

Characterization of lithic raw materials from the Middle Paleolithic site of Cova de Teixoneres (NE Iberian peninsula): Project approach and first results.

Alicia Muñoz del Pozo^{1,2}, Bruno Gómez de Soler^{2,3}

¹ *Universidad de Zaragoza (UNIZAR) / ² Institut Català de Paleoeologia Humana i Evolució Social (IPHES-CERCA), amdpozo@unizar.es*

² *Institu tCatalà de Paleoeologia Humana i Evolució Social (IPHES-CERCA) / ³ Universitat Rovira i Virgili (URV), bgomez@iphes.cat*

Abstract – In this work we present the characterization lithic raw materials project and the first data from the macroscopic study of the archaeological material from level IIIb of Cova de Teixoneres (NE Iberian peninsula). The Teixoneres cave was a settlement where hominin-carnivores interactions took place during the Middle Palaeolithic. This project proposes the study of the procurement areas of the Neanderthals that occupied the site during short stays, based on the determination of the origin of archaeological lithic raw materials. Through macroscopic and microscopic analysis, we will try to know the mobility patterns as well as the type of occupation. This information will be plotted on lithological maps, together with possible procurement areas, with the aim of developing a graphic and dynamic document which allow us to establish possible routes in relation with the site, the outcrops and the territory.

We present here the lithic raw materials project from Teixoneres cave (Moià, Barcelona). As it is in the execution phase, we are going to present its objectives, methodology and the results obtained until now.

In Paleolithic sites, lithic artefacts represent the most important archaeological element to delimit the exploitation of the territory. The origin of raw materials provides the ideal framework for understanding the territorial movements of prehistoric hunter-gatherers. Following residential or logistical models [1], the aim is to infer patterns of mobility and territoriality. Binford [2] recognized the difficulties in determining the mobility of hunter-gatherer groups through the archaeological record, considering the territory as a living system.

Nevertheless, the study of lithic raw materials is one of the scarce elements in the fossil record that allows us to approach the mobility patterns of hunter-gatherer groups. Through the recognition of the source areas and the type of introduction of the material, we will be able to know

whether the lithic assemblage was collected in the vicinity of the site or in its original formations. In addition, it will allow us to understand the evolution of lithic procurement strategies, which from the Lower Palaeolithic to the Neolithic have gone from an eminently local procurement (> 5 km), to a more regional one (15-20 km), until an exchange of exotic products (> 200 km) in the latest stages of prehistoric times [3][4][5][6]. In Teixoneres cave, the predominant hypothesis suggests human occupations by small groups of Neanderthals during short periods of time [7][8] and between these short occupations, carnivores used the cave [9]. The goal is characterizing the lithic material from the Teixoneres cave, with the aim of establish the mobility patterns of hunter-gatherer groups and verify the short occupations proposed previously, and if it is possible the type of settlement (hunting camps, observation sites, supply camps, etc.). In order to achieve our goal, we must first of all develop a geological/lithological map of the area, that will be useful not only for our research but for future studies on procurement of lithic raw materials in the area.

I. GEOLOGICAL SETTING

The Teixoneres cave is located in the Northeast of the Iberian peninsula and forms part of the karstic complex of the Toll caves, near the locality of Moià, Barcelona (Fig.1). The cave system is developed in the limestone of the Collsuspina formation of Bartonian age (Eocene). The cave is organized into three chambers, which were filled with sediments from the Pleistocene to the Holocene [8].

Within a more general geological setting, it is located within the Moianès plateau, formed by material of Palaeogene age [10]. Classic geological bibliography cites towards the Eastern area of the site, Triassic materials of the Muschelkalk formation, in which chert nodules have been found in primary position.

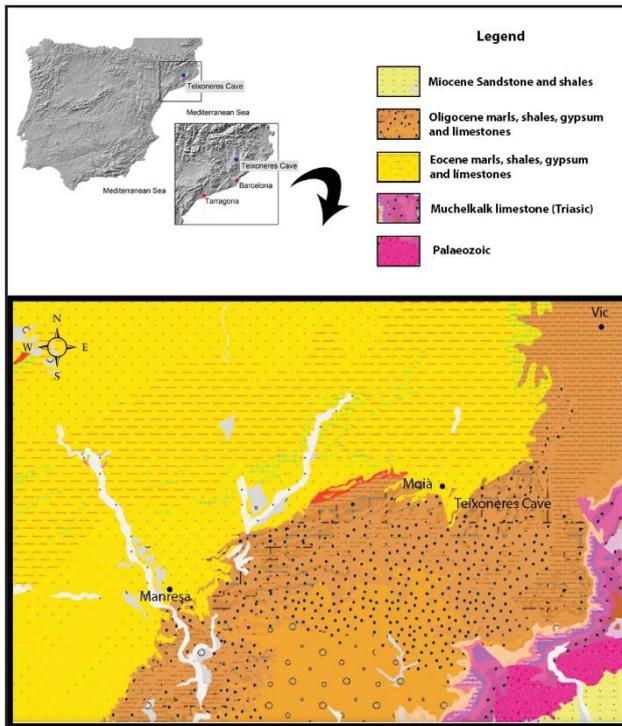


Fig.1. Location map and geological map, modified from *Institut Cartogràfic i Geològic de Catalunya*.

In the Upper Paleolithic of the Balma del Gai site, few kilometers from Teixoneres cave, Mangado & Nadal [10], refers to the presence of chert in secondary position associated with conglomerates and pebbles from the riverbed.

II. METHODOLOGY

The methodology used for the geoarchaeological study of the lithic material from the Teixoneres cave is divided into three main steps: (A) macroscopic and petrographic study of lithic materials from the site and the geological samples, (B) geological surveys with the intention of identifying possible source areas and development of a lithological map, and (C) comparison of archaeological and geological materials in order to establish the procurement areas for the Neanderthals who occupied the cave.

A. Macroscopic and microscopic analysis

For this purpose, the characteristics of each material are described, allowing us to differentiate between different lithologies, as well as different varieties within each lithology. We use a stereoscopic microscope (ZEISS Stemi DV4 8-32x) for macroscopic characterization. The characteristics described are: color (*Munsell Color Book*), hardness, translucency, brightness, type of fracture,

texture, presence of sedimentary structures, bioclasts, whether it has been subjected to tectonic processes, inclusions, crystals growth, etc. In addition, different alteration processes from the samples, both physical and chemical, have been considered [11].

Petrographic analyses will be carried out with a Polarizing Microscope (Nikon Eclipse E400 POL 40-400x), to describe the mineral composition in percentage of each of the elements, as well as their shape, sizes, type of contacts, relief, interference color, inclusions, and alochemical elements. The microscopic study of the samples allows us to observe details of the rocks that are not visible to the *visu*.

B. Prospecting and development of a lithological map

In this phase, we continue the prospecting survey started in 2019 and continued through 2022. The aim is to locate the outcrops susceptible to be the procurement areas of the lithic artefacts found at the site. Based on the knowledge of the variety of lithologies present in the site and the varieties of each of them, a study of the possible source areas is carried out, using orthophotographs, geological maps and specialized bibliography. It is also of special interest to know the hydrographic basins surrounding the site and the materials that flow through them. This will give us an insight into the origin of the pebbles transported by the nearby rivers and creeks.

The location of the outcrops is recorded with a GPS and located on a map created with software QGIS. It will show the points containing the same materials as those found in the site, the geological units that have these materials, the nearby routes, etc.

C. Comparison between geological and archaeological material

Finally, the results obtained in the surveys will be compared with those obtained through the study of the archaeological artifacts.

After knowing their correspondence, we will be able to confirm it as a catchment area. With this information, we trace the possible procurement routes of lithic raw materials supply and obtain the mobility patterns that are inferred from them.

III. RESULTS

The results presented are the initial phase in the study of the lithic raw materials from the Teixoneres cave. We are focusing on chert and the macroscopic characterization of the archaeological material from level IIIb recovered in the field seasons from 2007 to 2021 [12]. We have chosen to concentrate on this level because it is where most of the record of hominin activity is located.

The lithic industry is formed by 4931 remains, being the 33% (fig. 2a). The rest of lithologies are quartz (58%), limestone (2%), sandstone (1%), quartzite (1%) and other rocks (5%), which include schist, hornfels and other materials. Within the total set of chert analyzed at this stage, 56% corresponds to limestones of marine origin (fig.2b), 29% of the chert would have been formed in limestones of lacustrine origin and finally 15% corresponds to chert from evaporitic formations.

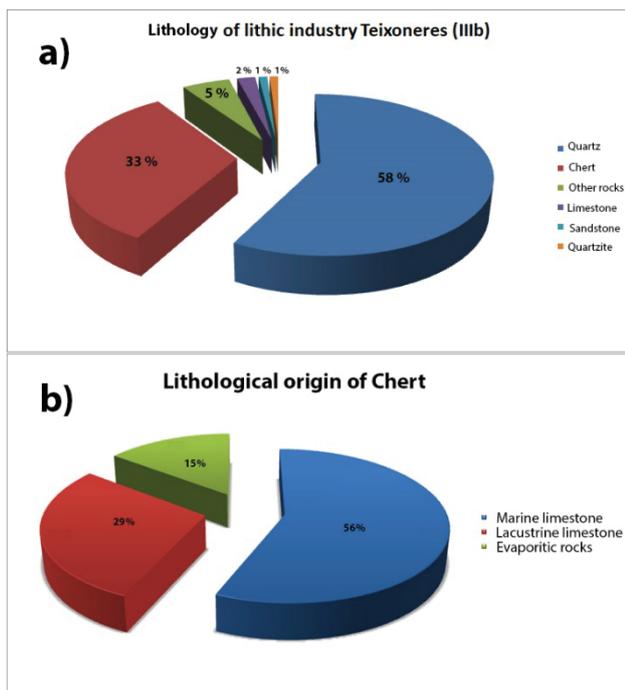


Fig.2.a) Graph with the percentages of lithic materials of different lithologies in level IIIb. b) Graph with the different lithologic bedrock nature of chert.

We have identified 19 types of chert in this phase of analysis, depending on the lithological origin of the bedrock, the texture of chert, the presence of allochemical elements, sedimentary structures and inclusions.

The most represented is TS1 type (fig. 3a) with 51%, whose geological ascription corresponds to the calcareous Muschelkalk facies (Triassic), in specific member M1 (lower Muschelkalk). It is characterized by grey colors (N5 Medium Gray), opaque, fine-textured and bioclasts. The following varieties with the highest representation, 8% each, correspond to TS9, TS13 and TS6. TS9 (fig. 3b) its enclosing rock is a lacustrine limestone and stands out for its bluish grey colours (5B 5/1 Medium Bluish Gray), is semi-translucent, fine-textured, and present bioclasts. TS6 (fig.3c) chert comes from evaporitic formations and presents grey colors (N6 Medium Light Gray), opaque, fine textured and evaporitic relicts. TS13 (fig. 3d), also comes from a lacustrine limestone, have brown colors (10YR 6/2 Pale Yellowish Brown), opaque,

medium texture and bioclasts as charophytes in form of moldic porosities are observed, and the presence of oxides is abundant.

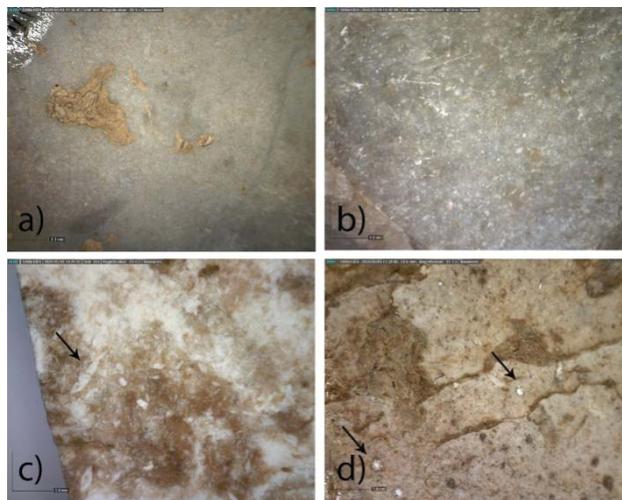


Fig.3.Images of the main chert varieties taken under the stereomicroscope (DinoLite). a) TS1: marine limestone, Muschelkalk facies origin, b) TS9: Lacustrine limestone origin, presence of fossils and phytoclasts, c) Evaporitic origin, presence of lenticular gypsum crystals, d) Lacustrine calcareous origin, charophytes are observed.

IV. DISCUSSION

Based only on the macroscopic description of the lithic artefacts from level IIIb of the Teixones cave, it is possible to identify certain elements, such as the presence of bioclasts or evaporitic relicts or carbonates, which reveal the nature of the bedrock in which the chert nodules were formed [13][14][15]. On this basis, different strategies can be used to locate the formations from which the different types of cherts come.

It is necessary to understand that geological materials are not homogeneous, since within the same geological unit there can be textural or compositional differences, both laterally and vertically, and even more in evaporitic environments. This heterogeneity is reflected in cherts, showing different textures, finer or medium, variation in color, even within the same geological formation, as well as the presence or absence of fossils. In addition, we must add the post-depositional alterations that the materials have suffered, which can alter the color and texture of the chert. Although, in some cases, these alteration processes allow us to see bioclasts or other sedimentary structures, that favors us the correct ascription.

An added difficulty is that the silicification process can also present different degrees of intensity, from complete silicification processes to initial stages of silicification, which gives rise to textural and compositional differences within the chert nodules.

Based on these similarities, with the information we

have at the moment, including data from the surveys carried out in 2019 and 2022, and taking into account the possible sources of the bedrock of the chert samples analyzed, the chert of marine origin which is the majority within the lithic assemblage, corresponds to the M1 member of the Muchelkalk facies, from several outcrops are found at the southeast and south of the settlement within a catchment area of less than 15 km. The chert from evaporitic formations, due to a total absence in the area, it could come from the nearest Eocene evaporitic formations of Sant Genís and Valldeperes, about 50 km to the south-west, and in the case of chert from lacustrine carbonate formations, it may have its origin in the Castellallat formation, more than 20 km from the settlement.

These classifications will be reviewed again after more geological surveys campaigns, the petrographic study of the geological and archaeological samples, which will allow us to refine this preliminary classification, being able to group some varieties, or to form subgroups within others.

V. CONCLUSIONS

Chert, the lithic material that has been analyzed in this first phase of the project, we can say that the predominant variety in the site within level IIIb is TS1 with a geological ascription to the Muschelkalk formation with 51%, half of the chert found belongs to this variety.

This chert could be collected directly in its primary position, as there are outcrops within a radius of 15 km from the site, although the orography of the terrain could imply a certain degree of difficulty, as there is a great difference in altimetry between this catchment area and the settlement.

The rest of the varieties are divided between chert formed in calcareous lacustrine materials (29%) and evaporitic formations (15%), which could come from the Castellallat formation, and Sant Genís and Valldeperes units for evaporitic origin, respectively. In addition, chert catchment from fluvial sources (secondary outcrops) could be possible, but never in the riverbeds near the site, since there is a total lack of this type of raw material.

In order to know and understand the mobility patterns and procurement areas of Neanderthal groups, it is also necessary to know the cost that the supply of these materials, in relation to the distance, quality, quantity, orography of the territory, among others (site catchment analysis and gravity models) may have influenced in its procurement strategies. This will also be one of the questions that this project aims to answer.

VI. ACKNOWLEDGMENTS

We would like to thank the directors and all the participants in the Teixoneres field seasons. To the Department de Cultura de la Generalitat de Catalunya for

the economic funding of the excavation under the project CLT009/18/00055. This research is framed in the 2017-SGR859 (AGAUR), E32_20R (GEOtransfer) and by the Spanish Ministry of Science, Innovation and Universities project PID2019-103987GB-C31. Research at IPHES is framed in the CERCA programme. This research was supported by the Spanish Ministry of Science and Innovation through the “María de Maeztu” excellence accreditation (CEX2019-000945-M) and by the Ministry of Universities through NextGenerationEU funding and the Recovery, Transformation and Resilience plan.

REFERENCES

- [1]Binford, L. R. (1980). Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American antiquity*, 45(1), 4-20.
- [2]Binford, L. R. (1982). The archaeology of place. *Journal of anthropological archaeology*, 1(1), 5-31.
- [3]Féblot-Augustins, J. (1993). Mobility Strategies in the Late Middle Palaeolithic of Central Europe and Western Europe: Elements of Stability and Variability. *Journal of Anthropological Archaeology*, 12(3), 211–265.
- [4]Féblot-Augustins, J. (1999). Raw Material Transport Patterns and settlement systems in the European lower and middle Palaeolithic: continuity, change and variability. *The Middle Palaeolithic Occupation of Europe*, 193–214.
- [5]Slimak, L., & Giraud, Y. (2007). Circulations sur plusieurs centaines de kilomètres durant le Paléolithique moyen. Contribution à la connaissance des sociétés néandertaliennes. *Comptes Rendus - Palevol*, 6(5), 359–368. <https://doi.org/10.1016/j.crpv.2007.06.001>
- [6]Terradas, X., Gratuze, B., Bosch, J., Enrich, R., Esteve, X., Oms, F. X., & Ribé, G. (2014). Neolithic diffusion of obsidian in the Western Mediterranean: New data from Iberia. *Journal of Archaeological Science*, 41, 69–78. <https://doi.org/10.1016/j.jas.2013.07.023>
- [7]Rosell, J., Blasco, R., Rivals, F., Chacón, M. G., Menéndez, L., Morales, J. I., Rodríguez-Hidalgo, A., Cebrià, A., Carbonell, E., Serrat, D. (2010). A stop along the way: the role of Neanderthal groups at level III of Teixoneres Cave (Moià, Barcelona, Spain). *Quaternaire. Revue de l'Association française pour l'étude du Quaternaire*, 21(2), 139-154.

- [8]Picin, A., Chacón, Gómez de Soler, B., Blasco, R., Rivals, F., & Rosell, J. (2020). Neanderthal mobile toolkit in short-term occupations at Teixoneres Cave (Moia, Spain). *Journal of Archaeological Science: Reports*, 29, 102165.
- [9]Sánchez-Hernández, C., Rivals, F., Blasco, R., & Rosell, J. (2014). Short, but repeated Neanderthal visits to Teixoneres Cave (MIS 3, Barcelona, Spain): a combined analysis of tooth microwear patterns and seasonality. *Journal of Archaeological Science*, 49, 317-325.
- [10]Mangado, J., Nadal, J. (2006). Caracterización y aprovisionamiento de materias primas en el yacimiento epipaleolítico de la Balma del Gai (Moia, Bages, Barcelona). G. MARTÍNEZ, A. MORGADO y JA ALFONSO (coords.), *Sociedades Prehistóricas, recursos abióticos y territorio*, Fundación Ibn al-Jatib, Granada, 179-197.
- [11]Soto, M., de Soler, B. G., Vallverdú, J., & Vaquero, M. (2014). Potential siliceous sources during Prehistory: Results of prospecting in the East margin of the Ebro Basin (NE Iberian Peninsula). *Journal of Lithic Studies*, 1(1), 293-318.
- [12]Zilio, L., Hammond, H., Karampaglidis, T., Sánchez-Romero, L., Blasco, R., Rivals, F., Rufà, A., Picin, A., Chacón, M. G., Demuro, M., Arnold, L. J., Rosell, J. (2021). Examining Neanderthal and carnivore occupations of Teixoneres Cave (Moia, Barcelona, Spain) using archaeostratigraphic and intra-site spatial analysis. *Scientific reports*, 11(1), 1-20.
- [13]Bustillo, M. (1976). Texturas de las rocas silíceas inorgánicas en ambiente continental y significado genético. *Estudios geológicos*, 32, 371 – 383.
- [14]Fernandes, P., Le Bourdonnec, F. X., Raynal, J. P., Poupeau, G., Piboule, M., & Moncel, M. H. (2007). Origins of prehistoric flints: The neocortex memory revealed by scanning electron microscopy. *Comptes Rendus Palevol*, 6(8), 557-568.
- [15]Bustillo, M. Á. (2010). Silicification of continental carbonates. *Developments in Sedimentology*, 62, 153-178.