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RESSOURCES LITHIQUES, PRODUCTIONS ET TRANSFERTS ENTRE ALPES ET MÉDITERRANÉE

ACTES DE LA SÉANCE
DE LA SOCIÉTÉ PRÉHISTORIQUE FRANÇAISE
NICE
28-29 MARS 2013

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Antonin Tomasso, Didier Binder, Gabriele Martino,
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5

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Raw-Material Procurement and Productive Sequences in the Palaeolithic of Southern Italy: the Tyrrhenian and Ionian Areas

An Integrated Approach to the Reconstruction of Human Behaviour.

Francesca Romagnoli, Francesco Trenti, Lorenzo Nannini, Leonardo Carmignani,
Giulia Ricci, Domenico Lo Vetro, Fabio Martini and Lucia Sarti

Abstract: The analysis of geological patterns has become a focus of research in European Palaeolithic archaeology in order to identify strategies in raw-material procurement and to interpret past technical behaviour. The reconstruction of past geological landscapes enables the correlation of archaeological assemblages with raw-material provenance and large-scale transport patterns. The evidence for procurement strategies and the patterns of raw-material exploitation and transport have been used to assess mobility and cognitive abilities among Palaeolithic groups, revealing differing strategies between Middle and Upper Palaeolithic hunter-gatherers. While Neanderthals seem to have organised their technology in a local or semi-local territory, modern humans have shown a more intense exploitation of distant sources. This scenario has been challenged over the last few years. Several studies have highlighted more complex environmental exploitation by Neanderthals through the catchment of distant lithic resources. The universities of Florence and Siena are engaged in a long-term project of geological survey that aims to identify lithic sources used during the Palaeolithic. Geological research has been carried out in parallel with technological analysis of archaeological lithic assemblages from the Mousterian layers of Grotta del Cavallo (Apulia, south-east Italy) and the Upper Palaeolithic layers of Grotta del Romito (Campania, south-west Italy). The project aims to answer specific questions regarding raw-material procurement: is it possible to predict human behaviour based on the distance between the settlement and the raw-material source? How did raw materials influence the variability of lithic assemblages? And, with regard to this latter question, which strategies were applied by hunter-gatherers regarding the use of the landscape and the available resources found within it? The integrated analysis of archaeological finds and ancient geological landscapes enables us to develop a complex scenario in which the rigid definition of the knapping concept and the economic strategies (e.g. curated and expedient behaviour) seems to be more strictly related to cultural constraints (shared knowledge, technical innovations and social and economic organisation) than to geophysical ones. We present here the methodology of geo-archaeological surveys and the preliminary results obtained for production sequences and procurement strategies at Grotta del Cavallo during the Middle Palaeolithic. At Grotta del Cavallo it could be evidenced that the human groups had great high mobility, which exceeded 50 km. Differences in techno-economy throughout the stratigraphical sequence of this site suggest that human strategies were influenced by several factors, including site use, demographic patterns and technical tradition, which generated various methods of adaptation to the available resources. The future implementation of this line of research, the integration of subsistence strategies and climate change analyses with that of stone tool assemblages and mobility, will make it possible to understand human behaviour and to explain the considerable variability of the archaeological record.

Keywords: Middle Palaeolithic, Upper Palaeolithic, techno-economy of lithic assemblages, mobility, human behaviour, Italy.

Résumé : L'analyse des ressources géologiques est devenue un thème central de recherche en archéologie paléolithique en Europe lorsqu'il s'agit d'identifier les stratégies d'approvisionnement des matières premières et d'interpréter les comportements techniques du passé. La reconstruction du paysage géologique des périodes étudiées permet de corréler les assemblages archéologiques avec l'origine des matières premières et les modes de transport à grande échelle. Les stratégies d'approvisionnement des matières premières ainsi que les modes de transport et d'exploitation ont été utilisés pour évaluer la mobilité et les capacités cognitives des groupes paléolithiques, montrant des stratégies qui différaient entre les chasseurs-cueilleurs du Paléolithique moyen et ceux du Paléolithique supérieur. Alors que les Néandertaliens semblent avoir organisé leur technologie sur un territoire local ou semi-local, les *Homo sapiens* semblent avoir été en mesure d'exploiter fortement des ressources éloignées au cours du Paléolithique moyen. Plusieurs exemples de transport sur de longues distances ont été présentés ces dernières années, apportant la preuve de l'existence de stratégies d'exploitation complexes du territoire par les Néandertaliens. Les universités de Florence et de Sienne ont initié un projet à long terme d'études géologiques visant à collecter et analyser des ressources lithiques utilisées pendant le Paléolithique. Les recherches géologiques ont été réalisées parallèlement à l'analyse technologique des assemblages lithiques archéologiques des niveaux moustériens de la Grotta del Cavallo (Pouilles, Sud-Est de l'Italie) et du Paléolithique supérieur de la Grotta del Romito (Campanie, Sud-Ouest de l'Italie). Les recherches visent à répondre à des questions spécifiques liées à l'approvisionnement en matières premières, comme par exemple: la distance à la source constitue-t-elle un indicateur du comportement humain ? Comment la matière première conditionne-t-elle la variabilité des assemblages lithiques ? Et, en rapport avec celle-ci, dans quelle mesure cette même variabilité a-t-elle été prise en compte par les chasseurs-cueilleurs dans leur utilisation des ressources disponibles et du paysage en général ? L'analyse intégrée des découvertes archéologiques et le paysage géologique du passé nous permettent de comprendre un scénario complexe, dans lequel la définition rigide du concept de débitage et des stratégies économiques (par exemple, « comportement structuré et opportuniste ») semble être plus étroitement liée aux contraintes culturelles (connaissance partagée, innovations techniques et organisation sociale et économique) qu'aux contraintes géophysiques. Nous présentons ici la méthodologie des prospections géo-archéologiques et les résultats préliminaires sur des séquences de production et les stratégies d'approvisionnement à la Grotta del Cavallo au cours du Paléolithique moyen. À la Grotta del Cavallo, nous avons montré une grande mobilité des groupes humains sur des distances de plus de 50 km. Les différences techno-économiques observées tout au long de la séquence stratigraphique de ce site suggèrent que les stratégies humaines ont plusieurs causes, dont l'utilisation du site, les tendances démographiques et la tradition technique qui ont généré différentes adaptations aux ressources disponibles. La future application de cette ligne de recherche, avec l'intégration des stratégies de subsistance et les changements climatiques dans l'analyse des assemblages lithiques et de la mobilité permettra de comprendre le comportement humain en interprétant la grande variabilité des témoins archéologiques.

Mots-clés : Paléolithique moyen, Paléolithique supérieur, techno-économie des industries lithiques, mobilité, comportement humain, Italie.

For a long time archaeological studies on Palaeolithic hunter-gatherers have dealt with the mobility of human groups. In recent decades, raw-material economy has become a research focus in Europe and has led to the petrographic and geological identification of lithic resources in the landscape and of archaeological lithic remains (Geneste, 1989 and 1992; Féblot-Augustins, 1997; Féblot-Augustins et al., 2005; Turq, 2005; Fernandes and Raynal, 2006; Fernandes et al., 2007 and 2008; Riel-Salvatore and Negrino, 2009; Duke and Steele 2010; Browne and Wilson, 2011; Eixea et al., 2011; Aubry et al., 2012; Olivares et al., 2013, among others). The integrated analysis of geological and technological patterns makes it possible to correlate the archaeological assemblages with resources located in the environment and addresses raw-material provenance and large-scale transport patterns. Because raw materials are distributed throughout the landscape, their procurement implies the investment of time and energy (Bousman, 1993). Palaeolithic data suggest that these technological factors, including transport distance, influenced human economic strategies, while resource availability influenced technological strategies. Raw materials are usually divided into local and non-local based on their distance from the site. According to many authors, resources available within a radius of 5 km from the site are considered as local, while regional or semi-local resources are 6 to 20 km away, and exogenous resources are more than 20 km distant (e.g. Geneste, 1989; Féblot-Augustins, 1999 and 2009; Fernandes et al., 2008).

Raw-material procurement analysis revealed that the Middle Palaeolithic hunter-gatherers preferred local and semi-local lithic resources, which constituted at least 90% of the assemblages, although the exploitation of raw materials from sources located farther than 50 km away has been identified at several sites (e.g. Geneste, 1988; Roebroeks et al., 1988; Féblot-Augustins, 1993, 1999 and 2009; Chalard et al., 2007; Slimak and Giraud, 2007; Porraz, 2010). Since the beginning of the Upper Palaeolithic *Homo sapiens* experienced various strategies for the exploitation of environmental resources, as is attested by the increasing quantities of generally fine-grained and highly homogeneous raw materials originating from more distant sources (e.g. Soffer, 1989; Dobosi, 1991; Mellars, 1996; Demars, 1998; Kuhn, 2004; Tomasso et al., 2014).

Evidence for procurement strategies and patterns of raw-material exploitation and transport were used to assess mobility (Thacker, 1996; Blades, 1999; Andrefsky, 2009; Delagnes and Rendu, 2011) and cognitive abilities (Roebroeks et al., 1988; Stiles, 1998) among Palaeolithic groups. Most artefacts made from exogenous resources were retouched tools and show signs of long-term use and re-sharpening (Geneste, 1988; Féblot-Augustins, 1993; Bourguignon et al., 2006; Delagnes et al., 2006). This observation fits with the idea of procurement strategies that involved preliminary planning and the transport of finished tools or of specific raw materials not available in the places in which they were needed (Kuhn, 1992, 1995 and 2004).

Teams of the universities from Florence and Siena carried out studies on Palaeolithic raw materials in Southern Italy for several years (Martini et al., 2003 and 2006) in order to understand the technological and economical aspects of lithic production and to reconstruct the mobil-

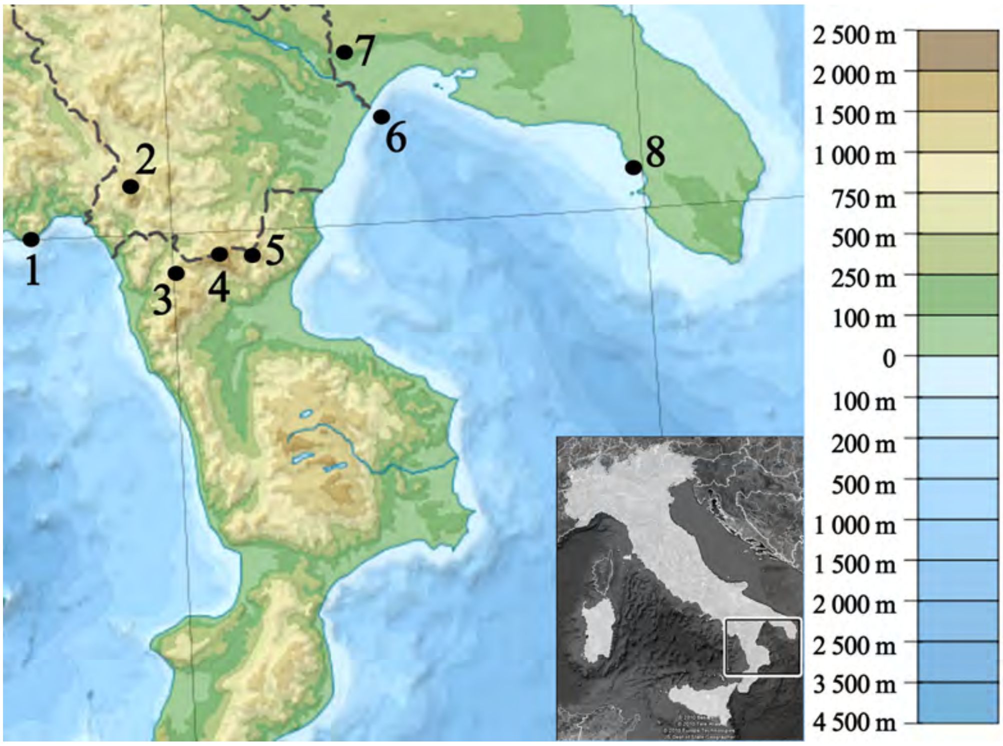

Fig. 1 – Study region and location of the main sites and geographic landmarks mentioned in the text. 1: Grotta della Serratura; 2: Sirino Mount; 3: Grotta del Romito; 4: Pollino Mount; 5: Serra di Crispo; 6: mouth of Bradano river; 7: Ginosa; 8: Grotta del Cavallo.

Fig. 1 – Région d'étude et localisation des sites et des principaux points géographiques mentionnés dans le texte. 1 : Grotta della Serratura ; 2 : Mont Sirino ; 3 : Grotta del Romito ; 4 : Mont Pollino ; 5 : Serra di Crispo ; 6 : embouchure de la rivière Bradano ; 7 : Ginosa ; 8 : Grotta del Cavallo.

ity patterns of hunter-gatherer communities. The research focused on two separate areas (fig. 1) and time periods: the Salento region of Southern Apulia in the eastern part of Southern Italy, for the Middle Palaeolithic, and the Tyrrhenian coast of Calabria in the western part of Southern Italy, for the Upper Palaeolithic (Gravettian and Epigravettian).

Many studies have considered the transfer distances related to time, the energy input and the quality of the raw materials in relation to the task for which the tools were designed (e.g. Renfrew, 1977; Torrence, 1983 and 1989; Ataman et al., 1992; Elston, 1992; Kuhn, 1992, 1995 and 2004; Bamforth, 2006; Brantingham 2006). Clearly many factors have to be taken into account when we consider why humans collected a specific raw material in a specific place, and why they may have divided the operational sequence *(chaîne opératoire)* of this raw material within their environment, including landscape geography, subsistence strategies, level of human planning and, obviously, cultural decisions. Furthermore we must consider that lithic technology, subsistence strategies, resource procurement, processing and transport efforts have a dynamic interaction within the environmental setting and the technical traditions of human groups (e.g. Binford, 1980; Shott, 1986; Geneste, 1988; Wilson, 2007; Romagnoli, 2015). Our hypothesis is that the selection of raw materials depended on numerous factors, such as the duration of occupation of the site, technical traditions, the presence of specialised craftsmen, the social organisation of the groups, expedient behaviours, and social networks. Accordingly, judging only from the distance between the sites and the lithic sources would not be an adequate criterion to explain the variability of technical behaviour, for the relationships between raw materials, technical variability and hunter-gatherer mobility should also be taken into account. Could the distance from the source predict human behaviour? How did raw materials condition the variability of lithic assemblages? And, correlated with this latter question, what were the strategies used by hunter-gatherers for the exploitation of available resources and of the environment in general?

We therefore launched a long-term project of geological surveys that aimed at collecting and analysing the lithic sources (of both good and poor quality) in primary and secondary deposits. The previous technological analysis of the archaeological stone remains was the basis for the geological surveys. Our study aimed at correlating the geological environment with the mobility patterns, procurement strategies and technical traditions of the Palaeolithic hunter-gatherers and it was based on two main archaeological sites: Grotta del Cavallo (Middle Palaeolithic, Lecce, Apulia; fig. 1) and Grotta del Romito (Upper Palaeolithic, Cosenza, Calabria; fig. 1).

This article presents the methodology of the geological-archaeological surveys of the two areas analysed in our projects. The results concerning mobility patterns and productive strategies are described in detail for the Middle Palaeolithic sequence of Grotta del Cavallo, and the strategies of raw-material transport and use are discussed, as well as the relevance of the integration of raw-material analysis into the behavioural approach.

THE RAW-MATERIAL STUDIES CARRIED OUT IN SOUTHERN ITALY

The method implemented for this geo-archaeological study is based on a protocol previously tested in other studies carried out on lithic raw materials, mainly using accurate and extensive ground investigation surveys as well as petrologic analysis of geological and archaeological samples (Turq, 2005; Eixea et al., 2014; Soto et al., 2014; Tomasso et al., 2014; Wilson, 2014). As part of a major multidisciplinary research project on Palaeolithic human frequentation of Southern Italy, this method was used for the first time by the University of Florence in 2001 in order to characterise the lithic raw materials of Gravettian and Epigravettian assemblages stemming from Grotta della Serratura (Marina di Camerota), a coastal site in the Cilento region (Southern Calabria; fig. 1). The geological surveys covered a wide area including the Cilento region and the Tyrrhenian reliefs of Basilicata (Mount Sirino and surroundings areas; fig. 1; Martini et al., 2003 and 2006). Geological investigations were later extended to the adjacent Tyrrhenian side of Northern Calabria with the aim of characterising lithic raw materials exploited during the Upper Palaeolithic at Grotta del Romito (Papasidero, Cosenza; Martini et al., 2006 and 2007). In 2009 a new season of surveys was carried out in Northern Calabria and Southern Basilicata based on the data stemming from the previous studies and including petrologic analysis of the geological samples collected and of the archaeological materials recovered from Grotta del Romito (Nannini, 2008–2009; Martini and Lo Vetro, 2011). In 2010 this method was used on the Apulian Ionian side to identify the lithic raw materials of the assemblages recovered from the Middle Palaeolithic layers of Grotta del Cavallo (Romagnoli, 2012 and 2015).

The method used consists of four main stages, as follows: 1) preliminary analysis of the geographic and geological context including the study of the geological literature on the archaeological data of the area under investigation; 2) geographical survey and sample collection; 3) macroscopic and microscopic analysis of the samples; 4) interpretation of the results.

The main goals are:

1) to reconstruct the mobility patterns of Palaeolithic hunter-gatherers;

2) to identify the technical processes and the economic strategies that led to the production of lithic assemblages;

3) to understand human behaviour and local resource exploitation strategies in relation to the regional setting and the diachronic changes in the environment.

In a first stage the analysis of geographical maps and geographical environments makes it possible to identify possible changes from prehistoric to present times (Rapp and Hill, 1998) and to classify the raw materials on the basis of the distances to the site and the displacement range. Numerous archaeological and ethnographical studies that focused on lithic procurement strategies suggest that the most appropriate area to be surveyed for raw material lies within a 30 km radius off the archaeological site (Binford, 1982; Turq, 1989; Geneste, 1992; Féblot-Augustins, 1999).

The formations containing exploitable flints were identified and mapped thanks to geological cartography and previous studies (Spinapolice, 2012). The daily displacement range depends on the difficulties related to the environment and the terrain (Wilson, 2007), which differs between the Salento and south Tyrrhenian areas. Salento is a flat peninsula with low hills in its southern portion that never rise above 200 m. By contrast the south Tyrrhenian area is characterised by a few coastal plains (restricted to the mouths of the rivers) and inland mountains over 1,000 m, some of which exceed 2,000 m in altitude, for example Mount Sirino, Mount Pollino, and Serra di Crispo (fig. 1).

Usually the local procurement area is based on the distance that can be covered during a one-day trip, taking into account an average rate of 5 km/h. According to the geographical features reported for Grotta del Cavallo, the limit between local and exogenous raw materials was fixed at 20 km in a straight line from the site, as it has been assumed that Palaeolithic people had a displacement rate of about 5 km/h for eight hours per day (Jarman and Webley, 1975). For Grotta del Romito this limit was fixed at 8 km in a straight line from the site. The limit, previously fixed at 10 km for Grotta della Serratura (Martini et al., 2007), was revised to adapt it to the geomorphological environment of Grotta del Romito. The inland of Calabria consists of a rough morphology with relevant physical obstacles. Taking into account the landscape, the limit between local and exogenous raw materials was assumed to coincide with the watershed of the Lao river valley, as well as with the routes along which the Palaeolithic hunter-gatherers roamed for hunting.

In a second research stage, surveys and samplings were carried out on the basis of the analysis of geological maps and literature. All the formations containing exploitable stone resources were sampled and the results were entered in a database in which geographical coordinates (GPS point), extent, slope and typology of the outcrops were recorded.

In a third stage both geological and archaeological samples were analysed macroscopically and microscopically, described, and compared with each other. Thin sections were cut for petrographical analysis. Macroscopic examination addressed the morphology of the support (block, nodule, pebble), the colour, the texture (showing the roughness of the surface to touch), the transparency, and the presence or type of internal structures (sedimentary structure, fissures and geodes, oxides or carbonates). Microscopic examination addressed particle size and microfossils content (Luedtke, 1992; Rapp and Hill, 1998; Fernandes et al., 2006). A stereomicroscope (SMZ-2T; Nikon, Tokyo, Japan) to analyse complete samples and a transmission microscope (C-4000Z BX51; Olympus, Tokyo, Japan) to observe thin sections were used. All the samples and thin sections were registered and classified in the rock collection of the Museo Fiorentino di Preistoria (Florence, Italy).

In a fourth stage the data gained from the previous three stages were combined to formulate a comprehensive process of raw-material procurement.

The geological study was carried out in combination with the technological analysis of the archaeological lithic assemblages, which was finalised to reconstruct past technical behaviour. The morpho-technical attributes of all the assemblages were analysed, reconstructing the life cycle of lithic artefacts from the discovery of the raw material to the discarding of the tools (Perlès, 1991; Inizan et al., 1995; Baena et al., 2010). The integrated approach combining geological and technological analysis aimed to evaluate human adaptation to the environment and to available resources, and to identify and interpret the technical strategies.

GEOLOGICAL CONTEXT

Ionian site of Apulia

Salento is a large plain without any obstacles for a long distance. The environment is geologically homogeneous and is composed of limestone units (Serre Salentine) outcropping in long ridges arranged north-west to south-east. These units are the result of tectonic events that occurred during the Cretaceous and the Early Pleistocene. The local limestone unit related to the Grotta del Cavallo area is called ‘Melissano limestone’ (Martinis, 1968; Largaiolli et al., 1969; Commissione Italiana di Stratigrafia, 2003). This formation is composed of a great variety of medium-fine grained microcrystalline limestone and dolomitic limestone. Occurring in joint sets, blocks of raw material are abundant throughout the formation. Chert is completely absent from the Salento formations, as attested to on the geological maps and confirmed by surveys carried out in 2010 across the whole Ionian side of Apulia. The cave opened onto a large plain during the last marine regressions (Siddall et al., 2003; Dorale et al., 2010), which have reached a maximum distance from the cave of approximately 12-15 km.

Geological sampling was carried out within a 30 km range off the cave. All the inter-formational varieties of lithotypes were sampled. The limestone lithotypes of the Melissano limestone formation are all abundant and easily available in the surroundings of the cave (< 5 km), both in primary and secondary position (fig. 2). The raw material was classified as follows: 1) limestone *sensu stricto*, 2) silicified limestone, and 3) laminated limestone with cleavages. Each lithotype exhibits a variety of colours and textures. To a varying degree of regularity all the lithotypes break with a conchoidal fracture. All the local lithotypes are attested to in the Middle Palaeolithic archaeological assemblages of Grotta del Cavallo and these raw materials were the most intensively exploited by Neanderthals at this site (Carmignani, 2011; Romagnoli, 2012 and 2015).

With the aim of identifying sources of fine-grained raw materials, sampling was extended from the south of the Salento peninsula to the border between Basilicata and Apulia (Fossa Bradanica), where, inside the alluvial deposits of the Bradano river, conglomerates with abundant Apennine siliceous pebbles have been found (chert and green radiolarites). The Bradano deposit consists of marine terraces that originated between the Late Pliocene and Middle Pleistocene. After the Upper Pleistocene marine regression, rivers began their erosion and accumulation activities that still characterise the Fossa Bradanica plain today (Lazzari and Pieri, 2002; Lazzari, 2008). The dimensions of the pebbles collected in the Bradano deposits vary from approximately 3 to 15 cm in diameter and all the pebbles evidence mechanical alteration on the rounded outer surface (fig. 3). The easy availability of this raw material also suggests that these deposits were possible procurement sources during the Pleistocene. Preliminary thin-section analyses have confirmed this hypothesis. The sources are located at a distance of 80–100 km from the cave. It is possible that in Palaeolithic times cobbles were collected at the mouths of the rivers or along the shores that were located closest to the cave. In any case, the small dimensions of the cobbles in the alluvial deposits near Ginosa suggest that the collection site was located nearby, given that the stone sizes usually decrease in parallel with the increase of the distance covered.

South Tyrrhenian side

The south Tyrrhenian area exhibits a great ecological variety, with several coastal plains (especially near the mouths of the rivers) with mountains reaching peaks up to 2,000 m (Mount Sirino and Mount Pollino) in the hinterland. Calabria displays a rough morphology with distinct natural barriers, in particular inland.

The archaeological assemblages recovered from the Grotta della Serratura and Grotta del Romito sites were usually made of high-quality flint. The geological context of the south Tyrrhenian side is varied and four formations have been identified as possible sources for raw material (Fogli 210 and 220, Carta Geologica d’Italia; fig. 4A): flint-bearing limestones (TsT4); siliceous shales containing radiolarites (G11Ts), grey flint-bearing limestone (MiE), and polygenic breccia containing black and grey chert (PCCs).

Fig. 2 – Grotta del Cavallo, Middle Palaeolithic. Variety of medium-fine grained microcristalline limestone and limestone *sensu strictu* sampled in the local Melissano limestone formation (photos F. Romagnoli).
Fig. 2 – Grotta del Cavallo, Paléolithique moyen. Variété de calcaire microcristallin et calcaire* sensu stricto *échantillonné dans la formation locale des calcaires de Melissano (clichés F. Romagnoli).

At Grotta del Romito (table 1) the lithic varieties primarily occurring in the archaeological assemblages are (fig. 4D, a-b) the following:

1) red and green radiolarites stemming from Mount Sirino (siliceous shale): these could be collected from the Noce river deposits as pebbles measuring 3 to 10 cm in diameter, at about 15–20 km directly from the cave. These raw materials were also widely exploited at Grotta della Serratura and were mainly collected close to the cave on the shores and in riverbeds (Martini et al., 2003, 2006 and 2007);

2) black chert, characterised by a poor quality and many fractures, which may have been collected from the Lao river deposits, near the cave (about 300 m away) and up to 5–7 km upstream. This kind of chert probably stems from polygenic breccias outcropping along the Lao valley, but we found it only in secondary deposits in the riverbed;

3) greyscale chert usually characterised by medium-poor quality, possibly from polygenic breccia outcrops.

Some high-quality chert lithotypes documented in the archaeological record were not localised in the local environment and perhaps came from a more distant source, possibly from Basilicata (about 50 km away). Indeed, preliminary surveys carried out in the Lucan Apennine outcrops and in their alluvial deposits, suggest possible procurement in this area (fig. 4D, c).

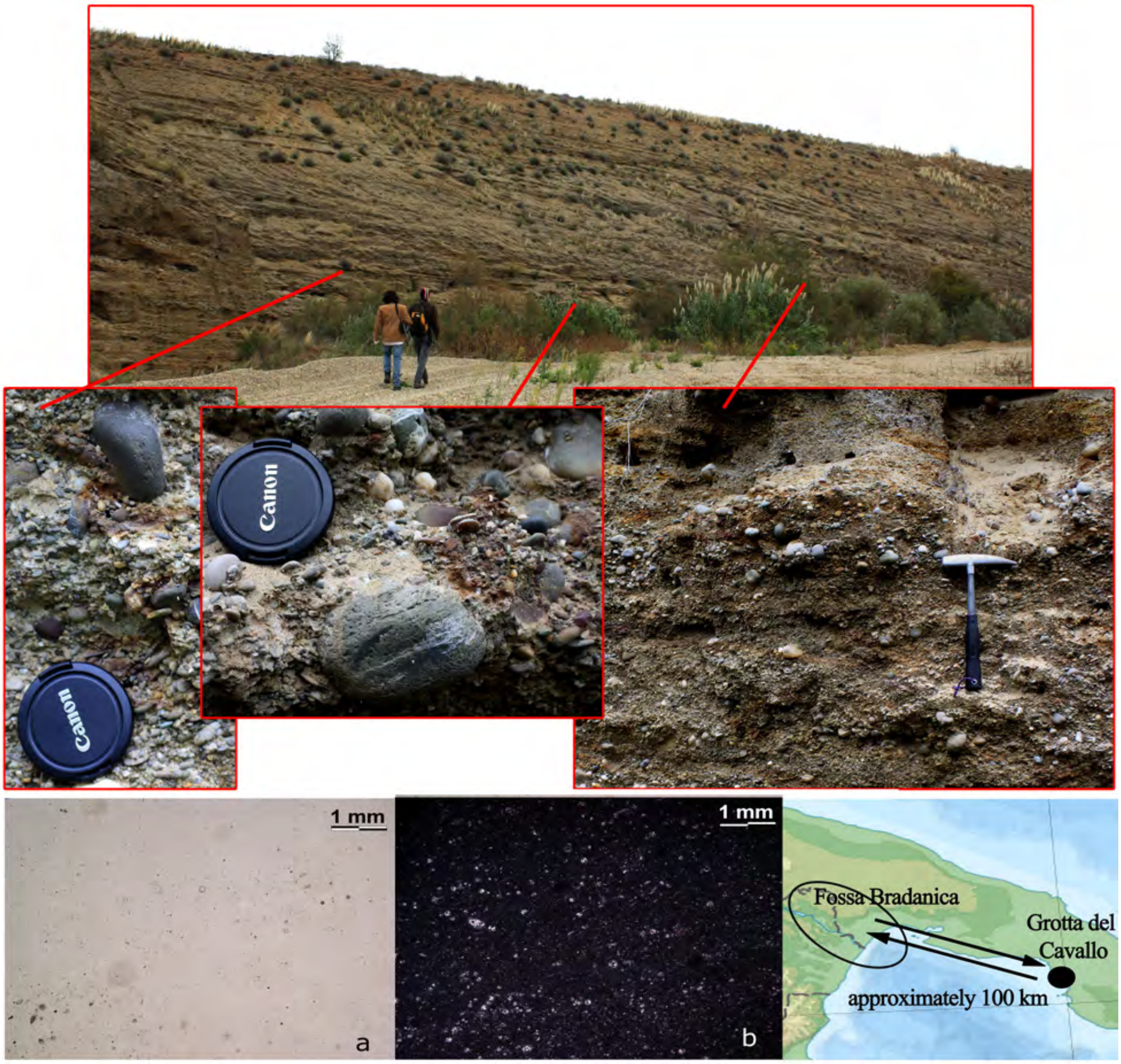

Fig. 3 – Grotta del Cavallo, Middle Palaeolithic. Chert and radiolarite cobbles sampled in the conglomerate of the 'Bradano trough' (paleodeposits originating from the hydrological system of the Bradano river). This procurement area is located approximately 100 km NW from the site. a: thin section of light microcrystalline flint, archaeological sample; b: thin section of green radiolarite, archaeological sample (photos F. Romagnoli and F. Trenti).

Fig. 3 – Grotta del Cavallo, Paléolithique moyen. Galets de silex et radiolarite échantillonnés dans le conglomérat de la « Fossa Bradanica » (paléo-dépôts du système hydrique de la rivière Bradano). Ce territoire d'approvisionnement est situé environ à 100 km au nord-ouest du site. a : lame mince de silex clair microcristallin, échantillon archéologique ; b : lame mince de radiolarite verte, échantillon archéologique (clichés F. Romagnoli et F. Trenti).

AN INTEGRATED APPROACH OF PRODUCTION STRATEGIES AND RAW MATERIALS: THE MIDDLE PALAEOLITHIC SEQUENCE AT GROTTA DEL CAVALLO

The site

Grotta del Cavallo is a karst cave located on the western coast of Salento in the southern part of Apulia (SE Italy). The cave opens onto the rocky coast of Baia di Uluzzo, about 15 m above the present day sea level, and consists of a single circular room, about 9 m in diameter (Palma di Cesnola, 1963). Archaeological investigations were directed by Arturo Palma di Cesnola during the 1960s (Palma di Cesnola, 1963, 1964, 1965a, 1965b and 1966) and then resumed in 1987 by the universities of Florence and Siena. The site preserves a seven metre-thick archaeological deposit, covering a time span ranging from MIS 5 to the final Upper Palaeolithic (fig. 5). The Middle Palaeolithic sequence (MIS 5 to MIS 3) is one of the most important in Southern Italy.

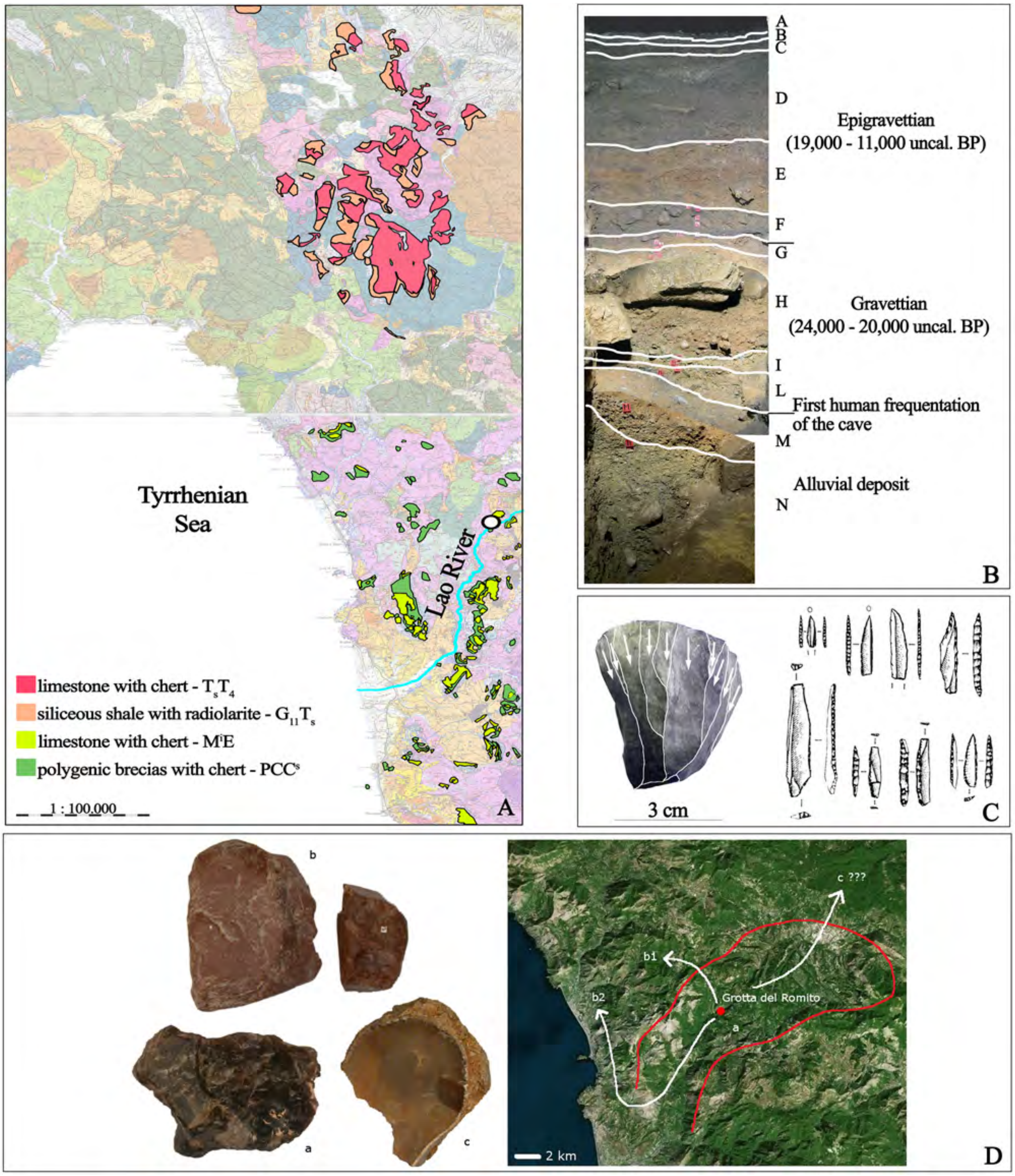

Fig. 4 – Grotta del Romito, Upper Palaeolithic. A: formations identified as possible raw-material sources (Carta Geologica d'Italia 1:100,000, sheets 210 and 220 http://193.206.192.231/carta_geologica_italia/default.htm, modified); B: stratigraphy of the cave (photos D. Lo Vetro); C: cores and backed tools, Late Epigravettian, layer C3 (photos D. Lo Vetro, drawings L. Baglioni); D: procurement area of the lithic raw materials, a: local black chert, b: radiolarite sampled from the Noce river valley, c: exogenous microcrystalline chert (photos F. Trenti).

Fig. 4 – Grotta del Romito, Paléolithique supérieur. A : formations identifiés comme possibles sources de matières premières (Carta Geologica d'Italia 1:100 000, feuilles 210 and 220 http://193.206.192.231/carta_geologica_italia/default.htm, modifié) ; B : stratigraphie de la grotte (clichés D. Lo Vetro) ; C : nucléus et outils à dos, Épigravettien final, couche C3 (clichés D. Lo Vetro, dessins L. Baglioni) ; D : territoire d'approvisionnement en matières premières lithiques, a : silex noir local, b : radiolarite échantillonnée dans la vallée du Noce, c : silex microcristallin exogène (clichés F. Trenti).

Sample code	Lab code	Layer	^{14}C BP uncal.	2σ cal. BP (Ox Cal V. 4.0)	Cultural phase
ROM 1	Beta-160295	C	11,060 ± 100	13,158-12,853	Late Epigravettian
ROM 2	Beta-160296	C2	11,090 ± 70	13,131-12,886	
ROM 3	Beta-160297	C3	11,380 ± 70	13,375-13,119	
ROM 4	Beta-160298	C4	11,250 ± 70	13,266-12,986	
ROM 5	Beta-160299	D	11,580 ± 70	13,617-13,278	
ROM 6	Beta-160300	D1	11,660 ± 70	13,695-13,345	
ROM 8	Beta-160302	D5a	12,060 ± 90	14,113-13,745	
ROM 9	Beta-160303	D5b	12,160 ± 50	14,148-13,866	
ROM 11	LTL234A	D8	12,170 ± 60	14,173-13,857	
ROM 14	LTL238A	D11	12,334 ± 75	14,749-14,015	
ROM 18	LTL607A	D13	12,258 ± 75	14,591-13,921	
ROM 23	LTL603A	D14	12,377 ± 95	14,875-14,051	
ROM 24	LTL608A	D15	12,331 ± 55	14,663-14,036	
ROM 25	LTL601A	D16	12,369 ± 100	14,877-14,036	
ROM 26	LTL602A	D20	12,438 ± 85	14,921-14,137	
R-33	LTL1050A	D29	12,494 ± 75	14,973-14,202	
R-31	LTL1052A	D35	12,970 ± 150	15,859-14,921	
R-37	LTL1046A	E2	13,650 ± 120	16,735-15,790	
R-36	LTL1047A	E5	13,646 ± 120	16,730-15,784	
ROM 38	LTL1590A	E8	14,373 ± 90	17,732-16,739	
ROM 39	LTL1591A	E10	15,273 ± 150	18,886-18,105	
ROM 40	LTL1592A	E16	16,129 ± 100	19,476-19,067	Evolved Epigravettian
ROM 41	LTL1593A	F1	17,376 ± 90	20,888-20,235	Ancient Epigravettian
ROM 20	LTL239A	F2	18,978 ± 130	22,846-22,230	
ROM 28	LTL606A	F3I	18,483 ± 95	22,326-21,518	
ROM 21	LTL236A	G1	19,351 ± 180	23,634-22,513	Late Gravettian
ROM 22	LTL237A	G2	19,373 ± 90	23,450-22,635	
ROM 30	LTL604A	H4	20,210 ± 245	24,962-23,510	
R-35	LTL1048A	I	23,475 ± 190	27,926-27,357	Evolved Gravettian

Table 1 – Grotta del Romito. Radiocarbon dates.
Tabl. 1 – Grotta del Romito. Datations radiocarbone.

The bottom layer is a marine interglacial beach conglomerate, layer O, MIS 5a (Sarti et al., in press) covered by Mousterian layers, approximately four metres thick, layers N-F (Sarti et al., 1998–2000 and 2002; Palma di Cesnola, 2001), Uluzzian layers, layers E-D (Palma di Cesnola, 1965a and 1966), a sterile tephra empirically related to the Campanian Ignimbrite eruption (layer C) and an Epigravettian layer (layer B). The base of the Uluzzian layers has been recently dated to 47,530–43,000 cal. BP, radiocarbon analysis on shell remains (Benazzi et al., 2011). Absolute chronometric data are currently not available for the Middle Palaeolithic sequence. As regards the Mousterian layers the faunal assemblages are dominated by *Cervus elaphus*, *Dama dama*, *Equus ferus*, and *Bos primigenius*, with different relative frequencies along the stratigraphy (Sarti et al., 1998–2000 and 2002; Cecchetti, 2003). All layers display several hearths and fireplace features. The lithic data presented here relate to the recent excavation directed by Lucia Sarti carried out on a surface of approximately 12 m^2.

Lithic technology

In the Middle Palaeolithic sequence of Grotta del Cavallo over 80% of the lithic artifacts were made from local raw material (table 2). The proportion of exogenous lithic resources changes during the sequence, suggesting different mobility patterns and probably different occupation strategies during the Middle Palaeolithic. Exogenous raw materials were flint, radiolarite, and in rare cases quartzite. The surveys have suggested that these raw materials were collected more than 50 km north-west of the site, between Ginosa and Ginosa Marina (fig. 3), as small fluvial cobbles and were invariably brought to the site as finished tools.

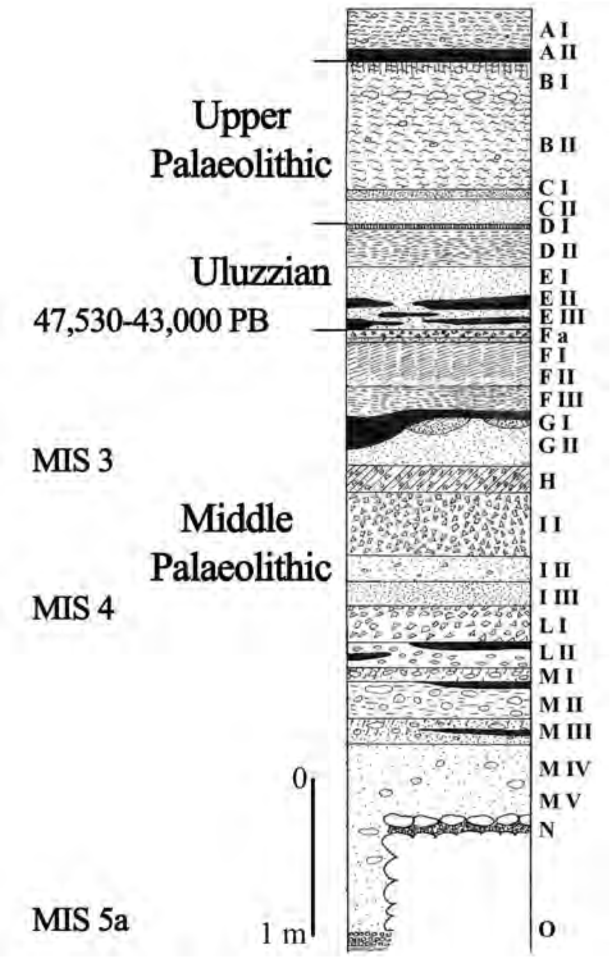

Fig. 5 – Archaeological sequence of Grotta del Cavallo (Palma di Cesnola 2001, modified).
Fig. 5 – Séquence archéologique de la Grotta del Cavallo (Palma di Cesnola 2001, modifié).

A great variability according to the layers was also observed for local stone resources. Neanderthals exploited different local raw materials during that time, although the procurement strategy remained unchanged. Local raw materials were collected from primary deposits by exploiting small sub-prismatic blocks occurring in joint sets. The variability of the raw-material economy and the exploitation techniques of local resources are related to differences in technical knapping methods and in the fragmentation of the operational sequences *(chaînes opératoires)*. The layers M, L, and F are presented below.

Layer M: 3458 pieces (fig. 6a-b)

Exogenous raw materials were used in this layer only for a small number of remains (6.6%). Among local raw materials the most frequently used material was coarse-grained white limestone sensu stricto (45.4%) with irregular conchoidal fracture. Flat prismatic blocks of this material were exploited for unipolar adjacent reduction sequences with the aim of producing elongated flakes (fig. 6a, 3 to 4). The production sequences started from a lateral natural edge and continued on the largest surface of the block. Sequences were short for the greater part, characterised by the production of elongated flakes with an asymmetric triangular section and, in general, partially corticated.

Thick sub-prismatic blocks of coarse-grained limestone or grey laminated limestone were exploited for 'classical' discoidal sequences (*sensu* Boëda, 1993). The debitage was bifacial, with no hierarchical surfaces. Throughout the debitage both centripetal and chordal flakes (core-edge flakes—*éclats débordants*—and pseudo-Levallois points) were produced (fig. 6b).

Medium- to fine-grained laminated and silicified limestones were collected as flat prismatic blocks for a third method of debitage. Blocks with varying texture and internal structure were selected. All displayed natural flat surfaces on the margins, covered by a reddish patina. They were quite regular in shape, short and narrow, and were exploited on the largest surface. The production sequences were organised to establish a hierarchy between the two surfaces of the core and they were generally unipolar or

	Layer M		Layer L		Layer FIIIe-FIIId		Layer FIIIa-FI	
	N	%	N	%	N	%	N	%
Limestone *sensu stricto*	839	*45,4*	259	*27,5*	80	*1,5*	96	*9,2*
Laminated Limestone (Silicified)	359	*19,4*	297	*32,6*	5,226	*95,7*	592	*56,6*
Silicified Limestone	15	*0,8*	34	*3,6*	-	-	-	-
Quartzite	15	*0,8*	5	*0,5*	27	*0,5*	51	*4,9*
Chert	84	*4,6*	65	*6,9*	21	*0,4*	127	*12,1*
Radiolarite	9	*0,5*	25	*2,7*	65	*1,2*	90	*8,6*
Callista chione	-	-	126	*13,4*	-	-	-	-
Indeterminable	528	*28,5*	121	*12,8*	41	*0,7*	90	*8,6*
TOTAL	1,849	*100%*	941	*100%*	5,460	*100%*	1,046	*100%*

Table 2 – Grotta del Cavallo, Middle Palaeolithic. Distribution of the lithotypes in the layers that are presented in this paper.
Table 2 – Grotta del Cavallo, Paléolithique moyen. Répartition des lithotypes dans les niveaux présentés dans le texte.

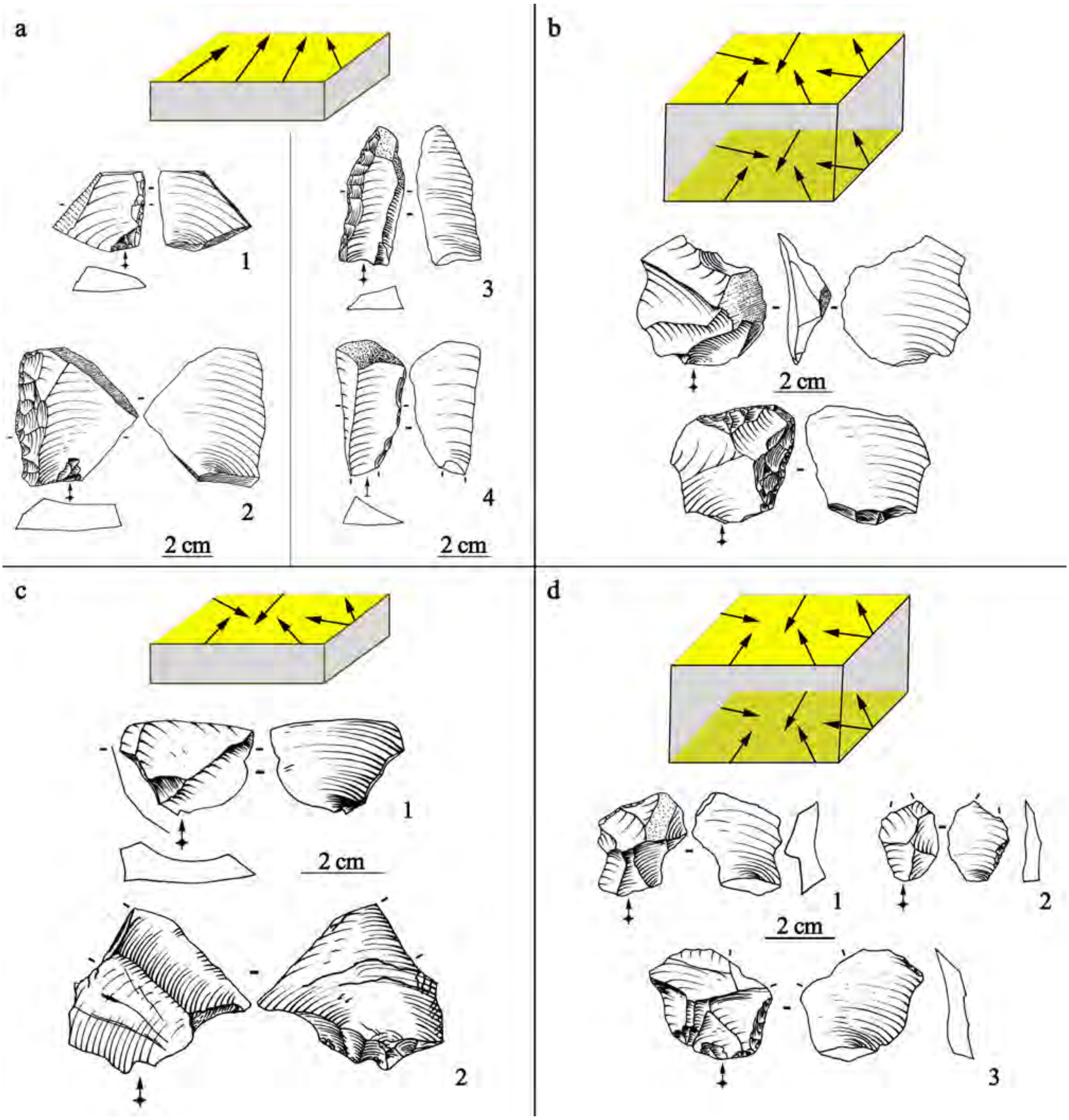

Fig. 6 – Grotta del Cavallo, Middle Palaeolithic. Production methods and selection of raw-material volumes in layer M (a–b) and layer L (c–d). a: unifacial unipolar debitage, reduction sequences aiming at the production of natural backed flakes (1–2) or elongated flakes (3–4); b: bifacial centripetal debitage, classical discoid; c: unifacial centripetal debitage, hierarchical discoid, 1-2: Pseudo-Levallois points; d: bifacial centripetal debitage, classical discoid, 1-3 centripetal flakes (drawings F. Romagnoli).

Fig. 6 – Grotta del Cavallo, Paléolithique moyen. Méthodes de production et sélection des volumes de matières premières dans les niveaux M (a-b) et L (c-d). a : débitage unipolaire unifacial, chaînes opératoires dédiées à la production d'éclats avec dos naturel (1-2) ou d'éclats allongés (3-4) ; b : débitage centripète bifacial, discoïde classique ; c : débitage unipolaire unifacial, discoïde hiérarchisé, 1-2 : pointes pseudo-Levallois ; d : débitage centripète bifacial, discoïde classique, 1-3 : éclats centripètes (dessins F. Romagnoli).

slightly convergent, with the debitage axis parallel to the shortest dimension of the core (fig. 6a, 1–2). This mode of production made it possible to obtain short core-edge flakes *(éclats débordants)*, with an asymmetric transversal section and lateral cortical back, produced on the lateral portion of the exploited surface of the core.

Layer L: 1,911 pieces (fig. 6c-d)

The proportion of exogenous raw material in this layer is 13.2%, higher than in layer M (table 3). The lithic assemblage is characterised by shorter dimensions than that of layer M and in many cases the products were 'microlithic'. Reduction sequences had a fragmented spatio-temporal character and recycling behaviour was often attested to, regardless of the distance to the procurement sources (Romagnoli, 2015).

In this layer Neanderthals used all the lithotypes attested in the local formation of Melissano limestone. In addition to stones, valves of *Callista chione*, a large marine mollusc, were also exploited to produce retouched scrapers during this occupational phase at the site (Romagnoli et al., 2015a and 2015b).

The main production methods were two types of recurrent centripetal debitage on the surface: without hierarchy (bifacial recurrent centripetal debitage: 'classical' discoid; fig. 6d) and with hierarchy (unifacial recurrent centripetal discoid; fig. 6c; Locht and Swinnen, 1994; Terradas, 2003; Wallace and Shea, 2006; Slimak, 2008; Vaquero et al., 2008; Baena et al., 2012). Each type of debitage was used to exploit distinct lithotypes characterised by specific volumes. Unifacial centripetal debitage was made on flat, sub-prismatic blocks of grey laminated limestone and produced abundant pseudo-Levallois points. Thick blocks of several lithotypes, with a variable degree of silicification, texture, and structural homogeneity, were exploited by bifacial centripetal production sequences leading to the extraction of both centripetal and chordal flakes (*éclats débordants* and pseudo-Levallois points).

Layer F

This layer was divided into three archaeological levels (FIII, FII, FI). FIII was further divided into five sub-levels, named by a letter and identified on the basis of ash concentrations. The levels and sub-levels were grouped together in three units based on the technological and typological features of the lithic remains: from bottom to top these are FIIIe–FIIId, FIIIc–FIIIb, FIIIa–FII–FI. The FIIIc–FIIIb unit yielded a small number of pieces which were difficult to analyse because of a high degradation of the raw material caused by desilication.

Artefacts made from exogenous materials are in a strict minority at the base of the layer (1.7% in FIIIe-FIIId), whereas they reach the highest value of the Mousterian series remains, although still in a minority, on top of the layer (18.2% in FIIIa–FII–FI; table 3).

FIIIe–FIIId: 12,343 pieces (fig. 7a-c)

The main flaking systems were the Levallois method as well as blade and bladelet volumetric reduction. The exploited raw material was almost exclusively silicified limestone, with a high degree of homogeneity (table 2). It was collected as flat sub-prismatic blocks. The Levallois methods used were mainly centripetal (fig. 7b) and, secondly, unipolar and bipolar debitage. The unipolar and bipolar Levallois debitage aimed to produce quadrangular flakes that rarely reached the size of a blade module (fig. 7a).

Volumetric reduction produced blades with a triangular cross-section with parallel edges, and backed blades with an asymmetrical triangular or quadrangular section (fig. 7c). The blade reduction system followed the unidirectional method. The blocks of raw material were not subjected to sophisticated preparation, although the sporadic configuration of a crest is attested. The technique used was invariably direct percussion with a hard hammer. Bladelets were produced during the advanced reduction phases of blade cores.

Independent, unipolar, bladelet volumetric reduction was based on the exploitation of small flakes that served as cores (fig. 7c, 1). As is the case for blade production, the natural edge of the core was usually exploited. Some remains revealed more accurate initialisation through the preparation of a crest, and the maintenance of the distal convexity of the core by small removals opposite the striking platform.

FIIIa-FII-FI: 2,388 pieces (fig. 7d)

Levallois and blade-bladelet production disappeared. The main production method was 'classical' discoid,

	Local Raw Materials	Exogenous Raw Materials	Indeterminable
Layer M	65.6%	5.9%	28.5%
Layer L	77.1%	10.1%	12.8%
Layer F (FIIIe–FIIId)	97.2%	2.1%	0.8%
Layer F (FIIIa, FII, FI)	65.8%	25.6%	8.6%

Table 3 – Grotta del Cavallo, Middle Palaeolithic. Distribution of local and exogenous raw materials in the layers that are presented in this paper.
Tabl. 3 – Grotta del Cavallo, Paléolithique moyen. Répartition des matières premières locales et allochtones dans les niveaux présentés dans le texte.

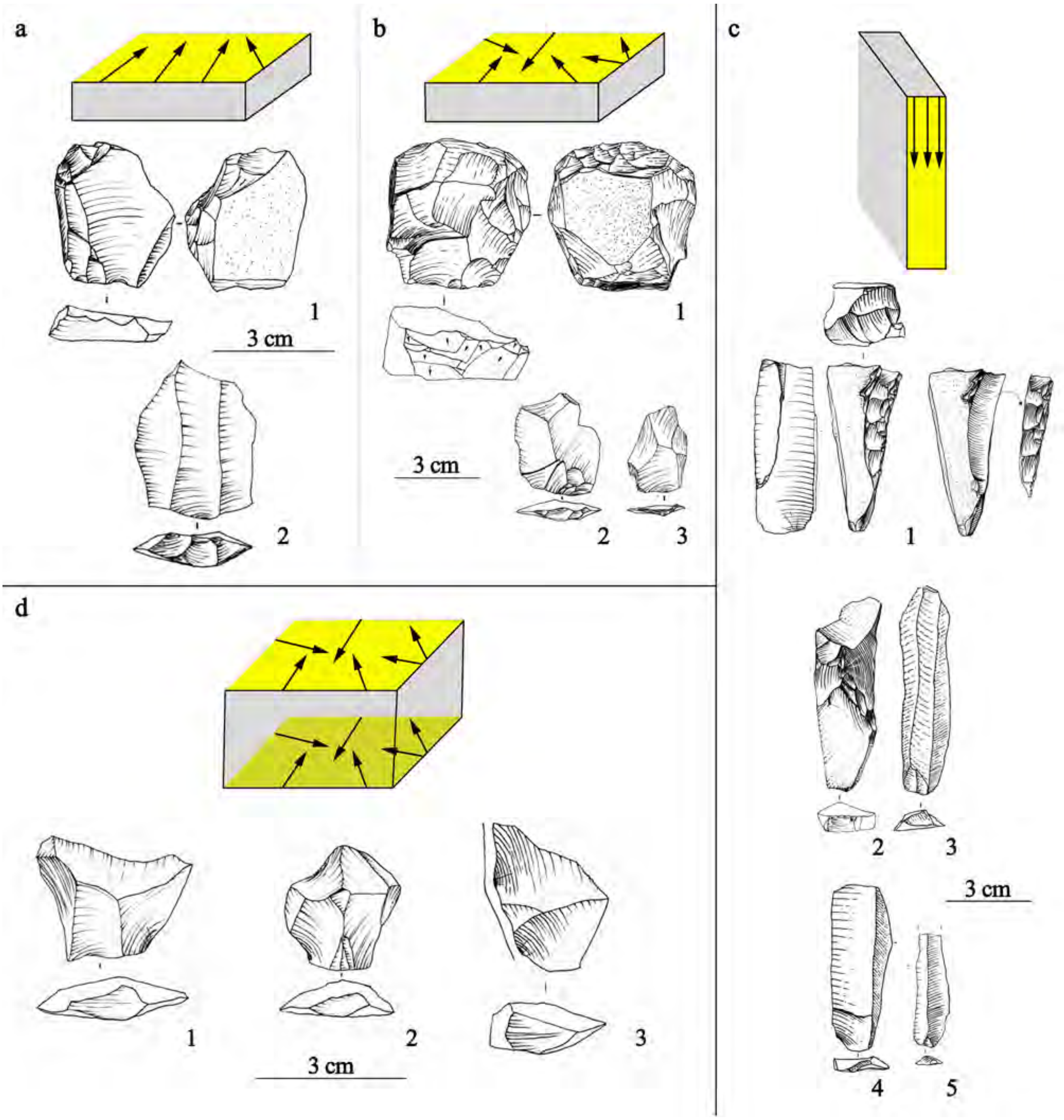

Fig. 7 – Grotta del Cavallo, Middle Palaeolithic. Production methods and selection of raw material volumes in level F, layers FIIIe–FIIId (a–c) and layers FIIIa–FI (d). a: unipolar Levallois debitage, 1: core, 2: unipolar flake; b: centripetal Levallois debitage, 1: core, 2–3: centripetal flakes; c: blade-bladelet volumetric debitage, 1: refitted bladelet core, 2: crest blade, 3–5: blades; d: bifacial centripetal debitage, classic discoid, 1–2: centripetal flakes, 3: pseudo-Levallois point (drawings L. Carmignani and C. Tessaro).

Fig. 7 – Grotta del Cavallo, Paléolithique moyen. Méthodes de production et sélection des volumes de matières premières dans le niveau F, couches FIIIe-FIIId (a-c) et couches FIIIa-FI (d). a : débitage Levallois unipolaire, 1 : nucléus, 2 : éclat unipolaire ; b : débitage Levallois centripète, 1 : nucléus, 2-3 : éclats centripètes ; c : débitage volumétrique laminaire et lamellaire, 1 : remontage de nucléus à lamelles, 2 : lame à crête, 3-5 : lames ; d : débitage centripète bifacial, discoïde classique, 1-2 : éclats centripètes, 3 : pointe pseudo-Levallois (dessins L. Carmignani et C. Tessaro).

with bifacial centripetal removals that produced centripetal flakes, *éclats débordants* and pseudo-Levallois points (*sensu* Boëda, 1993; fig. 7d). It exploited thick subprismatic blocks of various lithotypes of local silicified limestones. The production of splintered pieces is also noted.

The change in production systems was associated with a significant increase in exogenous raw materials (table 3). The mainly exploited raw materials are local, silicified limestones, while the use of limestone slabs decreases considerably (table 2).

Reconstructing Neanderthal behaviour at Grotta del Cavallo

In the Middle Palaeolithic sequence of Grotta del Cavallo there is a clear predominance of local raw materials (tables 2 and 3). These were abundant and readily available in the surroundings of the site (> 5 km). They were always collected as small, sub-prismatic blocks occurring by joint sets. The exploitation of local raw material is a common behaviour throughout the European Middle Palaeolithic and is often related to differences regarding the quality of the available lithic resources.

Despite a stable availability of raw materials, the Mousterian sequence evidences a great variability of production methods over time, which were related to the selection of flat or thick volumes and indicate specific adaptations to the quality of the raw materials within different techno-complexes. In the same way, the selection of different local resources in the different layers attests to a great variability of these adaptations and reflects a wide knowledge of the territory by Neanderthals, as clearly expressed by the use of *Callista chione* valves (Romagnoli et al., 2015a and 2015b). These tools were manufactured by selecting a complete valve on the beach, collected after the death of the mollusc, based on the typometric characters of the shells. The valves were indeed collected according to a standard size of 8 cm width, most likely in relation to the minimum thickness needed for the retouch. Experimentation has suggested that a thickness of the edge of less than 1.6 mm increases the risk of incidental ruptures during retouch. The valves were retouched on the external edge, invariably on the internal surface of the shell, using the same technical actions as for Quina and semi-Quina retouch, which is attested on 60% of all the retouched flint tools in this layer. These data, together with the operational sequence *(chaîne opératoire)* of Callista chione tools and the recycling behaviour within this *chaîne opératoire* suggest that this production was completely integrated into the technical traditions and was most likely related to mobility, economic strategy, and the Neanderthal capacity for innovation (Romagnoli et al., 2015a and 2015b; Romagnoli, 2015).

Although the exogenous raw materials occurred invariably in a minority, their ratio changed along the sequence, with fluctuations apparently related to abrupt technical changes between layers rather than to a gradual evolution of a single technical and economic behaviour. Within this variability the import of retouched tools, ready to be used and made from high-quality material, appears as a constant feature of the site during the Middle Palaeolithic and suggests the existence of procurement strategies (Kuhn, 1992 and 1995) as well as of types of curated behaviour (Binford, 1979; Shott, 1996). The fragmented character of the operational sequences *(chaînes opératoires)* using local resources is well documented in layer L. The fragmentation of the production sequences across the territory has clearly been demonstrated in the Middle Palaeolithic context of Western Europe (e.g. Roebroeks et al., 1992; Bourguignon et al., 2006 and 2008; Brenet et al., 2008; Faivre, 2011; Turq et al., 2013), suggesting that tool mobility was a technical behaviour based not only on the quality of the raw material, but also on a more complex strategy across the territory. The organisation of the lithic technology is the result of a dynamic interaction between functional needs, the duration of the occupation of the site, the activities carried out at the site, the constraints arising from these activities, and the social organisation. In layer L the analysis of raw-material units (Roebroeks, 1988; Larson and Kornfeld, 1997), the morpho-technical analysis, and the reconstruction of the direction and chronology of each removal (diacritical approach, Inizan et al., 1995; Baena et al., 2010) suggest that the lithic assemblage is the result of multiple independent episodes carried out at the site by a group that was highly mobile across a large territory and that was probably present at the site for short-duration occupations. Furthermore the strategy of producing tools in advance, independently of the distance of the raw-material sources, and the recycling behaviour for reasons of expediency (Romagnoli, 2015) suggest, according to Torrence (1983), great time pressure during the organisation of the activities at the site.

The results of this study up to now suggest that exogenous, good-quality raw material was collected from the same area during the whole Middle Palaeolithic frequentation of the site, implying mobility over long distances, about 80 km NW-SE. The hypothesis of restricted mobility of Neanderthals is increasingly challenged as various examples have already shown regular, long-distance mobility, sometimes exceeding 100 km (e.g. Geneste, 1988; Roebroeks et al., 1988; Féblot-Augustins, 1993, 1999 and 2009; Chalard et al., 2007; Slimak and Giraud, 2007; Negrino and Starnini, 2010), leading to the assumption of the existence of extensive regional networks (Kaufman, 2002). In the Salento region high mobility would have been facilitated by the landscape, with a wide plain that extends up to the Taranto Gulf and to the Ionian coast of Basilicata.

The variations in exogenous raw-material procurement could be related to many factors such as different mobility patterns, different durations of frequentation of the site, different site use, and different cultural traditions of the human groups. These factors are not mutually exclusive and may well be the reason for the great variability of European Middle Palaeolithic industries as discussed since the 1960s. The highest fragmentation of the *chaîne opératoire* in layer L, for example, suggests that the human group that frequented the site during this phase had a high level of planning most likely related to social organisation, seasonal mobility and fragmentation of their activity within the landscape. This 'cultural dynamism' could have facilitated technical innovations, such as shell tools (Romagnoli et al., 2015b).

CONCLUSION AND PERSPECTIVES

It should be highlighted that the understanding of past human behaviour is a long process that requires interdisciplinary and multidisciplinary approaches. Strict interconnection between geology and archaeology is imperative for proposing hypotheses on human mobility and technological organisation. The differences identified by our studies for lithic remains along the Middle Palaeolithic sequence of Grotta del Cavallo suggest that cultural constraints (shared knowledge, technical innovations, and social and economical organisation) are more relevant than geophysical ones in determining the behaviour of humans in ancient times, as in present ones. Furthermore, the analysis of the organisation of technology on a large spatial scale (fragmentation of *chaîne opératoire*, recycling behaviour, mobility range of human groups) makes it possible to link these changes in mobility and land-use strategies with changes in stone tool manufacture and use. In this way we can perceive cognitive abilities and behavioural changes in past societies (Bamforth, 1986; Kelly, 1988; Andrefsky, 2009; Delagnes and Rendu, 2011; Romagnoli, 2015). From a technological perspective the combination of attributes that govern the lithic production determines the production and transportability of tools. According to P. Bleed (Bleed, 1986) the main attributes are 1) the complexity of the reduction sequence, 2) the tool's useful life, 3) the tool efficiency, and 4) the productivity of the knapping method that was used. This complexity also includes the time spent on raw-material procurement and on the volumetric construction of the core that was required to produce the desired tools. The Levallois technology is more time-consuming than unipolar or orthogonal methods and the volumetric constraints impose a more rigid selection of raw materials, with regard to both quality and volume. The production aimed at manufacturing tools with a high resharpening potential (e.g. Quina tools). These were a good choice to be transported because their long life cycle guaranteed the constant availability of functional tools. This tool efficiency implies a high technical investment in the preparation of the functional cutting edge, and it can be related to the high production input (the use of a complex production method increases the degree of control of the final product) or to the integration of retouch within the production sequence relating the volume of the flakes to retouch techniques that were used to manufacture the edge. The number of products obtained from a given raw-material volume makes it possible to reduce the effort invested in production and to obtain a greater number of functional products in less time. This may be favourable with regard to specific constraints of tasks and of mobility strategies.

This behavioural analysis has shown that the Middle Palaeolithic variability at Grotta del Cavallo is a multi-causal phenomenon, as highlighted in other regional studies in Europe (Delagnes and Rendu, 2011; Raynal et al., 2013; Turq et al., 2013; Lazuén and Delagnes, 2014; Moncel et al., 2014; Vaquero et al., 2015, among others). This behavioural approach does not consider the procurement strategy to be a simple local/exogenous dichotomy; rather the procurement distance was incorporated into a large-range scenario, in which the duration of occupation of the site, the social organisation, the economic strategies, and the expedient behaviour play a significant role in shaping human behaviour. Future research will focus on the detailing of the technological organisation in the entire sequence and on the linking of strategies of stone-artefact manufacture and raw-material exploitation to subsistence strategies and environmental changes. The top of the Middle Palaeolithic sequence attests to the association between Levallois and blade reduction technologies. Levallois and blade reduction technologies have been reported from several sites in South-Western France characterised by many different faunal associations (Delagnes and Rendu, 2011). Non-migratory species are the most abundant in these assemblages. In this respect it will be worth investigating if the same association occurred at Grotta del Cavallo and examining in more detail the fragmentation of the production sequences. This will make it possible to understand if the constraints imposed by the volumetric construction of the knapping methods played a role in mobility patterns and site location, instead of the animal resources that were probably available year-round in the same location, as is the case at the French sites.

With regard to the Tyrrhenian area the analysis of the lithic assemblage is still in progress and currently only limited data are available. The focus of the research in this area will be the definition of the technological behaviour along the Gravettian and Epigravettian sequence of Grotta del Romito, human mobility within the late Upper Palaeolithic climatic fluctuation, and the progressive creation of micro-regional original trends probably influenced by better adaptation to local resources, as is visible in subsistence strategies (Martini et al., 2007 and 2009; Palma di Cesnola, 2007; Craig et al., 2010).

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