“Mucientes Chert” in the Northern Iberian Plateau (Spain)

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Abstract:

The so-called “Mucientes chert" is a variety that appears in the central area of the Iberian North Plateau, in the Duero Basin. It is widely known in the geological and archaeological literature and its use for knapping was especially important in Prehistory. From a macroscopic point of view it is a nodular chert, with white and very porous cortex, and brown to blackish or beige colour in the inner part.

In this work we carried out a more accurate petrographic, mineralogical and chemical characterization of this lithology using SEM, XRD and XRF techniques in samples coming from “Las Canteras” (Mucientes village), a chert outcrop of the “Cuestas” Unit (Vallesian-Aragonian, Miocene Age). Also, we have made a review of its geological occurrence and archaeological distribution areas. It is intended to sketch the delimitation of the geographical area of occurrence taking into account the geological and archaeological references.

Keywords: chert, Iberian North Plateau; Duero Basin; raw materials; lithic artefacts; “Cuestas” Unit

1. Introduction

One of the best known chert types at archaeological sites in the central part of the Duero River Basin is known as *Sílex de Mucientes* (Mucientes chert). Geologically it has been cited in the limestone moors in this area, in the geological materials known as the “Cuestas” Unit, of Miocene age. The name given to this chert type comes from the town of Mucientes in the Province of Valladolid, where outcrops of this chert type have been found as well as archaeological sites connected with its use (Sánchez-Yustos & Díez-Martín 2007).

The use of Mucientes chert for the manufacture of lithic objects in Prehistory is widely known, as shown in the appraisal carried out by Sánchez-Yustos & Díez-Martín (2007), who examined the sites cited in this area. After studying and assessing the lithic materials, they determined a series of sites dated in the Ancient Palaeolithic and in Recent Prehistory.

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However, despite the wide knowledge of the use of Mucientes chert in Prehistory, it is mainly identified by general macroscopic traits, such as colour. Therefore, the objective of the present study is to characterise the Mucientes chert type in greater detail, taking into account their petrographic, mineralogical and geochemical characteristics. As the ultimate objective is to identify lithic artefacts made in this chert type at the various archaeological sites, samples from the main outcrop of the chert (Las Canteras, Mucientes) have been taken and analysed. The petrographic characterisation of these samples will act as a reference to be able to confirm the assignation of different types of archaeological objects susceptible to being attributed to this raw material.

This work follows the guidelines on the analysis of the lithic raw materials used in prehistoric times, using the analytical protocols and approaches developed by different authors working in the Iberian Peninsula (for example, Aubry et al. 2012; Mangado 2005; Terradas 2001; Tarriño 2006, in press). Also it is intended to fill the gap that exists in the Northern Iberian plateau in relation to the characterization of this type of materials.

In addition, in a previous study (Fuertes et al. in press-a) a working hypothesis was sketched out according to which the procurement area of Mucientes chert was located in the central part of the Duero Basin, particularly in the area of the Montes Torozos. Data obtained in the present study will be able to verify this working hypothesis.

2. Geological context

The Duero Basin is a Cenozoic geological unit mainly composed of non-marine rocks including both Palaeogene and Neogene deposits. The Paleogene successions are restricted to the basin margins, and to Neogene sequence outcrop mainly in the extensive central region of the basin (Figures 1 and 2). In its central zone (Valladolid and Palencia provinces) only the Miocene succession (lower Serie of the Neogene) outcrops that is made up of three informal lithostratigraphical units (Portero et al. 1982; Armenteros et al. 2002); from bottom to top, they are (Figure 3):

1. "Arcillas de la Tierra de Campos" (Aragonian). Siliciclastic (clays, silts, sandstones, micro-conglomerates and marls) fluvial sediments.
2. "Cuestas" Unit (Aragonian-Vallesian). It is composed of gray calcareous siltstones and mudstones with decimetric beds of limestones bearing gastropods and characeae algae. Because these calcareous beds stand out in the landscape, they are usually used as levels of reference for correlation. In the lower part of the unit, gypsum is locally abundant. Chert nodules occur sometimes within the calcareous beds (Portero 1982). The "Cuestas" Unit sediments have been interpreted as being of lacustrine origin.
3. "Páramo Inferior" Limestone (Vallesian- Turolian). It is a lacustrine limestone, which is located at the top of the central high plain of the Duero basin.

Chert nodules outcrop in the surroundings of Mucientes area (Figure 2) and are hosted in the limestone beds, ca. 1 m thick, belonging to the "Cuestas" Unit (Figure 4). These limestone beds outcrop close to the town of Mucientes (especially in the area of Las Canteras, a name meaning 'The Quarries'), Cigales and Fuensaldaña (Valladolid Province), where the occurrence of cherts is cited (Portero 1982).

Some other references from geological literature for the Duero Basin have also been traced. The oldest citation is Cortázar (1877: 99) who notes the occurrence of chert ("pedernal") in the middle unit of the Tertiary in the Duero Basin (a unit which would correspond to the "Cuestas" Unit), and more precisely in several localities placed on the right bank of the Pisuerga River. Calderón (1910) quotes some chert nodules in areas around the towns of Cigales, Mucientes and Fuensaldaña, and also in "Villalba de Alcor" (*sic*) where Calderón (op. cit.) indicates chert of cavernous type. These localities have been cited again by some modern authors (Vicente & Ruiz 2006), who also identify three new localities: Berceruelo (Galán & Mirete 1979), Torrelobatón (Martín Vivaldi 1986) and Wamba (Delgado & del Valle 2007) (Figure 2).

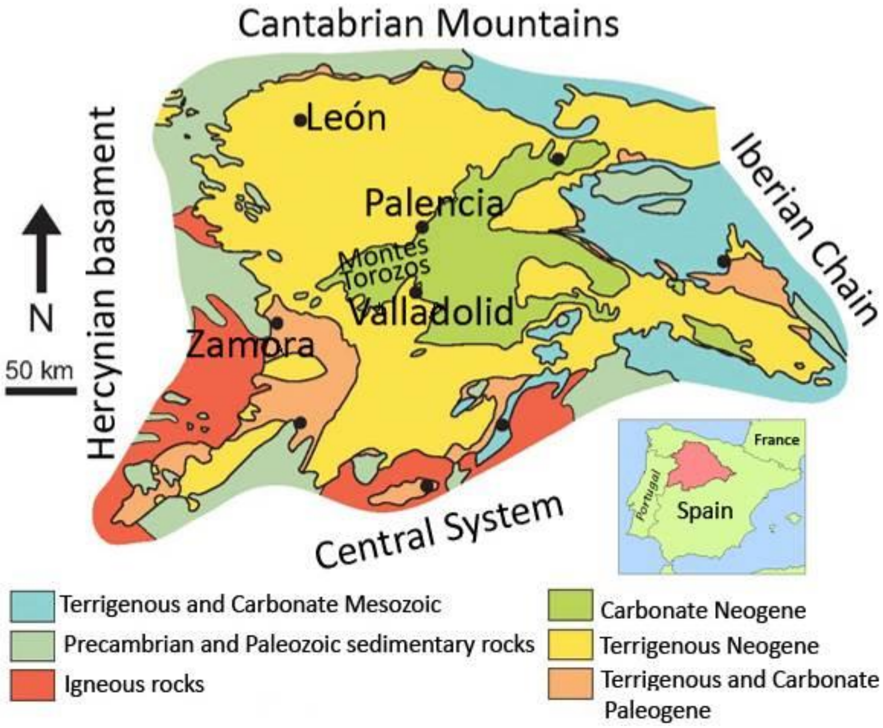

Figure 1. Geological context of the Duero Basin in the Iberian Peninsula (Modified from Armenteros et al. 2002).

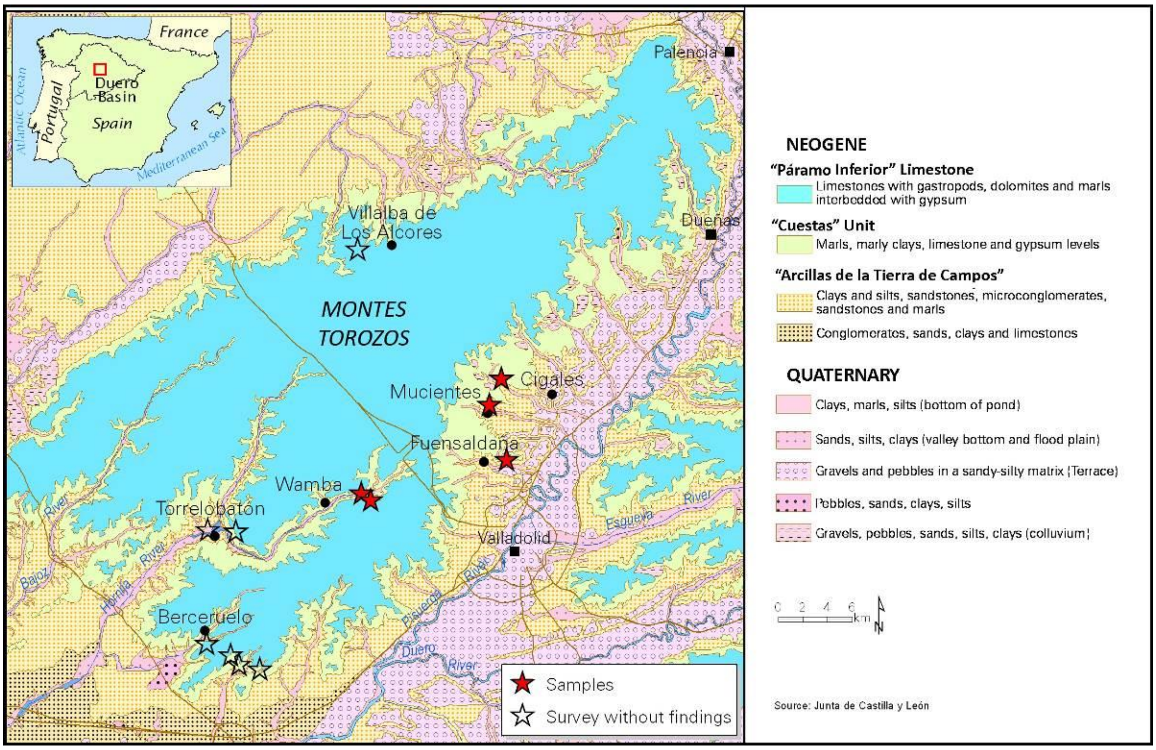

Figure 2. Geological map of the region (Source: Cartographic database of Junta de Castilla y León, Geology: synthesis from Portal de Datos Abiertos of Junta de Castilla y León). Black dots: localities where chert has been cited in geological literature. Empty stars: areas prospected without finds. Full stars: locations of the chert samples that have been located.

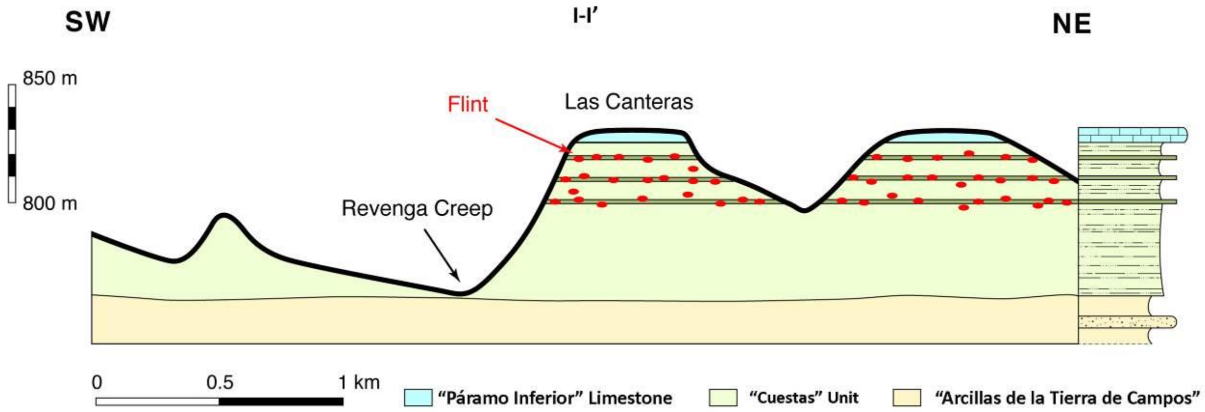

Figure 3. Geological cross-section in the area of Las Canteras (Mucientes, Valladolid), as indicated in Figure 4.

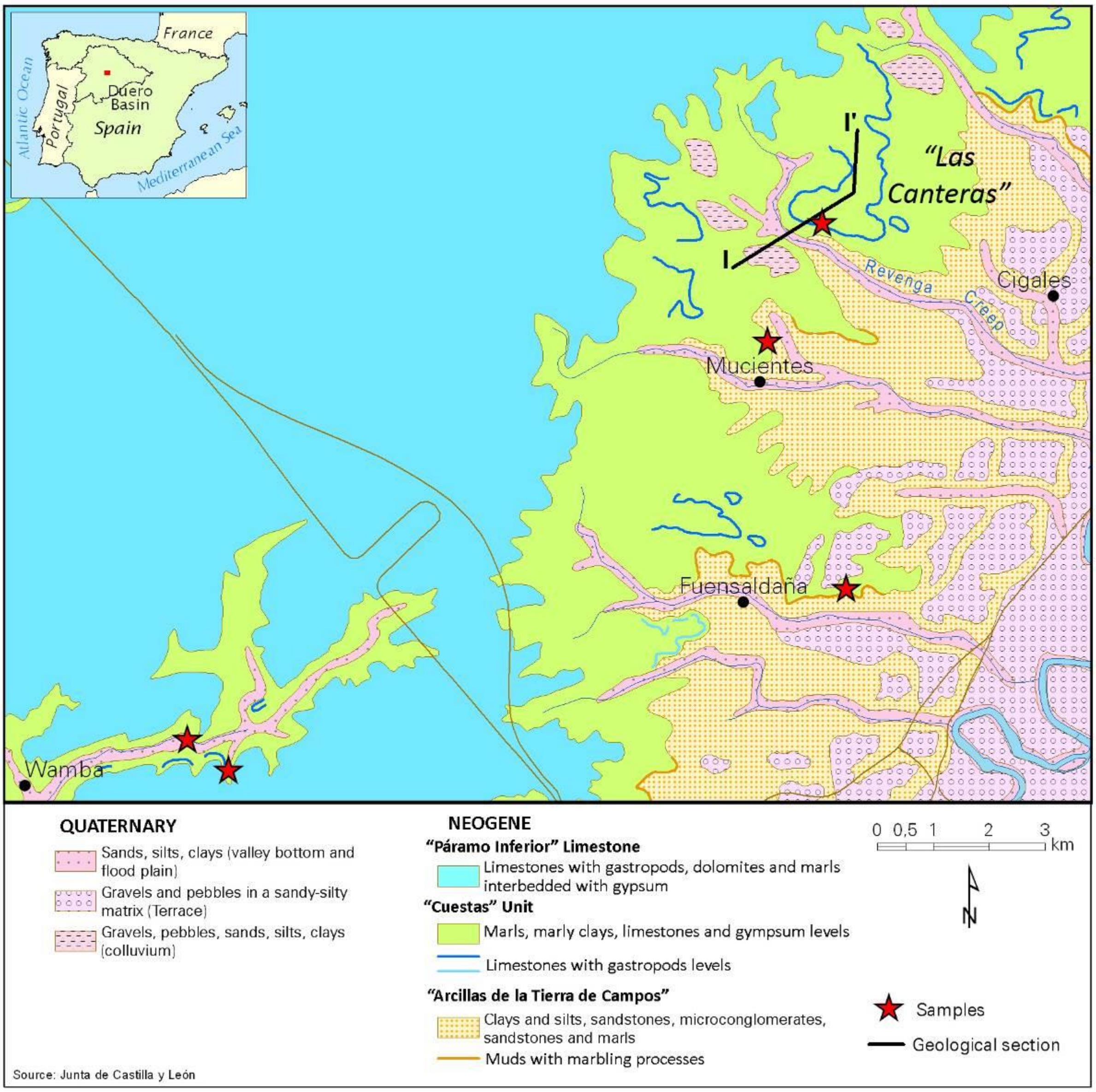

Figure 4. Detailed geological map of the Mucientes area (Source: Cartographic database of Junta de Castilla y León; Geology: synthesis from Portero 1982 and Piles et al. 2007). Stars mark the location of the samples found, especially in Las Canteras.

Geological maps (Pineda et al. 2007) also note the presence of chert pebbles and stones in the sediments formed by the erosion of the Miocene “Cuestas” Unit and outcropping in the Pleistocene terraces located on the right bank of the Duero, Bajoz and Hornija rivers.

A main conclusion can be deduced from the geological data: the supply of the material corresponding to the so called “Mucientes chert” comes from an area located in the geographical middle of the Duero Basin, but there are two different sources (as is shown in Figure 5):

a) Outcrops of the Miocene lacustrine sediments corresponding to the “Cuestas” Unit, where the chert nodules would be mainly in a primary position, although some erosive process could generate the occurrence of cherts in a derivative/secondary position (Figure 5, source area A).

b) Pleistocene fluvial terraces of several rivers in the Duero Basin, where the genetic position of the cherts is derivative/secondary as they have come from primary sources by erosion-transport-deposition processes (Figure 5, source area B).

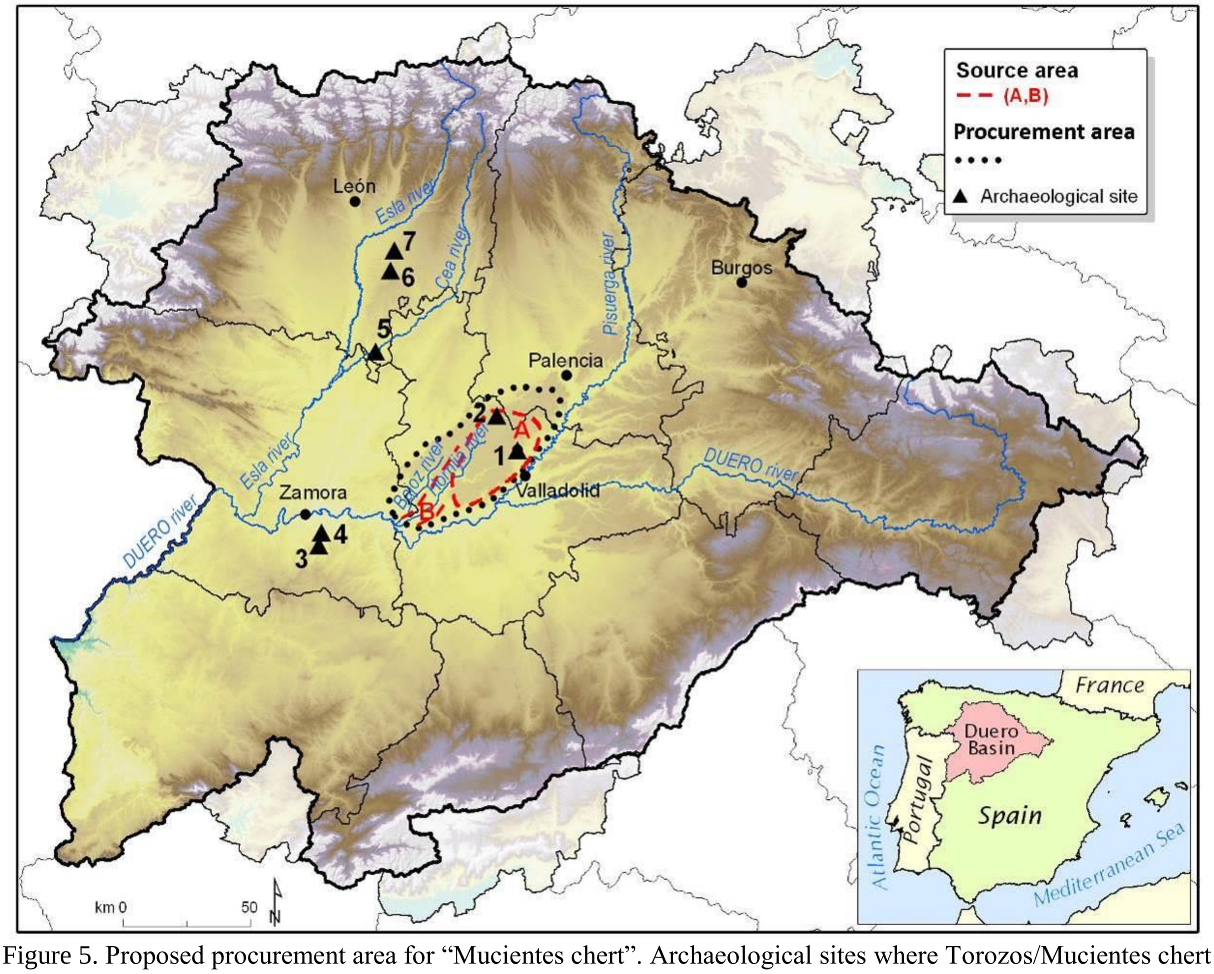

Figure 5. Proposed procurement area for “Mucientes chert”. Archaeological sites where Torozos/Mucientes chert objects have been cited. 1: Los Cercados (Mucientes, Valladolid). 2: El Casetón de la Era (Villalba de los Alcores, Valladolid). 3: Canchal de Jambrina (Peleas de Abajo, Zamora). 4: Las Pozas (Casaseca de las Chanas, Zamora). 5: Los Villares (Valderas, León). 6: Los Palomares (Fontanil de los Oteros, León). 7: Las Choperas (Santas Martas, León).

3. Methods and materials

The methodology applied includes five types of analysis:

1. Review of geological literature with references to Mucientes chert and location of possible source areas (Olmo & Cabra 2007; Piles et al. 2007; Pineda et al. 2007; Portero 1982;

Ramírez et al. 1982), based on a previous study (Fuertes et al. in press-a). This phase is still not finished as the fieldwork is ongoing.

2. Fieldwork to locate the exact position of the outcrops cited in the literature and to take samples. In particular, priority was given to locating limestone beds in the “Cuestas” Unit, where the chert nodules are in a primary position.
3. The macroscopic analysis was carried out with 20 hand samples from the site of Las Canteras (Mucientes). It followed the proposal used in previous studies (Fuertes et al. 2010, in press-b), which considers six general attributes such as colour (using the code Cailleux, 1981), the pattern (arrangement of the colours), structure (homogeneity of the pieces in terms of the presence of fracture planes, more irregular areas, etc.), appearance (gloss and transparency), cortex and grain size.
4. Four thin-polished sections (30 μm thick) of chert samples coming from the Mucientes quarries (Las Canteras outcrop) have been studied under the microscope using: a) an Olympus BX51 petrographic microscope equipped with an Olympus Camedia C-5050 Zoom camera and, b) a JEOL JSM-6480 scanning electron microscope (SEM), equipped with an Oxford D6679 EDS detector. The analytical methodology is the same as in a previous work (Fuertes et al. 2010), using the following criteria:
    - Principal mineral component (approximate percentages of silica and calcite).
    - Degree of grouping of the calcite minerals (in aggregates and disperse).
    - Presence of laminations at microscopic level (reflecting laminations seen in hand samples or with a magnifying-glass).
    - Presence/absence of organic matter (easily recognisable and usual in some samples).
    - Presence and type (high range taxa) of skeletal components.
    - Secondary elements (diagenetic and post-diagenetic).
5. To perform the mineralogical and geochemical analysis, representative fractions of the nucleus and cortex of a sample of Mucientes chert were ground to fine powder using a TEMA ring-grinder mil. Representative portions of each powder were oven-dried, and then heated to 1050°C prior to preparation of fused borosilicate disks for X-ray fluorescence analysis (XRF). The loss in mass associated with heating the oven-dried material to 1050°C (loss on ignition) was also determined in each case. The borosilicate disks were analysed in a Philips PW2404 X-ray fluorescence spectrometer to determine the percentages of major elements present.

Other representative portions of each powder were subjected to X-ray powder diffraction, using a Philips X’PERTPRO diffractometer system with Cu Ka radiation and a 0.4354° divergence slit. Step size was 0.013° 2θ and the scan step time 39.27 s.

4. Fieldwork

4.1. Sampling at Las Canteras (“Cuestas” Unit)

Following the references on the geological map (Portero 1982) the place known as Las Canteras (or ‘The Quarries’) was surveyed. As its name indicates, this is an abandoned quarry, where abundant chert nodules are found *in situ* in the limestone (Figure 6). Additionally, a large number of nodules lie separated from the limestone blocks by the quarrying work (Figure 7). Some thirty nodules were collected, all of them loose and dispersed among the limestone blocks or on the edges of the surrounding fields.

Figure 6. Detail of Las Canteras: *in situ* chert nodules in the limestone bed.

Figure 7. Loose chert nodules at Las Canteras.

4.2. Surveying in other locations belonging to the "Cuestas" Unit cited in the literature.

Fieldwork has been carried out in several places cited as a source of this chert type in geological literature. To be exact, these places were Mucientes (in different locations from Las Canteras, called "Mucientes-2"), Fuensaldaña, Berceruelo, Torrelobatón and Villalba de los Alcores. The results obtained (Figures 2 and 4) were:

- Mucientes-2. This is an area of farmland to the north of the town, where fragmented pieces of chert and remains of broken nodules have been found, all of small or medium size (~5 to 10 cm). The agricultural work may explain the absence of large pieces or nodules and also some of the alterations (fractures and breakages) suffered by the pieces. However, many of these objects might also correspond to the remains of knapping activities (Figure 8).
- East of Wamba. A large number of chert nodules, of a similar size and shape to those at Las Canteras, were found (Figure 9). Although they have been moved by farming work, it is feasible that this secondary position is near to their source. It remains to be determined whether this is the clay or shale materials in the "Cuestas" Unit or limestone beds (Piles et al. 2007).
- East of Fuensaldaña. Two chert objects were found that might be pieces derived from a knapping process and a fragmented nodule (Figure 10).
- Torrelobatón, Berceruelo and Villalba de los Alcores. To date, no outcrops of nodules or chert pieces have been found in the area around these sites which have been visited although the surveying is still not completed.

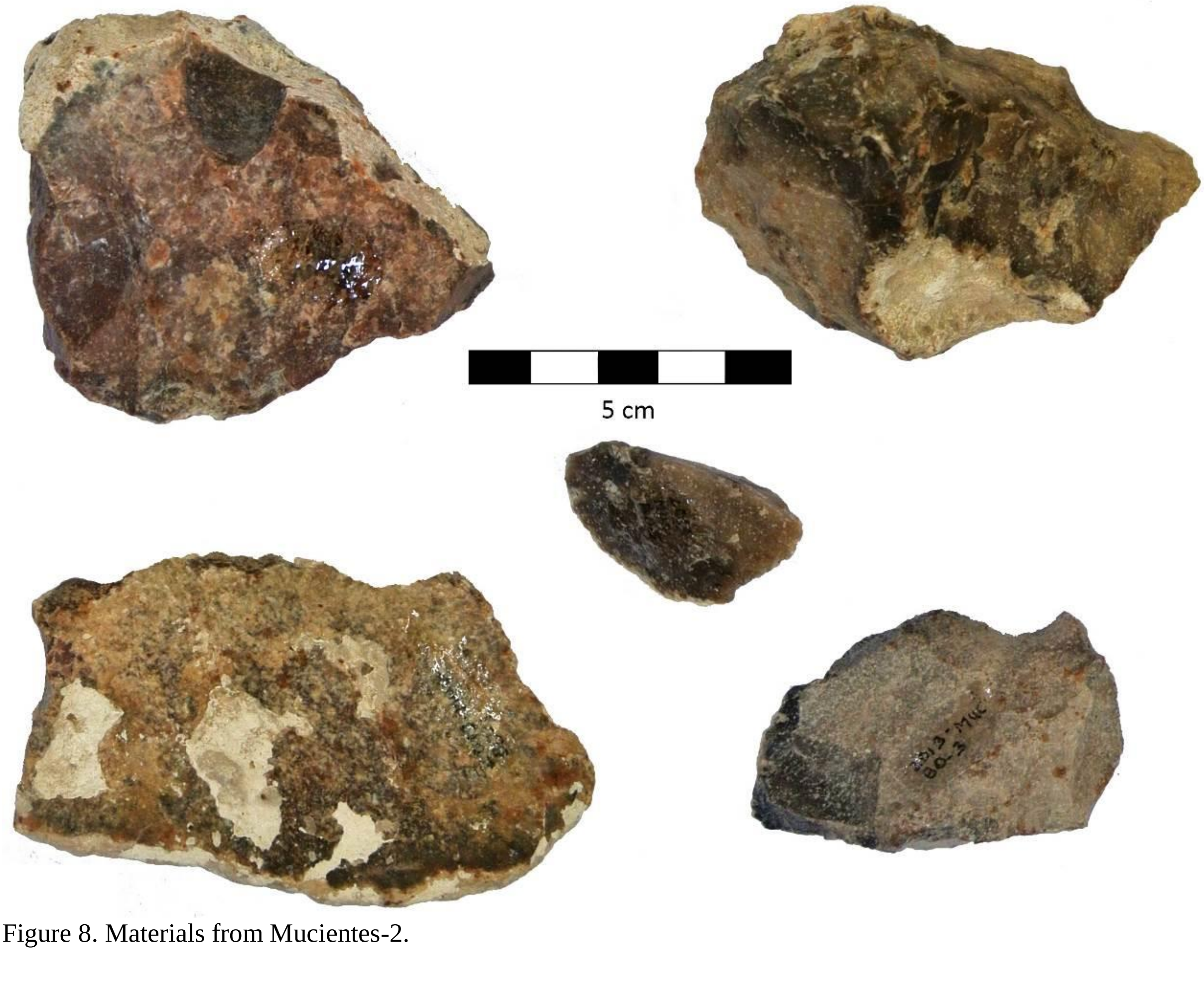

Figure 8. Materials from Mucientes-2.

Figure 9. Nodules from Wamba.

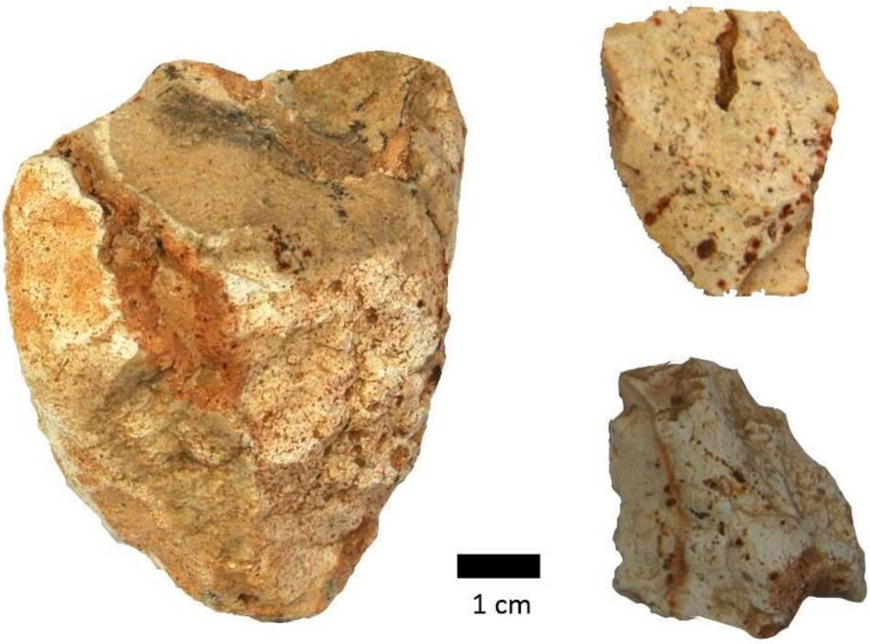

Figure 10. Nodule and pieces from Fuensaldaña.

5. Macroscopic features

The chert nodules from Las Canteras are rather heterogeneous. Their size and shape varies as there are flat prismatic blocks, in the form of plaques about 6 or 8 cm thick and of different sizes, usually between 20 or 23 cm long and 15 cm wide. Others are more cubic in shape (20 cm long, 16 cm wide and 15 cm thick), while others are more irregular, more or less elongated and in different shapes (Figure 11.A).

The macroscopic features of the twenty nodules selected for study (Figures 11 to 13) are described in Table 1.

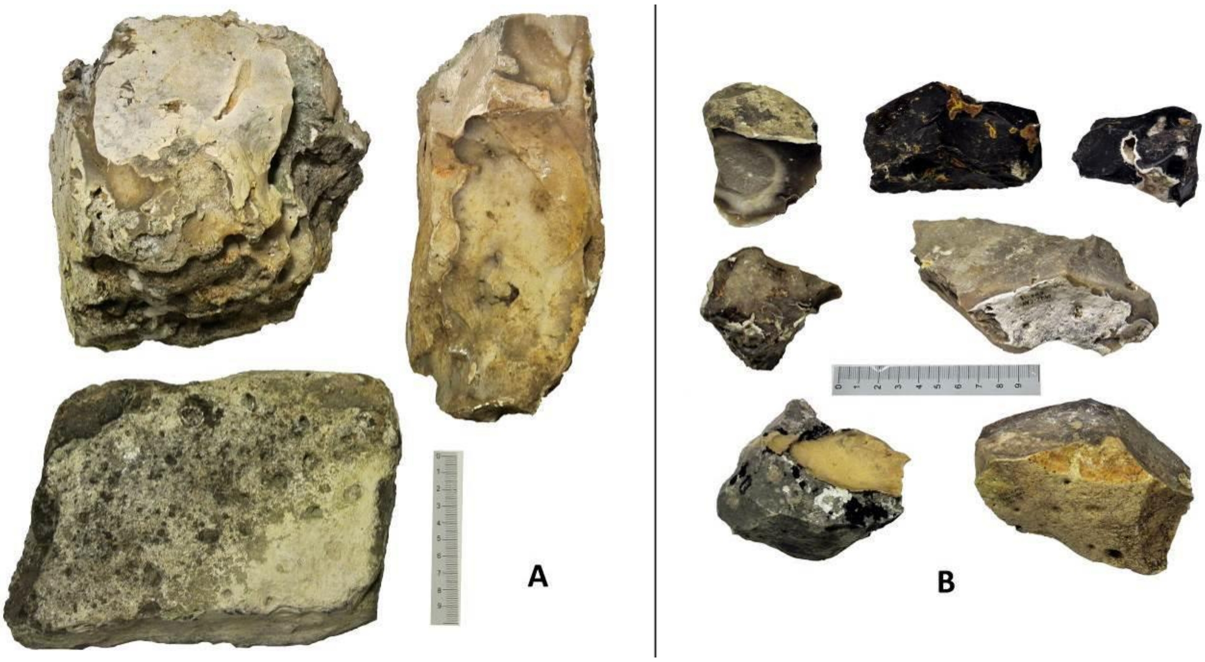

Figure 11. Chert pieces from Las Canteras. A: Nodules. B: Nodules and remains of cores used for experimental knapping.

Figure 12. 1: Detail of a nodule with striping and infra-cortex line. 2: Nodule with a rough light grey area not fully silicified.

Figure 13. Pieces with alterations: Burnt (1, 2), double patina (3) and white patina (1, 4)

Table 1. Macroscopic features of Las Canteras nodules

Colour (according to the Cailleux Chart)	Two ranges (Figures 11B & 12): - Dark brown, which is the variety that most clearly defines the chert (P51, grey brown; T51, very dark grey brown; S70, dark brown). - Grey or beige/light brown, lighter tones in general (L31, light grey; K92, white; M51, pink grey; M75, very light brown).
Pattern (distribution of the colour)	Colour is sometimes uniform, but more often it is distributed unequally, in large stains or also in stripes that combine the two colour ranges. In some nodules there is a darker infra-cortex line (Figure 12.1). Presence of white dots in some of the varieties.
Structure and appearance. Assessment of suitability for knapping.	Heterogeneous. Some nodules are quite compact with good conchoidal fracturing and fine-grained, quite glossy and only slightly transparent in the edges. It seems that these characteristics, generally more suitable for knapping, are more frequent in the dark brown varieties. The light grey areas often correspond to areas not fully silicified, totally opaque, with large-grains, rough texture and irregular fracturing, which means their quality for knapping is mediocre (Figure 12.2). However, the lighter grey colours are not only associated with this rough texture and poorer knapping quality, as they are also found in well-silicified, very compact and transparent areas of good potential quality, even if they are usually associated with the former. The presence of voids or not fully silicified areas is common in all types of nodules, and also appear in bands that are developed to a lesser or greater extent and affect homogeneity and aptitude for knapping negatively. Absence of natural cleavage planes.
Cortex	Fresh, with whitish, beige or light brown colours, with a similar appearance to the surrounding limestone and with a very irregular surface. The contact is clear, but generally irregular. The thickness ranges from thin (0.3 – 0.6mm) to medium (2 – 3mm) and in some places can be rather thick (7mm).
Alterations	On some of the visible chert surfaces can be seen: - White patina (Figures 11 –upper left-, 13.1, 13.4) - Old or double patina with a lighter colour in the interior (light brown-orangish) and slight rounding (Figure 13.3). - Occasional fire action seen in greenish and red tones and cracking (Figure 13.1, 13.2). Red stains are sometimes seen on the cortex.

6. Microscopic features

This chert is formed by an aggregate of crystals of very fine-sized quartz (from 15 to 30 μm average size) (Table 2). This mass contains fragments of siliceous material, and occasionally carbonates, shells and dispersed grains of detrital quartz (Figure 14). The main minerals are quartz, which is the main mineralogical component, and calcite. As accessory minerals appear pyrolusite, muscovite, rutile, ilmenite, apatite, Fe, zircon, monacite and barite, sometimes rich in Ca and Sr.

Sedimentologically, this chert probably corresponds to the post-sedimentary replacement of lacustrine limestones, as evidenced by the presence of limnic fossil ghosts (mainly mollusc fragments) and burrowing. Shells were recrystallized and/or dissolved -and then filled with sparite- during the early diagenesis. Replacement by silica occurred later.

The latter process affected mainly the fine-sized carbonates, both of the matrix and of the micritised shells. Later processes included deposition of radial quartz and filling of void spaces by calcite, as well as precipitation of pyrolusite and iron oxides.

Table 2. Microscopic traits seen in the thin sections of Mucientes chert.

Principal component	Accessory components	Sedimentary structures	Organic matter	Skeletal fraction
Authigenic microcrystalline quartz (size range: 15 – 30µm)	Calcite (<0.5 – 20%) in shells and in the matrix. Detrital quartz. Very minority components: pyrolusite, muscovite, rutile, apatite, ilmenite, iron oxides, zircon, monacite and barite.	Bioturbation clearly evident in some thin sections. No lamination observed in the thin sections.	No organic matter itself.	Fragments of carbonate shells, partially or totally replaced by silica. Indeterminate siliceous microfossils.

The polished surfaces of the inner part and the cortex generate the same grey tones in backscattered electron images (SEM), and therefore they cannot be distinguished visually. Equally, the semi-quantitative analysis carried out with the EDS detector fitted to the microscope was unable to discriminate them by their chemical composition.

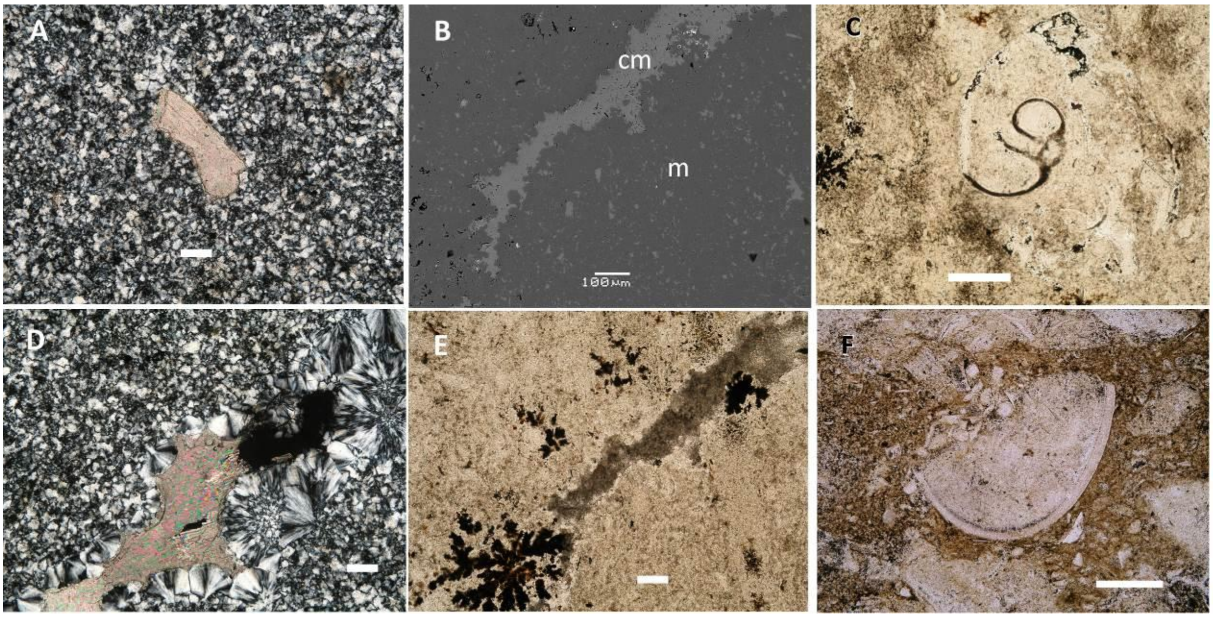

Figure 14. Microphotographs from thin polished sections. A: Preservation of a calcite shell fragment within the siliceous matrix (optical microscopy, crossed polarisers). B: BSE image showing replacement of a micritised calcite shell (cm) by silica (dark grey) of the matrix (m). C: Gastropod shell fragment floating in a silica matrix (optical microscopy, plane polarised light). D: microcrystalline quartz with a diagonal void filled with a first generation of radial fibrous chalcedony followed by a late sparite mosaic (optical microscopy, crossed polarisers). E: Same area as B (optical microscopy, plane polarised light). F: Bioturbated area with diverse bioclast (optical microscopy, plane polarised light). Scale: 100 µm (A, B, D, E) and 500 µm (C, F).

7. XRD AND XRF data

The diffractograms obtained have only revealed the presence of quartz and calcite as the main minerals both in the centre and cortex of the sample. An X-ray diffractogram of a “Silex Mucientes Core” (core from Mucientes chert) sample is shown in Figure 15, with no significant differences observed between the diffractograms of the centre and cortex.

The results of the XRF analysis (Table 3), as for major elements, agree with the mineral phases observed by XRD and SEM, with a predominance of SiO_2 and CaO over other oxides, and also with no significant differences between centre and cortex.

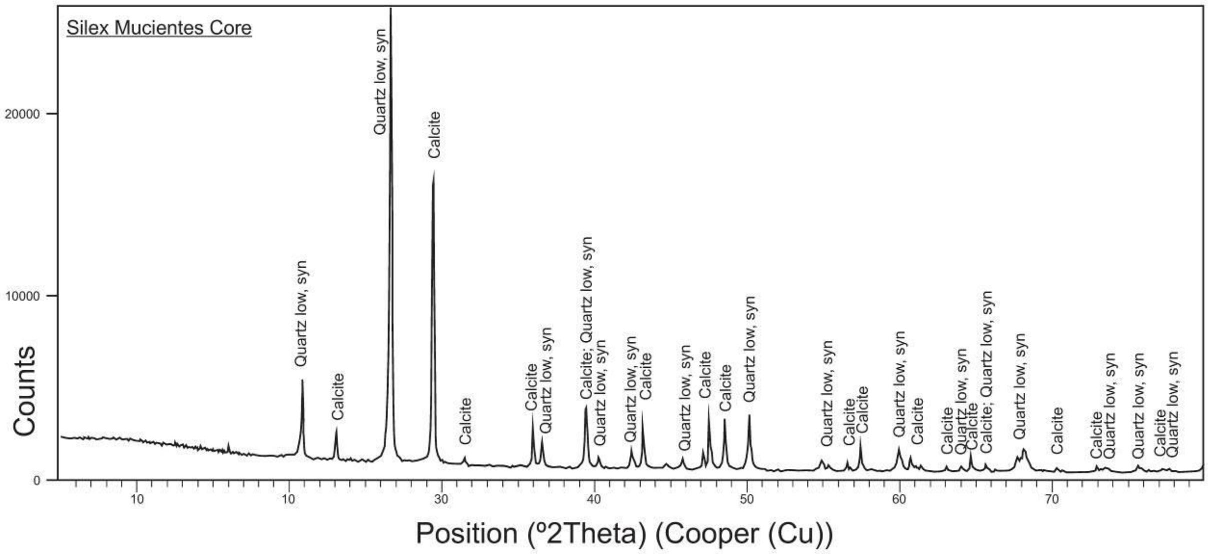

Figure 15. Diffractogram of the sample “Silex Mucientes Core” (core from Mucientes chert).

Table 3. Chemical analysis data from X-ray fluorescence analysis (weight % and ppm). Abbreviations: d.l. = detection limit; <d.l. = below detection limit; LOI = loss on ignition. LOI(1) = stoichiometrically CO2% inferred from CaO%, assuming that all CaO comes from calcite (CaCO3). LOI(2) = LOI - LOI(1) ≈ organic matter%.

Oxides (weight %)	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI	LOI(1)	LOI(2)	Total
MucCore	64.38	0.40	1.92	0.04	0.20	17.26	0.07	0.08	0.02	0.02	15.05	13.74	1.31	99.44
MucCortex	60.76	0.35	1.49	0.03	0.18	19.60	0.07	0.07	0.02	0.02	16.83	15.59	1.24	99.42

Elements (ppm)	Sc	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Rb	Sr
d.l.	2	3	2	3	2	2	1	1	1	3	1	1	1	1
MucCore	8.8	13.3	1082.5	3.2	481.2	35	81.9	<d.l.	<d.l.	3	<d.l.	18.6	6.8	43.8
MucCortex	11.9	6.5	843.2	4.3	147.5	20	42.6	1.1	<d.l.	<d.l.	<d.l.	10.5	6.7	42.4

Elements (ppm)	Y	Zr	Nb	Mo	Ag	Cd	Sn	Sb	Te	I	Cs	Ba	La	Ce
d.l.	1	1	1	1	3	3	2	3	3	4	5	8	8	7
MucCore	<d.l.	5.3	<d.l.	10.1	14.2	9	4.3	<d.l.	4.7	<d.l.	5.6	65.4	<d.l.	<d.l.
MucCortex	<d.l.	5.2	<d.l.	8.3	<d.l.	<d.l.	3.8	3	3.4	<d.l.	<d.l.	65.4	<d.l.	<d.l.

Elements (ppm)	Pr	Nd	Sm	Gd	Yb	Hf	Ta	W	Hg	Tl	Pb	Bi	Th	U
d.l.	11	4	5	5	4	3	3	2	1	2	2	1	2	1
MucCore	<d.l.	<d.l.	<d.l.	<d.l.	<d.l.	<d.l.	<d.l.	19.5	<d.l.	2.6	19.7	<d.l.	<d.l.	2
MucCortex	<d.l.	<d.l.	<d.l.	<d.l.	<d.l.	<d.l.	3	20.8	<d.l.	<d.l.	17.2	<d.l.	<d.l.	2

The total mass loss by calcination (%LOI) has been separated into two fractions: (1) %LOI(1)=%CO_2 stoichiometrically related to the %CaO, assuming that all the Ca in the sample comes from calcite ($CaCO_3$) and (2) %LOI(2) =%LOI-%LOI(1), which would be the portion of LOI assignable to the organic matter contained in the sample. As shown in Table 3, to justify the %LOI values, the %CO_2 contained in the calcite is not enough, and there must have been a small portion of organic matter (1.31 y 1.24% en Muc_Core and Muc_Cortex, respectively), prior to calcination.

Most of the trace elements agree with those observed with the SEM. The Ni, Zn, Cu and Pb content would be totally or partially related to the presence of sulphurs, connected to diagenetic processes of the organic matter. However, the Cr and W content is quite striking. These metals can be found in resistate clasts like chromite (CrF_2O_4) and scheelite ($CaWO_4$). Future research will determine whether these results, currently isolated cases, can be extended to all the Mucientes chert, in which case they would form diagnostic elements of this chert.

8. Discussion

The fieldwork, although it has not been completed, indicates that Mucientes chert in the "Cuestas" Unit appears in two forms. First, associated with outcrops of the raw materials, where nodules of a medium or large size are abundant (Las Canteras and Wamba). Second, remains of small or medium size may correspond to materials moved a short distance from their source and alternatively to knapping activity.

At Las Canteras the availability of chert nodules is quite good in terms of abundance and ease of access. The nodules are numerous but very heterogeneous in size and quality. In very general terms, their quality for knapping is rather average or mediocre, although some nodules are clearly of good or acceptable quality. This may suggest that what is now left is the waste of the previous selection of the best blocks for knapping.

Although many nodules are fragmented or display large fractures, which may be a consequence of the quarrying and other processes of alteration, some others exhibit large extractions on their sides. It may be proposed that these correspond to the testing of the material for knapping and are therefore connected with the use of this rich outcrop. This hypothesis is plausible above all in the nodules affected by a double patina or white patina. Owing to the quarrying works it is difficult to assess the use of this place for the procurement of chert in historical times.

However, the use of Mucientes chert for the manufacture of lithic artefacts in Prehistory is widely-known at other places in this region. The existence of a vast workshop of chert linked to the exploitation of the abundant nodules that appear in the triangle whose vertices will be Mucientes, Fuensaldaña and Cigales (Figure 4) is known in the archaeological literature (Martín Santamaría et al. 1986: 89). The abundance of lithics in the area makes it sometimes difficult to assign the lithic assemblages to a specific period. Nevertheless, the typo-technological features of these lithics have enabled the identification of several archaeological sites close to the locality of Mucientes, especially dated in the Middle Paleolithic and in Recent Prehistory (Sánchez-Yustos & Díez-Martín 2007). Several Copper Age sites are of particular interest, especially Los Cercados, where a specific workshop of foliated tools (denticulates and tanged arrowheads among them) has been located (Delibes et al. 1995). These archaeological sites attest the exploitation of chert nodule outcrops in the area around the town of Mucientes; the central-eastern part of the Montes Torozos (Mucientes, Cigales and Fuensaldaña) surveyed in this study and associated with the "Cuestas" Unit (Figure 2).

It remains to be seen whether there are other archaeological sites associated with the exploitation of chert mentioned in the geological survey and which appear in other places in the area of the Montes Torozos. These might be regarded as symptomatic of the use of this local chert and therefore of the radius within which it was available. As noted above, numerous nodules have been identified in Wamba, where there are also some references to prehistoric lithic materials (Palol & Wattemberg 1984: 217). In Torrelobatón and Villalba de los Alcores, no chert outcrops have been located, but again there are some reports of prehistoric knapped artefacts (for Torrelobatón: Palol & Wattemberg 1984: 163-164). For the second place, located to the north of the Torozos and therefore outside the classic distribution area of this chert, the Chalcolithic site of El Casetón de la Era is of special interest as the use of the characteristic local chert in the Torozos has been specifically cited (Gibaja et al. 2012).

These clear references to the archaeological use of local chert in Los Cercados and El Casetón de la Era complete the geological information about the appearance of chert associated with the "Cuestas" Unit (indicated in Figure 2) and allow a hypothetical procurement area to be proposed for this material. Figure 5 shows this area, differentiating the source area, where the nodules would have been in a primary position (Miocene lacustrine sediments, "Cuestas" Unit) (Figure 5, Source area A) from the area where they would have been in a derived position (Pleistocene river terraces) (Figure 5, Source area B). This second area has been established from geological references.

The importance that Mucientes chert might have had in recent Prehistory can be seen in the way that pieces of this chert, identified by hand specimens appear at several archaeological sites in the Duero Basin far from the geological zone of origin ("Cuestas" Unit) and, therefore, outside the area of strictly local supply (Figure 5). Some examples are sites located in the provinces of Zamora (Las Pozas, El Canchal de Jambrina) (Delibes et al. 1995) and León (Los Palomares, Las Choperas and Los Villares) (Fuertes & Pérez 2008; Martín Fernández 2011) (Figure 16).

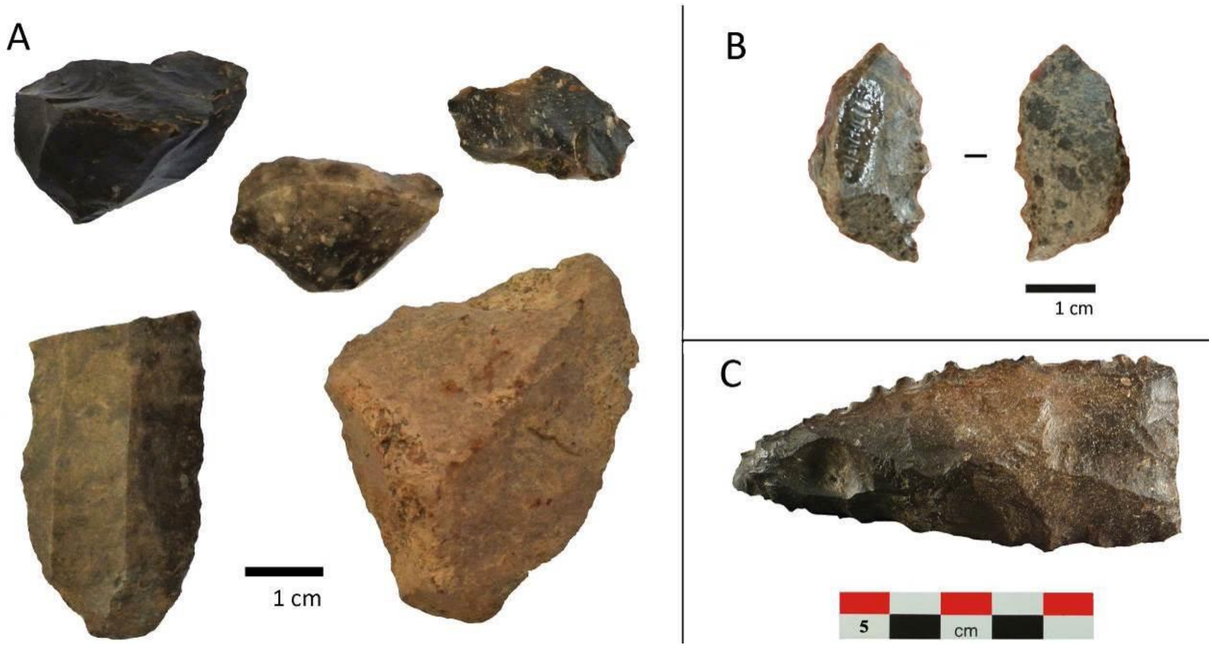

Figure 16. Proposed Mucientes chert (hand specimen identification) from archaeological sites at León. A: Objets from Las Choperas (Santas Martas). B: Sickle tooth from Los Palomares (Fontanil de los Oteros). C: Denticulated foliate from Los Villares (Valderas, Photo: J. L. Puente).

9. Conclusions

This study has attempted a first characterisation of Mucientes chert, at macroscopic, microscopic, mineralogical and geochemical levels. This is an Aragonian-Vallesian (Miocene) rock, with a diagenetic origin -on primary lacustrine carbonate facies- of the "Cuestas" Unit.

Macroscopically it displays a fresh, whitish cortex and an internal dark brown colour, although grey and light beige tones are also found. The microscopic study has been able to determine certain mineralogical homogeneity in the samples. They are formed mostly by very fine-grained quartz and the main variations seen correspond to the presence of calcite. The differences visible between the outer cortex and the inner part are not observed microscopically and cannot be quantified through SEM. On the other hand, XRF data displays high Cr and W contents and future research will be able to assess their importance as diagnostic elements for this chert type.

Another future research line will consist of study the homogeneity of the cherts from Montes Torozos. It will be necessary to compare the characteristics observed in the chert from Las Canteras with other sources of chert in the "Cuestas" Unit. It also will be necessary to compare the geological samples with the archaeological ones. This will enable the verification of the distribution of lithic elements made from this chert type beyond its strictly local area, especially in the Chalcolithic. It will be necessary to carry out similar analyses to those performed in the present study in order to confirm whether the archaeological objects identified macroscopically correspond to the same chert type.

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