Research Article

Pedro Xavier*, José Meireles, Carlos Alves

Living in the Mountains. Late Mesolithic/ Early Neolithic Settlement in Northwest Portugal: Rock Shelter 1 of Vale de Cerdeira (Vieira do Minho)

https://doi.org/10.1515/opar-2022-0252 received April 28, 2021; accepted July 10, 2022

Abstract: In the 1990s, a research project was developed to identify, in the mountainous areas of the Northwest (NW) of Portugal, the existence of an occupation model associated with the last hunter–gatherer prehistoric communities in the region. Therefore, a set of consistent and detailed field surveys took place in the mountains of NW Portugal, leading to the discovery of the archaeological site named "Rock Shelter 1 of Cerdeira Valley," a granite rock shelter situated in Cabreira mountain. The campaigns of excavations undertaken permitted the identification of two combustion structures, from which charcoal samples provided two C-14 dates, as well as a significant stone tool assemblage (around 30,000 pieces), that established the prehistoric occupation of "Rock Shelter 1 of Cerdeira Valley" between the Late Mesolithic and the Early Neolithic. This archaeological site and its body of evidences are being analysed within the context of an ongoing PhD project developed by one of the authors (P. Xavier), through two mutually related lines of research. The first one relates to the complete technological and typological study of the lithic assembly, identifying the objectives of the stone tool production, i.e. lithic production systems and related chaînes opératoires; and the second concerns itself with the classification and characterisation of different raw materials exploited by the prehistoric communities and, wherever possible, to make some additional considerations about raw material procurement. The goals of this article are the presentation of the methodologies adopted in the study of raw materials and the results obtained from the techno-typological study. Keywords: NW Portugal, Late Mesolithic, lithic industry, raw materials, quartz

1 Introduction

In the 1990s, a research program was developed by one of the authors of this article (J. Meireles), dedicated to the recognition of an occupation model associated with the presence of the last groups of prehistoric

Special Issue published in Cooperation with Meso'2020 – Tenth International Conference on the Mesolithic in Europe, edited by Thomas Perrin, Benjamin Marquebielle, Sylvie Philibert, and Nicolas Valdeyron.

* Corresponding author: Pedro Xavier, Lab2PT, Laboratório de Paisagens, Património e Território, Universidade do Minho, Braga, Portugal; Departamento de História, Instituto de Ciências Sociais, Universidade do Minho, Braga, Portugal, e-mail: pedroxavy@gmail.com

José Meireles: Lab2PT, Laboratório de Paisagens, Património e Território, Universidade do Minho, Braga, Portugal; Departamento de História, Instituto de Ciências Sociais, Universidade do Minho, Braga, Portugal
Carlos Alves: Lab2PT, Laboratório de Paisagens, Património e Território, Universidade do Minho, Braga, Portugal; Departamento de Ciências da terra/Escola de Ciências, Universidade do Minho, Braga, Portugal

hunter–gatherers in the mountainous areas of Northwest (NW) Portugal. This project was based on studies carried out in the second half of the twentieth century in the northern mountains of Galicia, from which a set of epipaleolithic and mesolithic archaeological sites have been identified (Ramil Rego & Ramil Soneira, 1996; Ramil Rego, 1997). The results of the intensive fieldwork carried out in the mountainous areas of NW Portugal, determined the Cabreira mountain range (alt. max. 1,262 m) as the ideal location for the project. Amongst the identified and surveyed sites, the so-called "Rock Shelter 1 of Vale de Cerdeira" stood out, whose excavation and artefactual collection have already been the subject of several publications (Meireles, 2009, 2010, 2013).

Since 2017, the lithic assemblage from this archaeological site has been analysed with recourse to two main themes within the scope of a PhD programme (P. Xavier). The first concerns the techno-typological analysis and the comprehension of the technical systems of production and respective chaînes opératoires, whereas the second seeks to identify and characterise the different raw materials and lithological resources exploited and manipulated by the prehistoric communities of the Cabreira mountain range.

The present text intends to summarise the activities carried out so far, presenting some of the methodological options and technical procedures adopted in the observation of the raw materials, as well as the first results of this study and the techno-typological analysis.

2 Mesolithic Studies in Portugal: A Short Note

The study of the Mesolithic in Portugal goes back to 1,863 when the first shell-middens were discovered in the Ribeira de Muge, a tributary of the River Tagus. The ensemble of shell-middens of the Tagus valley dispersed, besides Muge, by the Magos and Fonte da Moça streams, are amongst the most significant pieces of evidence of this cultural phase at a European scale, partly due to the exceptional nature of their necropolis and burials, containing about 300 individuals (Bicho, 2009; Peyroteo-Stjerna, 2020).

In the opinion of several authors, amongst the main characteristics of this period are the consolidation of a littoral settlement model and the growing importance of the marine-estuarine resources in the subsistence of prehistoric groups (Araújo, 2016; Carvalho, 2009; Soares & Tavares da Silva, 2004; Zilhão, 2000). This propensity towards a coastal establishment dates to the Magdalenian period, but it was mainly around 9500 BC and following the abrupt climatic changes of the Dryas III to Pre-Boreal (or Greenlandian) transition that it became more significant. According to J. Zilhão, the marked climatic improvement at the start of the Holocene and the resulting consequences – forest expansion, drastic reduction in the herbivore biomass, etc., associated with the absence of major hydric resources, would have significantly deteriorated survival conditions, leading to the desertion of more inland areas of the Iberian plateau and relocation to areas closer to the coast (Fullola & Zilhão, 2009; Zilhão, 2000, 2004).

The discovery of some archaeological sites with occupation levels within the Boreal period in very inland regions of the country, namely the site of Prazo, in Alto Douro, NE Portugal (Monteiro-Rodrigues, 2011) and of Barca do Xerez de Baixo, in Alentejo (Araújo & Almeida, 2013), have not swayed the apologists of the hermitage thesis. In their view, the sites referred do not represent an occupation, but rather the frequentation and exploitation of the valleys of the great rivers, which would occur up to 100 to 200 km upstream from the rivers (Carvalho, 2003; Zilhão, 2003). These episodes would have occurred until the Boreal period, not extending into the Atlantic (ibidem), a moment from which and with a strong influence of the 8200 cal BP event, a new restructuring of the Mesolithic settlement takes place, from now on concentrated in nuclei represented by the shell-middens of the Tagus, Sado, and Mira paleo-estuaries and Alentejo coast (Araújo, 2015; Carvalho, 2007). Regarding the interior regions, they would remain, this time definitively deserted until, approximately, the beginning of the 5th millennium BC, when they would be reinhabited by farming and herding communities (Zilhão, 2000).

However, more and more evidence is coming to contradict the scenario just described. On this subject, we should mention once again the Prazo site, which not only features an occupation of the Boreal period, but rather a practically uninterrupted sequence between the end of the Upper Paleolithic and Early Neolithic (Monteiro-Rodrigues, 2011, 2012). Yet, in NE Portugal, one can find the site of Terraço da Foz do Medal, where an Early Mesolithic occupation phase has been identified (Gaspar, Ferreira, Carrondo, & Silva, 2016), as well as the site of OlgaGrande 6, whose similaritieswith the artefactual assemblagesof Vale do Sado and Prazo allow it to be framed in the Late Mesolithic (Aubry, Barbosa, Luís, Santos, & Silvestre, 2016a; Aubry, Gameiro, Santos, & Luís, 2017). Still in the North of Portugal, but this time in Northwestern, Meireles (2009, 2010, 2013) has revealed the site that is the basis of this article, "Rock Shelter 1 of Vale de Cerdeira." In the Interior Alentejo, besides the settlement of Barca do Xerez de Baixo, there is a group of four archaeological sites – the nucleus of Baixa do Xerez – unfortunately without radiometric dating but whose material culture supports their integration in the Late Mesolithic and transition to the Early Neolithic (Gonçalves, Sousa, & Marchand, 2013).

Regarding the "Rock Shelter 1 of Vale de Cerdeira," its discovery, endorsing the existence of a prehistoric settlement, previously unknown in the mountainous areas of the NW of Portugal, will certainly reflect, similarly to the other aforementioned archaeological sites, on the dominant models accepted for the evolution of the Mesolithic period in Portugal.

3 The Archaeological Site of Vale de Cerdeira

The archaeological site of Vale de Cerdeira is located in the parish of Vilar Chão and Anjos, Vieira do Minho, Braga district (Figure 1). It is positioned at 660 m above sea level, commanding a privileged location, confirmed by the access to water resources, to be more precise near a stream, a wide view of the surrounding area, controlling natural access routes to the western part of the Cabreira mountains and also by the proximity of quartz veins, pegmatite bodies, and consequent raw material resources (Meireles, 2009, 2013).

The area where the site is located fits the typical pattern of some granitic regions, composed of coarsegrained porphyritic calc-alkaline granites, which frequently through processes of subaerial and subcutaneous evolution, along with phenomena of chemical weathering and differential erosion, define a pattern

Figure 1: Location of "Rock Shelter 1 of Vale de Cerdeira" archaeological site.

known as block chaos (Figure 2) supplying protected spaces, either in the form of shelters or open-air areas surrounded by clusters of rocky outcrops (ibidem).

The Vale de Cerdeira Shelter resulted from the longitudinal fracture of a large porphyritic granite block that created two sheltered areas: an upper one, designated Shelter 1, which has a sheltered area of 36 m^2, and a lower one, named Shelter 2, defined by a small visor. After opening test pits in both rock shelters, the excavation work continued only in the one called Shelter 1, reaching a total excavated area of 20 m^2. The stratigraphic sequence recorded, less than 1 m deep, includes three stratigraphic units, named, from bottom to top, SU-1, SU-2, and SU-3, and a set of artefacts exceeding 30,000 pieces. The study is focused on SU-1 and SU-2 given the highly disturbed and uncharacteristic nature of SU-3 (associated with a severe erosive process), which conditioned any chronological or cultural consideration. At the base of SU-1, two combustion structures were identified, whose charcoal samples provided two C-14 radiometric dates, placing the human occupation of the shelter between the late VI (GrN-25614, 6240 ± 50 BP: 5316–5056 cal BC 2σ) and early V millennium BC (GrN-25613, 6090 ± 40 BP: 5207–4853 cal BC 2σ) (ibidem).

4 Raw Material Study

4.1 Objectives and Stages of Study

As mentioned in Section 1, one of the objectives of this article is the description of the methodological options and technical procedures adopted in the study of raw materials. Thus, the study of raw materials was developed with three mains objectives in mind:

- The classification and characterisation of different raw materials (of a local and exogenous nature) exploited by the prehistoric communities; • To recognise raw material management practices;

Figure 2: Granitic landforms in Cabreira mountain.

- To identify, if possible, exploited areas and potential sources of raw material.

For this purpose, a study schedule was established and divided into three distinct phases:

- Analysis of the raw materials that make up the archaeological assemblage;
- Conducting field surveys to comprehend the geological context and recall geological samples;
- Execution of analytical procedures to create associations between archaeological and geological specimens.

The analysis of raw materials was based on those of local origin, consisting of different varieties of quartz. This decision was made bearing in mind that local resources are dominant in both SU-1 and SU-2. For other raw materials, including those of exogenous origin, we have not established a specific study plan given their low significance in quantity and percentage. Their classification and provenance proposal was made by Thierry Aubry, whom we take this opportunity to thank for his valuable contribution.

4.2 Quartz Classification

As stated, quartz is the dominant raw material in the lithic collection recovered in Rock Shelter 1 of Vale de Cerdeira. By consulting the geological mapping that coincides with the location of the shelter (Geological Sheet 6-C, Cabeceiras de Basto, from the 1:50,000 Geological Map of Portugal) (Noronha, 1992) and the neighbouring areas, we can understand that this mineral is an abundant resource on a regional scale, available through both fault-associated veins and pegmatite geological bodies.

In previous studies by Meireles (2009, 2010, 2013), quartz was divided into two major categories: hyaline quartz or rock crystal and other quartz varieties, similar to Mourre′s proposed division (1996, 1997) between automorphic and xenomorphic quartz, referring to the crystal habit and the diverse environmental conditions of formation that enhance the emergence of different varieties. In the analysis that has been conducted recently, the hyaline quartz category was maintained, adopting for the other types a chromatic-based typology, comprising the following varieties: milky, translucent, rose, grey, and smoky.

Being conscious of the limitations of the use of chromatic classifications, rightly recognised and criticised by several authors (e.g. de Lombera-Hermida, 2020; Driscoll, 2010; Rodríguez Rellán, 2010), it was nonetheless decided to use them, given the use of identical designations in mineralogical studies but also for providing a first distinction of an expedient nature, easy to apply and which can also be related to different geological environments. In addition, in some recent works, which have quartz lithic industries as their object of study, the colour corresponds to one of the criteria used in the classification of the different raw materials (e.g. Aubry et al., 2016a; Gaspar et al., 2016).

In addition to the colour-based typology and to overcome its limitations, it was also decided to follow the methodology proposed by Llana Rodríguez for the quartz and quartzite from the Upper Palaeolithic of Galicia and Asturias (Llana Rodríguez, 1990; Martínez Cortizas & Llana Rodríguez, 1996). This macroscopic classification allows us to verify the presence or absence of two variables that seem to have more influence on the quartz's aptitude for knapping: texture and joints/internal effects/crystallisation planes/fractures.

In this sense, four morphostructural groups were established based on the presence (S) or absence (N) of the two indicated variables – NN, SN; SN and SS – with the first letter referring to the grain and the second to the internal planes: NN (no grain/no plane); NS (no grain/plane); SN (grainy/no plane) and SS (grainy/plane) (Figure 3). By relating quartz formation processes to its mechanical properties, this classification may help to uncover raw material acquisition and selection criteria and to identify some technical constraints associated with each group (de Lombera-Hermida, 2008).

Concerning the assemblage from "Rock Shelter 1 of Vale de Cerdeira," even though this analysis is still ongoing, it is relevant to point out that the quartz from category "NN," which reveals a great aptitude for knapping, is frequently used to produce bladelets or elongated blanks and to manufacture microlithic tools. In another sense, fieldwork made it possible to understand that the quartz existing in the immediately surrounding area of the shelter, which occurs in hydrothermal veins, displays a fine-grained texture fitting

Figure 3: Quartz morphostructural groups.

the SN and SS categories of the mentioned classification. Nevertheless, most of the quartz types present in the two stratigraphic units under study are of type "NS," which, as far as our fieldwork has shown, occurs in other sites located at a greater distance from the archaeological site. This fact reveals a selective behaviour on the part of the prehistoric communities of Serra da Cabreira concerning the supply of the raw material.

4.3 Fieldwork

To recognise some possible raw material supply locations, a series of archaeological surveys were carried out. For this task, geological mapping is of particular importance, as well as other resources, namely the webpage SIORMINP – Information system of Portuguese mineral occurrences and resources (http:// geoportal.lneg.pt/pt/bds/siorminp/).

The varieties of quartz present in the Vale de Cerdeira collection can be encountered in quartz veins and pegmatite formations. The study of the geological cartography and the initial fieldwork made us understand that it would be impossible, from the logistical and time perspectives, to characterise all the geological bodies existing on the periphery of the shelter. Thus, to make this survey more feasible, it was necessary to direct the search towards rarer types, namely rose, smoky, hyaline, and hyaline or translucent quartz with inclusions. The prospecting programme carried out to date, particularly focused on the detection of pegmatites positioned up to 15 km away from the archaeological site, has recorded more than 200 spots of possible archaeological and geological interest.

Despite occasional constraints, such as accessibility or the destruction and fragmentation of certain geological bodies, some of the detected points are worth highlighting, especially the site known as "Muro Alto," located about 5 km from the archaeological site. This is a pegmatite body, providing different types of quartz, including rose, smoky, translucent, and with inclusions. Nowadays, the place is very much modified from what would be its natural configuration, because of intense mining during the 40 and 50 s (pers. com. C. Leal Gomes). Also, according to C. Leal Gomes and based on the geological analysis of the available information, before the mining exploitation, the site could have presented an imposing quartz body, over 6 m high, constituting a true landmark in the surrounding landscape (which could be related to the place name "Muro Alto," which is Portuguese for "High Wall").

At present, the site has already been studied in the context of our work, and some geological samples have been collected. However, the dense vegetation and the lackof ground clearance have momentarily made it impossible to continue the work safely. We intend to collect some more samples and perform analyses and laboratory procedures that may permit comparison with the archaeological artefacts and associate or discard this geological body as a source of raw material for the Cabreira mountain prehistoric hunter–gatherers.

4.4 Analytical Procedures

The scarcity of provenance studies on quartz can be explained, to some extent, by the fact that quartz is generally considered an immediate and local resource and that this type of study has focused mainly on exogenous raw materials because of the information they can provide on exchange networks and circulation routes of goods and people (de Lombera-Hermida, 2020). Indeed, on this topic, Bracco (1997, p. 287) states that in regions where quartz is not present on a regional scale, it is not exploited, a fact that reveals its low circulation and its exclusion from exchange networks.

Just as relevant is the nature and chemical composition of this mineral, essentially based on silica, making it quite challenging to discriminate between different sources, even of close origin (Cousseran, 1999; Rodríguez Rellán, 2010). In comparison to other raw materials, namely flint, quartz reveals a low internal variability, which translates into an immense difficulty in determining provenance from macroscopic analyses (Pereira et al., 2015).

In recent years, different approaches have been developed to overcome these constraints, including those from the area of geochemistry. For example one can mention isotope and trace element analyses, whose principle is based on the identification and tracing of elements present in the quartz as silica substitutes or retained in the interstitial impurities (Meighan, Simpson, Hartwell, Fallick, & Kennan, 2003), and secondary ion mass spectrometry, used in the characterisation and sourcing of pegmatite quartz artefacts from the Boreal period of central Canada, suggesting the existence of displacements on the order of 200 km (ten Bruggencate, Fayek, Brownlee, Milne, & Hamilton, 2013; ten Bruggencate, Fayek, Milne, & Brownlee, 2014).

To characterise the different quartz from the collection, as well as discuss working hypotheses about the location of the supplying sites, some laboratory techniques used in Earth Sciences have been applied.

Full preference was given to non-destructive techniques from an early stage of the study, to ensure the inviolability of the artefacts (Garrison, 2006). This decision was based on the heritage and cultural value that we recognise in the archaeological artefacts, but also due to the expectation that, in the future, other procedures and research projects may be developed on the same materials, possibly involving the use of more accurate techniques.

The non-destructive concept has a double meaning: first, in the obvious fact of avoiding any alteration or damage to the piece submitted to the analytical procedure and, second, in the sense of being reproducible, allowing the repetition of tests or the performance of different analyses on the same artefact (Xavier & Alves, 2019). Some techniques, although destructive, requiring the cutting or fragmentation of the artefact, enable, on the contrary, the performance of several sets of tests, avoiding continuous damage to the archaeological material.

The set of laboratory techniques tested included (Figure 4): scanning electron microscope examination to obtain chemical characterisations and information concerning textural and structural analysis; RAMAN

Figure 4: Analytical procedures.

analyses, useful for the understanding of the mineral chemical composition; X-ray fluorescence studies, equally important in the chemical characterisation, both global and pointwise and, hyperspectral imaging analyses, which, through the quantitative evaluation of chromatic coordinates, allow, in an objective manner, to determine the colour of a certain piece.

Some of the difficulties experienced in these tests were related to the irregular surface of the artefacts, restricting the applicability of some procedures and the scarce penetration capacity of some of the techniques and equipment, an aspect that is particularly important in the analysis and detection of inclusions, both fluid and mineral, described in Section 4.5.

4.5 Study of Inclusions

As mentioned, the great chemical and crystallographic homogeneity between different varieties of quartz make it exceedingly difficult to detect the sources of supply (Cousseran, 1999; Cousseran, Pècher, & Bintz 2000). A possible approach to the provenance sites of these materials lies in the identification of inclusions in automorphic quartz artefacts, which can provide insights regarding the formation environment and, consequently, its origin (ibidem). Inclusions correspond to materials retained inside minerals and can be classified according to their nature as solid (when dealing with other minerals) or fluid, if in a gaseous or liquid state (Figure 5); they are also categorised according to their formation, being protogenetic when formed before the crystal, syngenetic, when facing a simultaneous development, and epigenetic, constituted only after the integral development of the crystal (Sachanbiński, Girulski, Bobak, & Łydzba-Kopczynska, 2008, p. 1013). This methodology requiring the use of analytical techniques, including microthermometry and RAMAN spectrometry, has been successfully applied, notably in S. Cousseran's studies for the Mesolithic and Neolithic of the Western Alps and Lombardy (Cousseran, 1999, 2000a, 2000b; Cousseran et al., 2000) and also those of Sachanbiński for Prehistory in the SW of Poland (Sachanbiński et al., 2008).

In the scope of our study, observation under the petrographic microscope of artefacts in hyaline and translucent quartz allowed the recognition of inclusions. A substantial part of the effort invested in the laboratory techniques mentioned in the previous point was devoted to the determination of the constituent material of the inclusions. As regards the mineral inclusions, the studies carried out suggest that they may correspond to schorlite and elbaite; as for the fluid ones, the results have been unclear because of the already mentioned limited capacity of penetration into the pieces by the laboratory equipment and to the circumstance that the analyses were done on the complete artefacts. Nevertheless, the identification of the mineral inclusions has provided possible guidelines for fieldwork.

Figure 5: Study of inclusions.

5 Lithic Industry

Some of the results of the lithic industry study, for each stratigraphic unit, are briefly presented below. A general description of the panorama of raw materials will be provided first, followed by an approach to the techno-typological characteristics of the main structural categories of artefacts. The percentage values presented, although very close to the final ones, may be subject to slight modifications in subsequent works.

5.1 Stratigraphic Unit-1

Amongst the raw materials, the vast majority, as will be demonstrated below, correspond to different varieties of quartz. However, and although representing a minor role, there are other lithologies, namely flint from the West Portuguese Meso-Cenozoic Border, the vast majority of which is attributed to the Bajocian, with a very small contribution of flint from the Tajacian (SU-1) and Cretaceous (SU-2). This classification, as already mentioned, was carried out by Thierry Aubry, who also made another valuable contribution by identifying a small group of micro-quartz silicifications that were provisionally classified as flint. According to the procurement studies carried out in the Côa valley, NE Portugal (e.g. Aubry, Chauvière, Mangado Llach, & Sampaio, 2003; Aubry et al., 2016a,b), these silicifications, of epi and hydrothermal formation, appear associated with milky quartz and chalcedony veins and are considered to be of local and/or regional origin, having been detected in primary position, at a distance between 20 and 50km from the archaeological sites. C. Leal Gomes had also pointed out the probable existence of these silicifications in the geological context where the "Rock Shelter 1 of Vale de Cerdeira" is located (C. Leal Gomes, pers. comm., August 2017).

This small group of artefacts shows some variability, revealing different origins; however, within the scope of this work, they will be treated as a whole, without any individualization. Under the designation of "Others," there is also a group of very diverse geological resources, such as schists, siltstones, or other undetermined resources, whose grouping is only justified because they constitute, in their totality, a rather reduced quantity of about two dozen pieces.

Thus, regarding the raw materials, in the general context of the collection (Table 1), one can observe the preponderance of xenomorphic quartz, namely milky, followed by translucent; the hyaline quartz

Table 1: General overview raw materials SU-1

Stratigraphic unit 1		
	%	Ab. Am.
Raw materials		
Milky quartz	43.1	6,298
Translucent quartz	35	5,099
Hyaline quartz	13.3	1,943
Grey quartz	4	591
Rose quartz	3.2	464
Smoky quartz	0.1	19
Quartzite	0.2	35
Micro-quartz silicifications	0.3	49
Flint	0.7	97
Others	0.1	18
Total	100	14,613
Morphostructural quartz groups		
NN	22.8	3,292

NS	69.3	9,982
SN	1.8	262
SS	6.1	878
Total	100	14,414

represents 13.3% and the flint not even 1%. In what concerns the morphostructural groups, the NS variety, fundamentally associated with milky and translucent quartz, is the most relevant, whereas the NN, generally related to the rock crystal, stands at 22.8%. The quartz with granular texture is not very significant in general terms, despite being available less than 5 m from the archaeological site. These proportions show, however, some variations between different structural categories.

Amongst the bladelets, there is a greater preference for the use of rock crystal (33%); at the same time, NN-type quartz also makes up 29% in these blanks, whereas flakes do not make up more than 16%. In this artefact category, the most frequent type of quartz is milky of the "NS" group, with a total of 40%. It is in the microlithic instruments where a greater use of flint and microquartz silicifications is observed (the management of these two resources is always carried out similarly) because 10% of these pieces were made in these resources. It is equally amongst these instruments that we can see great use of the hyaline quartz (>53%) and the quartz from the morphostructural group NN, in the order of 80%. In the opposite direction, in what corresponds to the common tools, the distribution of the raw material is identical to the non-retouched blanks, prevailing the quartz with milky and translucent tonality from the "NS" group. As a matter of fact, in this particular case, only different varieties of quartz were used in the fabrication of the tools.

The dominant structural category in SU-1 is that of knapping debris (chunks, chips, and indeterminate fragments), representing more than 75% of the collection. The second place is taken by debitage products (flakes and bladelets) close to 19%, whereas cores represent no more than 2.1%. Equally low is the percentage of tools, just above 2% (Table 2).

The high percentage of knapping debris and indeterminable fragments is partly explained by the fracture mechanics of quartz highly subject to the occurrence of fractures and is in line with what has been described by several authors (e.g. Bracco, 1997; Driscoll, 2011; Mourre, 1996, 1997; Tallavaara, Manninen, Hertell, & Rankama, 2010).

For a brief description of the blanks, it can be first noted that the great majority of the butts are plain (more than 50%), in both subcategories (flakes and bladelets). Contrary to what other studies and experiments on quartz have revealed (e.g. Driscoll, 2011), more than half of the debitage products show wellpronounced percussion bulbs (61% in flakes and 57% in bladelets). Regarding the morphology of the blanks, if in the flakes it is not possible to detect a preference for a certain shape, in the case of the bladelets, there seems to be a clear preference for parallel edges (36%). The occurrence of fractures is quite significant reaching 55%. Amongst the most common fractures are Siret (accidental break), more than 30%, and transversal ones, around 25%. However, if in the case of flakes the difference between Siret and transversals is not very pronounced, amongst bladelets, the transversal fracture represents half of the total and the Siret type no more than 17%.

Table 2: Lithic industry SU-1 (structural categories)

Lithic industry SU-1		
	%	Ab. Am.

Technological categories Knapping debris (Chunks)	16.2	2,366
Cores	2.1	300
Unretouched flakes	13.1	1,909
Common tools	0.6	93
Unretouched bladelets	5	739
Knapping debris (chips)	60.9	8,897
Microlithic tools	1.7	242
Diverse	0.1	18
Quartz crystals (raw material)	0.3	49
Total	100	14,613

The most common reduction strategies observed in cores are polyhedral (89 pieces – 29.7%), bipolaron-anvil (77 pieces – 25.7%), and prismatic (40 pieces – 13.3%). The bipolar-on-anvil method, commonly mentioned regarding lithic industries in quartz, was applied to smaller volumes of raw material; as for the prismatic method, it was usually practised on quartz prisms, taking advantage of the morphostructural characteristics of the crystalline rhombohedron for the production of bladelets and elongated blanks (Ramil Rego & Ramil Soneira, 1997).

Despite the raw material abundance in the local geological context, this does not prevent that more than 40% of the cores are intensively explored and 16% are even exhausted. We should note the collection of a set of unexplored raw material volumes, amongst which 49 quartz prisms can be understood as the constitution of a raw material reserve by the hunter–gatherers of Serra da Cabreira.

The typological features of the lithic industry show a robust microlithic character because these tools represent 72% of the total, as opposed to the so-called "common tools" that use flakes as blanks and which hold a share of 27%; the remaining 1% integrates the miscellaneous category.

Amongst the "common tools" (Figure 6), a total of 93 units, the four most represented groups, in descending order, are borers, notches, retouched flakes, and burins. Other types are also present, although in significantly smaller amounts, such as end-scrapers, denticulates, scapers, and truncatures.

As for the microlithics (242 pieces) (Figure 7), points are the predominant type, followed by segments and trapezes. The list is completed by retouched bladelets, followed by truncatures, micro-borers, and indeterminates.

Regarding microlithic points, triangular cross-section and morphology predominate, although a division must be established amongst those with a simple (non-retouched) (31 units) and retouched base (20 units). Equally framed in the triangular points, however, featuring a particularly original solution, is another subtype, made from a removal usually taken from the apex of the quartz prism. The dorsal surface of these blanks is thus devoid of previous extractions, rather displaying the original crystallographic face of the quartz prism. From then on, taking advantage of the usually triangular and pointed morphology of the blanks and through a discontinuous but very precise retouch – sometimes direct and marginal practised on one of the edges and, on other occasions, inverse and invasive, thinning the base – a pointed armature is shaped (Figure 8, no. 12 and 14). To this particular type of point and because, in our understanding, its conception results from the fact that quartz is the main raw material, from now on we would like to name it "Vale de Cerdeira microlithic point." This point variety reflects a great understanding of the characteristics

Figure 6: Common tools SU-1 (percentage and absolute amounts).

Figure 7: Microlithic tools SU-1 (percentage and absolute amounts).

Figure 8: Tools from stratigraphic unit 1.

of the raw material, i.e. the physical and mechanical behaviour of quartz, perhaps as a consequence of a long-term and solid territorial implantation. In SU-1, there are 19 of these points.

In a minority of cases, but equally present, are fusiform points (seven pieces), pedunculated points (five units), and points with bilateral convergent retouching (two pieces). Of particular importance to understanding the production method of these armatures was the identification of five pre-forms, i.e. points not fully configured, but in the middle of the production process.

The segments are mostly symmetrical (38 pieces); the asymmetrical and elongated segments present identical values, with a slight primacy for the former, 11 and 7 accordingly. Four pre-forms of this typology were also identified. In turn, amongst trapezes, there is a small advantage of the asymmetric ones (17) concerning the symmetric (13) and, also, in this case, pre-forms were reported (4). No triangle was identified amongst geometric tools.

There is a remarkable homogeneity between the geometrics manufactured in quartz and other raw materials, as far as their sub-morphologies, dimensional averages, and retouching mode are concerned. The retouching mode, except for minor variations, is identical in both "common tools" and microliths: direct, continuous, abrupt, marginal, and parallel or sub-parallel. In microliths, it is also often done on an anvil. Also, in this domain, it should be noted that the double bevel retouching technique was observed only at one point of the SU-1, not extending into the following stratigraphic unit.

In summary, about the lithic production system, there is complete agreement with what was previously defined by Meireles (2010, 2013). Thus, the strategy is geared towards the obtainment of two debitage products. With a greater preponderance, flakes of a small module are produced through operating chaînes opératoires from polyhedral, bipolar, and parallelepiped cores, consisting of so-called random methods of debitage. In smaller quantities, there is also the manufacture of bladelets and micro-bladelets from prismatic cores, essentially unipolar, standing out a specific chaîne opératoire based on the exploitation of quartz prisms, which takes advantage of the structural characteristics of the crystalline rhombohedron, using the natural facets of the crystals as guiding-ridges to define the debitage surfaces. A significant part of the microlithic instruments in the collection are made from these blanks.

5.2 Stratigraphic Unit-2

In the domain of raw materials, broadly speaking and compared with SU-1, there is an increase of milky quartz, which concentrates more than half of the entirety, as well as of flint and micro-quartz silicifications. On the contrary, the rock crystal shows a global decrease, although with a more directed application in the production of bladelets and configuration of microlithic tools (Table 3).

There is a slight increase in micro-quartz silicifications as well as flint. In SU-1, we found Bajocian and Tajocian flint (two artefacts) from the West Portuguese Meso-Cenozoic Border, more specifically from Cantanhede and Anadia localities, respectively. In SU-2, Tajocian flint disappears, being replaced by Cretaceous flint (about six artefacts), probably from the Rio Maior region. Amongst the "Others," besides schists, silcretes, and other unknown lithologies, another resource not present in the previous unit was identified, more specifically hornfels (a bladelet and a chip).

The quartz with granulated texture (morphostructural groups SN and SS) are only a small part of the resources manipulated, which may be related, more than to its lower or higher availability in the local geological environment, to the reduced aptitude for knapping that they seem to present. Within the cores explored under the prismatic method (23 units), it is worth mentioning a higher concentration of quartz from the "NN" morphostructural group (15 pieces), characterised by a higher textural and structural homogeneity, which are important requirements in the application of this reduction strategy.

The difference between the total number of artefacts between SU-1 and SU-2 is just over 3,000 pieces, the latter counting exactly 11,474 artefacts (Table 4). There are considerable similarities, in various aspects, between both stratigraphic units, starting with the percentage value of some structural categories. Thus, in SU-2, knapping debris is more than 80% and debitage products around 16%. However, there was a reduction in the percentage of cores as well as tools that, this time do not exceed 1.7%. Amongst these, the microlithics remain the great majority.

Table 3: General overview raw materials SU-2

Stratigraphic unit 2		
	%	Ab. Am.
Raw materials		
Milky quartz	47.7	5,480
Translucent quartz	31.5	3,612
Hyaline quartz	9.9	1,131
Grey quartz	3.4	396
Rose quartz	4.6	534
Smoky quartz	0.1	15
Quartzite	0.2	20
Micro-quartz silicifications	0.7	78
Flint	1.8	201
Others	0.1	7
Total	100	11,474
Morphostructural quartz groups		
NN	17.5	1,954
NS	74.6	8,330
SN	2	225
SS	5.9	659
Total	100	11,168

Table 4: Lithic industry SU-2 (technological categories)

Lithic industry SU-2		
	%	Ab. Am.
Technological categories Knapping debris (chunks)	26	2,986
Cores	1	118
Unretouched flakes	12.4	1,419
Common tools	0.4	48
Unretouched bladelets	3.5	406
Knapping debris (chips)	54.7	6,278
Microlithic tools	1.3	152
Diverse	0.2	8
Quartz crystals (raw material)	0.5	59
Total	100	11,474

The number of debitage products is lower than in SU-1, but their characteristics are quite similar. For instance, the percentage of fractured flakes and bladelets settles again at values close to 50%. There is also another similarity in the predominant type of butt (plain) – 57% in flakes and 44% in bladelets – as well as in the well-developed bulbs

– 61% in flakes and 62% in bladelets. Parallel-edged bladelets with prominent arris on the dorsal side correspond to the type of support most wanted by prehistoric knappers (35.8%).

Although the main reduction strategies are maintained from one stratigraphic unit to the other, there is a small difference in their order. This time, the main strategy is based on bipolar percussion on an anvil (29.7%), followed by polyhedral (21%) and prismatic (19%) percussion, once again, mainly from unipolar cores. The percentages of intensively exploited and exhausted cores remain high, 35.6 and 24.6%, respectively. In fact, amongst the possible causes for abandonment of the cores – and even though in more than 37% of the situations it was not possible to point out an objective reason – exhaustion had a more predominant role than, for example, raw material defects (13.8%) and the occurrence of fractures (15%). It is precisely amongst the cores exploited by the prismatic method where greater exploitation of the volumes is observed.

If the blocks or fragments are the types of support on which the polyhedral method is developed, as far as the bipolar and prismatic methods are concerned, these are practised fundamentally on quartz prisms. Similarly to what was mentioned for SU-1, intact quartz crystals were also recovered in SU-2, even in a larger quantity, counting 59 units.

In what concerns the tool structural category, the microlithic component remains more substantial, now representing 71%; the "common tools" represent 28% and the remaining 1% integrates the miscellaneous category.

In the case of common tools, with a total of 48 units (Figure 9), three morphologies can be distinguished, more specifically: retouched flakes, borers, and notches. Other types and morphologies go through a great decrease in their absolute values in this stratigraphic unit, such as burins, denticulates and scrapers. Once again, there is no evidence of particular management of lithological resources in the production of these tools, in contrast to what can be seen in the microlithic subcategory. Nevertheless, and contrary to what was described for SU-1, there are three tools not made in quartz, namely a quartzite "bec" and, in flint, a small thumb-nail end-scraper and a retouched flake.

As for the microlithic tools, this time segments are the predominant type (62 pieces), followed by points (40 pieces), even if, compared with SU-1, they register a remarkable decrease. The third most represented category is, for the time being, retouched bladelets (28), which, in percentage terms, are more than double that of SU-1. There is a notable decrease in trapezoidal armatures (only two units), also highlighting the presence of a triangle, a geometric sub-type not identified in the previous stratigraphic unit (Figure 10).

In layer 2, although not very significant (<15%, nine pieces), a new variant of a segment is observed. Such pieces are on the borderline between segment and microlithic point, as one of the ends is slightly angled or transverse, as if it were a small base. As in SU-1, symmetrical segments continue to predominate, representing more than 40% (26 units).

One issue that was not addressed in the previous section and that cannot go unmentioned concerns the mode of production of geometrics. In the lithic collection of Vale de Cerdeira, there is no evidence of the use of the microburin blow technique. Thus, the realisation of microlithic armatures, namely geometrical and

Figure 9: Common tools SU-2 (percentage and absolute amounts).

Figure 10: Microlithic tools SU-2 (percentage and absolute amounts).

points, followed two technical procedures. The first one comprehends the shaping, through retouching, of blanks of reduced modules, such as bladelets, flakes, or even, occasionally, chips; the second corresponds to the transversal rupture technique consisting in obtaining a fracture surface perpendicular to the blank axis through bending or, more rarely, percussion, from which a fragment is selected to manufacture the piece. This technique, known for its expeditious nature, was applied, amongst other possible examples, in the cave of El Espertín, in León, Spain (Fuertes Prieto, 2000–2001). Its recognition, in the Vale de Cerdeira case, was possible because of the identification of a set of bladelets proximal/mesial fragments, systematically fractured by bending, showing that this was not the result of some accidental circumstance but, on the contrary, of intentional behaviour.

The non-application of the microburin blow technique in Vale de Cerdeira can be, in our view, seen in two ways. If we assume that this circumstance is due to the raw material, and accept the often uncritical evaluation of quartz as a raw material of poor suitability for knapping, we could subscribe to the reflection of Araújo (1995–1997, p. 137) for whom this technique presents a reduced efficiency in low-quality lithic resources. On the other hand, there is the perspective of Eren, Lycett, Roos, and Sampson (2011) who state that the quality of the raw material should not necessarily be understood as a determining or constraining factor, but as an opportunity for prehistoric knappers to adapt, often with good results, to the characteristics of the raw material.

As far as the Vale de Cerdeira collection is concerned, not all quartz can be classified as having a low aptitude for knapping. The great majority of the hyaline quartz and some milky and translucent quartz, particularly those that fit into the morphostructural group NN, can effectively be considered good resources. However, other characteristics of this raw material (anisotropy? fracture mechanics?), other than its quality, can make the microburin blow technique not very suitable. Finally, we must also bear in mind the technical and "cultural traditions" of the human group, which might not have envisaged this mode of manufacturing microlithic tools. The truth is that, although in residual quantities, other lithological resources such as flint and micro-quartz silicification are present, both particularly directed towards the production of bladelets and microlithic instruments, without representing the adoption of significantly different technical procedures.

In the category of microlithic points, there is a decrease in the number of pieces, now counting 40 items. Continuity of the main types can be observed, as well as the primacy of points with triangular crosssection and morphology in the three aforementioned variants: simple base (7), retouched base (10), and "Vale de Cerdeira" (7) (Figure 11, no. 7 and 8). Points with fusiform morphology and points with peduncle (6) or bevelled ends (2) are also registered, in a similar proportion to the previous stratigraphic layer.

Nevertheless, some differences or innovations can also be observed. A particularly significant aspect is the appearance, in the various types and subtypes of these tools, of curved backs, a technical feature that does not occur in layer 1, where oblique or rectilinear backs prevail. Another differentiating element is the appearance of two transverse-edged points; in turn, the bilateral convergent-edged points, whose presence was already not very representative in the SU-1 context, are now reduced to a single piece.

It seems particularly relevant that only different varieties of macrocrystalline quartz have been used in the making of microlithic points (in both stratigraphic units). Flint, as well as micro-quartz silicifications or the few silcretes, is used in other classes of artefacts, such as bladelets, retouched or not, geometrics, basically segments, and even micro-borers. We do not have any evidence to explain this behaviour, which is unlikely to be the work of chance. Even as speculation, we can put forward some working hypotheses to be discussed in the future. Could the points that take part in composite tools different from those in which the geometric or retouched elongated blanks would be used? Or would the difference lie in the type of hunting prey, given that these types of tools, despite being suitable for other purposes (Clarke, 1978; Pignat & Plisson, 2000), are essentially used in hunting activities? Perhaps, we should not exclude cultural or identity criteria that may be underlying this decision.

On the other hand, the quartz used in the manufacture of points covers a great variety, both in what concerns the chromatism and in what relates to its attachment to a particular morphostructural group, being also worth mentioning the use of qualities with a notoriously lower aptitude knapping.

Importantly, there are no differences between the production system of SU-2 and SU-1, whereas the same strategy orientations of the previous set tool are followed. So, the most distinctive aspect of the second stratigraphic level is the presence of a small set of polished stone materials, constituted by a small

Figure 11: Tools from stratigraphic unit 2 (Photographs by Adriano Borges).

sillimanite/fibrolite axe, one fragment (butt) of another axe also in sillimanite/fibrolite and four other miscellaneous ones. Moreover, 20 sherds of ceramics were recovered, all of manual technique, most of them without any decoration. Amongst the four decorated fragments, two have a simple incised decoration and the other two impressions and dragged impressions, also known as "boquique type" (Figure 12). As a whole, these ceramics encountered parallels with Early Neolithic productions found in the archaeological site of Prazo, located in Alto Douro, NE Portugal, and, in the absence of radiometric dating, might provide a chronological basis for the occupation materialised in this stratigraphic unit (Monteiro-Rodrigues, 2011).

6 Final Remarks

One of the main motivations behind the realisation of a raw materials study, which also covered the discussion of potential procurement points, was the obvious lack of this analysis in the NW Peninsular region. Such scarcity seems to be the rule in regions where quartz is dominant and, on the contrary, flint is rare or even non-existent (de Lombera-Hermida & Rodríguez Rellán, 2010).

The study of raw materials, particularly about the detection of sources of supply, has so far produced limited results. This circumstance can be explained by several reasons, amongst which are the monotonous chemical composition of quartz, which lacks other elements that could help in the discrimination between different sources, the great variability of quartz varieties that are often detected in the same geological body, and the constraints experienced during the fieldwork and laboratory procedures. On the other hand, the success of this sort of project also depends on the existence of a previous inventory of the supply sources which includes, amongst other information, outcrop types and their abundance and variability (Almeida,

1: Polished stone axe; 2: Sherd of 'boquique type' pottery;
3: Sherd of incised pottery; 4: Sherd of impressed potery

Figure 12: Decorated ceramic sherds and polished axe from SU-2 (adapted from Meireles, 2010, p. 93).

Araújo, & Aubry, 2003; Aubry, 2005). Given this is the first attempt, on a regional scale, to carry out a provenance study, this inventory is only now beginning to take form. Simultaneously, as a result of fieldwork and geological sampling, a reference collection has been initiated, which may prove useful in further analysis, as well as in possible future research projects in the fields of Archaeology and Geology.

Meanwhile, more than 200 points of potential geological interest have already been recorded and characterised within a radius of 15 km around the archaeological site. All the information has been systematised in a geographic information system software (QGIS) and is being considered for release in a free access online platform.

According to Economic Zonation as defined by Geneste (1985, 1988) and given the composition of the archaeological collection, combined with the geological environment knowledge resulting from prospection work, most of the lithic resources demand would occur in the so-called "local" (up to 5 km) and "intermediate" (between 5 and 20 km) zones. A lower contribution would come from the third area, called "remote" (30 to 80 km), and materialized, amongst other lithologies, in micro-quartz silicifications and Bajocian, Tajacian, and Cretaceous flint from West Portuguese Meso-Cenozoic Border. As a working hypothesis, we can consider that in the first two areas (local and intermediate), the supply was direct, in the meaning of Ramos Millán (1986), i.e. resulting from the exploitation of the natural environment, whereas in the remote area and particularly concerning the more distant raw materials, it was indirect, through exchange processes with other communities (ibidem).

Some of the known studies on the raw material procurement and movement in Prehistory in Portugal and other European regions (e.g. Aubry et al., 2003; Mangado Llach, Aubry, & Sampaio, 2006; Martí Oliver, Aura Tortosa, Juan Cabanilles, García-Puchol, & Fernández Lopez de Pablo, 2009; Soares, Tavares da Silva, & Canilho, 2005/2007) corroborate the tendency that the further away a given raw material source is located, the less likely is it to be found at the site of human occupation, given the greater investment required in its acquisition. This principle was defined by the concept of the energy cost of raw material supply introduced by Ramos Millán (1984).

We also suppose that, for the areas closest to the "Rock Shelter 1 of vale de Cerdeira," considering the abundance of sources and different varieties of quartz found there, supply occurred along with other daily activities (embedded procurement in the sense ascribed by Binford (1979)). However, we emphasise that such ideas are, for the moment, no more than conjectures. We have no real evidence to support the claim that exogenous resources were obtained through exchange processes and not through meetings held in potential aggregation areas where communities separated for much of the year would meet on a seasonal basis (Aubry, Luís, Mangado Llach, & Matias, 2012) and we cannot rule out special-purpose expeditions (Binford, 1979).

Concerning the Bajocian flint from the locality of Cantanhede in the centre of Portugal, the most preponderant amongst the exogenous lithologies, what can be stated with certainty, according to the work done in the Côa Valley, is that in the period between the Upper Palaeolithic and the Late Mesolithic, that was the main centre of the diffusion of this raw material, amongst other varieties and sources already detected and characterised, both in West Portuguese Meso-Cenozoic Border and the Iberian plateau (T. Aubry, pers. comm., December 2020) (Figure 13).

On the other hand, the particular management observed for hyaline quartz and the circumstance that its occurrence in the local geological environment is rarer than other types of quartz could indicate a purposeful procurement. The same can be pondered about the micro-quartz silicifications. Generally more suitable for knapping compared with macrocrystalline quartz, sometimes similar to flint and managed in the same way, but with a very occasional and localised occurrence, its detection would occur by chance or through an intense search, considering that, for all purposes, its sources were closer than those of flint?

Concerning these lithologies, it can be mentioned that within SU-1 there are two small artefacts of a green micro-quartz silicification, very similar to type J2, identified in the provenance studies carried out in the Côa valley (Aubry et al., 2012, 2016b; Aubry, Mangado Llach, & Matias, 2014). These authors indicate that the source, for this last case, can be traced to Freixo de Numão, in NE Portugal, where we can also find the archaeological site of Prazo, whose lithic assemblage also includes artefacts made from this raw material (Monteiro-Rodrigues, 2011). The possible association of the pieces from Vale de Cerdeira, if proven, will establish a link between two regions of N Portugal during the Mesolithic period and opens new research perspectives.

Figure 13: Map of the main flint and siltstone sources from the West Portuguese Meso-Cenozoic Border during Prehistoric times (from Aubry, 2018, p. 16).

Indeed, shortly and within the scope of the study of the raw materials, we would like to give priority to the resolution of two issues. First, to understand, through the study of the inclusions, if the pegmatite body known as "Muro Alto" (mentioned in Section 4.3) was a source of raw material. Unlike other referenced sites, for this one, we have a good number of samples, as well as information pointing to the presence of quartz with tourmaline. Second, future fieldwork should focus on the detection of these micro-quartz silicifications. Being aware that their location is hard work, their identification could represent a real qualitative advance in research, not only by detecting a probable source of raw material but also by more objective data regarding the territory of exploitation of prehistoric groups.

On the subject of the lithic industry, the study of the Vale de Cerdeira assemblage has contributed to demystifying a sort of "atypicality," often associated with the artefactual assemblages made of quartz. Precisely in the reverse sense, we could highlight that there is excellent suitability of the main raw material to the lithic production system, noticeable in the chaînes opératoires, especially the one resulting from the application of the prismatic method, using the natural ridges of the quartz crystals, and in the manufacture of microlithic tools, for example, dismissing the use of the microburin blow technique and using more expedient procedures such as transversal rupture. Any hint of strangeness that might be hanging over the collection of Vale de Cerdeira would be contradicted by the fact that its set of tools is fully linked to the Geometric Mesolithic techno-complex, present in other Iberian and European regions in the period usually considered to be the Late Mesolithic (c.6500–5200/4900 BC).

As we have already demonstrated, regarding the tools, there is a higher proportion of the microlithic component, especially armatures, compared with "common tools," a parameter frequently used to evaluate the importance of hunting in archaeological sites (Pignat & Plisson, 2000, p. 67). This fact is, in this context, particularly significant as the excavation work did not retrieve any other evidence, namely of an archaeozoological nature, which would have allowed us to understand the food resources exploited by the prehistoric community. In the same sense, other site characteristics, namely its location – near a stream and with excellent control over natural access routes to the western slope of the Cabreira mountain range – and its dimensions – which cannot accommodate more than a small group of 10/12 people – seem to us compatible with an occupation dedicated to hunting activity. In any case, these interpretations must be made with precaution, given the inexistence of contemporary sites allowing the establishment of a typology of sites and, consequently, a greater knowledge of the nature of their occupations.

So, about SU-1, it seems to be quite peaceful to associate it with the Late Mesolithic and the Geometrical techno-complex, according to both the lithic industry and the C-14 dates that, as a reminder, provide a time interval between the third quarter of the 6th/first quarter of the fifth millennium BC. As for the second date (5207–4853 cal BC 2 sigma), the fact that it falls in the fifth millennium BC, a period that some authors consider to correspond to the Early Neolithic, does not seem particularly problematic, given the well-known persistence of the Mesolithic way of life in some Iberian regions, such as the Tejo paleo-estuary or the Alentejo coast, where hunter–gatherers remained until about 4750 BC (Zilhão, 2000). If we look exclusively at the chronological and typological aspects, in particular the predominance of segments within geometric tools, Vale de Cerdeira finds parallels in the shell-middens of Vidigal (Odemira, Alentejo Coast) and Amoreiras (Alcácer do Sal, Sado Valley) (Carvalho, 2009; Nukushina, 2012).

As for the double beveltechnique recordedon a microlithicpointof this stratigraphic unit, although some authors (e.g. Diniz, 2007; Marchand, 2005) assign some chronological relevance to it, linking it to the Early Neolithic and even to processes of technological transfer between agro-pastoralist communities and hunter– gatherer groups, others (e.g. Arias & Fano Martínez, 2009; Neira Campos, Fuertes Prieto, & Herrero Alonso, 2016) are more sceptical about its chronological significance, pointing to its presence in levels of the Late Mesolithic, from the beginning of the sixth millennium cal BC, in the Cantabrian Range. Also, in recent work on the Galician Mesolithic (Ramil Rego, Fuertes Prieto, Fernández Rodríguez, González Gómez de Agüero, & Neira Campos, 2021), the presence of double bevel retouch in the manufacture of geometric microliths is stressed, specifically in the site of Xestido III (Lugo) for which an absolute dating is known whose minimum limit fits the first quarter of the sixth millennium cal BC (GrN-16839, 7319 ± 160 BP; 6476–5886cal BC 2 sigma).

For SU-2, the situation is more challenging. Because of the absence of radiometric dating, we will have to rely on the whole artefactual assemblage to propose a chronological classification. Therefore, the lithic industry is very similar to the one from SU-1, in terms of the lithic production system and chaînes opératoires. There are some differences, apparently not very significant in some types, such as the great predominance of segments and a substantial decrease in the number of trapezes. The amount of microlithic points has also decreased, but this must be seen in light of the general reduction in the number of tools and, in fact, of the whole collection set when compared with SU-1.

On the other hand, the appearance of a set of technological innovations represented by polished flint tools and ceramics is relevant. These items, as is widely known, are associated with the so-called "Neolithic package." Concerning ceramics, and taking the "boquique" type decoration as a reference, it has parallels, as mentioned, in Early Neolithic productions from the archaeological site of Prazo, between 5100–4400 cal BC (Monteiro-Rodrigues, 2011). Carvalho (2019, p. 13) notes the appearance of this technique, almost simultaneously in three regions of Portugal – Beira Alta, Estremadura, and Alentejo – during the first quarter of the fifth millennium BC, providing as examples the sites of Quinta da Assentada, with a chronology of 4750 cal BC and Caldeirão and Pena d'Água between 4750 and 4700 cal BC.

Returning to the lithic industry, the segment seems to constitute the main typological element of the Early Neolithic in the Portuguese territory (Diniz, 2007; Soares, 1995), often even the only geometrical tool represented in archaeological sites of this chronology (Carvalho, 2007; Simões, 1999). Also, the chronological model established for central and southern Portugal (Manen, Marchand, & Carvalho, 2007), based on an initial systematisation established by Marchand (2001, 2005) – combining typological features with absolute chronologies – stresses the importance of segments in lithic collections in the Early Neolithic.

There seems to be some evidence supporting the association of this unit's occupation with the Early Neolithic. However, and although this is a subject that goes beyond the objectives and intentions of this article, it does not seem pointless for the moment, to consider this term only in a chronological sense, depriving it of its more strictly economic sense, related to an agro-pastoral way of life. Indeed, it would be unreasonable, from such a small set of technological innovations, to which we cannot associate any other evidence related to the practice of herding and agriculture, to presume a "Neolithic" economic system. The presence of a lithic industry, "inherited" from SU-1, clearly hunting-oriented, with chaînes opératoires oriented towards the production of geometric instruments and arrowheads, seems more compatible with a hunter–gatherer community undergoing a process of incorporation of "novelties" whose implications in an initial stage would be essentially social and only in the long term reflected in the economic sphere (Monteiro-Rodrigues, 2011). In any case, the study of SU-2 may certainly contribute to the discussion concerning the last groups of hunter–gatherers and the first agro-pastoral communities.

"As a matter of fact, even the most renowned author of the diffusionist/migratory paradigm (J. Zilhão) accepts that the NW Peninsular may have remained outside the 'Neolithisation process' through maritime pioneer colonization. This model defends the establishment, in the middle of the 6th millennium BC, of Neolithic colonies in coastal areas of Portugal (Estremadura and Algarve), which would have later expanded to the rest of the territory, including more inland areas, finishing their expansion around 4750 BC, when they reached the region of Trás-os-

Montes, NE Portugal)" (Zilhão, 2000). In fact, and unlike the rest of Iberia where the Neolithic process occurred through migration, in the NW of the Iberian Peninsula, Galicia, and Cantabria, it is accepted that it may have happened through adoption, giving greater participation to Mesolithic communities (Zilhão, 2011, p. 50). For these regions of Northern Spain, some authors have proposed the development of a mosaic model (e.g. Arias, 1999; Fábregas Valcarce et al., 2019), also defended in Portugal by researchers who criticise the diffusionist paradigm (Bicho, Lindly, Stiner, & Ferring, 2000; Jorge, 1999; Monteiro-Rodrigues, 2011), whereby the absorption of the so-called "Neolithic novelties" would be done unevenly (mechanism of selective assimilation), leading to the coexistence of communities with distinct characteristics and ways of life: with and without pottery; practising agriculture and/or herding or living exclusively from hunting-gathering, etc.

Acknowledgments: We thank Thierry Aubry (Fundação Côa Parque; UNIARQ, Universidade de Lisboa) for the classification of flint and micro-quartz silicifications artefacts and all information provided concerning provenance studies and lithic industries of the Côa Valley; Carlos Leal Gomes (DCT/ECUM and Lab2PT, Universidade do Minho) for giving very important information regarding quartz occurrences in northern Portugal and also guiding us in several fruitful fieldwork activities; Adriano Borges for the excellent pictures of the tools from stratigraphic unit-2; and Andrew May for the proofreading of the English text.

Funding information: The work was financed by Fundação para a Ciência e a Tecnologia (Foundation for Science and Technology): Ph.D. scholarship (P. Xavier), reference SFRH/BD/120806/2016.

Author contributions: All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

Conflict of interest: The authors state no conflict of interest.

Data availability statement: The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

References

Almeida, F., Araújo, A. C., & Aubry, T. (2003). Paleotecnologia lítica: Dos objectos aos comportamentos. In J. Mateus & M. Moreno-García (Eds.), Ecologia humana e arqueociências. Um programa multidisciplinar para a Arqueologia sob a tutela da cultura (pp. 299–349). Lisboa, Portugal: Instituto Português de Arqueologia.

Araújo, A. C. (1995–1997). A indústria lítica do concheiro de Poças de S. Bento (vale do Sado) no seu contexto regional. O Arqueólogo Português, 13–15, 87–160.

Araújo, A. C. (2015). A few steps backwards ....in the search of the origins of the Late Mesolithic. In N. Bicho, C. Detry, D. Price, & E. Cunha (Eds.), Muge 150th: The 150th anniversary of the discovery of Mesolithic Shellmiddens (Vol. 2, pp. 1–15). Cambridge, United Kingdom: Cambridge Scholars Publishing.

Araújo, A. C. (2016). Une histoire des premières communautés mésolithiques au Portugal. Oxford: BAR International Series 2782.

Araújo, A. C., & Almeida, F. (2013). Barca do Xerez de Baixo. Um testemunho invulgar das últimas comunidades de caçadoresrecolectores do Alentejo interior (Memória d'Odiana, 2ª Série, 332). Beja: Edia.

Arias, P. (1999). The origins of the Neolithic along the atlantic coast of continental Europe: A survey. Journal of World Prehistory, 13(4), 403–464.

Arias, P., & Fano Martínez, M. A. (2009). ¿Mesolítico geométrico o Mesolítico con geométricos?: El caso de la región cantábrica.

In P. Utrilla Miranda & L. Montes Ramírez (Eds.), El mesolítico geométrico en la Península Ibérica (Monografías Arqueológicas, 44, pp. 69–92). Zaragoza, España: Universidad de Zaragoza.

Aubry, T. (2005). Étude de l'approvisionenment en matières premières lithiques d'ensembles archéologiques. Remarques méthodologiques et terminologiques. In D. Vialou, J. Renault-Miskovsky, & M. Patou-Mathis (Eds.), Comportements des hommes du Paléolithique moyen et supérieur en Europe: Territoires et milieux (Actes du Colloque du G.D:R. 1945 du CNRS, Paris, 8–10 janvier 2003, pp. 87–99). Paris, France: ERAUL.

Aubry, T. (2018). Petroarqueologia:dimensões espacial e social no estudo das indústrias de pedra lasca. In M. de J. Sanches, A. Vale, & S. Monteiro-Rodrigues (Eds.), ARQUEOCIÊNCIAS 2018 Da matéria-prima ao artefacto. Instrumentos líticos e cerâmicas nos estudos de arqueologia (pp. 15–17). Porto, Portugal: Universidade do Porto. Faculdade de Letras.

CITCEM – Centro de Investigação Transdisciplinar Cultura, Espaço e Memória.

Aubry, T., Chauvière, F. X., Mangado Llach, X., & Sampaio, J. D. (2003). Constituition, territoires d'approvisionnement et fonction des sites du Paléolithique supérieur de la basse vallée du Côa (Portugal). In S.A. Vasil'ev, O. Soffer, & J. Koslowski (Eds.), Perceived landscapes and built environments: The cultural geography of Late Paleolithic Eurasia (pp. 83–92). Oxford: Archeopress.

Aubry, T., Luís, L., Mangado Llach, J., & Matias, H. (2012). We will be known by the tracks we leave behind: Exotic lithic raw materials, mobility and social networking among the Côa Valley foragers (Portugal). Journal of Anthropological Archaeology, 31(4), 528–550. doi: 10.1016/j.jaa.2012.05.003.

Aubry, T., Mangado Llach, J., & Matias, H. (2014). Matérias-primas das ferramentas em pedra lascada da Pré-história do Centro e Nordeste de Portugal. In P. A. Dinis, A. Gomes, & S. Monteiro-Rodrigues (Eds.), Proveniências de Materiais geológicos (pp. 165–192). Porto, Portugal: Associação Portuguesa Para o Estudo do Quaternário.

Aubry, T., Barbosa, F., Luís, L., Santos, A. T., & Silvestre, M. (2016a). Quartz use in the absence of flint: Middle and Upper Palaeolithic raw material economy in the Côa Valley (North-eastern Portugal). Quaternary International, 424, 113–129. doi: 10.1016/j.quaint.2015.11.067.

Aubry, T., Gameiro, C., Llach, J. M., Luís, L., Matias, H., & Pereiro, T. (2016b). Upper Palaeolithic lithic raw material sourcing in Central and Northern Portugal as an aid to reconstructing hunter–gatherer societies. Journal of Lithic Studies, 3, 1–22. doi: 10.2218/jls.v3i2.1436.

Aubry, T., Gameiro, C., Santos, A. T., & Luís, L. (2017). Existe Azilense em Portugal? Novos dados sobre o Tardiglaciar e o Pré-Boreal no Vale do Côa. In J. M. Arnaud & A. Martins (Eds.), Arqueologia em Portugal. 2017 – Estado da Questão (pp. 403–418). Lisboa: Associação dos Arqueólogos Portugueses.

Bicho, N. (2009). Sistemas de povoamento, subsistência e relações sociais dos últimos caçadores-recolectores do Vale do Tejo. Estudos Arqueologicos de Oeiras, 17, 133–156.

Bicho, N., Lindly, J., Stiner, M., & Ferring, C. R. (2000), O processo de neolitização na Costa Sudoeste. In Actas do 3° Congresso de Arqueologia Peninsular, III (pp. 11–22). Porto: ADECAP.

Binford, L. (1979). Organization and formation processes: Looking at curated technologies. Journal of Anthropological Research, 35, 255–273.

Bracco, J-P. (1997). L'utilisation du quartz au Paléolithique Supérieur: Quelques réflexions tecnho-économiques. Préhistoire Anthropologie Méditerranéennes, 6, 285–288.

Carvalho, A. F. (2003). A emergência do Neolítico no actual território português: Pressupostos teóricos, modelos interpretativos e a evidência empírica (O Arqueólogo Português, série IV, 21, pp. 65–150). Lisboa: Museu Nacional de Arqueologia,

Carvalho, A. F. (2007). A neolitização do Portugal meridional: Os exemplos do maciço calcário estremenho e do Algarve ocidental. Faro, Portugal: Universidade do Algarve. http://hdl.handle.net/10400.1/1791.

Carvalho, A. F. (2009). O Mesolítico final em Portugal. In P. Utrilla & L. Montes (Eds.), El Mesolítico Geométrico en la Península Ibérica (Monografías Arqueológicas, 44, pp. 33–68). Zaragoza, Spain: Universidad de Zaragoza.

Carvalho, A. F. (2019). Produção cerâmica no início do Neolítico em Portugal: Dados recentes sobre os VI e V milénios a.C. SAGVNTVM. Papeles Del Laboratorio de Arqueología de Valencia, 51, 9. doi: 10.7203/sagvntvm.51.12934.

Clarke, D. L. (1978). Mesolithic Europe: The economic basis (p. 78). London: Duckworth.

Cousseran, S. (1999). Origine et circulation des quartzs archéologiques. Application de la méthode des inclusions fluides à quelques sites des Alpes occidentals. In Circulations et identités culturelles à la fin de la préhistoire – Matériaux pour une étude – Programme CIRCALP 1997–1998 (pp. 197–210). Valence, France: Travaux du Centre d'Archéologie Préhistorique de Valence 2.

Cousseran, S. (2000a). Discrimination des quartz archéologiques de quelques sites des Alpes françaises par leurs inclusions fluides. In Tillet, T. (Ed.), Les paléoalpins : hommage à Pierre Bintz (pp. 49–58). Grenoble: Inst. de Géologie - Assoc. Dolomieu, Documentation.

Cousseran, S. (2000b). L'étude des inclusions fluides appliquée au problème de la circulation des quartz archéologiques dans les Alpes occidentales. Acquisition de nouvelles données sur les gîtes primaires. Revue d'Archéométrie, 24, 169–177.

Cousseran, S., Pècher, A., & Bintz, P. (2000). Quartz taillés à inclusions fluides de quelques sites préhistoriqus dans les Alpes du Nord. In P. Crotti (Ed.), Meso 97. Actes de la Table Ronde "Épipaléolithique et Mésolithique" de Lausanne, 21–23 novembre 1997 (pp. 59–63). Lausanne: Cahiers d'Archèologie romande.

de Lombera-Hermida, A. (2008). Quartz morphostructural groups and their mechanical implications. Museologia Scientifica e Naturalistica, 3, 1–5. doi: 10.15160/1824-2707/488.

de Lombera-Hermida, A. (2020). Gestión de materiales silíceos macrocristalinos en el Pleistoceno de Europa occidental. Evolución de las estrategias de adaptación a los condicionantes litológicos (Vol. 1). Santiago de Compostela, España: Universidade de Santiago de Compostela.

de Lombera-Hermida, A., & Rodríguez Rellán, C. (2010). Gestión y Estrategias de abastecimiento de las materias primas locales (cuarzo, cuarcita y pizarra) en la Prehistória del NW Peninsular. In S. Domínguez-Bella, J. Ramos Muñoz, J. M. Gutiérrez López, & M. Pérez Rodríguez (Eds.), Minerales y Rocas en las sociedades de la Prehistóris (Grupo de I, pp. 49–60). Cádiz, España: Universidad de Cádiz.

Diniz, M. (2007). O sítio da Valada do Mato (Évora): Aspectos da neolitização no Interior/Sul de Portugal. Lisboa: Instituto Português de Arqueologia.

Driscoll, K. (2010). Understanding quartz technology in early prehistoric Ireland (Unpublished PhD thesis). School of Archaeology, University College Dublin, Dublin. http://www.lithicsireland.ie/PHD_Quartz_lithic_technology_ CONTENTS.html.

Driscoll, K. (2011). Identifying and classifying vein quartz artefacts: An experiment conducted at the world archaeological congress, 2008. Archaeometry, 53(6), 1280–1296. doi: 10.1111/j.1475-4754.2011.00600.x

Eren, M. I., Lycett, S. J., Roos, C. I., & Sampson, C. G. (2011). Toolstone constraints on knapping skill: Levallois reduction with two different raw materials. Journal of Archaeological Science, 38(10), 2731–2739. doi: 10.1016/j.jas.2011.06.011.

Fábregas Valcarce, R., Carvalho, A. F., de Lombera-Hermida, A., Cubas, M., Lucquin, A., Edward Craig, O., & RodríguezÁlvarez, X. P. (2019). Vaso con decoración cardial de Cova Eirós (Triacastela, Lugo). Trabajos de Prehistoria, 76(1), 147. doi: 10.3989/tp.2019.12231.

Fuertes Prieto, N. (2000–2001). El modo de producción de los microlitos geométricos: El caso de la Cueva de"El Espertín." Lancia, 4, 51–70.

Fullola, J. M., & Zilhão, J. (2009) La cuestión de la ocupación de las áreas interiores ibéricas en el contexto del Paleolítico Superior peninsular. In T. Aubry (Ed.), 200 séculos da história do Vale do Côa: Incursões na vida quotidiana dos caçadoresartistas do Paleolítico (Trabalhos de Arqueologia, Vol. 52, pp. 15–17). Lisboa: IGESPAR.

Garrison, E. (2006). Techniques in archaeological geology. In: G.A. Wagner,C.E.Miler,& H.Schutkowski (Eds.). (2nd ed.,p.364). Springer.

Geneste, J. M. (1985). Analyse lithique d'industries moustériennes du Périgord: Un approche technologique de comportement des groupes humains au Paléolithique moyen. Bordeaux, France: Université de Bordeaux I.

Geneste, J.-M. (1988). Système d'approvisionnement en matière premières au Paléolithique moyen et au Paléolithique supérieur en Aquitaine. In L'homme de Néandertal, 8, La Mutation, 1988 (pp. 61–70). Liège: Université de Liegè.

Gaspar, R., Ferreira, J., Carrondo, J., & Silva, M. J. (2016). The use of quartz during the Upper Paleolithic and Early Mesolithic in Sabor valley (NW Iberia): The Foz do Medal case. Quaternary International, 424, 98–112. doi: 10.1016/ j.quaint.2015.10.095.

Gonçalves, V., Sousa, A. C., & Marchand, G. (2013). Na margem do Grande Rio. Os últimos grupos de caçadores-recolectores e as primeiras sociedades camponesas no baixo Guadiana (Memórias d'Odiana – 2 Série). Évora, Portugal: MC/EDIA.

Jorge, S. O. (1999). Domesticar a Terra. As primeiras comunidades agrárias em território Português. Lisboa: Gradiva.

Llana Rodríguez, C. (1990). Algunas consideraciones económicas del Paleolítico superior a través de los cuarzos y cuarcitas de grano grueso. Gallaecia, 12, 29–37.

Manen, C., Marchand, G., & Carvalho, A. F. (2007). Le Néolithique ancien de la péninsule Ibérique: Vers une nouvelle évalation du mirga africain? In J. Évin (Ed.), Un Siècle de construction du discours scientifique en Préhistoire (XXVIe congrès préhistorique de France – Avignon, 21–25 septembre 2004. Vol 3 Aux Conceptions d'aujourd'hui, Issue January 2007, pp. 133–151). Paris: Société préhistorique française.

Mangado Llach, J., Aubry, T., & Sampaio, J. (2006). Los recursos líticos utilizados durante el Paleolítico superior del Valle del Côa (Portugal). Aprovisionamiento, caracterización, gestión e interpretación. In G. Martínez Fernández, A. Morgado Rodríguez, & J. Andrés Afonso Marrero (Eds.), Sociedades Prehistóricas. Recursos Abióticos y Território (Actas de la III reunión de trabajo sobre aprovisionamiento de recursos abióticos en la prehistoria, pp. 159–177). Fundación Ibn al-Jatib de Estudios de Cooperación Cultural.

Marchand, G. (2001). Les traditions techniques du Mésolithique final dans le sud du Portugal: Les industries lithiques des amas coquilliers deVárzea daMó et deCabeçodoRebolador (fouilles M.Heleno). Revista Portuguesa deArqueologia, 4(2), 47–110.

Marchand, G. (2005). Interpretar as mudanças dos sistemas técnicos do Mesolítico final em Portugal. O Arqueólogo Português (4ª Série), 23, 171–196.

Martí Oliver, B., Aura Tortosa, J. E., Juan Cabanilles, J., García-Puchol, O., & Fernández Lopez de Pablo, J. (2009). El Mesolítico geométrico de tipo "Cocina." In P. Utrilla & M. Lourdes (Eds.), El Mesolítico Geométrico en la Península Ibérica Monografías Arqueológicas 44 (pp. 205–258). Zaragoza, España: Universidad de Zaragoza.

Martínez Cortizas, A., & Llana Rodríguez, C. (1996). Morphostructural variables and the analysis of their effect on quartz blank characteristics. In N. Moloney, L. Raposo, & Santonja, M. (Eds), Non – Flint Stone Tools and the Palaeolithic Occupation of the Iberian Peninsula (Vol. 649, pp. 49–53). Oxford: Tempus Reparatum.

Meighan, I. G., Simpson, D. D. A., Hartwell, B. N., Fallick, A. E., & Kennan, P. S. (2003). Sourcing the quartz at Newgrange, Brúna Bóinne, Ireland. In G. Burenhult & S. Westgergaard (Eds.), Stone and bones: Formal disposal of the dead in atlantic Europe during the MesolithiceNeolithic Interface 6000e3000 BC (pp. 247–252). Oxford: Archaeopress.

Meireles, J. (2009). Os primeiros povoadores. A Pré-história Antiga do Minho. In P. Pereira (Ed.), A identidade do Minho (pp. 20–66). Braga: Conselho Cultural da Universidade do Minho.

Meireles, J. (2010). Os últimos caçadores-recolectores da Serra da Cabreira (NO de Portugal). O Abrigo 1 de Vale de Cerdeira (Vieira do Minho). In A. M. S. Bettencourt, M. I. C. Alves, & S. Monteiro-Rodrigues (Eds.), Variações paleoambientais e evolução antrópica no quaternário do ocidente Peninsular (pp. 83–96). Associação Portuguesa para o Estudo do Quaternário, Centro de Investigação Transdisciplinar "Cultura, Espaço e Memória".

Meireles, J. (2013). O Abrigo 1 de Vale de Cerdeira. In A. M. S. Bettencourt, M. I. C. Alves, & S. Monteiro-Rodrigues (Eds.), A PréHistória do Noroeste Português (Arkeos 36, pp. 116–123). Tomar, Portugal: Centro de Pré-História do Instituo Politécnico de Tomar and Braga, Portugal: Centro de Investigação Transdisciplinar "Cultura, Espaço e Memória".

Monteiro-Rodrigues, S. (2011). Pensar o Neolítico Antigo. Contributo para o Estudo do Norte de Portugal entre o VII e o V milénios a. C (Estudos Pré-históricos, 16). Viseu: Centro de Estudos Pré-históricos da Beira Alta.

Monteiro-Rodrigues, S. (2012). Novas datações pelo Carbono 14 para as ocupações holocénicas do Prazo (Freixo de Numão, Vila Nova de Foz Côa, Norte de Portugal). Estudos Do Quaternário/Quaternary Studies, 8, 22–37. http://www.apeq.pt/ojs/index.php/apeq/article/view/20%5Cnpapers3://publication/uuid/8B1AC2C5-1A13-475F-98D3-C1D9A214C589.

Mourre, V. (1996). Les industries en quartz au Paléolithique. Terminologie, méthodologie et technologie. Paléo, 8(1), 205–223. doi: 10.3406/pal.1996.1160.

Mourre, V. (1997). Industries en quartz: Précisions terminologiques dans les domaines de la pétrographie et de la technologie. Préhistoire Anthropologie Méditerranéennes, 6, 201–210.

Neira Campos, A., Fuertes Prieto, N., & Herrero Alonso, D. (2016). The Mesolithic with geometrics south of the "Picos de Europa' (Northern Iberian Peninsula): The main characteristics of the lithic industry and raw material procurement. Quaternary International, 402, 90–99. doi: 10.1016/j.quaint.2015.10.065.

Noronha, F. (1992). Carta geológica de Portugal na escala 1:50,000. Folha6-C (Cabeceiras de Basto). Lisboa: Direcção-Geral de Minas e Serviços Geológicos de Portugal.

Nukushina, D. (2012). Tecno-tipologia lítica e cronometria no Mesolítico final do vale do Sado. O caso do concheiro das Amoreiras (Alcácer do Sal). Lisboa, Portugal: Universidade de Lisboa.

Pereira, T., Bicho, N., Cascalheira, J., Gonçalves, C., Marreiros, J., & Paixão, E. (2015). Raw material procurement in Cabeço da Amoreira, Muge, Portugal. In N. Bicho, C. Nuno, T. D. Detry, & E. Price (Eds.), Cunha, Muge 150th: The 150th anniversary of the discovery of Mesolithic Shellmiddens (Vol. 1, pp. 147–160). Cambridge, United Kingdom: Cambridge Scholars Publishing.

Peyroteo-Stjerna, R. (2020). Chronology of the burial activity of the last hunter–gatherers in the Southwestern Iberian Peninsula, Portugal. Radiocarbon, 63(1), 1–35. doi: 10.1017/RDC.2020.100.

Pignat, G., & Plisson, H. (2000). Le quartz, pour quel usage? L'outillage mésolithique de Vionnaz (CH) et l'apport de la tracéologie. In P. Crotti (Ed.), Meso "97: Actes de la table ronde "Épipaleolithique et Mesolithiqe." Lausanne, 21–23 novembre 1997 (pp. 65–78).

Ramil Rego, E. (1997). La transición del Paleolítico Superior en las Sierras Septentrionales de Galicia. Una aproximación preliminar. II Congresso de Arqueología Peninsular: Paleolítico y Epipaleolítico (Vol. 1, pp. 273–285). Zamora: Fundación Rei Afonso Henriques.

Ramil Rego, E., & Ramil Soneira, J. (1996). El fin de los templos glaciares en Galicia. Magdaleniense y Epipaleolítico. In R. Fábregas Valcarce (Ed.). Os primeiros poboadores de Galicia: O Paleolítico (Cadernos do Seminário de Sagadelos 73, pp. 117–146). Coruña: Edícios do Castro.

Ramil Rego, E., & Ramil Soneira J. (1997). La talla del cristal de roca: Una primeira aproximación experimental. Lancia, 73, 11–22.

Ramil Rego, E., Fuertes Prieto, N., Fernández Rodríguez, C., González Gómez de Agüero, E., & Neira Campos, A. (2021). The Mesolithic in the northwest of the Iberian Peninsula (Galicia, Spain): The state of art. In D. Borić, D. Antonović, & B. Mihailović (Eds.), Foraging Assemblages (Vol. 1, pp. 289–294). Belgrade, Serbia: Serbian Archaeological Society.

Ramos Millán, A. (1984). La identificación de las fuentes de suministro de un asentamiento prehistórico. El abastecimiento de rocas silíceas para manufacturas talladas. Arqueología Espacial, 1, 107–134.

Ramos Millán, A. (1986). La explotación de recursos líticos por las comunidades prehistóricas. Un estudio sobre economía primitiva. Cuadernos de Prehistoria de la Universidad de Granada, 11, 237–272.

Rodríguez Rellán, C. (2010). Unha perspectiva tecnolóxica e experimental das industrias sobre lousa, cristal de rocha e cuarzo na Prehistoria Recente do Noroeste Peninsular. Santiago de Compostela, España: Universidade de Santiago.

Sachanbiński, M., Girulski, R., Bobak, D., & Łydzba-Kopczynska, B. (2008). Prehistoric rock crystal artefacts from Lower Silesia (Poland). Journal of Raman Spectroscopy, 39(April), 1012–1017.

Simões, T. (1999). O sítio neolítico de S. Pedro de Canaferrim, Sintra. Contribuições para o estudo da neolitização da Península de Lisboa. Lisboa: Instituto Português de Arqueologia.

Soares, J. (1995). Mesolítico-Neolítico na Costa Sudoeste: Transformações e Permanências. Trabalhos de Antropologia e Etnologia, 35(2), 27–42.

Soares, J., & Tavares da Silva, C. (2004). Alterações ambientais e povoamento na transição Mesolítico-Neolitíco na Costa Sudoeste. In A. A. Tavares, M. J. F. Tavares, & J. L. Cardoso (Eds.), Evolução geohistórica do Litoral Português e fenómenos correlativos. Geologia, História, Arqueologia e Climatologia (pp. 397–423). Setúbal, Portugal: Universidade Aberta.

Soares, J., Tavares da Silva, C., & Canilho, M. (2005/2007). Matérias-primas minerais e mobilidade logística no Mesolítico da Costa Sudoeste. Os sítios de Samouqueira I e Armação Nova, Musa, 2, 47–62.

Tallavaara, M., Manninen, M. A., Hertell, E., & Rankama, T. (2010). How flakes shatter: A critical evaluation of quartz fracture analysis. Journal of Archaeological Science, 37(10), 2442–2448. doi: 10.1016/j.jas.2010.05.005.

ten Bruggencate, R. E., Fayek, M., Brownlee, K., Milne, B., & Hamilton, S. (2013). A combined visual-geochemical approach to establishing provenance for pegmatite quartz artifacts. Journal of Archaeological Science, 40(6), 2702–2712. doi: 10.1016/j.jas.2013.02.008.

ten Bruggencate, R. E., Fayek, M., Milne, B., & Brownlee, K. (2014). Characterizing quartz artefacts: A case study from manitoba's Northern Boreal Forest. Archaeometry, 56(6), 913–926. doi: 10.1111/arcm.12092.

Xavier, P., & Alves, C. (2019). Non-destructive studies of prehistoric lithic material culture in the search for sources of geologic raw materials: An overview of techniques and issues. Cadernos Do Laboratorio Xeoloxico de Laxe, 41, 123–140.

doi: 10.17979/cadlaxe.2019.41.1.5820.

Zilhão, J. (2000). From the Mesolithic to the Neolithic in the Iberian Peninsula. In T. D. Price (Ed.), Europe's first farmers (pp. 144–182). Cambridge: Cambridge University Press.

Zilhão, J. (2003). Algumas observações acerca do Mesolítico do Interior Peninsular e do modelo de passagem ao Neolítico através de colonização pioneira por via marítima. Comentário ao artigo: "A emergência do Neolítico no actual território português: Pressupostos teóricos, modelos interpretativos e a evidência empírica." In de A. F. Carvalho (Ed.), O Arqueólogo Português (série IV, 21, pp. 108–118). Lisboa: Museu Nacional de Arqueologia.

Zilhão, J. (2004). The Mesolithic of Iberia. In Ancient Europe 8000 B.C.–A.D.1000: Encyclopedia of the Barbarian World (Vol. I, pp. 157–164). New York: Charles Scribner's Sons.

Zilhão, J. (2011). Time is on my side. In A. Hadjikoumis, E. Robinson, & S. Viner (Eds.), The Dynamics of Neolithisation. Studies in honour of Andrew Sherrat (pp. 46–65). Oxford, United Kingdom: Oxbow Books. doi: 10.1016/j.jacr.2016.08.001.