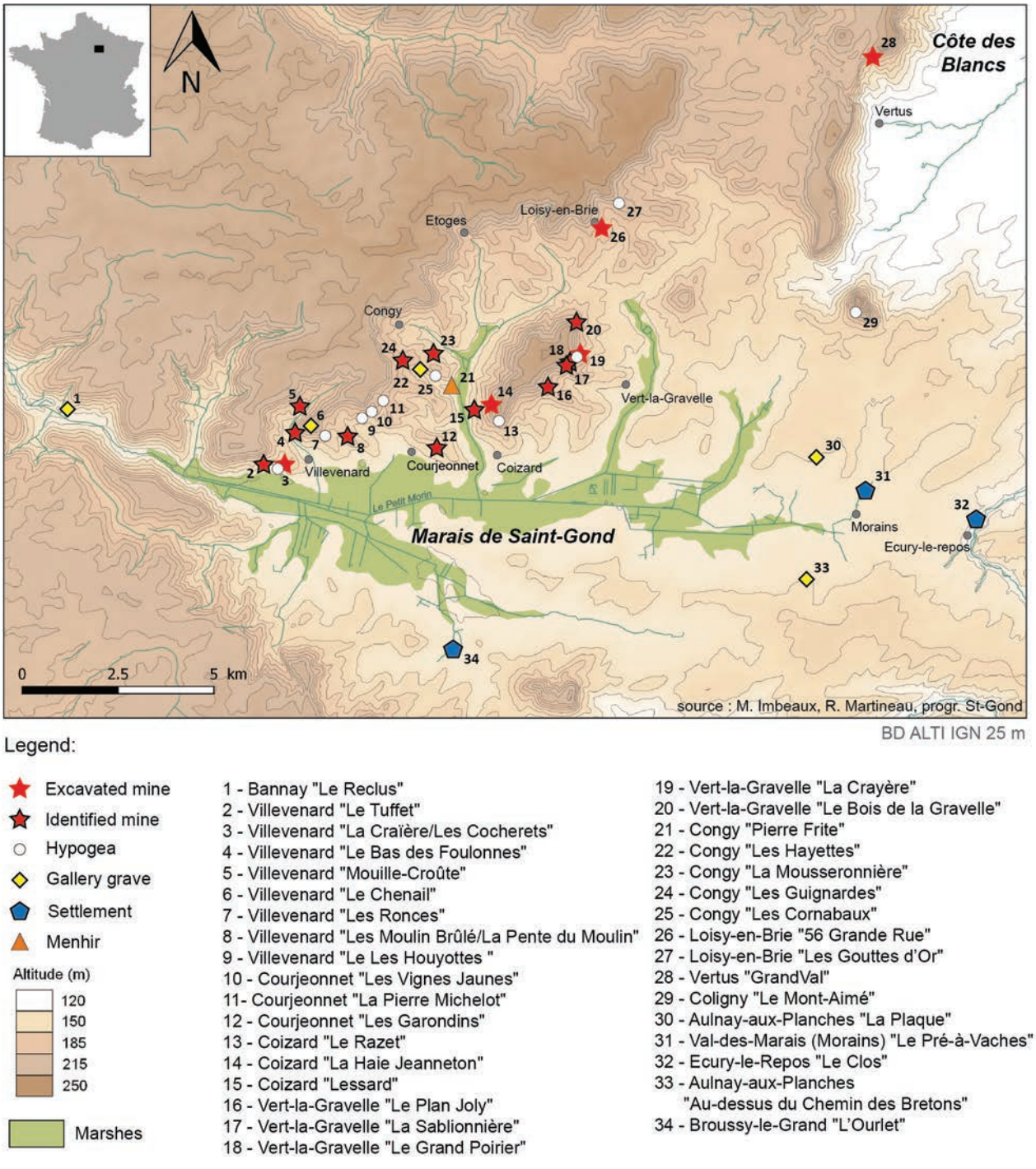


Fig. 1 – Location of the main Neolithic sites around the Saint-Gond Marshes. CAD M. Imbeaux.

All periods of the Neolithic are represented in this region. The beginning of the Neolithic is known only by a very important single burial attributed to the Linear Pottery Culture, discovered in Vert-la-Gravelle (Vert-Toulon) 'Le Bas des Vignes' (CHERTIER & JOFFROY, 1966; CHERTIER, 1988). The Middle Neolithic period is also documented in Broussy-le-Grand 'L'Ourlet'. Most of the Neolithic sites in this region are attributed to the Late Neolithic period (phase 1), dating between 3500 and 3000 cal BC. All the collective burials of this region, notably the hypogea and gallery graves also date from this period.

The chronological question is very different for the flint scatters observed in the fields compared to the flint mines. Detected by walk-over or aerial surveys, most of these sites are presently undated. Mines may occur over a long period of time, between 4700 and 2300 cal BC. However, the flint scatters discovered in the fields probably date from the Neolithic period.

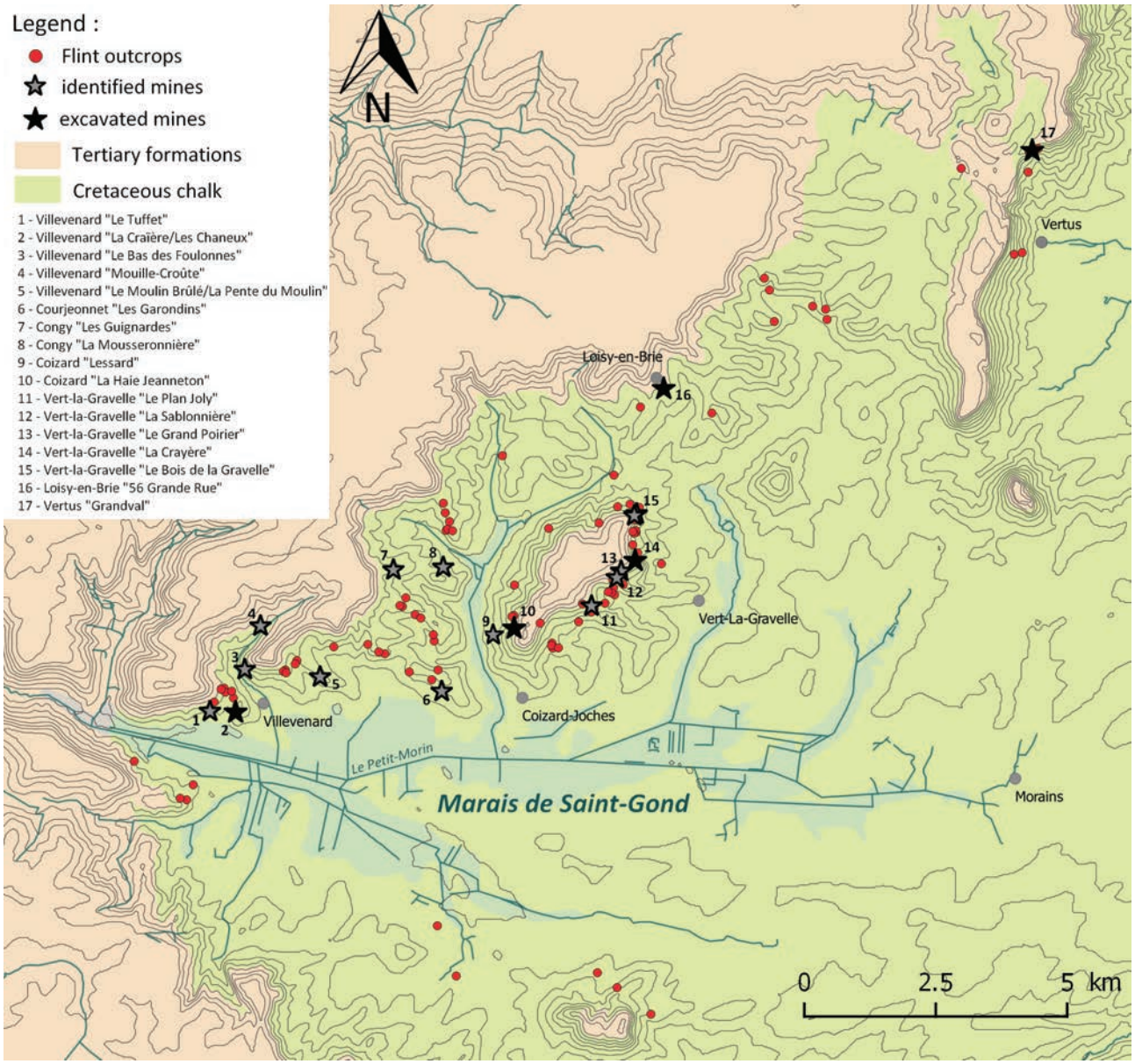


Fig. 2 – Location of the flint mines and the natural flint distribution in the Saint-Gond Marshes. CAD M. Imbeaux.

These flint spreads are usually interpreted as 'knapping workshops' although in the absence of excavations, the actual function of these sites (artisanal or domestic) is generally unknown.

The dense concentration of Neolithic sites, mainly attributed to the Late Neolithic period, comprising knapping workshops, earthfast polissoirs, settlements, but also numerous collective burials, allows us to define a new 'mining complex', according to the definition given by Pierre-Arnaud de Labriffe and Dominique Thébault (DE LABRIFFE & THÉBAULT, 1995, p. 49). According to this definition, the question now is to discover whether this high concentration of sites is due to flint exploitation or if the settlement pattern is not in fact directly associated with the presence of this abundant resource.

2.3. Geological context

The Saint-Gond Marshes are found along the eastern side of the cuesta of the Île-de-France, topography created during the Quaternary (HATRIVAL *et al.*, 1988). It followed the substantial erosion of the Cretaceous chalk, which was not protected by Tertiary formations during several successive glaciations and inter-glacial periods. The erosion of the chalk hills revealed the flint on the slopes, providing access to the raw material.

The chalk was formed in the Late Cretaceous, 75 million years ago, during the Late Campanian (ALCAYDE *et al.*, 1980). It contains dark brown and black flint. Knowledge of geological data is important for mapping the siliceous raw material sources and the knapped flint distribution in this region.

In order to identify the extension of the flint outcrops and to characterise the diversity of the flint, five walk-over surveys have been carried out in this region since 2012 (MARTINEAU *et al.*, 2016). Taking into account the ancient Neolithic discoveries and current geological knowledge, the potential of flint resources for prehistoric flint exploitation is very high for this region. The Butte de Toulon has been entirely prospected and many other sectors (Chouilly, Loisy-en-Brie, Villevenard, Oyes) have been explored to identify lithic resources. Several flint seams are visible in the chalk outcrops. At least 110 flint outcrops have been precisely located and sampled to determine the sedimentary facies (Fig. 2).

The outcrop located at Vert-la-Gravelle 'La Crayère' shows a high concentration of nodules in a shallow sub-horizontal flint seam (MARTINEAU *et al.*, 2016; Fig. 3). These nodules measure on average 50 cm long and can reach up to 80 cm. Two flint seams have been identified at this site, but eight or nine seams could be stratified within the hill.



Fig. 3 – A flint outcrop in Vert-la-Gravelle (Vert-Toulon) 'La Crayère' (Marne, France), close to the Neolithic site. The nodules have been broken by the exploitation of the chalk in this stone quarry located close to the Neolithic site. Photo R. Martineau.

The flint of Saint-Gond ranges from black to dark brown with a white cortex. We can find it as irregular nodules or as tabular deposits. The nodules are suitable for making blades, whereas the tabular flint is not easy to flake because they are faulted and recrystallised. Macroscopically, it resembles the Maastrichtian flint from the Belgian Dutch region but microscopically it is possible to distinguish the flint of the Saint-Gond Marshes from that of the Belgian Dutch region by its sedimentary facies (IMBEAUX *et al.*, 2018). The petrographic facies of Saint-Gond has been determined and subdivided into five sub-facies. Each of them characterises a sedimentary environment, which constitutes a precise description for the determination of

the raw material sources (SÉRONIE-VIVIEN, 1987; FABRE, 2001; AFFOLTER, 2002; DELVIGNE *et al.*, 2016, IMBEAUX *et al.*, 2018).

The sedimentary environments of the sub-facies of the flint have been determined on raw material from five excavated mines. The Saint-Gond facies is characteristic of a shallow marine environment, an open carbonate platform comprising many bioclasts, like sponges, sea urchin spines, bryozoans and foraminifers.

Within this study, it appears that it is possible to distinguish each mine by slight differences in the Saint-Gond flint facies. On the basis of these differences, five flint sub-facies have been distinguished. Each of them has been called by the name of the site, corresponding to each mine. These differences between each mining sector represent the variation in space and time of sedimentary environments in the Cretaceous sea (Fig. 4). Over time the sea level has fluctuated, which has impacted upon the sedimentary environment. For example, a small difference in depth can influence the currents, temperature or chemistry of ocean water. These characteristics directly impact the marine fauna and the sedimentary processes, which can then be seen by the aspect (notably their state of preservation) of the fossils and other clasts preserved in the flint.

The analysis of the sedimentary facies of the flint raw material and of the archaeological artefacts discovered in the Neolithic sites of the region, allows us to link the mining activity with the

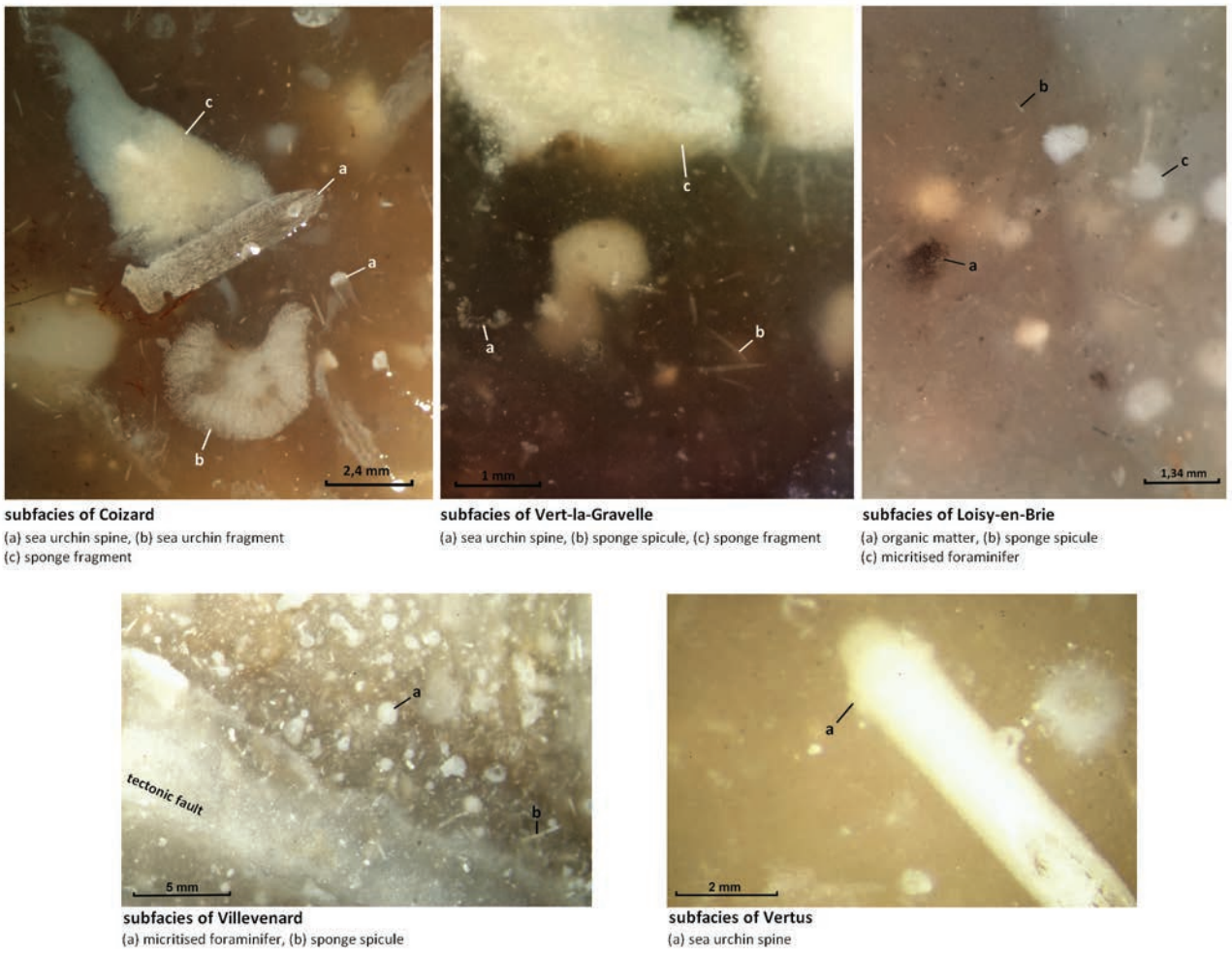


Fig. 4 – Microscope photographs of the principal clasts of the five subfacies identified. Photos M. Imbeaux.

other sites, like settlements or collective burials. These investigations will reveal the practices and habits of acquisition and the distribution of flint by Neolithic groups.

The Saint-Gond flint has been recorded at five collective burials and two settlements dated to the Late Neolithic period (IMBEAUX, 2016; IMBEAUX *et al.*, 2018). Saint-Gond flint constitutes the major part of the lithic resources in these sites. Each of the sub-facies has been identified in each Neolithic site. These first results show that the mines were exploited during the Late Neolithic period. Each mining sector analysed provided a source of raw material for the local communities, who did not only exploit these mines. Other sources have been identified at the archaeological sites. More interestingly, a network of lithic exchange seems to have existed between the sites (and maybe between the groups or communities) of this region.

3. THE FLINT MINES OF LA BUTTE DE TOULON

The sector of the eastern slope of La Butte de Toulon was intensively exploited for flint mining during the Neolithic. Ancient discoveries, recent walk-over surveys, and new excavations in this sector have discovered at least four large mines.

3.1. The site of Vert-la-Gravelle 'La Crayère'

The site of Vert-la-Gravelle 'La Crayère' (Vert-Toulon, Marne department) is located on a steep slope, on the eastern side of the Toulon hill, in a wood near the Champagne vineyard. Since 2012, excavations have explored Vert-la-Gravelle 'La Crayère'. This site was first identified through the discovery of a hypogeum, around 1870, which led to the discovery of two other hypogea and a flint mine located at the same place, both excavated by J. de Baye in 1873.

The mining structures were not previously visible, because they were buried beneath a thick layer of topsoil. Consequently, their state of preservation is very good. Two contemporaneous trenches (Trench 1 and 3) were aligned along the flint seam and separated by two bell-shaped shafts. Behind and above Trench 3 lay four hypogea, which have been previously excavated. Trench 3 measures 25 m long. The trench was filled with sediment composed of a mixture of chalky silt and chalk (1.2 m thick). In the Trench 1 and 3, the miners have excavated the chalk as far as possible to exploit the flint. But this exploitation system has a limit: the quantity of chalk sediment to extract.

Trenches 1 and 3 were oriented east-west along the flint seam. The negative impressions of the nodules in this trench showed that the same flint seam had been exploited on two levels, demonstrated by the dispersion of the nodules and slabs in this sector. Several niches and negative impressions left by flint extraction are clearly visible in the trenches. The dimensions of the nodules and the slabs can be deduced from these impressions.

The nodules surviving in the chalk have been recorded precisely to determine the altitude of the flint seam. The impressions of the nodules that were removed from the chalk by the miners have also been recorded (MARTINEAU *et al.*, 2016). This data indicates that the seam is located at an altitude between 190.8 and 193.8 m. The largest nodules lie in the central part of the seam, whereas the smaller nodules are located in the lower and the upper parts.

Thirty nodules have been sampled to determine the variation of the sedimentary facies in the site. The sedimentary facies, 65 m long and 3 m thick, is totally homogenous. Some tectonic faults and joints were also locally filled by flint, which fragmented into plates parallel to the fractures. These appear only at the same altitudes as the nodules. In the layers of chalk that do not contain flint, the fractures do not show such silicification. These plates have the same sedimentary facies as the nodules but they are lightly more recrystallised. Furthermore, some nodules have been observed which were partially deformed into plates. This indicates that they were not due to the circulation of fluids along the fault or the joints, but rather that the plates were originally ancient nodules which were deformed by tectonic movements.

Two shafts were unfortunately excavated by J. de Baye in 1873 and rediscovered during our excavations. Shafts 1 and 2 are bell-shaped shafts (in German *duckelbau*) and measure 2 m wide at the mouth and 2.4 m deep (Fig. 5). These shafts are linked by a passage supported by a pillar. The pillar mining technique seems to have been used systematically in the shafts, and sometimes in the trenches.

Two other shafts had been dug close to Trench 1. Shaft 3 was unfortunately also previously excavated by J. de Baye, but one part of the filling had been left untouched by the excavators. This shaft has to be considered as a prospecting pit, because the flint seam was not reached in this case. The fill of Shaft 4 was preserved and its excavation is currently underway. Shaft 1 is linked to Trench 1 by a short passage, indicating that the two structures were probably contemporaneous (Fig. 6).

At this site, the system of flint exploitation combines several types of structures: shallow pits, bell-shaped or cylindrical shafts, and trenches. All of these forms of extraction seem to be contemporaneous. Amongst the diversity of flint mines in Europe, the system of digging by trenches discovered here seems to be original. Moreover, the site of Vert-la-Gravelle 'La Crayère' is absolutely exceptional because of the presence of a hypogeum necropolis dug into a pre-existing flint mine. Four hypogeum corridors were found in the filling of Trench 3. This arrangement gives the impression of having been very well organised, the corridors being placed according to and following the morphology of the trench.

Stratigraphic observations clearly show that the hypogeum corridors were dug after the mine trench was abandoned. One of the main questions is to reconstruct the process of the successive occupations, and notably the chronology of the site. Six radiocarbon dates have been obtained for Trenches 1 and 3. They have been obtained from charcoal (excluding the 'old wood'), and on antler fragments. These six dates correspond exactly to the same period, between 4350 and 4000 cal BC, compatible with the Middle Neolithic phase II. Culturally, the mine could correspond to the Michelsberg or to the Northern Chassean cultures

Hypogea are generally attributed to the Late Neolithic period, dated between 3600 and 3000 cal BC. This period is 500 years later than the flint mine of Vert-la-Gravelle 'La Crayère', which corresponds perfectly with the stratigraphic observations. Because of the rarity of pottery



Fig. 5 – Vert-la-Gravelle 'La Crayère'. Interior of the bell-shaped shafts 1 and 2.
View of Pit 2 in the direction of Pit 1. A pillar was left between the pits, in order to buttress the mining area. Some retained pillars are also observable.
Photo R. Martineau.



Fig. 6 – Vert-la-Gravelle 'La Crayère'.
Trench 1 at the end of the excavation campaign. We can see the passage with Pit 1 and several niches and negative imprints left by the extraction of flint nodules.
Photo R. Martineau.

in the collective graves in the north of France, the hypogea of this region are not yet culturally defined. To resolve the chronological question surrounding the successive phases, the fillings of the corridors and the objects discovered in the hypogeum chambers at the end of the nineteenth century need to be dated by radiocarbon analysis. Consequently, ten new radiocarbon dates have been sent to be analysed in the framework of the Neomine project (resp. Stephen Shennan, University College of London).

More than 50 antler fragments have been discovered in the mining structures, notably in Trenches 1 and 3. They are very well preserved. Some of these antler fragments were mining tools (picks or levers), while the others were probably manufacturing waste (Fig. 7). Two antler tools have a perforation, which suggests that they had a handle. Antler picks were probably not the only tools used to dig the mining structures. Long wood levers and wedges were almost certainly also used for this purpose.



Fig. 7 – Vert-la-Gravelle 'La Crayère'. Trench 3. Some antler picks, levers and debitage coming from the manufacture of tools. Photos R. Martineau.

Several thousand pieces of flint comprising cores, flakes, blade fragments and flint hammerstones have been discovered between 2013 and 2016. Two transverse arrowheads correspond culturally to the period dated by radiocarbon analysis.

It is important to note, for instance, that no workshops have so far been identified in the periphery of the mines. However, the site is very extensive and probably covers several hectares, so knapping workshops could have existed at the bottom of the hill several dozen metres from the excavations. In the coming years, trial trenching will be carried out to explore this sector and to test this hypothesis.

Many other ancient discoveries have been made in this area, close to the mine of 'La Crayère'. We know that discoveries have been made in the forest located to the south of the site, in the upper part of the hill. In this sector, a 5 m deep shaft with characteristic lateral galleries was discovered in 1938 by A. Brisson. It produced siliceous blocks, an axe fragment and a large pottery sherd (BRISSON, 1938, p. 65). Two other shafts have been excavated to the south of this site.

About 350 m from the 'La Crayère' site the shaft of Toulon-la-Montagne 'Les Marnières' was excavated by André Brisson, Pierre-Marcel Favret, Jacques Prieur and Léon Petit on 23rd April 1938 (BRISSON, 1938; LANTIER, 1943, p. 211). A 4 m deep shaft with several lateral galleries 60 cm high was dug through a very poor quality chalk. For safety reasons, these excavations were abandoned.

A second shaft is located 300 m from the previous one. The shaft of Vert-la-Gravelle 'La Belle Gueule' was excavated in 1937 by André Brisson and André Loppin (BRISSON, 1946; LOPPIN, 1937). The shaft was 2.6 m in diameter and 2.8 m deep. At the bottom, seven galleries measuring 1 m long were observed. Only flint flakes were discovered in this shaft.

3.2. The sites of Coizard 'Lessard' and 'La Haie Jeanneton'

In the sector of the eastern slope of La Butte de Toulon, a flint mine was discovered in 1872 by J. de Baye at Coizard 'La Haie Jeanneton' (DE BAYE, 1872, 1880, p. 134, 1884, p. 150-151, 1885, p. 242-244, 1888, p. 64-65). This constitutes the first discovery of a flint mine in the Saint-Gond Marshes. At this site, J. de Baye found a flint mine comprising numerous bell-shaped shafts, more than three metres deep, inter-connected by several narrow galleries. About twenty flint flakes and one core from this site survive in the de Baye collection curated in the National Museum of Archaeology at Saint-Germain-en-Laye. The flint mine of Coizard 'La Haie Jeanneton' was rediscovered in 2015 during our walk-over surveys. The mouths of the shafts are still visible today.

Very close to this flint mine, aerial reconnaissance has brought to light a previously unknown large flint mine in Coizard 'Lessard'. The crop marks are distributed over at least 40 ha. All the shafts measure 3 to 5 m in diameter and seem to be aligned east to west (Fig. 8). A large amount of knapping waste and numerous flint nodules have been observed in the fields surrounding this site.

For the moment, it is not possible to know if the flint mine of 'Lessard' belongs to the same phase of exploitation as 'La Haie Jeanneton'. In all cases, this sector appears to have been totally exploited by flint extraction. It is also useful to recall that these two flint mines are located near the biggest and best-known hypogeum necropolis of Coizard 'Le Razet', which comprises at least 37 hypogea. This hypogeum necropolis is renowned for the sculptures of axes and human figures represented into the walls of the funerary chambers.

4. THE FLINT MINES OF LA BUTTE DU CHENAIL

At the foot of 'La Butte du Chenail', not far from the marshes, at Villevenard 'La Craïère/Les Cocherets', a flint mine was excavated by A. Roland in 1907. A series of interconnected galleries had been dug to a depth of four metres, maybe on two levels (ANONYMOUS, 1907a, 1907b). Bones and charcoal fragments were found in the fills of these galleries. At the same site, two other shallow pits, interpreted as flint extraction, have been excavated (VILLES, 1987). More recently, a flint seam has been observed on this site. Close to this flint mine, at Villevenard 'La Craïère', a hypogeum



Fig. 8 – Coizard 'Lessard' (Marne, France).
Aerial view showing hundreds of pits and shafts revealed by cropmark anomalies © Bing.

necropolis was excavated by J. de Baye. This example shows once again the spatial proximity between the hypogea and the flint mines.

At Villevenard, many other potential flint mines have been detected by aerial photography, at 'Le Moulin Brûlé', 'Mouille Croûte' and 'Le Tuffet'. Walk-over surveys have to be carried out to confirm the nature of these sites, which will open possibilities for further research.

Two dates have been obtained from charcoal: the date of Pit D ranged between 4555 and 4369 cal BC, whereas the date of Pit B lay between 3340 and 3022 cal BC. The difference between these two date ranges associated with two adjacent pits could be explained by the 'old wood effect', which was unfortunately not taken into account for these dates. For this reason, new radiocarbon analyses are underway.

5. The flint mine of Loisy-en-Brie

The flint mines are not only located in the Saint-Gond Marshes. The flint exploitation phenomenon extends to the north of this region, notably in Loisy-en-Brie, Givry-lès-Loisy and also on the Côte des Blancs to the north-east, in Vertus.

In 2012, six shallow pits were discovered in Loisy-en-Brie '56 Grande Rue', constituting the first discovery of flint exploitation in this sector. A rescue excavation was undertaken before the building of a house. Six shallow pits (under 1 m in depth) with irregular shapes (between 0.5 to 4 m long and 0.5 to 2 m wide) were excavated (MARTINEAU *et al.*, 2012; Fig. 9).



Fig. 9 – Loisy-en-Brie '56 Grande Rue' (Marne, France). A shallow pit (F) showing a niche for the extraction of flint. Photo R. Martineau.

The rescue excavations on the Loisy-en-Brie shafts delivered around 450 artefacts from the fills of the pits and niches. The assemblage is composed of 40 % of unused blocks, resulting from the first stage of testing and cleaning the raw material recovered from the pits. In fact, observations of the lithic assemblage show that the raw material was very poor quality, which justified this initial selection phase. The natural blocks and the tabular flint are all affected by a more or less continuous, poorly silicified central zone, creating areas of weakness and cavities, often problematic for knapping. The technological study of the debitage highlights the existence of two main products. Firstly, the production of bifacial pieces, probably axeheads, which have been recognised exclusively through the characteristic bifacial preparation flakes (Fig. 10). No roughly flaked axeheads or fragments have been found. Secondly, flake production has been identified, especially from the presence of cores. The morphology of some and the unipolar negatives on the flakes indicate that one of the objectives of this production was to obtain elongated flakes (Fig. 11). This type of flake production in a mining context is associated with the flint mine of Villemaur-sur-Vanne 'les Orlets' (DE LABRIFFE *et al.*, 1995), but the reduction sequence there was similar to the Levallois method and, therefore, different from that of Loisy-en-Brie. However, flake production could be linked to the Middle Neolithic phase of exploitation of this flint mine, while axe production could be more recent.

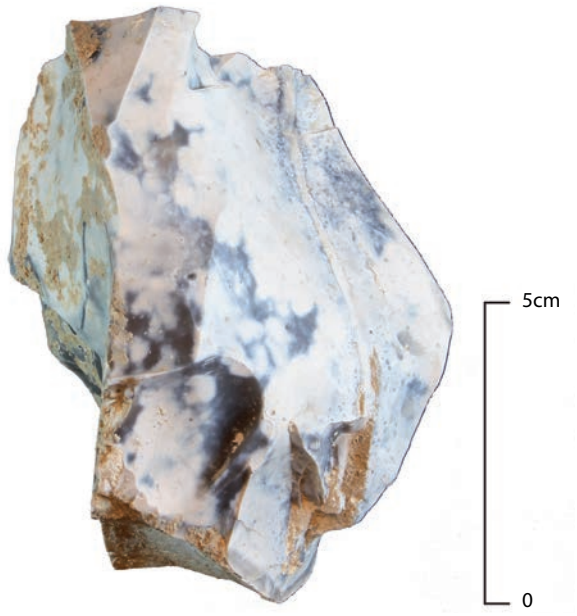


Fig. 11 – Loisy-en-Brie '56 Grande Rue'. Flake core from Pit B. Photo F. Bostyn.

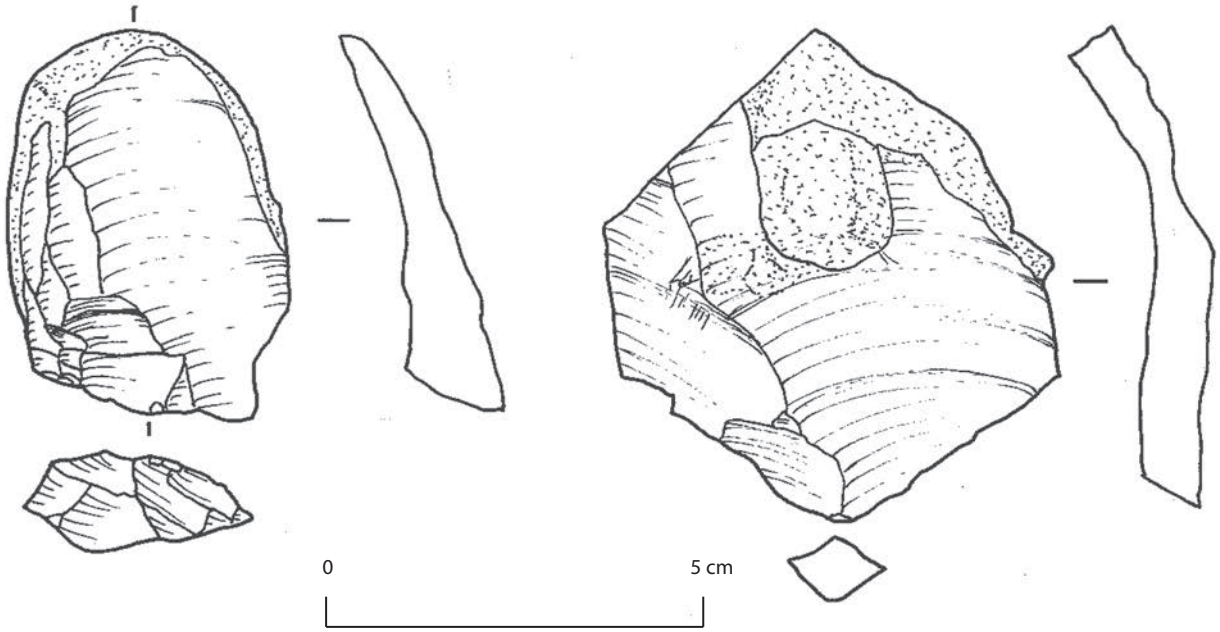


Fig. 10 – Loisy-en-Brie '56 Grande Rue'. Characteristic bifacial preparation flakes. Drawing F. Bostyn.

Loisy-en-Brie constitutes a new mining area, which was completely unknown until recently. A hypogeum, at Loisy-en-Brie 'Les Gouttes d'Or', is located 800 metres from this mine (CHERTIER *et al.*, 1994).

To the north of Loisy-en-Brie, another flint mine has been detected by the aerial photographs of Bernard Lambot. In Givry-lès-Loisy 'Part de Comté', 'Le Gros Terrier', and 'Les Champs Moreaux', numerous cropmarks suggest a very probable flint mine. This type of site has never been identified before in this area. This flint mine and that of Loisy-en-Brie attest the presence of a new mining area, located to the north of the Saint-Gond Marshes. These new flint mines greatly extend the known area of flint exploitation.

6. The flint mine of La Côte des Blancs

Several kilometres to the north-east, another flint mine was discovered in 1940, on La Côte des Blancs. A mine shaft (about 3.5 m deep) with three galleries was observed at Vertus 'Grandval' (COUTIER *et al.*, 1962; MARTINEAU *et al.*, 2014). About five kilograms of knapped flint composed of flakes, blades, a blade core and some flake cores, were associated with a calcareous fragment interpreted as a possible lamp, and a polished flint nodule, which constitute the artefact assemblage from this site, which is now unfortunately lost. This type of lamp is known in several flint mines in England and Belgium, notably in Spiennes (SOULIER, 1971; VERHEYLEWEGHEN, 1958).

At the bottom of the shaft, a skeleton was discovered, associated with three antler picks and some knapped flint. One of the three picks has been dated between 3310 and 2904 cal BC, corresponding to the transition between Late Neolithic I and Late Neolithic II. The skeleton was that of a woman who was estimated to be 40 years old (RIQUET, 1962). Unfortunately, the absence of archaeological observations from the time of discovery renders it impossible to know if the skeleton represents a burial or a mining accident. The skeleton seems to have been mislaid in the museum collection.

The date from the pick corresponds very well with the period of the hypogeum phenomenon. A very well-known hypogeum necropolis is located close to the mine of Vertus 'Grandval': this is the site of 'Les Mournouards' at Le Mesnil-sur-Oger. Two hypogea have been excavated here: the first one by André Brisson and Léon Coutier, and the second one by André Leroi-Gourhan in 1961. It was in this hypogeum that A. Leroi-Gourhan conducted his exceptional work, which marked the beginning of modern scientific grave excavations (LEROI-GOURHAN *et al.*, 1963).

7. The site of Tours-sur-Marne

Between 1836 and 1839, on the chalky slope of a Marne river bank, seven collective graves were excavated at Tours-sur-Marne (precise site unknown), in the northern stretch of the River Marne. These graves have a bell-shaped morphology resembling a shaft and were accessible by a vertical tunnel measuring 1.5 to 2 m deep. The burial chambers measured 3 m in diameter and comprise one or two narrow galleries. In these collective graves 160 skeletons were discovered. Many artefacts, such as deer antler tools, axeheads, arrowheads, blades, and ornaments were discovered in the seventh grave (NICAISE, 1876). The traditional hypothesis proposed a reutilisation of ancient flint mine shafts as collective burial sites, but this has recently been challenged (IHUEL *et al.*, 2014). This recent study interpreted these structures as hypogea because the artefacts discovered are characteristic of that type of site. However, this hypothesis does not explain the morphology of the structures nor the presence of galleries, and above all it does not make clear the use of vertical tunnels to access the graves. Access to a hypogeum is always horizontal, but at Tours-sur-Marne access was vertical. The ancient descriptions are sufficiently clear to suggest that these structures were originally flint mines. Further surveys could provide evidence of flint outcrops on this bank of the River Marne, which constitutes a necessary precondition for the presence of a flint mine.

8. DISCUSSION

Without taking into account the case of Tours-sur-Marne (located in the north of the River Marne, nearly 20 km from the Saint-Gond Marshes), the area covered by attested flint mines in Villevenard, Courjeonnet, Coizard, Vert-la-Gravelle (Vert-Toulon), Loisy-en-Brie, Givry-lès-Loisy and Vertus is extremely large. Many other probable flint mines have been detected in other areas, in Congy, Etoges and Fèrebrianges.

The radiocarbon dates obtained for the flint mines of Vert-la-Gravelle 'La Crayère', Loisy-en-Brie '56 Grande Rue' and Vertus 'Grandval' cover a large period of time. The chronology of flint mining in this area spans at least the Middle and Late Neolithic periods (Fig. 12 and Fig. 13). The oldest date, around 4500 cal BC, is associated with the pit of Loisy-en-Brie '56 Grande Rue', whereas another date for the same pit from this site corresponds to the Late Neolithic phase I, between 3300 and 3000 cal BC. Most of the radiocarbon dates at Vert-la-Gravelle 'La Crayère' are from the Middle Neolithic II, between 4300 and 4000 cal BC. These six radiocarbon dates, obtained on charcoal and antlers, are very coherent. The youngest date was obtained on an antler pick from Vertus 'Grandval', which is dated to the end of the Late Neolithic phase I and the beginning of the Late Neolithic phase II.

This broad chronology is not surprising. Some other flint mines, like Jablines 'Le Haut Château' (BOSTYN & LANCHON, 1992), Spiennes or, even nearer, the flint mines of Le Pays d'Othe (Aube), have comparable situations.

The presence of a prospecting pit (Pit 3) at Vert-la-Gravelle 'La Crayère' is unusual. Its location

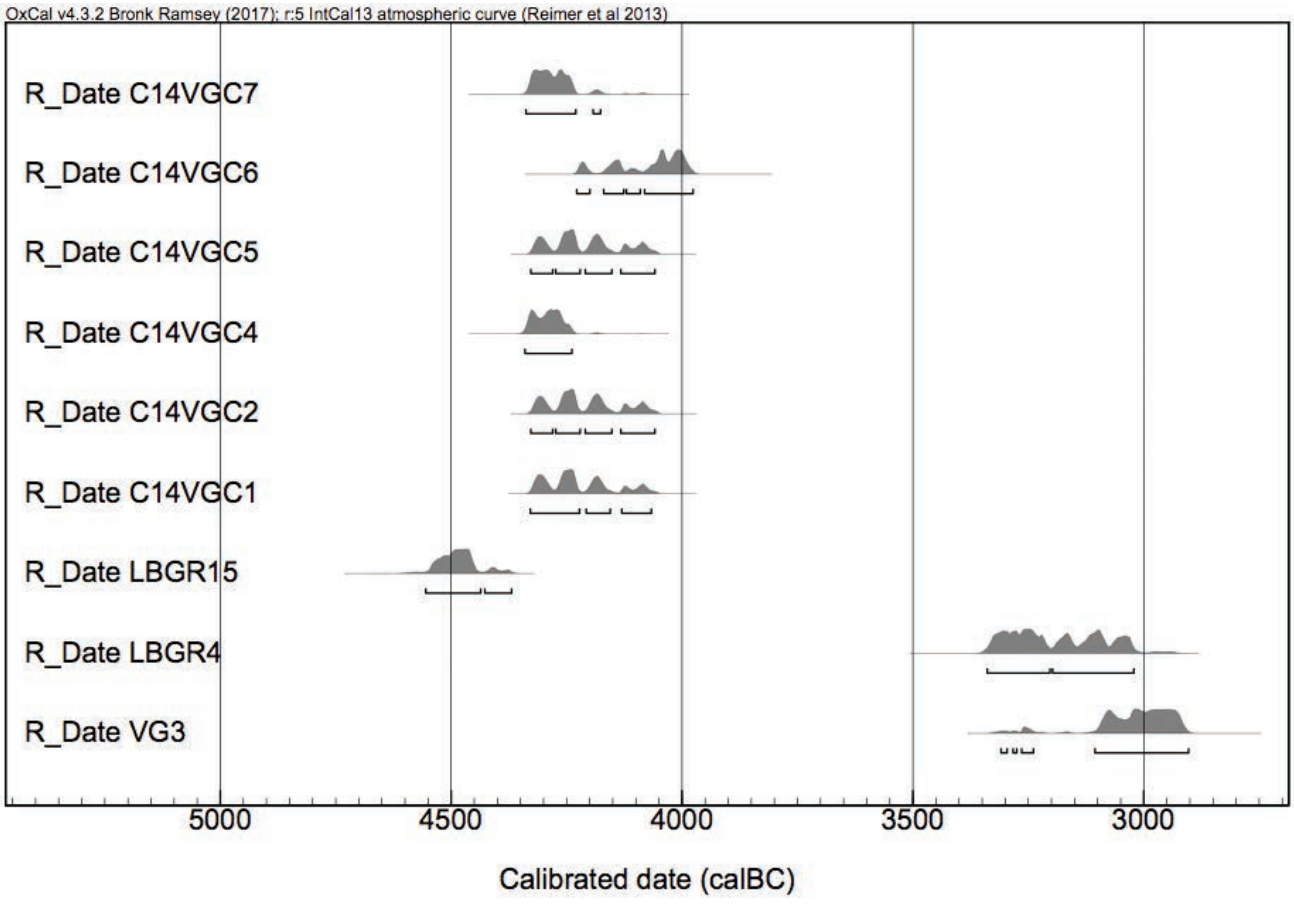


Fig. 12 – Synthesis of the radiocarbon dates from the flint mines of Vert-la-Gravelle 'La Crayère', Loisy-en-Brie '56 Grande Rue' and Vertus 'Grandval'. CAD R. Martineau.

Municipality	Locality	No sample	Lab. code	BP date	Cal BC date, 1 sigma	Feat.	m²	SU	Depth	Material dated	No object/ Remark	Old wood effect taken into account
Vertus	Granval	VG3	Poz-46885	4390 ± 40	3310-2904	-	-	-	bottom of the shaft*	deer antler		
Loisy-en-Brie	56 Grde Rue	LBGR4	Poz-53602	4465 ± 35	3340-3022	Pit D	-	3	60 cm	charcoal		no
Loisy-en-Brie	Rue	LBGR15	Poz-53603	5655 ± 35	4555-4369	Pit D	-	12	upper part	charcoal	sample n°1	no
Vert-la-Gravelle	La Crayère	C14VGC1	Ly-12461	5370 ± 30	4329-4067	TR3	-	65	40 to 100	deer antler	VGC177	
Vert-la-Gravelle	La Crayère	C14VGC2	Ly-12466	5365 ± 30	4328-4059	TR1	5	8	45	charcoal		yes
Vert-la-Gravelle	La Crayère	C14VGC4	Ly-12464	5425 ± 30	4341-4239	TR1	1	8	70	charcoal		yes
Vert-la-Gravelle	La Crayère	C14VGC5	Ly-12462	5365 ± 30	4328-4059	TR3	-	33	?	deer antler	VGC176	
Vert-la-Gravelle	La Crayère	C14VGC6	Ly-12463	5250 ± 30	4229-3977	TR1	1	8	?	deer antler	VGC99	
Vert-la-Gravelle	La Crayère	C14VGC7	Ly-12465	5405 ± 30	4339-4177	TR1 (ST4)	3	8	5	charcoal		yes

*antler pick associated with the skeleton
SU: stratigraphic unit

Fig. 13 – Radiocarbon dates from the flint mines of Vert-la-Gravelle 'La Crayère', Loisy-en-Brie '56 Grande Rue' and Vertus 'Grandval'.

between the flint seam found at 192 m altitude (corresponding to the exploitation of trenches 1 and 3) and the seam discovered at nearly 192 m altitude (corresponding to Trench 2) suggests that this mining structure was a prospecting pit. Another pit (Pit 4) currently being excavated could be a second prospecting pit. Consequently, at this site some pits may have been used to prospect for flint seams, whereas the horizontal trenches could have been dug to exploit large open-air surfaces covering several dozens of metres along the flint seams.

Some examples of this type of pit are known in England. At Easton Down (Wiltshire), in some cases no flint seam was encountered at the bottom of the shaft. This fact was interpreted as the shaft having been left unfinished (BARBER *et al.*, 1999, p. 12). Four of the six shafts excavated by J. Stone in Easton Down did not reach a flint seam. This high percentage of potentially abortive shafts might be considered unusual and seems to indicate that the depth of the seam must have been relatively straightforward to follow. In comparison to the two larger shafts which exploited the flint, the prospecting shafts were all relatively narrow (1.25 m wide), only large enough for one miner (BARBER *et al.*, 1999, p. 36-38). Similar narrow cylindrical shafts excavated at Grime's Graves have also been considered to have been dug to test for the flint seam at a known depth. Some of them were a little over 1 m in diameter and equally unsuccessful in locating the flint.

Another important point has to be taken into account: the question of any potential relationship between the flint mines and the hypogea. We can cite several examples where these two categories of sites are found in close proximity. This is the case for the flint mine of Vertus 'Grandval' located 2 km from the necropolis of 'Les Mournouards' at Le Mesnil-sur-Oger, for the flint mine of Loisy-en-Brie '56 Grande Rue', located 800 m from the Loisy-en-Brie 'Les Gouttes d'Or' hypogeum, and for several other examples in Les Marais de Saint-Gond (notably in Villevenard 'La Pente du Moulin' or 'La Craïère', in Courjeonnet 'Les Vignes Basses', in Coizard 'Le Razet', 'La Haie Jeanneton' and 'Lessard' or in Vert-la-Gravelle 'La Crayère'). In all of these examples, both the flint mines and the hypogea are systematically close to each other. It is evident that the close proximity of these sites is not sufficient to conclude that they were contemporaneous. Evidently, for the moment, this relationship has to be kept as a hypothesis, and further research is needed to

test it. The question of chronology is undoubtedly the way to investigate the possible relationship between hypogea and flint mines. The radiocarbon dating of as many flint mines as possible would be the best way to establish whether these sites had been exploited during the period of the hypogea phenomenon. Spatial analysis is also planned to compare the topographic locations of the hypogea and of the flint mines, and to measure the average distances between these sites.

9. FURTHER RESEARCH

The next step in this research project will be to map the distribution of all the Neolithic sites and to quantify the area covered by flint mines in this region. Distribution maps of flint mines and the quantification of the areas involved will be possible very soon, through GIS data processing.

The other important aspect will be the detection of new flint mines. The use of remote sensing methods like LIDAR, satellite and drone images, or thermal infrared images, will be invaluable to detect new sites. Walk-over surveys will also be pursued, in order to verify any newly detected sites, and also to complete the mapping of the natural flint.

One of the other main research questions is that of the distribution of flint from Saint-Gond. The successful characterisation of the flint facies from Saint-Gond will allow us to study the diffusion of flakes and tools into the neighbouring regions (Alsace, Burgundy, Paris Basin, etc.).

At the site of Vert-la-Gravelle 'La Crayère', several opportunities are envisaged: at the end of the current excavation programme, new radiocarbon dates, lithic and antler studies, but also anthracology and geophysical analysis will all be carried out.

The detection of settlements by surveys and trial trenching is also underway in the Saint-Gond Marshes. Identifying the settlements of the miners, knappers and all those buried in the numerous collective graves constitutes one of the major questions for a better understanding of the Neolithic period in this region.

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