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Land-Use Strategies, Related Tool-Kits and Social Organization of Lower and Middle Palaeolithic Groups in the South-East of the Massif Central, France

Strategien der Landschaftsnutzung, Geräteinventare und soziale Organisation von alt- und mittelpaläolithischen Gruppen im südwestfranzösischen Zentralmassif

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Abstract - In the southern French Massif Central and on its southeastern border but at different altitudes, open-air sites, rock-shelters and caves have yielded artefacts ranging from isolated finds to abundant series that date from MIS 9 to at least MIS 3, representing Lower Palaeolithic (sensu Acheulean bifacial production) and diverse Middle Palaeolithic facies. From the upstream part of the gorges of the Allier and Loire Rivers to the Chassezac and Ardèche Rivers surveys, excavations and detailed analyses of the material from these sites offer data on subsistence behaviours including among others raw material acquisition, lithic reduction sequences, hunted species and carcass treatment. This information has been gathered during a Collective Research Program (PCR Espaces et subsistance au Paléolithique moyen dans le sud du Massif central) and enables discussion of the mobility of human groups, the size of the territory they occupied, duration of site occupation, landscape cognition and resource exploitation and allows some speculation about the way these humans perceived the landscape in which they lived and how these ethnographic perceptions may have changed over time.

In this paper, we focus on results obtained from stratified sites dated from MIS 9 until MIS 4. Orgnac 3, Payre and Barasses II sites, Abri du Maras and Abri des Pêcheurs are caves and shelters located on low plateaus on the right bank of the Rhône corridor while the cave of Sainte-Anne I and Baume-Vallée rock-shelter are located in the mid-mountains of the Velay. The lithic repertoires found in Payre, Saint-Anne I, Baume-Vallée, Abri du Maras, Abri des Pécheurs and Barasses II suggest that the stone knapping and retouching activities that took place in them were directed towards achieving different objectives at each of them. In the several human occupation phases at Payre, the main core technology closely parallels the discoid type that provides unstandardized flakes. A lack of hafted points and the importation into the site of large flakes made from various local stone types along with introduced flint flakes and nodules are related to the seasonal occupation of the site due to its location. The flint reduction sequences are quite complete but those on local stones are often partial, indicating mobility of the occupants and off-site manufacture of lithic tools.

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Lithic raw material imported into Sainte-Anne I originates from more than thirty different primary localities close to the site as well as from secondary and sub-primary colluvial and alluvial outcrops. The Neanderthals who used this cave obviously had an excellent knowledge of the occurrence and potential of local resources. The presence of some specific flint types suggests the use of exploitation or trade routes which crossed the borders of fluvial systems. If the duration of occupation events can be judged from the presence of a large number of artefacts produced on local volcanic rocks, quartz and types of flint, the absence of certain items like large-sized and retouched flakes from the reduction sequences, indicates that these products were used away from the site or removed when the occupants moved on through their territories.

In the upper layers of Abri du Maras, the presence of flakes and pointed artefacts as well as the kind of retouch on them suggests that special equipment was being manufactured, possibly involved with hunting and butchering reindeer and horses during long-term residential occupation. Most of the Levallois lithic processing systems are complete but, judging from the size of the core-flakes, large un-retouched blades were being imported into the site suggesting that other tasks may have been undertaken there using these transported artefacts. At Abri des Pêcheurs, irregular and thick broken flakes of quartz and small flakes of flint suggest an expedient lithic technology. This assemblage was probably the result of brief human occupation events in the shelter during which they processed some parts of a few cervids and ibex. The *chaîne opératoire* is complete for quartz but incomplete for the flint assemblage which contains a higher ratio of tools to unmodified lithics. At Baume-Vallée, a range of flakes was produced by a variety of knapping techniques. Using different techniques to obtain different types of tool blanks from the same core was presumably a strategy of exploitation designed to conserve a precious resource that was available mainly as small pebbles. This assemblage indicates that multiple tasks were conducted simultaneously at a seasonal horse and cervid hunting camp. Microwear analysis shows that the stone artefacts were used to work soft or semi-hard materials, probably wood. The "Charentian" aspect of the assemblage is a reflection of intense edge reduction and appears identical to that identified at the Abri du Maras.

Overall, faunal remains indicate that a diverse range of landscapes was exploited during its procurement. Also, the territorial perspective provided by the widely disparate sources of lithic raw materials indicates that the groups inhabiting the sites were mobile and undertook multidirectional and more or less long-distance forays into the surrounding landscapes. Despite the complexity of territorial exploitation strategies suggested by the importation of varied and remote resources into these three sites, at present these subsistence activities provide no evidence for the existence of planning strategies comparable to those observed elsewhere. Nor can we confirm a strictly bipolarized (summer-winter / highlands-lowlands) circulatory subsistence pattern. However, there are suggestions of exploitation routes that proceeded back and forth along the course of the Allier and more certainly along the Loire for Charentian groups. The locations of the more remote geo-resources indicate the existence of a widespread exploitation pattern radiating outwards from semi-residential camps. The dispersed locations visited or exploited by the groups of hunter-gatherers transiently occupying other camps that were brief stopping places also supports this patterning. Additionally, remote or semi-remote lithic outcrops may mark some territorial limit or perhaps they may be places where adjoining groups could meet for some unknown purpose or, such locations may even be the source of particular raw materials needed for special occasions if not for unique tasks. In the same vein, lithic artefacts abandoned in the landscape that are often categorized by archaeologists as isolates may just as easily have been left intentionally as markers for others to discover. Although a resource territory may well differ from a social territory, petro-archaeology may be able to contribute new methods through which to decipher more of the Neanderthals' cognitive sphere.

Among the exploitative itineraries we have identified are: collection of lithic resources; transportation of these lithic resources; their abandonment; seasonal hunting of selected target species; collection of other permanently available or seasonally abundant resources; processing these and other resources at a variety of stopping places and camps; the possibility of single gender as well as mixed-gender groups undertaking specific tasks; confirmation that, from MIS 9 until MIS 3, Neanderthals were not simply reacting to landscape characteristics, they were interacting with landscape features (geosymbols) and responding to environmental and bio-resource changes in a deterministic manner. These kinds of responses to landscapes and resource occurrence are very close to modern hunter-gatherer behaviour.

Zusammenfassung - *Im südlichen französischen Zentralmassif und an seinem südöstlichen Rand, allerdings in verschiedenen Höhenlagen, finden sich in Freiland-, Abri- und Höhlenfundstellen isolierte aber auch dichtere Streuungen von Artefakten. Diese beinhalten altpaläolithische (sensu Acheulean) bifazielle als auch verschiedene mittelpaläolithische Konzepte, die mindestens in Marine Isotopenstufen (MIS) 9 bis MIS 3 gestellt werden. Geländebegehungen, Ausgrabungen und detaillierte Analysen des Materials vom oberen Lauf der Schluchten der Allier und der Loire bis zu den Flüssen Chassezac und Ardèche liefern Informationen zum Subsistenzverhalten (Rohmaterialgewinnung, Abbaukonzepte, Jagdbeute und deren Verarbeitung). Im Rahmen einer wissenschaftlichen Zusammenarbeit (PCR Espaces et subsistance au Paléolithique moyen dans le sud du Massif central) erfolgt eine Bearbeitung der Fragestellungen der Mobilität, Größe des Schweifgebiets, Dauer der Belegung der Fundstellen, Wahrnehmung der Landschaft und deren Nutzung durch die paläolithischen Menschengruppen. Dies erlaubt die Erstellung von Hypothesen zur Wahrnehmung der Landschaft über die Zeit aus einem archäo-ethnographischen Blickwinkel.*

Der Fokus dieses Manuskripts liegt auf stratifizierten Fundstellen, die in MIS 9 bis MIS 4 gestellt werden. Die Fundstellen Orgnac 3, Payre und Barasses II Höhle, Abri du Maras und Abri des Pêcheurs sind Höhlen und Felsschutzdächer auf den unteren Plateaus am rechten Ufer des Korridors der Rhône, während sich die Höhle von Sainte-Anne I und das Felsschutzdach von Baume-Vallée in mittleren Höhen der Velay befinden. Die Steinartefaktindustrien von Payre, Saint-Anne I, Baume-Vallée, Abri du Maras, Abri des Pécheurs und Barasses II deuten auf unterschiedliche Zielsetzungen in der Herstellung und Retuschierung von Steinartefakten zwischen den Fundstellen. Die vorherrschende Kerntechnik in den verschiedenen Phasen der menschlichen Begehung von Payre produziert nicht standardisierte Abschläge in einer der diskoiden ähnlichen Technik. Das Fehlen von geschäfteten Spitzen und der Import von Abschlägen aus verschiedenen lokalen Rohmaterialien, von Feuersteinabschlägen und Knollen stehen im Bezug zur saisonalen Begehung aufgrund der spezifischen Lokalität. Die Abbausequenzen von Feuerstein sind relativ komplex, während sie an lokalem Material oft nur partiell durchgeführt vorliegen, was auf ein Voraussehen des Bedarfs hindeutet.

In Sainte-Anne I erfolgte die Rohmaterialbeschaffung an mehr als 30 Lokalitäten sowohl in der Nähe der Fundstelle als auch in sekundären und sub-primären kolluvialien und alluvialen Aufschlüssen. Die Neanderthaler hatten offensichtlich eine genaue Kenntnis der potentiellen lokalen Rohmaterialvorkommen. Das Vorkommen von bestimmten Feuersteintypen legt die Nutzung von Routen über mehrere Flusssysteme nahe. Unter der Annahme dass die Anzahl an Artefakten aus lokalem vulkanischen Gestein, Quartz und verschiedenen Feuersteintypen, sowie das Fehlen bestimmter Glieder der Abbausequenzen wie große und retuschierte Abschläge darauf hindeuten dass diese außerhalb der Fundstelle hergestellt oder beim Verlassen des Territoriums mitgenommen wurden.

In den oberen Fundschichten des Abri du Maras deuten das Vorkommen von Abschlägen und spitzen Artefakten, sowie die Art der Retusche auf die Herstellung von speziellen Ausrüstungsgegenständen, die möglicherweise im Zusammenhang mit der Jagd und der Zerlegung von Rentier und Pferden während längerfristigen stationären Belegung stehen. Die meisten der Levallois basierten Abbauschemen sind vollständig. Diese eingebrachten Artefakte wurden aber aufgrund der Größe der Kernabschläge und großer unretuschierter Klingen wohl auch für andere Arbeiten verwendet. Im Abri des Pêcheurs deuten unregelmäßige und dicke zerbrochene Quarzabschläge und kleine Feuersteinabschläge auf eine zweckbezogene Technologie. Dieses Inventar ist möglicherweise auf eine kurze Belegung zur Verarbeitung von einigen Teilen von wenigen Cerviden und Steinbock zurückzuführen. Die chaîne opératoire des lokalen Quarz ist vollständig vorhanden, während die des Feuersteins, welcher mit mehr Geräten vertreten ist, unvollständig vorliegt. In Baume-Vallée wurden verschiedene Gerätevorformen von demselben Kern mit verschiedenen Schlagtechniken gewonnen. Vermutlich diente diese Strategie der Schonung einer wertvollen Materialquelle in der Form von kleinen Geröllen. Dieses Inventar deutet auf die gleichzeitige Durchführung verschiedener Tätigkeiten in einem saisonalen Kamp zur Jagd auf Pferde und Cerviden. Gebrauchsspurenanalysen zeigen die Verwendung dieser Steinartefakte zur Bearbeitung von weichen oder halbharten Materialien (Holzbearbeitung). Der Eindruck des Vorliegens des "Charentian" für dieses Inventars ist auf die intensive Reduzierung der Kanten zurückzuführen und scheint identisch mit dem im Abri du Maras festgestellten zu sein.

Obwohl die vorliegende Fauna auf eine Diversität der genutzten Landschaften hindeutet, zeigt die territoriale Perspektive auf Basis der Rohmaterialquellen für Steingeräte, dass die Menschengruppen die diese Fundstellen besiedelten mobil waren und multidirektionale aber auch Streifzüge über mehr oder weniger große Entfernungen in die umgebende Landschaft unternommen haben. Trotz der Komplexität der Nutzungsstrategien des Territoriums, die durch den Import von verschiedenen und aus weit entfernten Quellen stammenden Materialien in diesen drei Fundstellen nahegelegt wird, sind diese Aktivitäten zurzeit nicht vergleichbar mit anderswo beobachteten Strategien der Planung. Ein strikt bipolarer (Sommer-Winter / Hochland-Tiefland) Kreislauf der Lebensgrundlage kann nicht bestätigt werden, obwohl die Idee der Nutzung entlang der Allier, oder sicherlich entlang der Loire für Charentien Gruppen, in einem Hin und Her nicht verworfen werden sollte. Die Lage der entfernteren Georessourcen deutet jedoch auf ein radiales Muster ausgehend von semi-stationären Kamps hin. Unterstützt wird dieser Typ an organisierter Nutzung durch den Besuch oder die Nutzung von weit auseinanderliegenden Lokalitäten durch Gruppen von Jägern und Sammlern als Rastplätze. Zusätzlich markieren ferne oder weit entfernte Aufschlüsse möglicherweise territoriale Grenzen oder sind vielleicht Plätze an denen benachbarte Gruppen sich für unbekannte Zwecke treffen konnten. Solche Orte könnten sogar die Quelle für Rohmaterialien sein, die für spezielle Anlässe oder sogar spezielle Zwecke benötigt wurden. In diesem Sinne könnten Steinartefakte die in der Landschaft zurückgelassen wurden, und oft als isolierte Funde kategorisiert werden, intentionelle Markierer sein. Es muss hierbei beachtet werden, dass ein Territorium für Ressourcen sich durchaus von einem sozialen Territorium unterscheiden kann. Offensichtlich muss in Zukunft die Gesteinsarchäologie neue Wege zur Interpretation der kognitiven Fähigkeiten der Neanderthaler finden.

Unter den ausbeuterischen Routen wurden hier identifiziert: Aufsammlung , Transport und Aufgabe von Rohmaterial und –quellen; saisonale Jagd von speziellen Spezies; Sammlung und Verarbeitung in verschiedenen Arten an Rastplätzen und Camps von anderen permanent oder saisonal verfügbaren Ressourcen; die Möglichkeit dass geschlechtsspezifische als auch gemischte Gruppen spezielle Aufgaben unternahmen; Bestätigung der Besiedlung von MIS 9 bis 3; Neanderthaler reagierten nicht einfach auf bestimmte Charakteristiken der Landschaft sondern interagierten mit Besonderheiten in der Landschaften (Geosymbole) und antworteten auf Umwelt- und Bioressourcenveränderungen in deterministischer Weise, welche sehr nahe an dem Verhalten moderner Jäger und Sammler liegt.

Keywords - geo-resources, bio-resources, territories, Lower and Middle Palaeolithic, Massif Central, South-Eastern France
Georessourcen, Bioressourcen, Territorien, Alt- und Mittelpaläolithikum, französisches Zentralmassif, südöstliches Frankreich

Introduction

Open-air sites considered as Lower Palaeolithic and yielding bifacial lithics exist in the study area and demonstrate that the previously recognised site of Orgnac 3 was not the sole location of Acheulean occupation in the area which can be partly attributed to the presence of *Homo heidelbergensis*. The open-air sites date to MIS 9 or older but some may be contemporaneous with enclosed stratified sites that offer comprehensive data and which relate to Neanderthal land-use. Recent discussion in the literature regarding the differences in behaviour between Neanderthals and anatomically modern humans is based on current perceptions of the extent of territories and subsequent land-use of the two groups. In the following discussion, petro-archaeology provides answers to several important and classical questions including: Where were the exploited resources located? In what quantities were they sampled, and in what proportion

one to another? What were the minimum distances travelled to obtain them?

To answer these and other similar questions, information was gathered about: the direction in which resource-gathering journeys were made to and from a particular site; circulation patterns within an exploited territory given various topographical constraints; whether groups attributed any deeper meaning to the journeys they made beyond that of obtaining resources and, lastly, what might have been the economic and / or social significance of the resources gathered. Definitive answers to these questions remain unknown and far beyond our present level of understanding, however, what happened to lithic resources that were imported into or exported from an ancient site can be determined by a detailed analysis of the *chaînes opératoires* (which includes all the processes applied to a resource beginning with its collection and proceeding through its modification until it is finally discarded). Another question that might be asked is: Does the site contain a series of different phases of utilisation for every type of raw material? For some raw materials, distinctive because of their particular origin or occurrence in a landscape, the reason that they were chosen for the task to which they were applied remains enigmatic despite the fact that we have some understanding of their function thanks to use-wear analysis.

During the last decade considerable progress has been made towards discovering and refining more accurate techniques for sourcing the origins of various lithic raw materials, especially where secondary sources are concerned, these being by far the most popular occurrences that were exploited (Masson 1981; Fernandes 2006, 2012; Fernandes & Raynal 2007 Fernandes et al. 2008). Comparative work in other regions has proven that different exploitation strategies occur amongst different groups of individuals, but these strategies may not relate directly to the accessibility and abundance of any particular raw material. Even if such information brings forth great detail about the territory that was systematically utilised by a group of individuals and also reveals some of the cognitive process related to the exploitation of that territory, for any given task we are no closer to an understanding of the strictly cultural aspects linked to and perhaps governing the choice and use of, a particular raw material. On the other hand, detailed zoo-archaeological studies of several sites have revealed information regarding different types of occupation that took place and their various durations. These included ephemeral short-term visits, regularly visited hunting camps occupied for a short time in alternation with periods of carnivore occupation, along with semi-permanent occupational events indicative of longer-term residential sites (Daujeard 2008; Daujeard et al. 2012).

To gain a new perspective on Neanderthal lifeways in the south-eastern Massif Central, and to enable us to propose a more detailed demographic, social and perhaps even a cultural vision of Neanderthal life, we have for the past few years combined the study of subsistence strategies and raw material management into a three dimensional model by including spatial and temporal data. In other words, we have tried to draw together information connecting the landscape, its geo-resources, bio-resources, seasonality and patterns of exploitation by humans. The connections that we have been able to make between the highlands of the Velay and the lowlands of the Rhône Valley, have enabled us to highlight Neanderthal land-use and residential models that differ in circulation patterns and logistics from those classically identified in other areas of Europe (see many references for this in Daujeard & Moncel 2010; Daujeard et al. op. cit.; Raynal et al. 2012). This collaborative research is still in progress under the auspices of a Collective Research Program (PCR *Espaces et subsistance au Paléolithique moyen dans le sud du Massif central*) focused on Neanderthal subsistence strategies and mobility in the south east of the Massif Central being supervised by two of us (J.-P. Raynal & M.-H. Moncel).

In this paper, we focus on results obtained from stratified sites dated from MIS 9 to MIS 4. Orgnac 3, Payre, Barasses II, Abri du Maras and Abri des Pêcheurs are caves and rock-shelters located on low plateaus on the right bank of the Rhône corridor (fig. 1) while the cave of Sainte-Anne I and Baume-Vallée rock-shelter belong to the mid-mountains of the Velay (Raynal et al. 2005; Moncel et al. 2010; Moncel 2011).

Methodology

The lithic assemblages were studied by reconstructing the *chaînes opératoires* for each major class of raw material. To source the raw material we used geological surveys along with detailed observations according to a methodology developed by two of us (Fernandes 2006; Fernandes & Raynal 2007; Fernandes et al. 2007). This method is based upon an analysis of the evolutionary sequence governing the geological behaviour of silica, the results of which allowed us to group siliceous artefacts according to their facies, a characteristic which identifies various different gathering environments, namely: directly from or close to static outcrops, from colluvia, from recent alluvia or from older formations.

By examining a complete site assemblage and considering any pre or post-depositional evolution of flint found in a site we are able to avoid most of the facies convergence errors introduced by evolutionary processes. This methodology brings considerable precision to the identification of places visited by humans bent on gathering particular resources.

The technical processes we considered are described in the literature, (Geneste 1988; Boëda et al. 1990; Boëda 1993, 1994; Geneste et al. 1997; Jaubert 1997). Using them we proceeded to record

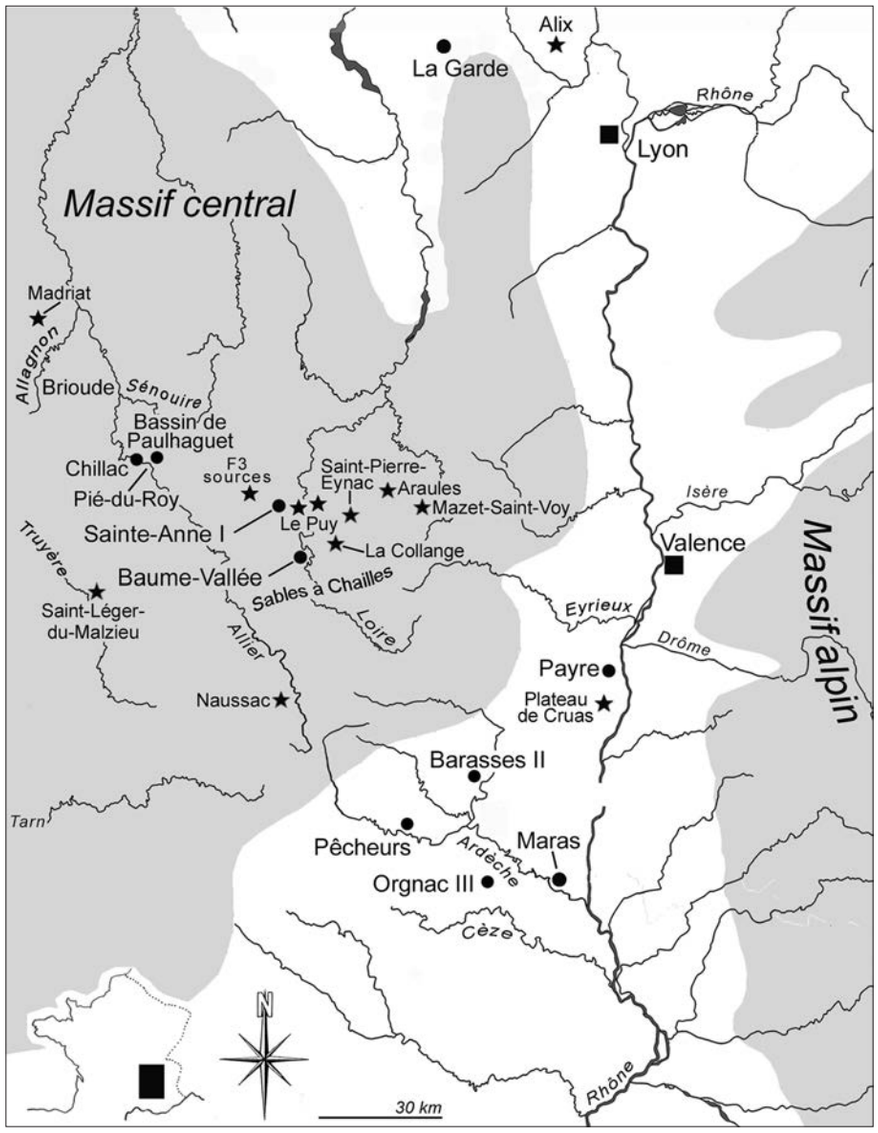


Fig. 1. Location map of archaeological sites (black dots) and some specific raw material sources (black stars).

Abb. 1. *Karte der im Text erwähnten archäologischen Fundstellen (schwarze Punkte) und besonderen Rohmaterialquellen (schwarze Sterne).*

the knapping, shaping and retouching modes according to the technical characteristics of the lithic raw materials. We also identified the various techniques applied to each type of raw material being used and the tool types being manufactured from each of them. The analysis of the complete *chaînes opératoires* was conducted according to the various techno-economic phases that underline the human strategies for managing their environmental resources, their preferences for particular technological schema and/or the coexistence of different knapping techniques (among others: Geneste 1985; Boëda 1986, 1994; Geneste 1988; Jaubert & Bismuth 1996; Jaubert & Farizy 1995; Jaubert & Mourre 1996; Mourre 1996, 1997).

For each faunal assemblage, our analysis identified the total number of remains (NR), the number of identified specimens (NISP) and minimum number of individuals (MNI) (Lyman 1994). Bone accumulation processes (hunting, scavenging or natural) are discussed on the basis of the work of a number of authors who considered the various taphonomic aspects of these processes (Hill 1980; Binford 1984; Klein & Cruz-Uribe 1984; Blumenshine 1986, 1988; Brugal et al. 1997; Fosse et al. 1998; Costamagno et al. 2005; Coumont 2006; Daujeard 2008; Daujeard & Moncel 2010; Daujeard et al. 2011;). The type of damage caused by humans, carnivores, rodents or climato-edaphic alterations found on each specimen was recorded systematically, except for those on

dental remains (apart from cases of ingestion), unreadable remains and bone pieces less than 5 cm long (Brain 1981; Haynes 1983; Lyman 1994; Fisher 1995). The latter category of small fragments was used for fragmentation studies (Blumenshine & Selvaggio 1988, 1991; Villa & Mahieu 1991) and carbonization analyses (Costamagno et al. 1998; Théry-Parisot 2001; Théry-Parisot et al. 2005).

Summary of Site Data

Stratigraphical and bio-stratigraphical data for ancient open-air sites are scarce and the availability of material for wide-ranging comparisons is thus very limited. Stratigraphical and bio-stratigraphical data for human occupation events in caves and rock-shelters (Payre, Sainte-Anne I, Baume-Vallée, Abri du Maras, Abri des Pêcheurs) are sustained by several absolute dates obtained using various methods (TL, ESR, ^{14}C, U-Th) (Evin et al. 1985; Raynal & Huxtable 1989; Masaoudi et al. 1994; Moncel & Michel 2000; Raynal et al. 2005) (fig. 2) and new results are expected from TL and RPE samples recently collected at Balazuc, Sainte-Anne I and Rond de Saint-Arcons.

Open-air sites with bifacial pieces

Assemblages with bifacial pieces are known from open sites in the upper basins of the Loire and Allier Rivers, however no excavations have taken place in these localities and our knowledge thus relies on analysis of their surface collections.

The lithic assemblage of La Garde near Roanne (Loire) along the Rhins Valley is a coherent Acheulean series; probably final Acheulean (Moncel et al. 2011b). It provides insights into localised human occupation and perhaps the movement of human groups between the Saône-Rhône corridor and river basins in the Massif Central. Technical strategies identified in the assemblages suggest that multiple activities have taken place on the site because of the presence of flakes obtained from Levallois, discoidal and orthogonal flaking techniques along with large bifacial tools (n = 102). The bifacial tools can be divided into three groups according to their overall form and tip shape (triangular, ovate with and without a back, and with a transversal cutting edge) (fig. 3). The shaping strategy and retouch found on different parts of the cutting edges and on the tips shows that these are cortical bifacial tools with various use areas. Tools with a transversal cutting edge and bifacial tools with a distal notch do not fit within the *Moustérien de Tradition Acheuléenne* series described in the area (Philibert 1982; Soressi 2002, 2004), rather, they resemble the bifacial tools observed at the top of the sequence of Orgnac 3 which contains plano-convex bifacial scrapers (Moncel 1995). In south-eastern France bifaces disappear around MIS 7 in an Early Middle Palaeolithic context (Moncel 2003). The site of Payre yielded a few bifaces (MIS 8 to end of MIS 6) made on large quartzite and basalt flakes that were produced away from the site (Moncel (Ed.), 2008). However, the presence in the assemblage of pieces with a transversal cutting edge («biface-cleaver») makes this series unique. Similar objects have been found northwest of the Massif Central, at La Grande Vallée (Hérisson et al. 2012). In this part of France, partial bifaces and bifaces with a distal notch are considered to belong to the Upper Acheulean (Combier 1976) and the first evidence for Levallois flaking is found at around 350-300 kya (Moncel 1999; Despriée et al. 2009). These features do not exist in the assemblages from Chaumette Quarry close to La Garde where the series is composed mainly of pebble tools, scrapers and notched pieces. These assemblages have been described as "Clactonian" (Combier 1976).

Lithic assemblages have been found during detailed and repetitive surveys of several localities on the surfaces of the alluvial terraces of the upper basin of the Allier River between Brioude and Langeac. These are situated mainly in the Paulhaguet basin between the Senouire and the Allier Rivers (unpublished material of Y. Consigny and L. Servant, fig. 4). Unfortunately, these quartz assemblages, which contain some bifacially flaked pieces are not dated (Le Gall & Raynal 1986; Magoga et al. 1991) but it is possible that they are contemporaneous with the assemblages from Payre and Sainte-Anne I (see *infra*) but may be even more recent. However, an isolated biface discovered near Chilhac (Haute-Loire) undoubtedly testifies to an Acheulean presence there (fig. 5). This basalt implement was manufactured on a large asymmetrical flake showing that it is a product of a centripetal production of flakes from blocks or large cobbles coming from upstream within the volcanic massif.

Orgnac 3 (Orgnac, Ardèche)

Orgnac 3 is the only cave site with a clear stratigraphical context. The site is a sediment filled sinkhole located on a plateau close to the Ardèche Gorge (fig. 1). Hominins initially occupied a cave, then a shelter that was formed by the progressive enlargement of an aven on the surface of the plateau (Combier 1967). During the excavations conducted between 1959 and 1972, ten occupation phases were identified and dated by Electron Spin Resonance (ESR) and Uranium/Thorium (U/Th) at 288 000 – 45/+ 82, 309 000 ± 34 and 374 000 – 94/+ 165 BP for the levels associated with MIS 9 (Falguères et al. 1988; Masaoudi 1995). Recent dates by 40Ar/39AR and U-Th confirm this age (Michel et al. 2011) (fig. 2). Upper level 2 contains volcanic minerals sourced to an eruption of the Mont-Dore volcano which can be attributed to the beginning of MIS 8 (298 000 ± 55 000 BP) (Debard & Pastre 1988). Combined bio-stratigraphical studies of mammal remains, microfauna and fossil pollens suggest that the basal layers of the sequence were deposited in a temperate context, characteristic of a

Ages	Sites	Deposits	Palaeoecology	Microfauna	Lithics	Zoo-achaeology	Climato-chronology
	Orgnac 3	Clast-supported and matrix-supported deposits resulting partly from roof collapse	Temperate at the bottom Cold at the top	Large variety of Rodents	Acheulian to Middle Palaeolithic (Levallois debitage, standardization)	Short-term seasonal occupations Various activities or hunting site	MIS 9 to 8
251 ky 145 ky[1]	Payre	Brecciated deposits overlain by silts supported clastic deposits	Temperate context *Equus ferus, Cervus elaphus, Capreolus capreolus, Ursus spelaeus.*	Large variety Rodents: *Microtus arvalis/agrestis/ gregalis Chionomys nivalis Plyomis lencki*	Discoid and orthogonal Few flake tools Some large tools Flint and local stones	Seasonal hunting camps on cervids, equids and *Bos*	Bottom of the sequence MIS 8/7 Top MIS 6/5
	Sainte-Anne I	Sands and silts supported deposits overlain by diamicton and gravity rock-falls. Heavy secondary frost action.	Cold context: open arctic fauna and mountain fauna groups: *Rangifer tarandus, Equus caballus piveteaui, Capra ibex, Mammuthus primigenius, Coelodonta antiquitatis*		Discoid, Levallois, SSDA, bifacial. Basalt and phonolite are dominant, quartz, local and semi-local flint varieties, a few more distant ones.	Seasonal hunting camp	MIS 6?
80 ky[2]	Baume-Vallée	Clast-supported and matrix-supported deposits resulting of a secondary stratogenesis of cryoclastic material by solifluxion	A mosaic of non-arctic, woode and arctic environments dominated by the open non-arctic group. In order of abundance: *Equus caballus germanicus, Cervus elaphus, Rangifer tarandus, Capra ibex, Bos* or *Bison, Equus hydruntinus* Several bird species	In unit 1, under study	Mixed Quina and Levallois knapping of several flint types. High ratio of retouched artefacts and high reduction by use on some tools (stepped retouch). Granite hammerstones. Bone and lithic retouchers. Quartz knapping and use in the lowermost unit 0	Seasonal hunting camp with more or less complete butchery sequences on the three main species (horse, cervids and ibex)	Bottom of the sequence (unit 1) dated to the end of MIS 5
TL dates and ESR in progress	Balazuc	Clast-supported and matrix-supported deposits resulting of Rock-falls	Rocky landscapes, forest and open environments *Capra ibex, Rupicapra rupicapra, Bos/Bison, Cervus elaphus, Rangifer tarandus, Equus* sp.*), Carnivora (Canis lupus, Vulpes vulpes, Ursus spelaeus, Panthera pardus, Lynx* sp., *Martes* sp., *Mustela* sp.	Rodents: *Allocricetus bursae, Apodemus cf. sylvaticus, Microtus (Chionomys) nivalis, Pliomys lenki, Microtus group arvalis/agrestis, Microtus arvalis, Arvicola cf. terrestris),*	Levallois flaking on flint and basalt Few tools Artefacts brought already worked Punctual flaking on small cores	Brief stops (hunting or scavenging) alternating with large carnivores occupation	MIS 5: bottom MIS 4/3: bottom
31 ky[3] 39 +3/ -2 ky[4] 118 ±19 ky[4]	Abri des Pêcheurs	Azoic brecciated deposits overlain by clayish sands and silts supported clastic deposits	Rocky landscapes group: *Capra ibex cebennarum,* Other groups: *Cervus elaphus, Rangifer tarandus, Capreolus capreolus*	Rodents : *Microtus arvalis/agrestis Chionomys nivalis* and *Apodemus* cf. *sylvaticus* in bottom units Amphibians : Cold and wet in bottom units Birds : cold, various species in bottom units	Discoid knapping on quartz. Products are fragmented and poorly retouched. A few flint flakes.	Brief stops (hunting or scavenging) alternating with large carnivores occupation (bears and wolves)	End of MIS 5 and human occupation in MIS 4
72±3 ky[5] 87±5 ky 89±4 ky 91±4 ky	Abri du Maras	Loess at the bottom then clays supported clastic deposits	Open arctic and non arctic environments groups in the top units: *Rangifer tarandus, Equus* cf. *germanicus, Bison priscus, Capra ibex* Well-wooded environment group in lower units: *Cervus elaphus, Equus* cf. *germanicus, Capreolus capreolus, Sus scrofa*	rare	Levallois, Kombewa and discoïde knapping on flint. A few Side scrapers	Seasonal reindeer hunting camps with an extensive butchering Hunting stops (Red deer) Hearths	Bottom of the sequence dated to the end of MIS 5. Middle part of the sequence possibly MIS 4.

Fig. 2. Stratigraphical and biostratigraphical data for the human occupation of Orgnac 3 (Combier excavations), Payre (Moncel excavations), Sainte-Anne I (Seguy and Raynal excavations), Baume-Vallée (Laborde and Raynal excavations 1964-1997), Abri du Maras (Combier and Moncel excavations), Abri des Pêcheurs (fieldworks Moncel 2005-2010) and Balazuc (excavations Daujeard 2011-2012): [1] (Valladas et al. 2008); [2] TL (Raynal & Huxtable 1989) and ESR (Raynal et al. 2005); [3] ^{14}C uncalibrated dates (Évin et al. 1985); [4] U-Th/ESR (Masaoudi et al. 1994); [5] U-Th (Moncel & Michel 2000).

Abb. 2. *Stratigraphie und Biostratigraphie der Funsschichten von Organc 3 (Grabung Combier), Payre (Grabung Moncel), Sainte-Anne I (Grabung Seguy & Raynal), Baume-Vallée (Grabung Laborde & Raynal 1964-1997), Abri du Maras (Grabung Combier & Moncel), Abri des Pêcheurs (Grabung Moncel 2005-2010) und Balazuc (Grabung Daujeard 2011-2012): [1] Valladas et al. 2008; [2] TL-Datierungen (Raynal & Huxtable 1989), ESR-Datierungen (Raynal et al. 2005); [3] ^{14}C -Datierungen (Évin et al. 1985); [4] U-Th/ESR-Datierungen (Masaoudi et al. 1994); [5] U-Th-Datierung (Moncel & Michel 2000).*

Middle Pleistocene interglacial period. Upper level 1 is indirectly attributed to MIS 8 using evidence from the micro-mammal assemblage and the persistence of the tahr (*Hemitragus bonali*) and Deninger bear (*Ursus deningeri*), which suggest that this level cannot be more recent than MIS 8. Levels 2 and 1 are mainly characterized by species typical of an open landscape and by the replacement of the equid *Equus mosbachensis* by *Equus steinheimensis* (Moncel et al. 2011a).

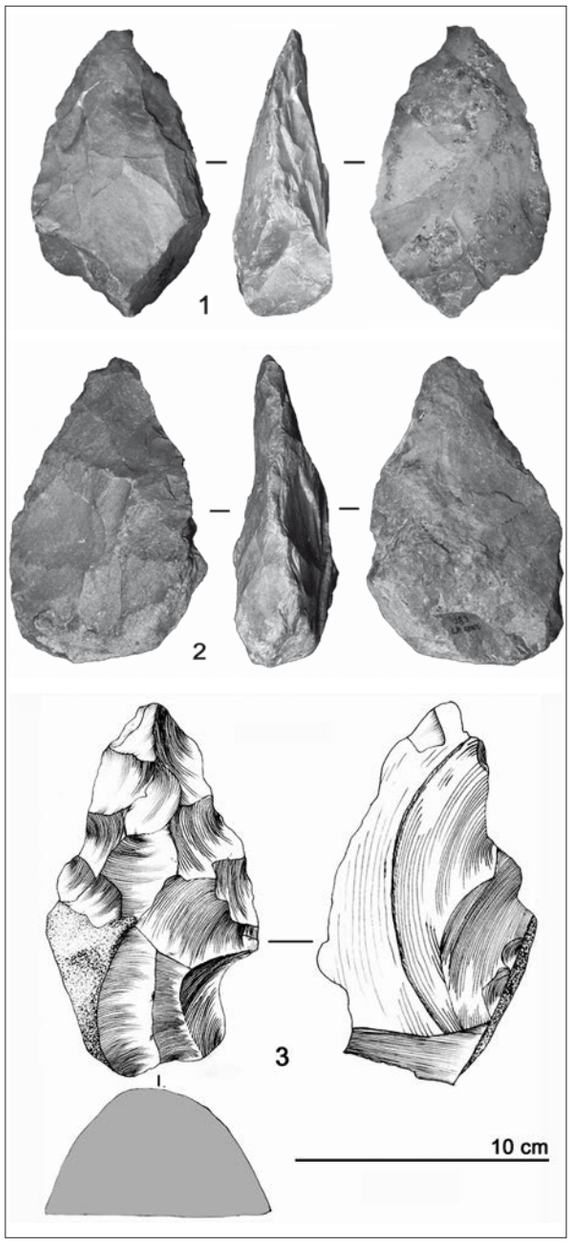


Fig. 3. Acheulean artefacts from the open-air site of La Garde, near Roanne (drawings by Angeliki Theorodopoulou).

Abb. 3. *Acheuleen Artefakte aus der Freilandfundstelle La Garde in der Nähe von Roanne (Zeichnungen: A. Theorodopoulou).*

The top of the Orgnac 3 sequence contains evidence of Upper Acheulean occupation (Combier 1967) along with Middle Palaeolithic technological strategies (Moncel 1995, 1999, 2003; Moncel et al. 2005, 2011a, 2012) (fig. 6). The first evidence of a Levallois core technology arrives in the middle part of the sequence. Over time, the use of flakes as raw materials for producing a standardised form of scraper is seen to increase while there is a simultaneous decrease in the number of bifaces made on locally gathered raw material. Above the middle part of the sequence changes in subsistence behaviour and land-use become apparent as selective horse hunting and standardized carcass treatment decrease in importance and carnivores abandon of the site. Over time, a changing mosaic of hominin subsistence and technical behaviour can be seen with both gradual and punctuated changes that cannot be explained by environmental factors such as site formation processes or climatic transitions. Generally, behavioural change at Orgnac 3 is multifaceted, consisting of a combination of gradual and punctuated adjustments being made by its hominin inhabitants.

Payre (Rompon, Ardèche)

Payre is a rock shelter formed from a collapsed cave located in the Rhône Valley (fig. 1). The stratigraphic sequence is more than 5 m thick with 8 occupation levels dated by ESR-U-series, TL, and TIMS from MIS 8-7 to the end of MIS 6 / beginning of MIS 5, (Masaoudi et al. 1994; Grün et al. 2008; Valladas et al. 2008). The whole sequence lies on a thick stalagmitic floor (229 kya ± 2 – 291 kya ± 3 by U-series-TIMS). Unit G levels Gb and Ga are dated by TL to 247 kya ± 29 (arithm. mean), unit F levels Fd, c, b and a are dated by TL to about 251 kya ±25 and units E and D (top of level F) to 145 kya ±35 by ESR-U-series (fig. 2).

Flint dominates the Early Middle Palaeolithic lithic assemblages (figs. 7 and 8) but other local stones were also used. The majority of the flint was gathered from various outcrops on the southern plateau between 8 and 30 km distant and from secondary formations in the valleys of small tributaries (Fernandes et al. 2008). It was gathered as broken nodules or sometimes as large flakes. [The diversity of the various flint outcrops that were available is in contrast with the few flint types collected on the open-air site of Andance (Saint-Bauzile) close to Payre (Bernard-Guelle et al. 2011)]. Rare small flakes in the Payre site originate from a source 60 km away to the south. The core technology is mostly discoidal and orthogonal in technique and the retouched artefacts consist primarily of scrapers and points (10-20 % of flake-tools). Some large tools (bifaces, bifacial scrapers, simple scrapers) are made on pebbles or large flakes of quartzite, limestone or basalt. These tools were produced away from the site (Moncel et al. 2008a) and brought into it for specific use, which, from the evidence provided by their strongly crushed edges, was probably butchery.

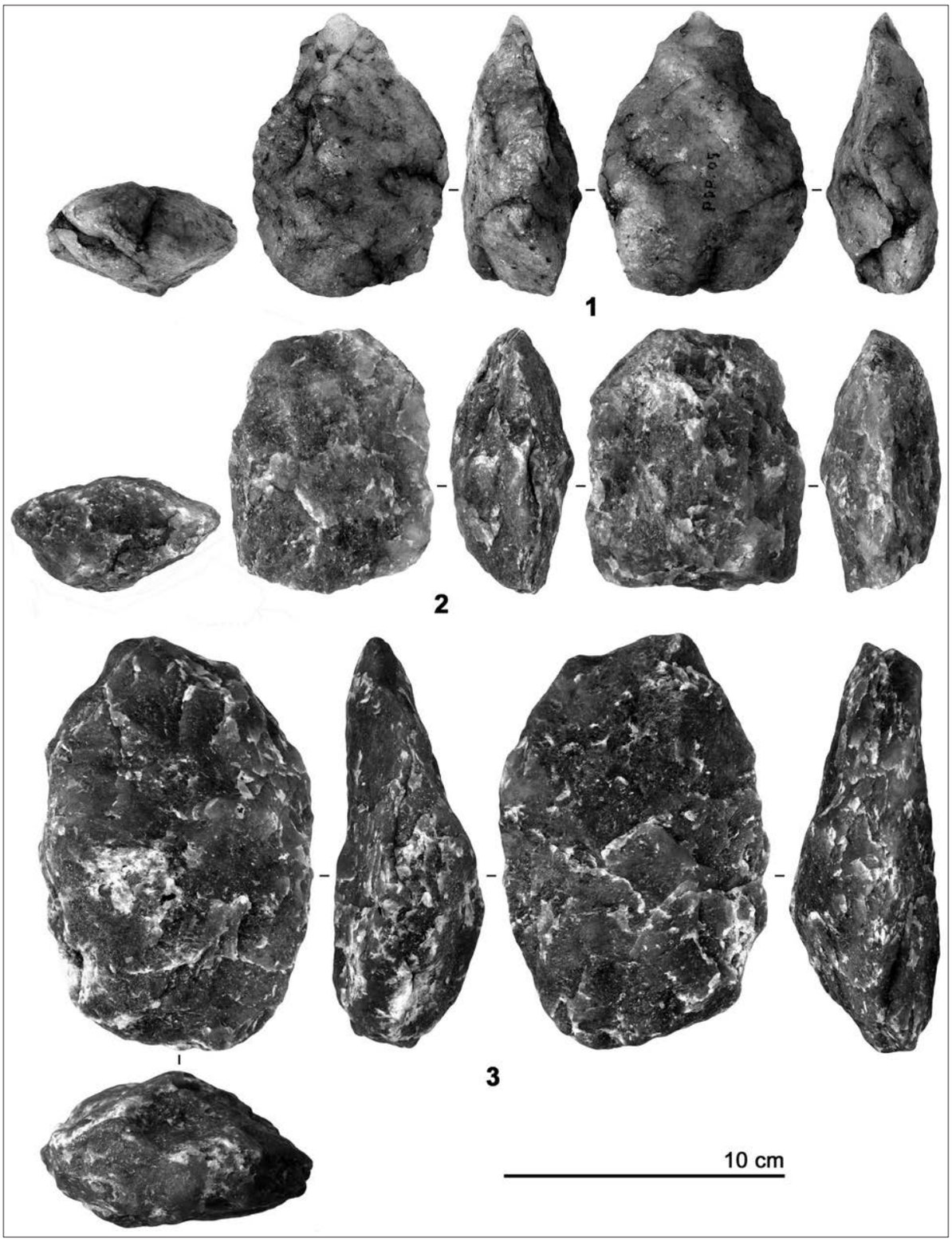


Fig. 4. Quartz artefacts from open-air sites in Paulhaguet basin (Haute-Loire): biface-like discoid core (1), bifacial discoid core (2), ovate biface (3) (photos by Gauthier Devilder).

Abb. 4. *Quarzartefakte aus der Freilandfundstelle Paulhaguet basin (Haute-Loire): quasi bifazialer diskoider Kern (1), bifazialer diskoider Kern (2), bifazielles (ovate) Gerät (3) (Photos: G. Devilder).*

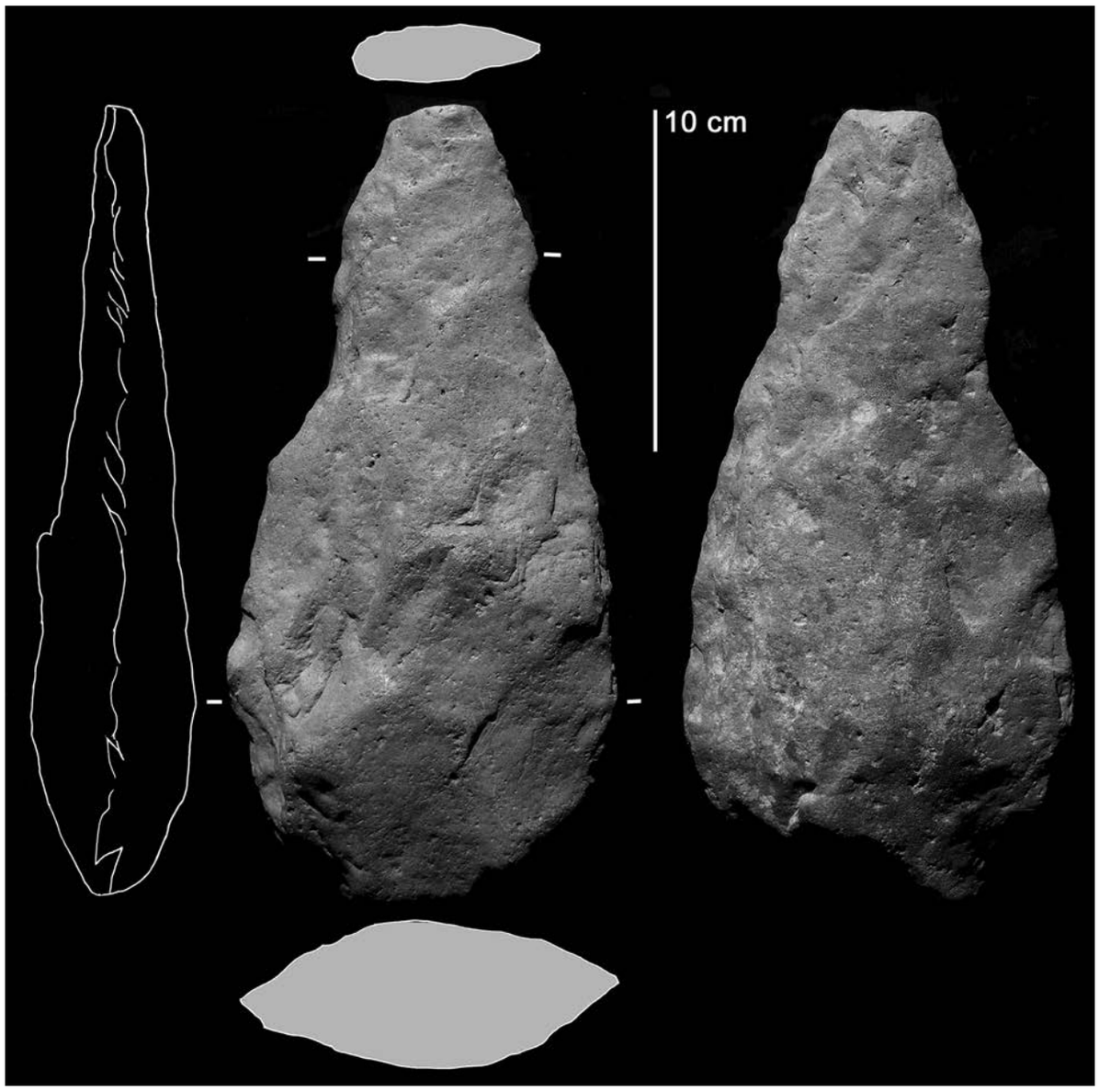


Fig. 5. Basalt hand-axe from Chilhac (Haute-Loire).
Abb. 5. *Bifazielles Gerät an großem Basaltabschlag von Chilhac (Haute-Loire).*

Micro-wear studies have shown the diversity of other activities undertaken on the site (Hardy and Moncel 2011).

The main faunal species present are: *Equus ferus*, *Stephanorhinus kirchbergensis*, *Stephanorhinus hemitoechus*, *Elephas*, *Bos primigenius*, *Hemitragus bonali*, *Cervus elaphus*, *Capreolus capreolus*, *Ursus spelaeus*, *Panthera leo spelaea*, *Cuon priscus*, *Felis silvestris*, *Lynx lynx*, *Vulpes vulpes* and *Castor fiber*.

Lithic and faunal remains suggest that human activities were more-or-less unchanged throughout the whole sequence. Neanderthals occupied the cave several times during temperate periods, due perhaps to its location above the confluence of the Rhône and Payre Rivers (Debard 1988; El Hazzazi 1998; Kalaï 1998; Moncel 2002, 2008a, 2011a). Cervid, equid and bovid remains carry signs of anthropic activity indicating that these animals were hunted while rhinoceros and elephant remains were probably scavenged (Patou-Mathis et al. in Moncel (Ed.) 2008; Daujeard & Moncel, 2010; Daujeard et al. 2011). Lithic residues and use-wear analysis provide evidence for fish processing in levels Fa and D and the use of avian resources in level Gb (Hardy & Moncel 2011). Zoo-archaeological analysis indicates that there were successive short-term seasonal occupations of the site with in-situ carcass consumption (Rivals et al. 2009; Moncel et al. 2008a; Daujeard 2008; Daujeard & Moncel 2010; Moncel & Daujeard 2012). There are indications of the use of fire in each level. An ashy lens

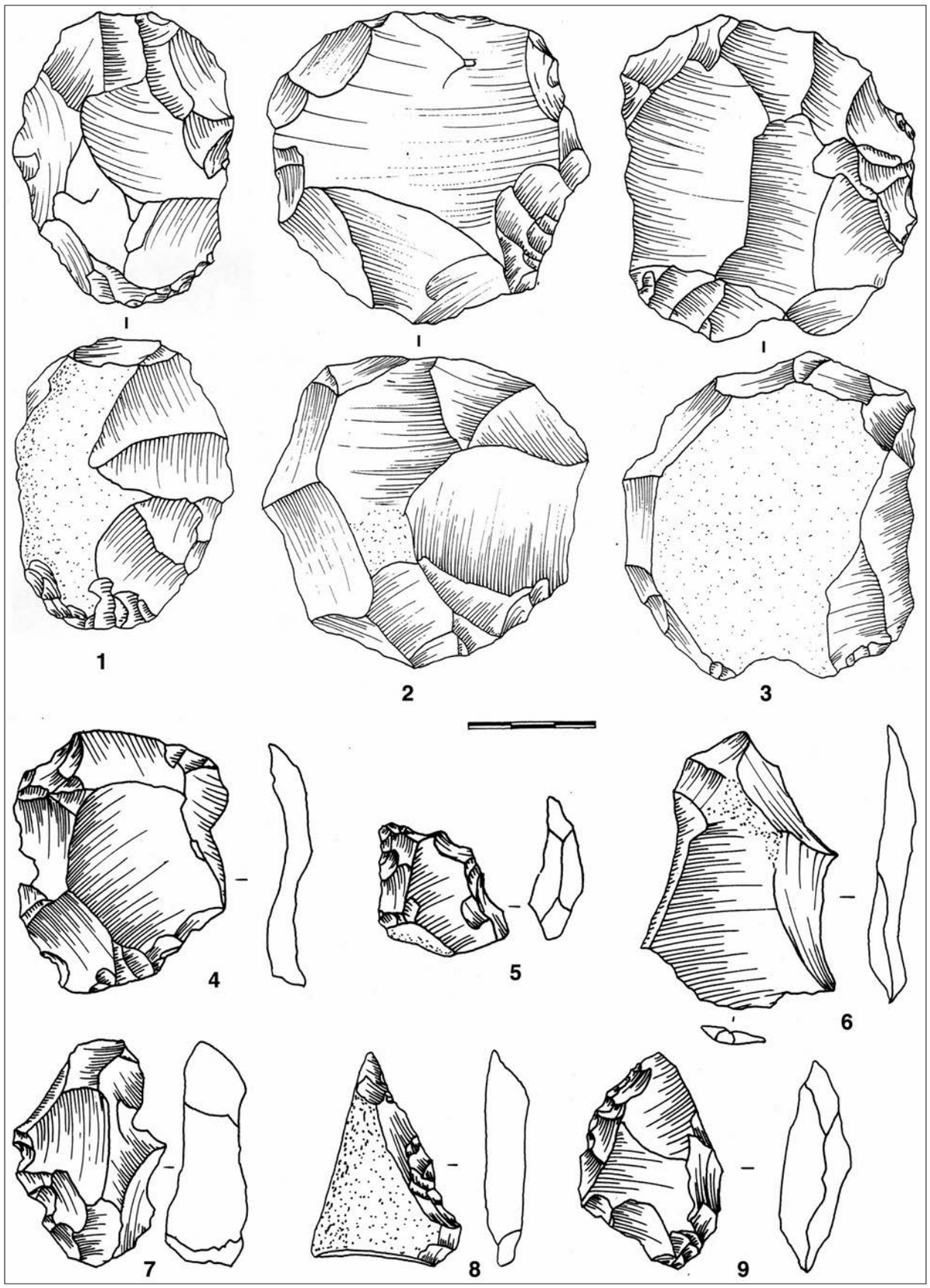


Fig. 6. Lithic assemblage at Orgnac 3.1: flint discoid core (level 3).2: flint Levallois core (level 3).3: flint biface (level 5b).4: flint discoid cores (level 5b) (drawings by O. Bernardini).

Abb. 6. *Steingeräteinventar von Orgnac 3. 1: Discoider Kern aus Feuerstein (Schicht 3). 2: Levalloiskern aus Feuerstein (Schicht 3). 3: Bifazielles Gerät aus Feuerstein (Schicht 5b). 4: Discoider Kern aus Feuerstein (Schicht 5b) (Zeichnungen: O. Bernardini).*

was discovered at the top of level Ga but it has no clear hearth structure. Intensive bone breakage is probably the result of marrow extraction; some bone pieces were burnt and others used as retouchers. No spatial patterning or organization was detected in the various Neanderthal occupation phases (Moncel et al. 2008a; Moncel (Ed.), 2008).

Carnivores also inhabited the site, as indicated by the abundant remains of bears (mainly *Ursus spelaeus*) that died during hibernation, especially in unit F (levels Fd to Fa), suggesting that hominid occupation alternated with carnivore denning.

Sainte-Anne I cave (Polignac, Haute-Loire)

The cave of Sainte-Anne I is a small south-facing cavity (50 m^2) at 737 m above sea level (fig. 1) in which several archaeo-stratigraphic deposits containing Middle Palaeolithic assemblages containing handaxes have been recognized (fig. 2).

Here, quartz, volcanic rocks and certain types of local flint (type F3 and its varieties), exhibit complete reduction sequences indicating that these abundant local lithic materials were flaked within the site. However bifaces and unifacially flaked tools were produced away from the site, introduced into it and used there before being broken. The evidence for this sequence of events is shown by the numerous broken extremities of these tools found within the cave. Other lithics from semi-local and exogenous sources also show incomplete reduction sequences and were prepared elsewhere before transport to the site. Easy access to local raw materials seems to have resulted in the local production of a comparatively large number of tools. Comparison between units J2 and J1 shows no significant differences (Raynal et al. 2007; Santagata 2006, 2012; Santagata et al. 2002), except that the number of tools made on volcanic pebbles varies between units J2 and the more recent J1, but this apparent bias may be a result of excavation history. Another difference is that polyhedral cores are more numerous in unit J1 but the proportion of debitage to finished tools remains unchanged.

Levallois and discoidal flaking were applied to cores made of volcanic rocks and the occasional production of quadrangular flakes was the result of orthogonal, or some other unipolar flaking activity. The dense nature of the kind of raw material available sometimes required reduction of a core using bipolar anvil percussion.

The full range of Levallois products from basalt shows similar morphometric characteristics; recurrent centripetal production methods were used by the knapper in unit J1, while preferential or recurrent unipolar techniques and opposed bipolar flaking was used in unit J2. Unifacial and bifacial discoid production was used to a great extent at the site.

The petrographic nature of phonolite, with its inherent cleavage planes, forms a constraint on the flexibility of knapping techniques. The planar morphology of the slabs or small plates that were available and their minimal thickness required the use of their naturally occurring convex surfaces as an intrinsic part of the final form of the tools. Flake removals proceeded in series along bipolar orthogonal or opposed directions on a core. Flaking activity sometimes ended with the production of a flake with a predetermined shape or size or perhaps with a range of discoid flakes. Even the discoidal products are flat over their flaked surfaces because of the physical constraints and petrographic characteristics of the cores.

The assemblage made from quartz pebble cores using a discoidal method of flaking and its variants produced flakes of a very homogenous morphometry. Flakes with a cortical platform and back, a cortical back or an enveloping back are all results of a unifacial discoid flaking technique, particularly from the initialization phase of core preparation. They play a role in maintaining the convexity of the core and its surface management and consequently the ultimate form of the flakes removed during the production phase.

The different varieties of local flint (F3, F3b, F3d) have been knapped in various ways according to their morphology. For small plates or rolled blocks, a recurrent Levallois unipolar or bipolar flaking method was used in unit J2, and a preferential flake removal with minor variants when compared to the "classical" rules was used in unit J1. The more-or-less planar flaked products were produced by knapping around a core from all directions, invading the whole core surface with the aim of completely exhausting it. Even the bifacial method of discoidal flaking was adapted to the morphology of the material. For the flint lithotype F3c, the knapper applied a classical Levallois method with preferential flake removal or less frequently, a recurrent unipolar or bipolar technique. The very small size of the cores fits well with the very small dimensions of the flakes recovered, implying that exploitation was taken to its ultimate extent. The scarcity of raw material close to the cave indicates that the knapper's intention with this material was to conserve the resource while producing as many flakes as possible from it with a conservative flaking methodology.

For all raw materials, core reduction technologies which were conservative in their manner of preparing and maintaining the resource were used alongside opportunistic flaking methods, in order to produce flakes whose unmodified edges gave the functionality required for particular subsistence activities; a requirement that explains the small number of retouched tools found at the site (fig. 7). The absence of flakes produced when shaping unifacially flaked objects and bifaces shows that these tools were manufactured outside the cave, perhaps at their source or on open-air activity areas (Boëda et al. 2000). The lithic assemblages of Sainte-Anne I therefore demonstrate the inhabitants' adaptation to

Sites	Archaeo-stratigraphy	Flint					Other stones	Shaped tools (F= flint)	Total
		Flakes < 20 mm	Flakes > 20 mm	Cores	% flake-tools	% convergent tools			
Payre	Level D	433	1425	84	31	58	671	6*	2216
	Level F(a,b,c,d)	2215	1399	42	20-44	30-40	703	22*	4336
	Level G (a,b)	1301	2575	106	12-15	22	546	4*	4503
Sainte-Anne I	J1	472	306	46	1.8	54.5	3523 (1)	27 (F=3)	4566
	J2	994	361	64	0.8	56.3	7180 (1)	24 (F=0)	9062
Abri du Maras Old excavations	1-1'-1 ''	885	3036	59	7.7	17	120	-	3695
	2	60	94	1	8.1	12	54	-	209
	3	558	467	16	5.2	6.8	59	-	1100
	4	183	203	8	9.3	9.7	46	-	440
	5	58	159	4	11.6	14.2	19	-	240
	6	43	81	3	6.8	11.1	5	-	132
	7	35	34	1	9.7	-	2	-	72
	8	16	16	1	23.5	12.5	1	-	34
Recent excavations	4	26	291 Flakes 82 Blades 23 Points	11	5.7	-	32	-	399
	5	89 Flakes 3 Blades 1 Point		4	11.6	50	4	-	101
Abri des Pêcheurs Recent excavations	- Upper units:								
	Recent excavations	5		-	2 tools	-	143	6	155
	Old excavations	154		3	11.6		837	1	995
	- Lower units:								
	Recent excavations	-		-	-	-	47	-	47
	Old excavations	13		-	-	-	157	63	233
	Ensemble 7 (g, h, i, i', j)	1746	1794	104	3.7 to 6.4	2.9	207	-	3705
	- Lower units	257	245	3	5.1	1 tool	419		924
	unit u	158	48	1	10	14.2	7	-	214

*For Payre, number of bifacial or unifacial large tools on flakes and pebbles
(1) details on the other stones at Saint-Anne I, see following tables

(1)	Sainte-Anne I volcanic raw materials						
	Flakes <20 mm	Flakes > 20 mm	Cores	% flake-tools	% convergent tools	shaped tools	Total
J1	548	1131	77	4.0	32.5	22	2807
J2	1693	2156	81	0.40	41.7	23	5384

(1)	Sainte-Anne I, quartz						
	Flakes <20 mm	Flakes > 20 mm	Cores	% flake-tools	% convergent tools	shaped tools	Total
J1	171	263	39	0.4	22.2	2	714
J2	326	520	79	0.1	87.5	1	1796

Fig. 7. Lithic assemblages at Payre, Sainte-Anne I, Abri du Maras and Abri des Pêcheurs.
Abb. 7. *Steingeräteinventar von Payre, Sainte-Anne I, Abri du Maras und Abri des Pêcheurs.*

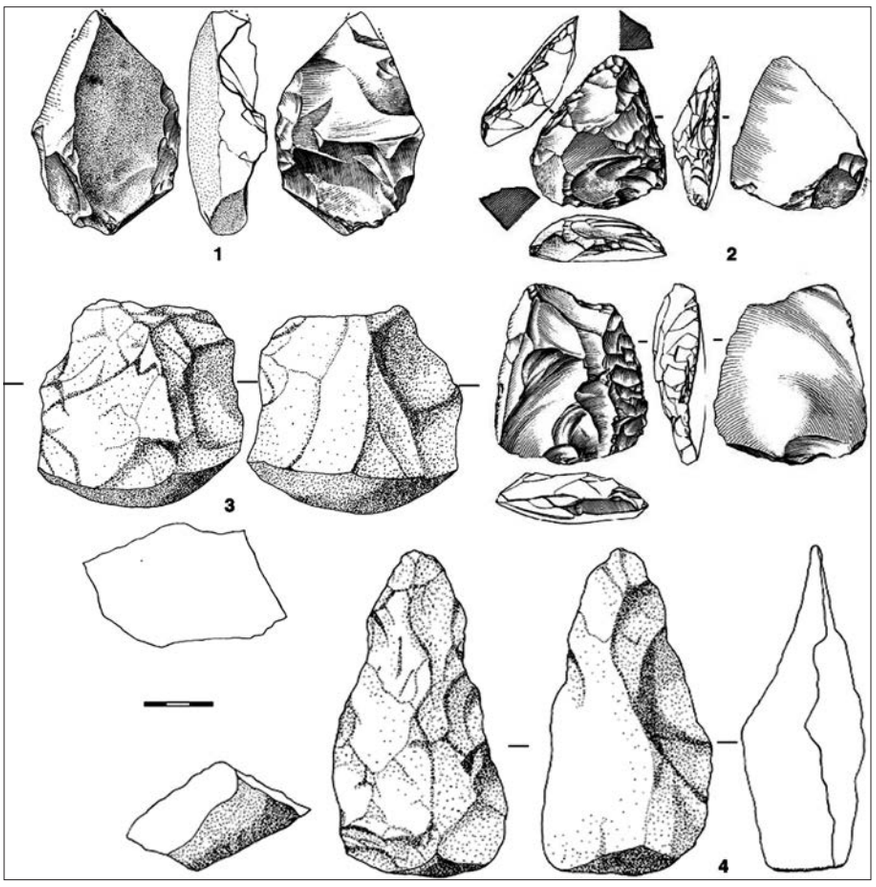


Fig. 8. Lithic assemblages at Payre. 1: flint flake-core (level Ga). 2: flint flake-tools (level Ga). 3: bifacial tool on quartzite (level Fa).4: broken bifacial tool or core on quartzite (level Fa) (drawings: 1 and 2: G. J. Marcillaud; 3 and 4: M.-H. Moncel).

Abb. 8. *Steingeräteinventar von Payre. 1: Abschlagkern aus Feuerstein (Schicht Ga). 2: Abschlaggeräte aus Feuerstein (Schicht Ga). 3: bifazielles Gerät aus Quarzit (Schicht Fa). 4: zerbrochenes bifazielles Gerät oder Kern aus Quarzit (Schicht Fa) (Zeichnungen: 1 und 2: G.J. Marcillaud; 3 und 4: M.-H. Moncel).*

the available lithic resources, their volumes and mechanical limitations, and their needs according to the activities they undertook while at the site (Boëda 2001). The lithic reduction sequences reveal a system of economic organization which was at least partially based on mobility, as demonstrated by the presence of the large unifacially flaked tools and bifaces (fig. 9), along with a more settled domesticity that required the production of small sharp-edged flakes (Delagnes 2010). Typologically, the lithics resemble the series recovered from Payre, along the Rhone Valley in Ardèche where raw materials were chosen for their proximity rather than for their quality (Moncel 2003; Raynal et al. 2005, 2007; Fernandes et al. 2008).

The lower unit J2 contains the same ungulate species as the upper unit J1 (Raynal et al. 2005, 2007, 2008). The faunal group is dominated by reindeer, the horse and the ibex. Woolly rhinoceros, bovines and other cervids complete the spectrum. From a palaeo-environmental viewpoint, the most important part of the spectrum is occupied by open arctic and mountain fauna groups, suggesting harsh and severe climatic conditions like those that dominated during MIS 6. The presence of the red deer, a dominant species among the forest fauna group, may be because the compartmentalized landscape topography produced some isolated forested and leafy refuge zones. Carnivore remains are rare, but foxes, wolves, lynx and the extinct cave lion are present.

Cut marks are more frequent on the bones than are carnivore tooth-marks. The proportions of cut marks to gnawing marks vary according to species. Reindeer were the focus of human activities like skinning, dismembering, de-fleshing, scraping of the metapodia and marrow extraction. The extraction of marrow from long bones, mandibles and phalanges, the parts which preserve their fat for the longest time and which contain the highest proportion of non-saturated fatty acids, indicates an optimal exploitation of carcasses. Initially, humans consumed carcasses in the cave, while carnivores gained secondary scavenging access to these kills. No trace of

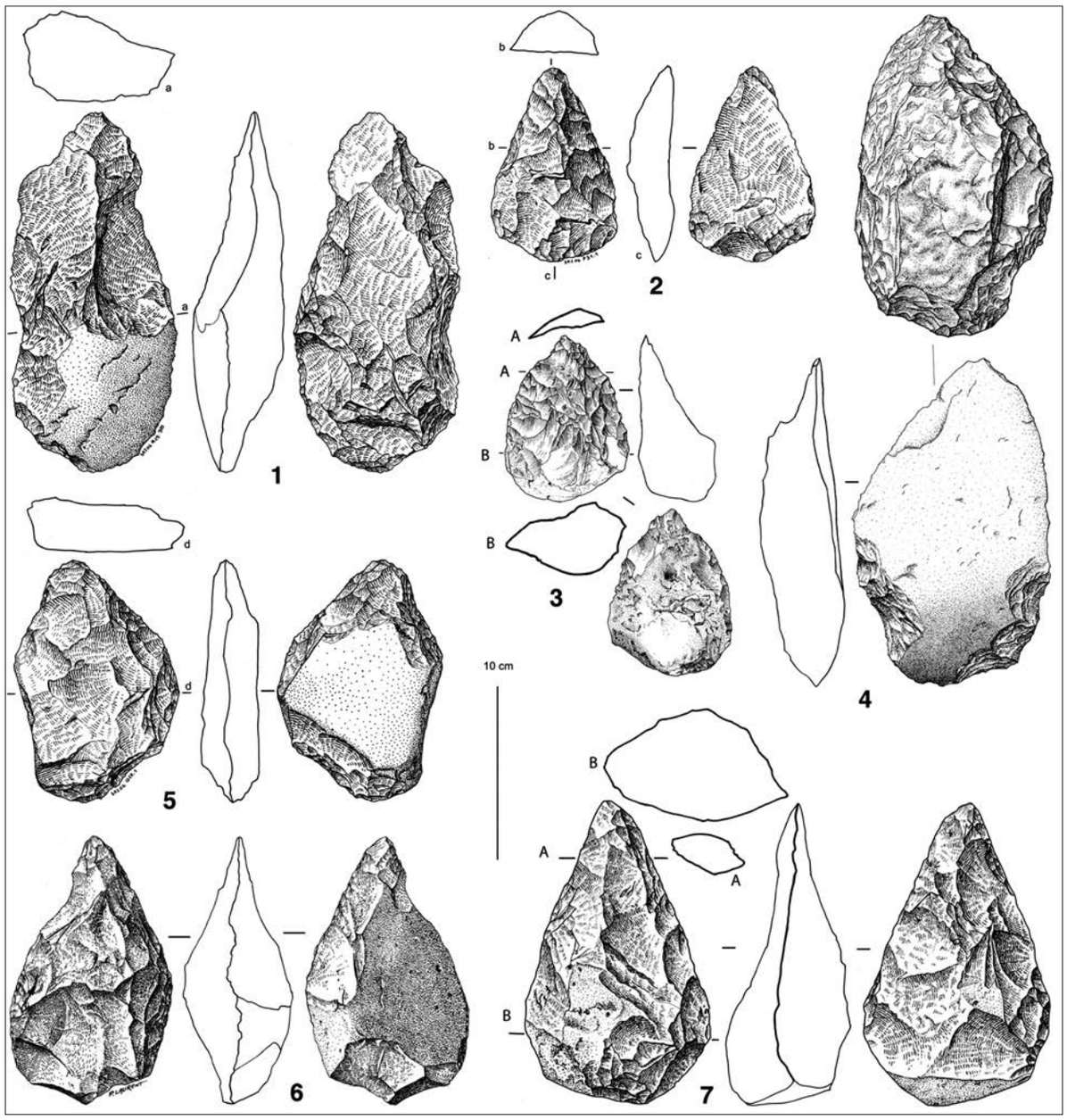


Fig. 9. Lithic assemblages at Sainte-Anne I: bifacial diversity (drawings by M. Hirbec-Raynal, except 4: by C. Decroix-Bourhim, and 6: by P. Laurent).

Abb. 9. *Steingeräteinventar von Sainte-Anne I: diverse bifazielle Geräte (Zeichnungen: M. Hirbec-Raynal, ausser 4: von C. Decroix-Bourhim, und 6: von P. Laurent).*

fire has been identified on the bone material, but the presence of fragments of burnt flint in the deposits show that there was some use of fire. Several bone retouchers have been recovered from the assemblage.

In unit J1, the pattern of skeletal remains suggests that entire carcasses of medium-sized animals were brought to the site for processing but only the most useful parts of horse carcasses (Raynal et al. 2007).

In unit J2, all age classes of reindeer and horse are present but the majority of both these species are young adults (fig. 10). The presence of deciduous teeth (NR=4) indicates the kill time was autumn.

Baume-Vallée (Solignac-sur-Loire, Haute-Loire)

The south-east facing Baume-Vallée rock-shelter (also named Laborde rock-shelter) is located at Solignac-sur-Loire in the Velay at the foot of a cliff at 795 m above sea level. It is on the left bank of the Ourzie River, which is a left bank tributary of the Loire (fig. 1). In its lower part the shelter contains several archaeo-stratigraphic units belonging to the Ferrassie type of

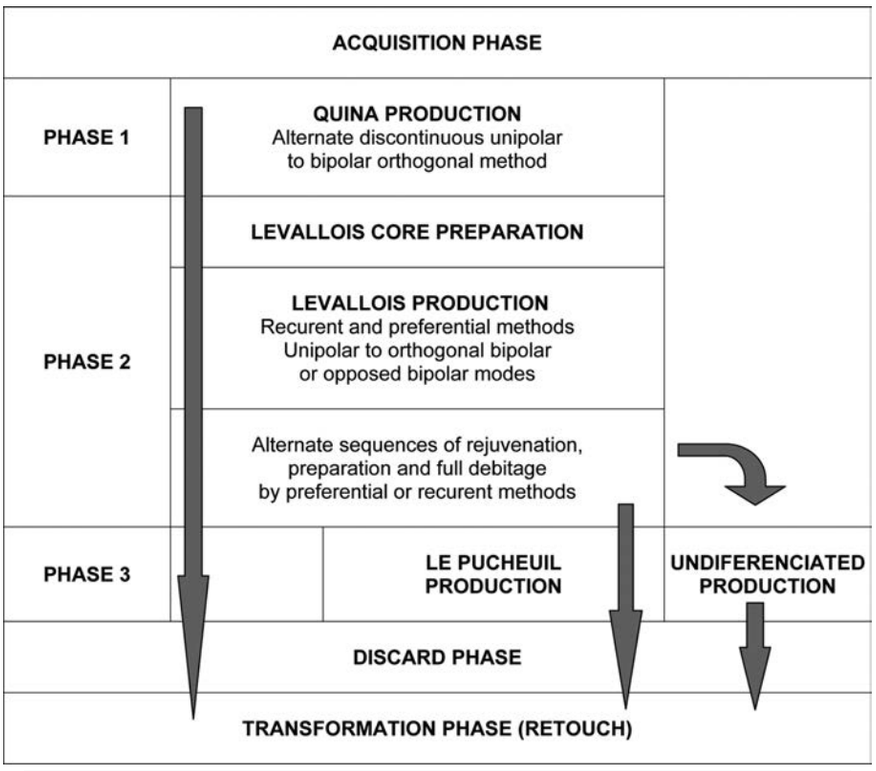
		MNI					
Sites	**Units**	**Equids**	**Cervids**	**Ibex/Tahr**	**Bovines**	**Rhinocerotids**	**Others**
Baume-Vallée	Unit 2	11	2	4	1	-	-
	Unit 1	10	3	5	1	-	-
	Unit 0	5	6	4	1	-	-
Abri du Maras	Unit 1	3	4	-	2	-	-
	Upper units	4	9	2	1	-	-
	Lower units	2	7	-	-	-	1
Grotte des Barasses II	Upper units (previous excavations)	1	8	17	3	2	5
	Upper units (new excavations)	1	2	8	2	-	1
	Lower units (new excavations)	-	1	6	-	-	1
Abri des Pêcheurs	Levels 1-8 (new excavations: 5 m²)	-	4	3	-	-	-
	Levels 1-3 (previous excavations: sector 4 - ibex)	-	-	39	-	-	-
Grotte de Sainte-Anne I	Unit J1	7	7	4	2	1	6
	Unit J2	7	7	2	1	1	-
Payre	Unit D	3	15	4	2	4	3
	Unit F	18	61	18	15	11	8
	Unit G	8	15	2	5	5	4
Orgnac	Unit 1	20	7	1	15	1	1
	Unit 2	26	15	1	16	1	4
	Unit 3	3	9	1	11	-	2
	Unit 4a	4	17	1	12	4	3
	Unit 4b	7	18	1	17	2	3
	Unit 5a	7	13	1	8	2	2
	Unit 5b	11	25	1	15	2	3
	Unit 6	9	35	2	11	4	6
	Unit 7	4	13	1	6	3	2

Fig. 10. Animal resources processed at the different sites based on the minimum number of individuals (probably an under-estimate). Small bovids: tahr at Payre and Orgnac, ibex at others. Data after Daujeard (unpublished results of undergoing excavations and 2008), Daujeard & Moncel (2010), Daujeard et al. (2010, 2012), Guadelli (2007), Moncel et al. (2008a, 2012). This table is a compilation of several faunal spectra coming from various studies. The MNI were the only data available for comparison.

Abb. 10. *Verarbeitete tierische Ressourcen in den verschiedenen Fundstellen basierend auf Mindestindividuenzahlen (wahrscheinlich eher eine Untersschätzung). Kleine Boviden: Ziegen (Tahrs) in Payre und Orgnac, Steinbock in den anderen. Data nach Daujeard (unpubliziert aus der laufenden Grabung und 2008); Daujeard und Moncel (2010); Daujeard et al. (2010; 2012); Guadelli (2007), Moncel et al. (2008a , 2012).*

Charentian Mousterian (fig. 2). The stratigraphy shows that sedimentation was the result of frost action, in particular solifluction, which becomes increasingly evident towards the top of the Mousterian sequence and delineates a secondary strato-genesis. Thermo-luminescence (TL) and Electron Spin Resonance (ESR) dates give an age of around 80 kya (MIS 5a) (Raynal & Huxtable 1989; Raynal et al. 2005).

Seventeen gitological types of flint have been identified in a total sample of 1229 lithic artefacts recovered from unit 1 in which flint comprises 90 % of the lithic assemblage (Fernandes et al. 2006). 'Gitological' is derived from the French term 'gîte', used in mineralogy for a place where specific materials are encountered and which includes the notion of whether from a primary occurrence in a single outcrop or a secondary position within the same. The most abundant Bajocian flint types originate from the south (Lozère) and occur in local formations named "sables à chailles" (Fernandes & Raynal 2007) preserved beneath ancient basaltic flows and in more recent colluvia and alluvia close to the site. The second significant resource consists of Sannoisian flint types also found not far from the site in the Le Puy basin. Their neo-cortical attributes indicate that they were collected from colluvia and the local fluvial system. The third most common variety is a Sannoisian silcrete from Saint-Léger du Malzieu (Delporte 1966). Its neocortical attributes show that it was collected from sub-primary exposures of local colluvia within the Malzieu, 46 km to the west. Some raw materials have regional derivations, for example a Miocene silcrete from La Collange 8 km to the north-east. Its neo-cortical facies indicates that it was collected in colluvia close to the primary outcrop. Some marine types and hydro-thermal silica, known from a primary outcrop in a fault system, were obtained from old alluvia at Naussac 22 km to the south. Other types come from sources more-or-less closer to the site like the silcrete from Saint-Pierre-Eynac (Werth 1991) collected from colluvium on the primary outcrop 17 km distant and the Araules and Mazet-Saint-Voy silcretes that were gathered from secondary alluvial outcrops in the le Puy basin. Other regional resources were collected from 53 km north near Arlanc along the Dore River in the Ambert basin (Daugas et al. 1988) and 78 km away to the north-west along the Allier Valley at Madriat. Despite the fact that the major gathering activities for siliceous materials occurred relatively close to the site, the geological knowledge of the inhabitants included an awareness of resources found up to 53 km away from the site. A few artefacts suggest that there were relationships between people and resources that were much more distant, for example more than 120 km north-eastwards along the Loire corridor. A Bathonian oolitic specimen has its origin in the Monts du Lyonnais (Montjuvent et al. 1973). Its neo-cortex indicates clearly that it was gathered from a secondary alluvial source and its presence at the site shows knowledge of the resources available from remote



ACQUISITION PHASE	Cobbles, natural flakes, humanly produced flakes
PHASE 1	Cortical flake, Semi-cortical flake Cortical backed flake, Quina flake
PHASE 2	Levallois preparation flake Flake with residual cortex Ouflanking Levallois flake Indifferenciated flake
	Preferential Levallois flake Recurrent Levallois flake I, II, III Outflanking Levallois flake
	Levallois preparation flake Ouflanking Levallois flake Indifferenciated flake *Possible restart of Levallois knapping alternating with preparation sequences and full debitage process*
	Preferential Levallois flake Recurrent Levallois flake I, II, III Outflanking Levallois flake Indifferenciated flakes
PHASE 3	Bird wing flakes Indifferenciated flakes
DISCARD PHASE	Quina core, Levallois core Le Pucheuil core, Indifferenciated core
TRANSFORMATION PHASE (RETOUCH)	Retouched flakes retouch flakes

Fig. 11. The *chaînes opératoires* for flint in achaeostratigraphic unit 1 at Baume-Vallée. Organisation of lithic production in the case of co-existing *chaînes opératoires* (11a) and resulting products (11b).

Abb. 11. *Die ‚*chaînes opératoires*' für Feuerstein in der Archäostratigraphie der Schicht 1 in Baume-Vallée.*

landscapes either through the exchange of raw materials that passed through a number of human hands or by direct extraction and removal of the resource by one individual (or group of people). Currently, other specimens are under investigation that might show that there was resource importation from Barremo-Bedoulian secondary sources located on the right bank of the Rhône.

Technological analysis was performed on 1602 artefacts from unit 1 and 950 artefacts from unit 2 in which flint represents 90 % and 73 % of the total lithic raw materials present respectively. Cores are in the

Abri du Maras	tools	scrapers	points	dominant knapping
unit 5	11.6 %	60 %	14.2 %	Levallois
unit 1	7.7 %	44 %	17 %	Levallois (blades and flakes)

Fig. 12. Proportion of tools, side-scrapers and points in Middle Palaeolithic lithic units of Abri du Maras (old excavations).

Abb. 12. Anteile der Geräte, Schaber und Spitzen am mittelpaläolithischen Inventar von Abri du Maras (Altgrabung).

minority of artefacts and represent 2 % of the unit 1 assemblage and 6 % of that from unit 2. Quina and Levallois knapping methods were used within both unique and composite reduction sequences (one stage within the complete *chaînes opératoires*) illustrating a concern for conserving a resource as well as a sophisticated technical understanding of its capabilities (figs. 11a and 11b).

Retouched products represent 20 % of the assemblage in unit 1 and 35 % in unit 2. They consist mainly of Levallois debitage (including over-flanking flakes) or cortical Quina products. Around 80 % of the pre-determined Levallois flakes and 50 % of the diverse cortical ones have been modified by continuous adjacent retouching (up to 84 % of the margin) while notches represent 8 % and 3 % of the total respectively while denticulates remain rare. Some flaking directed towards thinning the tools exists in the assemblage. Among the side scrapers, simple lateral ones are dominant (40 % and 42 %), followed by transverse (15 % and 9 %), convergent (15 % and 21 %) and double ones (10 % and 18 %). A few Upper Palaeolithic types are present including end scrapers, atypical borers and scrapers. Microwear analysis on about 300 flint artefacts from unit 1 demonstrates that tools were used for cutting, thinning and scraping various resources including soft animal materials, herbaceous plants or soft wood (Lemorini, in Raynal et al. 2005).

At Baume-Vallée (Fiore et al. 2005; Raynal et al. 2005), horse (*Equus caballus germanicus*) is the prevalent species, followed by the cervids (*Cervus elaphus* and *Rangifer tarandus*), ibex (*Capra ibex*), bovines (*Bos* or *Bison* sp.) and other equids (*Equus hydruntinus*), while the remainder of the assemblage is composed of bird species (Gala et al. 2005) and indeterminate carnivore fossils. Besides a certain displacement of the faunal remains, periglacial taphonomic processes have also caused significant surface abrasion and fragmentation of the assemblage (Guadelli 2008). The only complete bones are small ones from joints and the phalanges. Articular portions of the long bones are very rarely represented, but isolated teeth are abundant. In spite of the poor state of preservation, butchery processes including marrow extraction and de-fleshing have been identified, as well as the use of certain pieces of bone as retouching tools. Carnivore modification to the bone assemblage is very rare and the major part of fresh bone fracture can be attributed to human activity. At this site, hunting focused mainly on cervids and equids during the first period of human occupation, while equids become the dominant species hunted during later times. The ibex, which is in third position numerically, is present throughout. All age classes of these three groups, from juveniles to mature adults are represented. In the most recent phases, the majority of horse remains are young or mature adults. Skeletal profiles indicate that provisioning took place at the site using entire carcasses of medium-sized ungulates, but only portions of the larger equine carcasses (Fiore et al. 2005).

The presence of all parts of the skeleton processed during primary and complete butchery sequences, at least for one of the main species present, supports the hypothesis that the site was used for regular habitation. The diversity of the ungulate spectrum argues for opportunistic hunting. Occupation of a site at such high elevation above sea level was probably sporadic, since winter snow-cover on the surrounding plateaus would certainly limit or even completely prevent many human subsistence activities. The rarity of carnivore marks on the bones can be explained by human occupation episodes being very closely spaced in time or by a human presence just prior to the beginning of winter conditions that were sufficiently severe to limit the activity of scavenging animals. Bone and stone retouchers are present in the site in great quantity. All this evidence suggests that the site was a seasonal hunting camp (Daujeard et al. 2011). Very few burnt bones have been recorded (Fiore et al. 2005; Raynal et al. 2005) but the presence of numerous charcoal fragments, several burnt flints and obvious lenses of ash confirms the use of fire within the confines of the site.

Abri du Maras (Saint-Martin d'Ardèche, Ardèche)

This shelter is located in a small dry tributary on the left bank of the Ardèche River, not far from the plateau (fig. 1). It was excavated in the 1950s and 1960s by R. Gilles and J. Combier who identified eight archaeological units (Combier 1967; Gilles 1950). A new excavation begun in 2006 in front of the older site identified two large units lying on the limestone substrate, (unit 4 & unit 5) and a small fireplace in the bottom-level. These units correspond with the middle and lower part of the sequence identified during the previous excavations. The middle part of the sequence (Moncel et al. 1994; Moncel & Michel 2000) is dated by U-Th to the end of MIS 5 and the beginning of MIS 4 and this date is supported by the bio-stratigraphy (Crégut-Bonnoure et al. 2010) (fig. 2).

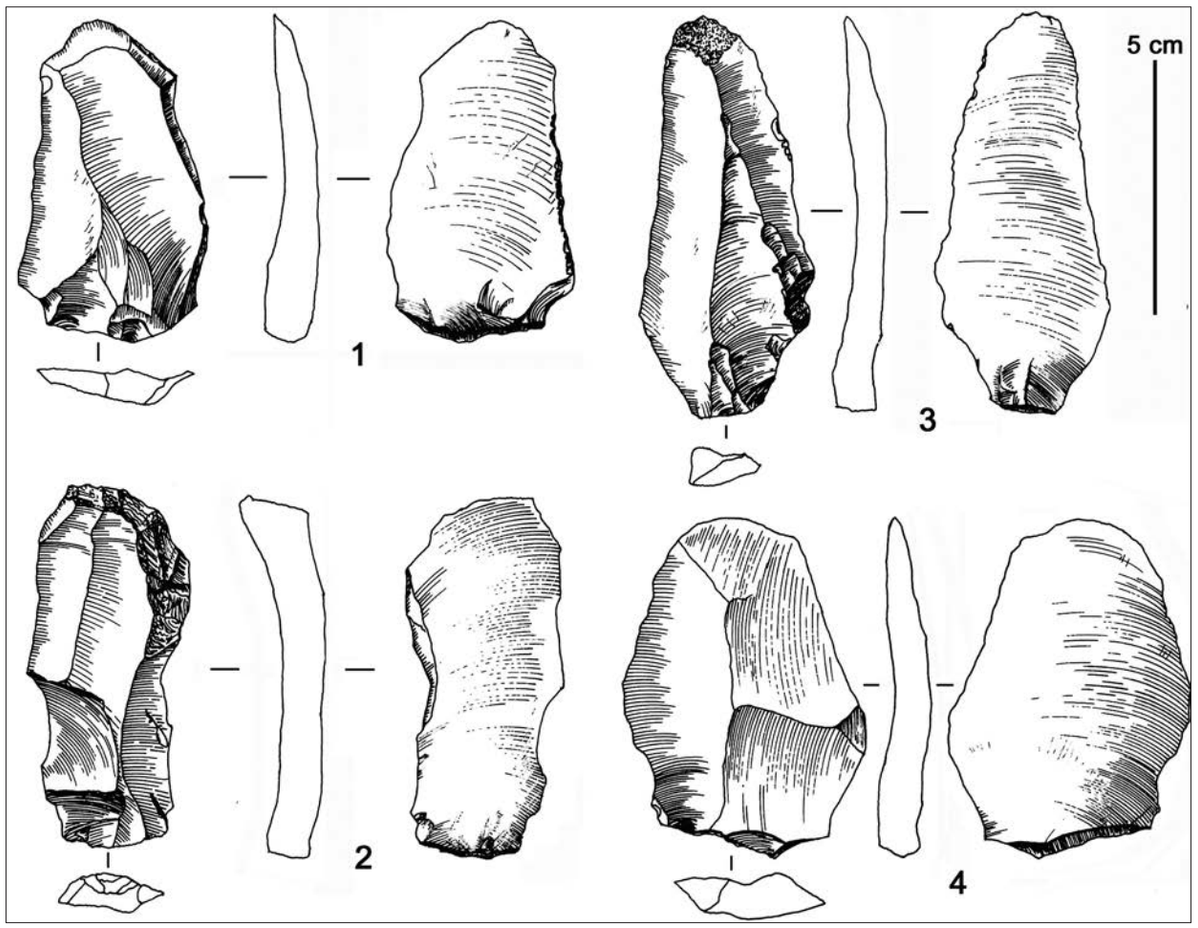


Fig. 13. Abri du Maras (Moncel excavation). Elongated blade-like products, unit 4 (drawings by Angeliki Theorodopoulou).
Abb. 13. *Lange klingenähnliche Artefakte aus Schicht 4 der Grabung Moncel im Abri du Maras (Zeichnungen: A. Theorodopoulou).*

The main lithic raw material used by hominins at this site was flint, recovered as tabular fragments, nodules and pebbles gathered locally (less than 5 km away) or within a semi-local perimeter of 20 to 35 km radius (Moncel 2002, 2003). Generally, exploitation territories were confined to the Rhône Valley especially the southern areas which are rich in flint, although a diverse range of outcrops was exploited in this landscape of varied ecological contexts. During each occupation phase of the site, flint collection concentrated on one or two main outcrops or formations.

In the older excavations, the upper part (units 3 to 1) yielded laminar products from Levallois and non-Levallois flaking techniques (Moncel 1994, 1996) (fig. 12). The two upper units (MIS 4 and 3) contain evidence of laminar flaking (5 % - 10 % of blade production) following a Levallois method (uni-bipolar and convergent unipolar flaking) on flint pebble cores (Combier 1967; Moncel & Michel 2000; Moncel 2003) that produced more or less elongated and pointed blades, however the Levallois cores in the assemblages are flake cores not blade cores (Moncel 2005; Moncel & Daujeard 2012). Only some cores can be associated with laminar knapping technologies, with the elongated removals made directly on the cortical surfaces of small round pebbles (direct knapping). In assemblages rich in blades, such as here in Abri du Maras, tools are mainly side-scrapers made on flakes.

The bottom of the sequence (units 6 to 8) was excavated over a smaller area (3 m^2). A lesser proportion of elongated products was found here, being replaced by more invasive and semi-Quina type retouched material. The knapping method used was Levalloisian. The top of the sequence was ascribed to Recent Mousterian and the bottom to Ferrassie Mousterian.

The lithic assemblages coming from the new excavations in units 5 and 4 are mainly composed of flint but also contain a few other stone types. Flint was collected as pebbles, nodules and slabs and evidence for the whole of the *chaînes opératoires* occurs in the site.

The assemblage from unit 5 (excavated over only 2 m^2) comprises 101 artefacts and that of unit 4 lying above it (excavated over 16 m^2) contained 399 artefacts. The objects found in the two units share common features, being mainly small flakes (<15 mm) and flakes of >20 mm, but some are up to 100 mm in

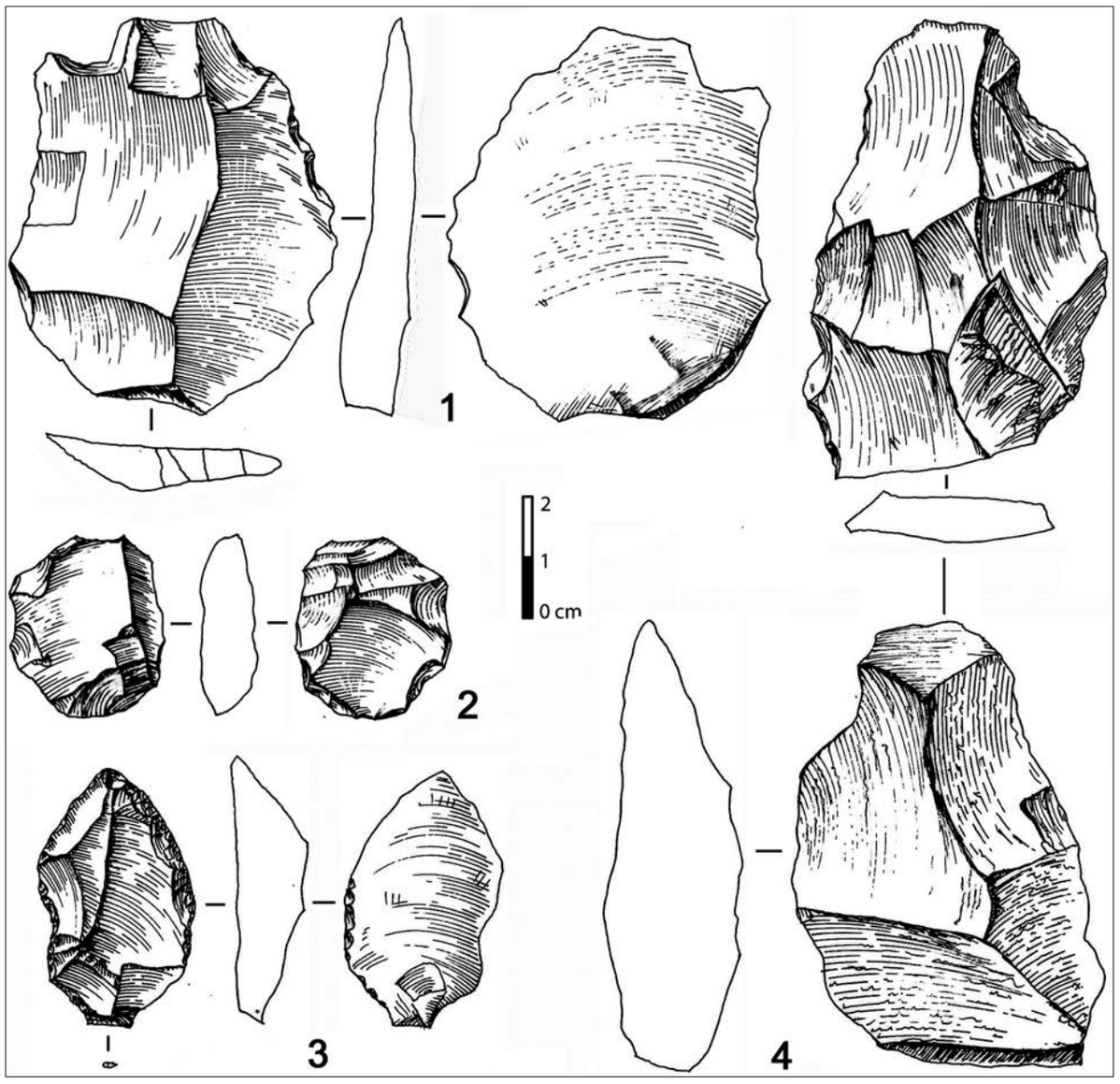


Fig. 14. Flint tools from Grotte des Barasses II at Balazuc (recent excavation) (drawings by Angeliki Theorodopoulou).
Abb. 14. *Feuersteingeräte aus der neuen Grabung der Grotte des Barasses II at Balazuc (Zeichnungen: A. Theorodopoulou).*

length. The presence of micro-flakes, flakes and cores shows that a complete reduction system exists at the site along with some selective retouching. Cores, backed flakes, cortical and non-cortical flakes demonstrate that the main flaking technique used belonged to the Levallois mode. Flake removals are unipolar or convergent unipolar and flat striking platforms are the most frequently occurring type, followed by punctiform, dihedral and facetted. Some evidence of Quina knapping is observed on cores from unit 5.

Blades and bladelets make up 21 % of the industry in unit 4 but these forms are less abundant in unit 5 where the elongated objects are blade-like flakes (fig. 13). Some of these are backed and in unit 4 twentyfour are of Levallois type (including some that are 100 mm long). Most are non cortical and only one is a crested blade – the edge of a core. Blade and bladelet removals are unipolar or convergent unipolar. Levallois points total 5.9 % of the assemblage. Their removals are centripetal, unipolar or convergent unipolar.

Tools are rare in unit 4 (5.4 % of the total) and more frequent in unit 5, consisting of modified flakes and, rarely, retouched blades. Most of those found in unit 4 are scrapers with marginal retouch but more invasive retouch was used on those from unit 5, where little evidence of semi-Quina retouch occurs. Denticulates and micro-denticulates made on elongated pieces make up a second tool kit found in unit 4. The retouching styles (Quina, semi-Quina and denticulate) are successive in time (Theodoropoulou 2008) and may suggest a change in the needs of the occupants and consequently in the function of the site.

Units	Quartz basic production	Quartz cores	Entire and broken pebbles	Flint production	Flint cores	Other rocks	Total
Upper unit 3	67	5	37		8	2	119
Middle unit 2	28		2		2	1	33
Lower unit 1	32		21		3	7	63
Artefacts from disturbed context			12			1	13

Fig. 15. Lithic production ratios in Middle Palaeolithic units at Abri des Pêcheurs (Ardèche).
Abb. 15. *Steingeräteherstellung in den mittelpaläolithischen Schichten des Abri des Pêcheurs (Ardèche).*

The core forms show that a variety of flaking modes was used despite the fact that most of the flaking debitage originates from a Levallois technique. There are Levallois point cores and flake cores for preferential flakes, but there are also discoidal cores and an orthogonal core. Comparison between sizes of the flake scars on the cores and sizes of the flakes themselves suggest that some large Levallois blades and flakes may have been brought on to the site rather than being made there.

The features of unit 4 fit well with what Combier (1967) described for his units 3 and 4, while the features of unit 5 correspond to units 8 to 4 of Combier's sequence. The bottom series is characterized by products that are less elongated and have more invasive retouch; some are of Quina type.

Fauna from both the older and the more recent excavation (up to 2006) at Abri du Maras includes: *Equus* cf. *germanicus*, *Equus hydruntinus*, *Sus scrofa*, *Cervus elaphus*, *Capreolus capreolus*, *Rangifer tarandus*, *Bison priscus* and *Capra ibex* (Daujeard 2008; Daujeard & Moncel 2010; Moncel et al. 2010). There are no carnivore remains. According to the presence of these taxa in various sectors of the sequence, temperate environments dominated during the accumulation of the lower units, while cold and exposed environments prevailed during the formation of the upper units. Cervids (reindeer in the upper units and red deer in the lower units) dominate the faunal spectrum.

Desquamation, root etching and surface crumbling rates of the bones are highest in unit 1 and the upper units, where the state of preservation of the bone surfaces makes it difficult to determine whether or not any damage was the result of activity by biological agents. However, cut marks appear frequently on more than 20 % of the decipherable remains and carnivore tooth marks occur on less than 2 %. This indicates that the faunal accumulation is due mainly to hominid activity (fig. 10).

Rare indications of seasonality show that reindeer were hunted during autumn, the period of migration and rutting. Ungulates are represented by all age classes. At the site, carcasses, systematically retrieved whole, were skinned, eviscerated, filleted, dismembered and the bones broken to extract marrow. Almost half of the small fragments recovered from sieves are burnt (size <5 cm), which may suggest the regular use of bones for fuel. Bone retouchers have been identified in the assemblage. Evidently, hominids living in the Abri du Maras rock shelter applied an intensive and complete butchering sequence to the carcasses they took there. Taking into account lithic criteria like artefact density and completeness of the operational sequences, the zoo-archaeological data confirms the long-term residential occupation of this site.

Grotte des Barasses II (Balazuc, Ardèche)

Barasses II cave (Balazuc, Ardèche) was discovered in 1966 and first investigated in 1967 and 1968 (Combier 1967, 1968). It is a small and narrow cavity located on the right bank of the Ardèche River, about 55 meters above the present bed of the river (fig. 1). Oriented to the south, it consists of the residual part of an eroded larger cave and includes a small room (20 m^2). With several Middle Palaeolithic layers and a fauna with several taxa dominated by ibex and accumulated by various agents (natural, animal and human) (fig. 2), the site was considered as a bivouac (Daujeard 2008; Daujeard & Moncel 2010). Beginning in 2011 one of us (C. Daujeard) began a new evaluation of this site.

A lithic assemblage coming from a 4 m^2 test pit and made up of 400 various types of artefacts consists primarily of short, elongated or pointed flakes with little evident cortex. These flakes were introduced ready-made into the cave so the *chaînes opératoires* are incomplete but Levallois methods (centripetal and unipolar), associated with Kombewa technique can be identified. The few cores discovered inside the cavity were made on small flint flakes and suggest a complementary *in situ* debitage on mobile matrixes (fig. 14).

Various types of flint drawn from within a wide perimeter form the main raw material used at this site, but the frequency of basalt and volcanic rocks in the assemblage shows that many local types of stone from along the foot of the cliff were used as well. These were used as hammers, pebble tools and as a core for producing a bifacial tool. The site contains small flaked pebbles collected from river banks although major

bed lag deposits were the sources for very large pebbles. No basalt cores were discovered suggesting that basalt cores were flaked outside the cave. There are no ambiguous occurrences in the core technology.

Flake tools are few at 7 % of the total lithics, which include scrapers, points and denticulates. Retouch is scalar or semi-Quina and numerous micro-flakes show that flaking activities and retouch took place inside the cave.

A large part of the series is broken, something that probably happened during flaking events. This may be evidence for low interest in the ultimate shape of the lithic products brought into the cave, suggesting that the primary requirement for an artefact was for it to have sharp unretouched cutting edges. However, the presence of some broken points shows that incomplete or unsuitable products were discarded as well.

A long and diverse faunal list shows that the site was situated near rocky landscapes, forests and open environments (Daujeard 2008; Daujeard et al. 2011, 2012; Le Pape 2012). Species present include:

- ungulates (*Capra ibex*, *Rupicapra rupicapra*, *Bos/Bison*, *Cervus elaphus*, *Rangifer tarandus*, *Equus* sp.),
- carnivores (*Canis lupus*, *Vulpes vulpes*, *Ursus spelaeus*, *Panthera pardus*, *Lynx* sp., *Martes* sp., *Mustela* sp.)
- rodents (*Castor fiber*, *Microtus* (*Stenocranius*) *gregalis, Allocricetus bursae, Apodemus* cf. *sylvaticus, Microtus (Chionomys) nivalis, Pliomys lenki, Microtus* group *arvalis/agrestis, Microtus arvalis, Arvicola* cf. *terrestris)*,
- other mammals; Insectivora (*Talpa europaea*), Chiroptera (*Myotis* sp.), Lagomorpha (*Oryctolagus cuniculus*),
- birds (*Lagopus* sp., *Perdrix perdrix*, *Tetrao tetrix*, *Columbia livia*, *Pyrrhocorax graculus*, *Pyrrhocorax pyrrhocorax*),
- amphibians (*Bufo bufo*, *Rana temporaria*) and
- fishes (*Thymallus thymallus* and *Anguilla anguilla*).

Carnivore remains are abundant, representing more than 20 % of the MNI, with fox, wolf and cave bear being the most numerous species. Among ungulates, the faunal spectrum is varied but the ibex dominates widely at more than 80 % of the herbivore NISP.

Taphonomic analysis supports a mixed origin for the bone accumulations. Visits by carnivores and humans alternated in this cave. A human presence is tenuous and more important in the lower part of the sequence (cut-marked bones making up less than 5 % of the NR). On the other hand, bones modified by carnivores are well represented throughout the sequence (chewed specimens being more than 14 % of the NR). The distribution of various marks on long bones indicates some primary human access to the carcasses. Species of secondary numerical importance, mainly cervids were those most regularly processed by Neanderthals. Ibex bones with cut-marks are scarce and the presence of chewed bones, whole carcasses and a wide age range among individuals suggests that the remains of these small bovids are the result of natural accumulations.

In summary, from the faunal evidence, the cave was used as a shelter by ibex, carnivores and humans. Despite the small size of the test pit, the recovered lithic series suggests Neanderthals selected a particular corpus of items for use during the short-term occupations (bivouacs) represented by the assemblage.

Abri des Pêcheurs (Casteljau, Ardèche)

This small south-southeast facing cavity (20 m^2) is situated on the Chassezac, a major tributary of the Ardèche River at 26 m above the current river level. It was initiated by diaclasis allowing the penetration of eroding water through the Kimmeridgian limestone (fig. 1). The cave appears pit-like having its actual entrance bordered by a rock step covered by stalagmitic flowstone.

Several seasons of fieldwork took place here during the 1970s and 1980s (Lhomme 1983, 1984, 2003; Lhomme et al. 1980). They revealed a multi-layered sequence dating from the Middle to the Upper Palaeolithic (Aurignacian to final Magdalenian), interstratified with sedimentary units of collapsed limestone blocks (Debard 1988). Several human teeth were discovered within the Middle and Upper Palaeolithic units (Bouvier 1982). New excavations took place in 2005 over the whole surface of the Middle Palaeolithic sequence (fig. 2).

The bottom of the sequence (sector 4, 3 units) has been attributed to the end of MIS 5 and the beginning of MIS 4. Although some technical problems occurred at the time, radiocarbon results gave dates between 24 kya and >31 kya (Evin et al. 1985). More recently, bones were dated by U/Th and suggest an age spanning between 120 and 40 kya. ESR dates on the hardened units at the base give an age of around 100 kya (Masaoudi et al. 1994). These uncertainties in dating are due to geochemical activity, which strongly affected the uranium fractions. Geo-chronological interpretation suggests a phase of MIS 5 *sensu lato* for the basal sterile units. Moreover, a sedimentological study of the rest of the sequence indicates a cold wet climate (Debard 1988) which is confirmed by faunal, micro-faunal and palynological studies. In fact, the pollen spectrum indicates that there was a reduction in the quantity of trees equivalent in time to the beginning of the basal level and extending through to the upper part of the sequence, with other minor vegetation changes occurring throughout the course of time (El Hazzazi 1998; Kalaï 1998; Jeannet 1980). The deposits from the lowest part of the sequence (Sector 4), attributed to Middle Palaeolithic

occupation, are likely to be related either to a sub-phase at the end of MIS 5 (especially 5b) or to a colder period contemporary with MIS 4.

Artefacts represent 73 % of the total lithic assemblage, with 27 % of them being complete or broken pebbles (Moncel & Lhomme 2007; Moncel et al. 2008b) (fig. 15). The main lithic raw material is quartz (cores and flakes), followed by flint (flakes) and other rock types, especially of metamorphic origin. All these can be collected readily, either as pebbles from below the cave along the Chassezac River or from the Pliocene formations located up on the plateau.

It is possible that some rounded and ovate pebbles were deposited in the cave by natural processes and later utilized by the human groups that occupied it and some may be manuports that were collected from Pliocene formations on the plateau and brought into the cave.

Quartz artefacts consist essentially of cortical backed flakes and flakes exhibiting part of a non-cortical core edge. They are associated with 5 cores coming from the upper layer. Flakes are short and un-retouched and originate from different phases of core reduction. Most are broken and have few cutting edges. Their lengths vary from 10 to 40 mm, but most are at the shorter end of this range and all are from 10 to 15 mm thick. Some rare cortical and non-cortical backed flakes are longer (45-65 mm). Where platforms can be identified, they are plain or cortical. Removals are unipolar.

The cores are pebbles measuring between 40 and 95 mm long and 20 to 40 mm thick, knapped from adjoining angular surfaces. Several reduction strategies resulted in knapped products with total or partial, unifacial or bifacial flaked surfaces. The main knapping methodology is discoidal, either unifacial, bifacial or both. Generally, platforms are the cortical faces of the more-or-less quadrangular pebbles. The removals indicate centripetal knapping methods were used and utilization of the core edges resulted in the production of some flakes that are naturally backed.

The location of each consecutive flake removal depended on the form of previous removals and the overall shape of the pebble. Thus, the forms of the cores governed the ultimate shape of the knapped flakes found in the assemblages. No evidence for the use of hammer and anvil bipolar flaking methods was identified. The entire quartz reduction sequence is well represented in the assemblages and suggests that quartz knapping took place inside the cave or in its immediate surroundings.

Despite flint being uncommon in the assemblage, 27 gitological types have been identified (Fernandes et al. 2010) and the nature of the remnants of cortex on these types indicates that they were collected from primary or secondary outcrops as either nodules or slabs. The cave is located in Kimmeridgian limestone from which flint is absent but the Portlandian limestones (Tithonique) are located a mere 200 m from the site and these yield flattish nodules of a brown or ruddy flint, which is found in the assemblages. Other types of flint originated from various outcrops, some still unidentified, but their presence shows that the cave occupants gathered them from, or at least had knowledge of flint sources within a radius in excess of 30 km from the site, with the principal focus directed towards the east and into the Rhône Valley.

The entire flint knapping process is not represented by the assemblage found within the cave because there are very few flake cores and those that were found in the cave are very small and are unlikely to be the source of the entire assemblage. However, the assemblage is technically homogeneous. Flake lengths vary from 10 mm upwards, with one single flake measuring 100 mm, the small flakes being produced by retouching activities. Flakes are non-cortical, lack modification and some are products of the Levallois technique. Scrapers do not have intensive retouch. Our conclusion regarding these occurrences is that flakes were generally produced at the outcrops or at other localities and brought into the site.

The faunal list for the final excavations (2005) (Moncel et al. 2010; Daujeard & Moncel 2010) was the same as determined in previous studies (Balme 1984; Crégut-Bonnoure 1987; Moncel et al. 2008b; Prucca 2001) with an abundance of small bovids and carnivores, mainly canids and cave bear. Ibex (*Capra ibex cebennarum*) is the dominant species at more than 80 % of the herbivore NISP. Cervids present include red deer, reindeer and roe deer. The fauna is typical of a rocky and forested environment with only the presence of reindeer indicating a relatively cold climate and wide open landscapes.

At Abri des Pêcheurs, carnivores are major contributors to most of the modifications of the bone assemblage and they certainly account for some part of the total accumulation. Only 3 % of the faunal series shows damage caused by lithic tools, whereas carnivore tooth-marks (especially on ibex) appear on 4 % of recently excavated bones but on more than 20 % for the older series (Daujeard 2008; Daujeard & Moncel 2010; Moncel et al. 2008b). For the former series, the distribution of cut-marks and tooth-marks on herbivore long bone shaft fragments indicates that their modification was primarily due to carnivores (Table 6). Apart from several canine perforations, which suggest the presence of a wolf-sized carnivore, it is difficult to determine which of the two canids present, fox or wolf, was responsible for the tooth-marks - which consist of grooves and impacts. The presence of whole ibex carcasses of almost all age classes, some with bones preserved in anatomical articulation, implies that the ibex assemblage is a natural accumulation of some kind which was exploited regularly by canids (Crégut-Bonnoure 1987, 1992, 2002; Daujeard 2008; Daujeard & Moncel 2010;

Moncel et al. 2008b; Prucca 2001). Hominids may have contributed to a lesser degree to the accumulation of the ibex carcases as suggested by a few marks on them attributable to human activity; perhaps human activity accounts for the other species that are less numerous in the total assemblage. Whereas ibex carcasses are complete and include both young and adult individuals, cervids are represented by meat-poor pieces like skull fragments and limb ends as well as by young individuals, a situation usually indicative of scavenger activity. The proportion of cut-marks to other modifications on cervids is slightly higher than that for ibex suggesting more human activity involving the carcasses of this group. No bones recovered from the recent excavation carry evidence of burning and no bone retouchers were found in the assemblage.

Stone artefacts and the hearth discovered during previous excavations in sector 4, along with the rare occurrence of bones that have been shattered or marked with cuts, are the only evidence for the brief visits to this cave made by humans. All the cultural features noted above recall the corpus of evidence gathered from the Middle Palaeolithic site of Les Barasses II at Balazuc, only a few kilometres away (Daujeard 2008; Daujeard & Moncel 2010).

Discussion

Despite there being little to discuss concerning the old open-air sites thought to be Acheulean, the more recent sites contribute more information. The lithic repertoires from Payre, Saint-Anne I, Baume-Vallée, Abri du Maras, Abri des Pécheurs and Barasses II suggest that the stone knapping and retouching activities were directed towards different activities undertaken at each site. These objectives answered the different demands made by each of the local environments and were a response to the range of durations of site occupancy regardless of the species being hunted from each site and its particular behaviour.

The site of Orgnac 3 contains records of Upper Acheulean occupation, with evidence for Middle Palaeolithic technological strategies being undertaken at the top of the sequence (MIS 8) and with a Levallois core technology appearing in the middle part of the sequence (MIS 9). Behavioural overlaps and a mosaic of changes in hominin subsistence and technical behaviour suggest that both gradual and punctuated temporal changes occurred.

In the different human occupation phases at Payre, the main core technology is close to the discoidal type with some technical variations especially in level G. This flaking strategy produces non-standardized flakes with long cutting edges and asymmetrical triangular flakes that can be modified by retouching to form a very useful edge. The lack of hafted points (Moncel et al. 2009), importation into the site of large flakes made of various local stones and presence of flint flakes and nodules are related to its seasonal occupation and location. Here, flint reduction sequences are complete suggesting importation of this material as cores while sequences on local stones are often partial, suggesting opportunistic acquisition and some use away from the site.

At Sainte-Anne I, raw material was procured from more than thirty different localities close to the site in the Puy-en-Velay basin, as well as from secondary and sub-primary colluvial and alluvial outcrops. In the Massif Central, flint in primary geological context is not abundant and is found only in lacustro-palustrine basins. The most abundant lithic resources occur in old alluvial formations belonging to a vast and ancient drainage system along the southern and eastern margins of the Massif (Lozère and Ardèche) where limestones of the Lias and Dogger series contain abundant flint sources. Neanderthals obviously had an outstanding knowledge of the occurrence of these local resources. The presence of certain specific flint types suggests that they used exploitation routes that crossed the borders of fluvial systems. Neanderthal frequentation of the western highlands of the massif and of the valleys of the Loire, Dore and Allier Rivers demonstrates that they also used some north-south routes. The use of the valley of the Allier is suggested by evidence, albeit limited, of flint from Madriat, Arlanc and La Comté. One piece indicates a journey to (or from), or trade with, the hills of the Bas-Beaujolais at Alix in Rhône close to the northern Rhône Valley. The territorial perspective provided by an analysis of the lithic raw materials reveals procurement circuits - local, regional and more remote – that are only one aspect of the palaeo-ethnographic activities of what appears to have been very mobile Neanderthal groups. The low volume of material carried from long distances and the multiplicity of the outcrops used suggests that stone procurement took place during short-term seasonal subsistence activities (Raynal et al. 2005, 2007, 2012; Daujeard et al. 2011) rather than as a result of systematic collection strategies. Such a residential pattern also seems confirmed by the occurrence of limited numbers of exhausted cores of local raw material that have been used to produce standardized flakes. The duration of occupation events may be judged by the presence of a large number of artefacts produced on local volcanic rocks, quartz and types of flint. The absence of certain items from the reduction sequences, like large-sized and retouched flakes, suggests that if they were present in the tool kit of the occupants, then these products were used away from the site or removed from it when the occupants moved through their territories (Santagata 2006, 2012). Some flint types can even be considered as 'mobile' or 'portable' products when flaking workshops appear on outcrops (such as flint from Le Malzieu, Madriat, Laps or Arlanc for example), or even as territorial indicators (like the flint from Bas-Beaujolais).

At Baume-Vallée, various flakes used to provide tool blanks were produced by a range of knapping techniques on the same core. This was presumably a strategy of use designed to conserve a precious resource available mainly as small pebbles. This assemblage indicates that multiple tasks were being conducted simultaneously within a seasonal camp from which horses and cervids were hunted. This conclusion is supported by the number of slaughtered animals present (fig. 10) and the somewhat high proportion of retouched artefacts, regardless of how these were produced. Microwear analysis shows that the stone artefacts were used to work soft or semi-hard materials and based on the ethnographic record this may be related partly to wood working. A range of tree species was available at the end of MIS stage 5 from which to make tools to undertake certain tasks as opposed to making them from bone. The "Charentian" aspect of the assemblage derives from the intense reduction of edges and makes it appear identical to that identified in the recent excavations in unit 5 of Abri du Maras. The diversity of technical behaviour represented in the stone tool assemblage from the site as well as its diverse composition suggests long-term occupancy with a wide range of tasks being performed there, possibly reflecting gender collaboration or division of labour. At Abri des Pêcheurs, the assemblages seem to result from bivouacs by a party consisting of a few individuals who camped there during subsistence activities. Perhaps this was a gender specific group fraction, while the occupation pattern seen at Baume-Vallée and Le Maras, points towards seasonal or residential use by a group of mixed gender and age who were processing game and vegetal resources, undertaking wood working and so on. All the members of the group probably collaborated actively during their stay to produce an optimal result, particularly at Baume-Vallée, located as it is in the mid-mountains.

In the upper layers of Abri du Maras, the presence of flakes and pointed artefacts as well as the retouch on them suggests that special equipment was being manufactured, possibly involved with hunting and butchering reindeer and horses during long-term residential occupation – a situation suggested by the number of slaughtered animals present (fig. 10). Most of the Levallois flaking systems are complete but, according to the size of the core-flakes, large un-retouched blades were being imported into the site. These transported artefacts may have been needed for currently unidentified site-specific tasks.

Barasses II cave (Balazuc, Ardèche) was probably a bivouac. The lithic assemblage contains various artefacts, mainly short, elongated or pointed flakes that were introduced ready-made into the cave. The *chaînes opératoires* for the several series are only partial. Levallois flaking methods (centripetal and unipolar) are associated here with Kombewa techniques. Flint is the main raw material used and the various types have been gathered from within a relatively large territory, but numerous basalt pieces and volcanic rocks show considerable use of local stones as well. No particular technique within the lithic management techniques or core technology deserves special comment. There are few flake tools at this site. The diverse fauna found here had a preference for rocky landscapes and forests as well as open environments. Carnivore remains are abundant and these animals alternated with humans in their visits to the cave, which, as shown by the depositional sequence, also served as a shelter for ibex. Despite the small size of the test pit, the recovered lithic series is sufficient to suggest that the objects are the result of a careful selection by Neanderthals to facilitate certain activities that were undertaken during the short-term occupational events they made in this cave.

At Abri des Pêcheurs, irregular and thick broken flakes of quartz and small flakes of flint suggest an expedient technology to satisfy an immediate need. The few formal tools present are made on flakes produced by discoidal knapping. This assemblage was probably the result of brief human occupation events in the cavity during which they processed some parts of cervids and ibex (fig. 10). The *chaîne opératoire* for local quartz objects is complete but there are few tools made in this material while the *chaîne opératoire* for the flint assemblage, which contains a higher ratio of tools, is incomplete. Flint retouch is more or less invasive which suggests resharpening activities were limited and implies that the flint tools of good quality were for short-term use. This is good evidence for the movement of materials and humans through the landscape as this material, which is foreign to the site, must have been carried with them on their travels.

Although the patterns of faunal procurement indicate that diverse landscapes were being exploited, the territorial perspective provided by the sources of lithic raw materials indicates that the groups inhabiting the sites travelled widely, undertaking multidirectional and more or less long-distance forays into the surrounding landscapes. There seems to be no good reason to consider the collection of lithic raw material as a specific subsistence activity and the gathering of lithic materials probably occurred in conjunction with other hunting and gathering activities. The Ferrassie Mousterian industry of Unit 1 of Baume-Vallée shows that the occupants were familiar with a number of lithic raw material procurement circuits – locally, regionally and more remotely. The range from which lithic raw materials were sought was large and similar in size to that deduced for Abri des Pêcheurs. Our petro-archaeological analysis has provided evidence for the circulation of lithic materials between the Massif Central sites

in Velay and those in the Rhône Valley. As the assemblages in Abri du Maras and Baume-Vallée sites are similar, it may be that these two sites were places occupied by one group that ranged over a wide subsistence area. Alternatively the sites may have been situated in the territories of two distinct groups that exploited different regions. Nevertheless, whether this occupation question can be answered or not, the mobility of Neanderthal groups is only one aspect of the complexity of these palaeo-societies.

That raw materials were being imported to sites from outcrops where there are also workshops illustrates the fact that the hominins had an appreciation of the availability and probably the workability of the lithic resources within their territory. Perhaps the abundance of a particular lithic type in a site indicates that this resource belonged in the territory regularly exploited by the site occupants. The presence of exogenous stones abandoned at a different stone source suggests that whoever left them had knowledge of an even wider world and this knowledge may in fact delineate a space that is close to the actual social territory of the individual.

Despite the complexity of territorial exploitation strategies suggested by the importation of varied and remote resources into these sites, this activity does not, at this moment in time, suggest planning strategies comparable to those observed elsewhere. Nor can we confirm a strictly bipolarized (summer-winter / highlands-lowlands) circulatory subsistence pattern, even though we should not reject the idea of exploitation occurring back and forth along the course of the Allier or more certainly along the Loire for Charentian groups. However, the locations of the more remote geo-resources suggest that there was a radiating exploitation pattern spreading out from semi-residential camps. Similarly, widespread locations visited or exploited by groups of hunter-gatherers transiently occupying brief stopping places support the same organised exploitation patterns. Remote or semi-remote lithic outcrops that were visited infrequently may mark some territorial limit or perhaps they might be places where neighbouring groups could meet for some special purpose; such locations may even be the source of raw materials needed for special occasions if not for special tasks.

In the same vein, lithic artefacts abandoned in the landscape, which are often categorized by archaeologists as isolates, may just as easily have been left intentionally as some kind of marker for others to discover. One must keep in mind that a resource territory may well differ from a social territory (Wragg-Sykes 2012). Obviously, petro-archaeology must in the future find new ways to decipher more of the Neanderthals' cognitive sphere (Wynn 2003).

Landscape knowledge – geo-knowledge as well as bio-knowledge – is a cognitive process involving demonstration, learning, transmission and other behaviours that, for Neanderthals, is often wrongly considered as opportunistic but in our opinion has far deeper cognitive implications. In some modern hunter-gatherer societies the task of understanding the landscape and its resources is a complex cognitive process involving life-long learning. For example, the exploitative structure of Aboriginal Australia was made up of many small mobile groups with specific languages and territories (Birdsell 1953) where the gendered social patterns were rooted in partially shared explanations of landscape features (i.e. geo-symbols), explanations of animal behaviour, location information related to seasonal resources of all kinds and observation and appropriation of lessons derived from the movements of planets and stars. Similarly, the world of the Neanderthals may have been a wide mosaic of communities in which sub-groups acted independently within a broad global paradigm. Neanderthal mobility, a fact now acknowledged by most researchers, implies that journeys were made by all-inclusive groups that included the young and the old who were cared for according to their needs (Kuhn & Stiner 2006). Apparently, the process of imparting knowledge about the landscape to the group took place concurrently with other subsistence activities. This seems likely to have been a structured activity because there was a potential for some aspects of life to be imparted separately by males and females to the young and since older, more knowledgeable people played a necessary and essential role in this process of passing the structured memory of the group down through the successive generations. This idea is supported by the high proportion of "old" adults among known Neanderthal burials (Maureille & Tillier 2008). Because young individuals grew rapidly, their capacity for learning may have been shorter-lived than for modern humans despite the similarity of the resource-based knowledge that both groups required. Moreover, it was necessary to maintain group efficiency in terms of size despite the apparently high mortality of young individuals (Maureille & Tillier 2008). This may imply that there was a gender specific response to particular rhythms of the landscape (Burke 2010) linked to learning/transmission processes and, in some way, may explain differences in subsistence patterns.

Conclusion

The exploitative itineraries we have identified are: collection of lithic resources; transportation of these lithic resources; abandonment of lithic resources; seasonal hunting of selected target species; other permanently available or seasonally abundant resources being collected and processed in a variety of stopping places and camps; the possibility of single gender as well as mixed-gender groups undertaking specific tasks; confirmation that, from MIS 9 to MIS 3, Neanderthals were not simply reacting to landscape

characteristics, they were interacting with landscape features (geo-symbols) and responding to environmental and bio-resource changes in a deterministic manner. Obviously, Neanderthals lived in a "speaking land"; moreover they "were" the land (Berndt & Berndt 1989). This remained a hunter-gatherer behaviour until the very recent past.

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