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RESEARCH

# Raw Materials and Lithic Production During the Early Magdalenian in Cantabrian Spain: Cova Rosa (Ribadesella, Asturias)

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**Abstract**

The lithic assemblage studied here comes from Cova Rosa, one of the main Upper Palaeolithic sites in Asturias (northern Spain). The remains were found in Layer B5, which was excavated by F. Jordá Cerdá and A. Gómez Fuentes in 1978 and are associated with an osseous assemblage and archaeozoological remains. This occupation has been dated by radiocarbon to about 16,400 BP (*ca*. 19.8–19.6 ka cal BP), corresponding to Archaic/Lower Magdalenian. The present study combines the determination of the raw materials and the identification of the production systems to achieve an understanding of the management of lithic resources by hunter-gatherer groups in the Late Pleistocene. The sourcing of mostly local materials (mainly Piloña flint), the wide variety of rock types of diverse provenances (up to 10 types), and the presence of well-represented lithological tracers (Flysch, Chalosse) turn Cova Rosa into an important case for studying different lithic raw material procurement models. The predominance of microlaminar production and the variability in the exploitation strategies used to obtain backed tools, as well as the poor standardisation of flake production, follow the dynamics observed in other occupations of similar chronology in a wide geographical area that includes Cantabrian Spain and south-west France.

**Keywords** Late Pleistocene · Magdalenian · Sella valley · Raw material procurement · Lithic technology

## Introduction

Occupations in northern Spain dated between the end of the Solutrean and the Early Magdalenian (21.5–18.0 ka cal BP) have been interpreted in different ways: (1) as continuity with the Solutrean; (2) as a break from the previous period, including those traditions well-defined in south-west France, such as the Badegoulian; and (3) as an archaic phase of the Magdalenian. In any case, the evolutionary relationships between Solutrean, Badegoulian, and Magdalenian are complex and difficult to address with regional data.

In the levels dated *ca*. 20.0–19.0 ka cal BP in the cave of Las Caldas (Asturias), continuity with the Solutrean has been observed in the form of leaf-shaped artefacts. The

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scarcity of *raclettes* and the small number or absence of transverse burins indicated that those levels were unrelated to the French Badegoulian (Corchón et al., 2015). Other researchers, however, thought that the presence of leaf-shaped objects in those levels might be the consequence of an intrusion from the Solutrean levels (Aura Tortosa et al., 2012). Because of the presence of *raclettes*, those levels were attributed either to the Badegoulian (Aura Tortosa et al., 2012; Bosselin, 2000) or to the Archaic Magdalenian (Utrilla, 2004).

The use of local raw materials and the presence of *raclettes*, added to the high number of common tools (retouched flakes, notches, denticulates, sidescrapers and splintered pieces), have been used to support the existence of the Badegoulian in Cantabrian Spain (Aura Tortosa et al., 2012; Bosselin, 2000). Nonetheless, the small number of those artefacts and the disparity of the tools accompanying them, including backed tools, have been factors that refute the presence of that phase in the region (Corchón et al., 2015). The Level III at Llonín (Galería) (Asturias) has provided decisive taphonomic, techno-economic and chronological data for a better understanding of the Solutrean-Badegoulian transition and its definition, with radiocarbon dates and techno-typological features compatible with those described in southern France and the Mediterranean region (Rasilla et al., 2019).

In Level 4 at El Cierro (Asturias) (F. Jordá Cerdá's 1950s excavations), finds of *raclettes* and the abundance of substrate tools originated a discussion about its chrono-cultural attribution either to the Type A Badegoulian (with few *raclettes*) (Bosselin, 2000) or to the Archaic Magdalenian (Álvarez-Alonso & Andrés-Herrero, 2012; Aura Tortosa et al., 2012; Utrilla, 2004). *Raclettes* and a burin with a lateral truncation in Level 5 at El Rascaño (Cantabria) were used to attribute it to the Archaic Magdalenian. Several *raclettes* and a transverse burin appeared in occupations above the Solutrean levels in La Riera (Asturias). The absence of these elements at El Mirón (Cantabria) led researchers to propose that the levels between the Solutrean and the Lower Magdalenian were not Badegoulian (Straus et al., 2014). These sites are probably related to the end of the Badegulian and the "formation" of the Magdalenian, an interface in the process of definition (Ducasse, 2012; Langlais, 2020).

The typological composition has largely guided the debate. However, technological data, to which the information in the present study should be added, is able to define the techno-economic traditions reflected in the lithic assemblages belonging to this time in northern Spain.

This study presents the first results of the analysis of the lithic assemblage from Layer 5 in Level B (Cova Rosa B5). These artefacts were excavated by F. Jordá Cerdá and A. Gómez Fuentes in 1978. The main objective of the present work is to document and better understand the lithic resource management by the Early Magdalenian hunter-gatherers in northern Spain. The raw materials are described followed by the determination of the provenance of the flint objects. The technological study will then identify the reduction schemes in both flint and quartzite. Finally, the results are compared with published data from sites in northern Spain and south-west France. The available radiocarbon dates allow Cova Rosa B5 to be ascribed to the Archaic/Lower Magdalenian.

## Cova Rosa

### Location and Fieldwork

Cova Rosa is located at the eastern end of the Asturian Massif in the Cantabrian Mountains. Its geographic coordinates (ETRS89) are:43° 26′ 37″ N and 5° 07′ 58″ W. With its entrance facing south-west, the cave is found at about 4 km in a straight line from the modern coastline and about 5.5 km from the left bank of the estuary of the River Sella (Fig. 1). The large rock-shelter ahead of the cave, which contains the archaeological deposit, is located 149 m a.s.l., at the bottom of an endorheic depression and at the foot of Peña Pagadín (417 m), a limestone hill, towards the south, which encloses a small blind valley.

F. Jordá Cerdá explored Cova Rosa in 1957 and in the following year began to clean up and straighten a section in a trench left by unknown looters. He also excavated an area of 3 × 1 m, differentiating two occupations, attributed to the Lower Magdalenian and Upper Solutrean, respectively (Jordá Cerdá 1960, 1963, 1977). In 1964, a new area of 3 × 0.75 m was excavated next to the previous one. Three different archaeological levels were identified, and the chronology established in 1958 and 1959 was confirmed (Álvarez-Fernández et al., 2015, 2019b, 2020b).

From 1975 to 1979, F. Jordá Cerdá and A. Gómez Fuentes excavated the deposit (Fig. 2). An area of over 13 $m^2$ was excavated by removing thin successive layers, following the dip of each level. The archaeological levels that were documented were called Cova Rosa A and Cova Rosa B. Square D4 was excavated in depth, reaching nearly 2 m, to collect more precise data about the Magdalenian and Solutrean occupations defined in the previous decades. The archaeological remains studied to date came from Cova Rosa A0, in a time of transition between the Upper-Final Magdalenian and the Azilian (Jordá Cerdá & Gómez Fuentes, 1982), and Cova Rosa B6, dated by radiocarbon and ascribed to the Lower Magdalenian (Álvarez-Fernández et al., 2019a).

Archaeological fieldwork in 2017 and 2019 began by cleaning the excavated areas and the stratigraphic sections that had been preserved. The rock-shelter and area of the excavations were surveyed, the stratigraphic sequence was

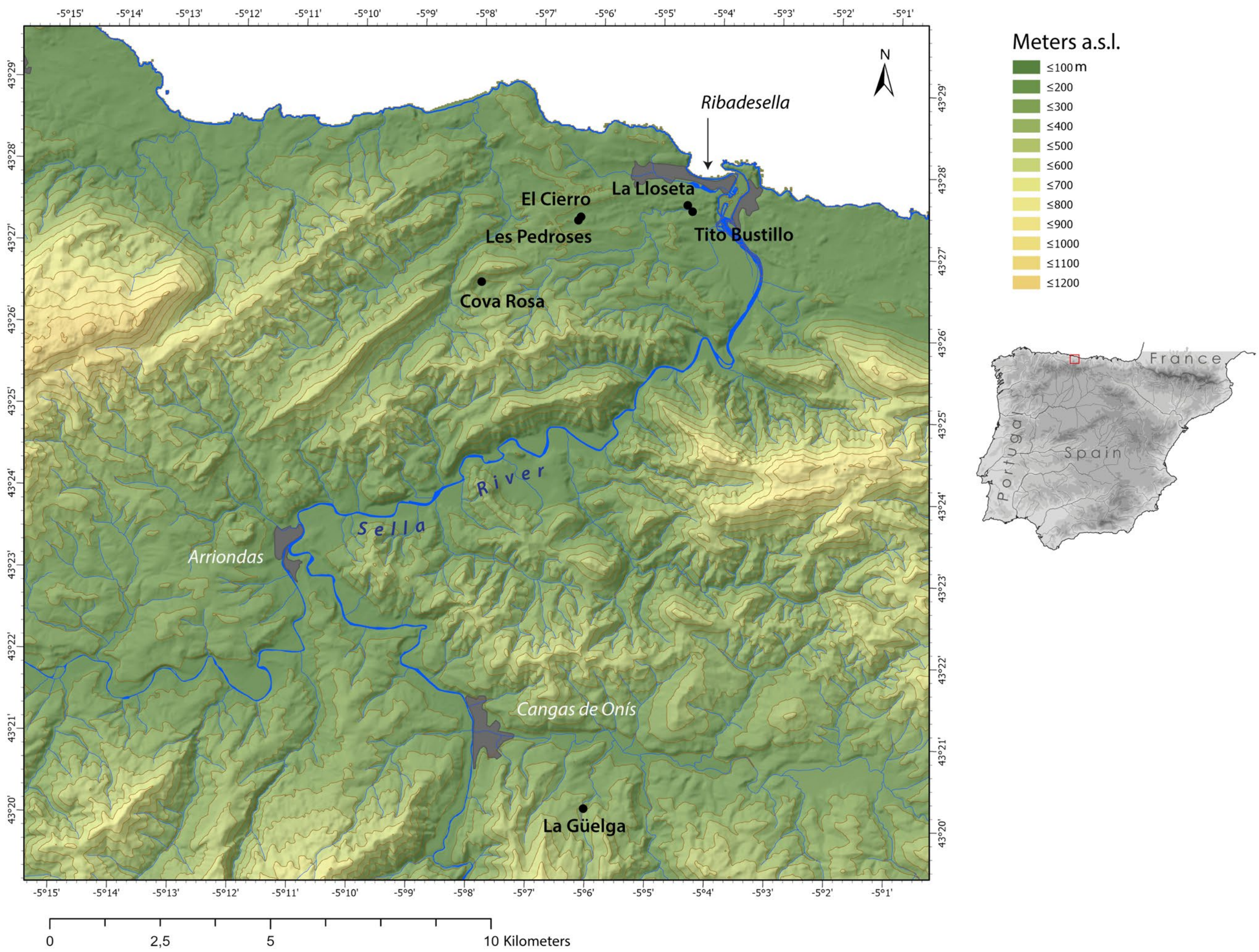


**Fig. 1** Map of the Sella river basin marking the archaeological sites with Early Magdalenian occupations, including Cova Rosa (map by L. C. Teira, modified by Álvarez-Fernández et al., 2021)

described, and samples were taken for geoarchaeological, palaeopalynological and palaeomagnetic analyses. The levels recorded in the first fieldwork (in the 1950s and 1960s), during the extensive excavation and test-pit in Square D4 (1970s), and in the most recent fieldwork were compared and correlated (Álvarez-Fernández et al., 2021; Jordá Pardo et al., 2022).

## Stratigraphy

Square D4 is in the south-east part of the site, near the cave entrance, on the boundary between the extensive excavation and the trench dug by looters. In the 1978 and 1979 excavations, helped by the geologist M. Hoyos Gómez, the archaeologists defined a series of arbitrary layers called, from top to bottom: Layer A0, "Transition A-B", Layers B2 to B8, "L–H-M-Hoyos (1–1979)", 1st level Upper Solutrean" and Layers IX, X and XI. Level Cova Rosa B, which includes all the layers named with that letter and numbers that increase from top to bottom of the sequence, revealed evidence of intense human activity in the form of a large volume of archaeological remains: mainly lithic and faunal remains.

In 2019, the stratigraphy was reviewed by cleaning the south section in Squares D6, D5 and D4 and the east section in Square D4, from the 1975–1979 excavations, allowing to obtain samples for dating from Square D4. Seven archaeological levels, CR1bis to CR6, were identified and described, as well as dated (Fig. 3).

Level CR2, between 25 and 42 cm thick, comprises a grey silty-clayey matrix with polyhedral limestone pebbles. It is probably an Early Magdalenian horizon, with two occupation phases, associated to Archaic/Lower Magdalenian and Lower Magdalenian, respectively. The older occupation in Level CR2 correlates with Layer B5 in the 1975–1979 excavations (Álvarez-Fernández et al., 2021; Jordá Pardo et al., 2022).

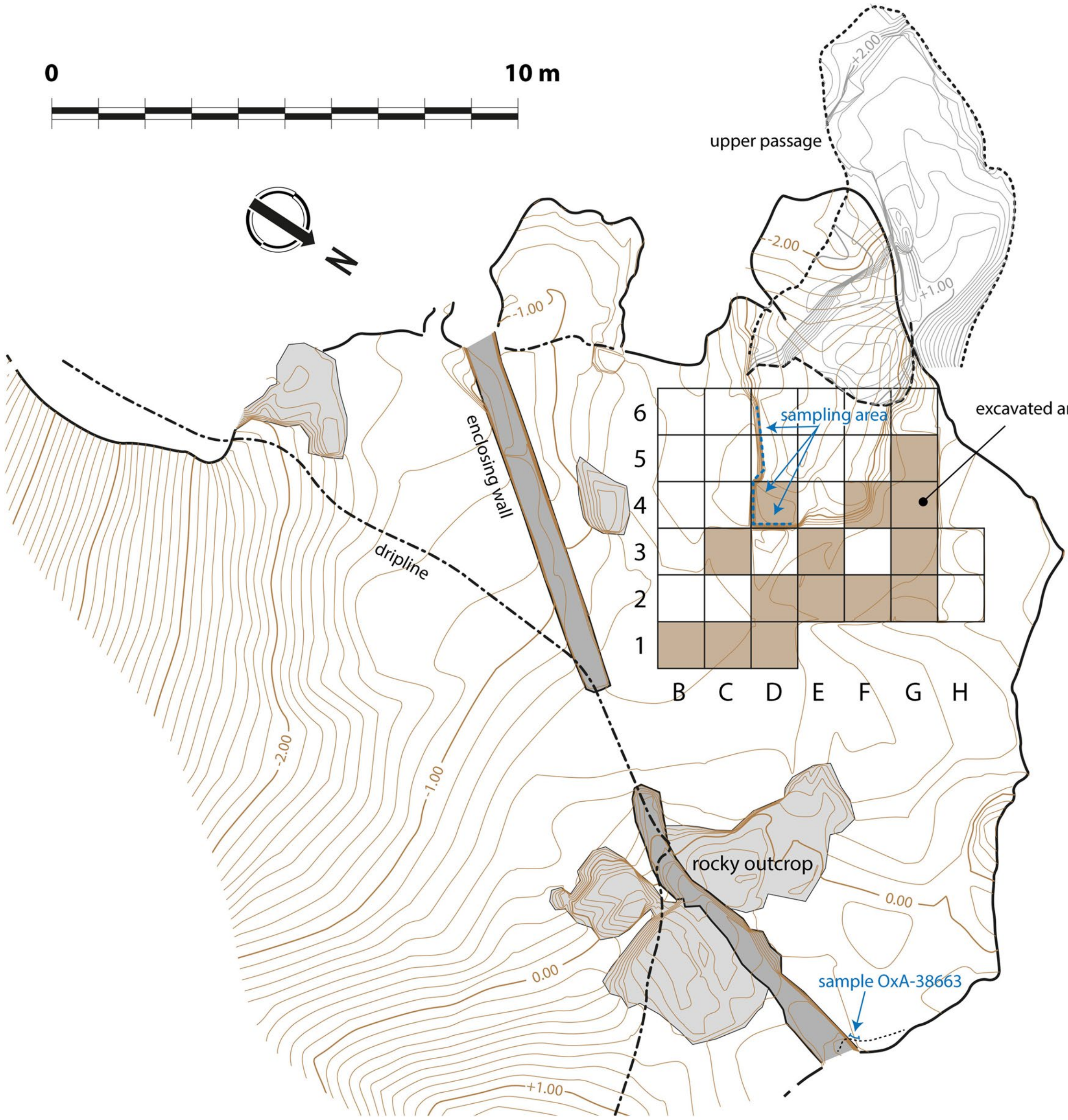


**Fig. 2** Plan of Cova Rosa, showing the fieldwork area and reproducing the information about the excavations in the 1970s. It shows the approximate place of the excavations carried out by F. Jordá Cerdá in the late 1950s and in 1964 (plan by L. C. Teira, by Álvarez-Fernández et al., 2021)

## AMS-$^{14}$C Dates

Twelve radiocarbon dates have been obtained for the Square D4 stratigraphic sequence; five from materials excavated in 1975–1979 and seven from the 2019 fieldwork. A date from the former group came from Layer B5 and two of the 2019 samples from the middle of Level CR2, in the south and east sections, respectively (Fig. 3; Table 1).

The Bayesian model dates Layer B5 and Level CR2 between *ca*. 19.8 and 19.6 ka cal BP, with 68.2% probability (Álvarez-Fernández et al., 2021).

These two dates for Level CR2 and their correlation with Layer B5, in the period *ca*. 20.0–19.5 ka cal BP, locates this occupation in a slightly warmer phase of Greenland Stadial 2 (GS2b), which was followed by a temperature drop.

## Methodology

### Raw Materials

The study of the lithic raw materials has focused on the description and provenance of the flint materials. The analytical and classification protocol was based on previous proposals (Herrero-Alonso, 2018; Herrero-Alonso et al., 2021; Tarriño, 2006; Tarriño & Terradas, 2013; Tarriño

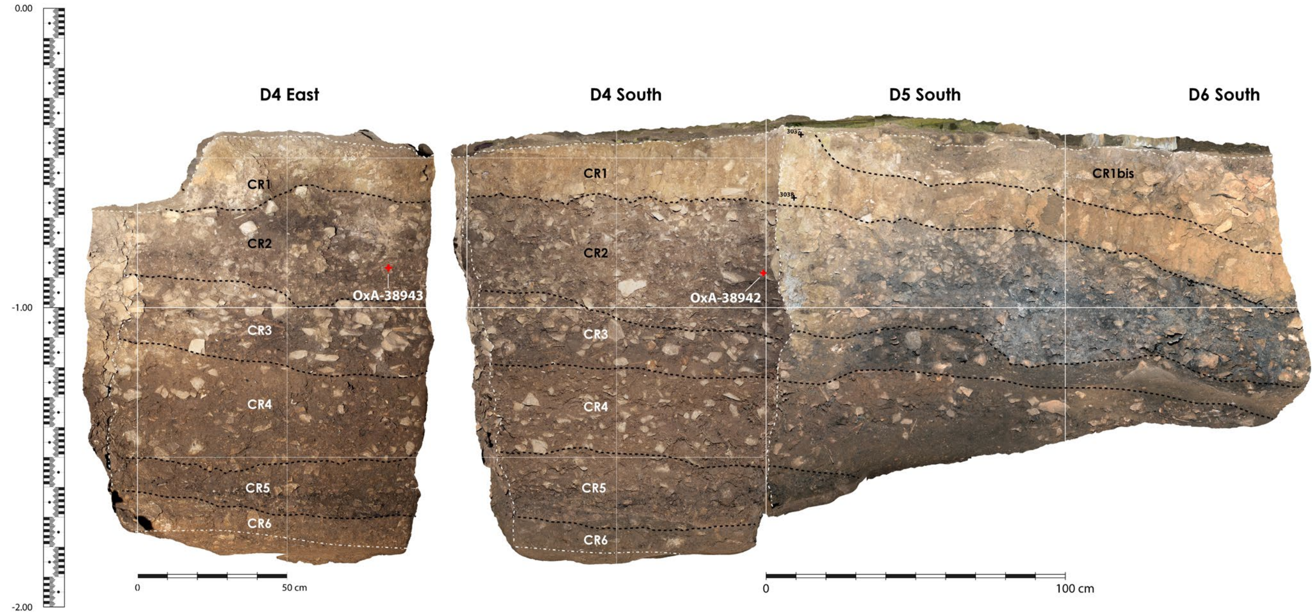


**Fig. 3** Orthophotographs and stratigraphy of the east and south sections in Square D4 at Cova Rosa, marking the samples for.$^{14}$C dating (image by L. C. Teira, modified by Álvarez-Fernández et al., 2021)

**Table 1** AMS-$^{14}$C dates for Layer B5 (1975–1979 excavations) and Level CR2 (2019 fieldwork) at Cova Rosa (Álvarez-Fernández et al., 2021)

| Square | Level | Split | Sample | Lab. Ref. | $^{14}$C | St. Dev. |
|---|---|---|---|---|---|---|
| Excavations 1975-1979 | | | | | | |
| D4 | B | 5 | Bone-Metatarsal with cut marks (*C. elaphus*) | OxA-38269 | 16400 | 90 |
| Fieldwork 2019 | | | | | | |
| D4 (S) | CR2 | – | Bone-Metacarpal (*C. elaphus*) | OxA-38942 | 16408 | 65 |
| D4 (E) | CR2 | – | Bone-Metacarpal (*C. elaphus*) | OxA-38943 | 16360 | 64 |

| | Calibrated (BP) | | | |
|---|---|---|---|---|
| | 68.24 % | | 95.46 % | |
| | from | to | from | to |
| Excavations 1975-1979 | | | | |
| OxA-38269 | 19890 | 19610 | 20050 | 19550 |
| Fieldwork 2019 | | | | |
| OxA-38942 | 19890 | 19620 | 19990 | 19570 |
| OxA-38943 | 19840 | 19620 | 19910 | 19550 |

et al., 2007, 2015, 2016). The most representative examples of each flint type were compiled to reflect the raw material variability used at Cova Rosa. Types were identified by *de visu* observation and the analysis of their external surfaces using a stereoscopic microscope. This approach to the study of lithic raw materials was applied previously for the nearby site of Tito Bustillo (Asturias) (Martín-Jarque et al., 2022). Through *de visu* observation, the colour, gloss, transparency, texture and cortex of the remains were recorded. Then, the composition of the quartz matrix and the different inclusions, both mineral (detritic quartz, carbonates, sulphates and oxides) and organic (bioclasts) were identified microscopically.

The lithic raw materials can be classified according to the distance between their outcrops or the potential sources for their supply and the archaeological deposit being studied.

In this way, three procurement models have been proposed (Tarriño et al., 2016): (1) local resources: those found in a radius of a half a day walking distance, less than 30 km. This model is divided into proximate local (< 15 km) and distant local (< 30 km); (2) regional resources: sub-divided into proximate regional within distances equivalent to a day and a half (30 to 60 km) and distant regional for those at a distance that can be covered in three days (60 to 120 km); and (3) tracer resources: those transported over more than three-day walking distances (120 to 250 km). Raw materials that require over a week's walk to procure them, covering distances over 250 km, are known as super-tracers.

### Technology and Typology

The lithic assemblage has been analysed from a technological (Perlès, 1991; Inizan et al., 1995; Pelegrin, 2000) and typological perspective (Sonneville-Bordes & Perrot, 1954, 1955, 1956a, 1956b). The aim was to define the production systems used in lithic reduction by the human groups that occupied Cova Rosa, differentiating between supported and hand-held percussion techniques. Supported percussion can be defined as the process in which in the material is struck while it is resting on a surface, either the ground or an anvil. Hand-held percussion refers to reduction while the material is held and is not supported on any surface.

Several categories have been discriminated based on the objectives for which they were produced, following the operational chain principles. The criteria considered to study these groups were specified and applied in previous research (Vadillo Conesa, 2018; Vadillo Conesa & Aura Tortosa, 2020). The first category includes cores or pieces with evidence of having been worked. The second category refers to the products of debitage: flakes and blades. Maintenance products form a third category, including objects related to actions aimed at creating a shape suitable for reduction, either in the initial phase or during the debitage process. The fourth category contains the retouched artefacts, which have been classified with the type list of D. de Sonneville-Bordes and J. Perrot. Finally, the debris or knapping waste (elements with a conchoidal fracture < 1 cm in size) and indeterminate fragments caused by thermal alterations or fractures have been grouped in a single category.

## Results

The lithic assemblage recovered from Cova Rosa B5 consists of 9444 remains, from which fragments of mineral (hematite) and pebbles (quartzite) without evidence of possible anthropogenic alterations have been excluded.

The knapped lithics are therefore represented by 9,433 remains. Three main groups of raw materials have been differentiated: flint and quartzite, and few quartz artefacts. The flint assemblage is much larger, with 5711 remains (60.5%), and quartzite is represented by 3708 remains (39.3%). The quartz group only comprises 14 remains (0.2%). Because of this small number, it was not possible to identify the production systems employed with that raw material.

### Raw Materials

The description and study of the provenance of the flint considered 909 remains (Table 2). The sample included all the types of remains, except for indeterminate pieces and debris, excluding a total of 306 objects, because their small size does not allow a clear identification. The flint type was determined in the case of 855 objects (94.1%) and 10 types were defined: Alba radiolarite, Piloña flint, Fito chert, Las Portillas chert, Monte Picota flint, Urgonian flint, Flysch flint, Treviño flint, Salies-de-Béarn flint and Chalosse flint (Fig. 4).

#### Local Resources

**Alba Radiolarite** The use of Alba radiolarite, with seven cases (0.77%), is quite limited bearing in mind its wide geographic distribution in the Cantabrian Zone. It formed in the Visean (Lower Carboniferous) in deep marine basin environments and outcrops in the middle and upper members of the Alba Formation (Wagner et al., 1971). The presence of this raw material has been known since the late twentieth century, while it was described more recently (Herrero-Alonso, 2018; Herrero-Alonso et al., 2021). Most of the Alba radiolarite identified at Cova Rosa comes from the middle member, characterised by very regular parallel laminations and the presence of radiolarians. The joint extinction of phyllosilicates can also be seen in thin sections.

**Piloña Flint** Piloña flint was the most used siliceous raw material with 435 specimens (47.86%). Formed in Santonian limestone (Upper Cretaceous) in external marine platform environments, it outcrops in the valley of the River Piloña, a tributary of the River Sella, but also appears in a secondary position in Eocene–Oligocene continental conglomerates, like the Posada pudding-stone, in the Oviedo Basin (Asturias). This flint was described a decade ago (Tarriño et al., 2013b) because of its common presence at Asturian Palaeolithic sites (Duarte et al., 2016; Tarriño et al., 2015). Piloña flint is characterised by a matrix with a micro-cryptocrystalline grain size and occasional fibrous quartz cement. A large quantity of detritic quartz and the sporadic appearance of benthic foraminifera (*Lacazina* genus) stand out among the inclusions.

**Table 2** Technological categories and provenance of the flint assemblage from Cova Rosa B5

| Technological categories | Types of flint | | | | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alba | Piloña | Fito | Portillas | Mt. Picota | Urgonian | Flysch | Treviño | Salies | Chalosse | Indeterminate | |
| Cores | 1 | 29 | 0 | 0 | 6 | 15 | 7 | 0 | 0 | 0 | 6 | 64 |
| Flakes | 4 | 127 | 1 | 1 | 36 | 29 | 11 | 0 | 1 | 7 | 18 | 235 |
| Microblades | 0 | 56 | 0 | 0 | 22 | 22 | 23 | 1 | 0 | 5 | 8 | 137 |
| Maintenance products | 0 | 13 | 0 | 0 | 6 | 6 | 4 | 0 | 0 | 1 | 1 | 31 |
| Retouched objects | 1 | 69 | 1 | 0 | 20 | 21 | 19 | 1 | 0 | 2 | 2 | 136 |
| Indeterminate pieces and debris | 1 | 141 | 0 | 0 | 49 | 61 | 25 | 1 | 0 | 9 | 19 | 306 |
| Totals | 7 | 435 | 2 | 1 | 139 | 154 | 89 | 3 | 1 | 24 | 54 | 909 |

**Fito Chert** Fito chert is scarcely represented with only two pieces (0.22%). It outcrops at the head of the River Ponga, another tributary of the River Sella, in carbonate facies of the Podolskian/Myachkovian (Upper Carboniferous) and formed in the transition from a prograding delta to a subsiding platform. There are few references to silicifications in this geological formation, as they are only mentioned in a single report (Bahamonde, 1989), and their first description is quite recent (Herrero-Alonso, 2018; Herrero-Alonso et al., 2021). Fito chert is characterised by lenticular lamination with frequent bioclasts and dolomite idiomorphic crystals, marked by easily recognisable brownish and blackish colour.

### Regional Resources

**Las Portillas Chert** The use of Las Portillas chert is documented by a single piece (0.11%). This chert formed in a shallow marine platform during the Famennian-Tournaisian transition (Devonian-Lower Carboniferous) and outcrops in a very specific part of northern Spain near Espinama (Cantabria). As in the case of Fito chert, there are few references to those silicifications, except for one study (Raven, 1983) and this raw material has only been described recently (Herrero-Alonso, 2018; Herrero-Alonso et al., 2021). Las Portillas chert is characterised by a homogeneous matrix with an intense vitreous lustre and the frequent presence of detritic accessory minerals (quartz, tourmaline, zircon, etc.).

**Monte Picota Flint** Monte Picota flint is represented by 139 pieces (15.29%). This raw material formed in an internal marine platform in the Maastrichtian (Upper Cretaceous). Its main outcrop is in the Santillana-San Román syncline, near Monte Picota on the coast to the west of Santander (Cantabria). This flint type is found in many of the Cantabrian Palaeolithic sites that have been studied (Tarriño, 2016; Tarriño et al., 2013a), but was only recently described (Herrero-Alonso, 2018). Monte Picota flint is characterised by a chalcedonitic matrix with abundant microgeodes and fissures cemented by fibrous quartz and megaquartz, as well as the usual dolomite idiomorphic crystals.

**Urgonian Flint** Urgonian flint is one of the most abundant flint types, with 154 remains (16.94%). It formed in the carbonate reef platforms in the Aptian-Albian (Lower Cretaceous) (Bustillo et al., 2017) and appears in the Urgonian complex, widely distributed in the Basque-Cantabrian Basin (Tarriño, 2006). Despite the great potential of the Urgonian complex to contain flint, this raw material has been occasionally exploited due to its limited knapping properties (Tarriño et al., 2015, 2016). Urgonian flint is characterised by an abundance of rudists and corals, both massive and branching, among many other identifiable fossils.

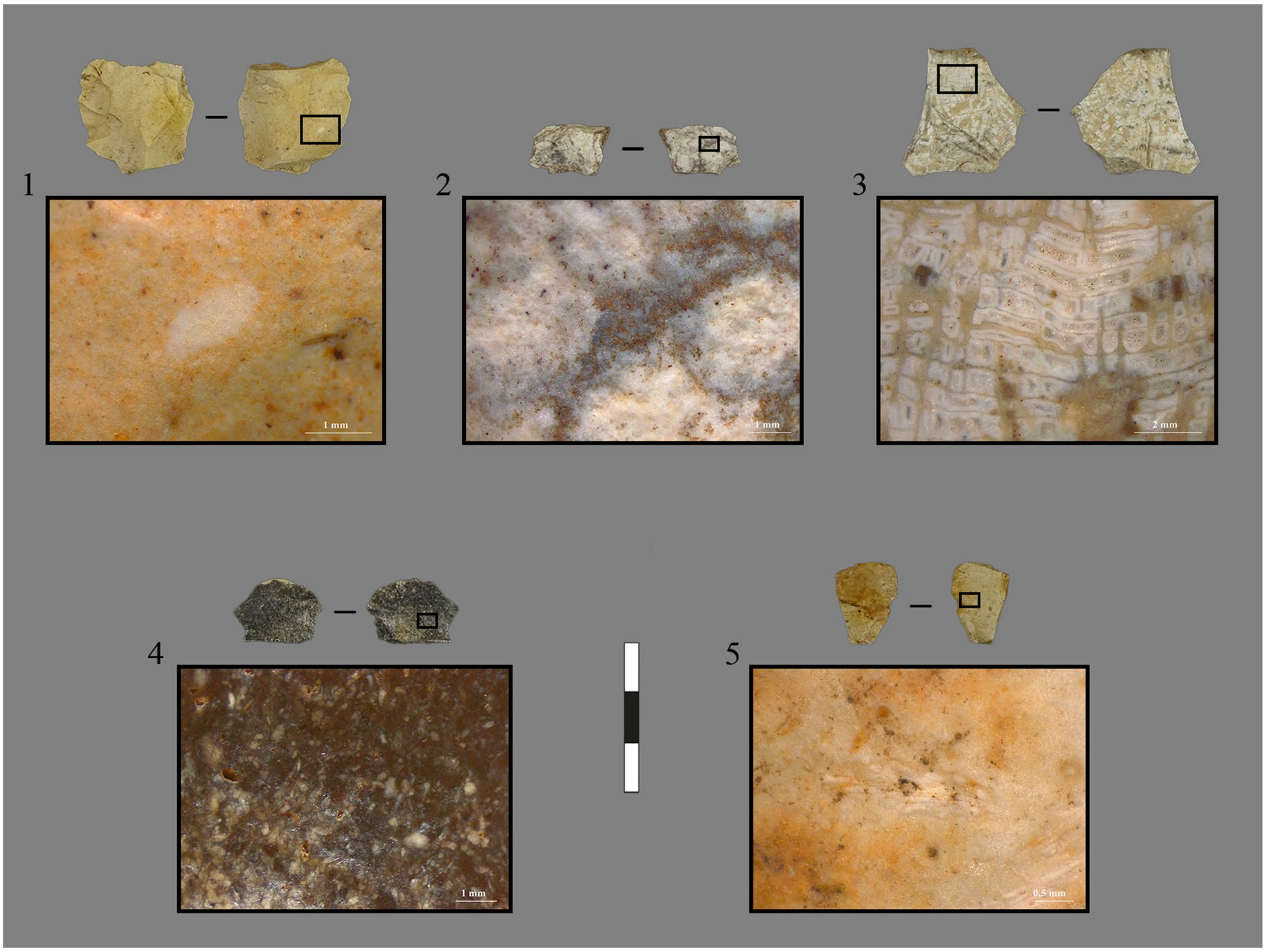


**Fig. 4** Samples of the most represented flint types in Cova Rosa B5. **1** Piloña flint. Micro-cryptocrystalline texture with benthic foraminifera (*Lacazina* genus). **2** Monte Picota flint. Texture with a chalcedonitic composition dominated by oxide inclusions, with patina. **3** Urgonian flint. Texture formed by a tabular coral with fibrous quartz cement, with patina. **4** Flysch flint. Bioclastic texture with multiple longitudinal and axial sections of sponge spicules. **5** Chalosse flint. Texture zoned by the patina with an alga (Dasycladaceae family)

## Tracer Resources

**Flysch Flint** Flysch flint is well represented by 89 remains (9.79%). This raw material comes from turbiditic geological formations deposited in deep water at the foot of the slopes connecting marine platforms with the pelagic ocean floor. Several varieties have been discriminated corresponding to outcrops on both sides of the Pyrenees. The Kurtzia variety, the only one definitely identified at Cova Rosa, dated in the Cenomanian-Santonian (Upper Cretaceous), has been described in a very specific part of the coast near Barrika (Biscay, Basque Country) (Tarriño, 2006). It is one of the main lithological tracers in northern Spain as it has been documented in practically all the Palaeolithic deposits studied in the region (Tarriño et al., 2007, 2015, 2016). Kurtzia Flysch flint displays a characteristic turbiditic lamination in a generally translucent matrix affected by the stigmas of powerful marine abrasion. The inclusions include a large amount of detritic quartz, sponge spicules and organic matter.

**Treviño Flint** Treviño flint was a rarely used raw material, as only three pieces have been identified (0.33%). It formed in a lacustrine-palustrine environment in the Miranda-Treviño Depression, associated with the Aquitanian (Miocene). It outcrops in the hills of the Sierra de Araico and extends to the north into the Cucho-Busto Hills (between the provinces of Alava in the Basque Country, and Burgos, in Castilla y León) (Tarriño, 2006). It is an important lithological tracer as it reached a large number of Palaeolithic sites studied in North Spain (Tarriño et al., 2007, 2015, 2016). Treviño flint is characterised by typical fossils of continental environments (gastropods, ostracods, pedotubules, etc.).

**Salies-de-Béarn Flint** The use of Salies-de-Béarn flint was extremely limited with a single identified piece (0.11%). This raw material formed in a carbonate series of the Campanian (Upper Cretaceous) that outcrops in the Peyrehorade anticline, near the town of Orthez (Pyrénées-Atlantiques, France), associated to a deep marine basin (Normand, 2002). It is found mainly at Palaeolithic sites on both sides of the Western Pyrenees (Tarriño et al., 2007, 2015, 2016). Salies-de-Béarn flint is characterised by bioturbations rich in carbonate relicts that create a zoned outer appearance. Planktonic foraminifera (*Globigerina* genus) are often present.

**Chalosse Flint** Chalosse flint is well represented by 24 artefacts (2.64%). This lithic resource formed in an outer marine platform in the Maastrichtian (Upper Cretaceous), outcrops in a sector of the Audignon-Montaut anticline and on the edges of the Bastennes-Gaujacq diapir, between the towns of Orthez, Dax and Mont-de-Marsan (Landes, France) (Chalard et al., 2010). It was described before the primary outcrops were discovered (Bon et al., 1996), as it is one of the most important lithological tracers north of the Pyrenees and is documented in numerous Palaeolithic sites, also to the south (Tarriño et al., 2007, 2015, 2016). Chalosse flint is characterised by an external zoned appearance, when displaying patina, and large bioclasts, particularly bryozoans, algae and benthic foraminifera (*Lepidorbitoides* genus).

### Indeterminate Resources

Some flint artefacts could not be assigned to a precise provenance because of different processes hindering their determination. Five flint objects (0.55%) have the external appearance altered to varying extents (burnt, white patinas, etc.) generating microfissures, colour changes and porosity. Forty-nine pieces (5.39%) remained undetermined either because the matrix surface is too small or because it is simply absent.

The largest group, formed by 37 artefacts, is a variety with a bioclastic matrix containing unidentified benthic foraminifera and detritic quartz that cannot be associated to any of the known flint types. Ten artefacts display a matrix generally affected by alteration with benthic foraminifera (*Fusulina* genus) and idiomorphic dolomite crystals. These remains might correspond to Escalada chert (Fuertes-Prieto et al., 2016), although there are other formations, such as Tendeyón or Bachende, which may also contain fusulinids (Herrero-Alonso et al., 2021). Two remains display a matrix texturally compatible with a laminated black chert or with a fine variety of Alba radiolarite.

## Technology and Typology

The technological and typological study of the lithic assemblage included 9419 remains (Tables 3 and 4), consisting of all flint and quartzite materials, that had been modified. The production systems have been separated by raw materials.

**Table 3** Lithic assemblage from Cova Rosa B5 technologically analysed (note that the technological study excludes both quartz remains and elements classified as pebbles/nodules)

| Technological categories | Raw materials | | | Totals |
|---|---|---|---|---|
| | Flint | Quartzite | Quartz | |
| Pebbles/nodules | 0 | 3 | 0 | 3 |
| Cores | 64 | 10 | 0 | 74 |
| Flakes | 235 | 349 | 0 | 584 |
| Microblades | 137 | 40 | 4 | 181 |
| Maintenance products | 31 | 9 | 0 | 40 |
| Retouched objects | 136 | 0 | 0 | 136 |
| Indeterminate pieces and debris | 5108 | 3300 | 10 | 8418 |
| Totals | 5711 | 3711 | 14 | 9436 |

**Table 4** Typological inventory of retouched artefacts in the lithic assemblage from Cova Rosa B5

| Type-list | Retouched objects | |
|---|---|---|
| | *n* | % |
| Notched piece | 1 | 0.7% |
| Denticulated piece | 2 | 1.5% |
| *Raclette* | 17 | 12.5% |
| Triangle | 62 | 45.6% |
| Backed bladelet | 22 | 16.2% |
| Fragment of backed bladelet | 32 | 23.5% |
| Total | 136 | 100.0% |

### Production Systems in Flint

The objective of the production in flint was to obtain elongated blanks to make armatures. Most of the flint artefacts are classified as indeterminate pieces and debris, with 5108 remains (89.4%). Only 603 remains (10.6%) can be attributed to different phases of the operational chain.

**Kombewa Flakes** Thick cortical flakes produced in the first phases of the reduction of cores were used to obtain Kombewa flakes (Fig. 5 (1) and (2)). Also, these original cores continued to be used to obtain microblades to be shaped into armatures.

The purpose of the production of Kombewa flakes was to create very specific artefacts: *raclettes* (Fig. 5 (3) and (4)).

### Production of Microblades

A. Carinated microblades


**Fig. 5** Production systems in flint. **1**, **2** Cores used to obtain flakes. **3**, **4** *Raclettes*. **5**–**7** Cores used to obtain carinated microblades. **8**–**10** Backed bladelets on carinated blanks. **11**, **12** Cores worked on a wide face. **13**, **14** Pyramid or carinated-endscraper cores. **15**–**21** Backed elements on short and wide flat blanks

A certain diversity of debitage modalities is observed, also identifying those of "*caréné sur tranche ou fronts d'éclats*" types (Ducasse & Langlais, 2007). Carinated microblades 4 or 5 mm wide were obtained through at least two modalities from flake-cores, with different reduction stages. The flakes are obtained from cores whose complete exploitation could not be recognised. In all cases thick and some cortical, linked to the first phases of debitage, whereas those without cortex are associated with the main phase of the core reduction.

A1. Removals were taken from the narrow sides or flanks of the flakes. In both cases, either percussion platforms were prepared or natural flat surfaces were used for percussion, such as the butts of the original flakes. Total crests were shaped to create an arris-guide for the knapping surface and as longitudinal convexity (Fig. 5 (5)).
A2. In some cases, supported reduction (bipolar) was used on the flanks of flakes, as the characteristic splintering can be observed. The products of this system are very often polyhedral microblades or *bâtonnets* (Fig. 5 (6)).
A3. These products were sometime obtained from flakes with prepared platforms by small removals that created a retouched face from which tools of the transverse burins were obtained (Fig. 5 (7)).

In all cases, these are short production systems that required little or no investment in the preparation of the cores, from which few products were obtained.

These elongated lateral blanks were retouched to create backed bladelets with parallel and straight sides (Fig. 5 (8–10)).

B. Flat and short microblades

Reduction was also aimed at obtaining short, central or flat microblades, about 5 mm wide. Their shape occasionally resembled laminar flakes, and in some cases, they are twisted with convergent distal ends. The purpose of this system was to shape blanks for backed elements, often triangular (Fig. 5 (15–21)). Two strategies have been found:

B1. Removals from the wide faces of thick flakes (Fig. 5 (11 and 12)). The ventral face of the flake was sometimes used as the percussion platform, without preparation, whereas other times, the platform was evidently prepared through small removals. The convexities do not appear to have been managed, but arrises were used or created with large removals. Crests or removals from flake flanks indicating maintenance of transversal convexity have not been detected. The cornice was not prepared either. They seem to have been products with a short operational chain.
B2. Products of the pyramid or carinated-endscraper type (Fig. 5 (13 and 14)). This was a semi-surrounding production on flakes tending to converge. The intensity of these productions is reflected by the high number of maintenance or resharpening elements found. A large number of blanks were produced, mainly for microblades, since most of the armatures were shaped from these products.

### Production Systems in Quartzite

The technological study of the quartzite materials has identified different objectives associated with several operational schemes. Most of the quartzite remains are classified as indeterminate pieces and debris, totalling 3300 remains (89.0%). The remaining 408 objects (11.0%) can be linked to different moments in the reduction process of this raw material.

**Production of Thick Flakes** The production of thick flakes did not seem to follow any predetermined operational scheme. The products obtained are not standardised in their shape or size and therefore did not require specific preparation of the cores. The facts that the butts retain cortex, that few maintenance elements have been found, and that cores do not exhibit repeated removals support this deduction.

These artefacts were used unretouched. The frequency of splintering suggests a particular use that involved placing the artefact between a mobile object and the substance to be worked (Fig. 6 (1)). The flakes that were later used as cores to obtain elongated objects were created through this reduction process.

**Production of Microblades** Microblades were obtained by working the wide faces of thick flakes (Fig. 6 (2 and 3)). The surfaces were shaped through removals in the flanks. Splintering observed at the ends opposite the percussion platforms indicates bipolar knapping. Flat microblades are obtained from this reduction. Narrow cores worked in the same way suggests that they could result from the continued reduction of wide cores. The products obtained from the latter are carinated or polyhedral microblades (Fig. 6 (4 and 5)).

No retouched microblades have been documented and therefore it might be supposed that they were used without retouching, although some artefacts with possible abrupt retouch to create a back have been found (Fig. 6 (6–9)).


**Fig. 6** Production systems in quartzite. **1** Flake used with a bipolar method. **2**, **3** Cores on a wide face used to obtain microblade blanks. **4**, **5** Narrow cores used to obtain carinated microblade blanks. **6–9** Microblade artefacts

## Discussion

Flint was the most common raw material in the lithic assemblage in Cova Rosa B5 (60.5%). Quartzite makes up the rest of the assemblage (39.3%) except for a few remains in quartz (0.2%). In the absence of information about the petrographic characteristics of the quartzite, local raw materials were largely used to produce lithic implements at this site.

Piloña flint, a local resource, alone makes up nearly half the flint objects that have been studied (47.9%). In addition to its relative proximity, it is the raw material with the best properties for reduction and the most widely distributed type that has been identified in Asturias (Duarte et al., 2016; Tarriño et al., 2013b, 2015). Its use has been documented at other Palaeolithic sites near the mouth of the River Sella, at Les Pedroses, El Cierro and Tito Bustillo (Álvarez-Fernández et al., 2016, 2020a; Martínez-Villa et al., 2022; Martín-Jarque et al., 2022); as well as further west in the Nalón valley, at Las Caldas and La Viña (Corchón & Ortega, 2017; Martínez, 2015; Santamaría, 2012) and in the easternmost valleys in the province, at Cueto de la Mina, Coímbre and Llonín (Martínez, 2015; Tarriño & Elorrieta, 2017). Outside Asturias, it has been documented at the Mesolithic sites of La Uña and El Espertín, in the province of León (Herrero-Alonso et al., 2020) and at the Palaeolithic sites of El Linar, Las Aguas and Cualventi, in Cantabria (Tarriño, 2016).

In addition to Piloña flint, the lithic assemblage at Cova Rosa shows the procurement of lithic resources from different sources, and at least ten flint types used for lithic reduction have been identified (Fig. 7). The group of local resources (48.9%) is formed mostly by Piloña flint, as well as much smaller amounts of Alba radiolarite and Fito chert. The group of regional resources (32.3%) consists of Urgonian flint and Monte Picota flint, which are quite well represented at Cova Rosa, and also of Las Portillas chert, whose presence is purely anecdotal. The tracer resources (12.9%) are Flysch flint, which is well represented as the most common lithological tracer in northern Spain, and Chalosse flint, which is less common but also an important lithological tracer and has a provenance furthest from Cova Rosa, about 350 km in a straight line. Treviño and Salies-de-Béarn flint, which also belong to this group, were used less. The remaining percentage corresponds to flint pieces that are altered and indeterminate (5.9%).

The use of flint types from the Basque-Cantabrian Basin and the western Pyrenees in the lithic assemblage at Cova Rosa resembles the pattern observed at other Magdalenian occupations in northern Spain (Martín-Jarque et al., 2023). If this assemblage is compared with the lithic assemblage from Sub-level 1c2 at Tito Bustillo (*ca.* 18.3–17.7 ka cal BP), attributed to the Lower Magdalenian, a series of similarities can be seen: (1) the greater use of flint than quartzite, especially in the case of retouched artefacts; (2) the wide range of flint types from different sources, up to ten in both cases; (3) a preference for Piloña flint among the local raw materials, although at Tito Bustillo it was not the most-used resource; and (4) the presence of the same regional (Monte

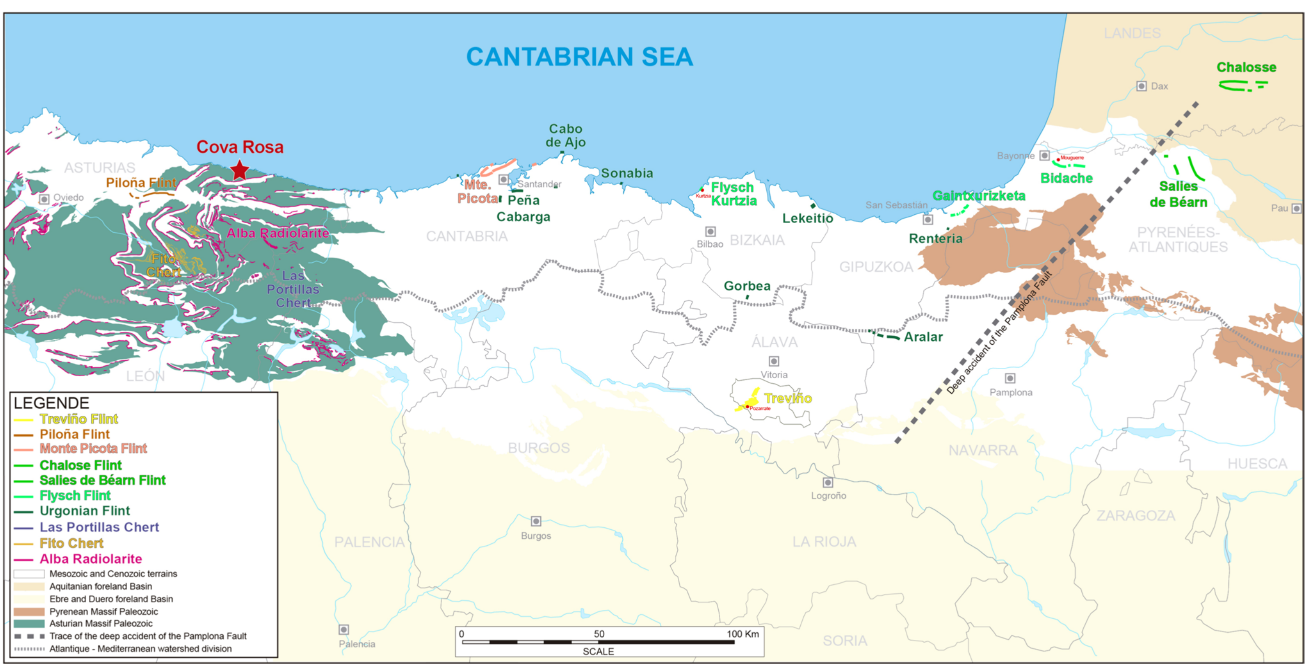


**Fig. 7** Map of the Cantabrian Mountains, the Basque-Cantabrian Basin, Western Pyrenees and the south-west of the Aquitaine Basin, showing the sources of the flint types identified in Cova Rosa B5 (modified by Tarriño et al., 2015, 2016)

Picota and Urgonian flint) and tracer raw materials (Flysch flint), equally well represented.

At Cova Rosa, the flint production systems are different from those in quartzite. Flint was used to obtain microblade blanks with which projectile armatures were produced. This was achieved with varying debitage methods: on flake flanks, of the burin type, sometimes truncated, or on wide, semi-surrounding faces of the carinated endscraper type (Le Brun-Ricalens & Brou, 2003). The production of flakes to be made into *raclettes* formed part of the initial phases of the operational chain that was aimed at creating microblades. Indeed, most of the debitage was used to obtain this kind of blank within production systems that varied in their method. The repetition of schemes in the debitage in flint, entailing certain technical requirements to manage convexities, contrasts with the lack of standardisation in the quartzite debitage.

Reduction in quartzite was mainly aimed at obtaining thick flakes. Such flakes also appear in flint although they were not the objective of debitage and moreover, they are also splintered. Their morphometric characteristics, as well as the shape, location and arrangement of the splintering support their classification in the category of intermediate objects (Vadillo Conesa et al., 2021). They are artefacts to be used in tasks with some material, in a bipolar fashion, in which they were intermediate tools, between the percussor and the material.

The central role of microblade products in lithic assemblages in the Early Magdalenian has been noted by several researchers (Cazals, 2005; Cazals & Langlais, 2005; Primault et al., 2020). This has been recorded, for example, in Level V at Erralla (Gipuzkoa, Basque Country) (*ca.* 19.8–19.2 ka cal BP), which is attributed to the Lower Magdalenian, and where this production system has been linked to the aim of obtaining curved and twisted bladelets. Additionally, an association has been found between backed bladelets and *raclettes* (Baldeón, 1985). At many of these sites, the autonomous production of flakes has not been observed, and instead they were obtained with the objective of achieving smaller cores than the original ones, which were then used for microblade production. The association between backed elements and *raclettes*, and the poor definition of flake production can both be clearly observed in the so-called "Magdaleno-Badegoulian" in Camparnaud (Grad, France) (Bazile & Boccacio, 2007). The predominance of backed implements, together with a few tools made from flakes, such as *raclettes*, are the traits that have been described in different lithic assemblages at the initial Magdalenian (Langlais, 2020; Utrilla, 2004; Utrilla & Montes, 2007).

At Cova Rosa, a part of the wide and short microblade blanks were configured as triangles, with sizes different from the geometric and truncated bladelets configured in Levels XIII-XII at Las Caldas (*ca.* 18.3–17.6 ka cal BP), attributed to the Lower Magdalenian. Also, have been described regular bladelets with parallel sides at Las Caldas (Corchón & Ortega, 2017). This situation shows a diversity of debitage to elaborate geometric tools; it may perhaps have value in chronological and evolutionary meaning.

This assemblage poses a series of questions related to (1) the composition of the assemblage, whose characteristics may be linked to functional aspects; (2) the contact between Badegoulian and Magdalenian groups and the exchange of *savoir-faire*; and (3) issues of a taphonomic nature (Ducasse & Langlais, 2007; Rasilla et al., 2019). In the case of Cova Rosa, the stratigraphy and the radiocarbon dates do not display any incoherence or taphonomic issues and therefore the last point does not appear to be responsible for the situation observed in the sequence. The other two points still need to be explored.

## Conclusions

The study of the lithic assemblage from Cova Rosa B5 defined the provenience of the exploited raw materials, as well as the technical strategies involved in the management of those resources during the Early Magdalenian. The procurement of mainly local raw materials (mostly Piloña flint) and the presence of a wide range of materials from different sources, some of them appearing in unusually high percentages (Urgonian flint), follows the pattern observed in other occupations of a similar chronology in northern Spain. This may be explained by knowledge of more distant outcrops and their frequentation by Magdalenian groups. The presence of all the phases of the operational chains demonstrates that lithic reduction was carried out on-site and allows a complete definition of the process. However, despite the variability in the raw materials, no selection of them based on the objectives of debitage can be detected. The different flint types are represented in all the production systems that have been identified.

Techno-economic studies carried out in recent decades have noted similar tendencies in a wide region that covers Cantabrian Spain and south-west France. These tendencies are seen in the importance of microblade production and the array of reduction systems used, including those carried out on carinated endscrapers and burins. At sites in which operational chains aimed at obtaining flakes have been observed, those processes are defined as simple and not standardised.

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**Data Availability** The authors confirm that all data generated or analysed during this study are included in this published article.

## Declarations

**Competing interests** The authors declare no competing interests.



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