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of the Middle Paleolithic and Middle Stone Age

Volume III

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21 Technical variability and changes in the pattern of settlement at Roca dels Bous (southeastern Pre-Pyrenees, Spain)

Jorge Martínez-Moreno, Ignacio de la Torre, Rafael Mora, Joel Casanova

Abstract. *This paper analyses the changes in the transport of raw materials in levels N10 and N12 of Roca dels Bous (northeast of the Iberian Peninsula). The study of the contexts of these lithic assemblages reveals differences in the intensity of occupation. At the same time, changes in the technical system are observed, especially in knapping methods and retouched tools. These variations enable us to reflect on the use of Roca dels Bous within the mobility patterns of the Neanderthals that inhabited the area connecting the Ebro Valley with the first slopes of the South Pyrenees. The characteristics of the lithic artefacts suggest changes in the strategies used to acquire, produce, use and discard stone tools. These questions allow us to examine the meaning of technical variability, a fundamental notion in any discussion of the evolutionary and cultural significance of the Middle Palaeolithic.*

Résumé. *Cet article dérive des implications observées dans les changements en l'apport des matières premières détecté aux niveaux archéologiques N10 et N12 de la Roca dels Bous (nord-est de la Péninsule Ibérique). L'analyse des assemblages lithiques déposés dans ces contextes sédimentaires, permet de reconnaître des différences dans l'intensité de l'occupation du gisement. Ce phénomène est associé aux changements dans les attributs caractéristiques des systèmes techniques qui sont surtout visibles dans les méthodes de taille et les pièces retouchés. On examine si ces variations peuvent se rapporter aux changements dans la fonctionnalité du site et des cycles de mobilité des Néanderthaliens qui ont habité dans la zone qui connecte le Bassin du Ebro et les premières chaînes montagneuses du sud des Pyrénées Orientaux. En même temps, ces modifications sont liées aux comportements qui affectent à l'acquisition, élaboration, usage et abandon des artefacts lithiques. Ces questions peuvent être mises en relation avec le concept de variabilité, notion essentielle dans l'interprétation de la signification évolutive et culturelle du Paléolithique Moyen.*

INTRODUCTION: ANALYSING THE SIGNIFICANCE OF THE NOTION OF VARIABILITY

In this article we analyse a traditional question in Middle Palaeolithic studies: how do we detect and explain changes in Neanderthal behaviour? This question is at the root of the debate on "Mousterian variability," which has monopolised the cultural characterisation of *Homo neanderthalensis* (Mellars 1996). It is important to define the concept of "variability" since, despite the enduring character and extensive geographical dispersion of Neanderthals,

their behaviour usually has been described as monotonous and conservative (Stringer and Gamble 1993; Kuhn 1995).

This monolithic perspective has been questioned on the basis of new interpretations of lithic assemblages. The application of the *chaîne opératoire* concept suggests that Neanderthal behaviour was technically sophisticated (Geneste 1985; Boëda 1991; Schlanger 1996). Recently it has been proposed that temporal trends can be observed in technical methods throughout the Middle Palaeolithic (Delagnes and Meignen 2006). At the same time, zooarchaeological studies suggest that Neanderthals responded in a number of different ways in subsistence activities such as hunting (Marean and Assefa 1999; Boyle 2000; Gaudzinksi 2006).

Artefacts provide the key to reconstructing technical and procurement strategies. However, the notion of variability is not recognised exclusively from the attributes of artefacts. By accepting that it is possible to detect changes in the general composition of the assemblages or in knapping methods, the question arises of whether these changes explain conscious decisions taken to ensure the continuity of these groups' social and cultural environment, or whether they are responses to external factors, and consequently solutions designed to resolve stress situations. From this point of view, it has been argued that the variability of artefacts is directly related with the particular adaptive strategies used in each environment (Binford 1981; Kuhn 1995).

Archaeological contexts consisting of bone remains, lithic remains and hearths (Villa et al. 2002; Vallverdú et al. 2005) are indicative of the activities of Middle Palaeolithic groups. Defining relationships between these components is a way of interpreting these accumulations, but multiple variables make it impossible to correlate contexts and artefacts mechanically. This difficulty could explain the limited interest that this contextual approach has arisen when analysing Middle Palaeolithic contexts.

In this paper, we attempt to elaborate a methodology with which to recognise and explain the archaeological record's variability from a contextual perspective. This is not a simple empirical approach. How the concept of variability should be analysed influences the sampling methods, classification schemes and the analytical procedures used to discuss it. These factors interact when it comes to explaining an archaeological phenomenon, which means that the decisions we take in the present when unearthing the archaeological record affect the outcome when examining the meaning of the concept of variability from archaeological contexts.

This methodological reflection affects the way we address two questions. In Roca dels Bous qualitative and quantitative changes are seen in the patterns of raw material procurement and use, with the predominance of flint in some levels, while in others metamorphic rocks are more abundant (Mora 1988). This pattern has been identified in two archaeological units that are currently being excavated, levels N10 and N12. Secondly, this article updates the observations made on N10, which were presented in the previous volume of this series (Martínez-Moreno et al. 2004a; Mora et al. 2004) (fig.1), and also sets out some parameters on N12, a level that has not previously been published.

This comparison of two archaeological records from a contextual point of view is aimed at determining whether the differences observed are related to *techno-economic* decisions or whether, on the contrary, they refer to the so-called Neanderthal *techno-psychological* background, *sensu* Boëda (1991). Reflecting on the causes of these changes in the record will enable us to evaluate whether they are immediate responses to contingent situations, or

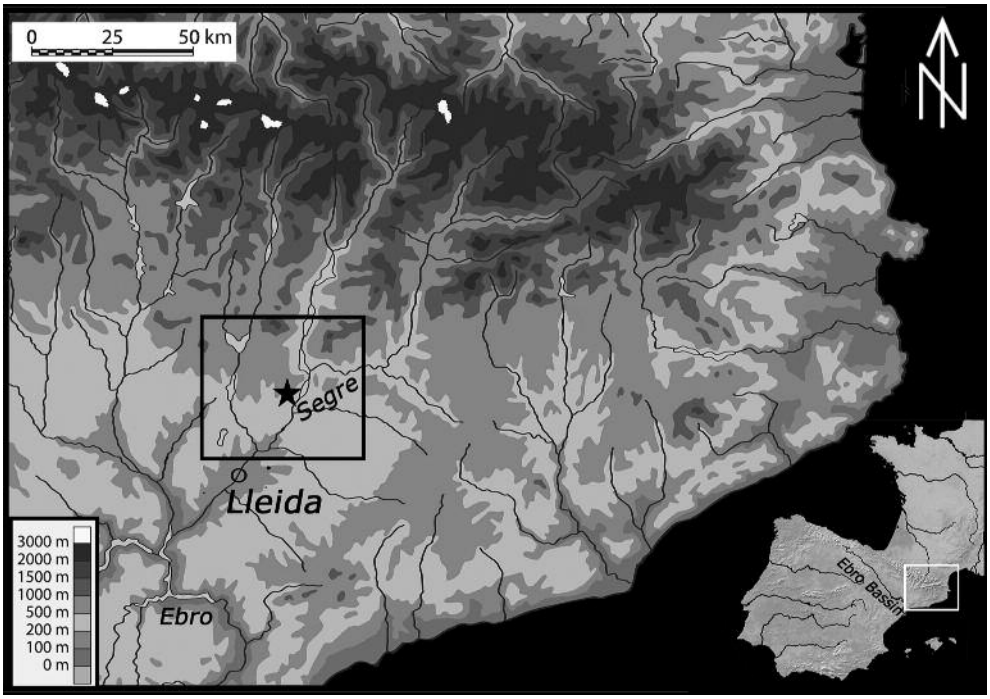


Fig. 1. Topographical location of Roca dels Bous, in the contact between Prepyrenees and Ebro Basin. The black rectangle refers to figure 11.

whether they are issues of remodelling that define a technical tradition that was transmitted over a long period. These inferences could thus contribute to an understanding of the concept of Middle Palaeolithic technical variability.

DEFINING THE NOTION OF CONTEXT

Archaeological remains – understood as any indicator of human activity – are materials that undergo transformation from the time they are abandoned until they become part of the sediment. In the course of this transition they are modified, which often affects their structure, morphology and appearance, but these modifications can provide information about the processes and agents related to their conservation (Gifford 1981; Schiffer 1987). From this perspective, the methods used to recover these items are part of the taphonomic process, and decisions about the type or size of the material to be recovered affect the quantity and quality of the information obtained.

Generally, the excavation is organised on the basis of the lithological properties of the sediments that define a stratigraphic sequence. In Roca dels Bous this procedure is not as straightforward, since geologically its deposits are very homogeneous, which makes it difficult to assign discrete archaeological "levels" to natural sedimentary units (Jordá et al. 1994). In view of this limitation, excavations have been directed at recording the distribution of arte-

facts and anthropic structures, establishing the three-dimensional position of all objects irrespective of their size. In the absence of natural lithological markers, treating the archaeological remains as sedimentary material allows the dispersion and horizontal and vertical geometry of the archaeological levels to be defined.

This aspect is essential in Roca dels Bous. The processes by which the deposit has been formed produce uneven sedimentary units, and microtopographic irregularities—natural depressions and slopes—can be detected that determine the volumetry of the archaeological levels. Because there are no lithological markers, object plotting indicates the general delineation of levels, as well as the natural microrelief and topographic features. The plotted items, whose vertical limits are marked by sterile sediments, do not necessarily define discrete periods of occupation. Archaeological levels that are not particularly thick could have been shaped by various occupation events (that is, their internal structure reveals that they cover a protracted period of time), and we assume that in Roca dels Bous this is a common phenomenon (Martínez-Moreno et al. 2004a; de la Torre et al. 2005).

A key in the use of archaeological elements as sedimentary markers or proxies is provided by the excavation of hearths. Although some pit-hearths have been recorded, in Roca dels Bous most are flat hearths set directly on the ground. These have been excavated by sectors in order to define their thickness and internal microstratigraphy, which in some cases makes it possible to identify separate re-uses over time. Furthermore, the correlation between the vertical dispersion of coordinates and the microtopography of the hearths produces a broad set of data that ranges from precise associations between hearths and archaeological remains,

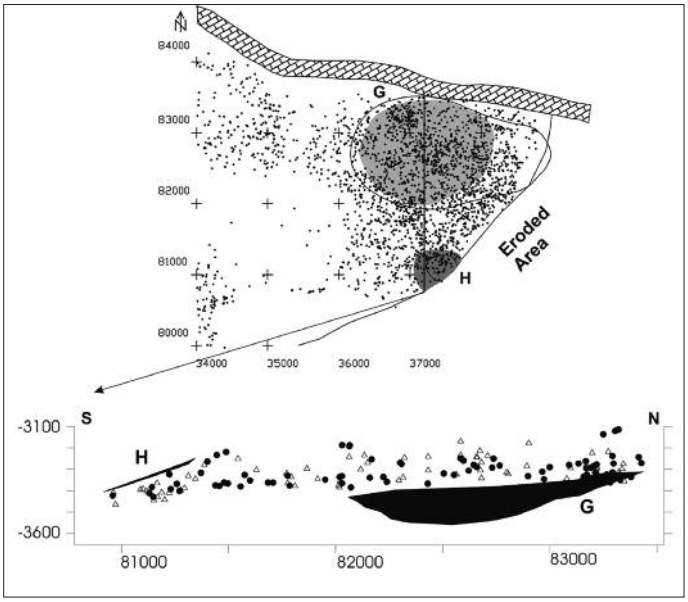


Fig. 2. Vertical dispersion of burnt (Δ) and unburnt (●) bones and their association with level N10 hearths G and H at Roca dels Bous (see Martínez-Moreno et al. 2004a). This distribution suggests that the area was re-used several times during the formation of level N10.

to other situations with apparent but in fact non-existent relationships (fig. 2). These interstratification phenomena imply protracted occupation of the same area at the site (Martínez-Moreno et al. 2004a; de la Torre et al. 2005).

Hence it can be said that, despite displaying limited vertical dispersion, the levels of Roca dels Bous are pristine assemblages, as also documented elsewhere (Gowlett 1997). This implies that Roca dels Bous levels cannot be interpreted at face value, although an examination of these accumulations allows us to infer at least some of the activities carried out on the site (Martínez-Moreno et al. 2006; de la Torre et al. 2005).

These methodological questions are relevant to the main objective of this article, which is to reflect on the differences between two distinct archaeological contexts, levels N10 and N12 of Roca dels Bous. Given that both have been excavated and analysed using the same methodological approach, any differences found in their composition would not be the result of different sampling techniques, so we will be able to examine whether they indicate changes in the activities or use of the settlement by the Neanderthals.

GENERAL FEATURES OF LEVELS N10 AND N12

In general terms, N10 and N12 are two independent archaeostratigraphic units separated by sterile sediments which, depending on the area excavated, vary from 15 to 50 cm thick (fig. 3). Both levels are on a slight slope (5º-10º) running E-W and extending eastwards, although the eastern sector was damaged before the current excavations.

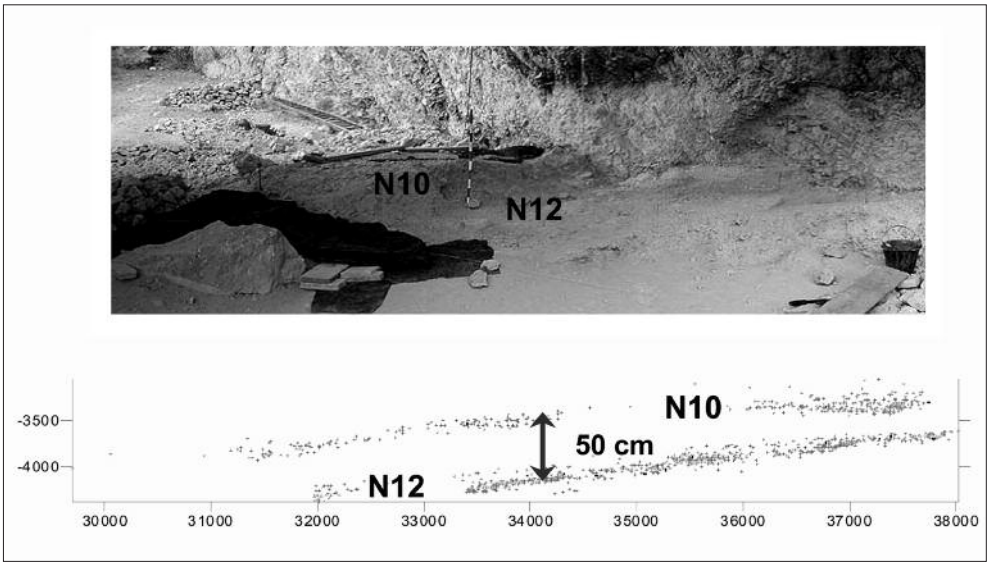


Fig. 3. **Above**: general view of the excavation area in Roca dels Bous showing N10 and N12. **Below**: vertical plotting of archaeological levels N10 and N12, separated by a variable thick sterile layer.

N10 and N12 are superimposed and distributed over unequal areas. N10 extends over 55 m^2, although this area is cut off at the E and W ends. To date, some 15 m^2 of N12 have been excavated, but it extends over a greater horizontal area, which will be defined in future excavations. Both levels have an average thickness of 15 cm, although the thickness of N10 varies considerably.

There are structural differences in the amount and type of artefacts from N10 and N12. Twice as many lithic remains have been plotted in N12 over an area equivalent to a quarter of the excavated part of N10. This greater number of artefacts is associated with a major difference in the type of raw materials brought to the site. The lithic assemblage of N10 amounts to 3,257 remains (including *microdebitage* less than 1.5 cm long) and approximately 66% of the total is flint. In contrast, 85% of the 6307 artefacts in N12 have been produced from metamorphic rocks.

Determining whether the variation in the density of materials and the difference in the raw materials are phenomena for which a covariance could be established is an interesting question. As a hypothesis, it could be proposed that a greater density of remains, as documented in N12, might indicate changes in the use or duration of the activities that took place on site. In the same way, these differences in the management of raw materials could suggest changes in the composition of stone tools, or in the frequency of visits to the raw material outcrops.

These inferences take us back to the question raised at the beginning of this paper, when we stated that our aim was to investigate the reasons for tool-variations. In order to study them, we will characterise the deposition contexts of N10 and N12 and then analyse the significance of the changes in the lithic technical systems by examining and discussing the attributes of the knapping and retouching methods. Finally, we will attempt to determine whether they reflect different types of Neanderthal settlement in the area.

ARCHAEOSTRATIGRAPHY: HORIZONTAL AND VERTICAL DISTRIBUTION OF LEVELS N10 AND N12

General microtopography of N10

It has been stated elsewhere that the horizontal and vertical dispersion of N10 was the result of several short events that shaped three clusters separated by a central empty area (Martínez-Moreno et al. 2004a; Mora et al. 2004; de la Torre et al. 2005). Nineteen hearths have now been detected in N10, twice as many as the number given in a previous study (Martínez-Moreno et al. 2004a). In general, they are small ellipsoidal-shaped hearths (less than 1 m along the longer axis) with a thin layer of burnt sediment, and both flat hearths and pit-hearths have been recorded. Blocks and stones around or within the hearths were deposited naturally after they were used, so it cannot be argued that rocks were intentionally positioned to delimit areas of combustion, retaining heat or for processing or cooking food.

The arrangement of hearths and the vertical distribution of archaeological items enable various contextual indicators to be analysed, including the level's microtopography. Elsewhere (Martínez-Moreno et al. 2004a) it was suggested that the stratigraphic superimposition of hearths follows a natural depression in the western part of N10 which was repeatedly used for placing hearths. Recent excavations support this observation. In this natural sedimentary depression, which is about 10 m^2 and 40 cm thick, 10 stratified hearths were record-

ed. These hearths lie on opposite slopes that make it possible to identify the natural walls and morphology of the depression.

By relating the geometry of the hearths to the vertical dispersion of the archaeological items, distribution patterns can be seen that are difficult to discern during excavation, but which can be recognised through vertical plots (fig. 4).

In some areas, N10 displays a relatively thin vertical dispersion that could be interpreted as a single episode of occupation, while in others it is subdivided into alignments that indi-

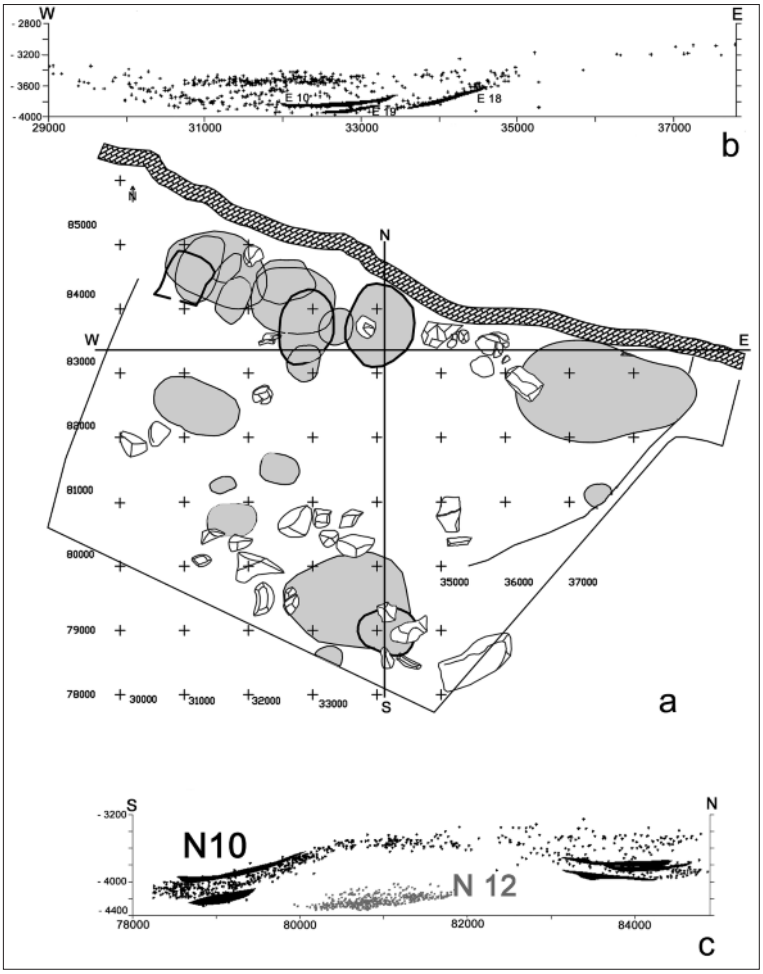


Fig. 4. Plan and vertical plots of level N10. The plan shows 19 excavated hearths from this archaeological unit **(a)**. Vertical dispersion of the items in an E-W direction between X= 83.000-83.250 on the Y axis = 29.000-37.000. Note the stratigraphic superimposition of 3 hearths in the W accumulation **(b)**. Projection of coordinates in the N-S plots on the Y axis = 34.000-34.250 between X= 78.000-85.000, showing the superposition of hearths in the W and S accumulations, and also fusion/fission phenomena within this archaeological unit. Vertical plot of N12 artefacts underneath N10 **(c)**.

cate various events. In the sector between X=35000 and 29000, the items are vertically dispersed through a thickness of 40 cm and outline a concave shape. Three of the 10 interstratified hearths are located in this area (E10, E18 and E19), enabling two inferences to be made. Firstly, the geometry of the vertical dispersion of coordinates indicates that hearths were built on the west side of a natural depression. At the same time, these hearths suggest 3 different occupations that cannot be related with the bulk of the material plotted, which is 30 cm above the hearths (fig. 4).

This observation is consistent with what has been described in previous studies (Martínez-Moreno et al. 2004a), and implies that N10 is a conglomerate of various short-term occupations within a time scale that is difficult to determine, but which was probably not very long. An inference that can be drawn from this type of vertical dispersion is the identification of "fission/fusion" phenomena. These processes could be associated with different rates of sedimentation, which means that in some places artefacts and hearths were buried more rapidly than in adjacent areas. These differences enable separate archaeological events to be identified (they indicate internal time span), while in areas where sedimentation took place more slowly the material from different periods of occupation produced a single archaeological unit.

In short, the absence of lithological markers in Roca dels Bous makes it necessary to adopt an alternative perspective that does not involve excavating arbitrary units, since this is regarded as an unsatisfactory solution. By treating the archaeological items as sedimentary particles and monitoring their horizontal and vertical dispersion, the variable geometry of the archaeological level can be recognised. Although this method does not solve the problems of internal synchrony, it indicates that apparently synchronic assemblages with limited vertical dispersion actually relate to different depositional events. These implications suggest that N10 is the result of re-using this space over an indeterminate period of time.

General microtopography of N12

N12 is 30–50 cm below N10, under a sterile layer that enables the two archaeological units to be differentiated as clearly separated levels (fig. 3). About 15 m^2 of this level have been partially excavated, although it extends over an area that is similar to or greater than N10. In this level, plotted items produce a continuous bed in which artefacts of different sizes overlap, with a high proportion of microdebitage less than 1.5 cm. The vertical dispersion of the artefacts in an E-W direction outlines a level with a subhorizontal slope similar to that of N10 (fig. 5), while N-S a slightly convex surface can be made out with a slight slope at each end.

In many places the vertical dispersion of coordinates defines a level that is less than 10 cm thick level and in which to date no fission phenomena such as those described in N10 have been detected. Hence the homogeneous distribution of the lithic material could suggest that this level represents a single event. However, this possibility cannot be sustained, since three superimposed hearths have been excavated at the eastern end, indicating that there were at least two distinct periods of occupation. The concentration of artefacts into a homogeneous layer could be due to the fact that sedimentation occurred more slowly in N12 than N10, although it could be due to more intensive occupation. This inference will have to be evaluated in forthcoming field seasons, which will enable the microstratigraphy of the area not yet excavated to be determined.

COMPARISON OF N10 AND N12 LITHIC ASSEMBLAGES

Numerically significant lithic assemblages have been recovered in N10 and N12, consisting to date of 3,257 artefacts in N10 and 6,307 in N12. Similarly, numerous fragments of bone have been recorded (generally fragments less than 2 cm long), but their taxonomic attribution is difficult. This massive fragmentation is due to attritional destruction that occurred during site formation processes. Falling angular blocks and slabs, persistent trampling of bones lying on the surface or that were semi-buried, together with processes of sedimentary compacting (particularly in N12), explain the abundance of bone residues resulting in intense

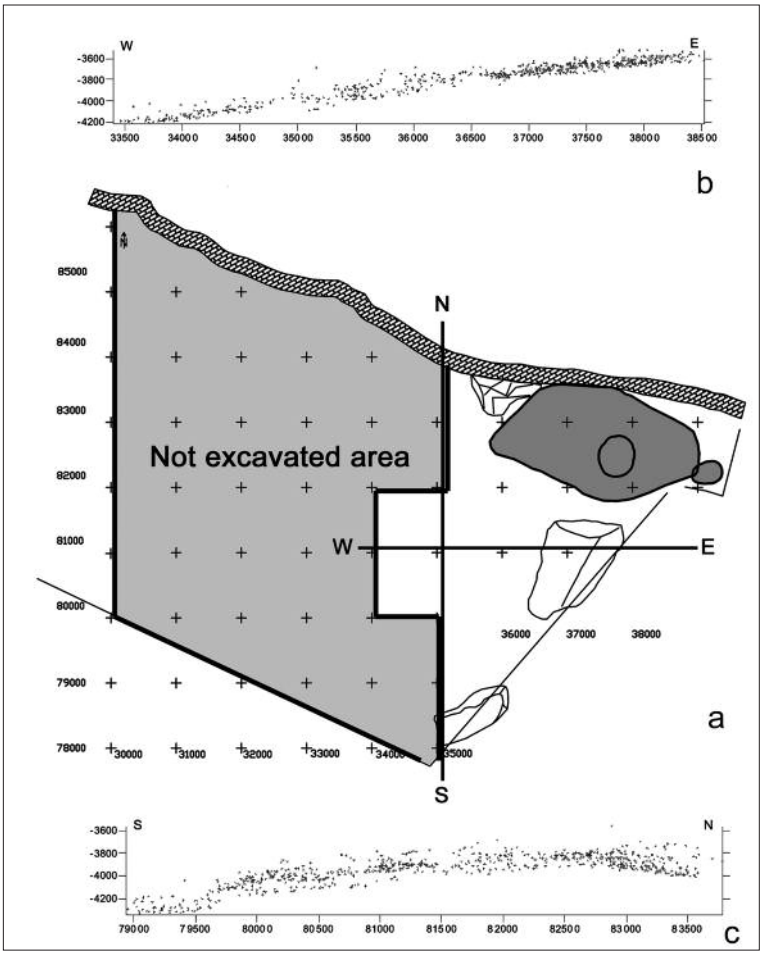


Fig. 5. Plan and vertical plots of level N12, showing the superimposition of 3 hearths in this level **(a)**. Projection of coordinates in an E-W direction between X=81.000-81.250, on the Y axis = 33.500-38.500, which shows a pronounced slope **(b)**. Projection of coordinates in the N-S plot on the Y axis = 35.000-35.250 between X= 79.000-84.000 **(c)**.

post-depositional fragmentation. Cut-marks, impact notches and charring can be discerned in the few remains that have survived these destructive agents, suggesting that humans hunted and consumed *Cervus elaphus*, *Capra pyrenaica*, *Equus caballus* and *Equus* cf. *hydruntinus*.

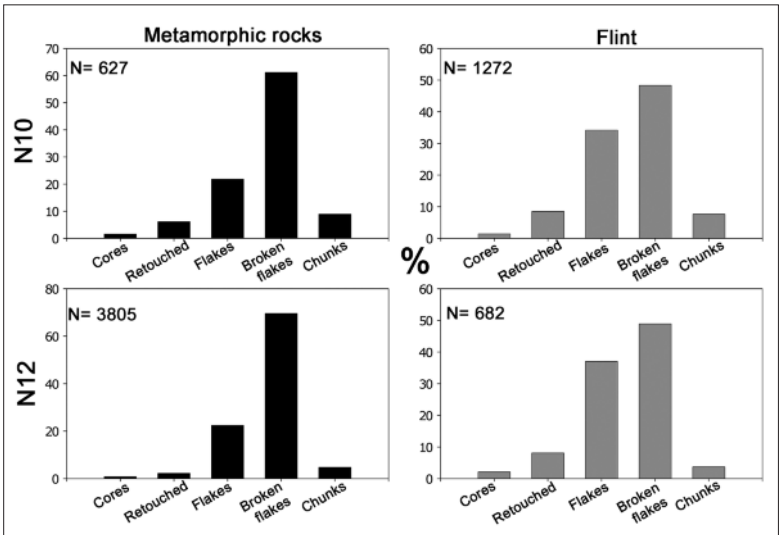
There are significant differences in the lithic raw materials from N10 and N12. In N10 66% of the stone tools are siliceous rocks, while in N12 85% of the material consists of metamorphic rocks (table 1).

One question that needs to be considered is whether there are differences in the generic lithic categories (such as cores, flakes, fractured flakes, chunks and debris) of these assemblages that would suggest changes in the composition of tools.

The Lien Test (Volle 1981) was used to discern differences in the configuration of the assemblages (fig. 6). We have excluded microdebitage, a category that is important for defining the geometry and extent of levels, but which the Lien test indicates is not significant.

Although quantitative changes in the distribution of categories can be seen in N10 and N12, these differences are not statistically significant. Both in N10 and N12, 95% of the

Table 1. Histograms and tables of N10 and N12 assemblages, broken down by categories (excluding microdebitage) and raw materials (metamorphic rocks -MTR- and flint). The number of cores and retouched pieces are in brackets.



% (N)		Core	Retouch	Flakes	Broken Flakes	Chunks	Σ
N10	MTR	1,6 (10)	6,1 (38)	21,8	61,2	8,9	627
	FLINT	1,4 (18)	8,5 (107)	34,2	48,3	7,6	1272
N12	MTR	0,8 (24)	2,2 (61)	22,4	69,6	4,8	3085
	FLINT	2,1 (15)	8,1 (54)	37,5	48,9	3,7	682

assemblage (excluding microdebitage) can be assigned to different elements produced by knapping activities (flakes, broken flakes and chunks), while the percentage of cores (1%) and retouches (3–5%) is very low. This suggests a low rate of transformation compared with the large quantities of unmodified flakes. In the same way, N12 contains a greater quantity of by-products (such as fractured flakes), which are more commonly amongst metamorphic rocks and that we assume were produced by knapping accidents. This interpretation is consistent with the hypothesis that unmodified raw materials were brought into the site for knapping.

In this paper we focus on cores and retouched pieces (table 1). According to the Lien test, there are no statistical differences between the cores from the two archaeological units, whilst retouched tools are comparatively more abundant in N10 than in N12, despite the fact that the percentages are similar in both levels. Although considerably less flint was brought to N12, in this level there are similar numbers of metamorphic and flint retouches, which supports the view that flint was selected preferentially to produce retouched tools.

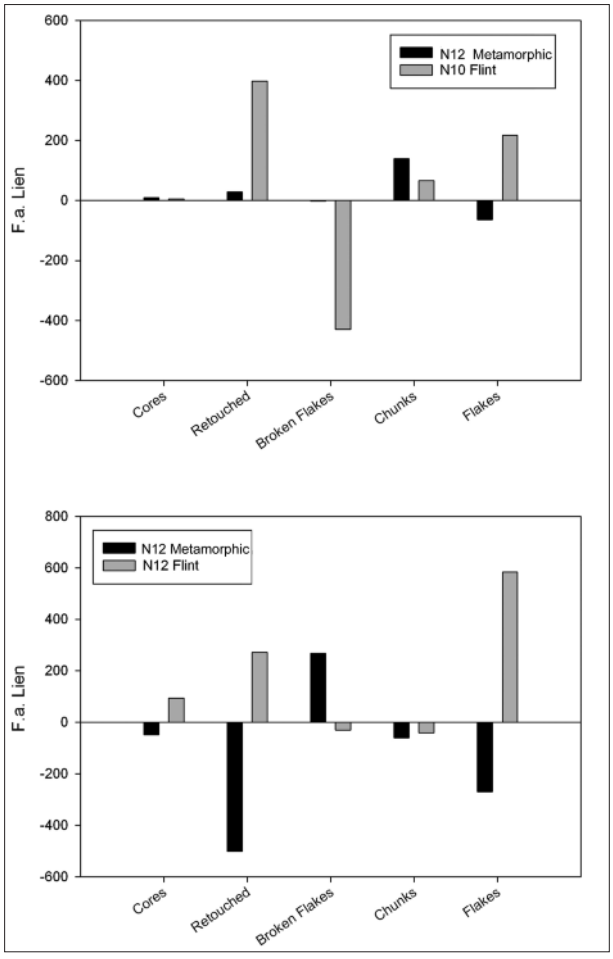


Fig. 6. Results of the Lien test (Volle 1981) on the lithic categories of N10 and N12 (see data in table 1). Note the overrepresentation of the flint retouches in N10 and N12 and flakes in N10, in contrast with the scarcity of N12 metamorphic retouched tools. These statistical differences can be interpreted in terms of selection of flint in preference to metamorphic rocks for producing retouched tools, especially in N12.

We do not intend to carry out a detailed study of knapping systems or the configuration of retouched tools in this paper, but to concentrate on the features that permit N10 and N12 to be compared. In this regard, the main characteristic of metamorphic and flint cores and retouches in N10 is theirsmall size, which is a pattern also shared by flakes and chunks. This implies that in N10 lithic production was aimed at obtaining small blanks. The largest pieces were selected to be retouched and the whole perimeter was usually intensively worked; many pieces were retouched on both cutting edges. In the same way, some small retouches show fractures resulting from use, which suggests that they were originally larger retouched tools that were re-worked after breakage (Mora et al. 2004). Retouches from metamorphic rocks are larger than those from flint, although they are also relatively small artefacts (less than 5 cm long) (fig. 7).

The cores are small and indicate intensive reduction sequences, being worked until they had to be abandoned as a result of knapping accidents or extreme exhaustion. This intensive reduction of the cores both of flint and metamorphic rocks could be interpreted as the result of a shortage of raw material in the area, or on the contrary it could be related with knapping schemas that are difficult to understand in purely cost-benefit terms (fig. 8).

In both levels, formal and informal knapping methods are identified. So-called formal methods include systems of organised reduction such as Levallois or discoid indicating the knapper's aim of maintaining convexities and volumes in order to obtain small flakes with stereotypical morphologies. These methods, which imply greater technical investment,

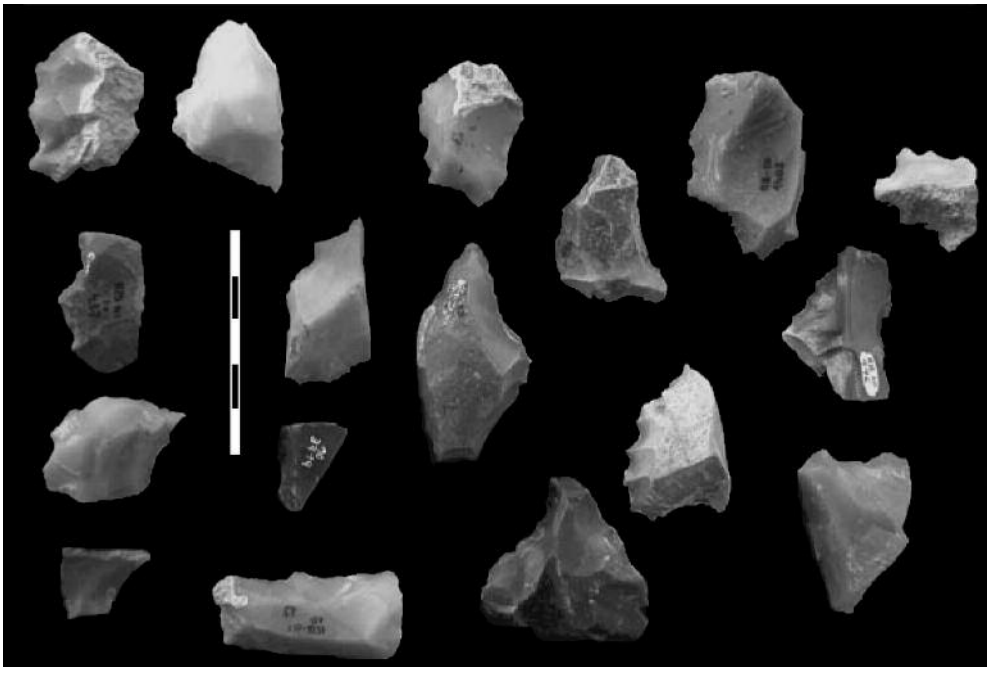


Fig. 7. Some retouched tools from N10, where small notches and denticulates predominate. Many of these show a heavily retouched perimeter and use fractures (Mora et al. 2004)

include both flint and metamorphic rock cores. At the same time some flint cores, generally fragments or flakes, were knapped expediently without any kind of preparation, obtaining single flakes or short sequences of products. The coexistence of the two distinct and complementary types of cores should be emphasised: one aimed at obtaining regular series compared with others from which only isolated blanks were obtained and which might meet different functional requirements.

The cores and retouches in the N12 assemblage show differences by raw materials. Flint retouches usually were made from small blanks and are more retouched than those produced from metamorphic rocks, which are generally larger. Retouching of metamorphic rocks affects specific areas of the edges and not the entire perimeter of the cutting edge (figs. 9 and 10). This pattern suggests that in the case of metamorphic rocks there was no interest in maximising the area retouched or including them in recycling sequences to prolong their use, as observed in flint retouches.

In level N12, cores produced from metamorphic and flint rocks are generally very small, which suggests intensive reduction. However, the most frequently-used technical systems, and those which in principle provided a greater quantity of blanks, were applied exclusively to metamorphic rocks, while flint is represented by informal cores.

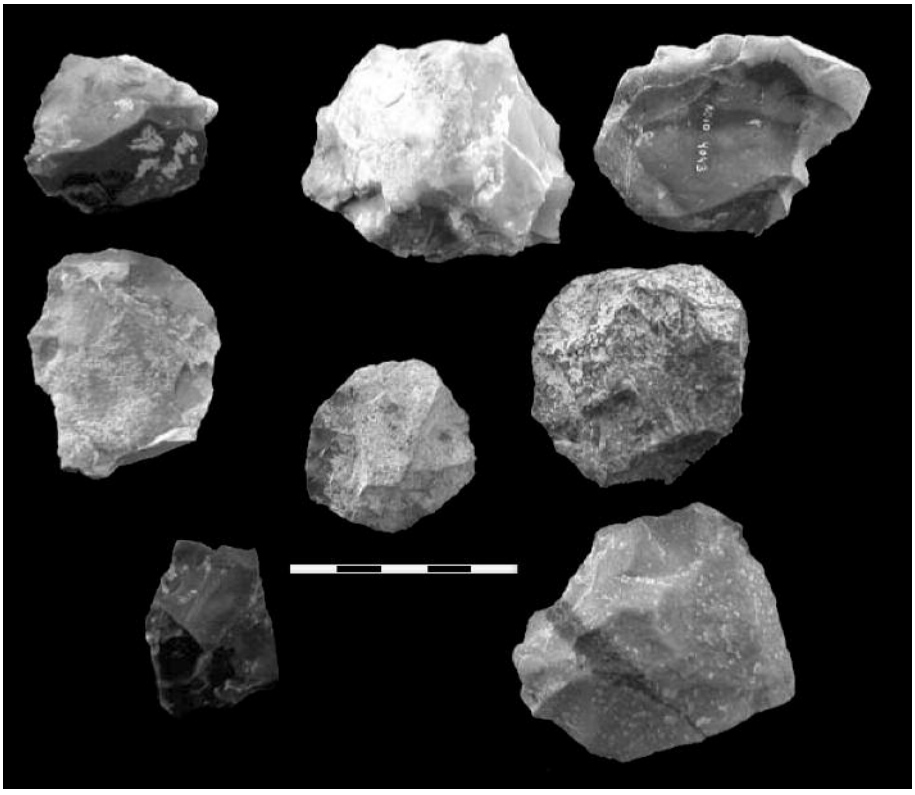


Fig. 8. Exhausted metamorphic rocks and flint cores from N10 ascribed to Discoid and Levallois methods.

These differences indicate that raw materials were managed differently in N12 than they were in N10. Metamorphic rocks were worked using methods that involved considerable technical investment, while the flint cores suggest expedient knapping that produced a limited number of blanks. This is unexpected, since predetermined blanks have been recorded—such as Levallois flakes—that could have been produced outside the settlement, and it takes us back to the question of whether these pieces could be considered indicators of curated technologies (Binford 1979), as suggested by Boëda (1991), for example.

TECHNO-ECONOMIC FACTORS: MANAGEMENT OF RAW MATERIALS

The study of the management of lithic raw materials covers numerous aspects, but in this study we shall concentrate on two parameters: the location of the raw material sources and

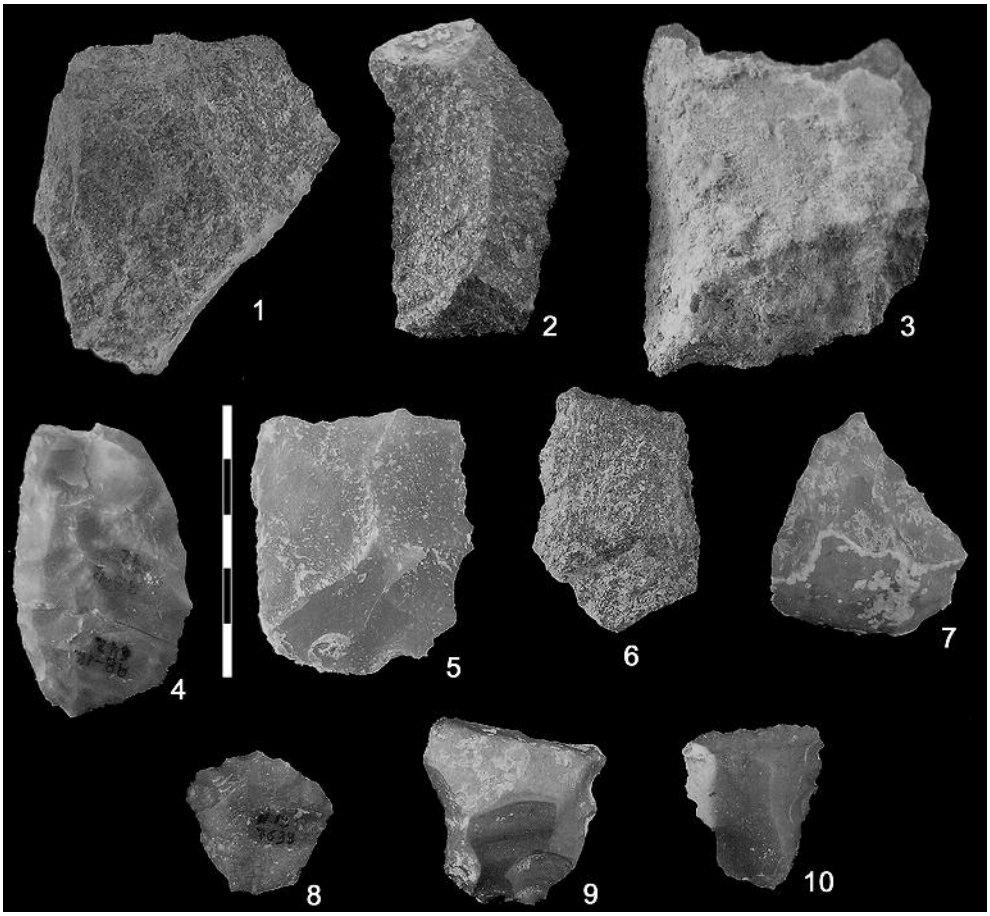


Fig. 9. Some retouched tools from N12 showing the difference in size between metamorphic rocks (1, 2, 3, 6) and flint (4, 5, 7, 8, 9 ,10), the latter similar to those described in N10.

the general characteristics of the lithic resources brought to the settlement. On the basis of the distance to the outcrops and the type of blanks obtained, we can construct a general picture of the strategy adopted for transporting resources to the settlement.

Surveys in the contact area between the Ebro Valley and the marginal sierras of the southern Pyrenees have identified several sources of raw material transported to Roca dels Bous (Mora 1988) and other Middle Palaeolithic sites such as Trago (Castañeda and Mora 1999; Parcerisas 1999; Martínez-Moreno et al. 2004b). These areas from which raw materials were procured were exploited over a long period of time (Mangado 1998).

The Roca dels Bous lithic assemblage consists of metamorphic and siliceous rocks. The metamorphic materials come from the river terraces nearby. The limestone cliff on which the Roca dels Bous layers are situated is crossed by the river Segre, which deposits metamorphic rocks on the calcareous substrate. Extensive terrace deposits are also located in the area

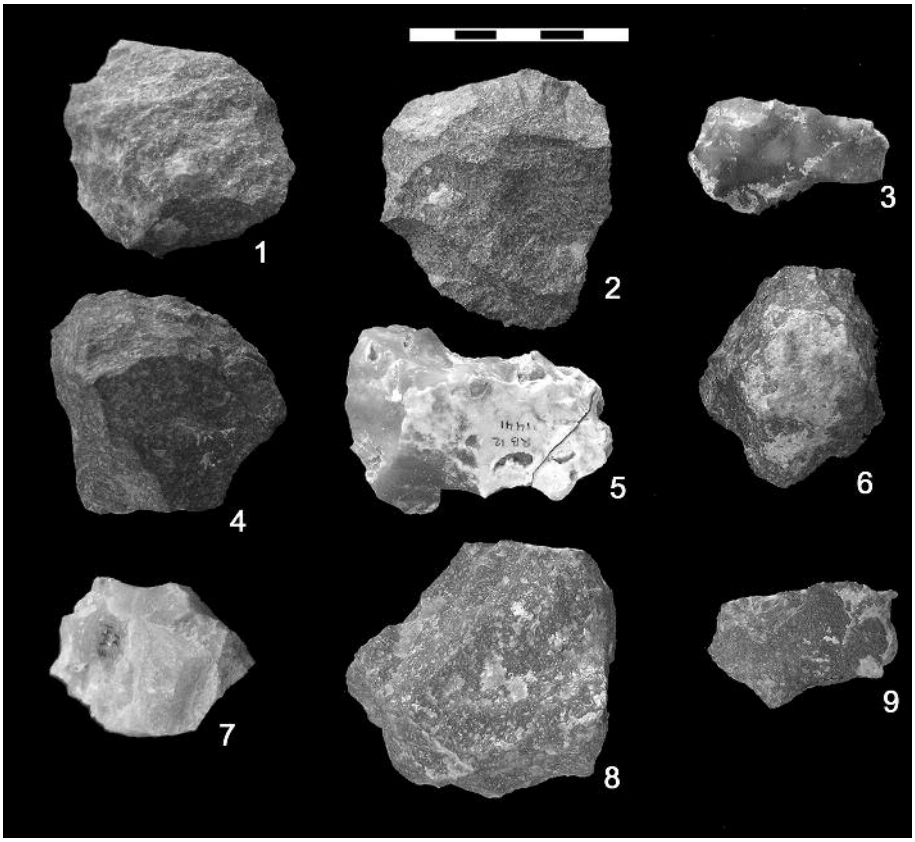


Fig. 10. Metamorphic rocks and flint cores from N12. Organized systems of reduction were preferentially used for metamorphic rocks (1, 2, 4, 6, 8, 9), while most of the flint cores (3, 5, 7) show expedient and irregular flaking.

around the rockshelter (Peña 1984). These formations contain small to medium-sized cobbles (less than 15 cm in diameter) suitable for knapping. They are coarse-grained, generally diaclastic rocks, i.e., they fracture along internal planes of weakness.

Various studies have characterised siliceous rocks of the region geologically and petrologically (Mangado 1998; Parcerisas 1999), so we shall concentrate on attributes relevant to the material recovered from the site. Although some flint is found in the local range (less than 5 km from the site), most of this raw material at Roca dels Bous comes from two formations located further away. The first type of flint comes from Serra Llarga, a low mountainous sierra 20 km southeast of Roca dels Bous, where flint appears in primary (embedded in Lower Oligocene ground chalk) and secondary positions (in the form of small eroded fragments of various sizes, in the foothills of this sierra). This flint is excellent for knapping, although the nodules are generally small (less than 10 cm).

The second type of flint is available in various large outcrops in the Palaeocene formations of the sierras to the north of Roca dels Bous. So far secondary position nodules have been found approximately 10–15 km from the site (fig. 11). They show a wide variety of macroscopic attributes (colour, texture) and suitability for knapping, ranging from good quality materials to others that break irregularly. The size of the nodules also varies, although large fragments (+ 20 cm) are common.

From preliminary observations, this range of metamorphic and siliceous materials corresponds with the features of practically all the lithic artefacts of N10 and N12. Today these outcrops are easy to reach, and there are no natural barriers that would prevent raw materials from being obtained there.

These patterns define a local and adjacent supply of raw materials, to use Geneste's terminology (1985). At first sight, the small size of cores and retouched pieces could be interpreted as the result of a shortage of raw material in the surrounding area. However, this does not seem to be the case; although there are constraints associated with the suitability of some of the raw materials (i.e., the small size of Serra Llarga flint nodules, the poor quality of some of the rocks from Palaeocene formations), they do not completely explain why cores and retouched pieces are so small.

An important difference can be established on the basis of the distance of the raw material outcrops from the site. On one hand, there is an area in which strictly local raw materials appear (distances of less than 5 km); these are essentially the metamorphic rocks originating in fluvial deposits, but also some flint blocks. The second group consists of a variety of siliceous rocks that are located in a radius of between 15 and 20 km, and which would correspond with the so-called adjacent zone, as defined by Geneste (1985, 1992).

Assuming that points of raw material procurement are indicators of activity ranges, it can be inferred that in N12 Neanderthals used essentially local raw materials, while in N10 they preferred to transport rocks from the adjacent area. This difference in the origin of raw materials could indicate changes in the organisation of technology or the use of the settlement.

TRANSPORT OPTIONS: SPATIAL FRAGMENTATION OF THE *CHAÎNE OPÉRATOIRE*

As mentioned above, there is a preference for retouching flint blanks both in N10 and N12. There seems to be an interest in curating and repairing retouched tools, which could be related with a recycling strategy (see Mora et al. 2004). Although some retouches on metamorphic rocks show intensive modification, this does not appear to have been a common practice, as

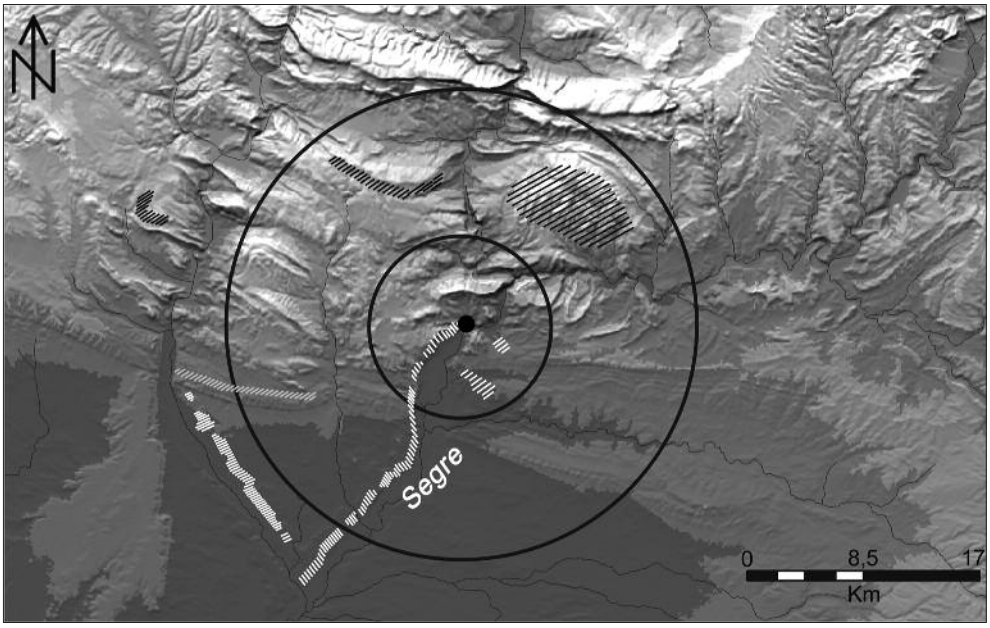


Fig. 11. Distribution of the main raw material outcrops for Roca dels Bous, on the basis of a distance radius of 5 and 20 km, respectively. The river terraces adjacent to the settlement where metamorphic rocks were obtained (white shaded area); and the location of the quarries of the principal types of flint, which originated in Lower Oligocene (grey shaded area) and Palaeocene (black shaded area) formations, are indicated.

opposed to flint. This suggests an expedient use of metamorphic rocks compared with the more intensive management of flint artefacts, at least in the case of retouched pieces.

This selective modification of retouches co-varies with alternative knapping systems. In general, flaking methods indicate intensive reduction that produced small (less than 5 cm) cores which were only abandoned when knapping accidents occurred (fractures, step scars), which made it difficult to continue knapping. Metamorphic rocks were usually reduced by following standardised schemas in order to obtain long sequences of flakes. Although examples of exhausted cores produced by recurrent strategies occur in the case of flint, this raw material was also exploited using methods that only produced a few blanks, usually of small size. In some instances such small flint cores were originally flakes or fragments, from which a few blanks were obtained expediently.

Expedient flaking methods are common throughout the Middle Palaeolithic (Kuhn 1995; Wallace and Shea 2006) but their significance and importance within the technical systems is under discussion. In the case of Roca dels Bous, these methods could be related with reduction sequences that involved a strong spatial and temporal fragmentation of the *chaîne opératoire*. Flint tools were produced outside the site and brought to Roca dels Bous to be used or as reserves of raw material. This pattern involves the intentional transportation of small pieces of flint (as fragments, finished tools, etc.) from which only a limited number of small (but presumably functional) blanks could be obtained.

This could explain the presence of flint Levallois flakes and large retouched pieces, which are not technically consistent with the other flint categories documented at the site (small cores and flakes), and which could have been introduced into the site as finished tools. This possibility entails conscious planning strategies by transporting finished flint tools, even though alternative raw materials were available in the vicinity. These pieces of flint were consistently rejuvenated so that they would remain functional, as shown by tools with heavily retouched edges, a practice already documented elsewhere (i.e., Roth and Dibble 1998).

The greater abundance of flint in N10 compared with N12 suggests more frequent visits into the adjacent area, that is, greater mobility ranges. Although some flint was procured from the adjacent area in N12 as well, the main raw materials obtained were metamorphic rocks. As aforementioned, these raw materials come from a smaller catchment area than in the case of level N10.

These differences cannot be explained by the fact that the outcrops in the adjacent zone were unknown to Neanderthals from N12, since some flint pieces in this level come from the same area as in N10. In fact, these outcrops were used from at least MIS 5e, as observed in the Middle Palaeolithic site of Tragó (Parcerisas 1999; Martínez-Moreno et al. 2004b). This suggests that Neanderthals knew exactly where the raw materials were located. Furthermore, it could suggest that this knowledge was used differently by the occupants of the different levels of Roca dels Bous.

CHANGES IN THE PATTERN OF NEANDERTHAL SETTLEMENT?

Roca dels Bous is located at a strategic point on the southern slopes of the Pyrenees, in the contact between the marginal sierras of the eastern Pre-Pyrenees and the Ebro Valley (Martínez-Moreno et al. 2004a) (see figs. 1 and 11). Two major rivers, the Noguera Pallaresa and the Segre, converge nearby, cutting through various calcareous massifs to create the natural corridors giving access to the inner Pyrenean valleys. Although reservoirs have now been built in these stretches which impede studying the lower terraces of these rivers, it can be inferred that the river network provided the main transit routes between the Ebro Basin and the inner valleys of the Pyrenees.

This has implications for the organisation of subsistence during the local Middle Palaeolithic. Assuming that hunting strategies were a common practice among Neanderthal groups, it could be suggested that knowledge of the landscape was instrumental in monitoring seasonal migrations of game. How do these observations apply to Roca dels Bous? The gorges through which the Pre-Pyrenean fluvial network flows are ideal places for planning and carrying out ambushes, even assuming that only simple tools were used. In N12, the presence of non-local flint implies that Neanderthals episodically crossed the so-called intermediate area (*sensu* Geneste 1985), but the abundance of metamorphic rocks indicates that their activities focused on the settlement's immediate vicinity.

According to this interpretation, occupation of the site could be primarily related with hunting animals during their seasonal migrations through the gorge in which Roca dels Bous is located, since these migrations constitute predictable behaviour that could be monitored from the rockshelter. Thus the targets and needs conditioning the technical strategies of N12 would be based on obtaining abundant materials in the immediate surroundings to make tools for hunting and butchering animals that crossed the area during their seasonal migrations.

In short, level N12 could have operated as a settlement for centralising subsistence activities related with the intensive management of the surrounding area (as the predominance of metamorphic rocks brought to the site would suggest) and to a lesser extent the adjacent area (as the presence of exotic flint indicates). This strategy produced a homogeneous archaeological assemblage that in N12 suggests dense and continuous occupation, although the possibility of various periods of occupation amalgamated by low sedimentary rates cannot be ruled out.

On the other hand, we assume that the occupation of N10 involved larger foraging ranges than in the case of N12, with many of its activities involving trips to the intermediate zone. The selection of flint blanks for transport to the settlement from relatively distant areas suggests a certain capacity for planning and indicates that the rockshelter was used in a different way, involving patterns of greater mobility. Although local raw materials were also brought to N10, the overall technical system seems to be based on a rather fragmented *chaîne opératoire* with a preference for small pieces of flint from outside the local area.

At the same time, while not abundant, some pieces with double patinas indicate that previously abandoned tools were recycled and re-used. This suggests that *scavenging* for lithic objects made the site itself another source of raw materials (Mora et al. 2004). In short, level N10 is characterised by a pattern of high mobility involving brief periods of occupation, an inference that can be drawn from the interstratification of hearths and a low density of artefacts across the area of excavation. This pattern produced spatially defined areas, difficult to correlate with each other, and reinforces the notion of short-term occupation in N10 (de la Torre et al. 2005).

FUTURE APPROACHES: ANALYSING THE CAUSES OF VARIABILITY

In this paper it has been proposed that the variation in the raw materials at Roca dels Bous could be related with changes in the mobility patterns of Neanderthals. This variability implies a reorganisation of technical strategies, which involved variable responses to the availability of resources in the landscape, depending on the activities or purpose for which the settlement was used. In the case of longer periods of occupation, as N12 appears to indicate, raw materials that could easily be obtained in the immediate vicinity were selected. In the case of shorter periods of occupation, such as N10, Neanderthals chose to transport a limited quantity of better quality raw materials from more distant sources.

These inter-layer differences encourage further reflection on the notion of technical variability, and at the same time provide an insight into the cognitive background of pre-modern humans. The scenarios proposed for N10 and N12 should be considered provisional and a more detailed analysis of the sedimentary and archaeological contexts and artefacts is required. The quantitative and qualitative data presented in this paper are not definitive, particularly in the case of N12, where excavations are in progress. However, the preliminary observations sketched in this paper suggest substantial differences between this level and the one above it, N10.

At the beginning of this paper it was pointed out that Neanderthal behaviour has habitually been characterised as monotonous and conservative. In Roca dels Bous there are proxies that can be used to analyse what the concept of variability entails. Changes in the management of raw materials suggest variations in the use of the settlement. It can tentatively be sug-

gested that in N12 such variations are associated with the management of local resources, whereas in N10 a larger foraging range involved visiting the adjacent zone more frequently.

This change in the procurement of raw materials can be correlated with different uses of the settlement. As a hypothesis, it could be proposed that N12 occupants concentrated on obtaining predictable local resources based on the seasonal movements of animals that crossed the immediate vicinity of Roca dels Bous. Prey would be obtained in ambushes planned to catch single animals brought to the site for butchering, a task that could be carried out using local lithic materials.

Thus, N10 could have worked as a point in the landscape to monitor herd migrations between the inner valleys of the Pyrenees and the Ebro Basin. During the formation of level N10, Roca dels Bous would have been used for brief occupations and not as a home base, as part of a broader network of settlements across the Pre-Pyrenees region.

This suggests that mobility strategies depended on the purpose for which the settlement was used. From this point of view, site-use variations indicate that the Neanderthals' responses were influenced by parameters that are difficult to evaluate in strictly cost-benefit terms. Settlement patterns were not governed by normative attributes, but quite the reverse; they were contingent on each particular situation. According to this perspective, it can be assumed that some flexibility existed in order to respond to the needs of specific circumstances, which are difficult to discern on the basis of the static nature of the archaeological record.

At present we cannot determine the causes of these variations or how they affected the organisation of subsistence, but changes in the zoning of raw materials or the intensity of the settlement's occupation are possible consequences of such variability patterns. From a processualist point of view, these variations are usually related with environmental changes. It has been suggested that the brief but severe cyclical environmental crises that occurred during MIS 3 would have affected the southern slopes of the Pyrenees and the Ebro Valley (d'Errico and Sánchez-Goñi 2003). This means that in relatively short periods of time, within a submillennial time scale, the same landscape could present different environmental challenges. Such variability would affect the quantity and distribution of resources, which would in some periods be highly predictable, and in others more scattered and irregular. This would make it necessary to vary (increase and/or reduce) the distribution range of the foraging circuits on the basis of the ecological characteristics of each period.

Perhaps this is the reason that lies behind the reorganisation of Neanderthal strategies at Roca dels Bous. It is tempting to suggest that N12 was a settlement related with monitoring the migrations of animals that roamed the nearby valleys at a time when such animal resources were highly predictable. N10 does not seem to reflect the same pattern, and we suggest that the site operated at the same as an intermediate point on the route of herd migrations, and was used during brief seasonal occupations.

A dynamic scenario, in which different responses succeeded each other depending on changing environmental conditions, is a hypothesis which should be analysed on the basis of more precise information on the impact of climate change on the ecosystems of the Ebro Valley/southern Pyrenees, a process which is still largely unknown. However, the sudden climate changes that occurred in MIS 3, in our view, did not stop the Neanderthals from developing an effective "cultural" environment, in which different options were adopted to deal with a changing ecological scenario.

In contrast with the strictly adaptive approach sketched out above, there are other indicators suggesting that the technical variations recorded in levels N10 and N12 could be influ-

enced by a particular cognitive and cultural background. The tendency to produce small tools or the extreme exhaustion observed in flint and metamorphic rocks cannot be explained only as the result of techno-economic constraints. Rather, they suggest that technical components were designed and produced following idiosyncratic rules. If this is the case, it would have implications concerning the technical and cognitive background of Neanderthals, aspects that in recent years have been analysed from a processual perspective (i.e., Stiner and Kuhn 1992), but which nevertheless—and with some exceptions (e.g., Geneste 1991)—have habitually played a secondary role in historical-cultural approaches.

The notion of Neanderthal technical variability is not easy to define, since it is affected by many internal and external aspects related with the way of life of pre-modern humans. In clarifying systems of subsistence, a central element to be addressed is the experience obtained by combining cultural rules and knowledge transmitted over a long period of time. Numerous attributes are implied in these responses that are difficult to recognise due to the static nature of the archaeological record. We are aware that numerous elements of a contextual/empirical nature are lacking in order to evaluate inferences such as those suggested in this paper, and hope that arguments will be put forward in the coming years to test their validity.

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