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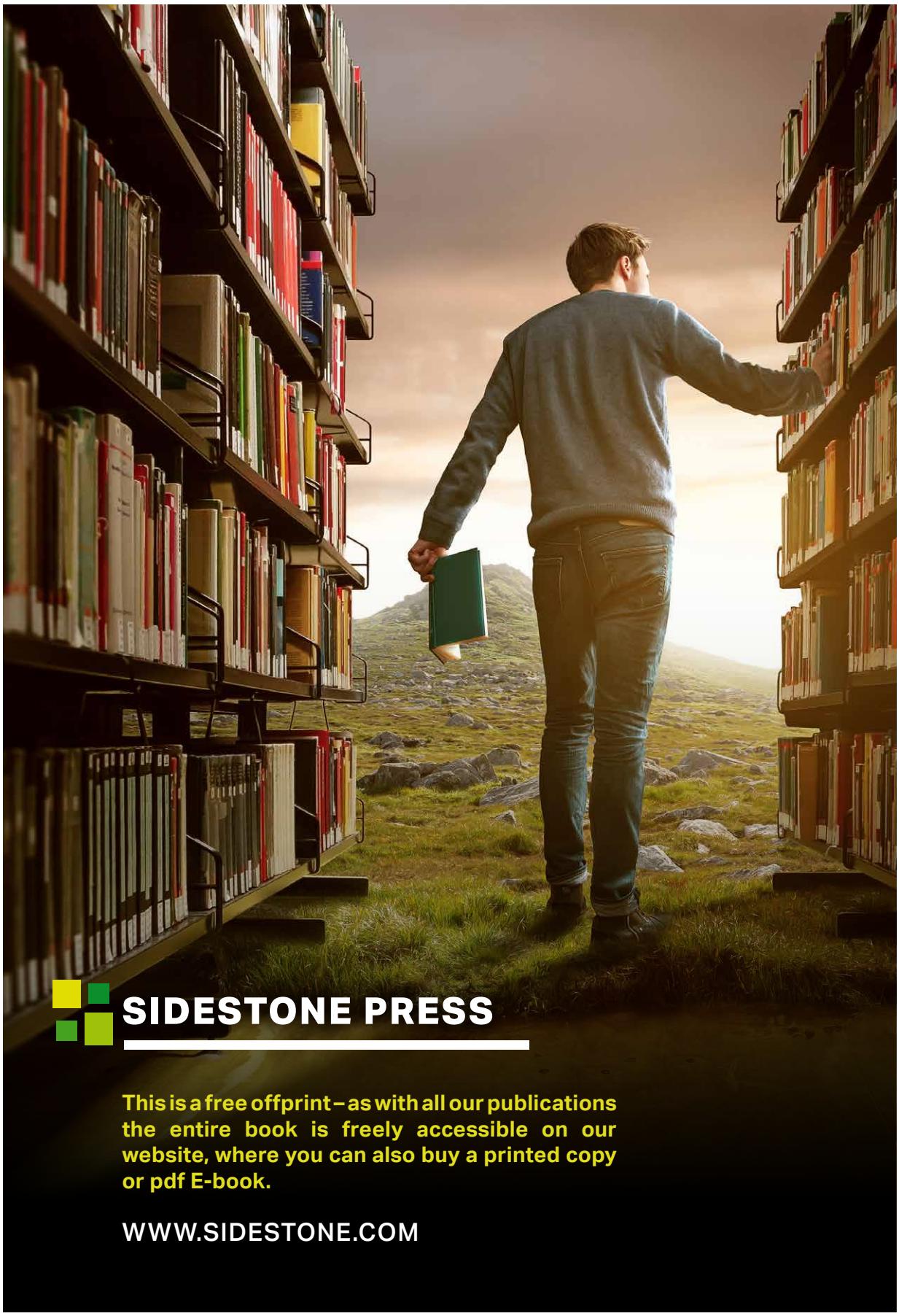

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Contents

Neanderthal mobility pattern and technological organization in the Salento (Apulia, Italy)

Enza Elena Spinapolice[1]

Abstract

The Salento, in the southeast of Italy, is rich in Mousterian sites and Neanderthal fossils, within the chronological time frame of the Upper Pleistocene. This region is well known for the absence of good quality raw materials. This paper presents results from the technological study of five Mousterian sites (Grotta Romanelli, Grotta Uluzzo C, Grotta Mario Bernardini, Grotta Torre dell'Alto, Grotta dei Giganti), showing technological organization, curation and expediency behaviours, probably related to a logistical mobility. This variability is becoming part of our understanding of Neanderthal behaviour, marked by a fragmentation of stone working in space, time and social dimensions and a planned and complex organisation, until recently considered as distinctive to modern *Homo sapiens*.

Keywords: Apulia (Italy), Mousterian, Neanderthals, raw material, mobility.

1. Introduction

The way lithic artefacts are procured, used, maintained and discarded, is strongly linked to hunter-gatherer resource exploitation strategies (Andrefsky 2009). This is because the use and depletion of lithic implements is influenced by factors such as raw material availability, site economy, site use and group mobility (Nelson 1991). Therefore, studies of lithic technology in restricted areas within a controlled period are useful to determine past hunter-gatherer land use patterns and social systems.

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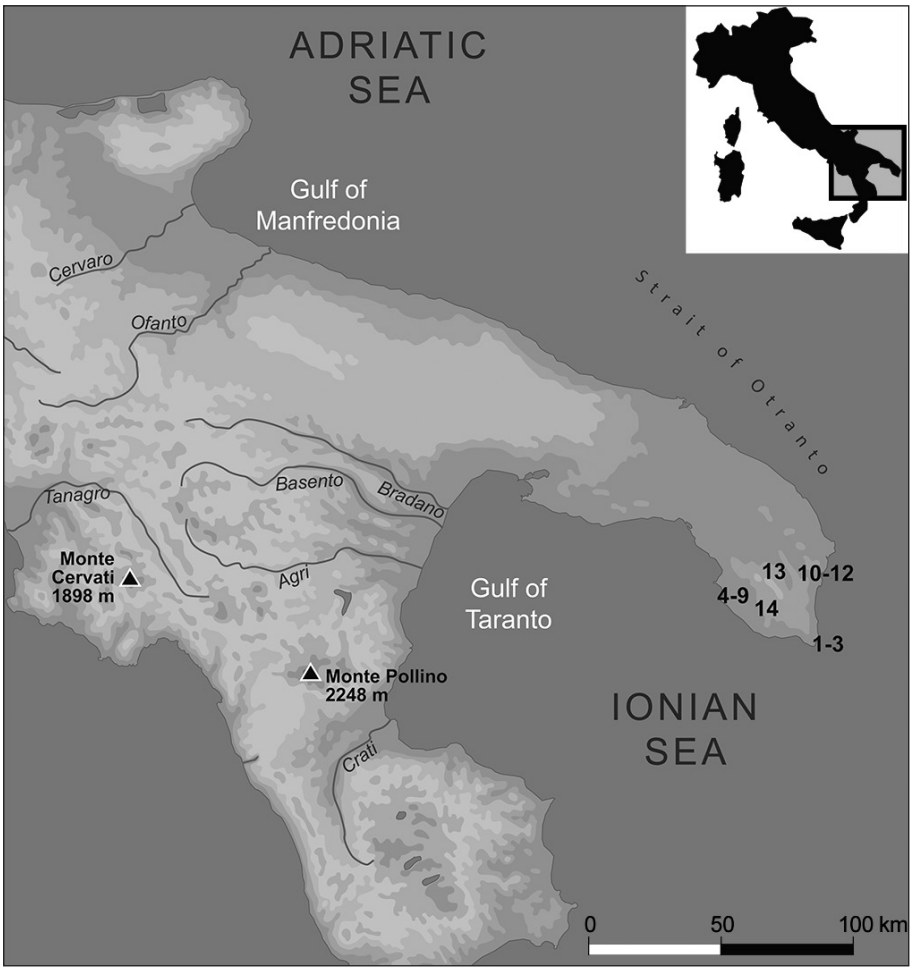

Figure 1. Mousterian sites in the Salento 1) Grotta dei Giganti; 2) Grotta Titti; 3) Grotta del Bambino; 4-9) Grotta del Cavallo, Grotta Uluzzo C, Grotta Torre dell' Alto; Grotta di Capelvenere; Grotta M. Bernardini, Grotta M. Zei; 10-12) Grotta Romanelli, Grotta Zinzulusa, Grotta delle Striare; 13) Fondo Cattie; 14) Grotta S. Ermete.

The present interest in Neanderthal settlement system and land use comes from the intent to understand behavioural differences in comparison with the *Homo sapiens*, particularly in the chronological frame of the Upper Pleistocene, immediately preceding Neanderthal extinction. The Salento is a region in south-eastern Italy that is rich in Upper Pleistocene Mousterian sites and Neanderthal fossils. The record of the prehistoric sites is largely the outcome of the past activity of the Istituto Italiano di Paleontologia Umana (IsIpU) and the Istituto Italiano di Preistoria e Protostoria (IIPP). This region is well known for the absence of good quality raw materials, flint in particular (Bietti, 2006; Bietti and Cancellieri, 2006; Milliken, 1998; Riel- Salvatore and Negrino, 2008). The explicit recognition of this absence and of the presence of long raw material transfer was established (Spinapolice, 2012) after systematic surveys in collaboration with the IsIPU in 2005-2006.

The long distance raw material procurement in the region (Spinapolice, 2012, 2018) makes this territory well suited for a study of raw material economy, linked with the analysis of the organization of technology and of curated behaviour. This paper shows that the scarcity of raw materials implies an intense use of artefacts, an increase in curation behaviour and a differential utilization for locally available raw material and imported ones.

The land use pattern was investigated through the analysis of the technological organization of lithics from five Mousterian sites, proposing a model of a logistical mobility within different site types used by Neanderthals.

2. Materials and methods

The lithics from five Mousterian sites (Fig.1) of the region (Spinapolice 2008, 2009) were analysed (Table 1): 1) Grotta Romanelli (40°0'10.69"N 18°25'52.73"E), one of best known Palaeolithic sites in Italy. (Cardini 1961-1970). The cave opens on the Adriatic coast, a few kilometres from Castro Marina. 2) Grotta dei Giganti (39°47'45" N, 18°20'15" E) is a semi-submerged limestone cavity located on the extreme edge of the Salento peninsula (Blanc 1958-61); 3) Grotta Uluzzo C (40°9'31.28"N, 17°57'35.03"E) is a karstic cave located on the Uluzzo Bay, between Grotta del Cavallo and Grotta di Uluzzo; 4) Grotta Mario Bernardini (-40°10'17.37"N, 17°56'52.60"E) is located near Serra Cicora A, slightly inland from the Bay of Uluzzo (Borzatti von Löwerstern, 1970, 1971); 4) Grotta Torre dell'Alto is located almost at the basis of the eponymous Tower, near Santa Caterina (Nardò) (Borzatti von Lowerstern, 1966; Borzatti von Lowerstern and Magaldi, 1967).

The lithics are analysed here according to the *chaîne opératoire* method (Geneste, 1985, 1988, 1991; Inizan, 1995; Leroi-Gourhan, 1964; Tixier 1978; Pelegrin, 1985), utilizing qualitative, standard quantitative approaches and taphonomy. The concept of *chaîne opératoire* is an ordered and hierarchical representation of the knapping process resulting in the manufacture of stone tools. According to this method, lithic production systems are examined as a sequence of actions embedded in a techno-economic process.

Each lithic object is classified following the knapping stages, from procurement (phase 0), to production (phase 1), use and maintenance (phase 2 and 3, tooling and retooling) and discard and depletion (phase 4). The presence or absence of the products typical of each stage of production (*i.e.*, fully cortical flakes, cortical flakes, plain *débitage* flakes, *débordants* flakes, retouched blanks) is recognized, to profile the assemblage. The identification of these production stages gives insights into the subsistence activities that were carried out at each site and the hypothesis of site function, within the wider frame of territorial exploitation.

Within the above approach, different patterns of site use can be defined, to reconstruct reasonable settlement systems, even in a broad chronological context (Marks and Chabai, 2006; Meignen *et al.*, 2007).

Every knapping product is reelated to a specific knapping sequence. The cores and the negative scars on flakes are particularly informative for the reconstruction of a knapping sequence, in order to link them to specific production methods. The patterns for curation and expediency in the technological system should be recognizable in the

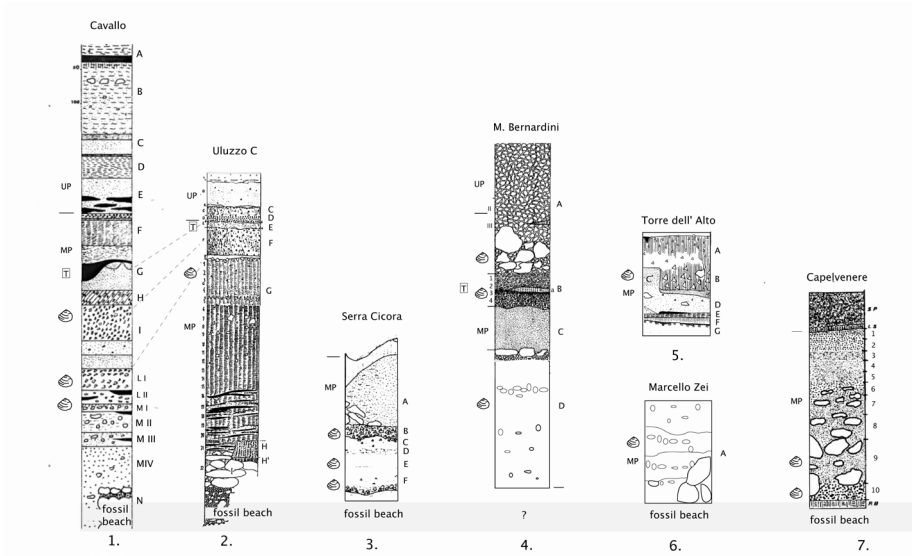

Figure 2. Drawings of stratigraphic sections of the main Mousterian sites. 1. Grotta del Cavallo; 2. Grotta Uluzzo C; 3. Grotta di Serra Cicora A; 4. Grotta Mario Bernardini; 5. Grotta Torre dell'Alto; 6. Grotta Marcello Zei; 7. Grotta di Capelvenere; 8. Grotta Romanelli; 9. Grotta dei Giganti. Modified after Palma di Cesnola (1969), Borzatti von Löwenstern (1966, 1970), Borzatti von Löwenstern and Magaldi (1969), Campetti (1986), Piperno (1976), Spinapolice (2009, (Modified after Douka and Spinapolice 2012)).

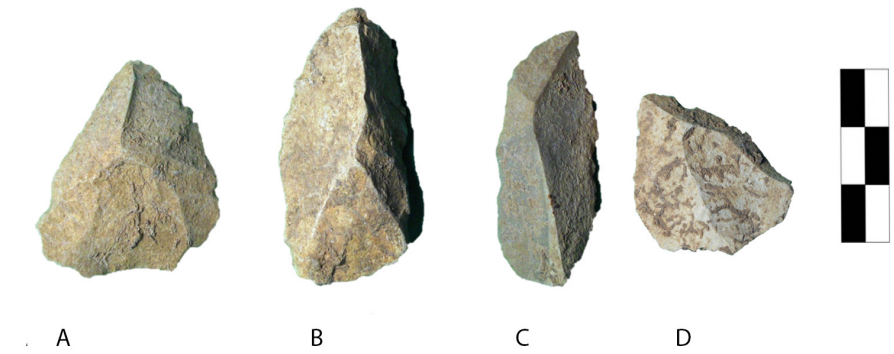

Figure 3. Levallois blanks from Grotta M. Bernardini.

archaeological record through the analysis of core reduction to understand the way in which blanks were produced, tool resharpened and the displacement of raw materials and artefacts across the landscape (Kuhn 1994). In order to achieve this understanding, the surface condition of the lithics is recorded to relate them to possible post- depositional events and use life; retouched artefacts are described: the location and type of retouch were taken into account, and the strategies of reduction, recycling and reuse are tested trough the analysis of double patina and double retouch series and reduction hypothesis based on main dimensions. The length, width and thickness are recorded, following conventional measurements (*i.e.* through the orientation of the lithic item)

on all the items. The unidentifiable fragments are classified as chunks, while *débris* are defined as the chips < to 2 cm.

3. Chronology

One of the major problems related to the study of Salento Mousterian is the lack of absolute chronological data, a slightly common matter in the Italian Middle Palaeolithic record (Higham *et al.*, 2009).

The chronology of these assemblages has traditionally been established through typological data combined with environmental data (*e.g.* Palma di Cesnola, 1996), introducing a significant bias in the interpretations. Here we propose a chronological framework based on the known chronological elements.

One of the useful elements to provide a timeline, is the Tyrrhenian transgression (Issel 1914), related with MIS 5e (124 ± 5 ka BP, Lambek, 2004). However, the determination of the sea-level position during the Last Interglacial, is not straightforward. This unit is recognizable at the basis of the archaeological stratigraphic sequences in several sites (Uluzzo C, Romanelli, Giganti, fig.2). Its altitude in Apulia is close to the eustatic level of the sea (Ferranti *et al.*, 2006) and it is assumed to be 7 ± 3 m relative to the present sea (Dai Pra and Hearty, 1988). Actually, the fossil marine beach of Uluzzo C is located at 8 m a.s.l., the Grotta Romanelli at 7.5 m and the Grotta dei Giganti at 5 m. More caves from Salento, not included in this study, have a Tyrrenian beach at the bottom of the sequence (Fig. 2): a marine beach at Grotta del Cavallo is located at 5 m; at Grotta Mr. Zei, a lithodoms line attributed to the Tyrrhenian is visible at 8 m. Large pachyderms, often associated with the OIS5e, are regularly present in those layers. In some sites, such as Grotta Marcello Zei, a second line of lithodomes (result of a second marine transgression) can be related to the OIS7 and located at ~ 9 m, but the sediments linked to this stage have been completely washed away.

The sequence of Grotta dei Giganti is related with the Grotta del Diavolo one, few meters apart, described by Mastronuzzi and colleagues (2007). The stratigraphy contains mostly slope deposits and is marked by three distinct beach levels, occurring at about 3.0, 3.5 and 5.9 m a.s.l., and by several speleothems. The oldest marine level has been dated at ~340 ka; the second beach level at about 5.9 m has a U/Th age determination between 170.3 and 146.5 ka BP. This date has been questioned by Mastronuzzi and colleagues (2007) who, according the geomorphology, propose a date of 125 ka for the beach and relate it to the Eutyrrenian. The third beach level at 3.5 m is overlain by a stalagmite about 78 ka BP. The sequence is capped by a breccia deposits retaining remains of continental cold fauna, which has been referred to the last glacial period.

At Grotta dei Giganti, applying the model drawn for Grotta del Diavolo, the Level A (Fig.2:9) corresponds to the OIS 5,1, the level B and the breccia (Br1) are associated to the OIS 9,3, the level C and the corresponding breccia, together with the speleothem, are related to the OIS 5,5 (Eutyrrenian). The archaeological deposit might then postdate the OIS 5,1. The major problem for these models is related to tectonics, which is supposed to have created major movements that make uncertain the attributions based on the elevation. However, the interpretation from Mastronuzzi and colleagues (2007) claims for a tectonic stability of the coastal cave in the region.

Grotta Romanelli (Blanc, 1920, 1928) opens at a narrow shore platform at about 7.4 m a.s.l. and is related to a notch with algae encrustations and a belt of lithophaga boreholes ending at about 9.8 m a.s.l. (Mastronuzzi *et al.* 2007). The chronology of the lower layers of Grotta Romanelli has repeatedly been questioned, although with an absolute date from the Level G, between 69 and 40 ± 3 ka BP: these ages were considered to be too recent by various authors, including Sala (1980), who attributed the deposit "to the Riss", based on the presence of *Canis mosbachensis* in the breccia in front of the cave. A more recent biochronological interpretation (Sardella *et al.*, 2013), however, do not validate this hypothesis, stating that the *Canis* remains fall into the variability within the *Canis lupus*, and confirms the attribution to the Tyrrenian of the beach located at 8 m (Di Stefano *et al.*, 1992). In this context the lower beach level has been attributed to the Neotyrrenian (90-80 Ka), and the related faunas to the age interval between OIS 5c and OIS 5a.

Another method of dating is to use the volcanic levels as markers, although a cautionary view has been recently expressed (d'Errico and Banks, 2014). The best known example is the "ignimbrite campana"(CI), dated ~40 ka BP, but new markers are increasingly used. The CI erupted from the Phlegrean Fields, near Naples (Giaccio *et al.*, 2008), its distributed tephra products fell over an extensive part of the Italian Peninsula (Fedele *et al.*, 2002) and has been dated using laser 40Ar/39Ar techniques at 39,280 ±110 BP (De Vivo *et al.*, 2001), while Giaccio *et al.* (2006) and Fedele *et al.* (2008) adopt an age of 40,012 BP through comparison against the GISP2 ice core chronology. This tephra layer can be used as a *terminus ante quem*, being present at the top of the Uluzzo C and Mario Bernardini sequences (Giaccio 2008).

The level tephra X 6 (Keller *et al.*, 1978) is a volcanic level of campane origin, that has been dated at 107 ± 2 ka BP and falls at the end of the Last Interglacial in the Lago Grande di Monticchio varve record and other Mediterranean marine cores (Brauer *et al.*, 2007; Paterne *et al.*, 2008; Wulf *et al.*, 2006) and has been recognized in the level G of Grotta del Cavallo. This tephra level is correlated with the OIS 5d, corresponding to a cooling climate during the last interglacial (C24). This gives us a *terminus ante quem* to include the sequences between the OIS 5e and 5d. Volcanic levels which are potentially correlated with tephra X6 are the level γ of Uluzzo C (at the basis of D layer) and the basis of B layer of Mario Bernardini.

If this hypothesis is valid, almost all the analysed series are related to the OIS 5. The faunas appear to be consistent with this framework: the environment, mostly temperate fresh, it is likely for the interglacial period.

The Grotta Torre dell'Alto shows no traces of the Tyrrhenian transgression and generally the faunas suggest a cooler climate. Traditionally this site has been dated to the beginning of the last glaciation, but this interpretation is likely to be reviewed, while if this hypothesis is confirmed, this sequence is the oldest in the region.

In summary, it seems likely that the relative age, as showed by geological features, sets those assemblages as younger than MIS 5e (Mastronuzzi *et al.*, 2007) and older than CI eruption at 40 ka BP (Fedele *et al.*, 2008).

4. Results

4.1. Raw material selection & blank production

The analysis of blank production showed that the reduction methods are varied, however the same range of methods is used in different assemblages and on different raw materials. Moreover, the sample analysed represents a good range of raw material variability, from sites where one type of raw material predominates, to sites where there is a balance among local and non-local raw materials (Table 1).

In terms of the technological traits that are at the basis of the technical choices, a dichotomy was recognised between Levallois / non Levallois. Levallois is the only method constantly present (Table 2), although in different proportions, in all the assemblages. Levallois is a reliable method to produce desired products (Lycett *et al.* 2015), statistically distinguishable (Scerri *et al.* 2015), having a robust working edge, and a great potential for retouch, and moreover this methods gives advantages in terms of raw material economy (*cf.* further). This is not true for other types of reduction methods, such as discoidal (present mainly in Grotta Romanelli) or the anvil percussion (found

	Dataclass	**GG**	**Rom G**	**UC G**	**MBERN**	**TdA**	**Total**
Limestone	natural bloc	1	83	0	1	0	85
	core	5	57	4	17	0	83
	flake	62	622	80	183	21	968
	tool	39	76	204	38	28	385
	chunck/frag	0	0	51	91	10	152
Siliceous limestone	core	2	0	3	11	0	16
	flake	13	3	37	88	5	146
	tool	5	5	268	44	116	438
	chunck/frag	0	1	2	25	14	42
Flint	core	1	0	1	2	0	4
	flake	54	1	40	11	4	110
	tool	111	4	307	5	29	456
	chunck/frag	0	0	17	1	1	19
Quartzite	flake	2	1	0	0	0	3
	tool	1	1	10	0	0	12
Jasper	core				1	0	1
	flake	0	0	2	2	0	4
	tool	1	1	18	1	1	22
	tool	0	0	1	0	0	1
Other	natural bloc	1	0	0	0	0	1
	core	0	0	1	0	0	1
	flake	2	0	2	0	0	4
	tool	5	0	5	0	2	12
	chunck/frag	0	0	0	0	1	1
Total	**dataclass**	**305**	**855**	**1053**	**521**	**232**	**2966**

Table 1. Technological composition and raw materials of analysed assemblages.

N	ROM	UC	MBern	TdA	Gig
Levallois	378	497	261	106	170
opportunistic	232	260	65	65	57
ind	66	87	71	27	63
discoid	69	6	2	0	2
anvil	58	3	3	5	12
komb	7	2	1	0	3
cobble/pebble	45	0	1	0	0

Table 2 . Knapping methods.

	Giganti		Romanelli		Uluzzo C		Torre dell'Alto		Mbern	
N	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material
0-1	7	3	182	0	36	11	0	0	32	4
2	63	38	506	0	88	16	20	3	469	17
3-4	37	91	95	6	330	206	117	24	62	6
5	7	34	61	0	173	174	30	8	66	3

	Giganti		Romanelli		Uluzzo C		Torre dell'Alto		Mbern	
%	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material	Local Raw Material	Imported Raw Material
0-1	6,2	1,8	21,6	0	5,8	2,7	0	0	5,1	13,3
2	55,2	22,9	60	0	14	3,9	12	8,6	74,6	56,7
3-4	32,4	54,8	11,2	100	52,6	50,7	70	68,6	9,8	20
5	6,2	20,5	7,2	0	27,6	42,7	18	22,8	10,5	10

Table 3. Local and non-local raw materials knapping phases (0-1=procurement; 2=production; 3-4=use and maintenance, 5= depletion).

in several sites, always in more or less circumstantial ways). This dichotomy points to great behavioural flexibility and probably to an unexpected complexity. The main factor driving the choice of these production methods appears to be the raw material, in terms of quantity, quality and morphology. Thus, the use of anvils appears to be ideal for blanks with a rounded morphology (pebbles) and the débitage on perpendicular planes is suitable for thin tabular blocks, such as limestone slabs. As for the Levallois method, it is likely that its use is focused on producing thin blanks with sharp edges and maximise the number of flakes from a given block of raw material.

Blank production at all sites is principally on local materials (Table 3), however the limestone cores were probably reduced directly near the raw material sources. The exploitation of limestone is mostly made following the Levallois method (48%), as in **Grotta Romanelli**, where this is the predominant raw material (99%). The whole assemblage includes 57 cores on different raw materials, where the standardized core morphologies (Levallois, N=17 and Discoidal, N=6) are a minority compared to more opportunistic morphologies (N=33). The knapping sequences thus seem very long, reaching the complete exhaustion of the cores. It is likely that irregular cores are here at

the very end of the *chaîne opératoire*: these include pseudo-prismatic cores and re-used exhausted Levallois cores. The Levallois sequence follows two dominant recurrent modalities: the centripetal and the unidirectional; the core shaping is done through very thin removals followed by preparation of the débitage surface, completed by débordant flakes and removals perpendicular to the platform. Those flakes are not very diagnostic and they are classified frequently as "*indifferenciés*". The cortical/non-cortical ratio is 2 to 1 and shows a high degree of exploitation of the natural blocks.

In **Grotta Torre dell'Alto,** the most common raw materials are siliceous limestones (58%), followed by limestone (25%). Here, the Levallois method, principally recurrent, is primarily used for blank production (53%), while 32% of the assemblage has not been attributed to a particular reduction method. The same pattern has been observed at **Grotta Mario Bernardini**, where the siliceous limestone and the limestone are the most common raw materials (Fig.3), and are processed principally by a Levallois method (68%), predominantly recurrent centripetal.

Other assemblages are characterised by the production both on local and non-local raw material, as **Grotta dei Giganti** (Spinapolice, 2009), where they are equally present. Here the Levallois method is used on limestone to obtain predetermined Levallois flakes (N=57), often morphologically elongated or Levallois blades (N=9) with unidirectional recurrent or bidirectional modality. Flint Levallois *débitage* is principally recurrent, both unidirectional and centripetal, producing highly standardized blanks, which are often heavily reduced (75%) (see further).

In Grotta **Uluzzo C** flint 37% (N=365), limestone 33% (N=339) and siliceous limestone 30% (N=310) are well represented in the assemblage. However, the total volume of limestone is significantly larger, (4,163,715 mm^3) against the siliceous limestone (mm^3 2,150,087) and the flint (mm^3 1,316,264). In general, the Uluzzo C shows a trend to the utilization of the Levallois method, regardless of the raw material used, for retouch or for use in unmodified form. An overall analysis of determinable blanks revealed a slight predominance of Levallois (N = 497) over other knapping methods (N = 358). Production appears to focus mainly on flakes and elongated flakes: the "typical" Levallois flakes make up 39% of the blanks, 37% retouched and 63% unretouched; 30% of them are obtained with unidirectional method.

It is likely that the limestone cobbles represented the biggest available raw material package size in the region, and were therefore selected to obtain longer blanks. Limestone flakes in the Uluzzo C assemblage are long in average 38,26 (σ12,6) mm and flint flakes only 27,55 (σ19,1) mm, whereas at Grotta dei Giganti while limestone blanks are 35,2 mm long, flint ones are only 17,82 mm.

The limestone cobbles were knapped to obtain predetermined blanks, probably to be used unmodified and they are assumed to be less mobile than flint blanks. However, limestone pebbles are not ubiquitously available in the region (Spinapolice 2012) and it is likely that they were moved. Since the Grotta dei Giganti is distant both from the flint and limestone sources, this site occupies a rather peculiar place in the settlement system. Conversely, the intentional production of very small flakes (<2cm) is attested by the presence of very small Levallois cores (Fig.4 A, B and D) and by flake production from tools (see further).

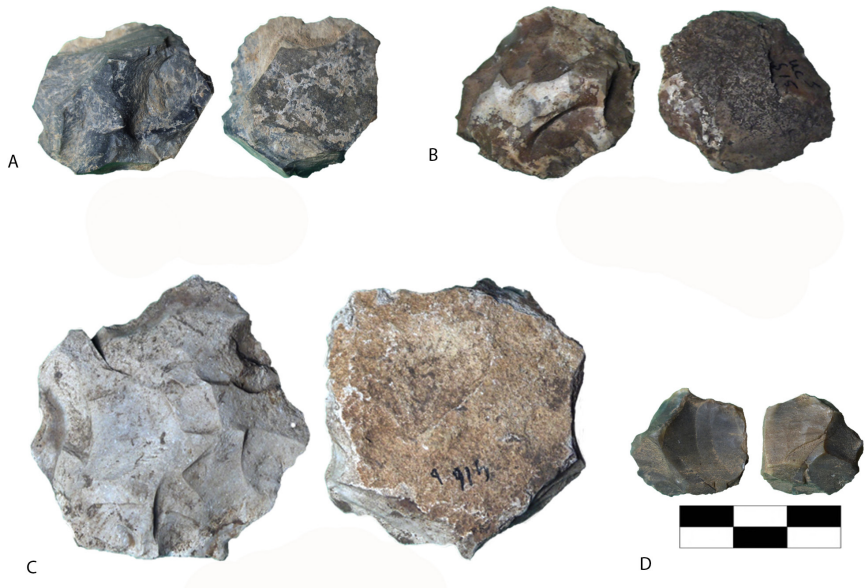

Figure 4. Exhausted Levallois cores on flint (A, B, D) and "placchetta"(C) . (A, C Uluzzo C; B, D Mario Bernardini).

The knapping of siliceous limestone, using the Levallois method, follows slightly different directions if compared to the limestone. At Uluzzo C this very flat raw material offers low possibilities of surfaces organization and induces a predominance of centripetal modalities to produce convexities (Fig.4, C), without platform preparation.

Non-Levallois production is oriented to the making of thick products, with a variable morphology. Knapping sequences on flakes are recognizable from undifferentiated products knapped from slabs: at Uluzzo C, this modality produced blanks (N=215) and cortical flakes (N=119). The "*faccia ventrale diedra*", pieces with the dihedral ventral surface, are numerous, especially in sites with limestone predominance. Expedient knapping of limestone slabs also occurs exploiting the elongated morphology to produce elongated blanks. Moreover, pseudo-prismatic cores, in Grotta Mario Bernardini (N=4) in Grotta Romanelli (N=1), in Grotta dei Giganti (N=2), in Grotta Uluzzo C (N=1, Fig.5, A) show an intentional volumetric exploitation.

Other opportunistic strategies include anvil percussion, particularly for first stages of cobble and pebble exploitation, such at Romanelli (N=14 cores), at Torre dell'Alto (N=3 cores on limestone pebbles) and at Giganti and Uluzzo C on flint, jasper and quartzite pebbles (GG=5, UC=15), often knapped to produce Quina scrapers.

In Grotta dei Giganti an opportunistic exploitation of *Callista chione* shells for the production of blanks has been outlined (Cristiani and Spinapolice, 2009; Douka and Spinapolice, 2012). This occurs in several sites in the Salento and has been associated with the scarcity of raw material, and not to symbolic behaviour (*contra* Romagnoli *et al.*, 2014).

4.2. Tool production and maintenance

The economic behaviour emerging from the assemblage analyses can be schematized into three sets of tools: expedient, opportunistic and curated. Thus, a raw material economy can be outlined, with a dichotomy of local and non-local raw materials, managed accordingly diverse patterns of raw material provisioning.

The tools on limestone and siliceous limestone are generally poorly reduced and frequently "expedient". Expedient tools (or instant tools, Gould, 1980) are characterized by a poor alteration of their original morphology. Nelson (1991) made a distinction between expedient strategies and opportunistic behaviour, where the latter are unplanned responses to an unanticipated need. Real expedient technologies are instead programmed responses to an expected goal that has minimal technological preparation, a brief period of use and the depletion of tools in the same place of use. When these strategies are used, it is implicit that the raw material is readily available. Thus, expedient technologies reduce transportation costs of raw materials, but also the time spent to repair and re-sharpen tools.

N	GG			ROM			Uluzzo C			M Bern			TdA		
Typology	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total
Points	9	1	10	0	2	2	4	3	7	0	0	0	0	0	0
Limaces	3	1	4	0	0	0	10	10	20	0	0	0		3	3
Scrapers	25	5	30	13	0	13	150	193	343	5	8	13	16	80	96
Endscrapers	0	0	0	3	0	3	7	14	21	0	0	0		1	1
Burins	0	0	0	3	0	3	1	3	4	0	0	0	0	0	0
Perçoirs	1	0	1	1	2	3	0	0	0	0	0	0	0	0	0
Notches&dent	0	0	0	29	1	30	4	7	11	27	25	52	4	10	14
Other	0	0	0	5	0	5	2		2	0	0	0	1		1
Retouched flakes	2	0	2	32	0	32	28	37	65	3	10	13	6	19	25

%	GG			ROM			Uluzzo C			M Bern			TdA		
Typology	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total	Limestone	Sil. Lim	Total
Points	22,5	14,3	21,3	0	40	2,1	2	1,2	1,5	0	0	0	0	0	0
Limaces	7,5	14,3	8,5	0	0	0	4,9	3,7	4,3	0	0	0	0	2,6	2,1
Scrapers	62,5	71,4	63,9	15,1	0	14,3	72,8	72,3	72,5	14,3	18,6	16,7	59,3	70,8	68,6
Endscrapers	0	0	0	3,5	0	3,3	3,4	5,2	4,5	0	0	0	0	0,9	0,7
Burins	0	0	0	3,5	0	3,3	0,4	1,2	0,8	0	0	0	0	0	0
Perçoirs	2,5	0	2,1	1,2	40	3,3	0	0	0	0	0	0	0	0	0
Notches&dent	0	0	0	33,7	20	33	2	2,6	2,3	77,2	58,2	66,6	14,8	8,9	10
Other	0	0	0	5,8	0	5,5	0,9	0	0,4	0	0		3,7	0	0,7
Retouched flakes	5	0	4,2	37,2	0	35,2	13,6	13,8	13,7	8,5	23,2	16,7	22,2	16,8	17,9

Table 4. Typology of local raw materials.

In the sample analysed (Table 4), the expedient behaviour category regroups principally notches & denticulates. In Grotta Romanelli, where the raw material is strictly local, the retouched items are few (11%) and notched pieces are the bulk of the series (N=30, 33%). Those tools can be considered as typically expedient (Costamagno *et al.*, 2006) and they are usually made on locally available raw materials (Thiébaut 2005). Notches and denticulates are often retouched on (predetermined) Levallois blanks and at Romanelli this is the case for 60% of this tool class. The retouch, when present, never led to a radical transformation of the object's morphology and there are no pieces bearing the scars of successive retooling that have significantly altered the volume of the initial blank. The tool making is probably associated here with very short use-lives.

At Mario Bernardini, denticulates form the major category of tools (N = 52), on blanks usually fine (average thickness 6.5 mm) Levallois flakes (78%), presenting for the most part a series of two or three notches, sometimes Clactonian. The raw material is exclusively local: 50% siliceous limestone (N = 27) and 50% limestone (N = 25).

Denticulate tools have been regarded as very mobile in some French Middle Palaeolithic sites (Slimak 2004). Conversely, these pieces are here considered to be highly local and not associated with a mobile toolkit, or linked to reuse and recycling. The pattern of low curation and transport for this tool class has been shown elsewhere (*e.g.* Geneste, 1985, 1988; Turq, 2000).

The scrapers on slabs, found in large quantities especially in the Bay of Uluzzo (Fig.5, B-G) are highly opportunistic. These are manufactured from a local raw material, the blanks are not knapped but are collected in the form of flat slabs in the proximity of the sites and they often have two cortical surfaces. In Uluzzo C, the scrapers on slabs are predominant in the tool kit (N=193), while only one of them is attested in Grotta dei Giganti, suggesting an occasional transport. These tools have been used only for short periods, emanating from an unplanned context related to the occupation strategy of the site. These scraping tools can thus be considered as "opportunistic", sensu Nelson 1991. The retouch is sometimes steep; however, it does not change very much the initial morphology of the blanks. Furthermore, the unretouched slabs are not present at the sites because their natural edges were not functional. The practical purpose of these scrapers, found in very similar types in the Uluzzian (Palma di Cesnola, 1993), remains unknown and there has been no study of their use-wear. The presence of opportunistic scrapers gives some insights about the function of the sites where they are found. While notches and denticulates seem to be linked to short occupations or distinct activity, siliceous limestone scrapers could be related to a more permanent occupation. Scrapers on slabs seem to indicate residential stability: the presence of these tools is expected to be related to processing, manufacturing and maintenance activities common in residential sites. Among the studied sites, Uluzzo C is the one most likely to represent residential occupation, since it is characterized by frequent tools and an important investment in their transformation.

In Uluzzo C, 74% of lithics are retouched, and the retouching equally affects all the technological categories (cortical products, undifferentiated, Levallois). The proportion of retouched items corresponds to different raw materials: 58% of limestone and 83% of the siliceous limestone blanks are retouched. The flint blanks are also frequently retouched (79%). In terms of absolute values, the flint blanks are the most retouched (N = 305, Table 5). It is likely that retouch on these raw materials has not

played the same role in the economy of the human groups, given the large differences in their suitability for knapping and efficiency in use.

When the imported raw material are analysed, the data show both curation and maintenance behaviour. First, the tools made on good quality raw materials appear to be more intensively retouched than the ones on local raw material. In Grotta Uluzzo C flint is used for 38% of tools and 47% of retouch flakes is on flint. In Grotta dei Giganti this proportion is higher, as flint represents 69% of tools and 96% of *débris*. Débris is composed for the most part of retouch flakes, and the possible presence of phantom tools (sensu Cahen and Keeley, 1980) has been outlined, as in Mario Bernardini, where a *dèbris* of a good quality brown flint has no correspondence to the assemblage.

Other imported raw materials such as quartzite and jasper, despite being rare, seem to have the same pattern of utilization as flint, and they might come from the same sources (Spinapolice 2012, 2018).

At Torre dell'Alto the rate of tool reduction is not very important. However, because of the provisioning distances and the original morphology of the raw material, the flint tools are the smallest, on average, among the retouched items (flint and jasper 2,53 cm, σ 0,76; sil. limestone 2,79 cm σ 0,57; limestone 3,16 cm σ 0,74). Retouched pieces on siliceous limestone are longer and wider and the morphology of the raw material limits their generally low thickness.

At Grotta dei Giganti 54,8% of the non-local raw materials relates to the transformation stage (N = 115), while only 32% of the local ones are retouched (Table 3, 4). Flint tools are more heavily retouched then limestone ones, both in terms of the density of retouched items/layer and in intensity of retouch itself; in fact only 9 limestone tools show intense retouch, against 37 flint ones. The typology shows that flint tools are the most retouched and reduced tool-types, *i.e.* double scrapers, limaces and convergent scrapers (Table 5, 6).

Additionally, specific tool classes have a particular role in the technological organization. This is the case of the limaces (Fig.6). The limaces, defined by Bordes (1961) as double convergent scrapers, are characteristic of the Salento Middle Paleolithic in Grotta dei Giganti and in other deposits of the region. These tool types are often "proto-limaces" (Fig. 6, 10-14), denominated "*Quinson type*" or "*de la Baume Bonne*" (Bottet and Bottet, 1951). The retouch makes a full circuit of the tool and bulb and platform are removed (Fig. 6, 1-5). Sometimes they maintain some of their dorsal cortex, possibly coming from an opportunistic blank (Fig. 6, 8).

The dimensions of the *limaces*, the degree of reduction, the raw materials, occupy a distinct place. The morphology and the volumetric design of these tools indicated that they are not simply the exhaustion stage of a scraper: this tool represents a flaking / shaping dichotomy and is associated with a complex and anticipatory behaviour.

The corpus includes 79 limaces on different sites mostly on non-local row materials (Table 6): 20 in Grotta dei Giganti (13% of the tool-kit), one at Grotta Romanelli, 5 at Torre dell'Alto (3%) and 53 at Uluzzo C (7%). To test for reduction, the maximum length of the limaces was compared with the length of double and convergent scrapers and of unretouched blanks; the reduction hypothesis was discarded because the average dimensions of the limaces are generally above the average of the corresponding blanks

Non Local RM	GG			ROM				Uluzzo C					M Bern			TdA		
Typology	Flint	Jasper	Total	Flint	Jasper	Quarzite	Total	Flint	Jasper	Quarzite	Granite	Total	Flint	Jasper	Total	Flint	Jasper	Total
Points	12	0	12	2	0	0	2	3	1	1	1	6	0	0	0	0	0	0
Limaces	16	0	16	0	0	1	1	32	1	0	0	33	0	0	0	2		2
Scrapers	54	1	55	2	1	0	3	220	12	8	0	240	2	0	2	22	1	23
Endscrapers	0	0	0	0	0	0	0	7	0	0	0	7	0	0	0	0	0	0
Burins	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perçoirs	2	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Notches&Dent	1	0	1	0	0	0	0	3	4	1	0	8	1	0	1	0	0	0
Other	9	0	9	4	1	1	6	0	0	0	0	0	0	0	0	0	0	0
Retouched flakes	20	0	20	0	0	0	0	39	0	0	0	39	2	1	3	5	0	5

Non Local RM	GG			ROM				Uluzzo C					M Bern			TdA		
Typology	Flint	Jasper	Total	Flint	Jasper	Quarzite	Total	Flint	Jasper	Quarzite	Granite	Total	Flint	Jasper	Total	Flint	Jasper	Total
Points	10,4	0	10,4	25	0	0	16,6	0,9	6	10	100	1,8	0	0	0	0	0	0
Limaces	13,9	0	13,9	0	0	100	8,4	10,5	6	0	0	9,9	0	0	0	6,9	0	6,6
Scrapers	47	100	47	25	100	0	25	72,3	66	80	0	71,9	40	0	33	75,9	100	76,7
Endscrapers	0	0	0	0	0	0		2,3	0	0	0	2	0	0	0	0	0	0
Burins	0,9	0	0,9	0	0	0		0	0	0	0	0	0	0	0	0	0	0
Perçoirs	1,7	0	1,7	0	0	0		0,3	0	0	0	0,3	0	0	0	0	0	0
Notches&Dent	0,9	0	0,9	0	0	0		0,9	22	10	0	2,4	20	0	17	0	0	0
Other	7,8	0	7,8	50	100	100	50	0	0	0	0	0	0	0	0	0	0	0
Retouched flakes	17,4	0	17,4	0	0	0		12,8	0	0	0	11,7	40	100	50	17,2	0	16,7

Table 5. Typology of non-local raw materials.

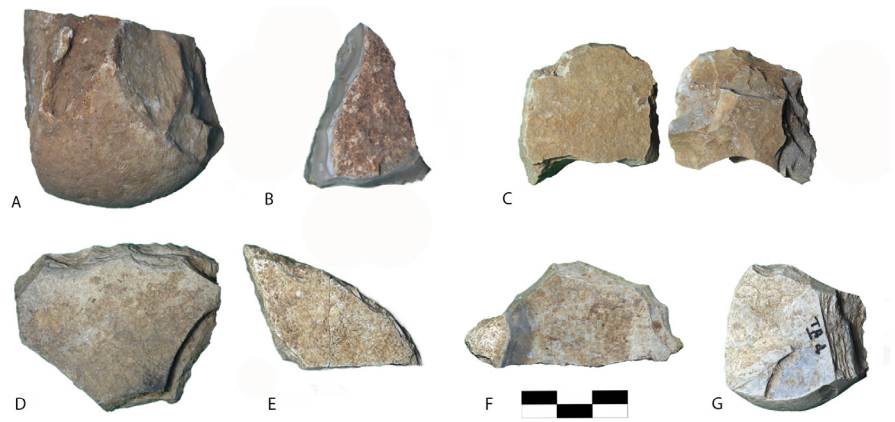

Figure 5. A. Pseudo prismatic core, Uluzzo C; B. Scraper on local flint slab (Uluzzo C); C-G: Scrapers on "placchetta" (D, E Uluzzo C; B, F Mario Bernardini; G Torre dell'Alto).

N	Typology									
Sites	Pointes	Limaces	Scrapers	Endscrapers	Burins	Perçoirs	Notches&Dent	Other	Ret. Flakes	**Total**
GG Local	10	4	30	0	0	1	0	0	2	**47**
GG non local	12	16	55	0	1	2	1	9	20	**116**
GG total	22	20	85	0	1	3	1	9	22	**163**
ROM local	2	0	13	3	3	3	30	5	32	**91**
ROM non local	2	1	3	0	0	0	0	6	0	**12**
ROM total	4	1	16	3	3	3	30	11	32	**103**
UC Local	7	20	343	21	4	0	11	2	65	**473**
UC non loca	6	33	240	7	0	1	8	0	39	**328**
UC Total	13	53	583	28	4	1	19	2	104	**801**
Mbern Local	0	0	13	0	0	0	52	0	13	**78**
Mbern non local	0	0	2	0	0	0	1	0	3	**6**
Mbern Total	0	0	15	0	0	0	53	0	16	**84**
TdA local	0	3	96	1	0	0	14	1	25	**140**
Tda non local	0	2	23	0	0	0	0	0	5	**30**
TdA total	0	5	119	1	0	0	14	1	30	**170**

%	Typology									
Sites	Pointes	Limaces	Scrapers	Endscrapers	Burins	Perçoirs	Notches&Dent	Other	Ret. Flakes	**Total**
GG Local	45	20	35	0	0	36	0	0	9	**29**
GG non local	55	80	65	0	100	64	100	100	91	**72**
GG total	100	100	100	0	100	100	100	100	100	**100**
ROM local	50	0	81	100	100	100	100	45	100	**88**
ROM non local	50	100	19	0	0	0	0	65	0	**12**
ROM total	100	100	100	100	100	100	100	100	100	**100**
UC Local	54	38	59	75	100	0	58	100	62	**59**
UC non loca	46	62	41	25	0	100	42	0	38	**41**
UC Total	100	100	100	100	100	100	100	100	100	**100**
Mbern Local	0	0	87	0	0	0	99	0	82	**93**
Mbern non local	0	0	13	0	0	0	1	0	18	**7**
Mbern Total	0	0	100	0	0	0	100	0	100	**100**
TdA local	0	60	81	100	0	0	100	100	83	**82**
Tda non local	0	40	19	0	0	0	0	0	17	**18**
TdA total	0	100	100	100	0	0	100	100	100	**100**

Table 6. Distribution of tool types per site and raw material.

	L	W	TH
UC 9-12	34,86	23,7	7,74
TdA 9-12	44	19,5	5
GG 9-12	19,46	20,58	18
Rom 9-12	33	48	14
MB 9-12	30	27	8
UC 13-17	29,83	21,91	6,58
GG 13-17	37	20,5	14,5
Rom 13-17	33,5	26	17,5
TdA18-21	33	32,5	10,5
GG 18-21	22,2	15,1	10,5
Rom 18-21	35,75	21,25	9,25
MB 18-21	29,5	19,5	8,5
UC 18-21	31,19	21,81	7,34
UC 8	34,96	18,13	9,73
TdA 8	26,5	18	12
GG 8	31,46	18,62	14,25

Table 7. Average dimensions in mm of single scrapers (9-12), double scrapers (13-17), convergent scrapers (18-22) and limaces (8) per site.

and other scrapers type (Table 7). In addition the largest blanks, longer and thicker, were the subject of more intense retouching compared to smaller tools.

At Uluzzo C the limaces are up to 7%, while the "proto-limaces" are less common (N=5) and are often shaped to obtain very sharp points on both ends, while traces of cortex are seldom seen on the dorsal surface. They frequently have the morphology of double convergent scrapers and are rarely obtained with flatter retouch; in fact the morphologies can be highly variable and the profiles often have a quadrangular section, seldom rounded or polygonal. The ends may be more or less sharp, linked to the raw material quality. Those tools were produced despite the significant expense of the raw materials involved, on blanks likely being transported to the site, ready-made.

The limaces are among the larger tools; they are most often made from good quality raw materials; the nature of the invasive removals extended to the entire piece could suggest the production of usable flakes. These objects have tool vocation but work together as a repository of raw material for the production of small flakes without cortex and faceted platform. Hence, this pattern shows that there is not a definite clear-cut between tools and cores: the great flexibility in the managing of non-local raw materials is coupled with the production of very small flakes and tools. The production of very small flakes from flakes or tool is a well-known behaviour, such as in Qesem cave (Lemorini *et al.* 2015), probably linked with the need to increase the raw material productivity and could be inscribed in a "ramification" process (Rios-Garaizar *et al.*, 2014). The production and use of very small blanks seems to be a recurrent behaviour, consistent with this hypothesis: in Grotta dei Giganti, a core on tool is attested – two blanks have been knapped from a flint scraper; moreover, both in Uluzzo C and Giganti, there are very small scrapers on flint: 3 simple scrapers and 2 retouched flakes at Uluzzo C are less than 2cm long, while several tools (N=12) are only between 2 and

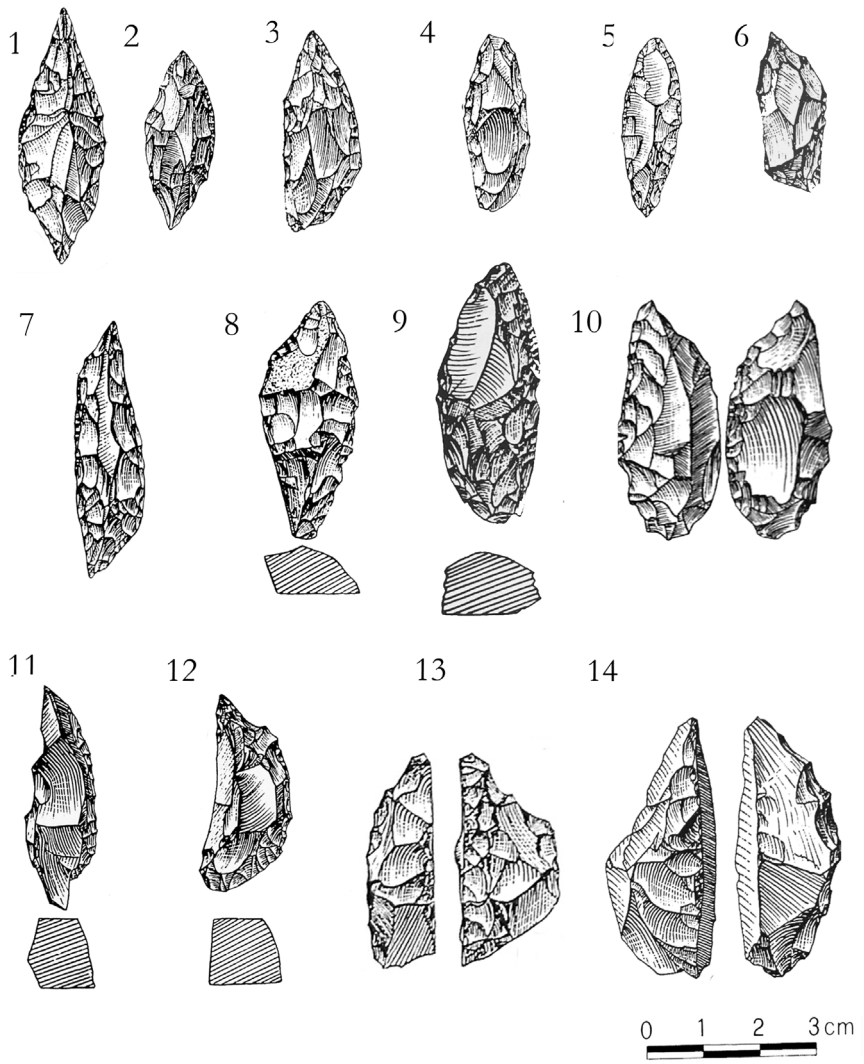

Figure 6. Limaces from Uluzzo C (modified after Borzatti von Löwenstern (1966), Borzatti von Löwenstern and Magaldi (1969).

3 cm long. The use of very small flakes and tools in butchering activities has already been shown in Italian Mousterian (Alahique and Lemorini, 1996), and they could possibly be linked with the "third hand" hypothesis (Spinapolice 2015).

Scrapers are very common in the Middle Palaeolithic (*e.g.*, Geneste, 1985, 1988; Turq, 2000, Costamagno *et al.* 2006) and very mobile in the Salento. The scrapers on non-local raw materials seem to follow a contrasting behavioural pattern compared to local non mobile ones, showing evidence for maintenance and reuse. Quina scrapers are relatively common, often being obtained by half pebbles of flint, jasper or quartzite (Fig.7). The high raw material investment linked to those tools, often having a fully cortical surface, indicates a specific place in the tool-kit, suggesting that those tools were mobile and maintained.

Furthermore, at Grotta dei Giganti, different tool morphologies (Mousterian points and convergent scrapers) seem to form a unique tool class, small in dimensions, characterized by a functional point, made in most cases on imported raw material and probably very mobile (Fig.8).

Almost no abandon of still exploitable item on good quality raw materials is assumed here, and the incorporation in archaeological assemblage principally by loss and depletion, in combination with a maximized use life (Schiffer, 1985; Shott, 1989).

4.3 Tool kit mobility and site economy

Generally, the artefacts that mobile people carry with them should be few in number, small and light (Nelson, 1991; Shott, 1986; Torrence, 1989). For example, Aboriginal hunters, usually carry some versatile implements with them (Gould 1980) and this minimal transported toolkit constitutes the "personal gear" (Binford 1979), frequently made of flexible or multifunctional tools (Bleed 1986).

In the Salento, the lithic items were transported in different forms according to their origin.

The raw materials of local and sub-local origin have been introduced in 1) raw material blocks if the transport distance was very short; 2) partially prepared blocks; 3) as cores or technologically processed products; 4) quality products, such Levallois blanks or tools. The less common products are the cores and the (fully) cortical flakes, related to an initial phase of knapping probably at the location of raw material source.

The non-local raw materials were introduced (in order of frequency): 1) retouched, as scrapers and limaces; 2) cores; 3) unretouched blanks.

First, we will consider the issue of movement of cores. Data from our case study challenge the results of Kuhn (1994) on the portability of small blanks as more effective than cores.

Indeed, in here it seems that the core transport is more common than unretouched blanks. The small cores, transported throughout the displacement of the group, are used as "reserve" of new blanks in situations of acute shortage of raw materials, and this possibility was also predicted by Kuhn (1994). To transport cores instead of flakes indeed presents a number of benefits. First, it prevents the damaging of flakes edges during transport and ensures availability of one or more blanks with sharp edges when the need arises. Then the cores can be used to perform other tasks, such as hammers, grinders or anvils (*e.g.* Thiébaut *et al.*, 2007; Thiébaut *et al.*, 2010). However, the cores on raw material from very remote origin are rare, very exhausted and often fragmentary (3=MB, 2=UC, 1=GG but 28=TdA/B (Borzatti 1966, 1967)).

The movement of tools, in some sites, concerns almost all of the tools on non-local raw material, imported as finished objects and possibly resharpened on site. In some cases, it seems that the retouched blanks, transported over long distances, can also be used as a reservoir of raw materials, as is the case of limaces or bifacially retouched tools, or exhausted tools used as cores. This dual status of cores thus represents a favourable factor for a more intense movement of certain categories of tools. This can be true sometimes for local raw materials: one limestone core on tool is attested in Grotta dei Giganti.

Finally, the presence of unretouched flakes in the sites, not coming from a complete *chaîne opératoire* (by the absence of any phase of core preparation or other flakes from

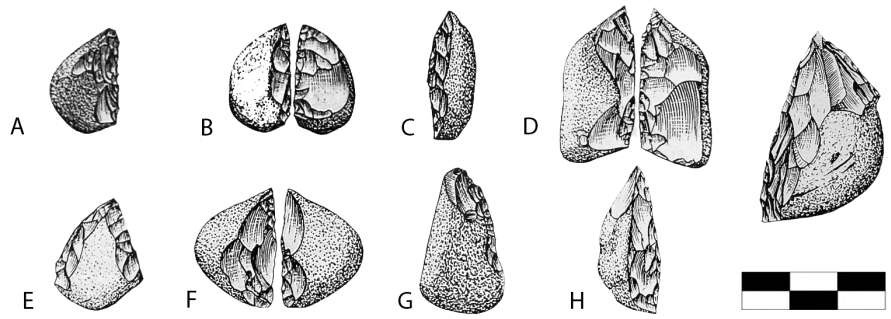

Figure 7. Scrapers on flint pebbles, Torre dell'Alto , modified after Borzatti von Löwenstern and Magaldi (1966, 1967, 1969).

Figure 8. Mousterian points on flint, Grotta dei Giganti.

the same sequence) may be related to the displacement from one site to another of small cores/tools, as well as the movement of the blanks themselves. Therefore, the transport of unretouched blanks cannot be excluded, while the cores/tools remain the most likely object to be moved.

4.4 Site function and distribution

The lithic analysis supports the model that the Mousterian sites in the Salento were a part of one or more settlement system, being related by the same technological organization and the fragmentation of *chaîne opératoires*, and inscribed in a "regional system of behaviour" (Binford 1983; Van Peer 2001). In this land use pattern, it is possible to differentiate residential vs. logistic sites; while residential sites are expected to show thick palimpsest and a complex combination of archaeological remains (Binford, 1980, 1982), the sites inscribed in high mobility, are expected to show a low degree of débris accumulation (Binford 2001): the presence of low remains densities would suggest short occupations (Bamforth and Bleed, 1997). Yellen (1977) notes that the smaller amount of débris was one of the main difference between Kung short-term rainy season camps and the longer occupied dry season camps. Hence, residential sites are characterized by a plurality of repeated occupation more or less separated in time;

activities of acquisition and consumption are performed, indicated by the variety of lithic industry, and space organization, as the presence of fireplaces. In the proposed model, the residential sites are located close to the Uluzzo Bay, because, among the various mineral zones of Salento, it appears the best one on the quality of the raw material (Spinapolice 2012, 2018). The presence of thin veins of local flint (Ranaldo personal communication) plays a major role in this model, while dolomitic limestone and siliceous limestone slabs are also part of this poor, but not hostile environment. In this "mineral area" are clustered the sites with the thicker and denser deposits. It is likely that the main attractions of the Uluzzo bay were related not to the lithic raw materials, but to the possibilities for hunting and gathering provided by the plateau overlying the bay. Thus, an interpretation of Uluzzo C site as residential occupation, probably repeated throughout the year, seems the most likely, at least concerning the G layer. This is characterized by the presence of several overlapping fireplaces, although the available data do not allow any assumption about the space organization inside the cave. It should be noted however that the excavations have involved only the half portion of the total surface (Borzatti von Lowerstern, 1966). New investigation actually are ongoing to clarify some aspects of the site function (Fiorini et al. 2017).

The second possible residential site is Mario Bernardini. Here**,** the *chaîne opératoire* in local raw materials is complete, except for the decortication flakes, showing a high rate of *in situ* raw materials exploitation, including retouch and resharpening (retouch flakes were isolated among the *debris*). Phases related to the abandon of tools (fractures, damage due to combustion, etc.) are represented and 26% of the lithics are fragmented while 50 pieces bear traces of combustion. Conversely, the non-local raw materials (Borzatti von Löwerstern, 1970, 1971) show uncomplete *chaînes opératoires*. This site could be interpreted either as a residential site, or issued as an alternation of residential and logistic occupations.

In the literature, another possible residential site in the same area is Grotta del Cavallo (Palma di Cesnola 2001). Here there is a thick palimpsest, and possible both production and transformation are attested, despite the complete technological analysis of the Mousterian levels is still ongoing.

In Torre dell'Alto an evaluation of the *chaîne opératoire* is not possible from the present sample. The small number of cores, however, shows a fragmentation of the reduction sequence that can partly take place outside the cave. However, frequent activities of knapping are indicated by the large number of materials from the excavation, and processing activities on site are suggested by the presence of retouching flakes. A typological homogeneity characterizes this assemblage, which remains rather different from the other series studied. The D layer from Torre dell'Alto for its stratigraphic characteristics and quantity of the remains, appears as a palimpsest, while it is impossible at present to determine the frequency and the overall length of the occupations. Torre dell'Alto might be a residential site, however the available evidence do not support to inscribe positively the site in the same settlement system, this hypothesis being neither entirely excluded.

Apart from the sites located in the area of Ionian coast, the other sites are probably temporary camps (Binford 1982) and they are linked to the acquisition of resources (hunting camp, gathering location, butchering/processing sites or facilities sites).

Grotta Romanelli shows the full knapping sequence performed on the spot. The observed variability within the layer G is very low and our analysis confirms the hypothesis of a very rapid deposition of this level and the inability to distinguish different human occupations contributing to the site formation. The refitting from the entire stratigraphy of the "bolo" confirms this strong homogeneity, which could be related to one occupation as well as few short events. The presence of pebbles just outside the cave seems to have been one of the criteria that led to the occupation of this cavity. Thus, the intense exploitation of these raw materials underlines an occupation oriented trough production activities. To this must be added the low number of retouched products. The site could be originated from a limited number of occupations, or even a single episode, as also evidenced by the presence of hyena coprolites and carnivores bones (Blanc 1928).

Grotta dei Giganti is located at the southern point of the peninsula, at the higher distance from the good raw material sources (Spinapolice 2008, 2012). Here, the knapping sequence is not complete: the preforms, the cores, the cortical and preparation flakes are almost entirely absent. Activities on site are limited to relatively short sequences of production, with exploitation of a few blocks of low quality local raw materials and production from cores introduced at advanced stages of exploitation (and carried as a personal gear). Apart from cores, a large number of prepared products were imported. The strong presence of retouched pieces and the frequency of retouching flakes, show tools manufacturing and maintenance at the site. The proportion of retouched blanks is quite large, probably reflecting a varied range of activities, which took place in or nearby the cave, requiring a differentiated tool kit. The knapping activities were therefore devoted to the processing and maintenance of products introduced in more or less finished forms. The Giganti lithics may reflect overall high mobility of predetermined and non-predetermined products (*e.g.* limaces) usable for the production of tools and unretouched products. The scarcity of the remains and the absence of a palimpsest points out through a mobile camp; the presence of well-separated levels and brief and repeated occupations in space and time are other elements of high mobility.

Other possible specialized sites in the southern Salento might be the other caves in the Capo di Leuca, Grotta Titti and Grotta del Bambino. Those are located few meters away from Grotta dei Giganti and yielded a Neanderthal human remain (Benazzi *et al.*, 2013; Blanc, 1962) and only few lithics remains (Spinapolice, 2008, 2018).

Two sites are particularly interesting, because they might be part of the same mobility pattern, and they are located inland. Grotta S. Ermete and Grotta Montani (Cremonesi, 1980a, 1980b) are characterized by a very low density of lithic and appear to have been occupied very sporadically: unfortunately, they were only partially excavated and studied. The raw materials are both of the local environment and more distant territories: they are accordingly interpreted as sites with episodic activities.

Thus, we take into account two territorial hypothesis. The first possibility is the existence of two independent territories. The first would be the north of our region, sites of the Bay Uluzzo being on its southern edge, and linked to the provisioning of raw materials in the Bradano basin and in the Central Apulia. The second area could include sites in southern Salento, inscribed in a residential mobility. Thus in this model we have two independent territories, each with a radius of about 50 km.

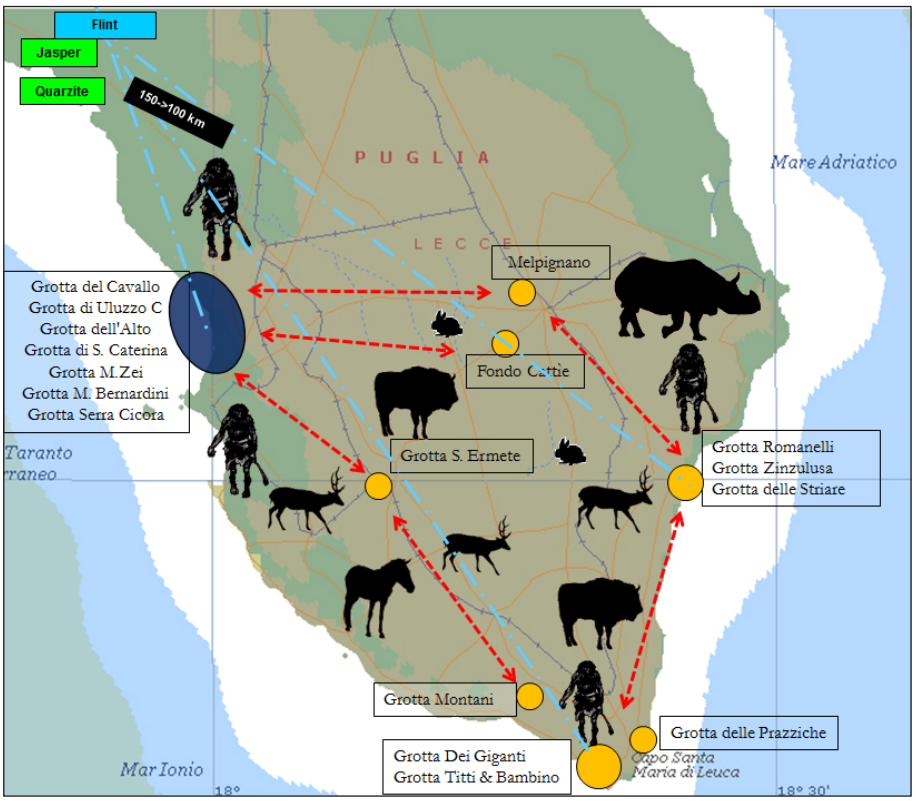

Fig. 9. Proposed territorial model.

Assuming two separate territories, we should however acknowledge a passage of men or objects through the second territory north to reach the sources of supply. Instead, we propose as a most likely the second hypothesis of territorial occupation (Fig.9). This hypothesis incorporates both regional territories in one macro territory crossed by the same groups of Neanderthals. Thus, the residential sites are north on the Ionian coast (*e.g.* Uluzzo C and Cavallo) and all the sites located below this line would be logistics and dedicated to specialized functions. The presence of imported flint in each site testify the (seasonal?) pathways of Neanderthals. Indeed, this hypothesis is supported by the large quantities in very remote raw materials found in the assemblages sites to the south (Giganti, but also San Ermete or Grotta Montani).

The geographical and environmental features of the Salento favoured humans traveling long distances since the landscape does not present major obstacles to overcome, being relatively flat and ease of access.

5. Discussion and conclusion

The availability, size, quality and shape of raw material strongly influence the technical systems during the Middle Palaeolithic. There is a close relationship between raw material economies, technological organization and the degree and modes for mobility (*e.g.* Odell, 2000). Archaeologically, we can recognize the provisioning

strategies principally through the study of raw material circulation over a specific area and the study of the site economy (Féblot-Augustins, 1997; Perlès, 1991). The Salento is an appropriate region to analyse this relationship, particularly for the peculiarity in raw material management. So, while the general "Middle Palaeolithic trend" is centred on the exploitation of local raw materials, in very high quantities (between 90 and 100% of assemblages) (Turq *et al.*, 2013), the Salento shows a different pattern (Spinapolice 2012, 2018).

Moreover, mobile toolkits organization can give information about the frequency of movements, resources availability and distribution, and other environmental elements, together with group structure and social organization. The study of technological organization and the ramification of *chaîne opératoires* throughout the landscape (Rios-Garaizar *et al.*, 2014) are powerful tools to study the dynamics of land use and site mobility.

The Salento is a peninsula that extends primarily in length, characterized by a north-south main axis and a width of about 40 km maximum. We described (Spinapolice 2012, 2018) the raw material coming from distant sources, probably not less than 100-150 km away. This remote space is incorporated into the territory of Neanderthal groups since these non-local materials (flint, jasper and quartzite) are present in varying quantities in all the sites examined. Likely their sources are north over the peninsula, and this implies that sites north of the study area (i.e the sites of the Ionian coast) are closest to the sources; conversely, the southernmost sites, are the farthest. The displacement of exotic implements over the Salento was embedded into a system of local sources exploitation and tool maintenance. The utilization of local sources was indeed regulated on the efficiency of the transported toolkits.

The results point out a differential technical behaviour in the managing of lithic resources by Neanderthal, probably linked to the anticipation of need and to a logistical land use.

The assemblages and the tool kits clearly suggest a combination of "curation strategy" (in the form of imported tools and personal gear) and "expedient strategy" (large amounts of tools and blank produced on the spot), that reflect an organized land use and a common strategy in the whole region. The differences in the assemblage composition are partially due to adjustments within the settlement system concerning site type. The residential sites are located on the Ionian coast and show a stronger pattern for expediency, linked to the occupation length. Conversely, the other sites can be interpreted as logistical spots, linked to raw material provisioning (Romanelli), and/or hunting /butchering (Romanelli, Giganti).

Therefore, the maintenance of the flint tools is a part of the Neanderthals occupation strategy, aiming to maximize the use life of those implements whose source was far outside the peninsula. This behaviour was coupled with the choice toward particular tool classes and reduction methods seeking to produce the most efficient blanks (Kuhn, 1992).

This variability is becoming part of our understanding of Neanderthal behaviour, characterized by a fragmentation of stone working in space, time and social dimensions (Turq *et al.*, 2013).

So what is the ultimate result of human occupation in the lower Salento? What purpose identifies a regular displacement of about 50 km from residential sites? The south-

ern Salento lacks immediate access to adequate sources of raw material, but it is rich in resources like game and water, ubiquitously distributed (Spinapolice 2008, 2018). The occupation of the southern area was probably linked to provisioning in non -lithic resources (*i.e.* water, game and vegetal resources). This fits with the hypothesis (Walker and Churchill, 2014) stating that Neanderthals must have relied heavily on animal protein in the plant food poor environment of Pleistocene Europe, home range sizes and levels of logistical mobility being determined by prey abundance and distribution and for that reason, Neanderthal maintained very large territories (1400-5400 km²). The concept of "embeddness" of provisioning of lithic raw materials (Binford 1979) is questioned here. Indeed, the territories of the southern Salento lacking these materials, they are associated to another territorial use model. Supplies of raw materials and game continues on two opposite sides, the first focused towards the north, the second towards the south. The occupation of a vast plain characterized by a high biodiversity can be related to a supply of game. A provisioning of raw materials is however possible for the site of Grotta Romanelli, where intense exploitation of the conglomerate was analysed. This is not the case with other sites that do not have the techno-economic facies of raw material acquisition, but almost exclusively facies of use/transformation.

The strategies employed in Salento finally seem to contradict the assertion that Neanderthals "shop food in the nearest supermarket" (Bar Yosef 2004). The occupation of a region devoid of mineral resources but rich in biodiversity and water is a potential demonstration.

Thanks to the analysis of raw material exploitation and site economy, significant behavioural peculiarities emerged in Neanderthal. A complete faunal study is expected, to test the proposed model at the light of the hunting and butchering data.

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PALAEOLITHIC ITALY

ADVANCED STUDIES ON EARLY HUMAN ADAPTATIONS IN THE APENNINE PENINSULA

The picture of the Palaeolithic adaptations in the Italian Peninsula has always been coarse-grained compared to various well-researched regional hotspots in central and western Europe, as a result of historical research bias preventing the application of new research methodologies. Nonetheless, discoveries regarding Neanderthal extinction and behavioural complexity, the dispersal of Anatomically Modern Humans as well as the origin and diffusion of modern technologies and symbolic behaviour in Europe have brought Italy into focus as an ideal region for understanding the evolutionary development of various hominin species that inhabited the continent in the Late Pleistocene. In particular the dynamics of the earliest human peopling of Europe, the reasons and timing of Neanderthals demise and how environmental factors affected human prehistoric behaviour, rates of technological innovation and connectivity of hunter-gatherer groups in Europe.

The edited volume "Palaeolithic Italy" aims to contribute to our better understanding of the previous, still open, research questions. This will be achieved by presenting the latest advances in Palaeolithic research in Italy due to the application of a variety of modern analytical methods and cutting-edge techniques when studying numerous collections of materials from both old and new excavations as well as the latest results of field research in the country. The volume is intended for the international academia, representing a key reference for all archaeologists and readers interested in Early Prehistory of the Mediterranean region.

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