Territorial mobility of Abric Romaní level M Neanderthals groups Capellades, Barcelona, Spain)

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Abstract: The Abric Romaní site is located in the northeast Iberian Peninsula, 50 km from Barcelona. The rock-shelter is situated over 317 m above sea level, in a travertine cliff on the right bank of the Anoia river, which is a tributary of the Llobregat river. This river passes by the Capellades locality, excavating a narrow gorge known as the “Cinglera del Capelló”. This corridor crosses the mountain range “Cordillera Prelitoral”, and is considered as a natural passage between the inland and coastal Catalonia regions. This strategic location of the site provides to hominids the possibility to exploit a great variety of biotopes: river beds, plain and plateau, benefiting from a very rich environment. This fact is shown by the continuous presence of humans at the rock-shelter during a long span of time.

The site yielded one of the more important and complete stratigraphic sequences of Europe Middle Paleolithic. Fifteen archeological levels had been excavated as of today (A to O). These levels appear as thin layers interbedded between the sterile travertine platforms. This sequence has been dated by U-series in between 70 and 40 ka BP. Except for the uppermost (level A), which is attributed to the Early Upper Paleolithic, the rest of the archeological horizons correspond to the Middle Paleolithic. Pollen analyses have revealed five climatic phases, ranging from the milder conditions at the bottom to the interstadial climate at the top, correlated with the Hengelo interstadial. It is, consequently, a key site for human’s behaviour studies among Neanderthal groups.

This paper presents the results of studies on resource procurements lithics and animals and on the territory use by Neanderthal groups, through the example of level M dated from about 55 ka BP.

The results of interdisciplinary analysis of lithic (raw material and technological studies) and faunal assemblages (zooarcheology, taphonomy, and paleoecology) suggest that the resource procurement and management is focussed on a local and semi-local exploitation in a geographic area of about 20 km around the rock-shelter.

Mots-clé: Paléolithique moyen, gestion des ressources, mobilité, assemblage faunique, technologie lithique, modes de mobilité

Résumé : L'Abric Romaní est situé dans le nord-est de la Péninsule Ibérique, à 50 km de Barcelone. L'abri sous roche est situé à 317 m d'altitude dans une falaise de travertins sur la rive droite de la rivière Anoia, un affluent du Llobregat. Cette rivière, qui passe par le village de Capellades, a creusé une gorge étroite connu sous le nom de "Cinglera del Capelló". Ce couloir traverse la zone de montagne de la "Cordillera Prelitoral", et est considéré comme un passage naturel entre la région intérieure et la zone côtière de la Catalogne. La situation stratégique du site fournit aux hominidés la possibilité d'exploiter une grande variété de biotopes: cours d'eau, plaine et plateau, bénéficiant ainsi d'environnements très riches. Ceci est attesté par la présence continue de groupes humains dans cet abri pendant une longue période.
Le site a fourni une séquence stratigraphique parmi les importantes et complètes du Paléolithique moyen d'Europe. A ce jour, 15 niveaux ont été fouillés (A à O). Ces niveaux se présentent sous forme de fines couches intercalées de plateformes de travertin stérile. Cette séquence a été datée par la méthode U-Th entre 70.000 et 40.000 BP. Mis à part le niveau supérieur (A), qui est attribué au début du Paléolithique supérieur, les autres horizons archéologiques correspondent au Paléolithique moyen. L'analyse palynologique a révélé cinq phases climatiques, allant de conditions tempérées à la base, à un climat interstadiaire au sommet, corrélé à l'interstade Hengelo. Il s'agit, par conséquence, d'un site clé pour l'étude des comportements des groupes néandertaliens.
Cet article présente les résultats de l'analyse de l'acquisition des ressources lithiques et animales et de l'utilisation du territoire par les groupes néandertaliens à travers l'exemple du niveau M daté d'environ 55 Ka BP.
Les résultats de l'étude interdisciplinaire des assemblages lithiques (incluant matières premières et technologie) et fauniques (archéozoologie, taphonomie et paléoécologie) suggèrent que l'acquisition et la gestion des ressources sont basées sur une exploitation locale et semi-locale d'une zone d'environ 20 km autour de l'abri.

Introduction

At present some studies about Middle Paleolithic are focused on the identification of settlement patterns and mobility strategies. The latter are related and give information about modalities of territorial occupation, variability of archeological assemblages, and cognitive capacities of Neanderthal groups.

The attempt to find the explication about this variability and the reasons that produced it has been developed in various ethnoarcheological studies (e.g. Bartram et al., 1991; Bunn et al., 1988; Binford, 1978; 1980; 1981; O'Connell et al., 1988; Yellen, 1977) and constitute a reference frame for many archeological works (e.g. Kuhn, 1995; Lieberman, 1993). They have demonstrated that the settlement and mobility pattern are the consequence of complex decisions associated to social and environmental factors (Kelly, 1992; 1995). The correlation of these factors can be explained from a dynamical perspective, but not directly transferred to the archeological record (Kroll and Price, 1991; Kent, 1992).

However some researchers (Shott, 1992; Conard, 2001a) proposed that the ethnographical models could be transferred to the past and give a better understanding of the interaction between individual and environment, its relationship with technology, the biotic resources and their use. Although, those models cannot be mechanically transferred to the static archeological record (Kroll and Price 1991).

Since late 1980' the development of zooarcheological studies (e.g. Farizy et al., 1994; Gaudzinski, 1995; 1996; Auguste et al., 1998; Boëda et al., 1998; Cáceres et al., 1998; Meignen et al., 1998; Patou-Mathis, 1996; Stiner, 1994; 2005; Faith and Gordon, in press) has demonstrated that Neanderthals have different hunting strategies and various transport and treatment modalities of animal biomass. These strategies not only require a collaboration and cooperation between human groups, but also a development of anticipations and planning strategies in their territorial mobility.

At the same time, the studies of lithic remains are focused on the procurement and management of raw materials developing different concepts like "embedded procurement" (Binford, 1982a), "approche techno-économique" (Geneste, 1985; 1990), "technological provisioning" (Kuhn, 1995), "technological organization" (Shott, 1986). All of them consider a more direct relationship between the settlement patterns and the organization of the lithic *chaîne opératoire* which provide different ways of technical activities transport and organization and also help us to interpret the functional variability observed in sites (Geneste, 1985; Meignen, 1988; Otte, 1990; Turq, 1992).

Nevertheless, some researchers still question this behavior of activities anticipation and planning realized by the Neanderthals (e.g. Binford, 1982b; Mellars, 1996; Trinkaus, 1986; 1989; Straus, 1996). For them, they are behavior attributed to anatomical modern humans.

Ingold (2000) defined mobility as the strategic displacement of the residential settlement from one location to another in order to obtain vital subsistence resources such as fuel, raw material, water and food. These strategies are designed to reduce risks derived from the discontinuous character of biological resources, such as animals and plants in the landscape. Following this definition, each site represents one stop in a determinate place and during a period of time before to continue the movement across the territory. These displacements can be characterized spatially and temporally, according to the time and the distance covered and whereas the group composition (displacement of a part or the totality), purpose, activities realized during the movements, etc.

Some researches are focused towards the study of the archeological site through two different scales of resolution (Burke, 2006a). The first analyze the function of the site as an individual entity, and the second place the site in a regional scale to establish relationships between other sites of the same geographic area and the land-use patterns (e.g. Conard, 2001b; 2004; Burke, 2006b; Costamagno et al., 2006).

Abric Romaní is an archeological site with a well documented sedimentary context (growth of travertine layers which embed the archeological deposits). Moreover its methodology of excavation (whole surface of the shelter) allows us to realize this kind of analyze. In the first resolution scale, we observe at the spatial level the existence of patterns in the structure, composition and distribution of the archeological record. The hearths play a central role in the space organization. They focused the subsistence activities realized and they are mainly located in the internal zones of the site more protected. Our basic element of study is the discrete archeological material accumulation, the relationship between them, and their function (Vaquero and Pastó, 2001). These kind of studies allow to identify different kinds of settlement patterns (short and long term occupation) (Martínez and Rando, 2001; Vaquero et al., 2001; 2004; Chacón et al., 2001; 2005; Chacón and Fernández-Laso, 2005a, 2005b; Vallverdú et al., 2005; Vaquero, 2005). All this information used in a regional scale lend to reconstruct lithic and faunal *chaîne opératoires* and give us information about the territory occupation pattern so, provide evidence Neanderthals cognitive complexity.

Abric Romaní located at the junction of three ecosystems provide a wide variety of resources for the Neanderthal groups. In this paper we present the results of the multidisciplinary study (such as lithic, bone, and vegetal remains) of the archeological record from the level M. The aim of this work is to realize the first study of this archeological record at two scales of resolution as described by Burke (2006a) to identify subsistence strategies and landscape management developed by the Neanderthals. However we do no compare with other sites, the second scale is limited due to the lack of work on the sites from the same geographical area.

The Abric Romaní: landscape and availability resources

The Abric Romaní site is located in the town of Capellades (north-eastern Spain), 50 km from Barcelona in the Catalonian Prelittoral Chain. It belongs to the Quaternary travertine formations located on the right bank of the Anoia River. The shelter is oriented toward the northeast, and located 317 m above the sea level.

A site like the Abric Romaní which is situated in a strategic position between mountainous inland and coastal plain offers a good opportunity for developing such an integrated approach. This rock-shelter is one of the many cavities found in the travertine complex known as “Cinglera del Capelló” (Capelló cliff) and represents a strategic passage way. Three main ecosystems occupy the area around the shelter: riverside, mountain uphill, and plain beyond the gorge. This territory provides a great variety and quantity of vegetation, faunal and lithic resources to hominids that occupied the site.

The stratigraphic sequence is about 20 m thick; the sedimentary activity is mainly related to the growth of travertine layers, which embed the archeological deposits. Twenty-seven archeological levels have been documented. This sequence has been dated by U-Series to 40-70 ka BP (Bischoff et al., 1988; 1994) (Figure 1).

PLACE FIGURE 1 ABOUT HERE

ACTIVITIES CARRIED OUT ON THE SITE: LEVEL M

The level M is dated to 54.2 ± 3.3 (USGS nº 54) (Bischoff et al., 1988). Over 247 m^2 were excavated and cover the entire surface of the rock-shelter. The archeological record yielded 13993 remains (7906 bones and 6087 lithics). This implies an average density of 56.6 remains by square meter. The characteristic of the travertine surfaces favor the conservation of archeological evidences, such as hearths and wooden implements in negative, pseudomorphs or burnt forms (Carbonell and Castro-Curel, 1992). The calorific impact of hearths is recorded perfectly on these surfaces and the location and size of these structures can be documented even when their sedimentary matrices have been substantially affected by post-depositional processes. Thirty seven hearths were identified in the level M (Figure 2).

PLACE FIGURE 2 ABOUT HERE

The archeological record is distributed on the whole surface although we observed areas with high densities of remains (Figure 3). In this paper we assume that the formation of this level is contemporaneous, and the possibility that this level was the consequence of one or several occupational events. The spatial and archeostratigraphic analysis currently under way will allow to characterize vertically and horizontally this level, and to define the settlement pattern. However those data were not available for this paper.

Vegetal resources

The vegetal resources recorded in level M are known from pollen and charcoal analyses. Each discipline indicates different assemblages which contribute to the knowledge of natural landscape and the exploitation of vegetal raw materials.

The range of dates of level M is within the OIS 3. This level is inserted in a cold phase among warm and humid episodes, in which open space taxa develop (mesothermophilic such as *Quercus* and thermophic as *Pistacia*) (Burjachs and Julià, 1994).

PLACE TABLE 1 ABOUT HERE

All the charcoal remains correspond to residues coming from the use of wood as a combustible. In this level we can identify a total of ten negatives in carbonized wood (NFC) along with thirty wooden negatives (NF) (Figure 2). The paleoenvironmental reconstruction according to the results of charcoal analysis shows a dominance of *Pinus type sylvestris/nigra* and unknown pines (Table 1). These data show a prevalence of cold and dry conditions in open pine areas. The varieties of species of *Pinus* show a change in altitude of the levels of vegetation. We observed two kind of wood exploitation, as firewood (primary access) and raw material to produce wooden tools. In the two cases the use was immediate (Allué, 2002).

PLACE FIGURE 3 ABOUT HERE

Faunal assemblages

The minimum number of individuals (MNI) was calculated from dental remains (Table 2). Non identified bones have been grouped into categories following anatomical and taxonomical criteria. On one hand, we use the categories of long, flat and short bones. Long bones are represented by limbs; flat bones by cranial and axial skeleton; and most of short bones are located at the end of the limbs. On the other hand, bones have been grouped by animal weight, taking into account the taxon and the age of animals. The following categories have been selected: large-sized (>300 kg), medium-sized (between 150 and 300 kg) and small-sized animals (>150 kg).

The faunal assemblage from the level M is characterized by (1) a high number of remains (NR=7906) in comparison to the other upper levels, (2) a high degree of bone breakage (54.52% of total are ≤2cm long), and (3) a high percentage of bones with signs of cremation (12.7% on maximum degrees). The intense bone breakage produced by human activities (6.9% of the NR) has made difficult anatomical and taxonomical identification.

PLACE TABLE 2 ABOUT HERE

The main species identified are *Cervus elaphus* and *Equus ferus*, specifically combined with *Bos primigenius*. The mortality profile shows that all age categories are represented, although prime adults are dominant, immature and old adults are also present (Table 2). The season of settlement was estimated by studying teeth with reduced use-wear (wear stage corresponding to the eruption of the tooth out of the gum). This criterion was used for detecting seasonality on isolated teeth, mandibles and maxillae using data from modern red deer (*Cervus elaphus*). Stages of tooth development were identified and assigned a score according to a scheme developed for modern red deer (Mariezkurrema, 1983; Carter, 1998). The molar dentition of two individuals (over a MNI of 9) compare favorably with animals which died between 17 and 18 months (Figure 3C). Taking into account that for modern red deer birth occurs in June (Nowak, 1999), we can propose that red deer were hunted from October to December. However, because the archeostratigraphy is currently under study, we cannot generalize this result to all hunting activities from the level M.

The skeletal part profiles shows differences between large-sized animals and medium and small sized animals. Large-sized animals are only represented by heads and forequarter and hindquarter (scapulae, humerus, radio-ulna, femur and tibia), axial skeleton, forefoot and hindfoot (metacarpal, metatarsal) and compact foot bones (carpal, tarsal and phalanges) are not represented. Sometimes axial skeletons of medium and small-sized animals were introduced to the site.

These differences result of a differential transport realized by hominids. This strategy varies depending on the type of processing (Perkins and Daly, 1968; Binford, 1978, 1981; Brain, 1981; Bunn, 1986; Klein, 1989; Gifford-Gonzalez, 1991; Faith and Gordon, in press). The results of the zooarcheological and taphonomical analysis indicate that they developed systematic and repetitive behavior patterns to obtain and consume animals. Large-sized animals, given their weight, were not transported integrally inside the shelter, and parts were transported selectively. A first processing (preparation and dismembering) took place at the location where the animals were obtained, being consumed and/or leaving those anatomic parts with the lowest meat content. The heads, forequarter and hindquarter were then transported to be eaten in the shelter. Medium-sized animals were often integrally transported to the Abric Romaní, where they were processed and consumed. This pattern is repeated in the upper levels, highlighting an early and persistent reliance on herbivores Everything suggests systematic activity related to the size of the animals, likely reflecting hunting strategies (Carbonell et al. 1992; 1996; 2002; Aïmene et al., 1996; Cáceres, 1998; Cáceres et al., 1998; Rosell, 2001; Vaquero et al., 2001; Cáceres, 2002; Chacón et al., 2005a; 2005b; in press).

Cutmarks highlight different activities related to herbivore processing, although they clearly depend on the animal size. Defleshing and long bone scraping are represented on animals of all sizes. Evisceration was only identified on medium-sized animals, not on large-sized ones due to absence of elements from the thoracic cavity. This pattern is repeated with the skinning identified in medium and small-sized animals. The bone fracture technique applied to obtain marrow implies separating the two epiphyses from the shafts longitudinally. There is a large number of percussion cones and marks. We observe a systematic fracturing of epiphysis, which is not well represented in this level.

The hominids carried out their activities around the hearths. Some bones present signs of heating by fire. They are usually small fragments located in or close to the combustion areas. We identified cutmarks on burned bones, so after preparing and consuming the animals, hominids threw the bones to the hearths (Figure 3B and C).

Lithic technology

The number of lithic remains recovered in level M is high (Table 3) in comparison to the others levels of the stratigraphic sequence (Vaquero, 1999; Vallverdú et al., 2005; Martínez et al., 2005; Chacón et al., in press). Only level J has a similar total lithic assemblage (Martínez and Rando, 2001; Vaquero, 1999).

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Flint is the dominant raw material (81%) but a great variety of other rocks (n=10) have been identified in this level. A part of flint, limestone, sandstone and slate show reduction sequences realized in the site. The others are only represented by finished products (flakes and retouched tools).

The raw materials have been introduced in various ways. Several modalities have been documented: whole blocs or pebbles, cores tested, cores in the first moments of the reduction sequence, middle or large tool blanks and retouched tools. The closest raw materials are generally introduced without modifications. It is the case for limestone, sandstone, and slate. Although the quartz has the same supply areas, in this level it shows a similar introduction pattern than agate, quartzite, porphyry, and granite that were brought to the site as final knapping products. The flint, raw material which procurement requires the longest displacement in the territory shows all kinds of introduction cited above (Table 4).

PLACE TABLE 4 ABOUT HERE

This technological behavior reflects some capacities of anticipation and prevision, in the frame of their displacements linked to the subsistence activities. This pattern can be integrated in the provisioning individual model proposed by Kuhn (1992, 1995). Lithic artifacts and raw materials were also transported for reserves (tool kit), in order to maintain a minimum resource availability to face unexpected problems. The ways of introducing lithic resources into the site reflects the spatial and temporal breakage of the *chaînes opératoires*. Moreover the core transport shows the discontinuous character of the lithic resource management, not only at the intersite level, but also at the intrasite one.

The aims of *chaînes opératoires* are the knapping products. Cores and retouched tools are very scarce (Table 3). This pattern is the general rule in the lithic assemblages of Abric Romaní sequence, but in level M it is even lower. The core reduction was organized by dividing it in two opposed secant surfaces, separated by an intersection plane (normally the horizontal). This reduction strategy offers a wide variability which depends on the relationship between the two flaking surfaces. This level is mainly characterized by non-hierarchical strategies (Figure 3D). We have to point out the presence of some cores whose attribution to the discoid method has raised doubts because their morphotechnical characteristics are close to the Levallois method (Boëda, 1993; 1994). We do not observe different knapping methods on raw materials. Strategies were identical for all kinds of rocks. Cores tended to be exhausted, flint ones especially, and the final stages of reduction are characterized by a systematic production of small flakes and by a change in the striking surface from horizontal to transversal. This change makes possible the total optimization of the core by obtaining the latest possible flakes on this small supports. These patterns reflect an economic behavior, characteristic of the whole technical system.

The knapping products are mainly small and medium-sized (90% $\leq$ 40 mm). There is no laminar tendency but we have to point out that in level M the percentage is higher (1.2 %) than in other levels of the sequence. The retouched tools are found principally on the biggest and thickest flakes, and are essentially denticulates (57.2 %) with side-scrapers (28.5 %) and some notches (14.3%). Retouch is usually lateral, unifacial, direct, and it does not affect more than 25% of the edge and does not modify the general morphology of the tool (Figure 3E).

As far as raw materials are concerned, they do not represent all the possibilities offered by the environment, but their selection is determined by cultural factors. They are a selective answer to the constraints imposed by the technical system used, and do not reflect the diversity of the close environment. Flint was mainly exploited for the reduction and configuration sequences, because it is the best suitable raw material for knapping, although its procurement entails the longest displacement in the territory and requires more time and energy.

ACTIVITIES CARRIED OUT OF THE SITE: LEVEL M

Biotic resources: vegetation and animals

The pollen sequence shows a large variety of woody taxa that grew in different environments from the region (Burjachs and Julià, 1994). Herbaceous plants and pines are the most important taxa in the pollen assemblage. Trees, shrubs, pines, and junipers were the main species of the arboreal cover. Other taxa such as *Quercus*, *Rhamnus*, *Olea-Phillyrea* and *Syringa* were also present. There were also riverside taxa, including *Populus*, *Alnus*, *Salix* and *Ulmus*.

The palynological analysis shows a dominance of arboreal pollen, suggesting a mild cold climate (pine forest). Thermophylous taxa were constrained to places where extreme conditions were ameliorated by the Mediterranean influence, as well as by the proximity of water sources in the Capellades Strait area. The rest of the surrounding landscape was steppe-like, occupied by plains of *Poaceae*, *Asteraceae* and *Artemisia*. Finally, the climatic evolution of this part of the archeological sequence shows an environmental context which progressively worsens in level M to L (mild cold conditions) and reaches the least favourable climatic conditions in levels I and H (Burjachs and Julià, 1994).

We can assume that the surroundings of the site were a pine forest, which does not exclude other biotopes, such as the river side formations in distant areas. During the Paleolithic, the forest resource exploitation depended basically on the environmental constraints. They were important and diverse, in areas with favorable climatic conditions especially. Immediate needs had to be fulfilled during short occupations and consequently the most abundant and nearest wood resource available were exploited for fuel. Moreover the species that produce more dead wood are more likely to have been chosen as fuel. It is the case for pine tree. This species produces more deadwood than others such as junipers. The perishable character of fuelwood and its immediate use do not require a selection process. This raw material is not dependent on quality as it could be for wood manufacturing (Allué and García-Antón, 2006).

The ecological conditions of the surrounding landscape of Abric Romaní offer a wide variety of habitats with high diversity of large mammals. The remains of carnivores are scarce and evidences of their activities were identified with the presence of coprolites and tooth marks on bones. In normal conditions the Abric Romaní is not an ideal habitat for this kind of animal because the formation of travertine involves high humidity levels. Nevertheless, as the ground of the site approaches the roof, there is a greater cave-like environment and the presence of carnivores is more frequent. Consequently, most of them are concentrated in the upper levels (Cáceres et al. 1993; Carbonell et al., 1996). It was documented the presence of ursids, canids, felids and hyenas that show/indicate an abundance and variety of herbivores in the environment as potential preys. So, we would find equines and rhinoceros in the open plain situated in the two side of Capellades Strait, and cross it the Anoia river. In the same way the cervids has a similar emplacement although more integrated in the open forest of conifers. The bovids are situated closer of the river beds. In the top of the mountain we find the caprins. All this herbivores have been identified in the different levels of the Abric Romaní site into the anthropic contexts.

The species of ungulates identified in the level M were analyzed to provide information about their habitats and the Neanderthal behavior. For this purpose we selected dental microwear analysis to provide a better reconstruction of paleodiets and paleoenvironments. The microwear analysis was performed following methods described by Solounias and Semprebon (2002) and Semprebon et al. (2004). We made high-resolution epoxy casts for 37 molar teeth. Casts were screened using a stereomicroscope and any specimens exhibiting signs of weathering were excluded (only two specimens). Our sample is made of 35 teeth which were suitable for microwear analysis: 13 for *Equus*, 19 for *Cervus*, and only three for *Bos*. The latter is a too small sample to get definite results. However because we have a few number of species, we decided to keep the sample. Microwear features were identified and quantified using a stereomicroscope under a 35x magnification. Those features were categorized as pits and scratches of various sizes and textures (Figure 4). To approximate their frequency, they are counted in a standard 0.4 x 0.4 mm square area on the lingual (inner) band of enamel on the paracone of the upper second molar and on the protoconid of the lower second molar.

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Summary statistics of microwear features for the three species are given in Table 5. The three species plot either in the grazing morphospace, or in the grazing-dominated mixed feeding morphospace (Figure 5). Both *Cervus elaphus* and *Bos primigenius* (even if the latter is a very small sample) plot close to each other and they fall in or near the grazing morphospace. *Equus ferus*, with high number of scratches, is located in the high abrasion end of the spectrum. Its diet was certainly more abrasive than the diet of *C. elaphus* or *B. primigenius*. Our findings suggest that the ungulates hunted in the level M enjoyed large amounts of high abrasive plants, such as grasses. This is especially true for *Equus* who has here a diet with higher abrasive level than any other modern ungulates. Because grasses are incorporated more in the diet of the fossil when they are abundant in the environment, we propose that they were selectively feeding on grasses. All three species selected open habitats probably because forest habitats were probably not very abundant at this time around the rock shelter. Their diet reveals here a rather cold climate as suggested by the faunal association this study) and by the pollen analysis (Burjachs and Julià, 1994). We can suggest that *E. ferus* was living in open grasslands, whereas *C. elaphus* and *B. primigenius* were probably in areas where ligneous plants (trees or shrubs) were more abundant.

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Abiotics resources: Raw materials

The studies realized until now about the origin of lithic resources at Abric Romaní have been focused on levels I, E (Morant, 1997; Morant and García-Antón, 2000; Bofarull, 1997) and L (currently under study). This works have based their methodology on a wide geological prospecting and rocks sampling (mainly flint). Subsequently the samples were analyzed using crystallographic rayon X diffraction and two kinds of microscopes: petrographic (Olympus BH2) and SEM (Scanning Electronic Microscope Jeol JSM-6400).

In relation to these studies different supply raw materials areas have been identified. These include flint and Paleozoic stones in primary position and other in secondary position that provide the same kind of rock that in the primary positions and also limestones and sandstones good for knapping (Table 4, Figure 6).

The raw materials closer to the site are located in the secondary outcrops on the fluvial terraces of Anoia River and the Carme (CME) and Sant Quintí de Mediona (SQM). Those conglomerates areas contain clasts and their dismantling would have allowed to get raw materials. The stones of Palezoic origin (PZC) are situated in primary position, although their materials come from quaternary dismantling of the terraces and the colluviums near the site. The predominant raw materials are quartz, slate, porphyry and quartzite.

All the siliceous outcrops identified are semi local and their distance is about 20 km from the site. Flint angular clasts also appeared in the Anoia River terrace.

The closest outcrop from the site (≥ 8-10 km) belongs to the Trias (Lower Muschelkak) and is situated towards the west in the dolomitic limestones mountains near Sant Quintí de Mediona (MED). It contains flint lens nodules of 20 cm, with a grey bluish coloration.

The flint of Valldeperes (VLD) formation appears in different positions in the same formation. In this work the rocks from Vallespinosa and Llacuna have been analyzed. They are located about ≥18-20 km towards the west-northwest from the archeological site. This outcrops origin is the Paleogene (Cuisiensian-Lutetian) evaporitic formation with bluish brown flint blocs fits in marls and lacustrine clays.

Near the Sant Martí de Tous (SMT) appears a Lagoonal area which belongs to the Paleogene (Sanonian) gypsum bearing (evaporitic) formation. It contains flint translucent nodules (black, bluish and reddish) and blocks measuring up to 1 m.

In relation to the limestone we identified a primary position outcrop near the site from ≥ 4-10 km toward the west. This is the Orpí formation belonging to the Eocene (Ilerdian) and formed by biomicritic marine limestone. They are brown light yellowish with *Nummulites perforatis* fossils and various alveolines.

The raw materials more used (Tabla industria) are flint from Vallespinosa (VLD) y Sant Martí de Tous (SMT) and limestone from the Anoia River and Orpí formation, probably because of their suitability for knapping.

Discussion and Conclusions

The Abric Romaní rock-shelter, due to its natural strategic situation and the higher resources availability, was a passing site inside the territory exploited by prehistoric settlers during thousands of years**.** Multidisciplinary studies of levels M have shown that Neanderthals hunter-gatherers exploited intensively their environment and their subsistence strategies are based on wide range mobility on the territory (Figure 6).

PLACE FIGURE 6 ABOUT HERE

Biotic resources, both fauna and vegetation, show a local exploitation. First of all, considering the faunal resources they have developed strategies mainly focused to obtain two species: red deer and horses punctually associated with bovids. These species related to ecosystems of plains indicate a mobility axe oriented towards the open areas in the Anoia Valley. Hunting, at least for red deer, occurred during the transition from the warm to the cold season autumn. Assessing the season of kill using mandibular tooth development and wear in red deer has made a significant contribution to solving the problem of when the level M at Abric Romaní was occupied. Identifying at what time of the year humans were present at the site means that wider issues such as social and economic structure may be better addressed.

The MNI suggests a high degree of animal exploitation (food) indicating a high availability of animal resources in the surrounding. Animal processing varies in relation to their weight. Horses and bovids were exploited in the killing site to make their transport to the shelter easier and also to reduce the energetic spending. Red deer were transported entirely to the site and their exploitation is totally realized in the site. The principal activities developed are the meat filleting and the bones breakage to obtain the bone marrow. These strategies of animal transport and exploitation show that hunting requires the cooperation and planning of the hominid groups.

In the other hand Neanderthals exploited different vegetal resources for fuelwood or to make wood artifacts. The most used species is *Pinus nigra* the most abundant in the surrounding environment. They do not use the species of river plains although they are closer to the site. The need of an immediate resource makes the operative chain of fire production an important activity that was solved at low energy costs (Allué, 2002).

In contrast to the biotic resources the abiotic ones show local and semi-local exploitation but they came principally from longer distance areas (Table 4). Flint is the main raw material (Table 3) used, and was collected further away from the site, about 5-10 km at least. The local raw material has two different models to introduction. Limestone and sandstone are introduced without modification and the complete reduction sequence was carried out in the site. The other local raw materials (Paleozoic rocks) were introduced as finished knapping products. There are two evident mobility axes. The first one has a northwest-southeast direction following the Anoia River bed towards Prelitoral Depression. In this area they collected the siliceous materials from Sant Martí de Tous (SMT) and Ódena (ODN). The other one have an east-west direction from the terraces in front of the site following by the Carme valley towards Vallespinosa (VLD). In this area they collected the Orpí limestone and the Valldeperes flint. For Orpí, the mobility direction is evident because the raw material appears in the downstream Anoia.

The difference between biotic and abiotic resources is usually linked to the easy reuse of the second ones. While biotic resources as wood and meat are perishable and permit one use only, abiotic resources may be recycled by tool resharpening or reuse of broken pieces. Biotics resources show a procurement pattern for immediate use, the abiotics resources do not necessarily follow the same pattern of profiting from the closest ones. They could be employed according to other selection criteria, such as their quality and aptitude for knapping.

The results from this first study of level M archeological record allow us to propose that the Neanderthals mobility patterns have had a whole knowledge of the territory and its resources, as well as a high degree of planning and anticipation. These mobility strategies also indicate the ecosocial complexity and the organization of the subsistence activities.

Comparing level M with the other levels of the sequence we observe that mobility pattern and resources procurement are similar but some differences can be recognized. If we consider the animal resources the Neanderthals selected red deer and horse in a systematic and repetitive way in all the levels of the sequence. Sometimes these two species are specially combined to bovids. We observe a higher variety of species in the upper levels and in the level Ja. This high specific diversity could be related to long-term occupations (Carbonell et al. 1992; 1996; 2002; Saladié, 1998; Rosell, 2001; Vaquero et al. 2001; Cáceres, 2002).

The patterns of lithic resources procurement show diachronic changes. These variations between different levels depend on the lithological diversity used, but flint was always preferentially selected. The only rupture identified in this pattern was observed in the intermediate levels (H, I and K), where percentages of flint are similar to local raw materials (limestone and quartz). Level Ja shows the most similar lithic resources procurement and management to level M (Bofarull, 1997; Morant, 1998; Vaquero, 1999; Morant and García-Antón, 2000; Carbonell et al. 2002; Chacón et al., in press).

The procurement patterns and territorial mobility observed in level M is very similar to those proposed for other archeological sites from the same chronological period such as Roca del Bous, Lleida (Martínez et al., 2004; Mora et al., 2004), Payre, Ardèche (Moncel et al., 2002; Moncel, 2003), or La Combette, Vaucluse (Texier et al., 1998).

The archeostratigraphic study currently under way will provide more information about the cognitive and settlement patterns developed in the site to distinguish the kind of occupation patterns in level M.

Future studies of this site and other Middle Paleolithic sites documented in the geographical area will enable us to obtain broader knowledge about the mobility of Neanderthals and their patterns of activity in the region. In this way, the realization of the second scale of analysis proposed in this article will be totally possible.

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FIGURES CAPTION LIST

Figure 1. (A) Abric Romaní geographic location and schematic lithostratigraphy of the sequence with the U-Series dates. (B) General view of the excavation in the level M. (C) General view of a part of the"Cinglera del Capelló". (C1) Front of the site. (C2) General view of the Anoia Valley.

Figure 2. (A) Wooden implements in negative. (B) Negative in carbonized wood. (C) Hearth

Figure3. (A) General distribution of the level M archaeological remains. (B) Bone refit. (C) Mandibule of red deer (C. elaphus) with M3 in eruption. (D) Discoidal core in flint. (E) Denticulate in flint.

Figure 4. Photomicrographs of Equus ferus (A) and Cervus elaphus (B) tooth surfaces at 35× magnification under a stereomicroscope. Scale bar equals 0.2 mm. Specimens numbers: AR'02-M-S50/55 (A) and AR'00-M-N47/41 (B).

Figure 5. Bivariate plot of the average number of pits versus average number of scratches in extant ungulates and fossils from the level M at 35× magnification (extant data from Solounias and Semprebon, 2002). Convex hulls are drawn around extant leaf browsing taxa and extant grazing taxa for ease of comparison.

Figure 6. Distribution map of the potential resources collected by Neanderthal groups from Abric Romaní.

Table 1. Results of charcoal analysis in the level M (Allué, 2002)

Taxons	NR	% NR
Pinus type *sylvestris/nigra*	154	52.2
Pinus type *sylvestris/uncinata*	4	1.5
Pinus sp.	17	6.5
Undetermined conifers	68	26.2
Undetermined	17	6.5
TOTAL		

Table 2. Number of identified specimens (NISP) and percentage (%NISP) and Minimum Number of Individuals by tooth (MNI) recovered at level M

	NISP	*%NISP*	*NMI*				
			Juvenile	*Immature*	*Subadult*	*Prime*	*Old*
Equus ferus	58	11.39		2		4	
Cervus elaphus	435	85.46	1		1	5	2
Bos primigenius	16	3.14		1		2	
Total	509	100	1	3	1	11	2

Table 3. Lithic assemblage from level M. Values in parentheses are percentages

	Flint	**Limestone**	**Quartz**	**Slate**	**Sandstone**	**Granite**	**Quartzite**	**Agate**	**Porphyry**	**Stalagmite**	**Jasper**	**TOTAL**
Unworked nodules		5 (62.5)			3 (37.5)							8 (.13)
Hammerstones		17 (89.47)		1 (5.26)	1 (5.26)							19 (.31)
Hammerstones fragments		7 (100)										7 (.11)
Cores	32 (78.05)	8 (19.51)			1 (2.44)							41 (.67)
Cores fragments	14 (87.5)	2 (12.5)										16 (.26)
Retouched tools	33 (82.5)	2 (5)	1 (2.5)	3 (7.5)						1 (2.5)		40 (.66)
Flakes	2666 (92.67)	149 (5.18)	27 (.94)	15 (.52)	2 (.07)	6 (.21)	5 (.17)	3 (.1)	3 (.1)		1 (.03)	2877 (47.26)
Flakes fragments	2152 (80.66)	293 (10.98)	115 (4.31)	101 (3.79)	2 (.07)	2 (.07)	2 (.07)	1 (.04)				2668 (43.83)
Fragments	18 (4.38)	94 (22.87)	180 (43.8)	115 (27.98)	3 (.73)	1 (.24)						411 (6.75)
TOTAL	4915 (80.75)	577 (9.48)	323 (5.31)	235 (3.86)	12 (.2)	9 (.15)	7 (.11)	4 (.07)	3 (.05)	1 (.02)	1 (.02)	6087

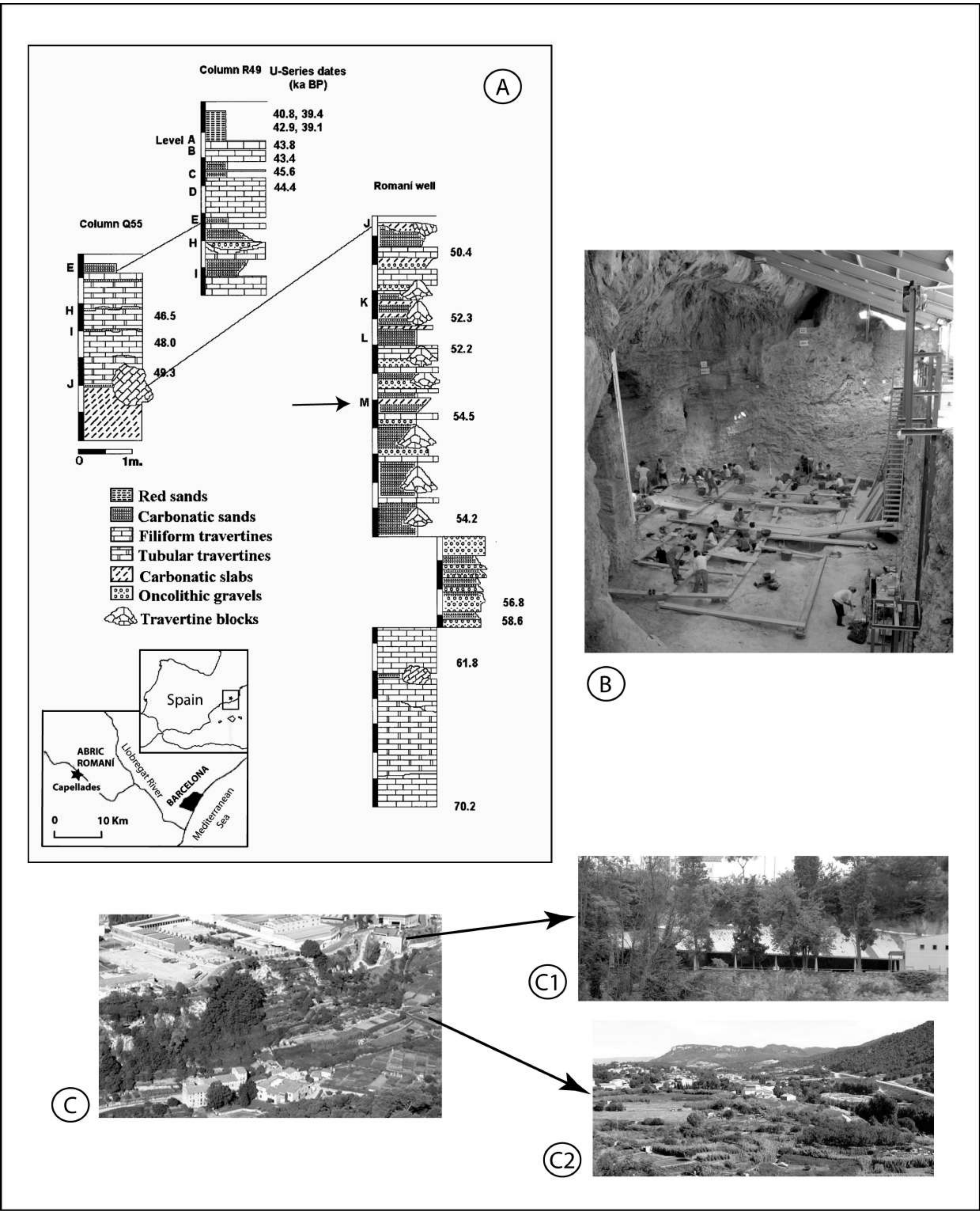
Table 4. Localisation and description of the raw lithic materials formation.

Geological formation age	Geological formation description	Outcrop location (*)	Raw material	Microscopic Texture	DRX	Size	Suitability for knapping	Distance
Eocene (Cuisiensian-Lutetian)	Valldeperes formation, Palaeogene evaporitic formation with flint blocs (whit metric dimensions) fits in marls and lacustrine clays	Vallespinosa (VLD)	flint in primary position	crypto to microquartz and fibrous LFC	quartz & moganite	≤ 1 m	good for knapping	≥ 15-20 km
Triassic (Lower Muschelkalk)	dolomitic limestone formation that contains flint lens nodules	St. Quíntí de Mediona (MED)	flint in primary position	cryptoquartz Small mosaic quartz & calcite	quartz, calcite & dolomite	20 cm	knapping difficult (by the internal fractures)	≥ 8-10 km
Oligocene (Sannonian)	lagoonal area which belongs to gypsum bearing (evaporitic) formation that contains flint translucent nodules and blocks	St. Martí de Tous (SMT)	flint in primary position	(♣)	(♣)	≤ 1 m	good for knapping	≥ 18-20 km
Eocene (Ilerdian)	marine limestone Orpí formation that contains fossils (*Nummulites perforatis*) and microfossils (severals types of alveolines)	Orpí	limestone in primary position	biomicrite	calcite	≤ 50 cm	good for knapping	≥ 4-10 km
Eocene (Cuisiensian-Lutetian)	conglomerate coarse detritic facies with rounded flint nodules	Carme (CME)	flint in secondary position	cryptoquartz Small mosaic quartz & larger crystal calcite	quartz, calcite & moganite	≤ 5 cm	good for knapping	≥ 3 km
Late Upper Miocene (Turolian)	stratified conglomerates formation that contains calcareous and siliceous rounded clasts whose	St. Quínti de Mediona (SQM)	flint in secondary position	crypto to microquartz and fibrous LFC mosaic quartz & euhedral quartz	quartz	6-18 cm	variable knapping suitability	≥ 5-10 km
Paleozoic (Ordovícian)	materials come from quaternary dismantling of the terraces and the colluviums	Capellades Strait (PZC)	slate, quartz, porphyry and quartzite in primary position	-	-	5-40 cm	variable knapping suitability	in front of the site ≥ 300 m
Quaternary	fluvial stepped terrace deposits that contains in sandy matrix, pebbles (**) and cobbles (***)	Anoia River	limestone, flint and quartz in secondary position	-	-	≤ 6 cm (**) ≥ 25 cm (***)	variable knapping suitability	≥ 150 m

(*) origin place of the samples. (**) pebbles size. (***) cobbles size. (♣) In process of study. LFC= Length-Fast Chalcedony.

Table 5. Summary statistics for the microwear features in the level M

	Number of specimens	Statistics	Number of pits	Number of scratches
Equus ferus	**13**	**Mean**	**11.8**	**34.3**
		Standard deviation	3.0	4.5
		Coefficient of variation	25.5	13
Cervus elaphus	**19**	**Mean**	**9.8**	**28.2**
		Standard deviation	1.9	4.2
		Coefficient of variation	19.8	14.9
Bos primigineus	**3**	**Mean**	**9.7**	**25.9**
		Standard deviation	2.7	9.7
		Coefficient of variation	27.6	37.6


A
Column R49
U-Series dates (ka BP)
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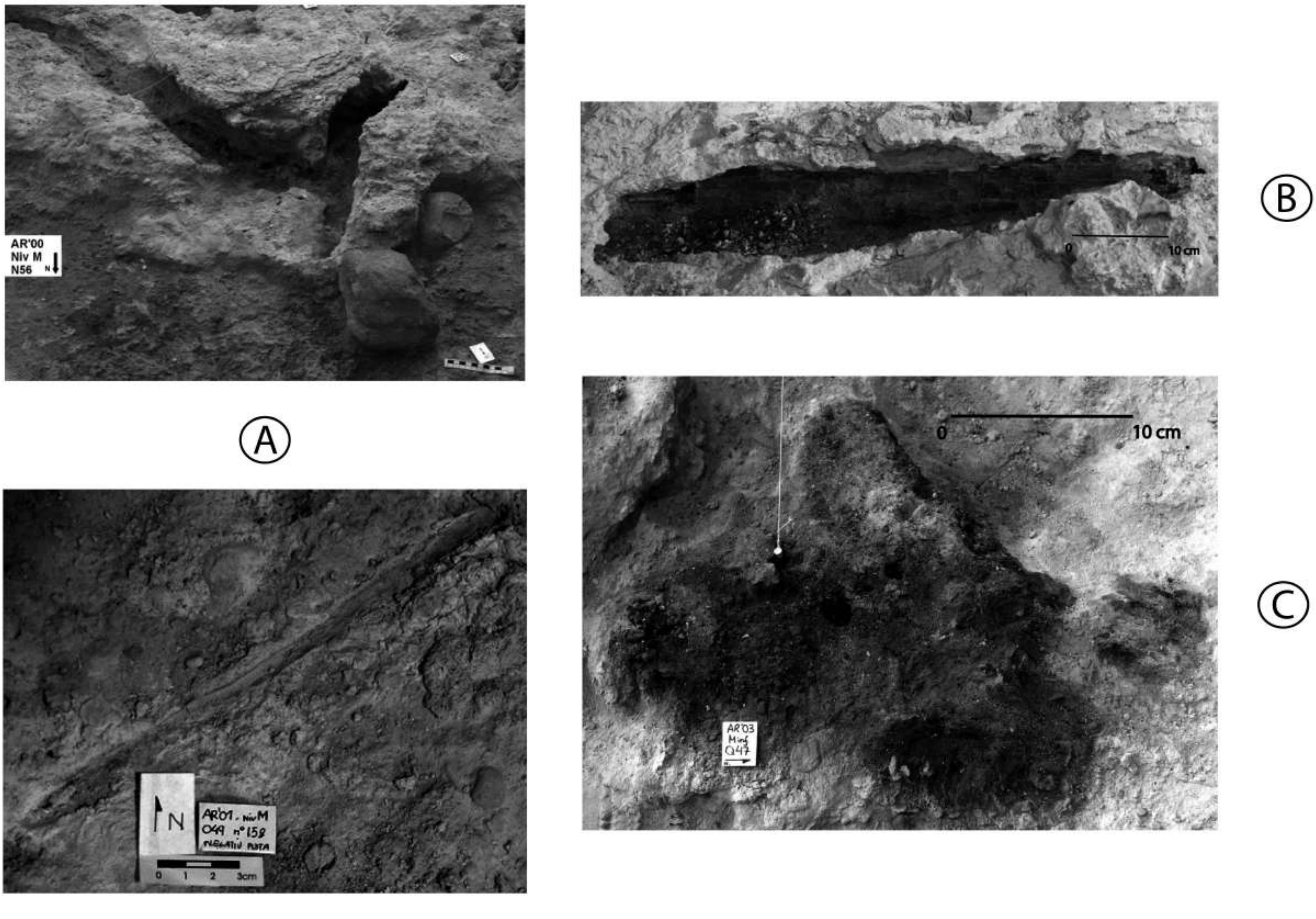
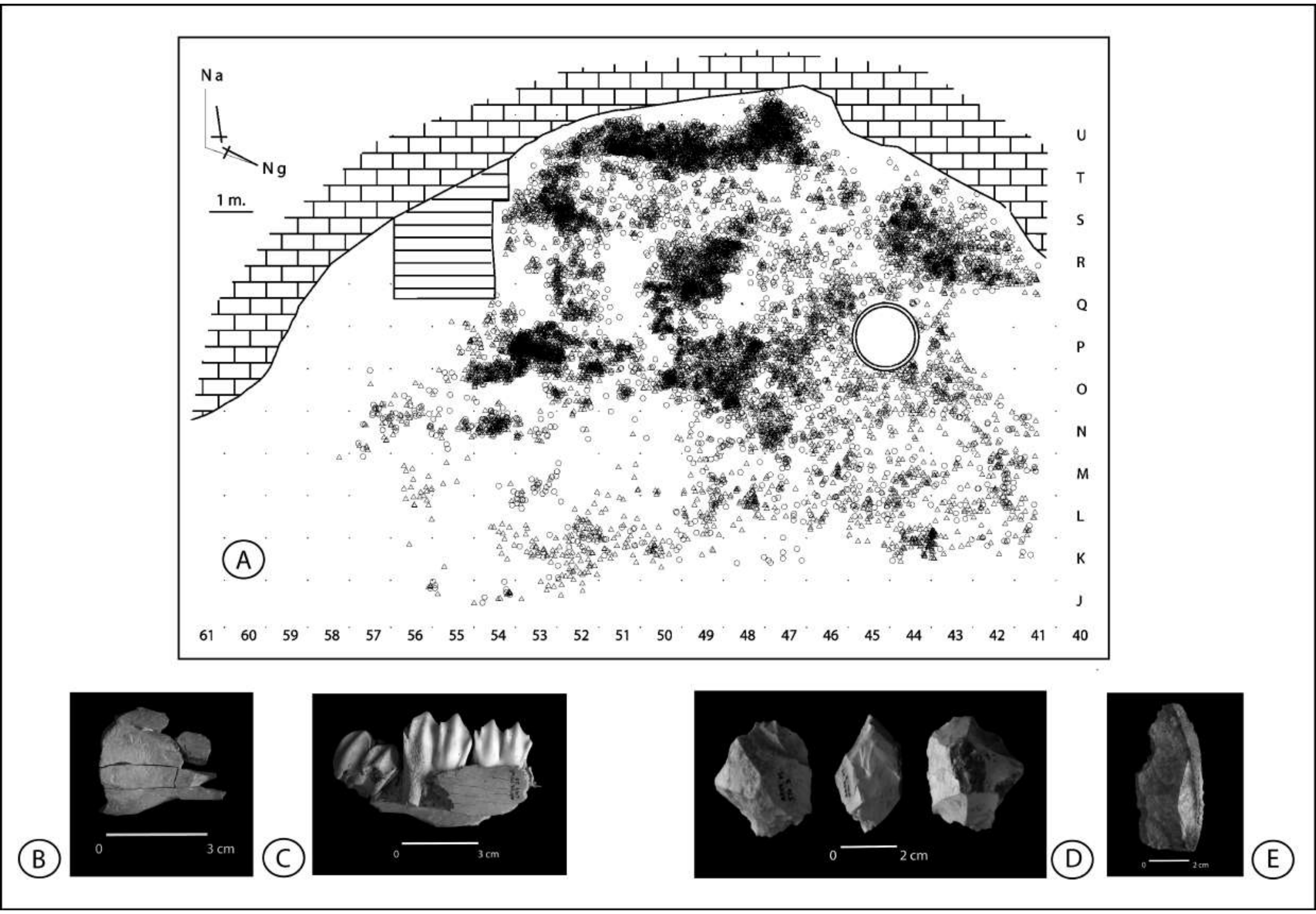
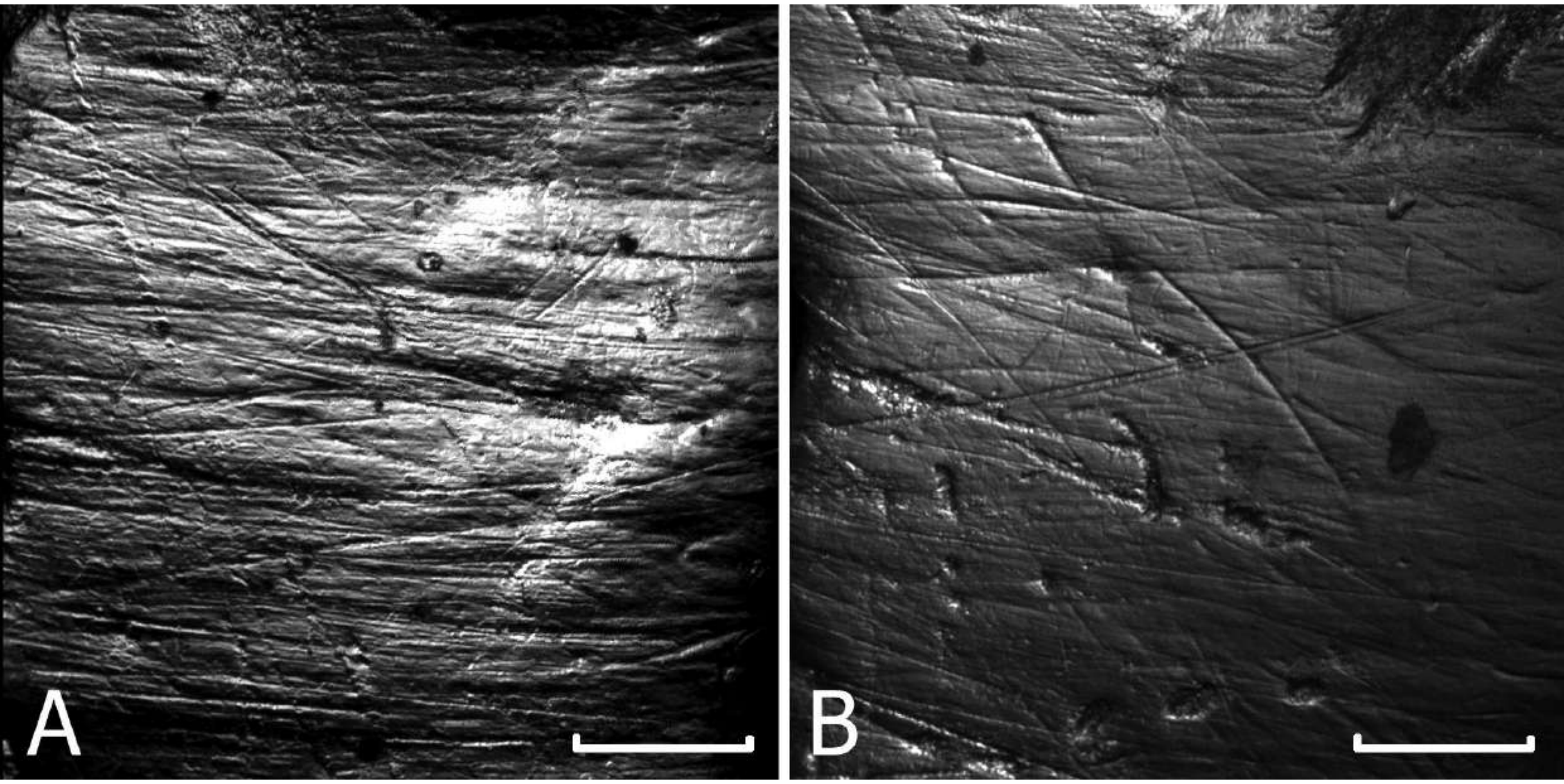
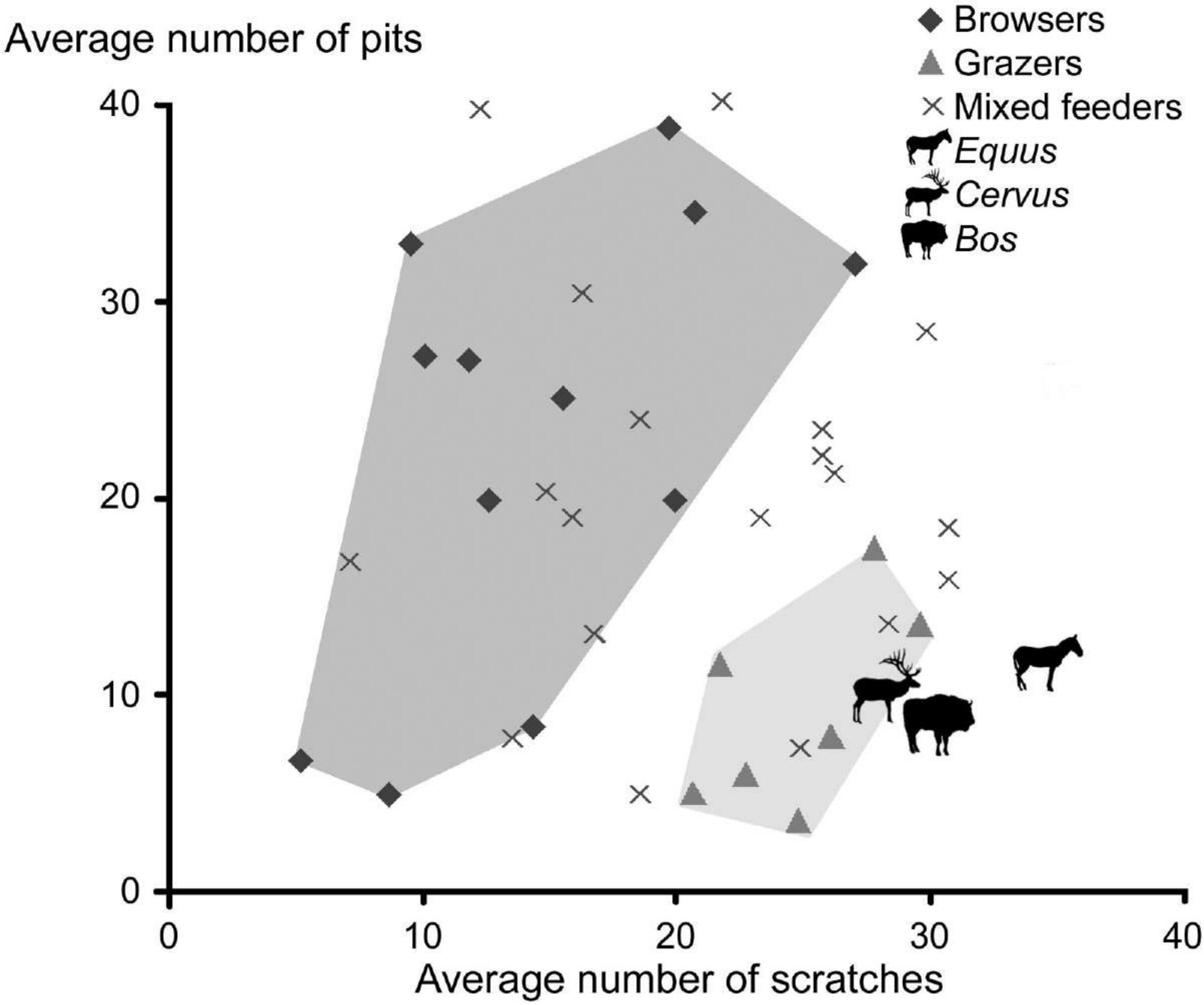
42.9, 39.1
Level A
B
C
D
E
H
I
43.8
43.4
45.6
44.4
Column Q55
E
H
I
J
46.5
48.0
49.3
0
1m.
Romaní well
J
K
L
M
50.4
52.3
52.2
54.5
54.2
56.8
58.6
61.8
70.2
Red sands
Carbonatic sands
Filiform travertines
Tubular travertines
Carbonatic slabs
Oncolithic gravels
Travertine blocks
Spain
ABRIC ROMANÍ
Capellades
Llobregat River
BARCELONA
Mediterranean Sea
0
10 Km
B
C
C1
C2

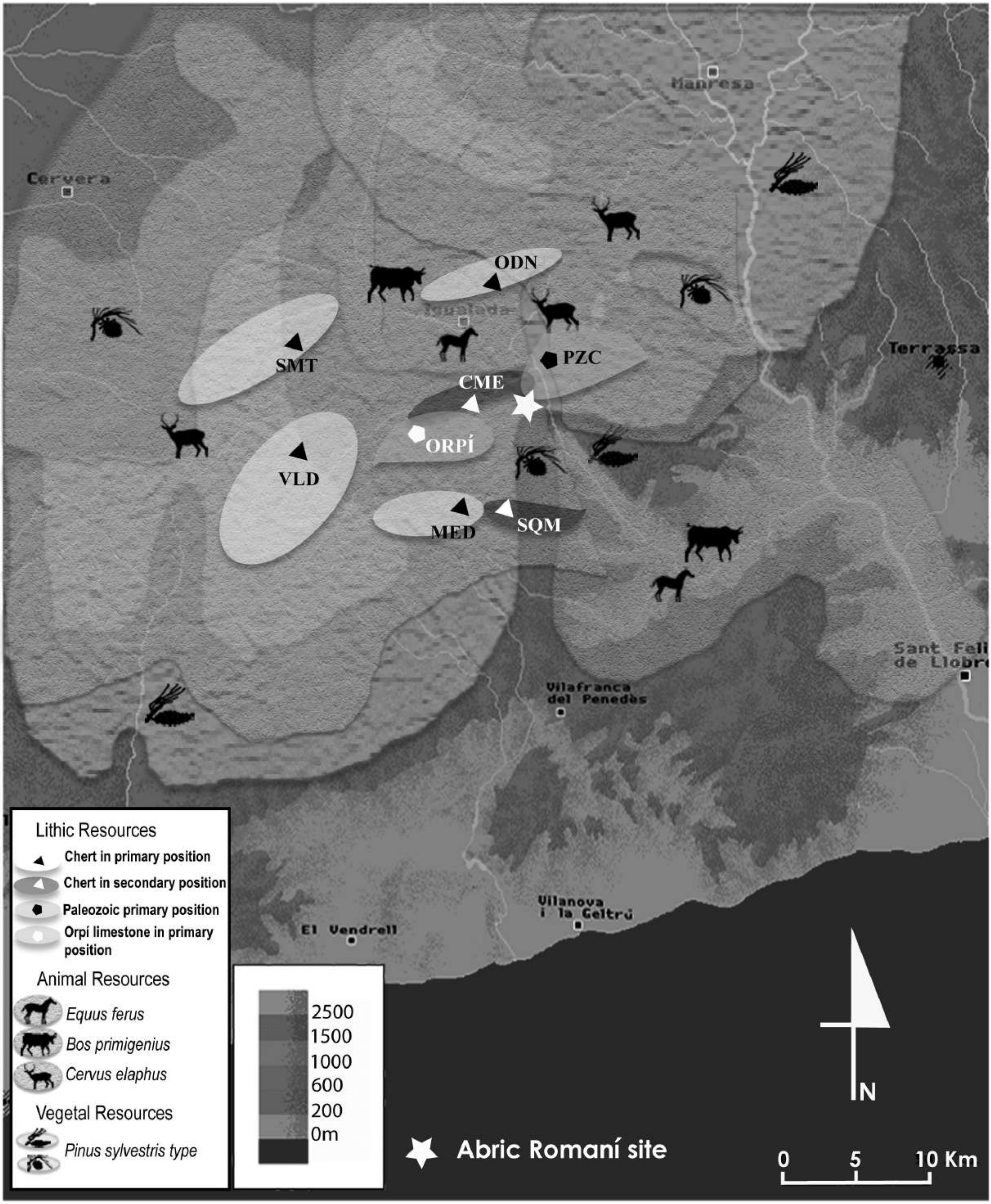

AR'00
Niv M
N56
N
A
B
0
10 cm
AR'01 - niv M
O49 n°158
N
0 1 2 3cm
0
10 cm
AR'03
M inf
Q47
C


Na
Ng
1 m.
U
T
S
R
Q
P
O
N
M
L
K
J
61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40
A
B
0
3 cm
C
0
3 cm
0
2 cm
D
0
2 cm
E


A
B



Average number of pits
Browsers
Grazers
Mixed feeders
Equus
Cervus
Bos
40
30
20
10
0
0
10
20
30
40
Average number of scratches



Manresa
Cervera
Igualada
Terrassa
Sant Feli de Llobr
Vilafranca del Penedès
Vilanova i la Geltrú
El Vendrell
ODN
SMT
PZC
CME
ORPÍ
VLD
MED
SQM
Lithic Resources
Chert in primary position
Chert in secondary position
Paleozoic primary position
Orpí limestone in primary position
Animal Resources
Equus ferus
Bos primigenius
Cervus elaphus
Vegetal Resources
Pinus sylvestris type
2500
1500
1000
600
200
0m
Abric Romaní site
N
0
5
10 Km