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Lithic Raw Material Resources and Procurement in Pre- and Protohistoric Times

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A siliceous rocks database for the northeastern Paris basin : the Soissons lithotheque

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Abstract

The Soissons reference collection has been created in the late 1980 s, in a region, in which the Early/Middle Neolithic period has been extensively investigated. The current French-German MK-project has provided the opportunity to update the existing collection and to incorporate the information into a GIS. The database contains 440 rock samples, mainly from the Aisne and Oise drainage systems in the north-eastern part of the Paris basin. Non-systematic sampling has now extended to the entire Paris basin and to neighbouring regions, including data from the Petite Seine, the Marne and the A5 motorway sites, as well as flint from the Jura Mountains, the Lorraine region, Poland, Belgium, Holland, the Rhineland and Hungary. In parallel, a similar database for clay is under construction.

The first results concern the relationships between lithic technology and flint/stone raw materials in the Neolithic. The lithothèque will possibly provide a reference collection for the identification of raw materials in the Paris basin.

Keywords : reference collection; Lithotheque; flint; procurement strategy; Paris Basin; Neolithic.

1. Historiography and aims

The project of a reference collection or lithothèque has been developed within an ATP (Action Thématique Programmée) between 1986 and 1989 by scientists of the Archaeological Research Centre (Centre de Recherches Archéologiques) of Soissons, as well as of the associated laboratories (« Département des Sciences Naturelles » at the University of Reims and the « Laboratoire d'étude de l'environnement » at the Institute of Prehistory of the Leiden University, Netherlands). Fieldwork has been carried out by a network of surveyors and archaeologists, the principal actors being Michel Plateaux, Jean-Claude Blanchet, Claudine Pommepuy, and Gilles Naze (Blanchet *et al.* 1989).

This project was part of a research theme on the

procurement strategies of lithic raw materials and supply territories of the neolithic and protohistoric sites in the Aisne valley. It primarily aimed at the systematic sampling of local geological formations within the catchment area of the Aisne valley (departments of Aisne and Oise) and the seeking for the potential raw material sources based on already petrographically determined archaeological objects. The sampling method is based on the systematic analysis of 1:50.000 scale geological maps and on the description of each formation in an analytical sheet (description of the formations and of the material types by geological stage). In Picardy, the entire Aisne and Oise departments as well as one part of Champaign (Ardennes, Marne), i.e. thirty geological maps, have been analysed, thus allowing a rapid evaluation of the quality and the variability of the existing materials and the identification of the most interesting formations.

Sampling has then been made in mines or on outcrops for each of the described formations with at least one sample, except for limestone, which is overrepresented, and for which only the larger petrographic type has been determined (coarse-grained limestone, cerithoid limestone, shelly limestone, miliolids limestone, nummulitic limestone). The potential of each sector has been evaluated in more detail. Finally, sampling has been performed during systematic surveys in sectors of particular interest for local surveyors : the mines and knapping workshops in the region of Nointel (P. Romenteau) ; the formations in the surroundings of Cuiry-lès-Chaudardes (Y. Naze, M. Plateaux), of Boury-en-Vexin (D. Verret, R. Martinez), the Ludian formations in the Tardenois sector (M. Plateaux, C. Pommepuy), and in the area of the Aisne river (M. Plateaux) as well as in gravel pits in the surroundings of the site of Amigny-Rouy (Y. Naze).

The assemblage has finally been enlarged in a non-systematic manner to the entire Paris basin by incorporating data stemming from La Petite Seine (A. Augereau), the Marne (F. Bostyn), the Oise (F. Prodéo) and from the sites discovered during the survey of highway A5 (P.A. de Labriffe). Samples stemming from the adjacent regions of the Paris basin

have also been incorporated into the database, still in a non-systematic manner (Jura, Lorraine, Belgium, Netherlands, Rhineland), or from more distant countries (Poland and Hungary). Since, an additional research project has been developed on Secondary flint, «*Géochronologie du silex du Nord-Ouest de la France*» (Allard *et al.*, 2005). The materials sampled within this research program have been shared by those of the Soissons reference collection and they are kept at the INRAP in Amiens.

The petrographical determination based on thin sections of all the materials has been performed by two geologists at the University of Reims (H. Guérin and J.-C. Foucher). It has notably permitted the determination of the sandstones and the distinction between Secondary flint (Upper Cretaceous) and Tertiary flint through micropalaeontological analysis of the enclosed fossils. The accurate attribution to a distinct geological stage that allows dating is however rare and only possible for very characteristic samples (presence of diagnostic fossils).

In a more general manner, the sampling, for the greater part, is representative of the northern half of France; the best represented sector being the north-eastern quarter of the country (Fig. 1 & 2). The assemblage extends eastwards, including samples stemming not only from neighbouring countries but also from more distant areas (mainly Belgium and Germany, the Netherlands and Poland). Only few samples stem from Southern and Western France.

The reference collection has permitted to carry out an intensive assessment of the stone resources in the Aisne-Vesle sector and in the central Oise valley principally (Fig. 2) : flint supply stemming from primary formations of the Mesozoic and the Tertiary, is composed, in the eastern part of the investigated area, of black Turonian flint of Rethel and greenish Cretaceous flint in the area of the Ile-de-France cuesta, of Senonian flint from Epernay in the southern part and of flint stemming from the Santonian and Campanian chalk formations west of the Oise valley. The flint resources stemming from primary formations of the Tertiary are located in the levels of the Upper Lutetian on the edges of the plateaus surrounding the Aisne valley. The formations of the Upper Bartonian (Ludian) are situated on the Tardenois plateaus. The residual formations on the terraces of the Aisne valley yield nodular quartz sandstone (Auversian), pebbles of Turonian flint as well as Tertiary silifications. In

addition to the sampling of these formations, the analysis of the geological maps and surveys has enabled the discovery of new sources in the local range as those of « quartzite sandstone » (sandstone constituted by over 80% of quartz grains or with mainly siliceous cementation). Its existence had been assumed by the archaeologists but remained unknown on the regional level. Their texture makes them convenient for knapping.

2. The database

The relational database has been created with Microsoft Access. It is subdivided into four sections. The first section concerns the information allowing to localize a piece in the reference collection and in the database, i.e. the number of the drawer corresponding to the original storage in the cupboards, the box number which corresponds to the new conditioning of the boxes made in 2012, the number of the card corresponding to the unique identifier of each registration in the database as well as the date of registration. A second section concerns the field data, i.e. the commune and perhaps the locality of the discovery, the name of the surveyor and the Lambert coordinates 1 and/or 2 as well as the number of the geological map and the numbering of the sites and the samples from 1 to n following the registration order of the pieces. The third section concerns the geological information of the sample, i.e. its identification as a raw material (limestone, sandstone, obsidian, flint, silification...), the geological stage and sometimes the precise code of this stage. The modalities of access to the materials (outcrop, mine, extraction pit, test trench or archaeological site) and their quantity on the site (abundant, medium or rare) are also described. Finally, two systems of measurement are proposed, a range and an average. The last section concerns the physical description of the raw material: the colour, the grain, the physical state of the piece, as well as the aspect of the cortex and finally the presence or absence of microscopic or macroscopic fossils.

Within the French-German ANR-DFG project « Emergence of social complexity: enclosures, resources and territoriality in the Neolithic. French-German research on the Michelsberg culture » the reference collection of Soissons has been updated. The database of the reference collection currently contains two hundred and sixty-eight samples, distributed over forty-seven geological maps. Three maps only show more than fifteen samples: the map of Soissons (17 pieces), the one of Clermont (50 pieces)

and the one of Saint-Just-en-Chaussée (44 pieces). The distributions by stage are utterly representative and consistent with the geological maps. Considering all materials, the database now contains four hundred and forty-four cards of which two hundred and eighty-five are described. One hundred and ninety-four samples, mainly flint have in addition been photographed, and this work will soon be completed for sandstone and limestone.

3. The raw materials

The major part of the samples registered in the database stem from the Cretaceous and the beginning of the Tertiary (Eocene and Palaeocene; Fig. 3). The raw materials of the Jurassic and the Triassic periods are only represented by about fifteen samples. The materials are presented here by the larger geological periods and the physical criteria of the different geological stages are identified and described. Only well characterized samples are used for this purpose. Deposits in secondary position or materials found in silt layers have been excluded as well as those which have not been well differentiated between two geological stages. Finally, all the pieces found in alluvial contexts or in silt contexts have not been taken into account, in order to base on most reliable data.

Three descriptive criteria have been chosen for the description of the materials: the morphology, the original colour and the thickness of the cortex. These three criteria have been selected in that they allow to have a global picture of the raw material and in that their description is standardized. We are aiming at proposing recurrent general criteria and do not attempt a typology of raw materials, given that the variation within a same geological facies is too important. We also have to take into consideration biases in sampling (number of pieces by deposit and representativeness of the occurring varieties). Finally, it is quite clear that the proposed macroscopic observations cannot substitute to petrographic analysis.

The Tertiary flint materials

The assemblage contains sixty pieces identified by primary geological stages. All the geological stages are represented, from the Ypresian to the Ludian of which the registrations are grouped together under the term « Upper Bartonian ». However, the upper stages are the best represented in the reference collection: twelve samples for the Lower-Middle Bartonian,

fourteen for the Upper Bartonian (Ludian) and nineteen for the entire stage of the Lutetian (fig. 4). On the other hand, the earlier stages are sampled with at least ten elements: three for the Sparnacian, nine for the Thanetian and only one for the Ypresian. Finally, two pieces assigned to the « Sparnacian/Thanetian » have been considered for the distribution map but they are set aside for the description. The raw materials exclusively stem from the north-eastern part of the Paris Basin. The best sampled area is located north and south of the Aisne River, between Soissons and Reims.

The distribution of the morphologies under the form of tabular or nodular flint allow to highlight several facts (Fig. 5 et 6): it can be stated that the raw materials which occur mainly under the form of tabular flint stem from the upper stages of the Eocene, i.e. the Ludian and the Bartonian: within the reference collection, the uppermost stage is exclusively represented by small slabs, as well as by a single bloc and a slab. The lower stages of the Bartonian contain a majority of tabular flint but also some nodules. Within the Lutetian stage, an intermediate stage of the Eocene, nodular and tabular flint occur in equal parts; moreover, it can be noted that the proportion of samples containing both tabular and nodular flint almost equals the preceding categories. Lastly, the Thanetian is mostly represented by nodules, occasionally by a pebble and not a single tabular flint piece occurs in the assemblage.

We have only three samples for the Sparnacian and one for the Ypresian. These elements do not allow to draw valid conclusions. It can merely be noted that the distribution of the Sparnacian overlaps with the elements of the Thanetian.

The thicknesses of the cortex of the samples equally mirror general trends (Fig. 7). With regard to the upper stages, a distinction between the two most recent stages can be noted : thus, on the samples of the Ludian, in most cases thick cortex between 5 and 10 mm can be observed, whilst it is thinner (1-2 mm), and even ultra-thin for the lower and middle stages of the Bartonian. Once again, the stages of the Sparnacian and the Ypresian are too insufficiently represented to draw any conclusions.

Only the middle and upper stages of the Eocene show a large variety of colours. More than 50% of the Ludian samples show red colours ranging from « pink light brown » to « brown dark red » that characterize 35 % of the registered pieces. The other colours are brown or grey with rather light nuances (Fig. 8).

Within the Lutetian stage, 20% of the samples show red colours but the greater part is comprised within brownish shades of colour (brown, light brown, dark brown, dark grey-brown totalizing 60 %). The shades of colour close to light and dark grey-brown complete the range (Fig. 8). In the Bartonian stage the major shades of colour range from brown to dark grey-brown (44%). 24 % of the samples show significantly lighter tints, the red colours represent only 16% of the assemblage (Fig. 8). For the lower stages, the variability of colours seems more restricted. Only the Sparnacian stage still provides enough elements: the tints vary from light grey to dark grey. The samples of the Ypresian and the Sparnacian do not distinguish from these tints (Fig. 8).

The Cretaceous flint materials

The assemblage contains ninety-two localized elements. The sampled area is centred on the north-eastern part of the Paris Basin concentrating in the region covered by the maps of Saint-Just-en-Chaussée, Beauvais and Clermont.

Almost all the geological stages of the Cretaceous are represented with thirty-one samples for the Campanian, nineteen for the Santonian, twenty-nine for the Coniacian and six for the Turonian. For seven samples it was impossible to determine the geological stage: six are registered as « Santonian/Coniacian » and one as « Turonian/Coniacian » (fig. 9). The Maastrichtian flint, the most recent stage of the Cretaceous, is represented by two samples only, one stemming from the commune of Eben-Emaël in Belgium, the other from the mining area of Rijckholt in the Netherlands.

The samples registered under the generic term « Cretaceous » have not been taken into account.

By contrast to the morphologies of the Tertiary age, those associated with the siliceous materials of the Cretaceous vary little: almost the totality of the samples occurs as nodules. The presence of tabular flint is anecdotic for the stages of the Campanian, the Santonian and the Coniacian (Fig. 10 and 11).

Equally, the greater part of the pieces presents an ultra-thin or thin (1-2 mm) cortex, for all of the materials. Only the samples of the Coniacian distinguish through thicknesses in average more important compared to the others and through a larger proportion of medium thick cortex (2-5 mm). The absence of very thick cortex (> 10 mm) can also be noted for the present assemblage (Fig. 12).

The colours of the Cretaceous flints vary from beige to very dark grey. The samples are mostly comprised within « brown-grey » or « grey-brown » tints. The very dark grey flint is present in all geological stages. The lighter shades of grey or brown are little represented (Fig. 13).

Thus, there are no clear distinctions between the Cretaceous stages based on the three criteria we have examined, by contrast to the observations made on Tertiary flint and silifications that show clear differentiation, even an evolution concerning the aspect of the raw materials according to the geological stages. From a physical point of view, it thus seems difficult to assume the geological attribution of the Cretaceous flints.

The Jurassic and Triassic flint materials

Out of a total of sixteen flint samples from both the Jurassic and Triassic periods, fourteen are localized. The sampling of these materials thus remains anecdotic for the reference collection of Soissons. In Normandy, the raw materials belong to the Middle Jurassic period; the two samples of the Bathonian stem from the mines of Ri and of Bretteville-le-Rabet, those of the Bajocian from Moutiers-en-Cinglais. The remaining samples of shelly limestone stemming from the Upper Jurassic (Oxfordian) or the Middle Jurassic are localized in Eastern France in an area spanning from the Ardennes in the north to the city of Epinal in the south.

Despite the apparent weakness of the sampling it is nonetheless possible to highlight distinct characteristics of the Triassic and Jurassic raw materials (Fig. 12). Thus the shelly limestone flints present within the reference collection exclusively occur under the form of tabular flint (5 specimen), whilst the Jurassic raw materials are found rather in the form of blocs or nodules, possibly pebbles. The thickness of the cortex is a criterion which allows to highlight that the Jurassic as well as the Triassic flint materials present mostly thin to ultra-thin cortex. On the other hand, the two samples of the Bathonian (Middle Jurassic) have thick to ultra-thick cortex (5-10 mm and > 10 mm). Finally, the colours of the Jurassic and Triassic flints span from light to very dark grey; one sample of the Middle Jurassic (Bajocian) has a « very dark grey brown » colour. In a more general manner, the colours of the Jurassic pieces seemingly exhibit lighter nuances than those of the Triassic period.

4. Case Studies

The Soissons reference collection has been used to perform several studies on raw material procurement strategies.

First and foremost, the research conducted by one of the initiators of the reference collection, M. Plateaux, into the Neolithic lithic industries of the Aisne valley and the Paris basin has to be mentioned (1987, 1989). More recent studies pursuing this work are based on the reference collection, for example those by P. Allard (2005). This latter has demonstrated an important variability of the types of procurement in the Early Neolithic Linear Pottery sites (5200-4900 BC), with sites rather close the ones to the others but showing quite different proportions of both local and regional materials. In these sites, the procurement is local and regional: the used materials are local Tertiary flint, Turonian flint, and Senonian flint from the more than 50 km distant Marne. The raw materials are mostly stemming from Mesozoic formation (chalk flint). Although the accessibility of the site is the same *a priori*, the strong variability of the materials from one site to the other apparently is due to cultural choices (Allard 2005).

With regard to the sandstones, another founder of the reference collection, C. Pommepuy, has carried out a synthesis on the grinding stones in the Bronze Age and the Iron Age in the Aisne valley. She has demonstrated choices in the use of distinct materials, in a region displaying a large number of diversified resources: sandstone and more particularly Belleu sandstone in the Final Hallstatt and Early La Tène period, limestone in the recent and final La Tène period (Pommepuy 1999).

In their studies, C. Hamon and G. Fronteau have also proposed a synthesis on sandstone materials outcropping in the Aisne valley from east to west, between the Champagne plain and the Soissons region (Hamon and Fronteau 2010). They have highlighted a large variety of accessible materials of which four at least are used during the Linear Pottery Culture.

At the end of the 5th millennium, in the area of the Michelsberg culture, the sites are not systematically established next to the flint resources and procurement focuses on high quality materials. For example, the sites of the Aisne valley indicate a major procurement of Bartonian flint from Romigny-Lhéry (at a distance of about 20 to 50 km) and an important supply with Senonian flints, probably stemming from the region

of Epernay in Champagne. Here, débitage, although primarily on flakes, is oriented towards a true laminar production of two types: a « domestic/household » production of blades made from both Senonian and Bartonian flint and a production of large blades made on Bartonian flint, but also on Spiennes and Rijckholt flint, possibly processed in mine sites of the Michelsberg area (Giligny & Manolakakis 2011).

5. Perspectives

After the updating of the data base and the description of the samples conducted within the French-German « MK-project », the reference collection currently is a useful tool for the study of lithic materials recorded from archaeological sites of the north-eastern part of the Paris basin. The development of new laboratory analyses may be envisaged as new petrographic analyses or those made with other methods.

The reference collection is considered as a referential in progress that can be enlarged by new surveys. Distinct areas would be worth investigated in a more systematic manner, for example the plateaus of the Tardenois and the central Oise valley, and in a broader context the Seine valley.

Materials other than flint, for example clays, limestone and sandstone will also be subject to a reassessment of the data and their descriptions completed in the database in order to complete the referential of lithic resources of the study area. An extension of the reference collection is planned through the incorporation of clay samples of the Aisne valley collected by one of us in the last years (B. Robert). Thin sections of backed samples will also be made soon and incorporated into the reference collection and used for pottery studies.

In the short term, the principal information of the reference collection will be placed on-line. About hundred raw material sources will be described including for each the localization of the site (administrative and geographic), the geological attribution and the macroscopic description of the samples.

The Soissons Lithotheque is a useful referential for studies on numerous materials (limestone, sandstone, flint) which in the future may be part of a network of regional reference collections as those of Amiens, Normandy and Belgium constituting a referential for the entire Paris basin and its margins.

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Translation: K. Mazurié de Keroualin

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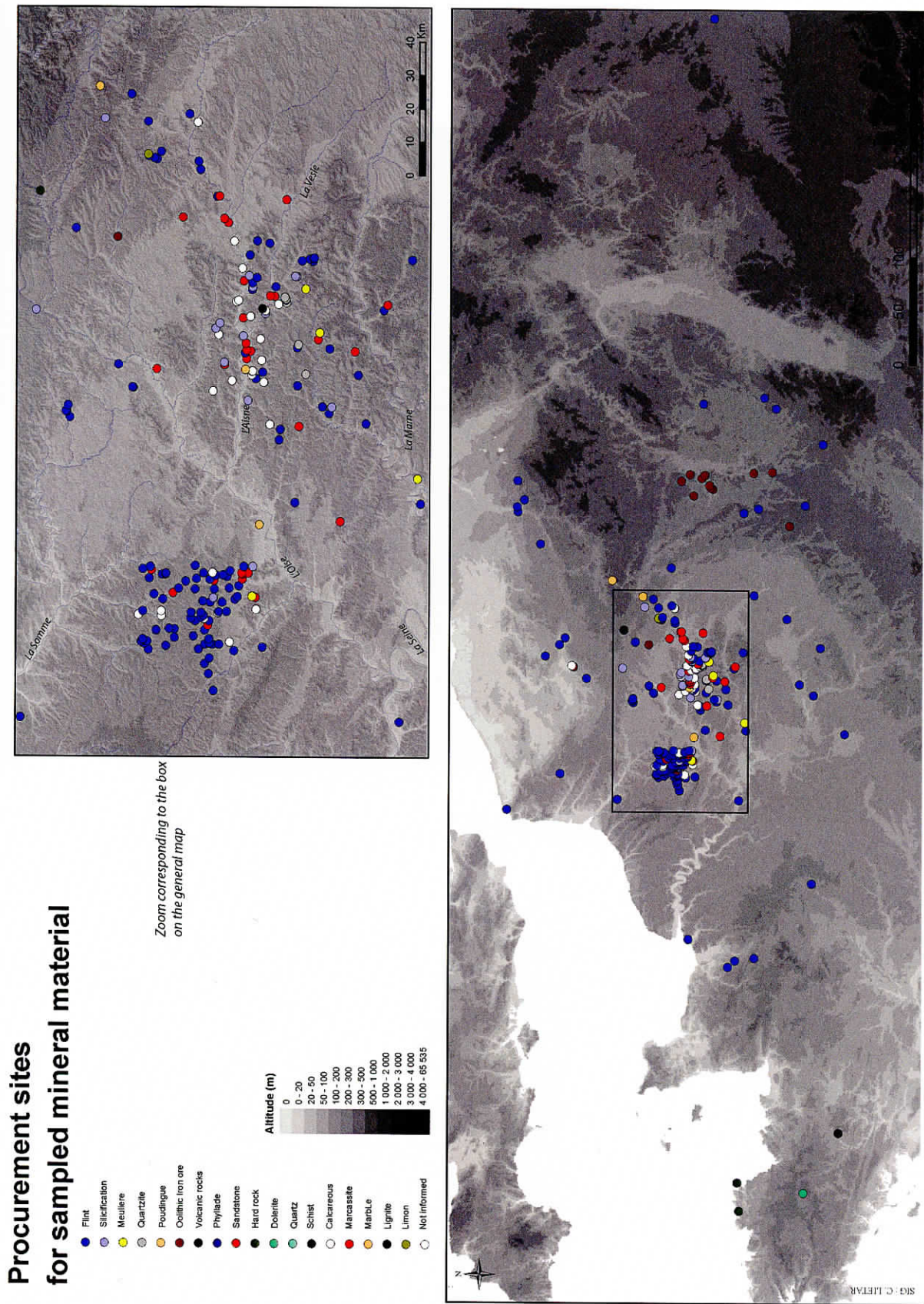


Fig. 1 : Distribution of the sources documented in the Soissons reference collection by material in Northern France and the adjacent regions.

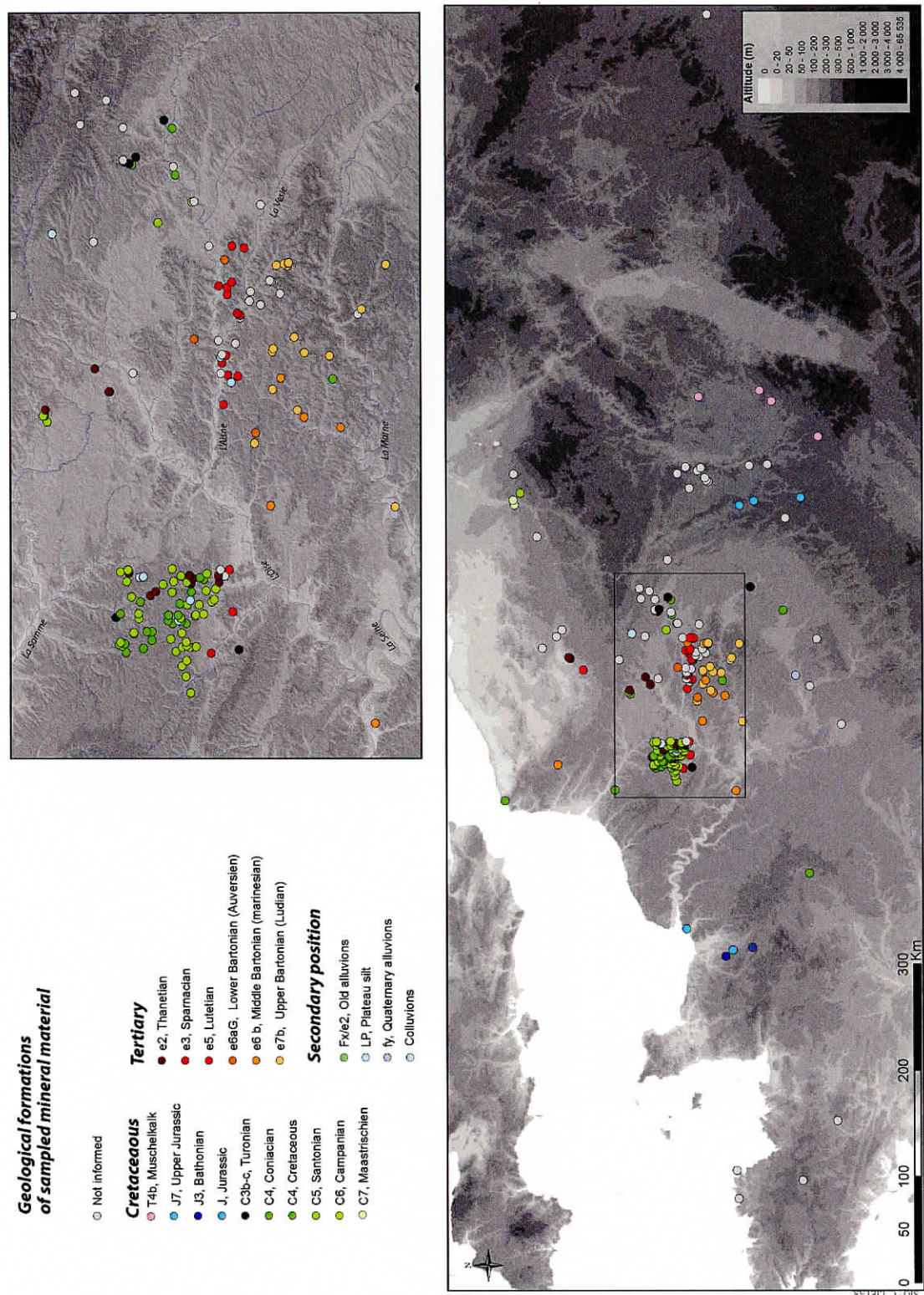


Fig. 2 : Distribution of the sources documented in the Soissons reference collection by geological stage in the Aisne and Oise valleys

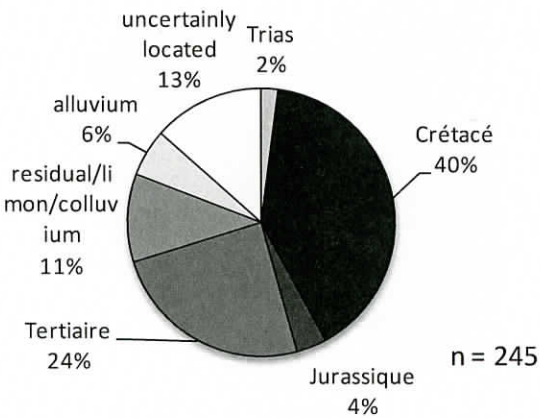


Fig. 3 : Distribution of the flint raw materials and silicifications by geological age.

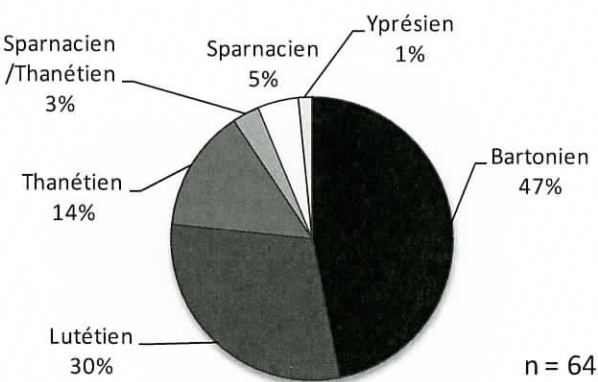
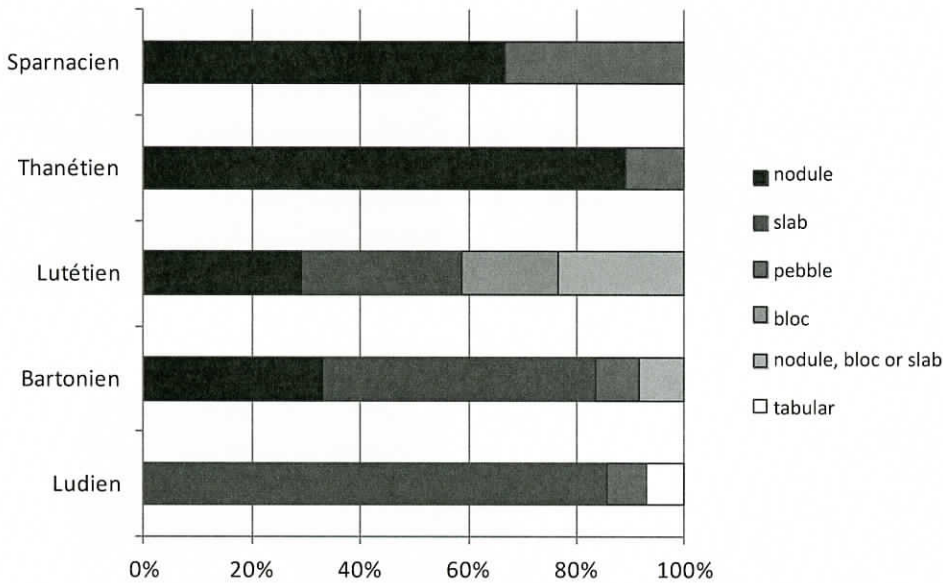


Fig. 4 : Distribution of the flint raw materials and silicifications of the Tertiary by geological stage.



	nodule	slab	pebble	bloc	nodule/ bloc/ slab	tabular	Total
Ludian		12	1			1	14
Bartonian	4	6	1		1		12
Lutetian	5	5		3	4		17
Thanetian	8		1				9
Sparnacian	2		1				3
Ypresian		1					1
	19	24	4	3	5	1	56

Fig. 5 : Morphology of the samples of the Tertiary by geological stage.

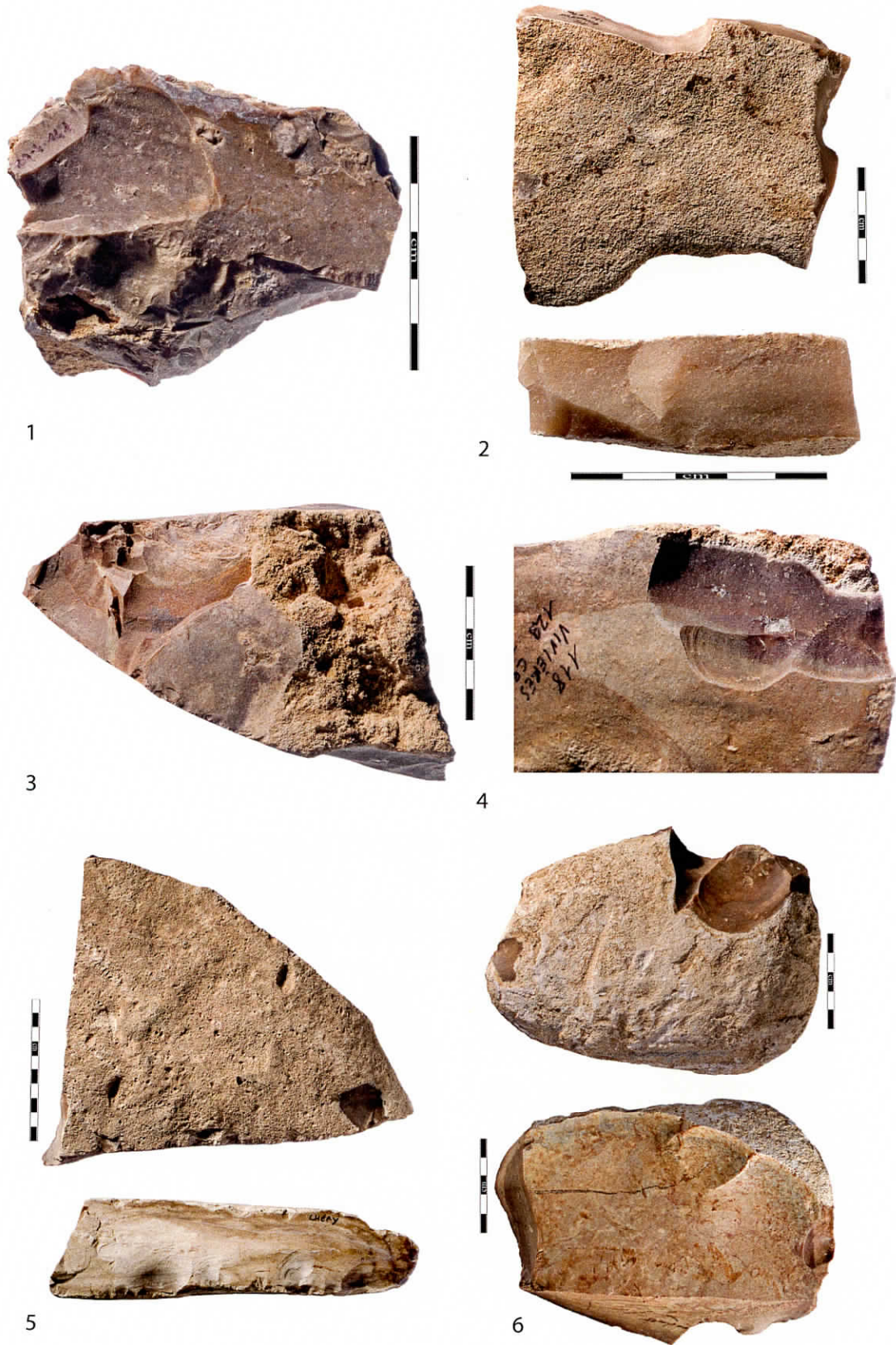


Fig. 6 : Silicifications of the Tertiary. 1. Glennes, Lutétien e5, 2. Beugneux, Ludien e7a quartzite, 3-4. Vivières, Bartonien e6, 5. Lhéry, Bartonien supérieur e7b , 6. Fl-ins-sur-Seine, Bartonien moyen/supérieur e6b-e7. (photos S. Oboukhoff, CNRS).

	pellicular	1-2 mm	2-5 mm	5-10 mm	> 10 mm	irregular	Total
Ludian	2	2	1	6	2	2	15
Bartonian	3	7	1	1	1		13
Lutétien	3	3	1	4	2	7	20
Thanetian	7					1	8
Sparnacian	2		1				3
Ypresian						1	1
	17	12	4	11	5	11	60

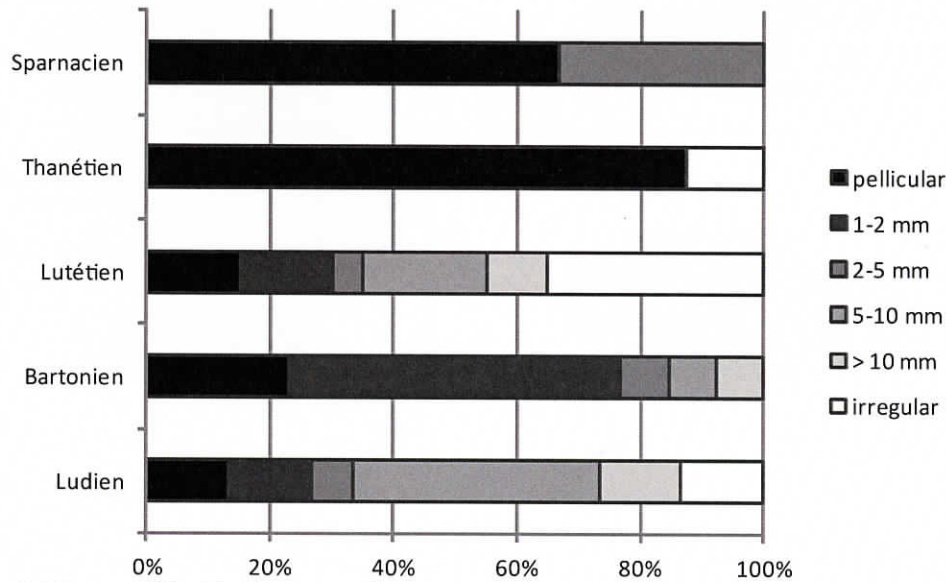


Fig. 7 : Cortex thickness of the Tertiary samples.

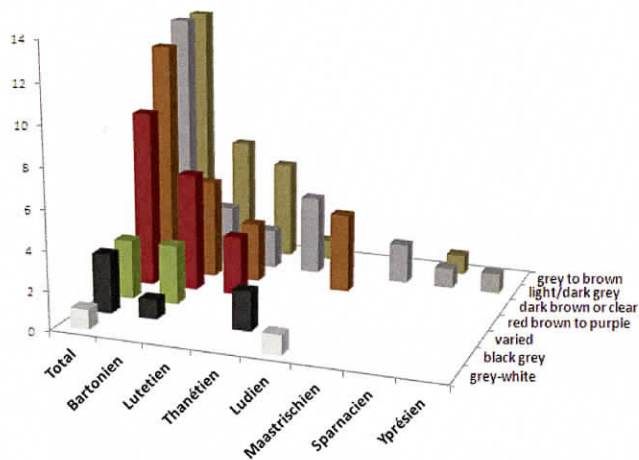


Fig. 8 : Distribution of the colours of the silifications of the Tertiary.

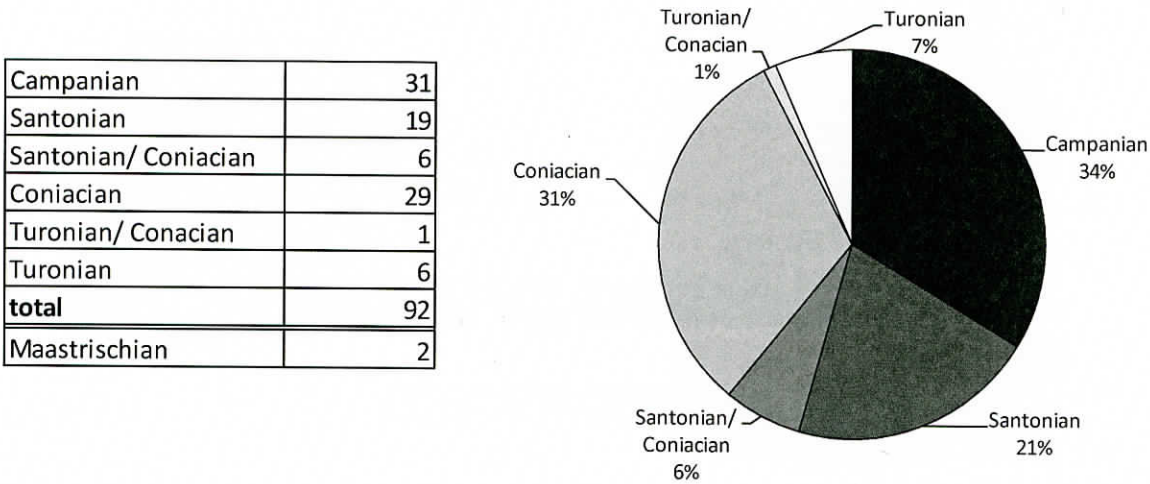


Fig. 9 : Distribution of the siliceous raw materials of the Cretaceous by stage.

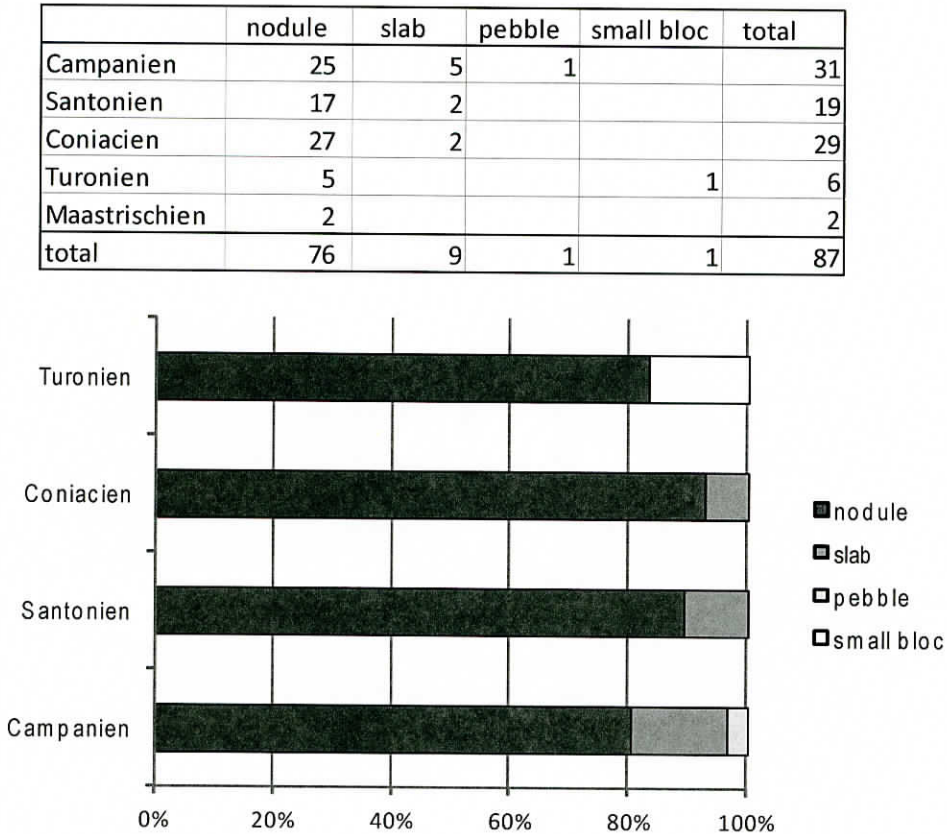


Fig. 10 : Morphology of the samples of the Cretaceous.

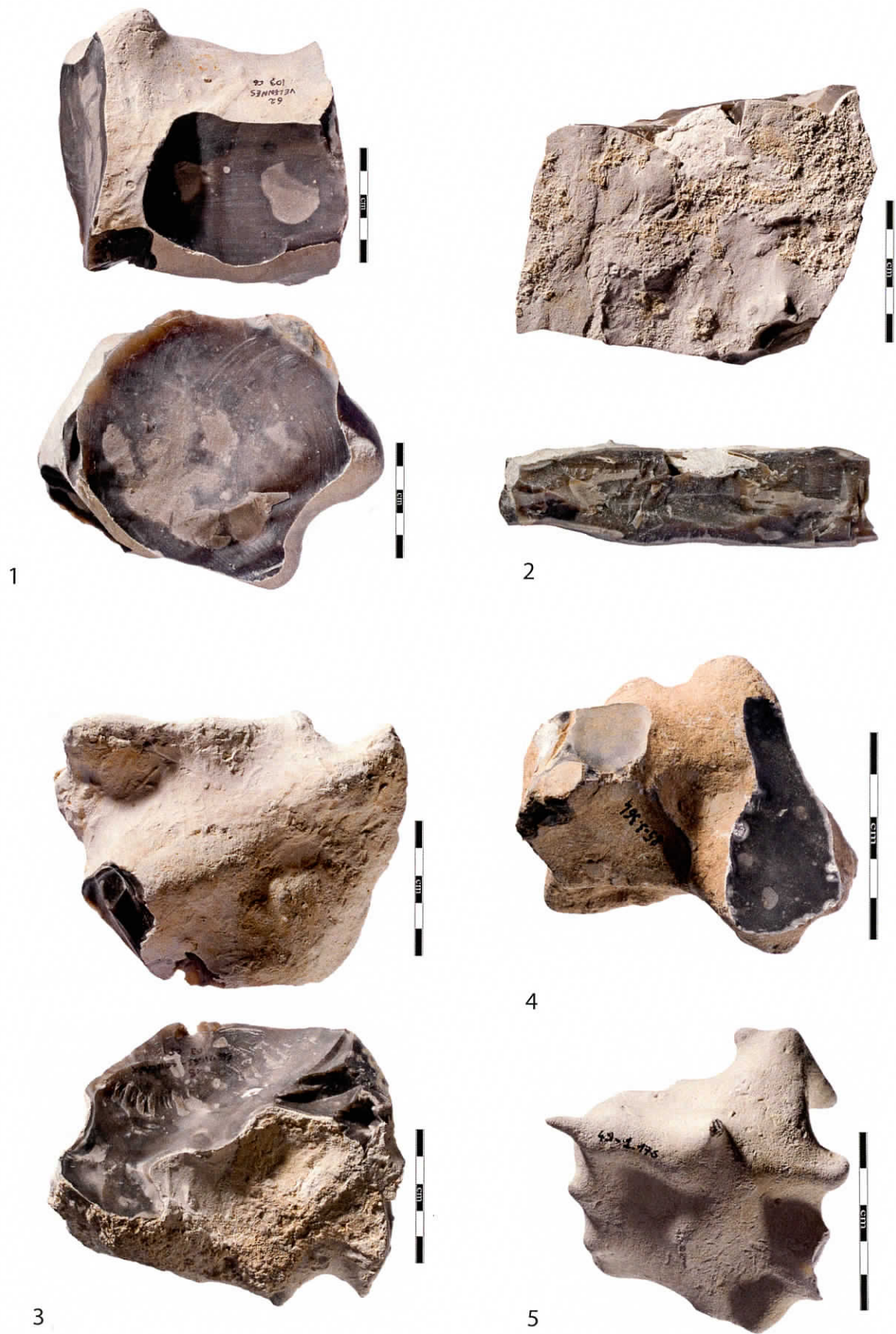


Fig. 11 : Silicifications of the Secondary. 1. Velennes, Campanien C6, 2. Hardivilliers, Campanien C6, 3. 3. Essuilkas, Santonien C5, 4. Remaucourt, Turonien C3b-c, 5. Villers-Outreaux, Coniacien C4-5 (photos S. Oboukhoff, CNRS).

	pellicular	1 - 2 mm	2 - 5 mm	5 - 10 mm	irregular	Total
Campanien	28	3				31
Santonien	12	4	1		2	19
Coniacien	7	14	7	1		29
Turonien	2	2	1	1		6
Maastrischien	2					2
	51	23	9	2	2	87

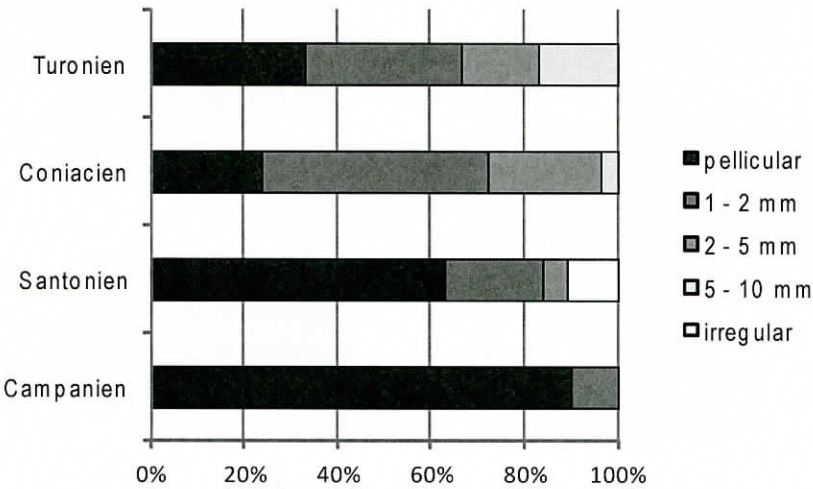


Fig. 12 : Cortex thickness of the samples of the Cretaceous by geological stage.

	nodule	slab	small bloc	pebble	undet/flake	total
Muschelkalk		5				5
middle Jurassic	1		2	1	2	4
superior Jurassic	1		2	1	3	7
total	2	5	4	2	5	16

Fig. 13 : Morphological characteristics of the samples of the Palaeozoic.