

Symbolic or utilitarian? Juggling interpretations of Neanderthal behavior: new inferences from the study of engraved stone surfaces

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Summary – *Different categories of finds reveal how Neanderthals have manifested at different moments behaviors not ascribable to the utilitarian sphere, but to the aesthetic or symbolic. When the majority of this evidence dates to the few millennia that preceded the spread of Anatomically Modern Humans in Europe, these are grounds to continue the debate regarding the emergence of complex behavior, seen as an autonomous phenomenon of Neanderthal man or as the result of contact with immigrant populations. Re-examination of pebbles or flaked stones, a large part of such evidence, using a rigorous technological and taphonomic approach integrated with experimental tests, has already revealed these materials to be insignificant or natural, rather than anthropic, in origin. The following work seeks to shed light on the uncertainty existing around those stones and lithic artefacts bearing surface lines and scratches; these are of doubtful anthropic origin, but have not, as yet, been definitively interpreted. Generally, these findings are occasional in Mousterian sites, and when they are recovered with an excellent degree of preservation, different methods and levels of observation can be used for investigating them. The case studies taken into account are three sites in north Italy, where the surfaces of pebbles and flakes reveal a variety of signs and modifications attributable to various utilitarian acts. Of these, preventive cleaning of flint nodules has not been excluded, even if the traces on some tools reveal intentionality and repetition of gestures applied to the construction of a curated artifact.*

Keywords – *Middle Palaeolithic, Stone surface modification, Pebble, Incision, Function, Italy.*

Introduction

For most of the 20th century, it was thought that the indigenous Middle Palaeolithic populations of Europe were not able to express symbolic behaviors comparable to those of the first representatives of our species (Mellars, 1996). In the last two decades, however, evidence of a diverse nature, inferred with great confidence, has demonstrated that Neanderthal manifested behaviors not ascribable to the utilitarian sphere. Different

categories of finds reveal attention to the aesthetic or uniqueness of certain products. Examples include carefully worked bifaces that retain a fossil in the middle (Mithen, 1996, but challenged by Soressi & d'Errico, 2007), the Mousterian 'Mask' from La Roche-Cotard (Marquet & Lorblanchet, 2000), the superficial modification of hard materials (animal, stone), the selection of attractive natural objects (i.e. crystals, fossils, and other materials imported to sites via long-distance transport like at Grotte de l'Hyène, Combe Grenal,

and Chez Pourré-Chez Comte (see Lhomme & Freneix, 1993), or the association of modified bones and stones with buried adults and children (Peyrony, 1934). Even if this evidence was to be interpreted as expressions of individuality within an egalitarian society, a change in mental abilities and the development of modern cognition, physical manifestations of social boundaries and connections, or territorial demarcations like those attributed to the Upper Palaeolithic (Cain, 2006), it would need sound confirmation.

In fact, the re-examination of a large part of this archaeological material, based on a rigorous technological and taphonomical approach integrated with experimental testing, has already concluded that it was not significant, or rather that it was attributable to natural rather than anthropic action. Many objects were interpreted as the result of alterations due to processes of pedological change or animal activity. The most well-known of these objects include incisions on the surface of a bovine rib from Pech de l'Azé II, meandering lines on bone fragments from level 17 at Cueva Morin, linear marks on the vertebra of an *Elaphus* from Strànska Skàla and a fragment of a horn core bearing parallel grooves from level 18 of Castillo cave. All these have been reclassified as the impression of capillaries or the result of postdepositional processes such as trampling, which produces U-shaped striations (d'Errico & Villa, 1997; 1998; Zilhão & d'Errico, 2003). Another noted example is the perforated femur of a young cave bear, recovered in the Slovenian cave of Divje Babe I, in a level with scarce Mousterian artifacts. Interpreted as a possible musical instrument (Turk & Kavur, 1997), this find has been subject to an intense debate. Results obtained from taphonomic analyses and experimental tests indicate that the four perforations aligned along the face of the bone appear fully comparable with those markings observed in accumulations of bear skeletons from those areas of the cave that lack in traces of human occupation but were frequented by carnivorous predators other than the bears themselves (Chase & Nowell, 1998; d'Errico *et al.*, 1998b; Diedrich, 2012).

In light of these more accurate revisions, recent acquisitions draw a more dynamic image of Neanderthal, attributing to them abstractive capability in a symbolic-ornamental sphere. The use of stones to grind or crush pigment, and the use of black, or more rarely, red pigment derived from the pulverization of manganese oxide or hematite, is attested to from more than 70 levels dated to MIS6-3. These levels mostly date between 60ky and 40ky BP, and are attributable to the Mousterian of the Acheulean Tradition or the Charentian Mousterian (Demars, 1992; Soressi & d'Errico, 2007). The possible doubts advanced on the effective utilitarian use of these pigments have been cleared by the recovery of colored residues in marine shells at Cueva de Los Aviones and at Cueva Antón in the Iberian Peninsula (Zilhão *et al.*, 2010) and in Pliocene marine shell from Fumane (Peresani *et al.*, 2013). From caves in Italy and in France emerge testimonies attributable to the intentional extraction of feathers from large raptors and other birds of medium size (Peresani *et al.*, 2011a) or terminal pedal phalanges of eagles (Fiore *et al.*, 2004; Morin & Laroulandie, 2012). Other key contributions also come from the study of the ornamental Castelperronian objects (d'Errico *et al.*, 1998a), which attest to the adoption of new techniques in the modification of hard animal material.

As the majority of this evidence is assembled into a time period that precedes the migration of Anatomically Modern Humans in Europe by a few millennia, these are grounds to continue the debate regarding the emergence of complex behavior as an autonomous Neanderthal phenomenon or as the result of contact with immigrant populations. The debate involves different aspects of the archaeological record of the transition and the nature of its maker, which is repeatedly examined and revised based on the chronology and taphonomy, as, for example, in the Castelperronian in France (for recent reference see Caron *et al.*, 2011; Higham *et al.*, 2010; Bar-Yosef & Bordes, 2010; Zilhão *et al.*, 2006; Mellars *et al.*, 2007; Hublin *et al.*, 2012).

Regardless of these claims, other elements of the archaeological record demand an in-depth

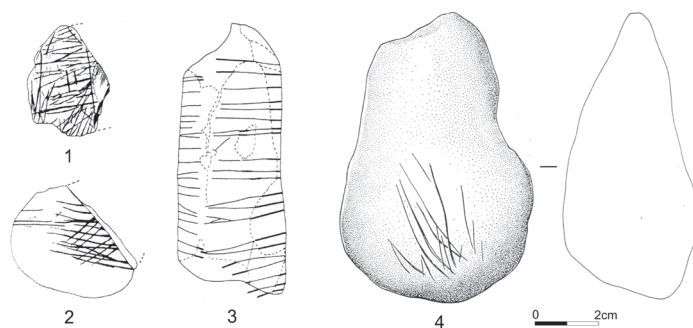


Fig. 1 - Engraved stones from Champlost (1), Chez Pourré-Chez Comte (2), Temnata (3), Grotta del Cavallo (4) (after Lhomme & Freneix, 1993; Lhomme & Normand, 1993; Crèmedes et al., 1995; Martini et al., 2004).

inspection that permits the development of a stronger body of evidence for or against Neanderthal behaviors, whether of a non-utilitarian character, or related to behaviors specific in the sphere of daily life. This current work aims to shed light on the uncertainty that reigns around a particular category of objects and lithic artifacts, altered on the surface by lines and scratches of undoubtedly anthropic origin, but as of yet not interpreted in a definitive way. Following a brief presentation of the state of knowledge of this type of material, our contribution is configured towards the generation of new data coming from observations carried out at the microscopic and ultramicroscopic scale on some recovered tools from three sites in northern Italy.

Engraved stones from Neanderthal sites

Objects and stone artifacts that appear to be lined by various types of incisions, either intentional or of secondary origin, are rather rare in the Mousterian sites of Europe and the Near East. Noted examples include the flint flake from Champlost Cave and the four pebbles found at Chez-Pourré-Chez-Comte Cave (France), the pebbles from Combe Grenal Cave, the flint block from Quneitra (Israel), the sub-circular fossil from Tata (Hungary), the schist flake from the Temnata Cave (Bulgaria), as well as other

objects from Castillo cave (Spain) and various Italian sites (Fig. 1). The artifact from Champlost is the distal end of a cortical flake, whose surface presents rectilinear lines of different width and depth that were made along four principal axes. Not excluding a priori the presence of a graphic manifestation, Lhomme & Normand (1993) determined the approximate order of the tracks, and, with the support of experiments, have demonstrated that the lines could have been similarly produced in an act to regularize a flake edge, using it to sharpen the cortical surface of another artifact. In regards to Chez-Pourré-Chez-Comte, of the four incised pebbles, one is of fine grained plutonic rock, and three are schist. The first is more well-known, and presents a fracture posterior to a group of intentionally well-defined incisions, rectilinear and developed along two axes. While the interpretation of these lines remains enigmatic, the other three pebbles, scored by light lines and speckles, are hypothesized to have been used like a base for cutting hide and other tissues. From the Near East comes the incised cortex recovered in a level 53ka BP old from the Mousterian site of Quneitra which remains, however, uncertain in its attribution of manufacture to Anatomically Modern Humans or Neanderthal. The first examinations, conducted by A. Marschak (1995) and subsequently clarified by A. Nowell and F. d'Errico (d'Errico *et al.*, 2003a) demonstrate the intentionality of the

concentric semi-circular incisions, definitively discarding the possibility that the changes in the direction of the tool engravings and the presence of the curved tracks could be attributed to a utilitarian significance.

A definitive interpretation has now been formulated for the incised sub-circular nummulate fossil from Tata (Hungary). The engraved line which intersects a natural fracture at a right angle, previously considered as intentional (Vértes, 1964), has now been recognized as made with an iron tool in recent times (Steguweit, 2003). Distinguished from these materials is an object recovered from layer VI, within a Levallois industry from the Temnata cave, dated to 50ky BP. It is a quadrangular schist flake with an accidental fracture on three sides, incised by 20 intentional lines along the wide margins of the entire profile in a fairly regular pattern. The incisions are identical, in that they present a symmetrical V-shaped section and are grouped in two series; those following toward the same way, and those that were performed with a single tool. Their interpretation is indefinite (Crèrnades *et al.*, 1995), but the authors contend that this object is the proof that engravings were a known practice at the end of the Middle Palaeolithic, and therefore represent the most ancient means of graphic expression in Europe. In regards to Castillo cave, the attribution of level 18 to an evolved Mousterian or transitional Mousterian, advanced by J.Zilhão and F.d'Errico (2003), involves the consideration of the incised sandstone block described by V.Cabrera and colleagues (2001). This slab bears a few wide grooves that may well be anthropic and interpreted as decorative, but these have yet to be subjected to detailed SEM inspections.

In the Italian context, we must mention the cortical incisions on objects from Riparo Tagliente in the Alpine region and from Grotta del Cavallo in the south of the peninsula. At Riparo Tagliente, the excavations from 1979 and 1980 produced a variety of material that can be grouped into two categories- a flake and a pebble with linear incisions and several flakes with parallel linear incisions, coupled, spaced or closed. P. Leonardi (1983) recognized the intentionality,

but lacked hypotheses about a particular activity for the flake, while for the pebble he advanced the hypothesis of a possible use as a support for cutting of hides or other objects. Remaining in the Alpine area, we should mention the dolomite slab recovered from Divje Babe I in the south-east Alps, scored by two incisions, the interpretation of which, however, has not been tested with more detailed analyses (Turq, 1997). In the Salento Peninsula, layers FII and FIII of Grotta del Cavallo have revealed three small carbonatic stones bearing a series of engravings (Martini *et al.*, 2004). The first stone is a plate covered by a reddish patina and crossed by fine incisions, of which some are parallel, and others intersect each other and are of variable length. The second stone is a flake fragment, with weak flaking by percussion in the vicinity of an edge, and a group of 14 short lines, few emphasized and subparallel, in the vicinity of a fracture. The third finding is an irregular pebble that has some abrasions due to use as a hammerstone, and is engraved by 16 very thin subparallel lines, decentralized on the surface. The authors make several interpretative hypotheses about these modifications, as well as about some details of their technical nature; however, these are not supported by taphonomic analysis conducted with appropriate methodological standards, or by experimental tests. Accordingly, the interpretation of these incisions remains to be established as a natural function, a testimony of graphic expression or a simple natural alteration. Another Italian example comes from level C of Grotta dell'Alto, also in the Salento peninsula. It is an elliptical limestone pebble, with two convex faces, one of which is affected by numerous very fine and orientated incisions, the other cut by some incisions that even outline a zoomorphic profile (Borzatti von Löwenstern, 1967). In this case as well, the lack of detailed observations does not allow formulation of reliable hypotheses on the origin and significance of these incisions.

Subject, therefore, to various interpretive uncertainties, these artifact types do, however, share some characteristics in the simplicity of their incised elements. These can be composed

of one or more lines, or articulated in a geometric pattern, usually small in size and executed in one phase, therefore not subject to subsequent changes. Where the functional explanations for some of the incisions imply the use of these stones as a support for cutting actions or for refining the functional edges of stone tools, one could include each of those cases that show shallower incisions, precisely produced by cutting actions. In our opinion, even the pebbles of Grotta del Cavallo fall within this category.

Much more reliable evidence about a targeted use within the symbolic realm come instead from the Mousterian of Acheulean Tradition site of Pech de l'Azé I, where more than 450 scraped blocks of coloring materials ranging in color from black to bluish grey have been recovered. The blocks are predominantly manganese dioxide and are associated with red or yellow pigments provided by some blocks of red ochre. Most of these blocks have surfaces flattened by abrasion, and in some cases are polished and covered with thin parallel striae that are distinguished from their natural, irregular surfaces. The facets of wear are commonly on the narrow edges of the blocks and pebbles, therefore in non-random positions and not lacking significance. The gestures connected to the abrasion appear standardized, as is suggested by the similarly oriented striae due to back and forth movement on a flat abrading tool to produce strictly flat or slightly convex, elongated facets. These facets could be used to mark, like charcoals, various soft materials including human skin to create corporeal designs (Soressi *et al.*, 2009; Soressi & d'Errico, 2007). In conclusion, the assignment of artifacts or other materials that underwent one or more anthropic modifications as appurtenance of the symbolic realm must be hypothesized only after every visible or detectable evidence has been carefully examined. It must be noted that non-iconic artifacts may contain symbolic messages as much as iconic markings, and possibly even more so. Nevertheless, for the particular case of Neanderthal-related items, the symbolic nature of some acts can be inferred only where every type of functional significance has been excluded.

Materials and methods

The engraved stones that are the subject of this paper were found at three sites in northern Italy - Grotta di Fumane, Riparo Tagliente, and Grotta Maggiore di San Bernardino (SI Fig. 1). The research at San Bernardino is recent, and is on-going at Fumane and Tagliente. Work at all sites has been conducted with the same methodological standards. Following a brief presentation of the three sites, we will discuss the methodological protocol and criteria for the classification of anthropic traces, and distinction of those of a post-depositional nature. In order to support the taphonomic interpretations an experimental process was also launched.

The sites

Grotta di Fumane, located at the southern fringe of the Venetian pre-Alps, is part of a complex karst system that allowed for the formation of a sedimentary sequence over 12 m thick, dated from the Middle to Early Upper Palaeolithic (Martini *et al.*, 2001; Peresani *et al.*, 2008; Higham *et al.*, 2009). Since 1988, yearly excavations have been carried out, for periods of variable duration, beyond the present-day drip-line and at the cave entrance. In this area, sediments from the final Mousterian to the Aurignacian derive primarily from frost-shattered slabs in which sand and aeolian dust are present in varying amounts, the former being prevalent in the western zone and the latter increasing from the entrance to the exterior. Lithic evidence, faunal remains, hearths and other structures are densely scattered on the ground, particularly in layers BR11, A11, A9, A6 and A5 (Mousterian, with different technological outlines) and A2, A1 (Aurignacian). Lighter densities have been noted in other Mousterian layers, the Uluzzian (A4, A3) and the Aurignacian levels (D3, D1) (Broglio *et al.*, 2005, 2006, 2009; Peresani, 2008; Peresani *et al.*, 2011b). The conditions of the conserved materials are generally excellent, but can worsen in response to their location and dispersion within the sediments.

Grotta Maggiore di San Bernardino lays at the edge of the Monti Berici karst plateau and

Tab. 1 - List of the pieces analyzed in this work. Note: GF, Grotta Fumane; RT, Riparo Tagliente; GSB, Grotta San Bernardino; numeric ages are in Ky Cal BP; age range of GSB scraper, unit II, is based on the two oldest dates of a total of four. See references in the text.

NATURE	SITE	CONTEXT	TECHNOLOGY	AGE	PRESERVATION	LEN.	BR.	TH.
Pebble 4747	GF	A5+A6	Levallois	45-44	Fragm.	--	37	12
Stone 273	GF	BR7	Levallois	MIS3	Compl.	115	72	46
Scraper	RT	34	Lev+Blade	MIS3	Compl.	123	49	10
Scraper	GF	BR7	Levallois	MIS3	Compl.	79	44	12
Scraper	GSB	II	Levallois	59-44	Compl.	73	44	9
Ind.	GSB	II	Levallois	MIS5-4	Fragm.	34	17	15
Ind.	GF	A6	Levallois	<45	Fragm.	71	35	20
Core	GF	BR4	Quina	MIS3	Compl.	28	26	12
Flake	GF	BR6	Quina	MIS3	Compl.	45	28	17
Blade	GF	A5	Levallois	45-44	Compl.	72	28	8
Blade	GF	A5+A6/A6	Levallois	45-44	Compl.	59	24	5

preserves a Middle-Late Pleistocene sequence (Cassoli & Tagliacozzo, 1994; Gruppioni, 2003; Picin *et al.*, 2013), with ages spanning from 202±30 kyr (unit VIII) to 52±5 kyr (unit II). The sequence records several climatic and ecological oscillations from moist-temperate to cool and dry conditions during the last two glacial cycles. Excavations carried out in the 60's and the 80's-90's yielded flint implements from each unit. Rates of cores, flakes and retouched tools vary as a function of the intensity with which the cave was used, the distance of raw material provenance and the fractionation of reduction sequences (Peresani, 1995-96; Porraz & Peresani, 2006). Finely textured flint from Cretaceous limestone was the most intensively used in order to produce Levallois implements, scrapers, denticulates and few points. Although some materials are intensely altered due to dripping within a specific area of the cavity, the conservation of the artifacts is generally excellent.

Riparo Tagliente was discovered and initially excavated in 1958 and it is currently in

the course of excavation. This shelter lies on the side of a large stream valley in the central Monti Lessini, and contains two main cultural sequences separated by an erosional discontinuity. The uppermost is Epigravettian, and the lowermost includes several Mousterian levels with variable content in flaked stone implements. Flint was supplied from slope waste deposits in proximity to the site, and from the coarse gravel stream bed. The method mostly used in flaking was Levallois. Retouched tools are more varied in upper levels (37-34) where intense, long-term or repeated occupations are suggested by larger amounts of lithic and faunal remains than in earlier times (Arzarello & Peretto, 2005). The conservation conditions of the materials are generally excellent.

The materials

The material taken into consideration for this study are those flaked flints totally or partially covered with cortex, regardless the degree of fragmentation. Only 30 out of thousands of artifacts

have been selected from the Fumane (27 from across layers A5 to S9) and San Bernardino (from units II to VI) assemblages, whereas only a single artifact recovered from Tagliente, in arbitrary cut 34, has been analyzed. In addition, all pebbles undoubtedly interpretable as exogenous material have been examined. Following a preliminary examination, most of these do not show surface traces of human modification, and so have been excluded from this analysis. Also included in the study is a cortical flake from Fumane (layer BR7) crossed by numerous parallel incised grooves that indicate its use as a retoucher (Dallatorre, 2010-2011) and a score of artifacts that are difficult to interpret due to their poor state of preservation. Of the 30 artifacts initially selected for this study (2 from San Bernardino, 1 from Tagliente, and 27 from Fumane), 9 present intensely scraped cortex, rendering the context of the cobble's provenance indeterminable, while for the most part (19) the cortex present is fresh and homogeneous, attributable to a sampling of blocks and nodules from a primary outcrop. Finally, only 11 pieces have been studied: 2 are pebbles, while the rest are retouched tools and fragments of cortical flint flakes (Tab. 1). Their stratigraphic distribution does not present a particular concentration in any of the sites. The incidence of these findings remains anecdotal, even within each single lithic set across the overall stratigraphic sequence.

The methods

The methods of surface analysis used in this study reproduce techniques used by other researchers (Fritz, 1999; d'Errico, 1994; Crémales, 1991, 1994). They distinguished distinct modifications of post-depositional origin from those produced with sharp lithics, both on hard animal tissues and on stone, on the basis of the morphology of the section and its variation along the incision according to the pressure or the orientation of the instrument (Fritz, 1999). Further diagnostic characteristics relate to the initial groove of the tract (d'Errico, 1988), possible micro-linear streaks parallel to each other and the edge of the incision (Fritz, 1999), the polarity of the incision, repeated incisions

for movement back-and-forth (d'Errico, 1994), and parasite lines, side or end to the main one. Finally, attempts at refitting of the selected materials have proved to be fruitful in a single case, which has allowed us to complete some of striae detected (Dallatorre, 2010-2011).

After having rejected the findings with clear alterations of post-depositional origin, it followed in some cases to clean the engraved surface by means of prolonged immersion in deionized water, followed by manual removal of the residual sediment. The successive analyses of the striae were exposed to further observations: at low magnification in reflected light using a Leica optical S6D stereomicroscope, equipped with Leica EC3 photographic equipment, and at high magnification using a scanning electron microscope Jeol JSM-5600LV, with varying success in the graphical depiction, as only six specimens had smooth surface which returned clear images. The images were made with light grazing Lumix DMC-FX12 and processed with Photoshop program.

These analyses were supported by the search for traces of use-wear on the margins of the three scrapers, which within the selected sample have a potentially higher function, as they are complete and in a good state of preservation. The analysis aimed to reconstruct the functional history of these three artifacts and to confirm or disconfirm the existence of hafting structures as responsible for the cortical engravings.

Functional analysis was carried out by examining the surfaces at different scales of magnifications (Tringham *et al.*, 1974; Keeley, 1980; Vaughan, 1985). The technical equipment consists of a binocular stereomicroscope for examinations at low power approach (until around 60X) and a metallographic microscope with incident light (Leica DMLM) for high power approach (till 200X). Observations at low power approach lead to the identification of macro-traces such as edge rounding and edge damage on the tools, while the high power approach confirms and goes a step further towards the interpretation of the previously observed traces, bringing clearly to light the nature of the exploited tissues by "micropolishes", features that look different on diverse materials and in

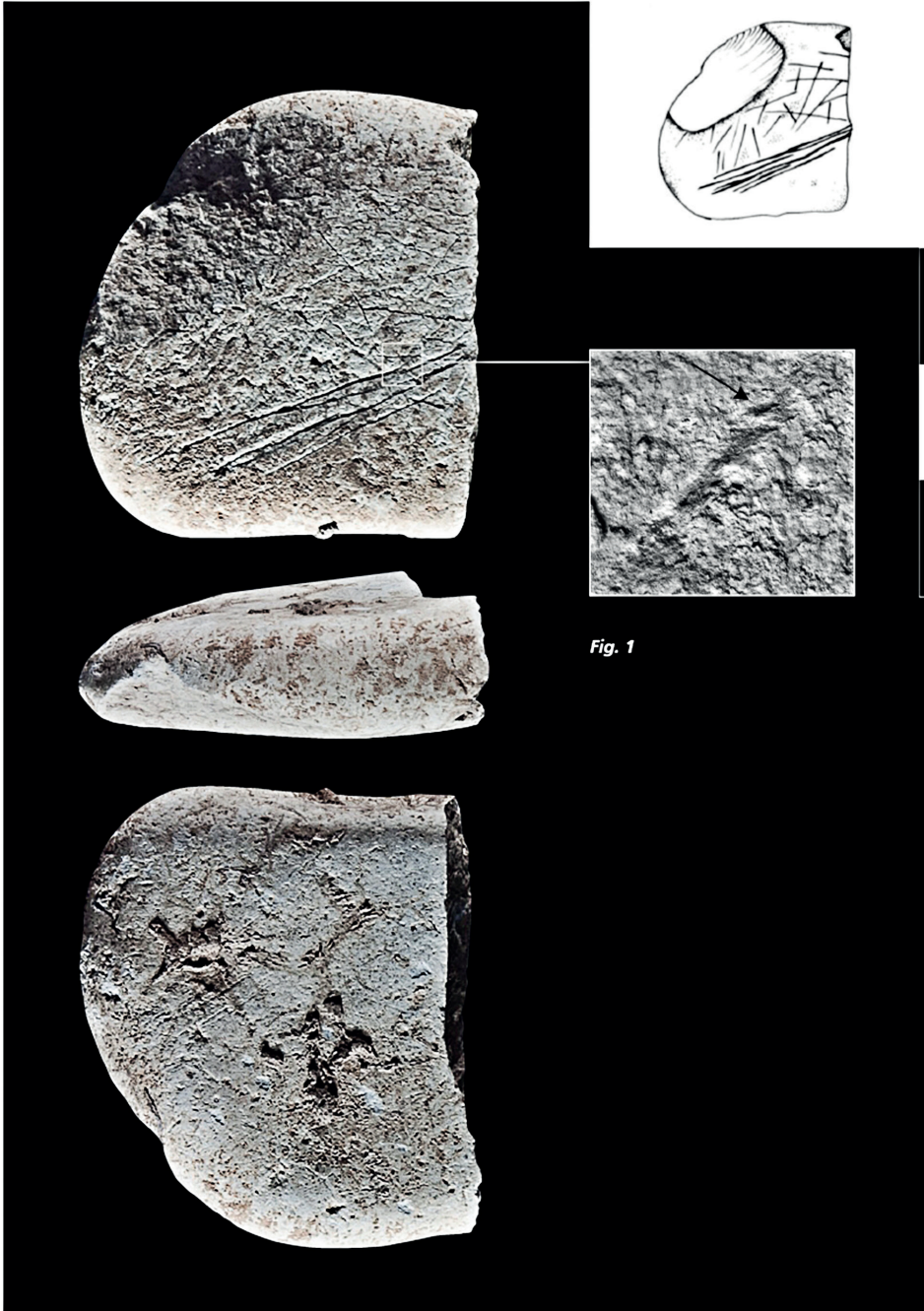


Fig. 1

Fig. 2 - Grotta Fumane, pebble 4747. Above, the surface engraved with two series of incisions: the series with more marked engravings is located in the lower part, the other in the upper one. On the right, SEM close-up of a typical rounding of the final part of a stria. The colour version of this figure is available at the JASs website.

diverse activities (Keeley, 1980; Vaughan, 1985). The collected data were inserted into a database for specific use in functional analysis, in order to enable processing and comparing results. A determination of the chemical elements in some incrustations visible on the cortical surface of the scrapers has also been carried out (see SIM). Typological classification has been based on Bordes (1961).

Results

Through microscopic analysis and experimentation (see SI text) it is possible to subdivide the incisions observed on the findings into three groups: engraving, scraping and various non-determinable signs.

Engraving

This first group contains a pebble from A5+A6 and a stone from BR7, both from Fumane.

Pebble 4747. Grey pebble fragment in micritic limestone of allochthonous provenance. The engraved surface is smooth, flat, and covered with a light incrustation that does not affect the interpretation of the incision. In proximity to the upper margin is a negative from flake removal, and around it are visible marks attributable to a percussive function of this piece. The pebble presents two series of incisions: the series with more marked engravings is located in the lower part, the other in the upper one (Fig. 2). The first series presents homogeneously oriented incisions, subparallel and of variable depth. Some of these are interrupted by the margin of fracture. All of the striae were derived from a single gesture. SEM denotes a typical rounding of the final part of the striae, which permits the determination of the source of the margin of fracture with the direction from right to left. For the other incisions it was not possible to verify direction or sequence. The striae on the lower zone interrupt those of the upper zone. For most striae it was possible to recognize a micromorphological "barcode", typical of the passage of a sharp lithic. Also in this case some incisions seem to carry beyond the margin of fracture of the pebble, but

in contrast to the other series these have diverse directions and are organized in a chaotic manner.

Stone 273. Smoothed tablet of micritic limestone, affected from a series of two/three flake removals on the longer side and also some markings relative to its use like a percussor along the lower length in proximity to the incised zone. The incisions can be divided into four series: in the left zone longer incisions are found (zone I in Fig. 3), with a probable "comet" morphology, oriented perpendicularly in respect to the others, and executed with a single gesture from up to down (Fig. 3). The other three zones are scored with uniformly oriented series of incisions, less profound in respect to the first. For these it was not possible to ascertain the course of direction. The morphology of the engraved area of both the artifacts is quite flat, so it would be useful as a support for cutting actions.

Scraping

Belonging to another class of materials are those findings bearing traces of intentional scraping of the cortex. These include a scraper found from Tagliente, a scraper, five flakes and fragments from Grotta di Fumane, as well as a scraper and a fragment from San Bernardino (Tab. 1).

Scraper, RT (Riparo Tagliente), Layer 34.

This scraper was manufactured on a large cortical flake, characterized by simple direct retouch, partial on both sides. The cortical face is totally crossed by uniformly oriented and subparallel striae, easily visible through the homogeneity of the cortex and the depth of the lines (Fig. 4). From the microscopic analysis we can observe that the incisions are interrupted in proximity to the margin of retouch, thus defining the antecedence of the cortical scraping operation to the removal of flakes and retouch of the tool. Because of the interruption it is not possible to realize the direction of the incisions. This surface cortex presents incrustations analyzed using XRD and FTIR and described later (see SI text, SI Tab. 1 and SI Figs. 2-5).

Under the microscope, the margins appear fresh, not affected by mechanical alteration or



Fig. 3 - Grotta Fumane, stone 273. Left, the surface engraved with four series of incisions, as shown from the drawing above right. Below, close-up of the long stria in the left zone (I). The colour version of this figure is available at the JASs website.



Fig. 4 - Riparo Tagliente, scraper with totally engraved cortex. Left and right, close-ups of the scores (A, B). Below, polishing attributable to contact with animal tissues observed at high magnification on the left edge. The position of the dark brown small and large concretions is indicated respectively by numbers 1 and 2. The colour version of this figure is available at the JASs website.

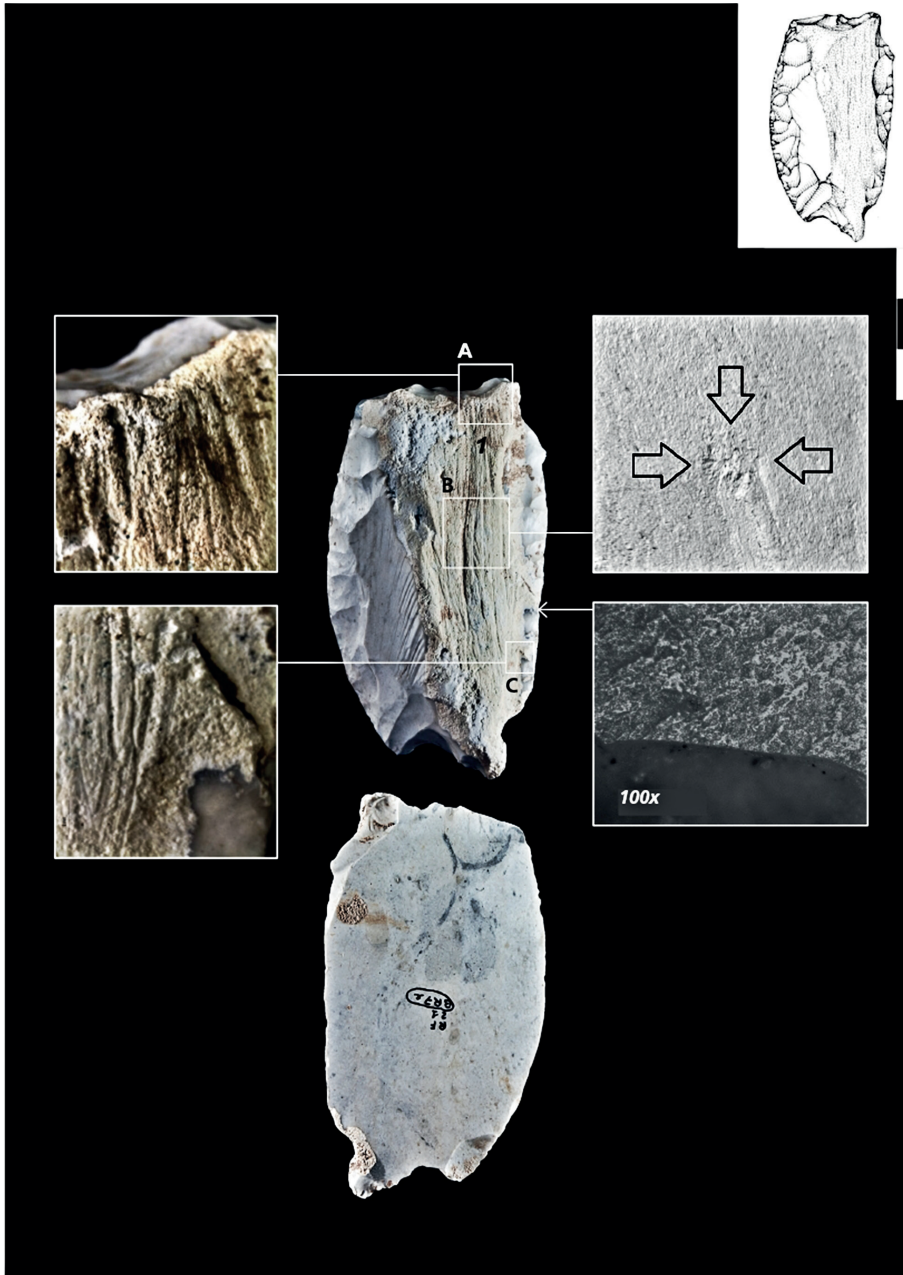


Fig. 5 - Grotta Fumane, scraper with engraved cortex. Left and right, close-ups of the striae (A, C) and of a "comet" morphology (B) observed by SEM in the middle of the surface. Right, below, patch of polishing attributed to the presence of a hafting system, observed at high magnification on the right edge. The position of the punctiform incrustations is indicated by number 1. Middle below, note the two burin spalls on the lower face of the scraper, respectively on the distal and proximal extremities. Top right, drawing by G.Almerigogna. The colour version of this figure is available at the JASs website.

deterioration of the surface. The retouching of the right side shows evident micro-chipping, with micro-scars compatible with a cutting action of a semi-resistant material; the distal portion of this margin has more evident wear, with some larger scars, an asymmetrical shape, and a more intense superimposition of micro-scars. The observation at high magnification shows the presence of generic weak polish on the whole length of the margin. The left margin has generic weak polish, and although more discontinuous, the mesial and proximal portions of the polishing is more developed and has characteristics attributable to contact with animal tissues with low resistance (skin / flesh) (Fig. 4). On the proximal portion and at the base of the tool more regular micro-scarring is attributable to a scraping action.

The observed evidence leads to the interpretation of the artifact as a multi-functional tool, used in cutting or scraping activities, for the most part in contact with semi-resistant animal tissues. The tool's use in slaughter is also plausible. Also some isolated bright spots, localized on the left proximal margin and due to contact with a more resistant material (for example, bone, or micro-chips detached from the same margin) can be associated to this action. Because the observed traces on the distal and the proximal part of the artifact present characteristics compatible with systematic contact with a working surface, the hypothesis for the presence of a hafting system cannot be supported.

Scraper, GF (Grotta Fumane), layer BR7

Bilateral scraper, with direct scaled retouch, sometimes overlapping, which is more intrusive on the left convex edge than on the right, and is straight. The ventral side has two burin spalls, diagonally opposed, both of which extend from two conspicuously retouched grooves. The cortical area is completely covered by well-defined, subparallel, uniformly oriented scratches, sometimes intersecting, preceding flake detachment and retouch. In the mesial zone, the scraping has partially exposed the underlying flint. In the distal part, a superficial alteration compromises interpretation. By SEM a "comet" morphology

was observed (Fig. 5), which indicates a movement from top to bottom. The use-wear analysis permitted the observation on the left side at the convex delineation a rounding mark that affects the middle part of the margin. The microscopic examination shows, however, the presence of a soil sheen across the entire surface. The zone affected by rounding is a potentially functional area, but the absence of further tracks does not confirm or deepen the interpretation. Again, the left side, on the ventral face, is affected by patches of polishing (Fig. 5), which extend towards the interior and are associated to some micro-scars; this association between patches and flaking can be attributed to the presence of a hafting system (Rots, 2002), to which they can also be related to the two burin spalls. Some rare punctiform incrustations are visible on the cortex, without which it could define a special relationship with some areas. The analyses of the incrustations revealed a composition attributable to a natural deposition of metal oxides (see SI text and SI Fig. 6).

Scraper, GSB (Grotta San Bernardino), Unit II

Lateral scraper, with direct scalar retouch on the entire left edge, so invasive as to remove the platform. The edge opposite is entirely cortical, but in the proximal zone it presents direct retouch that outlines a straight and convergent edge (Fig. 6). The ventral face has no modification. The cortex is marked by frost detachments that have removed part of the incised surface. The striae are located on the distal part of the scraper in proximity to the area of retouch and are uniformly oriented and poorly visible, making reading difficult because of the rough surface. These striae precede the retouch and, for this reason, are not directly tied to the last phase of sharpening and tool-use. It was not possible to infer the direction of the incisions. The proximal cortical zone presents a smoothing posterior to the detachments and to the scrapings that also, in some points, affects the incisions. The entire cortical face is covered by black punctiform incrustations disseminated on the cortex, incisions, frost detachments, and also over the retouch scars, but with major frequency in the distal zone. The

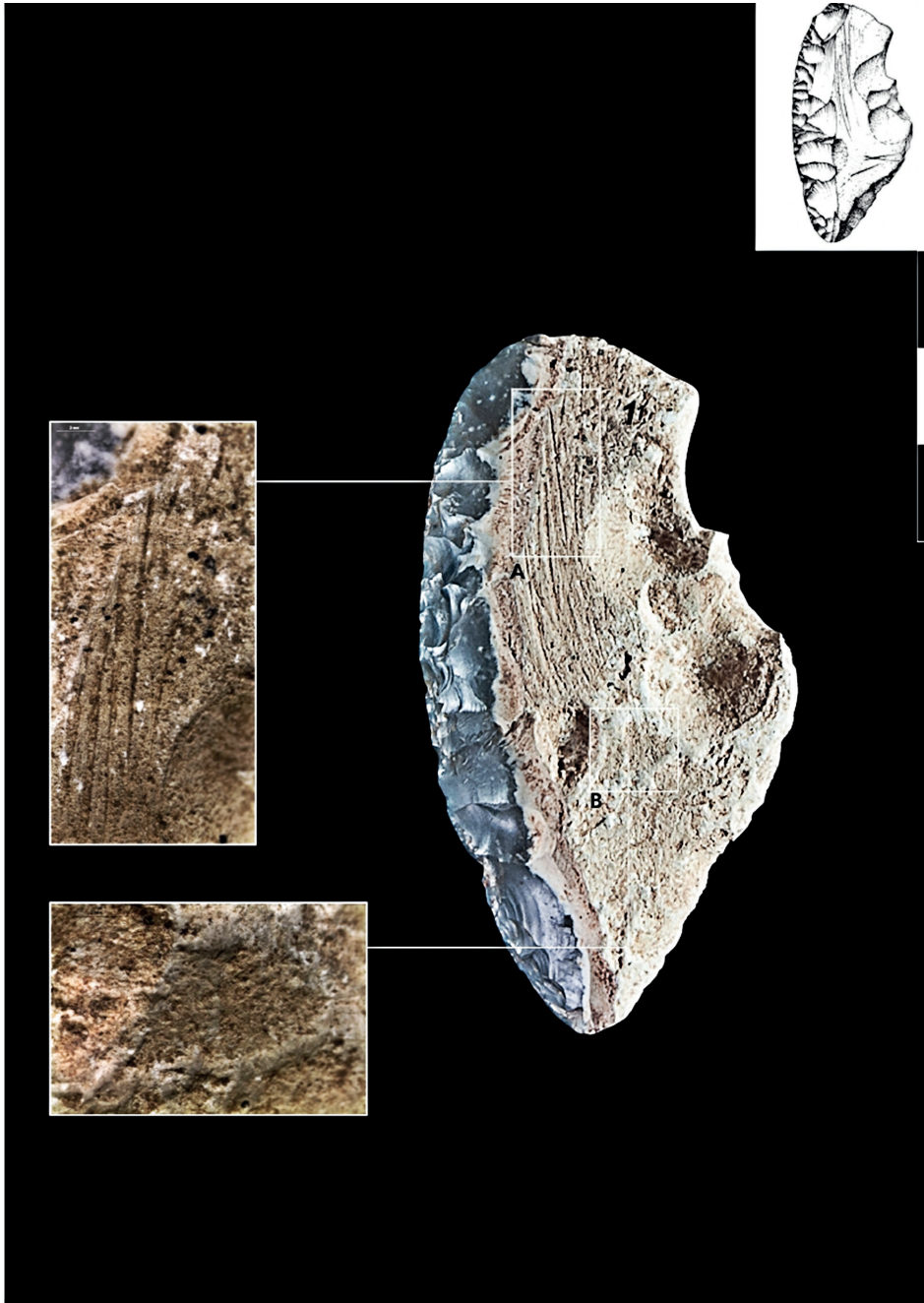


Fig. 6 - Grotta Maggiore San Bernardino, scraper with partially engraved cortex. Left, close-ups of the striae (A) and the smoothed surface visible on the proximal cortical zone (B). The position of the small black stains is indicated by number 1. Top right, drawing by G. Almerigogna. The colour version of this figure is available at the JASs website.

composition of these incrustations shown from the analyses supports natural deposition of metal oxides (see SI text and SI Fig. 7).

The microscopic observation points out an alteration diffused over the entire surface; these have not been observed to be diagnostic micro-polishing. The functional analysis has revealed, on the left side, small unilateral and symmetrical micro-scars accompanied by a rounding of the asperity. Evidence of wear is particularly clear on the ventral surface, where micro-scars are visible, mainly due to a longitudinal or mixed action (gesture that characterizes the way it works the skin). In the lower right zone, a clear smoothing of the incisions and the cortex is seen and is accompanied by a shiny appearance. Rounding of this area can be interpreted as a contact with a handle or with a system of grasping that altered the surface in a clear manner (Fig. 6).

Other engraved flakes and fragments

Fragment, GSB, Unit II

The fragment is totally cortical, presenting a series of interrupted incisions probably due to scraping action that preceded the detachment of the flake (Fig. 7, 1). A stria presents a “comet” shape that indicates movement from right to left. It is hypothesized that the scraping was aimed at reducing the thickness of the cortex, too large in relation to the other artifacts.

Fragment, GF, layer A6

The cortex presents alterations in several parts, which make the analysis of the incisions that extensively affect the cortical surface problematic. In some places the striae are interrupted near the edge of fracture: they are clearly visible, defined and subparallel (Fig. 7, 2). These were performed with repeated gestures, probably using a retouched tool, producing many striae with irregular margins for scraping.

Core, GF, layer BR4.

The cortex shows a series of easily visible subparallel lines (Fig. 7, 3). However, the

preservation state of the artifact hinders the determination of the line direction. The action of scraping precedes the detachment of the last flakes from the core, because the grooves go beyond the edge of the fracture. The fact that this specimen preserves on the left zone a thick portion of cortex, devoid of incisions, is a clear evidence of deliberate action aimed to reduce the cortex till to expose the underlying flint.

Flake, GF, layer BR6.

The flake is entirely cortical, but is affected by alterations that in part compromise the interpretation of the incisions. The cortex presents natural cupules and the incisions are concentrated on the left side of the artifact (Fig. 7, 4). There are three very definite striae, of diverse depth, that proceed beyond the flaking margin. The central stria has slight contiguous grooves, probably derived from repeated gestures. In addition to these traces there is a series of very thin striae, uniformly oriented, with consistent length and depth that demonstrate repeated passages of the cutting edge, likely due to a scraping action. Two semi-circular morphologies in an incision indicate the direction of movement of the tool from the top downwards.

Blade, GF, layer A5

The cortical face appears very irregular, crossed by deep natural cupules. It denotes isolated striae, interrupted at the flaking margin and in proximity to the cupules (Fig. 7, 5). Their origin precedes the detachment of the flake. Through SEM, the surface appears completely scraped by uniformly oriented incisions, shallow and irregular; however, it is not possible to determine their direction.

Blade, GF, layer A5+A6/A6

The flake presents a relatively homogenous zone with some incrustations, grooved by striae in the proximal and distal part, clearly due to post-depositional processes, which is suggested by their diverse coloration in respect to the surrounding cortex (Fig. 7, 6). Also revealed, however, were grooves produced with a lithic implement by



Fig. 7 - Other engraved fragments: 1) fragment GSB, Unit II; 2) fragment GF, layer A6; 3) core GF, layer BR4; 4) flake GF, layer BR6; 5) blade GF, layer A5; 6) blade GF, layer A5+A6/A6. The colour version of this figure is available at the JASs website.

repeated gestures, uniformly oriented, but of indeterminable polarity. Also this artifact has very thin cortex, which leaves the underlying flint exposed as the result of scraping.

Discussion

The surfaces of the calcareous rocks and the cortical surfaces of the flint flakes recovered in the Mousterian levels of Grotta di Fumane, Grotta Maggiore di San Bernardino and Riparo Tagliente reveal a variability of marks and modifications fully attributable to anthropic activity, rather than to the action of animals or other post-depositional mechanisms. The geometry of these incisions, their sections and their positions exclude the action of mechanisms like the pressure caused by the settling or expansion and contraction of sediments, or trampling and superficial rolling, of which there were no dominant traces in the archaeological levels containing these materials. These observations also exclude root activities as responsible for the micro-dissolution of the surfaces, as they produce tracks that are different than those usually observed (d'Errico & Villa, 1997).

Among this set of engravings, striae have been identified as obtained with a single movement and with repeated gestures. The first, found on the two stones from Fumane and on some fragments and cortical flakes, are found on rather flat surfaces, therefore useful as a support for cutting actions, which was also found experimentally. The incisions are well defined and have a regular profile, which suggests the use of flakes without retouched edges. Overall, the evidence suggests a utilitarian origin for these incisions, rather than symbolic. The experimental reproductions attest to the formation of regular, linear incisions, obtained by the cutting of tissues of various consistencies, with a single cutting gesture, contrary to those obtained in the case of a repeated gesture, persistent on the same marks. The isolation of the tracks on some surfaces, or their irregular arrangement, do not support the comparison with the schist flake from Temnata,

crossed by regularly spaced, intentional lines, but rather with the findings from Chez-Pourrè-Chez-Comte and Champlost (Lhomme & Normand, 1993) and others (Bordes, 1961; Leonardi, 1981; Roux, 2008), for which a utilitarian function has been hypothesized.

The incisions/scrapings obtained by repeated and distributed movements are generally subparallel and have variable depth. These, also, can be grouped into two categories: incisions obtained by following a singular direction, and those obtained with a back-and-forth movement. The experimental comparison has addressed the interpretation of archaeological material, since it has covered both the variability of the instrument used (flakes with irregular edges or retouched flakes with a linear edge), and the movements with which they were made (see SI). It was possible also to note that for the same amount of time used the scraping of the cortex is much more effective and immediate, putting forth more movements in opposite directions, resulting in a faster gesture. The cortex scraped with a retouched edge show deeper and more regular engravings than those processed with a brute, straight edge, which are compared to the scrapers Fumane and Tagliente. The striae, in all specimens analyzed, preceded flaking and, if present, retouching.

A possible interpretation of such traces is that scraping was performed to clean the dusty cortex of siliceous blocks of the sediment that covered them, which could be found on nodules from clay deposits derived from the pedogenesis of the limestone. Similar examples have been reported in the region in Neolithic contexts, where flakes and cores show evidence entirely similar to those observed on Mousterian objects, but which have not been subjected to microscopic or experimental studies (Chelidonio, 2001).

Another possibility is the interpretation of scraping as an intervention, intended to reduce the thickness and to increase, then, the efficacy of impacts in the flaking process. This hypothesis, based on experimental testing, would be refuted by the fact that the scraped cortical areas were not later used as a striking platform. To scrape a

surface ample enough for further utilization, and to then use only a relatively small part, seems rather meaningless. An alternative possibility would involve a thinning of the cortex in the vicinity of the edge of the flake to be transformed by means of retouching. The intervention, also reproduced with success experimentally, would facilitate the task of retouch and shaping of the edge, and at the same time would regularize the functional area of the tool.

Another functional hypothesis posits that the scraping of the cortex served as a preparatory action for the possible insertion of the instrument into a support of perishable material, possibly with the help of various adhesives. This hypothesis is supported by the results of the functional analysis, which has shown on one of the implements in question the presence of alterations attributable to contact of the tool with a haft. Furthermore, processing of the cortex could be conceived as preparatory action for the application of a glue to fasten the tool on a support, the traces of which, however, have not been recognized in the incrustations visible on the scrapers. Their composition has proved beyond the range of organic compounds compatible with the residues of adhesives. Although exceptional in the Palaeolithic archaeological record, some artifacts indicate that in the circum-Mediterranean area, tool hafting with organic glue had already been accomplished long before similar techniques became a diffused practice in other parts of the world. These materials show a composition that includes triterpenoids, characteristic of tars produced from bark or wood of *Betulaceae* trees, as in the case of the two stone flakes partly covered in birch bark tar from the Pleistocene site of Campitello, Italy (Mazza *et al.*, 2006) or the large number of Micoquian tools, 120,000 years old, from the Inden Aldorf site in Germany (Pawlik & Thissen, 2011). A different glue was the bitumen, the traces of which have been detected on a quartzite scraper made on a core-edge removal flake found at Gura Cheii-Râsnov Cave, Romania (Carciumaru *et al.*, 2012). The location of the blackish marks seen suggests the tool was obliquely hafted, the back of the

piece being caught in a kind of handle. Bitumen was also used at Umm-el-Tlel 70 and 40ky BP (Boëda *et al.*, 1998; 2008) and at Hummal, Syria, to haft over ten tools and flakes. The tools include scrapers, single and convergent, and flakes are different types of Levallois products; none of these presents cortex on the upper face. The sole cortical flake preserves dark marks on the upper face but not on the lower face, suggesting that this flake was detached after the original nodule was stained with bitumen (Boëda *et al.*, 1998). Furthermore, this flake shows no trace of modification on the cortical face or even on the edges. So, the archaeological record does not suggest the application of organic glues on cortical artifacts. Again on the Syrian artifacts, the SEM and X-ray analyses do not exclude that bitumen may have played a role in the concentration and subsequently in the precipitation of manganese and iron oxides at points where the organic adhesive was applied (Boëda *et al.*, 1998). Such a correlation between bitumen and chemical precipitation does not exclude *a priori* the use of glues on the Mousterian tools from the examined Italian sites. Nevertheless, it must be noted that an ubiquitous distribution of similar punctiform concretions has been observed also on natural sedimentary stones both in archaeological and sterile layers at Fumane, Tagliente and San Bernardino.

Finally, the possibility should not be overlooked that cortical pulverization provided a discrete quantity of a whitish dye product, from the calcium carbonate present in the cortex. For those artifacts made from flint from the Maiolica Cretaceous formation, the extraction of powder pigments would be facilitated by the incomplete diagenesis of the marly limestone that compose it and, due to the notorious susceptibility of this material to gelifraction, abundant debris would be produced. Contrary to what was observed in Pech-de-l'Azè I, the absence of limestone blocks and plates bearing traces of persistent scraping in Mousterian sites does not support the idea of the use of powders, even in mixed silicate-carbonate composites like those extracted from the cortical surface.

Conclusion

Neanderthals have utilized and manipulated lithic material by applying a discrete variety of techniques that have permitted them to maintain, in many cases, elevated levels of predetermination of domestic tools. If, on one hand, preventive cleaning of flint nodules and blocks of incrustations or surface sediments could appear like a simple intervention and low investment, on the other, the insistence of the analyzed traces on the retouched tools from Riparo Tagliente, Grotta Fumane and Grotta San Bernardino reveals the intentionality and repetition of the gestures. Here, this type of technological investment has been applied to the construction of a curated artifact, possibly equipped with a handle, but subject, however, to a functional destination in the transformation of organic material. Curation of lithic implements is a widely investigated aspect of hominin behavior (Binford, 1979; Kuhn, 1994), within a broad variety of situations that have permitted the inference of models of mobility and settlement dynamics (Bousman, 1993; Kelly, 1983). In this perspective, the taphonomy of the cortical surfaces of the products in flaked stone could contribute new behavior indicators, unconsidered until now.

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