HAL
open science

Conditioning of the raw materials on discoid exploitation strategies during the Early Middle Palaeolithic: the example of Payre level D (South-East France)

Sara Daffara, Antony Borel, Marie-Hélène Moncel

▶ **To cite this version:**

Sara Daffara, Antony Borel, Marie-Hélène Moncel. Conditioning of the raw materials on discoid exploitation strategies during the Early Middle Palaeolithic: the example of Payre level D (South-East France). Archaeological and Anthropological Sciences, 2019, 11 (9), pp.4681-4695. 10.1007/s12520-019-00823-6 . hal-02282103

HAL Id: hal-02282103

https://hal.science/hal-02282103v1

Submitted on 7 Nov 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Conditioning of the raw materials on discoid exploitation strategies during Early Middle Palaeolithic. The example of Payre level D (South-East France).

Authors: Sara Daffara[1,3], Antony Borel[2], Marie-Hélène Moncel[2]
(1) Dipartimento di studi umanistici, Università degli studi di Ferrara, Corso Ercole I d'Este 32, 44121 Ferrara, Italy.
(2) Histoire Naturelle de l'Homme Préhistorique (HNHP, UMR 7194), Sorbonne Universités, Muséum National d'Histoire Naturelle, CNRS, Université Perpignan Via Dominica, 1 rue René Panhard, 75013 Paris, France.
(3) Associazione culturale 3P – Progetto preistoria Piemonte, Via Lunga, 38, 10099 San Mauro T.se (TO), Italy.

Corresponding author
Sara Daffara
e-mail: saradaffara@gmail.com
phone: +393391750917
ORCID: 0000-0001-7150-0289

Abstract
In the last decades, a growing attention was paid towards the exploitation of other lithic raw materials than flint. In this context, the lithic assemblage of Payre level D, dated to the end of the MIS 6, offers the opportunity to make some considerations about the modalities of a discoid technology on various lithic raw materials. Payre is a very well-known Middle Palaeolithic site located on the right edge of the Middle Rhône valley. Three main archaeological levels attest an intense human frequentation of the site between the end of MIS 8 and the beginning of MIS 5. The rich faunal and lithic assemblages, recovered during systematic excavations from 1990 to 2002, have been deeply analysed for a precise understanding of the site formation processes and the modalities of the human occupation of the area. The exploitation of different local and semi-local raw materials made Payre an interesting case to observe how lithic resources with different petrographic characteristics were exploited by the Neanderthal groups. The present work aims to observe how the lithic raw materials have affected the discoid reduction sequences. This knapping method is widely attested in archaeological level D, the last large phase of human occupation at Payre. Among the different raw materials exploited (flint, vein quartz, quartzite, basalt and limestone), the discoid method is just applied on flint and vein quartz. The new technological analysis carried out focuses for the first time on the characteristics of the discoid technology present in level D and on the differences in discoid reduction sequences depending on the raw materials. The results indicate some expedients used to apply discoid reduction strategies on vein quartz and adapt this technology to the features of a coarse-grained stone. The use of such expedients testifies a large capability to manage the raw materials but also of the discoid method itself. Results allow to make considerations on some of the criteria proper to the technological definition of the method.

Keywords
Discoid technology, vein quartz, Middle Palaeolithic, France.

Acknowledgments
This work has been possible thanks to the International Doctorate in Quaternary and Prehistory programme and the support of the *Institut de Paléontologie Humaine* (IPH). Sara Daffara's Ph.D. research included a secondment grant to Museum National d'Histoire Naturelle of Paris financed by the project "Robes de pierre", part of the POLYRE ("L'Aventure Polychrome") Chair of Excellence, supported by Sorbonne-Universités. The excavations at Payre have been financially supported by the French Ministry of Culture, *Service Régional de l'Archéologie Rhône-Alpes.*

1. Introduction

The use of several kinds of lithic raw materials to produce tools is well attested in the European Middle Palaeolithic, suggesting capabilities of Neanderthals to manage various quality stones for producing the tools (e.g. ; Berruti and Cura 2016; Blaser et al. 2002; Carbonell et al. 2005;; Cologne et al. 2009;;; Daffara et al. 2014; de Lombera-Hermida et al. 2011; Degorce and Castel 2006;; Delagnes and Rendu 2011; Di Modica and Bonjean 2009;; Janot 1988;; Lamotte et al. 2014; Lazuén et al. 2011;;; Moncel et al. 2014, 2013; Moncel and Daujeard 2012; Moncel and Lhomme 2007;; Mourre and Thiébaut 2008; Nicoud 2010;; Rodriguez 2004; santagata et al., 2017; Thiébaut et al. 2012; Tuffreau et al. 2009;). However, their technological study was often approached without considering both their petrographic characteristics and specific response for knapping.

In recent years, researchers focused their attention to raw materials different from flint to understand how they were exploited, which their role was in the techno-economic behaviour of Neanderthals and which purposes they were exploited for (e.g. Ollé et al. 2016). This new interest is particularly on vein quartz, as it is one of the most largely used non-flint stone in Middle Palaeolithic sites (e.g. Cologne and Mourre 2006; de Lombera-Hermida 2009; Driscoll 2011). Probably due to its appearance, vein quartz lithic assemblages, typologically and morphologically less standardized than flint lithic industries by the tendency of quartz to break during knapping, this stone is often considered as a secondary raw material (Mourre 1996; Driscoll 2011; de Lombera-Hermida and Rodríguez-Rellán 2016; Rodríguez-Alvarez 2016). Moreover, knapping stigma are less visible on quartz flakes and cores, making the technological study more difficult (de Lombera-Hermida 2009; Driscoll 2011; Knutsson 2014; Rodríguez-Alvarez 2016). The recent studies about quartz series are no longer based on subjective features such as colour or opacity but are based upon a detailed knowledge about quartz formation processes that determine the presence of cleavage plans, the dimensions of the crystals and therefore the response to knapping (Martinez Cortizas and Llana Rodriguez 1996; Collina-Girard 1997; Bons 2001; de Lombera-Hermida et al. 2011; Driscoll 2011; Knutsson 2014; de Lombera-Hermida and Rodríguez-Rellán 2016).

Beside questions regarding the exploitation of non-flint raw materials, this work also aims to contribute to the current debate about the variability of the discoid core technology. In fact, even if Boëda (1993) determined six technological criteria for the method, a debate still persists on the variability of discoid cores and products (e.g. Peresani 2003). The debate concerns the technological definition of the method to the economic and/or behavioural reasons for the production of discoid flakes (e.g. Berruti 2017; Brenet et al. 2009; Eren and Lycett 2016; Kuhn 1994; Lemorini et al. 2003; Picin et al. 2014; Picin and Vaquero 2016; Terradas 2003; Thiébaut et al. 2013; Vaquero et al. 2015; Vaquero and Carbonell 2003). As observed by Baena-Preysler et al. (2003), many factors can affect the variability of the discoid method, such as site function, skills, composition of the human group, raw materials and many other unknown elements. In general, most of the authors agrees that the identification of discoid reduction sequences and its variability have to be based on the study of the whole lithic assemblage to reconstruct the reduction sequences (*i.e.* Baena-Preysler et al. 2003; Mourre 2003; Vaquero and Carbonell 2003). The present study aims to focus on one element of the discoid *débitage*, the volumetric and technical features defined by E. Boëda (1993) applied to vein quartz. The new technological analysis of the lithic assemblage of Payre level D starts from the most recent technological approaches of the study of vein quartz lithic assemblages (i.e. de Lombera-Hermida 2009; Driscoll 2011; Tallavaara et al. 2010) to deeply investigate how the raw material properties affected the utilization of the discoid method.

2. The site

The Middle Palaeolithic site of Payre is located on the right edge of the middle Rhône Valley (Fig. 1) and represents one of the few archaeological sequences dated between the end of MIS 8 and the beginning of MIS 5 in the South-East of France (Moncel 1993; Moncel et al. 2002; Moncel and Chacon 2007; Moncel et al. 2008a; Valladas et al. 2008). The site is located on the edge of a limestone plateau, on the western borders of the Rhône Valley (Moncel et al. 2002). The position of the site, at the crossroads of different environments, is strategic for the exploitation of different ecosystems despite the changing morphology of the cave that, at the end of MIS 6, collapsed and became a rock-shelter (Moncel 1993; Moncel et al. 2002; Moncel and Chacon 2007; Moncel et al. 2008a; Valladas et al. 2008; Rivals et al. 2009; Ecker et al. 2013).
From 1990 to 2002, systematic excavations took place at the site (Moncel 1993; Moncel and Condemi 1996, 1997; Moncel et al. 2002; Moncel and Chacon 2007; Bouteaux et al. 2008; Moncel et al. 2008a, b; Valladas et al. 2008; Moncel et al. 2009; Rivals et al. 2009; Hardy and Moncel 2011; Ecker et al. 2013; Rufà et al. 2016; Baena et al. 2017; Carmignani et al. 2017). The investigation on the whole terrace allowed a detailed understanding of the infilling dynamic and processes, yielding a 5 m thick sequence divided in five large units (G, F, E, D-C, and A-B) including sub-layers (Moncel et al. 2002; Moncel and Chacon 2007; Moncel et al. 2008a; Valladas et al. 2008; Rivals et al. 2009) (Fig. 2). The data from palaeontological, biochemical and pollinic analysis indicate that the three main occupation units (levels G, F and D) correspond to temperate and humid interstadial phases with a rather open and rocky landscape (Kalai et al. 2001; Moncel et al. 2002, 2008c; Moncel and Chacon 2007; Moncel and Patou-Mathis 2008; Rivals et al. 2009; Rufà et al. 2016). Faunal and zooarchaeological studies indicate that human occupations were more intense in the oldest levels suggesting repeated seasonal human settlements in the cave in relation to game availability (Bouteaux 2003; Moncel and Patou-Mathis 2008; Moncel et al. 2008c; Rivals et al. 2009; Rufà et al. 2016).

3. Materials and methods

3.1. Materials

We aim to focus on the role of the lithic raw material properties on the discoid reduction sequences. For that, the lithic assemblage of Payre level D (e.g. Baena et al. 2017; Bouteaux et al. 2008; Moncel et al. 2009; Moncel and Chacon 2007) has been revised in a new technological point of view. The lithic assemblage is composed of 3044 artefacts made on different kinds of lithic raw materials (flint – 77,8%, basalt – 11,6%, quartz – 8,2%, quartzite – 1,5 %, limestone – 0,8%, others – 0,6%) gathered on the plateaus and along the right side of the Rhône Valley southwards and eastwards the site (Moncel and Chacon 2007; Moncel et al. 2008). Quartz, basalt, and limestone pebbles (grey, black, marly or siliceous) were collected downhill in the Payre river while quartzite and flint pebbles came from the Rhône Valley, less than 1 km from the site. Most of the flint used in level D was however collected in nodules from the plateau located 10 km south, in Barremian/Bedoulian formations, while a small number of flint nodules is from the Tithonian-Portlandian limestone of the cave (Moncel and Chacon 2007; Fernandes et al., 2008). Most of the raw materials were introduced in the site as entire or tested pebbles/nodules. Just basalt, quartzite, limestone and rarely quartz were occasionally introduced in the form of large flakes (Moncel and Chacon 2007; Bouteaux et al. 2008; Moncel et al., 2008b). Regarding basalt and local/semi-local flint, the reduction sequences are complete. Flint was mainly knapped to produce different kinds of flakes and the flakes often retouched to obtain mainly scrapers and convergent tools. Basalt was sometimes shaped in choppers and some pebbles were used as hammers (Moncel and Chacon 2007; Bouteaux et al. 2008; Moncel et al. 2009; Santagata et al., 2017). Quartzite is found in the site as large cutting tools and unretouched flakes, from shaping or rejuvenation of unifacial tools on large cortical flakes produced out of the site through simple knapping methods (Moncel and Chacon 2007; Bouteaux et al. 2008; Moncel et al. 2008b). Limestone flakes were obtained from either knapping or shaping large pebbles, which took place outside the site for most of them (Moncel and

Chacon 2007; Moncel et al., 2008b). Quartz artefacts are mostly obtained from discoidal and opportunistic/multidirectional cores. The low number of cores and debris indicates that it was partially knapped out of the site. According to the characteristics of the cortex, two types of blanks were collected: medium-sized rounded pebbles and big flakes or tabular fragments obtained from big pebbles. Just a few pieces are retouched in sidescrapers and convergent tools (Moncel and Chacon 2007; ; Moncel et al. 2008b). Local and semi-local flint are the main raw materials with an unifacial *débitage* on a surface secant to a cortical surface, not prepared. The *débitage* is function of the morphology of the support explaining the great variability of the management of flint and quartz cores (. The exploitation of each raw material depends on the mechanical features. Since quartz and flint products have similar modules, quartz is managed both as a supplementary raw material used in the same way than flint, or as a raw material used differently by its petrographic feature (Bouteaux et al. 2008; Moncel et al. 2008b). On the other hand, considering the reduction sequences and the characteristics of the products, quartzite is possibly a raw material with a specific function (Moncel et al. 2008b; Pedergnana et al. 2018). Since discoid reduction strategies are attested in Payre level D exclusively on flint and vein quartz, the paper focuses on technological analysis of these raw materials for a total of 2315 lithic implements (Tab.1).

3.2. Methods

The technological study is based on the concept of *chaîne opératoire*, including all the technical procedures necessary to satisfy specific needs and implemented by the knappers according to their own skills (Leroi-Gourhan 1964; Tixier 1978; Pelegrin et al. 1988; Geneste 1991). A first level of analysis has been the technological reading of each object (core, flake, retouched tool, debris). A second and additional level has been the authentication of the relationship of the different products of the *chaîne opératoire*. Two additional concepts are the foundation of this technological study: i.e. knapping technique and method (Tixier 1967; Inizan et al. 1995; Pelegrin 2000). For flakes, different technological features have been considered: characteristics of the butt and the ventral face, sizes, presence and types of knapping accidents. For vein quartz, we refer to specific papers about the knapping stigmata and rate and modalities of fragmentation (Mourre 1994, 1996; Cologne and Mourre 2006; de Lombera-Hermida 2009; Di Modica and Bonjean 2009; Tallavaara et al. 2010; Driscoll 2011; Manninen 2016).

Retouched tools have been classified according to the typological list developed by F. Bordes (1961). The direction of the scars on the upper face and the presence and the position of natural surfaces (cortex and/or neocortex) were used to identify the knapping methods and the phases of cores reduction. The definition of each method is based on Forestier (1993) for S.S.D.A. (*Système par surface de débitage alterné*) reduction sequences and on Boëda (1993) for the discoid method. For the discoid reduction sequences, other recent papers about its variability have been taken into account (Peresani 1998, 2003; Picin et al. 2014; Picin and Vaquero 2016; Romagnoli et al. 2016). Finally, regarding vein quartz artefacts, we applied the subdivision in morpho-structural groups developed by Martinez Cortizas and Llana Rodriguez (1996) and by de Lombera-Hermida et al. (2011). Vein quartz can be divided in four groups depending on the presence/absence of grains and planes (*i.e.* internal flaws or crystalline surfaces): NN (no grain, no planes), NS (no grain, planes), SN (grain, no planes), SS (grain, planes).

4. Results

The huge number of discoid cores and products on flint and vein quartz offers the chance to observe how this method was applied (Tab. 2) on these two stones with different petrographic and mechanical characteristics.

4.1. State of preservation

The state of preservation of the artefacts of Payre level D is not similar. Quartz artefacts show a general good state of preservation while several post depositional modifications affect flint

artefacts. This is due to the internal structure of flint and the different processes that lead to the formation of surface modifications on these raw materials, even under the same conditions (Venditti et al. 2016). The large presence of white patina on flint made sometimes difficult the reading of the knapping scars and for this reason some products have been classified as “indeterminate”.

4.2. Degree of fragmentation according to stones

The rate of fragmentation is higher for quartz than for flint products (Fig. 3). The internal structure of the raw materials plays a determining role, especially during the *débitage*. Bending and radial or Siret accidents are more common for quartz artefacts due to the presence of internal flaws and properties like its relatively low tensile and compressive strength (Cotterell and Kamminga 1990; Domanski et al. 1994; Mourre 1996; Tallavaara et al. 2010).

As mentioned before, quartz and flint show similar reduction sequences and on both two opportunistic core technologies, S.S.D.A. and discoid-type methods were mainly applied, followed by a rare on flint *débitage*-on-flake classifiable as Kombewa *s.l.* (Tab. 2). However, by its punctual nature and the regular use of large flakes for multidirectional or centripetal cores, these cores have finally been classified as opportunistic component.

4.3. Quality of quartz

Concerning quartz, the subdivision in morpho-structural groups (Martinez Cortizas and Llana Rodriguez 1996; de Lombera-Hermida et al. 2011) is useful to see if there was or not a technological choice according to particular specificities of the raw material and it was already applied to the entire sequence of Payre (de Lombera-Hermida et al. 2011). Its application just at level D allows appreciating the originality of this series (Tab. 3). Results indicate that a choice of a type of quartz is not related to a knapping method, but a general prevalence of the NS group is present (62%). As for the lower levels, the grainy types of quartz are barely present reflecting their scarcity in the surroundings of the site (de Lombera-Hermida et al. 2011). Nevertheless, at Payre level D, the presence of inner flaws and crystalline surfaces on quartz does not preclude the use of more complex reduction sequences (i.e. discoid method).

4.4. Variability of the knapping methods

The discoid reduction sequences indicate a variability of the method and the adaptation to the raw materials employed, even if unifacial and bifacial modalities are the main ones without significant differences whatever the raw materials.

Discoid flint cores always record more than one phase of exploitation and are often completely exhausted (Fig. 4). The core is rarely discarded before its complete exhaustion when a shaping of the core is needed to restore the convexities. The second phase of exploitation is characterized by the production of flakes with dimensional and morphological differences. The management of the core convexities is aimed to assure a continuous production of flakes with dimensional and morphological specificities (Slimak 2003, 2008). It continues by the detachment of “debordant” flakes, often with a chordal direction, or by the detachment of a centripetal, invasive flake that removes the central and too pronounced convexity (Fig. 5). The production phases mostly correspond to a series of centripetal removals with a *débitage* secant to the plan of intersection between the two core surfaces. The products are short and wide, often with a back to assure a good management of the core convexities and with convergent edges (Fig. 5).

Discoid bifacial cores on flint show no hierarchization of the two surfaces. Both are used as striking platform surface and knapping surface. In the last phase of the core exploitation, the surfaces are in four cases not equally convex and the *débitage* direction becomes parallel to the plan of intersection of the two surfaces (Fig. 4). For these four cores, the two surfaces seem to be hierarchized and flakes are at this final stage produced only from one of the surfaces that progressively becomes flatter and flatter. The result is an asymmetrical core with a clear distinction between knapping

surface and striking platform. The hypothesis of the non-hierarchization of the core surfaces during the previous exploitation phases can be based on the features of the removals present on the surface which became a striking platform: the removals are invasive and centripetal with sizes and morphological characteristics not different from removals belonging to the full debitage stages (see fig. 4). When a preparation of the striking platform is visible, it consists of small and not-invasive centripetal removals. .
Sometimes, a third surface, perpendicular to the two others, is exploited by one elongated flake (Fig. 4). Due to the intensive exploitation of these cores, it is difficult to observe the presence of natural surfaces to identify what types of pebbles/big flakes were considered as suitable for the *débitage*.
Unifacial flint cores are common and often on the ventral face of large flakes (Fig. 4). . As for bifacial cores, the exploitation aims the production of short and thick flakes mainly through a centripetal direction (N = 67 – 56,8%). The flakes are often "debordant" (N = 31 – 26,3%), helping the management of the core convexities. The striking platform is prepared by small and not invasive centripetal removals and sometimes it is left natural. Even in this case, a choice of blanks with suitable convexities is obvious to immediately start the phase of production of flakes.

Quartz discoid cores show above all one phase of exploitation, except for one core, and short reduction sequences (Fig. 6). All the cores are discarded before their total exhaustion probably because of inner flaws and crystalline surfaces which makes difficult the management of the core convexities and the control of the knapping (Mourre 1996; de Lombera-Hermida et al. 2011; Driscoll 2011). Natural surfaces, i.e. neocortex, are often still visible on the cores attesting the collecting of round and oval pebbles with a suitable morphology for a discoid exploitation. As for flint, both bifacial and unifacial exploitation are used. The production starts directly from the natural surface of the pebbles and proceeds with centripetal removals, sometimes backed and often few invasive. Considering the shortness of the reduction sequences on quartz, the presence of backed removals could have a different meaning than for flint. As described before, on flint discoid cores, "debordant" flakes are useful for the core management and aimed to guarantee a continuous production of flakes (Slimak 2003, 2008) without re-sharpening core convexities. On quartz cores, where the exploitation is for the overwhelming majority limited to a single series of flakes, the presence of "debordant" flakes seems to be due more to the quality of quartz than to an intentional gesture. The products obtained are short and thick with common morphological characteristics with flint (Fig. 7).

4.5. Products from a discoid technology

Quartz and flint products from a discoid *débitage* have been identified by comparison with cores by the direction of the scars and sizes.
As observed on discoid cores, the centripetal organization was the main strategy used to produce short and thick flakes, while few removals indicate orthogonal scars related to a multidirectional exploitation of the core surfaces. The *débitage* is almost exclusively secant regard to the plan of intersection between the two core surfaces. In four cases, at the end of the exploitation, it becomes parallel. Only the complete/uncomplete products consistent with these characteristics and the fragmented products consistent with at least one of them have been identified as discoid flakes. Results show that flint and quartz cores were exploited in similar ways, even if flint was exploited more intensively than quartz cores, confirmed by the number of scars on the flakes (two or three for quartz, usually more than three for flint).
Slight differences between quartz and flint in core shaping and management are on the other hand visible on the characteristics of the butts of the discoid flakes (Tab. 4). On flint flakes are present, even if sporadic, faceted and dihedral butts, evidence of a preparation of the striking platform or of the presence of more than one phase of exploitation. For both quartz and flint products, butts are mainly flat , confirming that the exploitation starts mostly from cortical and natural surfaces.

About the sizes of the discoid products, compared with those of the products issued from opportunistic/S.S.D.A. reduction sequences (Fig. 8), we see that the discoid method was employed to produce shorter and wider flakes than the opportunistic/S.S.D.A. products. The characteristics of the products are in both cases clearly impacted by the morphology of pebbles and flakes selected for cores. However, it seems that the method influenced the choice of the raw materials to be collected and not the opposite.
Retouch is often used to modify or rejuvenate the edges of tools issued from the different knapping methods, particularly to obtain or modify convergent edges, i.e. convergent scrapers (Moncel and Chacon 2007; Moncel et al. 2009) with a sporadic evidence of denticulates and notches. Retouch was partially carried out in the site, as confirmed by the presence of 34 small flakes linked to rejuvenation or modification of tools 'edges.

5. Discussion

Level D represents the final and recent phase of human occupation of the site of Payre. The lithic assemblage is characterized by the use of different local and semi-local raw materials and by a technological variability that allow to make some considerations on some features of the discoid *débitage*.

5.1. Technological comparison with the lower levels

If the raw materials and the territory are similar between the different levels, (Moncel et al. 2002; Fernandes et al. 2006, 2008), from a technological point of view some remarks can be made. The lithic assemblages from levels F and G (e.g. Baena et al., 2017; Moncel et al., 2009, 2008b) have recently been subject to a new technological analysis (Carmignani et al. 2017) which highlights the peculiarities of the reduction sequences adopted. Quartz cores are very sporadic in these levels, one from level Fa and six from level Ga (Carmignani et al. 2017).
In the lower levels of the sequence, the centripetal method is widely attested and mainly conducted by centripetal and chordal removals each of them participating in the maintenance of the core convexities as observed in level D (Baena et al. 2017; Carmignani et al. 2017). The main differences between the core technology of level D and the lower levels concern the presence, in levels G and F, of a "peripheral parallel plans exploitation" strategy and the presence of some cores with secant centripetal removals limited to one side of the core, resulting of some uncertainties in the attribution to a discoid conception (Carmignani et al. 2017). In level D, the centripetal exploitation of flint cores corresponds clearly to the classical discoid concept defined by Boëda (1993). The *débitage* is made by centripetal removals, secant to the plan of intersection of the two core surfaces. Flint cores are intensively flaked and even when they are discarded before their total exhaustion, no part of the volume appears unexploited (Fig. 4). Only in the final phase, the *débitage* becomes in four examples almost parallel to the plan of intersection of the two core surfaces, one being the striking platform while the other becomes the knapping surface (Fig. 4). In these cases, the discoid method is more difficult to assess because close to a Levallois reduction strategy (Boëda 1994). Even though, the lack of phases of shaping or re-shaping of the core convexities, the *débitage* stays still generally secant and the absence of products with unquestionable Levallois features (Boëda 1994) suggests a final phase of a discoid reduction strategy.

5.2 Remarks on discoid exploitation strategies

According to the criteria listed by Boëda (1993), discoid cores should group six criteria for core geometry and shaping, hierarchization of the surfaces, *débitage* direction and technique of percussion. The debate about the effectiveness of these criteria is still ongoing and within the discoid method a high variability is recognized, questioning its status of predetermined method (e.g. Bourguignon et al., 2004; Carmignani et al., 2017; Delpiano and Peresani, 2017; Faivre, 2011; Martinez Lorenzo et al., 2014; Martínez Molina et al., 2006; Pasty, 2000; Peresani, 2003, 1998; Picin et al., 2014; Romagnoli et al., 2016; Thiébaut et al., 2012; Turq et al., 2013).

The analysis of the lithic assemblage of Payre level D contributes to one aspect of this broad debate: the concept of hierarchization of the core surfaces. In the Levallois method there is a clear distinction between the striking platform and the flaking surface, which deeply differ from each other in their geometry and general morphology (Boëda 1994). In the discoid *débitage*, the two surfaces are not hierarchized, both knapping surface and striking platform (Boëda 1993;). Nevertheless, at Payre, at the end of the core exploitation, each surface has in four cases a precise role. In these cases, we are face to a hierarchization of the core surfaces, as well as we do when unifacial discoid cores are considered. It explains difficulties to attribute these cores to a discoid or a Levallois reduction sequence. According to several authors, the hierarchization of the core surfaces is again one of the main criteria to distinguish the two methods despite their great variability (*i.e.* Boëda 1993; Pasty 2003; Vaquero and Carbonell 2003). Considering the lithic assemblage of Payre level D, the concept of hierarchization of the core surfaces seems to be completely absent. Beside an opportunistic/S.S.D.A. exploitation, flint cores are exploited according to a discoid scheme with centripetal and chordal removals obtained from a peripherical striking platform. When the cores are almost exhausted, all the flakes are detached from one of the core surfaces. Since this kind of hierarchization of the surfaces is not intentional but due to the wish to increase the productivity, we should not talk of hierarchized surfaces when describing these cores. It is similar for unifacial discoid cores, when one surface flaked by centripetal or chordal removals can be considered as an opportunistic behaviour due to the raw material morphology and sizes (Brenet and Folgado 2003; Terradas 2003) . The exploitation of just one surface during the whole reduction sequence or just in its last phase is not different conceptually from the opening of a third *débitage* surface perpendicular to the others at the end of the exploitation. Two surfaces should be considered as hierarchized when their roles are clear since the beginning of the core exploitation.

5.3. Quartz discoid cores

Different considerations have to be made about quartz cores, since the knapping methods employed are strongly conditioned by its response to knapping, which is determined by its petrographic features (Mourre 1996, 1994; Martinez Cortizas and Llana Rodriguez 1996; Cologne and Mourre 2006; Degorce and Castel 2006; Driscoll 2011; Arzarello et al. 2012; Daffara et al. 2014; Berruti et al. 2016; de Lombera-Hermida and Rodríguez-Rellán 2016; Manninen 2016). Discoid quartz cores in Payre level D show just one phase of exploitation, exception made for one core, thus giving the chance to observe the entire exploitation of these cores (Fig. 6), differently from what happens with flint cores that are intensively exploited. The shortness of the discoid reduction sequences, together with the frequent presence of natural surfaces highlights that, for quartz, the choice of blanks with a suitable morphology was far away more important than for flint. Moreover, the dimensional and morphological characteristics of the products are more determined by the core natural convexities than by the previous removals, which is the greater difference between quartz and flint discoid reduction sequences observed in Payre level D. On the other hand, the general characteristics of the discoid reduction sequences on quartz, allow to refer them, together with flint cores, to the classical discoid concept (Boëda 1993) since we observe a bifacial or unifacial exploitation of cores with two surfaces, equally convex, through removals secant with regards to the plan of intersection of the two surfaces and directed toward the middle of the core.

In conclusion, the main differences between flint and quartz discoid reduction sequences in Payre level D are determined by the petrographic characteristics of the raw materials but a differential exploitation between them is not attested (Fig. 9): in this lithic assemblage quartz is a complementary raw material, used in the same way as flint for the production of flakes with the wanted dimensional and morphological characteristics and with some adaptation (shortness of the reduction sequences, frequent exploitation of natural surfaces) necessary for the application of the discoid concept to this lithic raw material. If compared to the lithic assemblages of the lower levels (units G and F), we observe, all along the sequence, the acquisition of a discoid concept, going from

partial centripetal exploitation of the core volume to the bifacial and intense exploitation of the entire core. In addition, in level D the discoid method is systematically applied also on vein quartz through some expedients which testify the great knowledge not only of the raw material properties but also of the discoid method itself.

6. Conclusions

The technological analysis of the discoid component of the lithic assemblage of Payre level D highlights some features that can be interpreted as adaptation to the petrographic and mechanical features of the raw materials. While flint allows long production sequences and a good management of the core convexities, the vein quartz *débitage* is strongly affected by the presence of inner flaws and grains. Beside the aim of the discoid *débitage* at Payre level D, the process does not change according to the raw material and in both cases, it is all about the production of short and large flakes. Some characteristics of the discoid method on vein quartz cores and flakes could be referred to adaptation strategies to the raw material specificities: i.e. the shortness of the production phases and the general low technological investment visible by the lack of management of the core convexities. For vein quartz, the choice of blanks with natural suitable surfaces is much more important than for flint. The role of the core sizes on the characteristics of the discoid products is higher for vein quartz. Despite the apparent simplicity of vein quartz discoid reduction strategies, the evaluation of the technological rules used to adapt the discoid volumetric and geometric concept (Boëda 1993) to this raw material suggests that detailed studies on this "second rate" raw material would be useful. They should provide considerations about the technological strategies and skills of Middle Palaeolithic knappers.

References

Arzarello M, Daffara S, Berruti G, et al (2012) The mousterian settlement in the ciota ciara cave: The oldest evidence of homo neanderthalensis in piedmont (Northern Italy). Journal of Biological Research (Italy). doi: 10.4081/jbr.2012.4068

Baena-Preysler J, Carrion-Santafé E, Requejo-Lopez V (2003) Recent discoveries of Discoid industries in Western Cantabria (North Spain). In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 117–126

Baena J, Carrión E, Cuartero F, Fluck H (2012) A chronicle of crisis: The Late Mousterian in north Iberia (Cueva del Esquilleu, Cantabria, Spain). Quaternary International 247:199–211. doi: 10.1016/j.quaint.2011.07.031

Baena J, Moncel M-H, Cuartero F, et al (2017) Late Middle Pleistocene genesis of Neanderthal technology in Western Europe: The case of Payre site (south-east France). Quaternary International 436:212–238. doi: 10.1016/j.quaint.2014.08.031

Berruti GLF (2017) Use-wear analysis of discoid-conception lithic industries. International Doctorate in Quaternary and Prehistory (IDQP)

Berruti GLF, Bertè DF, Caracausi S, et al (2016) New evidence of human frequentations in the western Alps: The project "Survey Alta Valsessera (Piedmont–Italy)." Quaternary International 402:15–25. doi: http://dx.doi.org/10.1016/j.quaint.2015.10.073

Berruti GLF, Cura S (2016) Use wear analysis of quartzite lithic implements from the Middle Palaeolithic site of Lagoa do Bando (Central Portugal). Journal of lithic studies 3:1–24. doi: 10.2218/jls.v3i2.1400

Blaser F, Kurtanjek D, Paunovic M (2002) L 'industrie du site néandertalien de la grotte de Vindija (Croatie): une révision des matières premières lithiques. L'Anthropologie 106:387–398. doi: 10.1016/S0003-5521(02)01118-4

Boëda E (1993) Le débitage discoïde et le débitage Levallois récurrent centripète. Bulletin de la Société préhistorique française 90:392–404

Boëda E (1994) Le concept Levallois: variabilité des méthodes. Archéo éditions
Bons PD (2001) The formation of large quartz veins by rapid ascent of fluids in mobile hydrofractures. Tectonophysics 336:1–17. doi: 10.1016/S0040-1951(01)00090-7
Bordes F (1961) Typologie du Paléololithique ancien et moyen
Bourguignon L, Faivre J-P, Turq A (2004) Ramification des chaînes opératoires: une spécificité du Moustérien? Paléo 16:37–48
Bouteaux A (2003) Etude archéozoologique du site de Payre en Ardèche. In: Patou-Mathis M, Bocherens H (eds) Le role de l'environnement dans les comportements des chasseurs-cueilleurs préhistorique. Archaeopress, Oxford, pp 99–110
Bouteaux A, Julien M-A, Moncel M-H, Chacon-Navarro MG (2008) L'ensemble ou unité archéostratigraphique D. In: Moncel M-H (ed) Le site de Payre. Occupations humaines dans la vallée du Rhone à la fin du Pléistocene moyen et au début du Pléistocène supérieur. Mémoire de la Société Prhistorique Francaise, pp 243–265
Brenet M, Bourguignon L, Folgado M, Ortega I (2009) Élaboration D'un Protocole D'expérimentation Lithique Pour La Compréhension Des Comportements Techniques et Techno Économiques Au Paléolithique Moyen. Les Nouvelles de L'archéologie 118:60–64
Brenet M, Folgado M (2003) Le débitage Discoide du gisement des Forets a Saint-Martin de Gurçon (Dordogne). In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 153–178
Carbonell E, Canals A, Sauceda I, et al (2005) La grotte de Santa Ana (Cáceres, Espagne) et l'évolution technologique au Pléistocène dans la Péninsule ibérique. L' Anthropologie 109:267–285. doi: 10.1016/j.anthro.2005.04.016
Carmignani L, Moncel M-H, Fernandes P, Wilson L (2017) Technological variability during the Early Middle Palaeolithic in Western Europe. Reduction systems and predetermined products at the Bau de l'Aubesier and Payre (South-East France)
Cauche D (2007) Les cultures moustériennes en Ligurie italienne: analyse du matériel lithique de trois sites en grotte. L'Anthropologie 111:254–289. doi: 10.1016/j.anthro.2007.05.002
Collina-Girard J (1997) Les outillages sommaires sur supports naturels tenaces (quartz et quartzites). Technomorphologie et évolution psychique. In: Bracco, J.P. (Ed.),. In: Bracco J. (ed) L'exploitation du quartz au Paléolithique. Première table ronde, Préhistoire Anthropologie Méditerranéennes. Aix-en-Provence 18-19 Avril 1996. Éditions du CNRS, pp 210–226
Cologne D, Bruxelles L, Jamois M-H, Chevreuse F (2009) Périché (Verneuil-sur-Venne, Haute-Vienne), un gisement Paléolithique moyen en Limousin cristallin. Mémoire de la Société préhistorique française XLVII:151–171
Cologne D, Mourre V (2006) Quartzite et quartzites: aspects petrographiques, economiques et technologiques des materiaux majoritaires du Paleolithique ancien et moyen du sud-ouest de la France. In: Grimaldi S, Cura S (eds) Technological analysis on quartzite exploitation. Proceedings of the XV UISPP World Congress (Lisbon, 4-9 September 2006). BAR International Series 1998. Archaeopress
Cotterell B, Kamminga J (1990) Mechanics of pre-industrial technology : an introduction to the mechanics of ancient and traditional material culture. Cambridge University Press
Cura S (2003) Matière première et variabilité technologique au Paléolithique Moyen Portugais: l'example du site Sapateiros 2 (Baixo Alentejo, Portugal). Université Paris 1
Cura S, Grimaldi S (2009) The quartzite exploitation in a middle Pleistocene open air site: Ribeira da Ponte da Pedra (central Portugal). In: Grimaldi S, Cura S (eds) Technological analysis on quartzite exploitation. Proceedings of the XV UISPP World Congress (Lisbon, 4-9 September 2006). BAR International Series 1998. Archaeopress, pp 49–56
Daffara S, Arzarello M, Berruti GLF, et al (2014) The Mousterian lithic assemblage of the Ciota Ciara cave (Piedmont, Northern Italy): exploitation and conditioning of raw materials. Journal of Lithic Studies 1:63–78. doi: 10.2218/jls.v.1102
de Lombera-Hermida A (2009) The Scar Identification of Lithic Quartz Industries. In: Sternke F,

Eigeland L, Costa LJ (eds) Non-Flint Raw Material Use in Prehistory . Old prejudices and new directions. BAR International Series. Archaeopress, Oxford
de Lombera-Hermida A, Rodríguez-Rellán C (2016) Quartzes matter. Understanding the technological and behavioural complexity in quartz lithic assemblages. Quaternary International 424:2–11. doi: 10.1016/j.quaint.2016.11.039
de Lombera-Hermida A, Rodríguez XP, Fábregas R, Moncel M-H (2011) La gestion du quartz au Pléistocène moyen et supérieur. Trois exemples d'Europe Méridionale. L' Anthropologie 115:294–331. doi: 10.1016/j.anthro.2011.02.003
Degorce J, Castel J (2006) La gestion des quartz diaclasés de l'Albigeois cristallin (Tarn) au Paléolithique moyen. Bulletin de la société préhistorique française 103:233–239
Delagnes A, Meignen L (2006) Diversity of Lithic Production Systems During the Middle Paleolithic in France. Are there any chronological Trends? In: Hoverrs E, Kuhn S (eds) Transitions before the transition: evolution and stability in the Middle Paleolithic and Middle Stone Age. Springer Science & Business Media, pp 85–107
Delagnes A, Rendu W (2011) Shifts in Neandertal mobility, technology and subsistence strategies in western France. Journal of Archaeological Science 38:1771–1783. doi: 10.1016/j.jas.2011.04.007
Delpiano D, Peresani M (2017) Exploring Neanderthal skills and lithic economy. The implication of a refitted Discoid reduction sequence reconstructed using 3D virtual analysis. Comptes Rendus - Palevol 16:865–877. doi: 10.1016/j.crpv.2017.06.008
Di Modica K, Bonjean D (2009) The exploitation of quartzite in Layer 5 (Mousterian) of Scladina cave (Wallonia, Belgium): flexibility and dynamics of concepts of debitage in the Middle Palaeolithic. In: Grimaldi S, Cura S (eds) Technological analysis on quartzite exploitation. Proceedings of the XV UISPP World Congress (Lisbon, 4-9 September 2006). BAR International Series 1998. Archaeopress, pp 33–41
Domanski M, Webb JA, Boland J (1994) Mechanical properties of stone artefact materials and the effect of heat treatment. Archaeometry 36:177–208. doi: 10.1111/j.1475-4754.1994.tb00963.x
Driscoll K (2011) Vein quartz in lithic traditions: An analysis based on experimental archaeology. Journal of Archaeological Science 38:734–745. doi: 10.1016/j.jas.2010.10.027
Ecker M, Bocherens H, Julien M-A, et al (2013) Middle Pleistocene ecology and Neanderthal subsistence : Insights from stable isotope analyses in Payre (Ardèche, southeastern France). Journal of Human Evolution 65:363–373. doi: 10.1016/j.jhevol.2013.06.013
Eren MI, Lycett SJ (2016) A statistical examination of flake edge angles produced during experimental lineal Levallois reductions and consideration of their functional implications. Journal of Archaeological Method and Theory 23:379–398
Faivre J-P (2011) Organisation techno-économique des industries du paléolithique moyen récent dans le nord-est aquitain. Archaeopress, Oxford
Fernandes P, Raynal J-P, Moncel M-H (2006) L 'espace minéral au Paléolithique moyen dans le Sud du Massif central : premiers résultats pétroarchéologiques. Comptes Rendus - Palevol 5:981–993. doi: 10.1016/j.crpv.2006.09.009
Fernandes P, Raynal JP, Moncel M-H (2008) Middle Palaeolithic raw material gathering territories and human mobility in the southern Massif Central, France: first results from a petro-archaeological study on flint. Journal of Archaeological Science 35:2357–2370. doi: 10.1016/j.jas.2008.02.012
Forestier H (1993) Le Clactonien: mise en application d 'une nouvelle méthode de débitage s'inscrivant dans la variabilité des systèmes de production lithique du Paléolithique ancien. Paléo 5:53–82. doi: 10.3406/pal.1993.1104
Geneste J-M (1991) Systèmes techniques de production lithique: variations techno-économiques dans le processus de réalisation des outillages paléolithiques. Techniques et culture 17–18:1–36. doi: 10.4000/tc.5013
Gibaja JF, Clemente I, Mir A (2002) Análisis funcional en instrumentos de cuarcita: el yacimiento

del paleolítico superior de la Cueva de la Fuente del Trucho (Colungo, Huesca). In: Análisis Funcional: su aplicación al estudio de sociedades prehistórica. pp 79–86
Hardy BL, Moncel M-H (2011) Neanderthal use of fish, mammals, birds, starchy plants and wood 125-250,000 years ago. PLoS ONE 6:0–9. doi: 10.1371/journal.pone.0023768
Inizan M, Reduron-Ballinger M, Roche H, Tixier J (1995) Technologie de la pierre taillée. CREP, Nanterre
Janot A (1988) Paléolithique inférieur et moyen de Lorraine, originalité des industries à quartzites. Bulletin de la Société préhistorique française 85:291–303. doi: 10.3406/bspf.1988.9861
Jaubert J, Kervazo B, Bahain J-J, et al (2005) Coudoulous I (Tour-de-Faure, Lot), site du Pléistocène moyen en Quercy: bilan pluridisciplinaire. BAR International Series 1364:227–251
Kalai C, Moncel M-H, Renault-Miskovsky J (2001) Le Paléoenvironnement végétal des occupations humaines de la grotte de Payre à la fin du Pléistocène moyen et au début du Pléistocène supérieur (Ardèche, France). Trabajos de Prehistoria 58:143–151
Knutsson K (2014) 'Simple' need not mean 'archaic.' Antiquity 88:950–953. doi: 10.1017/S0003598X00050894
Kuhn SL (1994) Formal Approach to the Design and Assembly of Mobile Toolkits. American Antiquity 59:426–442
Lamotte A, Huguenin G, Campy M, et al (2014) Frettes (Haute-Saône, France): un gisement de plein-air du paléolithique moyen, premiers résultats. L'Anthropologie 118:449–475. doi: 10.1016/j.anthro.2014.10.005
Lazuén T, Fábregas R, Lombera A, Rodríguez XP (2011) La gestión del utillaje de piedra tallada en el Paleolítico Medio de Galicia. El nivel 3 de Cova Eirós (Triacastela, Lugo). Trabajos de Prehistoria 68:237–258. doi: 10.3989/tp.2011.11068
Lemorini C, Peresani M, Rossetti P, et al (2003) Techno-Morphological and Use-Wear Funtional Analysis: An Integrated Approach to the Study of a Discoid Industry. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, pp 257–275
Leroi-Gourhan A (1964) Le geste et la parole. Albin Michel, Paris
Manninen MA (2016) The effect of raw material properties on flake and flake-tool dimensions: A comparison between quartz and chert. Quaternary International 424:24–31. doi: 10.1016/j.quaint.2015.12.096
Martinez Cortizas A, Llana Rodriguez C (1996) Morphostructural variables and the analysis of their effect on quartz blank characteristics. In: Moloney N, Raposo L, Santonja M (eds) Non-Flint Stone Tools and the Palaeolithic Occupation of the Iberian Peninsula. Archaeopress, Oxford, pp 49–53
Martinez Lorenzo M, Bordes J-G, Jaubert J (2014) L'industrie lithique du Paléolithique moyen récent de Roc de Combe (Payrignac, Lot, France), un nouvel exemple de Moustérien Discoïde à denticulés. Paléo 25:1–24
Martínez Molina K, García Garriga J, Bargalló Ferrerons A, et al (2006) Un taller singular del paleolític mitjà: el jaciment del Puig Marí (Maçanet de la Selva, Girona):nuevas aportacions als mètodes de talla discoide i levallois. Cypsela 16:111–125
Matilla K (2005) L'industrie sur galet de La Chaise-de-Vouthon, Charente: synthèse des résultats. L' Anthropologie 109:481–498. doi: 10.1016/j.anthro.2005.06.014
Menras C (2009) Les industries lithiques de trois occupations de plein air et leur place dans le contexte Moustérien du Languedoc méditerranéeen: Le Cadénas (Bédarieux, Hérault), Les Cours (Plaissan, Hérault) et Le Serre du Coucouyon (La Capelle et Masmolène, Gard). L'Anthropologie 113:381–398. doi: 10.1016/j.anthro.2009.04.001
Moncel M-H (1993) Le site de Payre (Commune de Rompon, Ardèche): une occupation humaine du Paleolithique moyen ancien. Quaternaire 4:149–157. doi: 10.3406/quate.1993.2005
Moncel M-H, Auguste P, Bahain J-J, et al (2008a) Le cadre paléoenvironnemental des occupations humaines du site de Payre et implications sur le type d'occupation. In: Moncel MH (ed) Le site

de Payre. Occupations humaines dans la vallée du Rhone à la fin du Pléistocene moyen et au début du Pléistocène supérieur. Mémoire de la Société Prhistorique Francaise, pp 269–279
Moncel M-H, Borel A, de Lombera-Hermida A, et al (2008b) Quartz et quartzite dans le site de Payre (MIS 7 et 5, Ardèche, France): données techno-économiques sur la gestion de roches locales au Paléolithique moyen. Comptes Rendus - Palevol 7:441–451. doi: 10.1016/j.crpv.2008.07.004
Moncel M-H, Brugal JP, Prucca A, Lhomme G (2008c) Mixed occupation during the Middle Palaeolithic: Case study of a small pit-cave-site of Les Pêcheurs (Ardèche, south-eastern France). Journal of Anthropological Archaeology 27:382–398. doi: 10.1016/j.jaa.2008.03.005
Moncel M-H, Chacon MG (2007) Contribution to the understanding of Neanderthal technical behaviour during the end of OIS 6 and late interglacial (OIS 5) in Southern Europe: the lithic assemblage of upper level in the site of Payre (Rhone valley, Sotheastern France). Eurasian Prehistory 5:
Moncel M-H, Chacón MG, Coudenneau A, Fernandes P (2009) Points and convergent tools in the European Early Middle Palaeolithic site of Payre (SE, France). Journal of Archaeological Science 36:1892–1909. doi: 10.1016/j.jas.2009.04.018
Moncel M-H, Chacón Navarro MG, La Porta A, et al (2014) Fragmented reduction processes: Middle Palaeolithic technical behaviour in the Abri du Maras shelter, southeastern France. Quaternary International 350:180–204. doi: 10.1016/j.quaint.2014.05.013
Moncel M-H, Condemi S (1996) Découverte de dents humaines dans le site Paléolithique moyen de Payre (Ardèche): Comptes Rendus de l'Académie de Sciences 322:251–257
Moncel M-H, Condemi S (1997) Des restes humains dans le site Paléolithique moyen ancien de Payre (Ardèche): dents et pariétal. Nouvelles découvertes de 1996. Bulletin Societé Préhistorique Francaise 94:168–171. doi: 10.3406/bspf.1997.10874
Moncel M-H, Daujeard C (2012) The variability of the Middle Palaeolithic on the right bank of the Middle Rhône Valley (southeast France): Technical traditions or functional choices? Quaternary International 247:103–124. doi: 10.1016/j.quaint.2010.10.030
Moncel M-H, Debard É, Desclaux E, et al (2002) Le cadre de vie des hommes du Paléolithique moyen (stades isotopiques 6 et 5) dans le site de Payre (Rompon, Ardèche): d'une grotte à un abri-sous-roche effondré. Bulletin de la Societé Préhistorique Française 99:249–275
Moncel M-H, Fernandes P, Chacón Navarro MG, et al (2013) Émergence et diversification des stratégies au Paléolithique moyen ancien (350 000 à 120 000 ans) dans la vallée u Rhône (France). Les sites d'Orgnac 3 et Payre. In: Jaubert J, Fourment N, Depaepe P (eds) Transitions, ruptures et continuité durant la Préhistoire, actes du XXVIIe Congrès préhistorique de France (Bordeaux-Les Eyzies, 2010). pp 59–79
Moncel M-H, Lhomme G (2007) Les assemblages lithiques des niveaux du Paléolithique moyen de l'Abri des Pêcheurs (Ardèche, Sud-Est de la France). Des occupations néandertaliennes récurrentes dans un «fossé ». L' Anthropologie 111:211–253. doi: 10.1016/j.anthro.2007.05.001
Moncel M-H, Patou-Mathis M (2008) Les différentes phases d'occupations humaines à Payre et hypothèses sur les types d'occupation. In: Moncel M-H (ed) Le site de Payre. Occupations humaines dans la vallée du Rhone à la fin du Pléistocene moyen et au début du Pléistocène supérieur. Mémoire de la Société Prhistorique Francaise, pp 309–315
Mora R, de la Torre I, Martìnez-Moreno J (2004) Middle Palaeolithic mobility and land use in the southwestern Pyrenee: the example of Level 10 in La Roca del Bous (Noguera, Catalunya, northeast Spain). In: Conrad N (ed) Settlement Dynamics of the Middle Paleolithic and Middle Stone Age. Volume II. Kerns Verlag, Tübingen, pp 415–435
Mourre V (1996) Les industries en quartz au Paléolithique. Terminologie, méthodologie et technologie. Paléo 8:205–223. doi: 10.3406/pal.1996.1160
Mourre V (2003) Discoide ou pas Discoide? Réflexions sur la pertinence des critères technique définissant le débitage Discoide. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 1–18
Mourre V (1994) Les industries en quartz au Paléolithique moyen. Approche technologique de séries

du Sud-Ouest de la France. Université de Paris X
Mourre V, Thiébaut C (2008) L'industrie lithique du Moustérien final de la Grotte du Noisetier (Fréchet-Aure, Hautes-Pyrénées) dans le contexte des Pyrénées centrales françaises. Traballs d'Arqueologia 14:87–104
Nicoud É (2010) Les chaînes opératoires sur galets en roches volcaniques et quartz dans l'industrie lithique du gisement Moustérien de champ grand (Saint-Maurice-sur-Loire, Loire). PALEO Revue d'archéologie préhistorique spécial:107–122
Ollé A, Pedergnana A, Fernandez-Marchena J, et al (2016) Microwear features on vein quartz, rock crystal and quartzite: A study combining Optical Light and Scanning Electron Microscopy. Quaternary International 424:154–170. doi: 10.1016/j.quaint.2016.02.005
Ortega D, Maroto J (2001) Matières premières et technologie lithique du Moustérien final de la grotte des Ermitons (Pyrénées Méditerranéennes). In: Aubry T, Carvalho AF (eds) Les premiers hommes modernes de la Péninsule Ibérique. Actes du Colloque de la Commission VIII de l'UISPP. Vila Nova de Foz Coa, 1998. Instituto Português de Arqueologia, pp 69–76
Pasty J-F (2000) Le gisement Paléolithique moyen de Meillers (Allier): un exemple de la variabilité du débitage Discoïde. Bulletin de la Société préhistorique française 97:165–190. doi: 10.3406/bspf.2000.11085
Pasty J-F (2003) Le débitage Discoide au Paléolithique moyen en Auvergne (France): une variabilité attendue. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 179–192
Pedergnana A, Ollé A, Borel A, Moncel MH (2018) Microwear study of quartzite artefacts: preliminary results from the Middle Pleistocene site of Payre (South-eastern France). Archaeological and Anthropological Sciences 10:369–388. doi: 10.1007/s12520-016-0368-2
Pelegrin J (2000) Les technique de débitage laminaire au Tardiglaciaire: critère de diagnose et quelques réflexions. Memoires du Musèe de Prehistoire d'Ile de France 7:73–86
Pelegrin J, Karlin C, Bodu P (1988) «Chaînes opératoires»: un outil pour le préhistorien. Technologie préhistorique. Notes et Monographies techniques. 25
Peresani M (1998) La variabilité du débitage discoïde dans la grotte de Fumane (Italie du Nord)/The variability of discoid production at the grotte de Fumane. Paléo 10:123–146. doi: 10.3406/pal.1998.1133
Peresani M (ed) (2003) Discoid Lithic Technology: Advances and Implications. BAR International Series 1120. Archaeopress
Picin A, Vaquero M (2016) Flake productivity in the Levallois recurrent centripetal and discoid technologies: New insights from experimental and archaeological lithic series. Journal of Archaeological Science: Reports 8:70–81. doi: 10.1016/j.jasrep.2016.05.062
Picin A, Vaquero M, Weniger GC, Carbonell E (2014) Flake morphologies and patterns of core configuration at the Abric Romaní rock-shelter: A geometric morphometric approach. Quaternary International 350:84–93. doi: 10.1016/j.quaint.2014.05.004
Rivals F, Moncel M-H, Patou-Mathis M (2009) Seasonality and intra-site variation of Neanderthal occupations in the Middle Palaeolithic locality of Payre (Ardèche, France) using dental wear analysis. Journal of Archaeological Science 36:1070–1078. doi: 10.1016/j.jas.2008.12.009
Rodríguez-Alvarez XP (2016) The use of quartz during the Lower Palaeolithic in northeastern Iberia. Quaternary International 424:69–83. doi: 10.1016/j.quaint.2016.01.022
Rodriguez XP (2004) Technical systems of lithic production in the Lower and Middle Pleistocene of the Iberian Peninsula. Technological variability between north-eastern sites and Sierra de Atapuerca sites. BAR International Series 1323. Archaeopress, Oxford
Romagnoli F, Bargalló A, Chacón MG, et al (2016) Testing a hypothesis about the importance of the quality of raw material on technological changes at Abric Romaní (Capellades, Spain): Some considerations using high-resolution techno-economic perspective. Journal of lithic studies 3:. doi: 10.2218/jls.v4i2.1443
Rufà A, Blasco R, Roger T, Moncel M-H (2016) What is the taphonomic agent responsible for the

avian accumulation? An approach from the Middle and early Late Pleistocene assemblages from Payre and Abri des Pêcheurs (Ardèche, France). Quaternary International 421:46–61. doi: 10.1016/j.quaint.2015.05.016

Santagata C., Moncel M. H., Raynal J. P. (2017) Neanderthals and volcanic rocks. Opportunistic behaviour or optimized management?. Comptes Rendus Palevol 16(4): 474-487.

Slimak L (2003) Les débitages Discoide moustériens: évaluation d'un concept technologique. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 33–66

Slimak L (2008) Sur un point de vue heuristique concernant la production et la transformation de support au Paléolithique moyen. Gallia Préhistoire 50:1–22

Tallavaara M, Manninen M a., Hertell E, Rankama T (2010) How flakes shatter: A critical evaluation of quartz fracture analysis. Journal of Archaeological Science 37:2442–2448. doi: 10.1016/j.jas.2010.05.005

Terradas X (2003) Discoid flaking method: conception and technological variability. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, Oxford, pp 19–32

Thiébaut C, Claud É, Deschamps M, et al (2013) Diversité des productions lithiques du Paléolithique moyen récent (OIS 4-OIS 3): enquête sur le rôle des facteurs environnementaux, fonctionnels et culturels. In: Jaubert J, Fourment N, Depaepe P (eds) Transitions, ruptures et continuité durant la Préhistoire, actes du XXVIIe Congrès préhistorique de France (Bordeaux-Les Eyzies, 2010). pp 281–298

Thiébaut C, Mourre V, Chalard P, et al (2012) Lithic technology of the final Mousterian on both sides of the Pyrenees. Quaternary International 247:182–198. doi: 10.1016/j.quaint.2011.05.028

Tixier J (1978) Méthod pur l'étude des outillages lithiques. Notice sur le travaux scientifiques présentées en vue du grade de Docteur en lettres. Université de Paris X – Nanterre

Tixier J (1967) Procédés d'analyses et questions de terminologie dans l'étude des ensembles industriels du Paléolithique recent et de l'Epipaléolithique en Afrique du Nord-Ouest. In: Bishop WW, Clark JD (eds) Background to Evolution in Africa. University of Chicago Press, Chicago, p 771–820.

Tuffreau A, Goval E, Lefevre B, et al (2009) L'utilization du quartzite dans l'industrie moustérienne de Zabrani (Banat, Roumanie). In: Grimaldi S, Cura S (eds) Technological analysis on quartzite exploitation. Proceedings of the XV UISPP World Congress (Lisbon, 4-9 September 2006). BAR International Series 1998. Archaeopress, pp 25–32

Turq A, Roebroeks W, Bourguignon L, Faivre JP (2013) The fragmented character of Middle Palaeolithic stone tool technology. Journal of Human Evolution 65:641–655. doi: 10.1016/j.jhevol.2013.07.014

Valladas H, Mercier N, Ayliffe LK, et al (2008) Radiometric dates for the Middle Palaeolithic sequence of Payre (Ardèche, France). Quaternary Geochronology 3:377–389. doi: 10.1016/j.quageo.2008.01.001

Vallverdú J, Allué E, Bischoff JL, et al (2005) Short human occupations in the Middle Palaeolithic level i of the Abric Romaní rock-shelter (Capellades, Barcelona, Spain). Journal of Human Evolution 48:157–174. doi: 10.1016/j.jhevol.2004.10.004

Vaquero M, Bargalló A, Chacón MG, et al (2015) Lithic recycling in a Middle Paleolithic expedient context: Evidence from the Abric Romaní (Capellades, Spain). Quaternary International 361:212–228. doi: 10.1016/j.quaint.2014.05.055

Vaquero M, Carbonell E (2003) A temporal perspective on the variability of the discoid method in the Iberian Peninsula. In: Peresani M (ed) Discoid lithic technology: advances and implications. BAR International Series 1120. Archaeopress, pp 67–82

Venditti F, Tirill J, Garcea EA (2016) Identification and evaluation of post-depositional mechanical traces on quartz assemblages: An experimental investigation. Quaternary International 424:143–153. doi: 10.1016/j.quaint.2015.07.046

Captions to Figures and Tables

Fig. 1 Geographical location of Payre on a plateau in the middle Rhône valley and plan of the site

Fig. 2 Stratigraphic sequence of Payre with indication of the levels of human occupation and chronology (modified from Rivals et al. 2009)

Fig. 3 Payre level D. Rate of fragmentation of quartz and flint flakes. Numbers on top of bars are the actual numbers of fragmented quartz and flint flakes.

Fig. 4 Payre level D. Discoid flint cores. (a, b) bifacial cores; (c) exhausted bifacial core with a third surface exploited in the last phase of flake production; (d) unifacial core with a natural striking platform surface; (e) unifacial core with a striking platform partially prepared with centripetal non-invasive detachments.

Fig. 5 Payre level D. Discoid flint flakes. (a) core management flake; (b) discoid centripetal invasive flake removing the central convexity of the core; (c, d) discoid debordant flakes

Fig. 6 Payre level D. Quartz discoid flakes and cores. (a-d) discoid flakes with centripetal negatives on the dorsal face; (e) bifacial core; (f) unifacial core with natural striking platform; (g) unifacial core, two centripetal detachments prepare the striking platform

Fig. 7 Payre level D. Dimensional analysis of quartz and flint discoid products, fragmented flakes are not included. The wanted products are short and large flakes and no differences are visible between the two raw materials. Blanks with suitable dimensions were chosen to obtain flakes with the wanted dimensions. Elongated flakes are related to core management or to the exploitation of a third surface during the final stage of exploitation

Fig. 8 Payre level D. Dimensional analysis of quartz and flint opportunistic/S.S.D.A. products, fragmented flakes are not included. The wanted products are mainly elongated flakes. The morphology of the products is also related to the initial morphology of the raw materials collected

Fig. 9 Payre level D. Schematic representation of the main technological features of discoid reduction sequences on flint and quartz

Table 1 Payre level D. Composition of the considered lithic assemblage.

Table 2 Payre level D. Raw materials and *débitage* methods.

Table 3 Payre level D. Quartz morpho-structural groups and knapping methods.

Table 4 Payre level D. Typology of the butts of quartz and flint discoid flakes. The absence of dihedral and faceted butts for quartz discoid products suggest that generally discoid reduction sequences where shorter than for flint. No statistical differences are clearly visible between the two raw materials: a differential exploitation between them is not attested and quartz seems to be a complementary raw material, used in the same way as flint for the production of discoid flakes.