
New data about Cenomanian and Turonian chert from the Charente basin (France)

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Abstract:

Prehistoric studies in lithic raw materials have experienced some methodological innovations that have resulted in research breakthroughs. The transfer of methods from Geology to Archaeology has led to the development of a new discipline, Petroarcheology, which has allowed to go beyond the study of chert as a raw material, providing archaeological responses from Petrography's own methods.

Why did we choose the Charente's basin samples?

The history of research goes back to early 2000, with works like the PCR led by Anne Delagnes "Paléolithique Moyen dans le bassin de la Charente" and the doctoral thesis of Seon-Jing Park (2007), in relation to the question of Neanderthal human mobility and potential mineral resources of that basin. These works led to the initiation of different geoarchaeological surveys in search of quality siliceous raw materials for the manufacture of stone tools, whose positive results led, in 2002, to the creation of the regional lithothèque of Charente (Angoulême, France).

This lithothèque, located at the Museum of Fine Arts in Angoulême and with a collection of 183 samples of siliceous rocks - chert, jasper (Riba, 1997) and claystones (Riba, 1997)-, has become over the years an essential and very important tool for scholars interested in siliceous raw material availability and procurement in that region.

Our study has combined petrologic and micropalaeontological (both macroscopic and microscopic) analysis of all samples recovered from two of the four geological stages of the Upper Cretaceous represented in the lithothèque - Cenomanian and Turonian.

We've described some different kind of chert and we've made location maps with the aim, in the future, of compare and relate to archaeological studies on the origin of lithic industries recovered in the archaeological deposits of the area.

Keywords: petroarcheology; lithotheque; chert; petrological collections; Charente; raw materials

Resumen:

Los estudios en Prehistoria sobre materias primas han experimentado ciertas innovaciones metodológicas que se han traducido en grandes avances en la investigación. La conjunción de métodos



precedentes de la Geología hacia la Arqueología, ha supuesto el desarrollo de una nueva disciplina, la Petroarqueología, que ha permitido ir más allá en el estudio del sílex como materia prima, proporcionando respuestas de carácter arqueológico a partir de los métodos propios a la petrografía.

¿Por qué la elección de muestras de la Charente?

Los antecedentes de la investigación se remontan a inicios del año 2000, a raíz de los trabajos de Anne Delagnes, “El Paleolítico medio en la cuenca de la Charente” y la tesis doctoral de Seon-Jing Park (2007), en relación a la cuestión de la movilidad humana neandertal y los recursos minerales potenciales de dicha cuenca. Estos trabajos provocaron el inicio de diferentes prospecciones geoarqueológicas, en búsqueda de materias primas silíceas de calidad para la confección de utillaje lítico, cuyos resultados dieron lugar, en el año 2002, a la creación de la Litoteca Regional de la Charente (Angulema, Francia).

Esta litoteca, ubicada en el Museo de Bellas Artes de Angulema y con un fondo compuesto por 183 muestras de rocas silíceas (sílex, jaspes y arcillitas), se ha convertido con los años en una herramienta fundamental para los estudiosos de las materias primas silíceas de la región.

Nuestro estudio ha conjugado análisis petrológicos y micropaleontológicos (tanto macroscópicos como microscópicos) de la totalidad de las muestras procedentes de dos de los cuatro pisos geológicos del Cretácico superior representados en la litoteca – Cenomaniense y Turoniense- .

Se han descrito diferentes tipos de sílex y se han elaborado sendos mapas de localización con el propósito, en un futuro, de poderlos comparar y relacionar con estudios arqueológicos sobre la procedencia de la industria lítica recuperada en los yacimientos de la zona y así comprender el porqué de ciertos comportamientos humanos.

Palabras clave: petroarqueología; litoteca; sílex; colección pétreo; Charente; materias primas

1. Introduction

For several years starting in 2002, Anne Delagnes led a research project entitled “The Middle Palaeolithic in the Charente basin”, in which one of the main topics was about human mobility in relation to potential mineral resources. Meanwhile, Seong-Jin Park conducted a doctoral thesis on lithic production systems and the movement of raw materials in that region (Park 2007). In the course of this project were conducted several surveys to complete prior existing information (Séronie Vivien & Lenoir, 1987; Séronie-Vivien 1972; Séronie-Vivien and Séronie-Vivien, 1987).

Simultaneously, but independently, Christophe Delage carried out prospections for chert¹ outcrops in that same region, but more specifically within a 15 km radius of the prehistoric (Magdalenian) site of La Chaire-à-Calvin. This work provided a lot of information in relation to the amount and variety of chert outcrops in the area. A total of 123 chert-bearing outcrops from the Cretaceous were visited and sampled (Delage 2005; Delage *et al.* 2006), provide strong evidence about the availability of mineral resources in the immediate vicinity of the site.

These surveys were combined with important laboratory work, based on a macroscopic characterization of the samples. It was in this context that the Regional Lithothèque of the Charente’s basin (France) was created (Féblot-Augustins *et al.*, 2010). Located in the Fine Arts Museum of Angoulême this reference collection is composed of 183 samples of siliceous rocks -chert, jasper (Riba, 1997) and claystones (Riba, 1997).² The research potential of this Lithothèque lies in the fact that it provides data (such as the geological and geographical context of the samples) for the future identification of cherts recovered in various archaeological contexts.

Lithic materials are important at two different levels: the archaeological and the geological levels. As a geological matter, the natural entities of these rocks must be studied with natural sciences methodologies. But, on the other hand, since they have been modified

by humans, they are an archaeological remain, and thus they must be approached through cultural and technological analysis as well (Mangado, 2004). Masson (1981) stated in her thesis that cherts are siliceous rocks “with memory”. Thus, by studying their mineralogical, textural and structural components we can place them in a well-defined geographical space and at a specific geological time (see also Mangado, 2004: 11).

However, only an approach from the perspective of Social Sciences and Humanities may allow an interpretation of the human groups who used them as an economical or symbolical resource. Thus, to achieve its goals, Prehistoric Archaeology (as the most naturalistic of the human sciences) needs to draw on more empirical methodologies, such as Petroarcheology, to study the lithic assemblages from the two perspectives mentioned before (Mangado, 2002). The interest of petrographic analysis applied to archaeology relies on the creation of an empirical corpus of data to infer palaeoeconomic information resulting from human activity (Mangado, 2002). Such data set must be based on a specific protocol, which follows successive steps of observations and comparisons at different scales (Figure 1).

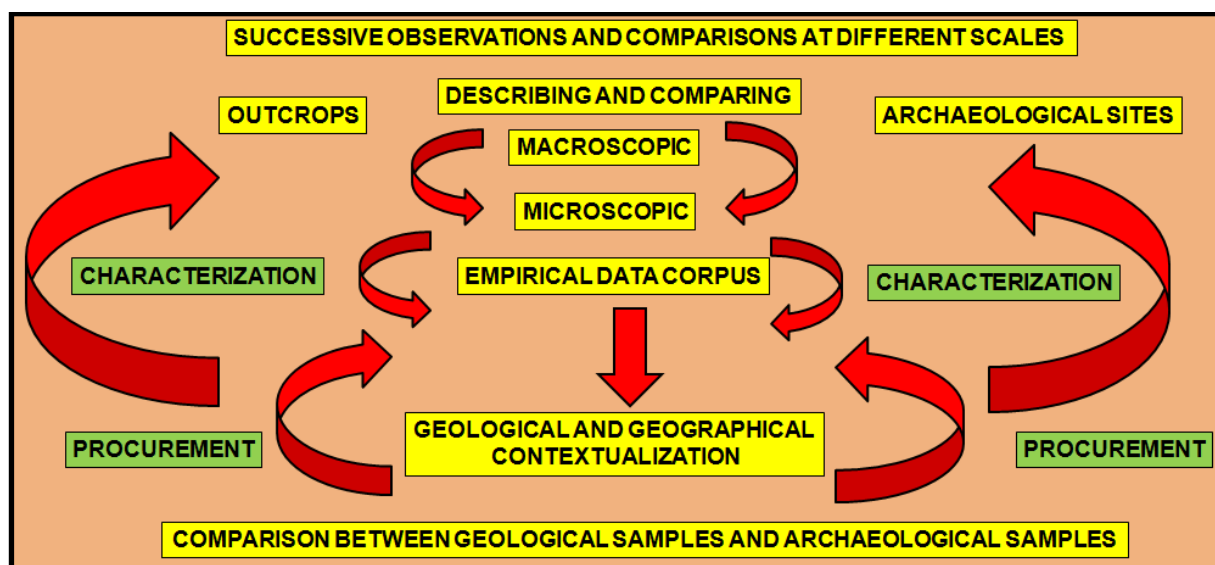


Figure 1. Petroarcheological methodology (Mangado & Rey-Solé, 2013).

2. Material and methods

The Chaire-à-Calvin rockshelter is a prehistoric site located in Mouthiers (France) (Figure 2) that has been prolific (there have been more than a single occupation, from Middle to Upper Magdalenian), notably in terms of the recovery of chipped stones (de Sonneville-Bordes, 1987). Their analysis may provide answers to several questions regarding the origin of these stone tools.

The study of the raw materials of this site has not been conducted yet. Thus there is a lack of knowledge about the mobility of the prehistoric communities inhabiting the area. There is no doubt that the only raw material used for the production of the lithic assemblage was chert, although different varieties of chert can be easily identified to the naked eye. Thus it seems evident that the different varieties have different geological and geographical origin, without further analysis.

The first step in this research on the Charente basin Lithothèque corresponds to the implementation of a petrological study, intended to categorize different types of cherts. As a side effort, it will locate geographically the different outcrops on the map.

Second, the same petrological methodology could be applied to the study of the archaeological lithic industry, through a comparison with the geological dataset. With the

observation, description and identification of the lithic assemblage recovered at the site we will produce a petroarcheological corpus data, to be compared with the corpus of data of the geological samples of the lithothèque from Charente's basin, which has been previously studied. From this research we intend to approach the origin of the raw materials used to produce the lithic tools, by locating the source of the cherts recovered at the site.

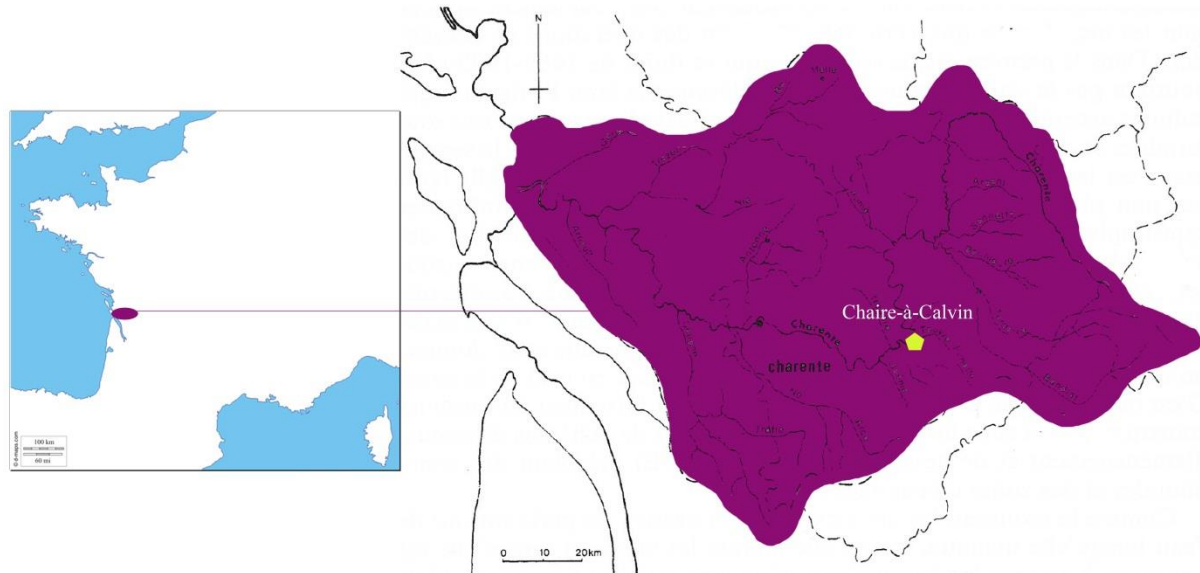


Figure 2. Charente's basin and the Chaire-à-Calvin site (modified from d-maps.com).

This is how the archaeopetrological study of the siliceous raw materials recovered at Chaire-à-Calvin site will allow us to understand and reconstruct the degree of mobility of the Upper Palaeolithic populations occupying the site and leaving behind traces of their activities.

The study of two geological ages, the Cenomanian and the Turonian, was the first step of our research related to the Charente basin Lithothèque. We studied 59 geological samples of chert, 55 of them came from 22 Turonian outcrops (16 in its original position and 7 in secondary location³) and 4 samples came from 4 primary Cenomanian outcrops.

The methodological approach consists in the textural analysis –both macroscopic (including naked eye and binocular magnifier) and microscopic- of all samples.

The macroscopic analysis was conducted by naked eye and also using a binocular magnifier (Olympus stereomicroscope with KL 1500 LCD cold light source) between 0.67x to 4.5x magnification ranges. The macroscopic description takes into account parameters as: colour, degree of patina, homogeneity, brightness, petrographic siliceous elements, texture, structure and micropaleontological contents (Dunham 1962; Luedtke 1992; Pettijohn 1970; Rey 2011; Riba 1997) (Figure 3). Many different types of carbonate relics (Foraminifera, bryozoans, algae, spicules, echinoderm plates, thecal plates of crinoids, etc.) revealed the silicification process and were significant of the original sedimentary environment. Depends on the carbonate relict it was identified at macroscopic level and/or at microscopic level.

28 thin sections of these previous samples were prepared at the Thin Section Laboratories of the University of Barcelona to analyse it by the Petrographic Microscope. The mineralogy, texture and structure of these samples have been analysed (Vallès Garcia *et al.*, 2006.). The microscopic description focuses on 3 criteria (Rey-Solé, 2011): siliceous components as: megaquartz, microquartz, chalcedony and opal; non-siliceous components as: host rock, micropaleontology, skeletal and non-skeletal components, pseudomorphs, relict textures and other relict or authigenic minerals (Figure 4); and finally diagenetic aspects, such as dolomitisation and anhydritation identified by cross-polarized light microscopy.

The study of the fossil record has been also useful to discriminate varieties, origins and provenances. These two levels of analysis have allowed us to differentiate several types of chert showing different characteristics.

Finally mention that SEM was used but did not give the expected results.

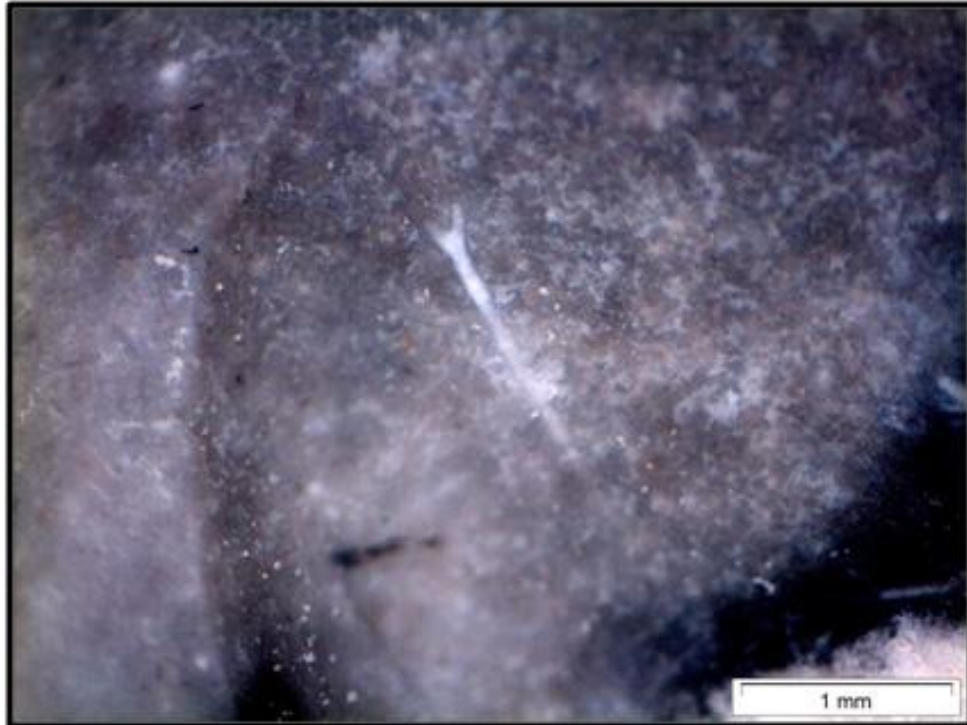


Figure 3. Carbonate relict of spicule from sample number 41-4. Cimenteries Lafarge. Macroscopic level. Binocular magnifier (3x).

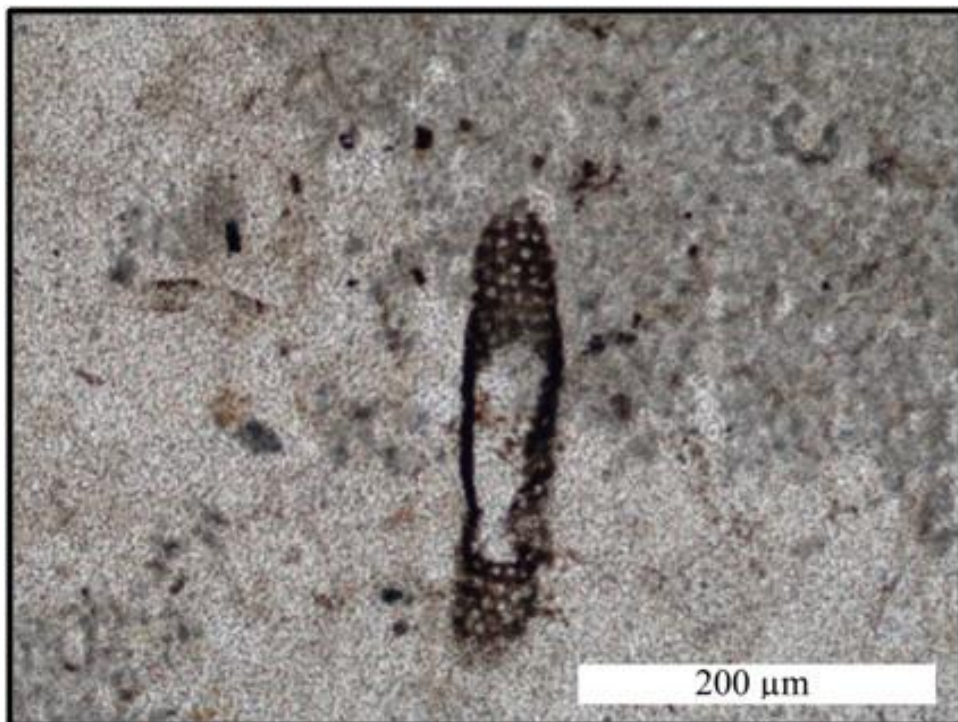


Figure 4. Radiolarian sample num. 41-4. Cimenteries Lafarge. Microscopic level. Petrographic microscope (20x).

3. Results

The methods of analysis used in this research have provided many information, especially the petrographic analysis with a wide-ranging empirical dataset that allow us to define certain varieties and sub-varieties of cherts.

We have defined a total number of 11 varieties of cherts (3 Cenomanian types and 8 Turonian types) all of them coming from the Charente basin (Cenomanian Fm and Turonian Fm) (Table 1 and Table 2).

We can observe that the Cenomanian age samples are quite homogeneous, at textural and micropalaeontological level, but in any case, each variety is perfectly distinguishable. By contrast, the Turonian age samples present a great variability and multiplicity of petrographic and micropalaeontological features that characterize the different varieties of chert (Figure 5).

In summary, all varieties of chert discriminated are marine, with a high percentage of bioclasts such as foraminifera, bryozoans, echinoderms or spicules. The difference between them lies in the grain size, the texture and the structure, there are mudstone, wackestone, packstone and grainstone varieties, or with differences between its majoritary siliceous elements (Microquartz vs. Macroquartz or Chalcedony), etc.

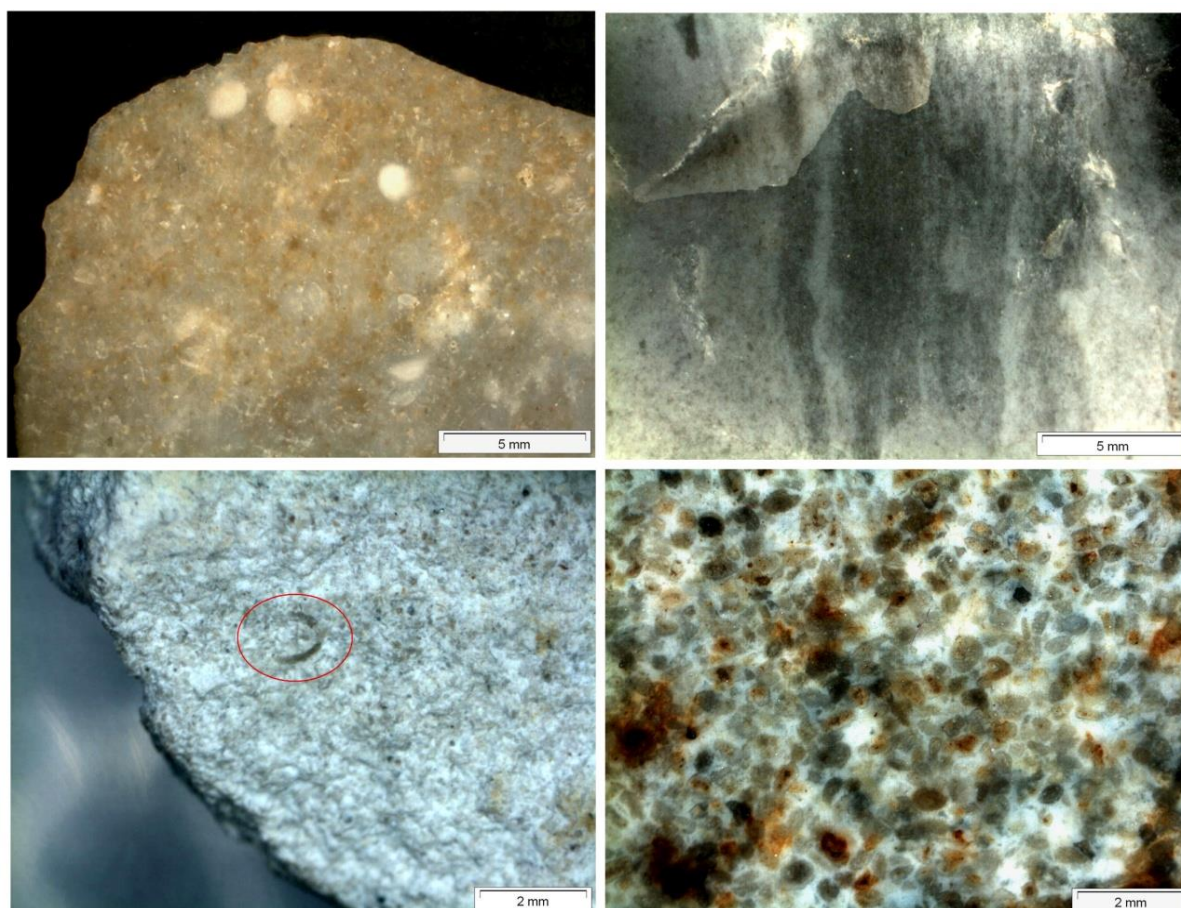


Figure 5. Different textures and varieties of chert from Charente's basin. From left to right and up to down: sample 44-1 from lower Cenomanian (F1 variety), sample 63 from middle Cenomanian (F3 variety), sample 45 from middle Turonian (E2 variety) and sample 20-6 from upper Turonian (E6d sub-variety).

Table 1. Macroscopic characteristics of defined types. (Rey-Solé 2013).

MACROSCOPIC ANALYSIS							
	Variety	Subvariety	Samples	Texture	Grain size	Colour	Observations
Cenomanien	F1		44-1, 44-2, 44-3, 51	<i>Packstone</i>	Coarse	HUE 7.5YR 4/2	Orbitolinidae, Brachiopoda, glauconite, peloids
	F2		100	<i>Mudstone</i>	Fine to Medium	HUE 2.5Y 5	Azoic, stromatolitic structure
	F3		61, 62, 63, 65	<i>Mudstone</i>	Very fine	HUE 2.5Y 5/2	Azoic, concentric zonation, metallic oxids, microgeodes
Turonien	E1	E1a	2, craix 2	<i>Mudstone</i>	Very fine	HUE 2.5Y 5/3	Micropaleontology in the cortex, rhomboidal pseudomorphs
		E1b	1, 8-7, 8-8	<i>Mudstone</i>	Very fine	HUE 2.5Y 6/1 y HUE 10YR 5/2	unkown micropaleontology, bioturbation traces
	E2		45	<i>Packstone</i>	Medium	HUE 2.5Y 6/1	Dasycladae, Bryozoa, benthonic Foraminifera, frag. of shell
	E3		16-1, 16-2, 20-1, 20-3, 20-4, 41-3, 41-4, 48-1, 76-1, 77-1	<i>Mudstone</i>	Very fine	HUE 2.5Y 2.5/1	Spicules, frag. of shell, relictual Foraminifera, metallic oxids
	E4		66-1, 66-2, 66-3, 73-1, 77-2	<i>Mudstone</i>	Very fine	HUE 2.5Y 5/2	Isolated spicules, <i>Incertae sedis</i> , metallic oxids, preferred orientation of the elements
	E5		47-2, 48-2, 76-3, 76-6, 81,	<i>Mudstone</i>	Very fine	HUE 10YR 4/2	Bryozoa, benthonic Foraminifera, frag. of Echinoderma, shells and Brachiopoda
	E6	E6a	40-2, 40-5, 67-1, 76-4	<i>Mudstone</i>	Fine to Medium	HUE 2.5Y 5/1	Abundantes foraminiferos e <i>Incertae sedis</i>
		E6b	72-2, 82-1	<i>Wackestone</i>	Fine to Medium	HUE 10YR 5/2	Spicules (including relicts), Bryozoa, fragm. of shell and <i>Incertae sedis</i>
		E6c	20-2, 40-1, 40-4, 41-2, 49, 74-1, 76-5, 72-1, 96-1	<i>Packstone</i>	Medium	HUE 10YR 4/4	Fragm. Echinoderma, Bryozoa, Miliolidae, benthonic Foraminifera, shells, plant remains, <i>Incertae Sedis</i>
		E6d	20-6	<i>Grainstone</i>	Medium to Coarse	HUE 7.5YR 3/2	Miliolidae, biserial Foraminifera, Bryozoa and frag. of Shell
	E7		20-5, 40-3, 76-2, 47-1, 171-1	<i>Wackestone-Packstone</i>	Fine to Medium	HUE 2.5Y 6/2	Bryozoa, spicules, Miliolidae, <i>Incertae sedis</i> , textural zonation
	E8		41-1, 79	<i>Mudstone</i>	Fine to Medium	HUE 10YR 4/6	Poor preferred micropaleontology, recrystalisations, mottled structure

Table 2. Microscopic characteristics of defined types. (Rey-Solé 2013).

		MICROSCOPIC ANALYSIS					
	Variety	Subvariety	Samples	Texture	Siliceous components	Micropaleontology	Observations
Cenomanien	F1		44-3, 44-1	<i>Packstone-Grainstone</i>	Microquartz (70%), Chalcedony (40%)	>70%: various foraminifera including miliolids, shell, echinoderm and gasteropoda fragm.	Banded - Chalcedony/Microquartz, differential conservation of the micropaleontology, pelloids
	F2		100	<i>Packstone</i>	Chalcedony (57%) Microquartz (40%)	>60%: unknown micropaleontology	Poorly preserved micropaleontology and replaced by Chalcedony
	F3		63	<i>Wackestone</i>	Microquartz (75%)	< 25%: spheric Radiolaria, unknown fragments	Relict micropaleontology and metallic oxides, stratified microfacies (=E1)
Turonien	E1	E1a	2, craix 2	<i>Wackestone-Packstone</i>	Microquartz (80%)	>60%: Echinoderma frag. Benthonic Foraminifera, Bryozoa, Tintinidae ressembling	Stratified microfacies, rhomboidal pseudomorphs relicts
		E1b	1, 8-7	<i>Mudstone</i>	Microquartz (99%)	20%: Echinoderma frag. And unknown Foraminifera	Stratified microfacies (Radiolaria/Microquartz)
	E2		45	<i>Grainstone</i>	Microquartz (77%), Megaquartz (20%)	>90%: unknown relictual Foraminifera, Ostracoda, Echinoderma picks	Stratified microfacies (Radiolaria/Microquartz)
	E3		16-2, 41-4, 76-1	<i>Mudstone a Wackestone</i>	Microquartz (56-97%)	<10%: Ostracoda, spicules, Radiolaria.	Microcrystalline microfacies (41-4, 76-1) and stratified (= E1) (16-2)
	E4		66-3	<i>Wackestone-packstone</i>	Microquartz (65%)	35%: <i>Incertae sedis</i> , bioturbation	Slightly stratified microfacies, very poorly preserved
	E5		76-3	<i>Mudstone</i>	Microquartz (95%)	<15%: spicules, unknown frag.	Microcrystalline microfacies, very poorly preserved
	E6	E6a	40-5, 67-1	<i>Packstone</i>	Microquartz (63-75%), Megaquartz (10-20%)	>50%: Miliolida and fragm of Foraminifera, Echinoderma, Ostracoda and shells	Bioclastic <i>Packstone</i>
		E6b	no samples				
		E6c	49, 20-2, 40-4, 74-1, 96-1	<i>Wackestone Packstone</i>	Microquartz (99,9-85%), Megaquartz (10-5%)	35 al 90%: Miliolida, fragm. of Echinoderma, shells and Bryozoa	Original carbonate structures, metallic oxides, rhomboidal pseudomorphs
		E6d	20-6	<i>Packstone - Grainstone</i>	Microquartz (85%)	>80%: Miliolida, fragm. Of Foraminifera, Echinoderma, shells and Ostracoda	Bioclastic <i>Packstone</i> with original carbonate structures
E7		20-5, 40-3, 76-2, 47-1, 171-1	<i>Wackestone-Packstone</i>	Microquartz (90-65%)) Chalcedonite (35-5%)	50 %: fragm. Echino., shells, Foraminifera, Bryozoa, spicules, Ostracoda	Bioclasts in replacement process, rhomboidal pseudomorphs and relicts	
E8		41-1	<i>Wackestone</i>	Microquartz (90%) Megaquartz (5%)	30%: fragm. of Rudist, Radiolaria (= E3)	Microcrystalline microfacies	

In the future, these defined varieties, will serve as a reference for the comparative petroarchaeological study of the stone-tools from the archaeological site of Chaire-à-Calvin (Figure 6).

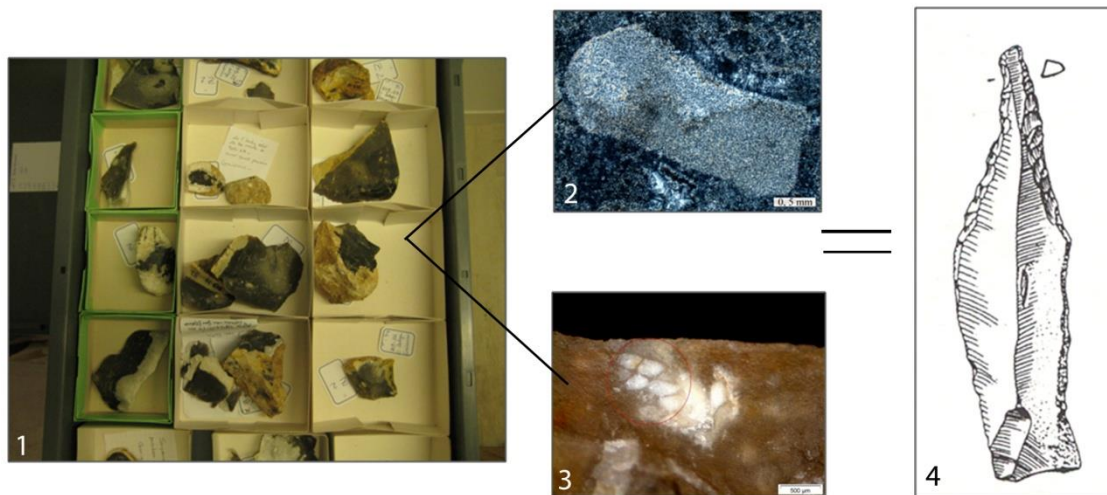


Figure 6. Simplified scheme for the next archaeopetrological study of comparison of geological and archaeological samples of Chaire-à-Calvin. 1. The lithothèque. 2. Microscopic photography of an echinoderm plate. 3. Macroscopic photography of thecal plates of a crinoid, both from La Couronne outcrop (Upper Turonian). 4. Perçoir from Chaire-à-Calvin.

The next step in our research and one of the objectives of this characterization of samples from the lithothèque has been to create maps of the Cenomanian and Turonian outcrops of the Charente's basin, in order to represent cartographically the siliceous resources and their characteristics in the territory. These maps are related to each one of the chert varieties with their particular characteristics (Figure 7).

At this point, we can consider that the Cenomanian and the Turonian cherts are quite well defined, at least, for the samples collected in a radius of around 15 km from the archaeological site of Chaire-à-Calvin. The resulting database will be useful to compare geological and archaeological samples in order to deduce the original environmental conditions of these cherts and thereby help in the future research in archaeopetrology of lithics of the site.

The next step to undertake would be try to answer some relevant questions, such as: which degree of mobility was developed by these populations looking for these raw materials? How many types of cherts were used in the manufacturing process of the stone tools? Why?

4. Conclusions

This study presents the preliminary results of our petroarchaeological research of the lithic collection of Chaire-à-Calvin site. The first step, which is the one presented in this paper, has been focused on the analysis of the existing geological lithothèque, while the analysis of the archaeological assemblage will be conducted in the near future. The research has shown the presence of different varieties of chert, with different characteristics pointing to different sources.

This paper shows once more how the characterization of the lithic raw materials through purely geological disciplines (such as Petrography and Micropalaeontology), provides significant information to understand the processes of mobility of prehistoric communities. Thus helping archaeologists to understand certain human behaviours, such as the collection and sourcing of lithic raw materials.

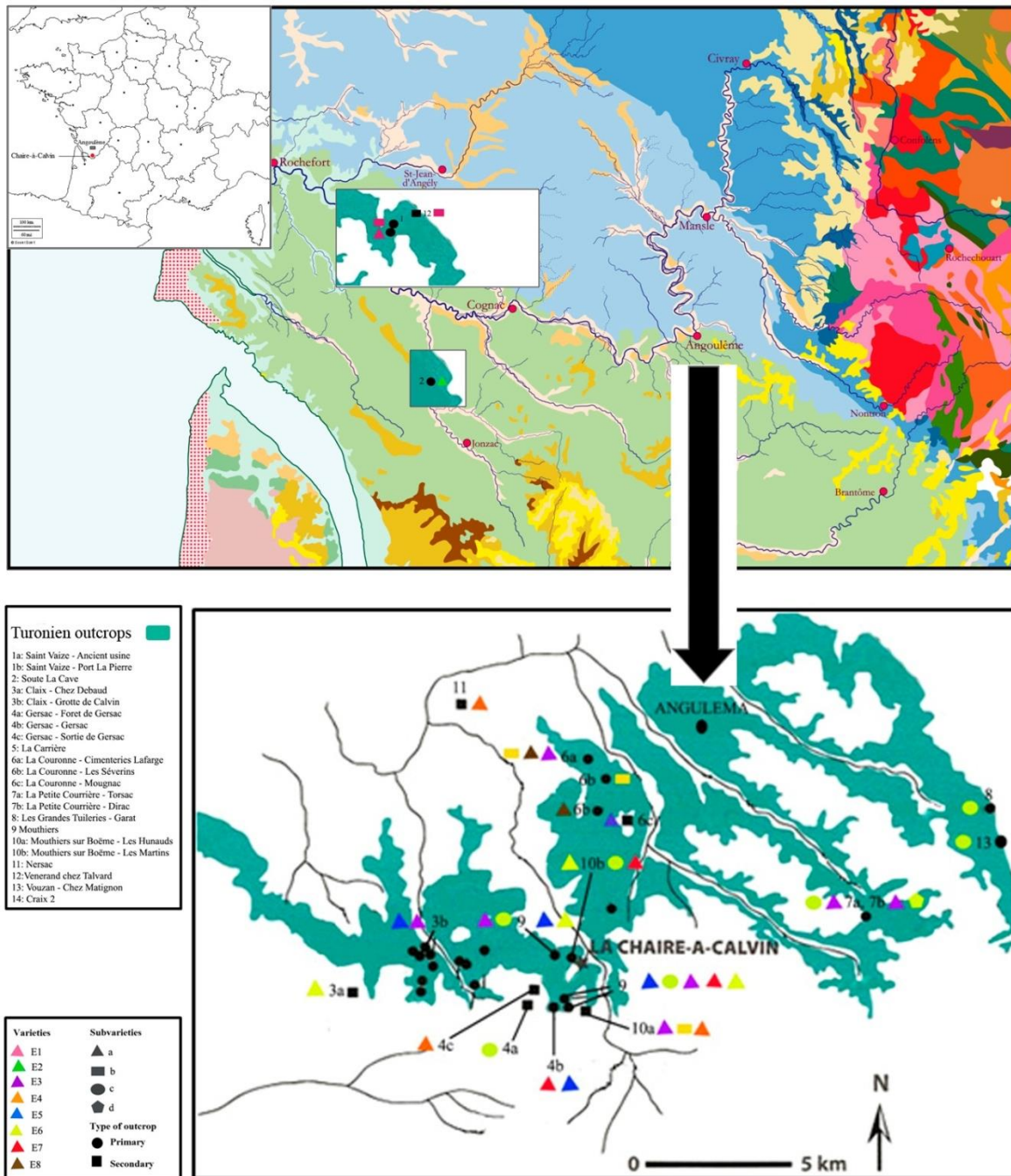


Figure 7. Location map of the Turonian varieties of chert from Charente's basin. Modified from Delage (2006) and Féblot Augustins & Monthel (2010).

Notes

1. The term ‘chert’ refers to microcrystalline quartz found in calcareous parent rocks. It also includes materials found in chalk, which are sub-categorised as ‘flint’.
2. There are data sheets that include photos, available on the Internet to ensure better dissemination of information: <http://www.alienor.org/ARTICLES/lithothèque/index.htm>
3. ‘Secondary location’ and ‘position’ refers to materials transported from bedrock outcrop by any dynamic process (i.e., Materials transported by riverbeds or materials included in conglomerate rock).

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