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Utilitarian or not: The engraved cortexes of the Mousterian Levels of Riparo Tagliente (Stallavena di Grezzana, Verona, Italy).

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"If I would study any old, lost art . . . I must make myself the artisan of it-must, by examining its products, learn both to see and to feel as much as may be the conditions under which they were produced and the needs they supplied or satisfied; then, rigidly adhering to those conditions and constrained by their resources alone, as ignorantly and anxiously strive with my own hands to reproduce, not to imitate, these things as ever strove primitive man to produce them"

[Cushing 1895:310]

"Ability is what you're capable of doing. Motivation determines what you do. Attitude determines how well you do it."

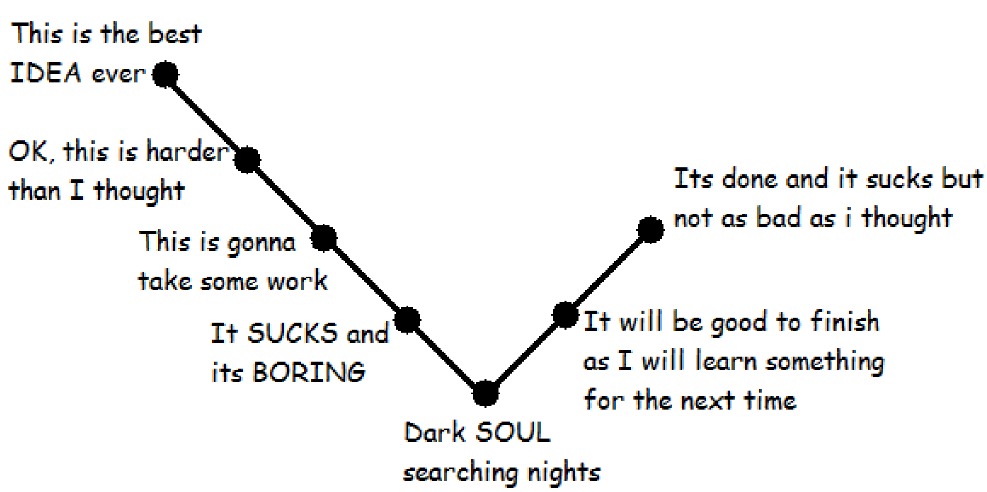
Lou Holtz

"The first draft of anything is shit."

Ernest Hemingway

Due Tomorrow? Do Tomorrow….

Reddit



MAUREEN McHUGH

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Abstract

In this study, 429 lithic artefacts fully or partially covered with cortical surface, from the Mousterian layers of the site Riparo Tagliente were analyzed. The objective was to look for the marks/lines/striations which could be associated with ancient anthropogenic activity. The analysis was carried out in 2 parts, first with naked eye to eliminate all the cortical lithic artefacts which showed no markings or markings which could be associated with weathering (physical or chemical), sin/post depositional damage (sedimentary abrasion, trampling, root etching etc.) or recent damage (during excavation or storage). 7 artefacts were selected which showed marks not related to anthropogenic activity for microscopic study for comparative purposes. Out of the 429 artefacts analyzed, only 3 (2 flakes (RT 11, RT 76) and 1 side scraper (RT 167)) showed marks which could have ancient anthropogenic origin. These 3 artefacts along with the side scraper RT 100, on which anthropic modifications have already been identified, were subjected to microscopic analysis. A reference experimental collection was built, performing various tasks related to scraping and incision activities to compare with the markings on the archaeological material.

Next the selected artefacts were subjected to microscopic analysis. Through microscopic analysis and comparison with the experimental reference collection, the marks on the artefacts were associated with 2 separate kinds of activities – Scraping and individual incisions. Flake RT 11 shows striations at one of the lateral edges of the flake which were interpreted as being made by scraping (with a flake) or abrasion (with a hammerstone) to thin the cortical surface for better efficacy for retouching the edge. Flake RT 76 shows a singular groove on the cortical surface which shows attributes of being made by a pointed end of a tool. No interpretation was given for this mark as there is a real possibility that it could have been made accidentally. Side scraper RT 167 shows 7 distinct grooves on the cortical surface (present on the distal end of the scraper) which can be easily separated from the marks created by weathering/ post depositional damage present on the surface based on their profile shape. These grooves were identified as not made by scraping but individual incisions. Some of the grooves show attributes of being incised by a pointed end of a tool. The aim and function of the grooves remains ambiguous as the cortex preserves only partial evidence of what could be a larger pattern of Utilitarian or Non-Utilitarian origin. On the side scraper RT 100, on reassessment, the grooves resulting from scraping activity as well as incision activity were identified based on the difference in their orientation. Through microscopic observation of the intersections the incision grooves make with scraping striations it can be said that the incision grooves were made after scraping activity took place. Some of the incision grooves show attributes of being incised by a pointed end of a tool. The presence of scraping striations and individual incision grooves on the same

cortical area, makes this artefact unique from the rest of the artefacts analyzed in this study as well as evidence reported before from Riparo Tagliente. What makes this side scraper unique, also makes it harder to interpret as first of all, the evidence present on the scraper is partial, the scraping striations and incision grooves are not confined to the cortical area present on the scraper, indicating that it was made before the flake was taken out. Secondly, the incision grooves do not present any identifiable pattern or show symmetry, and some of the grooves show variable depth (the depth becomes negligible in some sections which is not a sign of carefully executed action. Non-representational deliberate actions such as doodling or utilitarian actions as using the original nodule as a base can be considered but not with 100% confidence. Lastly, the lack of comparable evidence from European Middle Paleolithic of similar finds which show marks from both scraping and incision activity is not avaliable, making it difficult to hypothesize the function or purpose of these marks.

Table of Contents

List of Figures

List of Tables

Introduction

Evidence of deliberate, abstract engravings on bone and stone objects in a Middle Paleolithic context or specifically related to Neanderthals is still very low and fragmented. In recent years many new discoveries and reappraisal of old finds have provided strong evidence of Neanderthals cognitive capabilities of creating intentional designs (Rodríguez-Vidal et al.,2014; Majkic et al., 2018a; d'Errico et al., 2018; Shaham et al., 2019; Leder et al., 2021; Marquet et al., 2023). Usually, the type of engraved patterns found in these sites are simple, geometric, and abstract in nature. While an idea about the degree of intentionality behind these engravings can be assessed, what these designs/ patterns represent is still unknown. While some cognitive studies have suggested that these simple geometric designs did not carry any representational value and were drawn because these patterns were just visually interesting or in simple terms "pretty" (Hodgson, 2019; Tylén et al.,2020) others like – Mellet et al., 2019, using fMRI, have suggested that these patterns can carry representational message/symbolic meaning as they are processed as organized visual representations in the brain.

While what these designs represent is still unknown, such evidence is very low where their deliberate intention or non – utilitarian function can be unequivocally stated. In case of marked/incised stones, Majkic et al., 2018a has compiled a list of 27 Lower to Middle Paleolithic sites in Europe and Middle East which have such evidence out of which only a few have been interpreted as having a Non-Utilitarian purpose (Cremades, 1995; Jaubert et al., 2009; Marder et al.,2018; Majkic 2018a) while others are either attributed to Utilitarian activities related to scraping or incision or are too old that they need reassessment of their intended function/purpose. In Italian context, P. Leonardi was one of the first archeologist in Italy who recognized the markings on bones and cortical surface of lithics which could have anthropic origin (Leonardi 1975, 1979, 1981, 1983, 1988). Recently the studies of Dallatore, 2011 and Peresani et al., 2014 studied and compared such engraved lithic artefacts from 3 different sites in the region of Italian Pre – Alps – Grotta di Fumane, Grotta Maggiore di San Bernardino and Riparo Tagliente and identified the nature of the markings as being from two activities – scraping and individual incisions and have assigned the markings of having a Utilitarian origin rather than having a representational purpose.

This study presents 3 new artefacts (2 flakes and 1 side scraper) and reassessment of an old side scraper (Leonardi, 1983; Arzarello, 2003; Peresani et al.,2014) bearing marks of anthropogenic activity from the Mousterian assemblage of the site Riparo Tagliente, Stallavena di Grezzana, Verona, Italy. Riparo Tagliente, discovered in 1958 and initially excavated in 1962 presents a 4.50 m cultural stratigraphic sequence. The uppermost layers contain artefacts associated with Epigravettian Industrial complex while the lowermost levels/layers of the sequence belong to the Mousterian Industrial Complex.

In total 429 lithic artefacts with cortical surfaces were analyzed, the analysis was conducted in two phases. First the lithic artefacts were analyzed by naked eye, looking for macroscopic attributes (marks/incisions/striae) which could be related to anthropic activity based on methods developed in previous studies (d'Errico, 1993; Fisher, 1995; d'Errico and Villa, 1997; d'Errico and Nowell, 2000; Brumm et al.,2006, Nowell and d'Errico, 2007) and then the selected artefacts were subjected to microscopic study to analyze each groove individually. The objective was to look for microscopic clues which help in deciphering technical data such as type of tool used, number of tool used, direction of incisions, chronological order of incisions based on their intersections and junctions etc. (d'Errico 1995 a; Fritz, 1999). The microscopic study was conducted by the optical microscope Leica LAS EZ4 HD (8x-35x magnification) complemented by experimental replication studies and taphonomical analysis (also conducted under microscope) of the cortical surfaces of lithic artefacts for comparison purposes.

The results show that out of 429 lithic artefacts analyzed only 3 artefacts show marks which can be related to ancient anthropogenic activity. Flake RT 11 shows marks related to scraping or abrasion activity while the other two (one flake RT 76 and side scraper 167) show marks which can be attributed to incision activity. For the already known side scraper RT 100, grooves related to two separate activities - scraping and incision were identified on the cortical surface based on the difference in their orientation and comparison with the reference experimental collection.

For interpreting the aims and functions of these marks on the artefacts, many possibilities (Utilitarian or Non-Utilitarian) were critically assessed noting the implicit ambiguities in the analysis and interpretation of such Mousterian engravings. For the flake RT 11, a utilitarian activity – scraping or abrasion to facilitate better retouching is proposed to be reason/aim for the marks, while for others, merits and demerits of many hypotheses of utilitarian and non-utilitarian kind are discussed but a firm interpretation could not be given.

1 Origins of Symbolic Behavior

1.1 What is Symbolic Behavior and its role in defining Cultural Modernity:

The terms like Modern behavior or Cultural Modernity were defined in European context where the innovative behavioral traits of the Aurignacian archaeological record (Upper Paleolithic) (Fig 1.1), later modified to include instances of complexity from modern human populations in southern Africa were type casted as the behavioral traits of Modern Humans with advanced cognitive ability globally. The presence or absence of these behavior traits was used as a litmus test to indicate modern human intellect and in turn used to investigate and create hypothesis and models regarding the origins of cultural modernity (McBrearty & Brooks 2000).

Archaeological signatures of modern human behavior

Ecology
- Range extention to previously unoccupied regions (tropical lowland forest, islands, the far north in Europe and Asia)
- Increased diet breadth

Technology
- New lithic technologies: blades, microblades, backing
- Standardization within formal tool categories
- Hafting and composite tools
- Tools in novel materials, e.g., bone, antler
- Special purpose tools, e.g., projectiles, geometrics
- Increased numbers of tool categories
- Geographic variation in formal categories
- Temporal variation in formal categories
- Greater control of fire

Economy and social organization
- Long-distance procurement and exchange of raw materials
- Curation of exotic raw materials
- Specialized hunting of large, dangerous animals
- Scheduling and seasonality in resource exploitation
- Site reoccupation
- Intensification of resource extraction, especially aquatic and vegetable resources
- Long-distance exchange networks
- Group and individual self-identification through artefact style
- Structured use of domestic space

Symbolic behavior
- Regional artefact styles
- Self adornment, e.g., beads and ornaments
- Use of pigment
- Notched and incised objects (bone, egg shell, ocher, stone)
- Image and representation
- Burials with grave goods, ocher, ritual objects

Figure 1-1: Attributes associated with Modern human behavior (taken from (Mcbrearty and Brooks, 2000))

Overtime criticisms of the behavioral trait approach to cultural modernity were expressed by many authors as (Foley and Lahr1997; Deacon, 2001, Wadley 2001; Henshilwood and Marean, 2003) -

- Many traits were empirically derived from Western European Upper Paleolithic context, creating problems for their use in other contexts such as that of tropical/ subtropical Africa.
- Secondly adhering to the behavioral trait approach led to a circular argument where new evidence of modern behavior was judged based on old evidence which was decided upon as indicator of modern behavior without rigorous testing.
- The emergence of many of the so called modern behavioral traits can be linked to other processes such as resource or labor intensification and environmental pressure and not advanced cognitive ability.
- The presence or absence of material remains are subjected to taphonomical changes over time with respect to their specific environmental conditions, which might skew our understanding.

Instead of heavily relying on the behavioral – trait approach, an approach based on social intelligence and symbolic behavior was developed to re-define cultural modernity (Chase and Dibble 1987; Stringer and Gamble1993; Mellars1996; Wadley2001; McBrearty & Brooks 2000; Henshilwood and Marean 2003; Henshilwood & Dubreuil, 2011). Symbolic behavior is defined as "*one in which individuals understand that artefacts are imbued with meaning and that these meanings are constructed and depend on collectively shared beliefs*" (Henshilwood and d'Errico, 2011). Here the main importance is on the creation of symbolic material culture where artifacts or features carry a clear symbolic message indicating storage of symbolic information outside of the human brain. Presence of symbolic behavior or symbolically mediated behavior is associated with major cognitive advancement as it demonstrates the ability for sharing, storing and transmitting coded information within and across groups which in turn plays a role in creating, maintaining and transmitting the social conventions, beliefs and identities that characterize all known human societies (Wadley, 2001; Henshilwood and Marean, 2003, Henshilwood and d'Errico, 2011, Kissel and Fuentes, 2018).

Identification of what constitutes as symbolic material culture is difficult as artefacts with secular function such as bone tools or blade technology do not directly indicate symbolism and their mere presence cannot confer cultural modernity. "*It is only when that technology begins to participate in the social and ideological realms of life (Individual or group identity) that it takes on a symbolic role*" (Kuhn & Stiner 1998, 155–6). However, there is a consensus on what manifestations should represent symbolism in the archaeological record. These objects include figurative or non-figurative parietal art, portable or mobiliary art objects made on ivory, bones, antlers and stone (figurative carvings, engraved or painted designs (abstract or figurative)), use of pigments, ornamentation, burials, artefacts styles indicating individual or group identity, organized spatial layout of campsites etc. (McBrearty & Brooks 2000; Wadley 2001; d'Errico et al. 2003; Soressi and d'Errico, 2007, Henshilwood and Marean 2011).

The question of the emergence of symbolically mediated behavior in past hominin species has implications on how many species practiced symbolic behavior? How and when did this behavior emerge (abruptly, gradually or in a discontinuous manner)? and lastly what factors have driven cultural evolution in our lineage (genetic or cultural drift, climate, demography)? Various hypotheses and models have been proposed which keep on changing/adjusting as more discoveries are made.

1.2 Human Revolution Model:

The old viewpoint regarding the origin of symbolically mediated behavior along with other behavioral attributes which define modern culture/behavior (Fig 1.1) were linked to the transition from Middle to Upper Paleolithic in Europe and Middle to Late Stone Age Transition in Africa around 40 – 50 Kya (Binford, 1985; Clark, 1989; Klein, 1995, 2000, 2001; Klein & Edgar, 2002; Mellars, 1996). An abrupt innovation/advancement in terms of range occupied, deliberate structures, standardized technology (blade production), sustenance strategies, social organization complexity and explosion of complex mobile and parietal art along with other symbolic attributes in European Upper Paleolithic (Stringer & Gamble, 1993) was considered to be the culmination of behavioral changes which first appeared in a core population of Modern Humans in African Late Stone Age and later spread to Europe with the arrival of said population of Modern Humans. It inherently linked the term 'modern behavior' with our species while associating all the other archaic coeval hominin species such as Neanderthal's in Europe as 'non-Modern'. This viewpoint also considered the anatomically modern human populations of early Middle Stone Age in Africa as not behaviorally modern but existing with simple material culture, basic sustenance, and no symbolic behavior (Henshilwood and Marean, 2003). This theory often termed as "Human revolution" or "Upper Paleolthic Revolution" (Bar-Yosef 1998, 2002) compresses the emergence of symbolic behavior, expansion of Modern humans outside Africa and extinction of other coeval archaic hominin species in a very short time interval. Such a drastic change in a relatively short time interval was thought to be evidence of cognitive advance, reorganization of the brain and possible origin of language (Klein 2000, 2009).

1.3 Out of Africa Model:

A biological explanation of sudden advantageous neurological mutations proposed by the "Human Revolution" model, which led to the appearance of symbolic behavior and other so called "Modern" attributes in the Late Stone Age in Africa and Upper Paleolithic in Europe cannot be testified through fossil records. The origin of our species - anatomically modern humans is placed around 200 – 150 Kya, after which no further significant changes in the brain capacity can be observed (Mellars, 2006; Henshilwood and Marean, 2003). Apart from that, with new evidence of symbolic behavior and material culture in the African continent and Middle East, pre-dating the MSA – LSA boundary, the notion of abrupt emergence of symbolic behavior was replaced by an alternative model, which proposed a gradual and mosaic emergence of symbolic attributes during the Middle Stone Age as our species *Homo sapiens* evolved in the African continent. (McBrearty and Brooks, 2000; Henshilwood et al., 2002, 2004; Henshilwood and Marean, 2003, 2006)

1.3.1 Early evidence of symbolic behavior in African and Middle East MSA:

Burials:

Earliest examples of burial sites in *Homo sapiens* context are from 115 Kya occupation of Skhul cave, Israel (Grün et al., 2005) and 100 Kya occupation of Qafzeh cave, Israel (Vermeersch, 1970). At least two of the burials in these two sites are associated with grave offerings (a large deer antler lying directly on top of one of the Qafzeh skeletons and a complete boar's jaw said to be ''clasped in the arms'' of one of the burials at Skhul) showing ceremonial/ritualistic behavior. The interesting thing about these burials is that although they appear to be anatomically and symbolically modern, the stone tool technology associated with these sites has typical MSA features with no distinctively modern technological features. Other than these two examples, burial evidence is very scarce in the early MSA context. Only 3 more unambiguous examples are known - Panga ya Saidi (PYS), Kenya (82Kya – 74Kya) (Martinón-Torres et al., 2021), Border cave, South Africa ~ 70kya (Millard 2006), Taramsa, Egypt 68kya (Van Peer et al., 2010) (all three of them being infant burials) predating the MSA – LSA (50 Kya - 40 Kya) boundary after which burials become more common in modern human context (d'Errico & Henshilwood, 2011).

Personal Ornaments:

In early African and Middle Eastern MSA record, presence of marine shells such as *Nassarius kraussianus*, *Nassarius circumcinctus*, *Tritia gibbosula etc.* with artificial or natural perforations as well as presence of use wear and ochre residues on them at some sites has led to their interpretation of being intentionally collected and used as personal ornaments by *Homo sapiens* (d'Errico et al. 2005; Bar-Yosef Mayer et al., 2009; d'Errico et al. 2009; Vanhaeren et al., 2013; d'Errico and Backwell 2016). Some prominent examples include sites such as Skhul cave and Qafzeh cave (naturally perforated shells modified and having traces of suspension and pigmentation) in Israel (Vanhaeren et al. 2006), Blombos cave , Border Cave (associated with burial) and Sibudu Cave in South Africa (Henshilwood et al. 2004; Vanhaeren et al., 2013; d'Errico and Backwell, 2016; Vanhearen et al, 2019), Grotte des Pigeons, Bizmoune Cave, Rhafas and Contrabandiers in Morocco and Oued Djebbana in Algeria (Bouzouggar et al. 2007; d'Errico et al. 2009). All the sites mentioned above as well as other evidence of using marine shells as beads is dated between 135 Kya and 75 Kya (Steele et al. 2019) (Fig 1.2). While some shells were deliberately perforated at some sites, most of the sites' naturally perforated shells were slightly modified or not at all modified to be used as beads. What is consistent in all the evidence is the intentionality of the modern human groups in collecting the marine shells, with *Tritia and Nassarius* being the most common, over time and space in African and Middle East context. Even older evidence of deliberate collection of non-perforated shells comes from Misliya cave, Israel (240Kya – 160Kya) (Weinstein-Evron M et al., 2019) and Pinnacle point, South Africa (~ 164Kya) (Jerardino et al., 2019). After 70 Kya there is a gap till 40 Kya where no evidence of perforated shells is present and after which they reappear everywhere in Africa and Eurasia, differing from the earlier counterparts in terms of having different types, regional identities as well as use of different raw materials (bone, teeth, ivory, stone, metal, glass, eggshell, and mollusks) to make beads (d'Errico & Henshilwood, 2011).

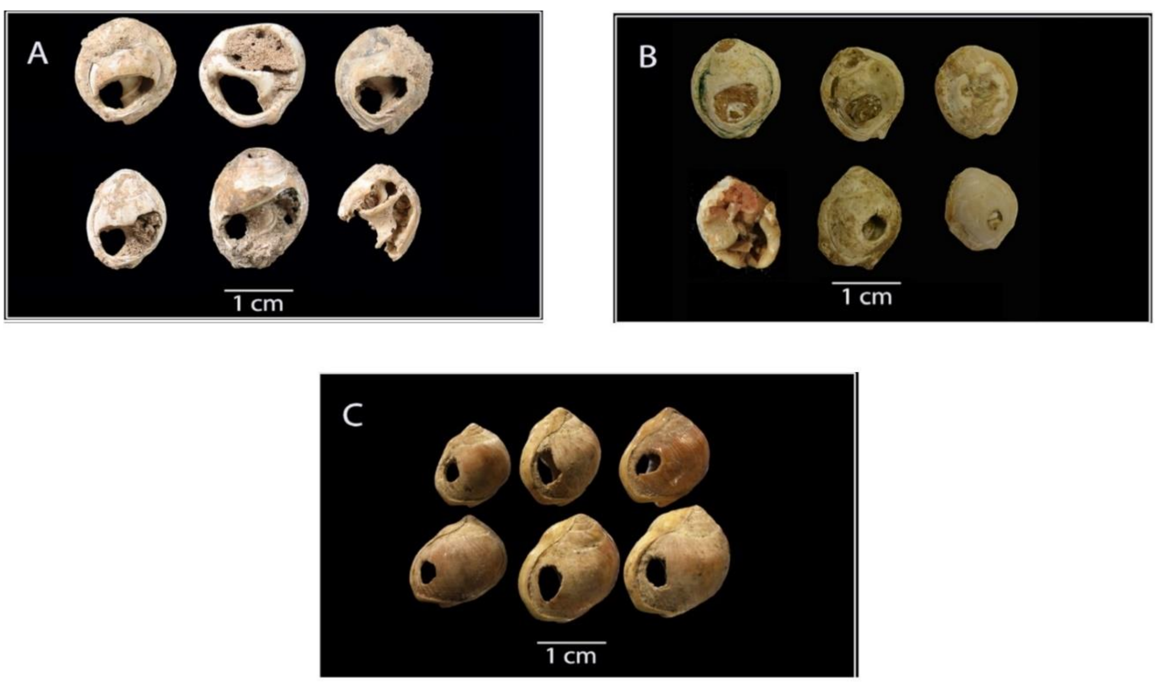

Figure 1-2: Examples of perforated shells interpreted as personal ornaments A) Contrebandiers Cave, Morocco,B) a fossil beach outcrop in Temara, Morocco and C) Blombos Cave, South Africa. (Taken from (Steele et al., 2019))

Engravings/paintings on bone, stone, and ochre:

Many early isolated examples of abstract and complex geometric patterns engraved on bone and ochre are present in the African MSA sites (~ 100 Kya) which are associated with *Homo sapiens* (d'Errico et al. 2012, Anderson, 2012). A few examples are - Kleinkliphuis River site, South Africa (engraved stone with a cross-hatched pattern) (Mackay and Welz, 2008); Palmenhorst, Namibia (an engraved pebble) (Wendt, 1975), Cape Hangklip, South Africa (parallel line engravings on stone)(Minichillo 2005), Klasies river (parallel lines engraved on bone fragments, ocherous pebble bearing a sequence of sub-parallel linear incisions)(d'Errico and Henshilwood, 2007; d'Errico et al. 2012). While evidences from most sites are singular and isolated, two MSA sites in South Africa - Blombos cave (Still Bay techno tradition, many engraved ochre pieces, one engraved bone fragment and one ground silcrete flake with a cross-hatched pattern drawn with an ochre crayon, 100 Kya – 70 Kya)(Fig 1.3, 1.4) (d'Errico et al. 2001, Henshilwood et al. 2002, 2009; Henshilwood and d'Errico, 2011; Henshilwood et al. 2018) and Diepkloof Rock Shelter (Howiesons Poort techno tradition, engraved ostrich eggshells, 65 Kya) (Fig 1.5)(Texier et al. 2010; Henshilwood & d'Errico, 2011) provide adequate evidence, ruling out an accidental nature of such engravings and proving an early capacity for symbolic thought before 50 Kya – 40 Kya period in Africa.

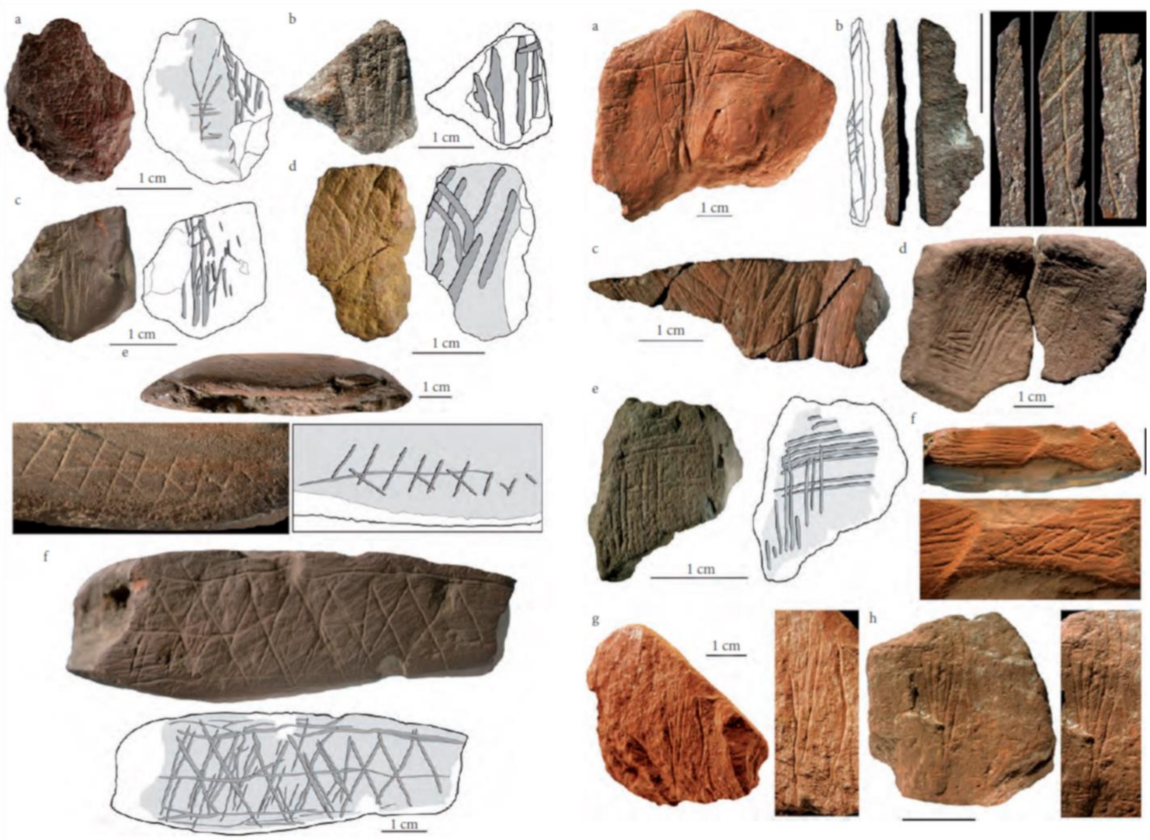

Figure 1-3: (on the left) Engraved ochre from the M1 phase (78–72 ka) at Blombos Cave, (on the right) Engraved ochre from the M2 and M3 phases (85–100 ka), at Blombos Cave. (Modified from Henshilwood and d'Errico, 2011)

Figure 1-4: A silcrete flake L13 displaying the drawn lines that form a cross-hatched pattern (73 Kya) (Taken from Henshilwood et al., 2018)

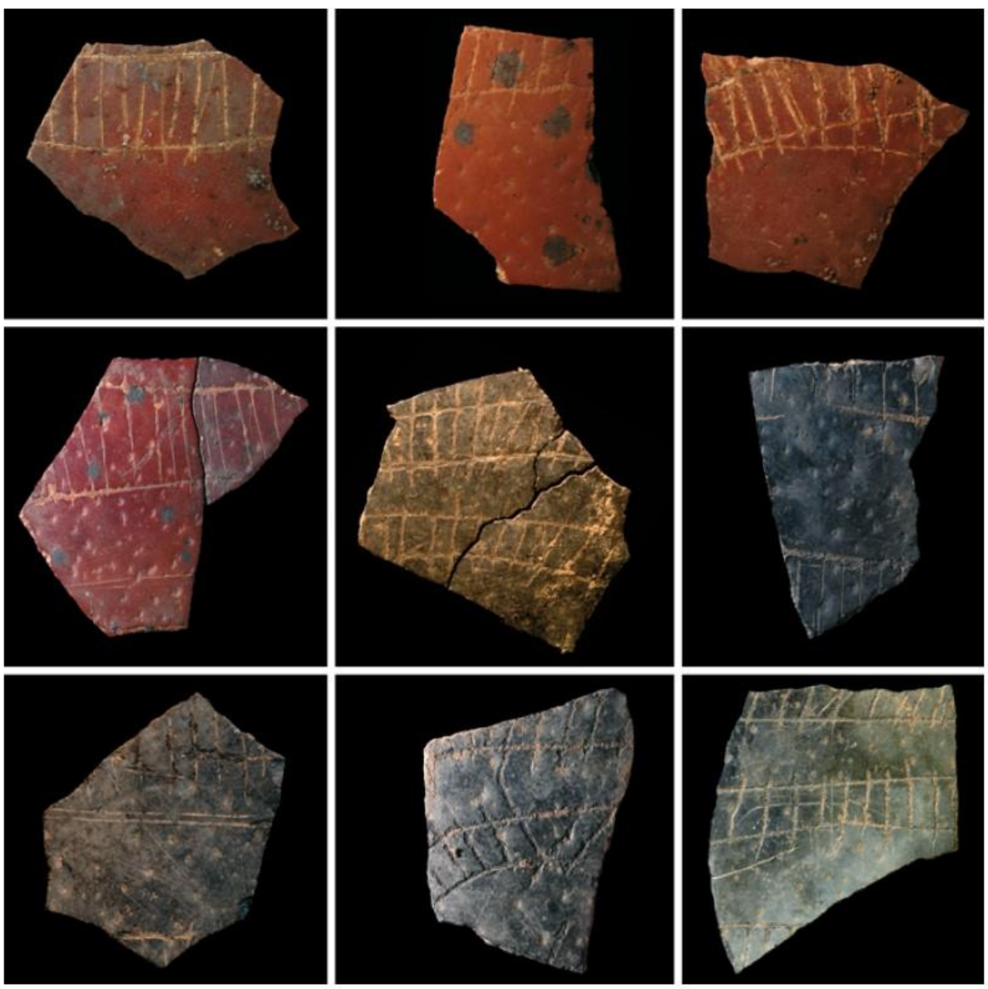

Figure 1-5: Engraved ostrich eggshell from the 60 ka Howiesons Poort levels at Diepkloof Rock Shelter, South Africa. (Taken from (Anderson, 2012))

Use of pigments:

Dapschauskas et al., (2022) observes 3 phases of ochre use in the continent of Africa from 500 Kya – 40 Kya with ochre being present in one third of the sites in Africa in the last phase starting from 160Kya. Although exploitation of ochre pigmentation can be associated with utilitarian activities such as - skin protection from sun or insects, as medicine, for tanning hides, or as a binding agent to facilitate hafting (Wadley et al., 2009), Dapschauskas et al., (2022) argues for a more ritualistic use of the ochre. The high frequency of use of ochre at many sites after 160Kya implies a repetitive, formalized behavior which in turn is the definition of ritualistic behavior. Other than that selection of ochre based on intense red hues, procurement from far away sources, heating of pigment to change color observed at many MSA sites give a more symbolic/ritualistic meaning to the use of ochre. Association of ochre with burials, abstract engravings on ochre and presence of ochre residues on the marine shell beads used as personal ornaments further signify the cultural use of ochre, especially colored shell beads as their analysis deduce that either the beads were intentionally colored, or they were rubbed against ochred material such as human skin or animal skin which links the ochre use and self-decoration of MSA people, including body, face, hair and hide painting, and/or the deliberate coloration of personal ornaments. In Middle east the oldest evidence of pigment use is around 100 Kya (d'Errico et al., 2010; Hovers et al., 2003).

1.3.2 Changing demography as a triggering factor behind the earlier origin of cultural modernity in African MSA:

Along with evidence of symbolic behavior, distinct elements of the social, economic and technological attributes (blade and microlithic technology, bone tools, increased geographic range, specialized hunting, the use of aquatic resources, long distance trade) associated with modern behavior can be observed in the African MSA archeological record. The evidences from the cultural stratigraphic levels belonging to 'Still bay techno tradition' at Blombos cave and 'Howiesons Port techno tradition' at Klasies River, Boomplas and Diepkloof MSA sites in South Africa between 75 Kya and 55Kya present a number of technological and cultural features which show resemblance with the sites associated with the anatomically and genetically modern populations at 50 Kya – 40 Kya in Europe and Middle East (Henshilwood & Dubreuil, 2011). These discoveries suggest that the Modern Human population which eventually moved out of Africa at 50Kya – 40 Kya were already behaviorally modern by the 80 Kya – 60 Kya time period (Mellars, 2006; Henshilwood and Marean, 2003, 2006; Henshilwood, 2012).

In the light of the new discoveries, it became apparent that the archeological evidence of symbolic behavior or in more general terms 'Modern Behavior' in the African MSA were present by ~ 150 Kya in

Africa and by ~ 100 Kya in the Middle East. Over time these attributes appeared, disappeared and reappeared at different times and places in the African and Middle east MSA sites and not as a collective package as stated according to the "Human Revolution" theory (Mellars, 2006; d'Errico and Henshilwood, 2011; Lombard and Parsons, 2011). This prompted the researchers to search for alternative reasons other than proposed neurological change at the 50 Kya – 40 Kya for the discontinuous evidence of origin of symbolic behavior. The cognitive requirement/capacity for symbolic behavior was probably developed early with the origin of anatomically modern humans and subsequent appearance, disappearance and reappearance of symbolic evidence can be explained through changing demographics of modern human populations with changing environmental and climatic conditions (local and global) as the major driving force (Mellars 2006; Henshilwood, 2008; d'Errico and Stringer, 2011). The role of population size in appearance as well as disappearance of cultural innovations can be paralleled to genetic evolution where low population size results in stagnation or loss of innovations by chance while a large population size prevents that and creates a positive feedback loop between survival rate and cultural innovations resulting in stable growth limited by the rate of cultural innovations (Shennan, 2001; Richerson et al., 2005, 2009; Powell et al., 2009). Changes in the demography explain the mosaic record of symbolic behavior in Africa without invoking an abrupt biological change at the MSA – LSA boundary. The question of how climatic variability and local ecological niches in which these populations evolved and affected human adaptations remains open. Further research is required to develop a single analytical approach which unifies the wide variety of data sets from multiple disciplines (archeology, paleoenvironmental studies and climate modelling) to reconstruct the timing and mode of emergence of key innovations in symbolic behavior in the African and Middle East MSA record associated with *Homo sapiens* as well as Middle Paleolithic record of Eurasia associated with Neanderthals (d'Errico and Henshilwood, 2011, d'Errico and Stringer, 2011).

1.4 Symbolic Neanderthal and Assimilation model:

The scientific consensus until late 20th century relegated Neanderthals along with other coeval archaic Hominin species as inferior to anatomically modern humans in terms of morphology, behavior and genetics. A sharp advancement in the material culture from Middle Paleolithic Industries (associated to Neanderthals) to Upper Paleolithic Industries (associated with modern humans) plus complete and rapid replacement of Neanderthals by Modern Humans in Europe painted a picture where archaic Neanderthals were of no match to the expanding modern human populations with superior cognitive abilities (due to speciation) and went extinct without descent (Stringer and Gamble, 1993).

Evidences of symbolic behavior (personal ornaments and decorated bone tools), after arrival of Modern Humans, from transitional Chatelperronian Industries in France and Spain and Uluzzian Industries in Italy (45 Kya – 40 Kya) associated with Neanderthals were explained as – maybe of natural origin, as intrusions from the overlying Aurignacian layers present in those sites (eg - Grotte du Renne, France) (White, 2002) or as a evidence of trade between the contemporary Neanderthals and Modern humans, refusing the Neanderthal origin of such artifacts. Even if the Neanderthal origin was demonstrated of such artifacts, it was considered a result of acculturation through either short distant contact with contemporary Aurignacian Industries which resulted in imitation of such artifacts or because of long-distance cultural diffusion (Stringer and Gamble 1993; Mellars, 1996, 1999; Hublin, 2000).

Overtime with new discoveries and reappraisal of key Mousterian sites in Europe and Middle East, evidences of Neanderthals having diversified hunting strategies (Gaudzinski-Windheuser and Niven, 2009; Rendu, 2010; Rendu, 2022), exploitation of a wide array of resources (Stringer et al., 2008; Hardy and Moncel, 2011; Salazar-García et al., 2013), ability to ignite and control fire (Heyes et al. 2016) and elaborate and complex tool technologies (Wooden spears, bone tools, use of birch tar adhesive to make composite tools) (Thieme, 1997; Mazza et al., 2006; Lazuén, 2012; Hardy et al., 2013, Soressi et al., 2013) have increased. Such examples dispel the previous notions of Neanderthals having limited planning capacities and develop only expedient technologies involving a low degree of conceptualization. Also, reinterpretation of the Chatelperronian sites with symbolic artifacts refuted the acculturation and taphonomic explanations (d'Errico et al., 1998, Zilhão, 2001; d'Errico, 2003; Zilhao, 2011b). At Grotte du Renne, most of the symbolic artifacts (ornaments) came from the lowest layers of Chatelperronian occupation, therefore making intrusion from above lying Aurignacian layers less likely. Other than that, close contact acculturation from Aurignacian sources was refuted based on differences in choice of blank, manufacturing technique, and function of the said artifacts (d'Errico et al., 1998). The only option of long-distance acculturation (Hublin, 2000) from Africa or Middle east via cultural diffusion can be justified but this approach implies spread of concepts from modern humans to Neanderthals over very long distances, inadvertently establishing that the cognitive abilities of Neanderthals were at par with Modern humans, thus disproving the lack of cognitive abilities in Neanderthals for which this hypothesis was first put forward (Zilhao, 2011b).

1.4.1 Evidence of Neanderthal symbolic behavior:

Engravings on bones and pieces of rock:

Rare and isolated occurrences of engravings have been reported from several Lower and Middle Paleolithic sites in Europe (Lorblanchet 1999; Bednarik, 1995). While there is a doubt on anthropogenic origin of many of such artefacts (d'Errico & Villa, 1997) some of them can be considered as being deliberately engraved. The engravings are very simplistic in nature, mainly being lines or group of lines. Even when anthropogenic origin is confirmed, associating them with symbolism is difficult as they could be a result of various utilitarian activities (Majik et al., 2018a). Evidence of Neanderthal engravings will be discussed in detail in the next chapter.

Personal ornaments:

Evidence of pigmented marine shells used as ornaments is very rare in sites associated with Neanderthals before arrival of *Homo sapiens* in Europe. Earliest evidence comes from Cueva de los Aviones, Spain (Fig 1.6) (115 Kya) (Zilhão et al., 2010; Hoffmann et al., 2018). Other robust evidences include sites like - Cueva Antón, Spain (Fig 10)(50 Kya) (Zilhão et al., 2010) and Mousterian Layers at Grotta di Fumane, Italy (47.6 Kya – 45.0 Kya) (Peresani et al., 2013). After arrival of *Homo sapiens* such evidence is associated with both Neandertals and *Homo sapiens* (d'Errico et al., 2003).

Figure 1-6: (Left) Perforated shells from Mousterian level II, Cueva de los Aviones, Spain, (Right) P. maximus shell from Mousterian level I-k of Cueva Anton, Spain (Modified from (Zilhao et al., 2010))

Evidence of pendants made from animal bone and teeth and of fossils (Fig 1.7) was recovered from Chatelperronian sites in France, like Grotte du Renne and Quincay Rockshelter (Roussel and Soressi, 2010; Caron et al. 2011; Zilhao, 2012). The pendants were made by making a groove around tooth root, for tying the string around it and when a piercing was used, the root was first perforated and then was enlarged and smoothen from the inside (d'Errico et al., 1998). The dating of Chatelperronian layers of Grotte du Renne puts the symbolic evidence at ~40 Kya, which is after the arrival of Homo sapiens into Western

Europe (Benazzi et al., 2011; Hublin et al., 2012).

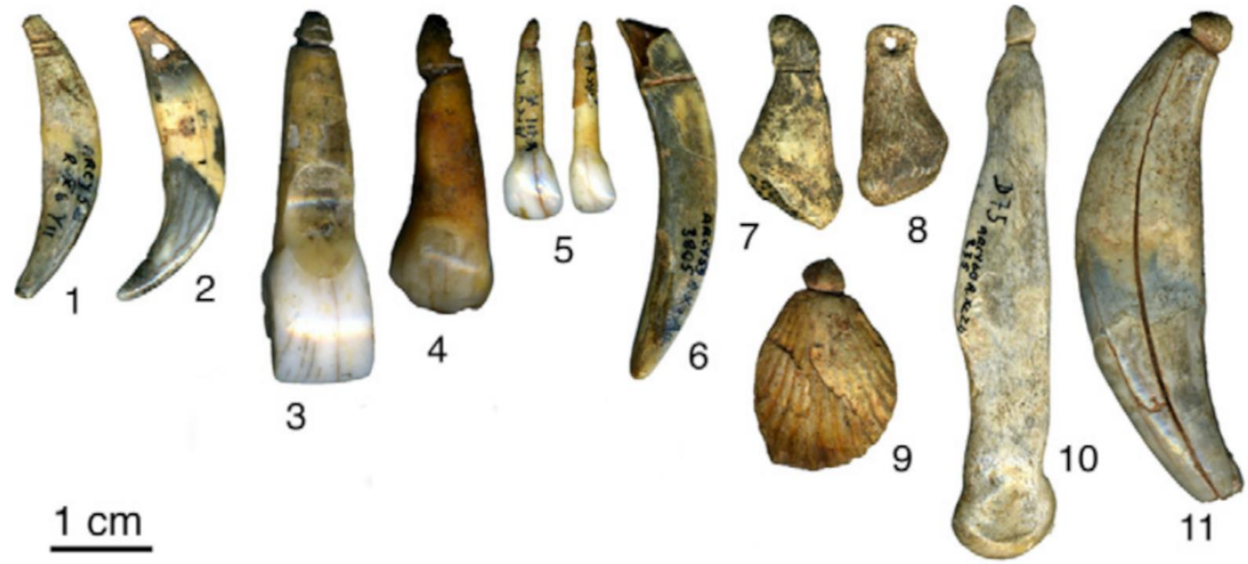

Figure 1-7: Personal ornaments made of perforated and grooved teeth (1–6, 11), bones (7–8, 10) and a fossil (9), Grotte du Renne (Arcy-sur-Cure, France)(Modified from (Caron et al., 2011))

Exploitation of wings and/or feathers for symbolic purposes in Middle Paleolithic has been attested from sites in Southern Europe such as – Grotta di Fumane, Italy (Peresani et al., 2011), Vanguard Cave and Gorham cave, Spain (Finlayson et al., 2012). Cut marks are observed on the humeri, radii, and ulnae of Alpine chough, red kite (*Milvus milvus*), and griffon vulture (*Gyps fulvus*) in Vanguard cave and Gorham cave. In Grotta di Fumane, scrape marks near the sites of feather attachment in addition to the cut marks related to disarticulation on greater spotted eagle (*Clanga clanga*), the bearded vulture (*Gypaetus barbatus*), the Eurasian black vulture (*Aegypius monachus*), the red-footed falcon (F*alco vespertinus*) as well as the Alpine chough (*Pyrrhocorax graculus*) and common wood pigeon (*Columba palumbus*) indicate use of a lithic cutting implement to cut the skin covering the ulna and to remove the flight feathers. As wings/feathers are inedible, the deliberate exploitation of part of wings or long feathers is linked to their use in adorning heads, bodies, and clothes (Peresani et al., 2011; Finlayson et al., 2019; Jaubert et al., 2022).

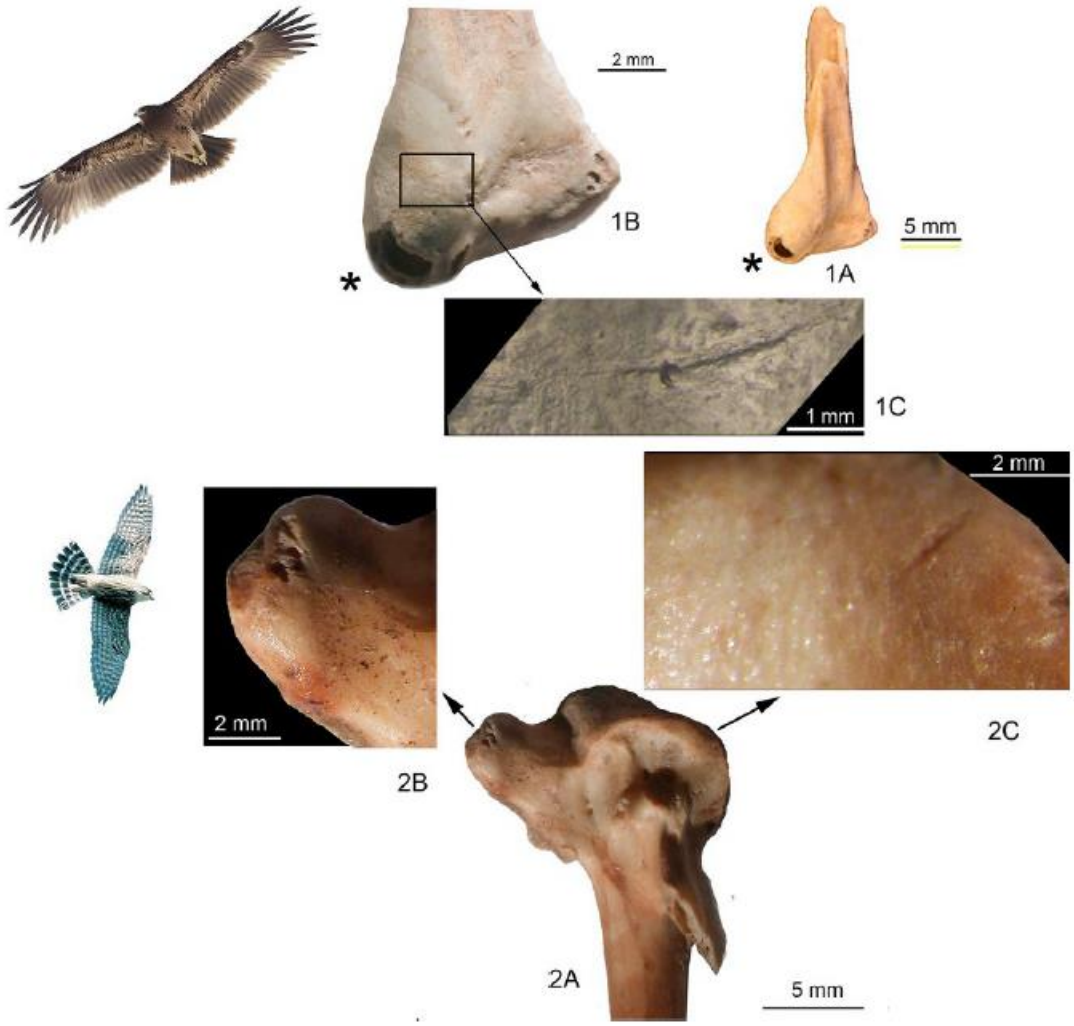

Figure 1-8: Cut-marked wing bones from the Middle Palaeolithic at Fumane Cave, Italy. 1. Clanga clanga distal radius; (1A) distal articulation with a puncture of the surface (*); (1B) detail of the incision; (1C) close-up from stereomicroscope image. 2

Like feathers, deliberate removal of raptor birds pedal phalanges in Middle Paleolithic indicates a symbolic use. Although its occurrence is rare but isolated examples of raptor phalanges bearing cut marks have been found in Pech-de-l'Azé I and IV, Baume de Gigny, Combe-Grenal, Les Fieux and Mandrin in France, Fumane and Rio Secco Caves in Italy, Karpina, Croatia representing their use over a large geographical area as well as a long time period (100 ka to 44–45 ka BP) (Jaubert et al., 2022). Disarticulation of the digits was done using lithic tools to cut into the thick skin, the stratum corneum, to expose the joints and sever the strong ligaments and tendons (Romandini et al., 2014). In Karpina, Croatia along with the disarticulation marks, remnants of a string and traces of ochre are also detected on the phalange

(Radovčić et al., 2020). Hypothesis suggesting ornamental use of the phalanges is based on their length and curvature, and possibility of their suspension in different ways as observed in ethnographic record.

Figure 1-9: Cut-marked raptor claws from the European Middle Palaeolithic. (Taken from (Romandini et al. 2014))

Burials:

Earliest evidence of Neanderthal burial comes from Tabun cave 1 in Israel (120 Kya) (Bar-Yosef and Callander, 1999) which is older than the evidence of modern human burial in the region. The youngest evidence of neanderthal burials falls between the time period of 45 Kya – 40 Kya from sites such as Le Moustier 2, France (Maureille, 2002), Spy II, Belgium (Devièse et al., 2021) and La Ferrassie 8, France (Balzeau et al., 2020). Evidence of symbolic artifacts or grave goods such as - a stone with cupules (La Ferrassie 6), three scrapers (La Ferrassie 5), some unmodified bony objects (La Ferrassie 1), a fragment of a Cervus elaphus maxilla (Amud 7), a small flat stone near the head, and a piece of flint near where the heart would be placed (Dederiyeh 1) is present but the nature of their origin (anthropic or natural) is contested (d'Errico and Henshilwood, 2011; Jaubert et al., 2022). In total 44 suspected burial evidence is associated with Neanderthals from 23 sites out of which a considerable part of the evidence of burial practice comes from 2 sites - La Ferrassie, France (~70Kya – 60Kya)(Peyrony, 1934; Zilhão, 2012; Balzeau et al., 2020) which contains 6 single burials and Shanidar cave, Israel (~100 Kya – 60 Kya)(Fig 14) (Solecki, 1971; Pomeroy et al., 2020) with at least five primary (single) and one collective (four individuals) burials.

Most of the evidence related to neanderthal burials lacks information on the study of taphonomy of the osteological remains within their sedimentological and archaeological contexts, as most of the sites were excavated a long time ago. It creates doubt over the anthropic origin or more specifically the intentionality of the burial as well as the other grave goods found near the grave (Dibble et al., 2015). Nonetheless, enough evidence exists to accept intentional burial of Neanderthals, albeit being simpler in form as compared to Modern human burials in the same time frame (Vandermeersch et al., 2008).

Figure 1-10: (Left) The burial pit of La Chapelle-aux-Saints 1, France (Photo B. Maureille)(Right) Partially excavated upper part of the trunk and the skull of a new Shanidar adult Neanderthal (Photograph and copyright: Graeme Barker (McDonald Institute for Archaeological Research, University of Cambridge (Modified from Jaubert et al., 2022)

Use of Pigments:

Evidences of Neanderthal use of pigments is sporadic, with 40 sites noted in Middle Paleolithic (MIS 6 – 3)(d'Errico et al., 2010). The earliest use is at 250 - 200 Kya from Maastricht-Belvédère, Netherlands (Roebroeks et al., 2012) and systematic use only after 60 Kya. Most of these sites have evidences of manganese dioxide pieces for black pigment with some of the sites such as Pech de l'Aze, France having more than 450 pieces out of which 250 show trace of utilization (d'Errico, 2003; Soressi and d'Errico, 2007, Zilhão et al., 2010). Pigment use is frequent and intensive in Mousterian sites located in France and Italy before the arrival of *Homo sapiens* in Europe (Salomon, 2009; Ronchitelli et al., 2009). However, it should be noted that associating symbolic meaning to pigment use requires more research as many utilitarian functions of pigment exist. One such study Heyes et al., (2016) links the deliberate collection of manganese dioxide pieces in Pech de l'Aze, France for fire making as manganese dioxide reduces wood's auto-ignition temperature and substantially increases the rate of char combustion.

Non - figurative cave art:

Any form of cave art was considered a forte of *Homo sapiens* but recent U –Th dating of calcite overlying motifs in 3 caves - La Pasiega, Maltravieso, and Ardales in Spain (Hoffmann et al., 2018a) reveal dates older than arrival of *Homo sapiens* in Europe, effectively associating them with Neanderthals. In one of the passages of La Pasiega Cave (García-Diez et al., 2018), one panel contains a ladder-shaped sign consisting of two parallel vertical lines with horizontal lines at different heights (Fig 1.11). The calcite formation partially covering the design is dated at 64.8 Kya (Hoffmann et al., 2018a). In Maltravieso Cave (Ripoll et al., 1999) a stenciled hand motif was dated to at least 66.7 ka (Hoffmann et al., 2018a). In Ardales cave (Cantalejo et al., 2006) a red pigment has been sprayed on convex and concave part of curtain like folds of a large calcite pillar to create elliptical shapes. Dating results of the red paintings showed that they were first made before 65.5 ka, with more graphic activity between 48.7 Kya and 45.3 Kya and again between 45.5 and 38.6 ka BP (Hoffmann et al., 2018a).

Various criticisms ranging from the reliability of U-series measurements of the sample ages, correct application of U-series method, demonstrability of stratigraphic relationships between art and samples and anthropogenic origins and intentionality of the motifs (Aubert et al., 2018; Slimak et al., 2018; White et al., 2020) have been cited regarding these evidence, generating intense debate (Hoffmann et al., 2018b, 2018c, 2019, 2020; Zilhão, 2020). If these cave motifs are fully accepted as created by Neanderthals, it proves that *Homo sapiens* were not the only species capable of figurative art plus raises doubt on other handprints and hand stencils, discs, and simple linear signs in other caves which could have been made by Neanderthals too (García-Diez, 2022).

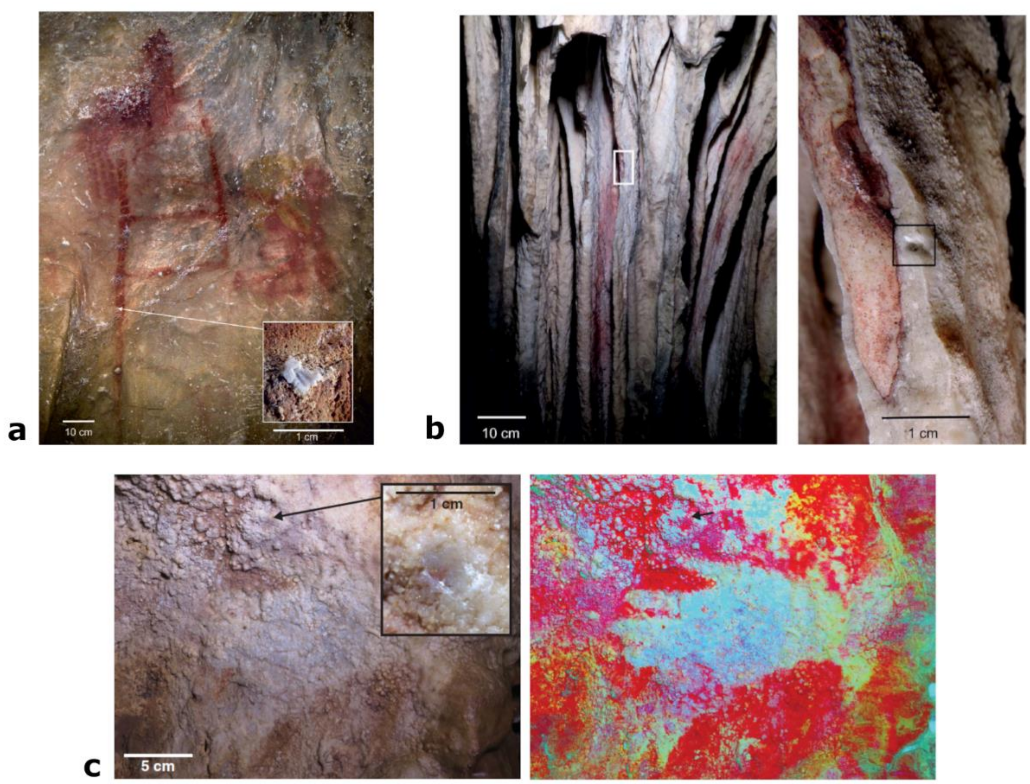

Figure 1-11: A) Red scalariform sign, panel 78 in hall XI of La Pasiega gallery C (64.8 Kya) B) Speleothem curtain with pigment in Ardales cave (65.5 Kya - 38.6 Kya) (Left - Series of curtains with red paint on top, Right - Detail of curtain 8. C)Hand stencil GS3b C) Hand stencil GS3b in Maltravieso cave (66.7 Kya) (Left - Original photo, Right - Under D - Strech software) (Modified from (Hoffmann et al., 2018a))

Other possible evidence of symbolic behavior -

336 m inside the Bruniquel Cave, Southwest France, there are 6 structures made up of stalagmites, out of which 2 are in a ring like structure while other 4 are accumulations. Alongside this, 10 fireplaces have also been found. Its age of 176.5 Kya puts the structures firmly in the Neanderthal territory. While studies are ongoing to test its symbolic or ritualistic nature (Jaubert et al., 2016; Salmon et al., 2017), other uses such as domestic or economic can be ruled out at the time being.

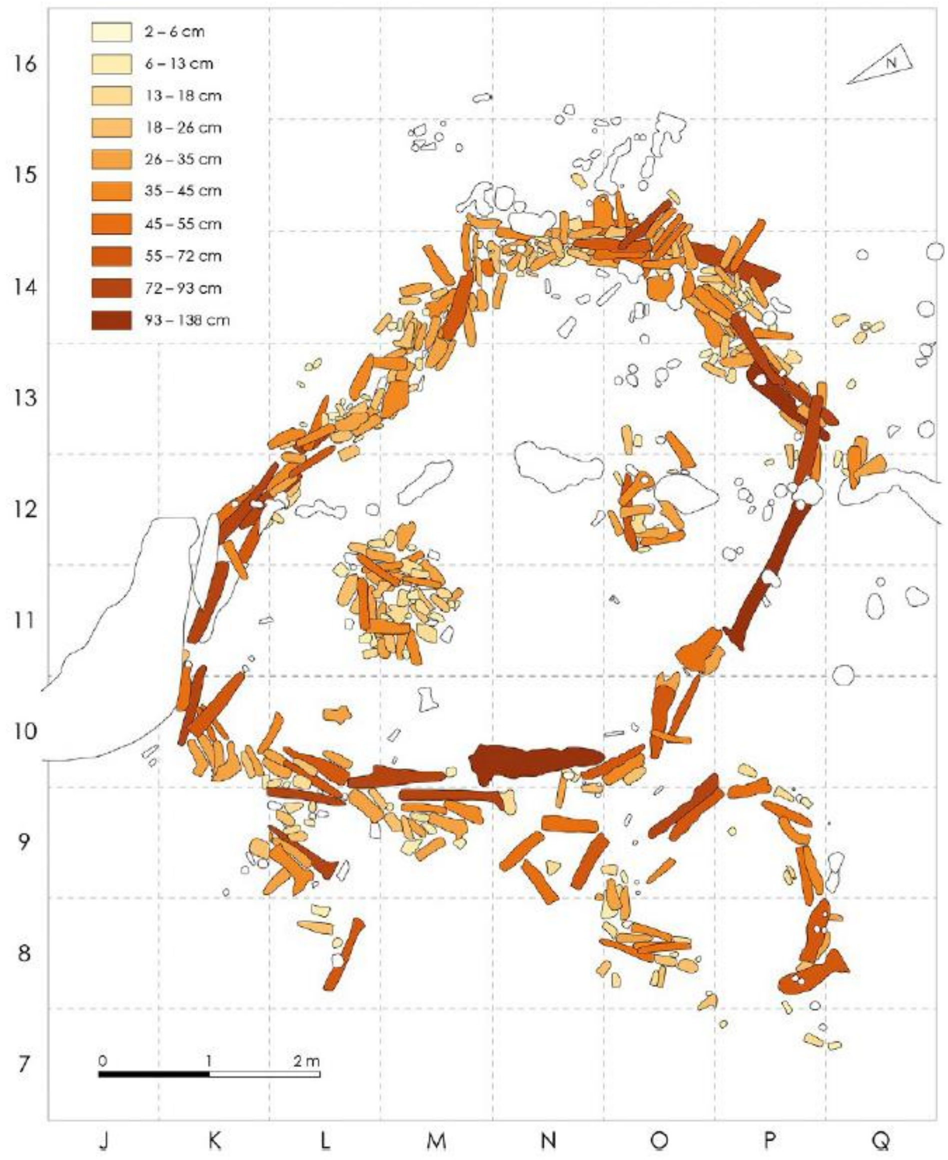

Figure 1-12: Bruniquel Cave (France, MIS 6). Plan of the structures, the different colours represent the length of the stalagmites (almost exclusively) used for these constructions. (Taken from (Jaubert et al. 2022))

1.4.2 Independent origin and parallel cultural evolution of Neanderthals -

At present, in terms of cultural modernity, evidence of Neanderthals symbolic behavior in Middle Paleolithic period when compared with the "fully symbolic sapiens behavior" of Modern Humans in the MSA of Africa, is almost similar suggesting that Neanderthals were behaviorally "Sapient" with at-par cognitive abilities. Early occurrences of key symbolic material culture, before the arrival of Modern Humans into Western Europe points towards an independent origin of symbolic behavior in Neanderthals (Zilhao, 2007, 2011a, 2011b, 2012). Other than symbolic material culture, the technological variability of the Mousterian artefacts in time and space show similar discrete cultural adaptations, like those in contemporary modern human populations in South Africa (d'Errico and Stringer, 2011). The widespread distribution of Neanderthals over Europe and Middle East covering several ecological and biogeographical niches demonstrates their well adaptability to their environment. In the Middle East region, both the Neanderthals and Modern humans occupied similar ecological niche, hunting similar species with comparable tool kits (Yeshurun et al., 2007). Retrieval of nuclear DNA from contemporary Neanderthal and Modern human fossils gives ample evidence of significant interbreeding with Modern Humans with a small percentage of Neanderthal DNA still surviving in today's populations (Lalueza-Fox, 2021). Overall, at least for Middle Pleistocene, both Neanderthals and Modern followed the same evolutionary pathway from a technical, cognitive, cultural, and symbolic perspective (Jaubert et al., 2022).

These discoveries refute the human revolution model completely which proposed that all living humans trace their ancestry exclusively back to a small African population that expanded and completely replaced archaic human species. The cultural and biological barriers which were set up to distinguish the uniquely modern Homo sapiens from other coeval hominin species especially Neanderthals in Europe, proved to be quite permeable, evident form significant admixture between Neanderthals and Modern humans. This assimilation scenario during the transition time from Middle Paleolithic to Upper Paleolithic is best summarized by Zilhao (2011b) as "*Independent invention cum migration, interaction, admixture and cultural blending" alternative to "Neandertal acculturation followed by extinction without descent*".

As for the origins of symbolic behavior in Neanderthals, the cognitive threshold or the capacity for symbolic behavior was in place before the divergence of the two species, as soon as the size and shape of the brain case entered modern ranges of variation (Lee and Wolpoff, 2003; McHenry and Coffing, 2000). After which the explanation of discontinuous Neanderthal symbolic record like Early Modern Humans of African MSA lies in the realm of cultural, demographic, and social processes, not in that of paleogenetics or paleoneurology (Zilhao, 2011a; d'Errico and Henshilwood, 2011, d'Errico and Stringer, 2011).

1.5 Symbolic behavior evidence from other hominin species?

Some isolated evidence of symbolic behavior has been associated with other coeval hominin species rather than *Homo sapiens* or *Homo neanderthalensis.* First of such evidence comes from the Acheulian site of Berekhat Ram, Israel (280 Kya – 250 Kya) where a pebble with natural features resembling a female figurine was engraved by the hominins to enhance the features such as head, neck and the arms of the figurine (Goren- Inbar, 1986; Marshack, 1997a) (Fig 1.13). A detailed microscopic study with morphological and metrical analysis of the sections of the grooves of the engravings by d'Errico and Nowell, 2000, confirms the anthropogenic modification of the pebble as signs of engraving by a pointed tool and abrasion are present on the pebble. While the study suggests a non-utilitarian function of the engravings, it refrains from identifying it as a female figurine as the features interpreted as hands, neck and the head are not very clear plus this artifact being one of its kind from Acheulian context makes it impossible for comparative analysis. Other researchers have criticized the interpretation as the engravings could be utilitarian in purpose too.

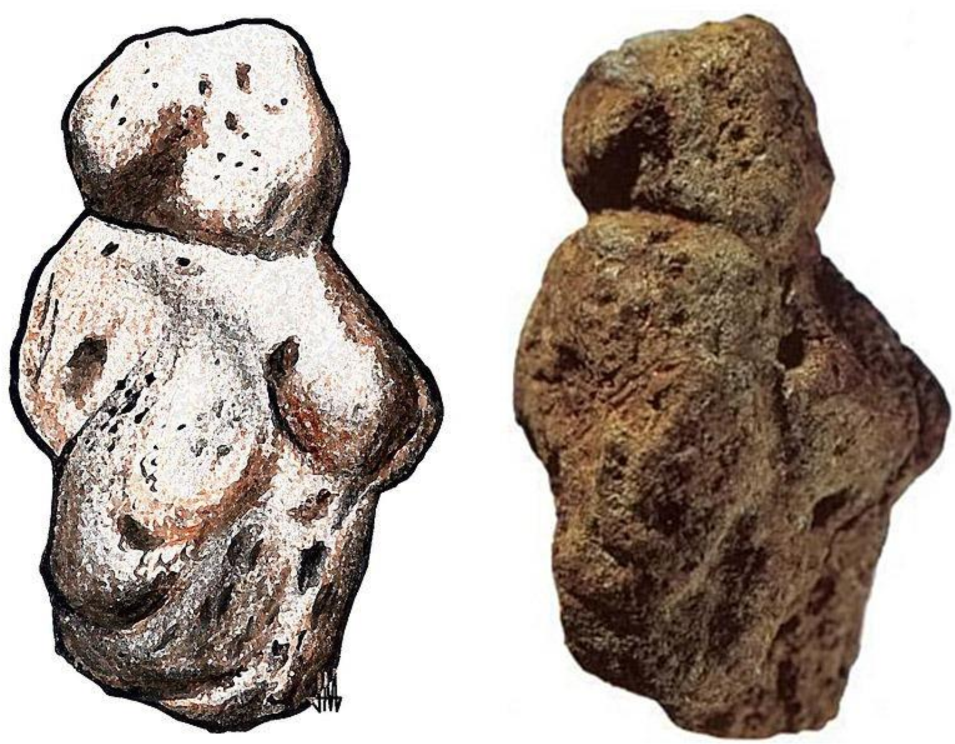

Figure 1-13: The Berekhat Ram figurine, Israel. Left - the interpretation as a female figurine, Right - original artifact (Taken from Wikipedia)

More engravings evidence coming from Asia include - an engraved freshwater *Pseudodon* shell from Trinil, Indonesia dated at ~ 500 Kya (Joordens et al., 2015) (Fig 1.14) putting the capacity of abstract engravings in the domain of *Homo erectus.* The study (Joordens et al., 2015) concludes that the engravings were made by a sharp fossil or a shark tooth, in one sitting.

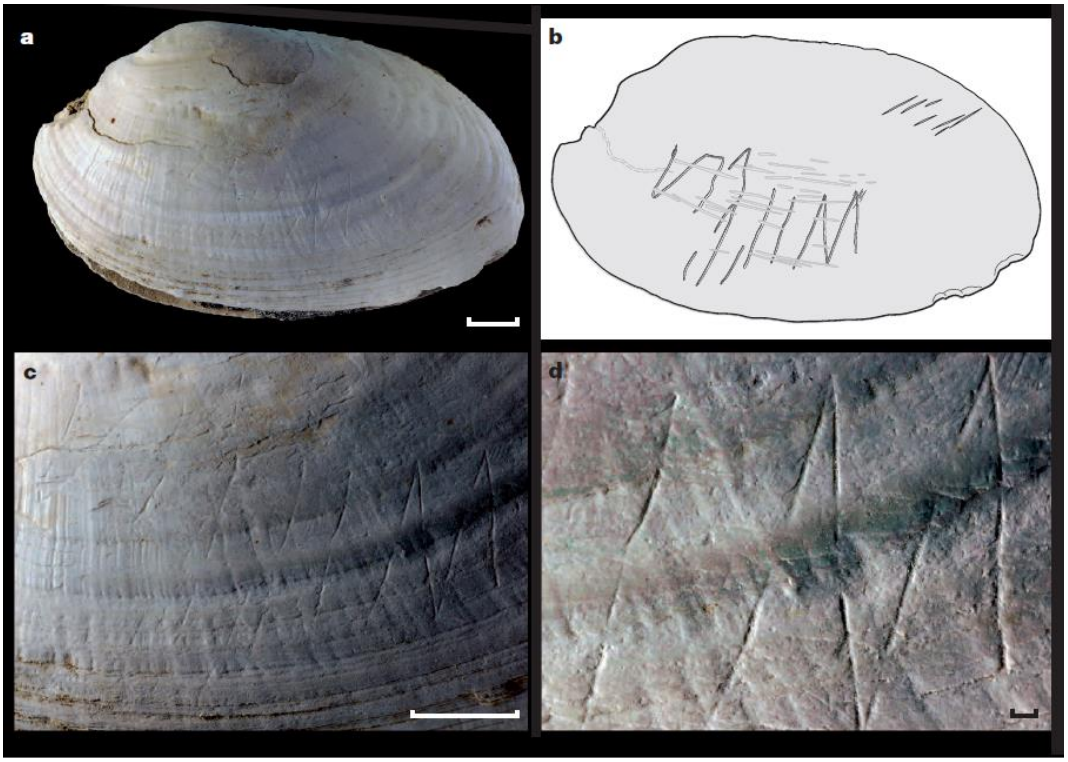

Figure 1-14: Engraved shell from Trinil, Indonesia (Taken from Joordens et al., 2015)

Older evidence come from China from the sites of Xinglongdong Cave (engraved ivory) (150Kya – 120Kya) (Gao et al., 2004) and Lingjing (two engraved bones) (125Kya – 100Kya) (Zhanyang Li et al., 2019) (Fig 1.15). While the site's chronology and the anthropogenic nature of the incisions on the ivory has been questioned for the Xinglongdong cave (Norton & Jin, 2009), In Lingjing the engraved bones come from the same layers as the hominin remains attributed to an archaic population, suggested as Denisovans (Martinón-Torres et al., 2017) although more paleogenetic evidence is needed for it.

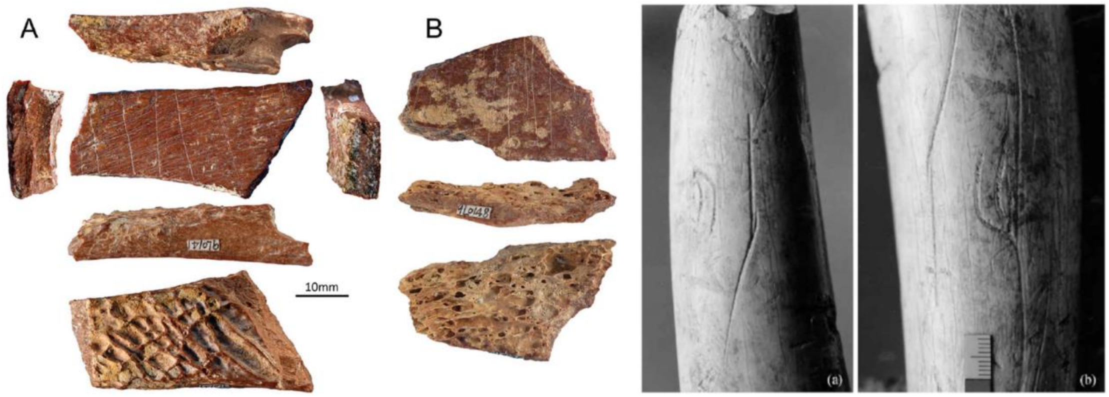

Figure 1-15: Examples of Engraved Bone from Linjingh, China (left), Engraved Ivory from Xinglongdong, China (right) (modified from Gao et al., 2004 and Zhanyang Li et al., 2019)

A case for the Acheulian origins of beadmaking or bead collection has been made by researchers in the past, which comes from evidences such as - fragments of ostrich eggshell beads at the Acheulian site of El Greifa, Libya (Ziegert 1995; Bednarik 1997) and presence of *Porosphaera globularis* shells in many Acheulian sites in England and Northern France (Boucher de Perthes 1847; Smith 1884; Bednarik 1997, 2001, 2005a, 2005 b). While for the El Greifa evidence, more data is needed on the dating, stratigraphic and cultural context of the site and the ostrich eggshell beads (Kuckenburg, 2001), Bednarik 2005a, 2005b argues in favor of *Porosphaera globularis* fossils being deliberately collected by Acheulian hominins based on differences between the natural assemblages and archeological assemblages of these fossils. According to him, the Acheulian hominins collected small sized, rounded *Porosphaera globularis* fossils with perfect perforations. Also, he stated that some of the beads show evidence of enlarging of the natural perforation in the fossils as well as wear marks because of friction between two shells when they are strung together in a necklace (Bednarik, 2005b). Later independent analytical studies of Rigaud et al., 2009 and Berruti et al., 2022 working on separate archeological collections of *Porosphaera globularis* rejected the use of these fossils by the Acheulian hominins based on multiple lines of evidence based on their accumulation, transport, selection, anthropic modification, and use. As most of the Acheulian sites with these beads were excavated in 19th century, there is no spatial distribution data of the beads associating them with the lithic industry, also later excavations in the same sites as well as new Acheulian sites did not produce any new beads. Differences in the archeological assemblage of shells on the base of size, shape and perforation frequency from natural assemblage can be attributed to the selection bias of the 19th century researchers, also the use wear marks in and near the perforations of the shells seem very recent due to them being kept in museums hung up on strings as a necklace. Overall, the studies termed the evidence of *Porosphaera globularis* being part of material culture of Acheulian hominins in Europe is very ambiguous and not reliable.

2 Engravings associated with Neanderthals/Middle Paleolithic context

2.1 What are engravings? And what do they represent?

Engravings, defined as the end product of an incising or a pecking design onto a material such as bone, ochre and stone with help of a tool (Henshilwood and d'Errico, 2011) is one of the many categories of material culture that are considered to be the evidence of symbolic behavior. Engravings can be considered as a special category of material culture in which most of the information on the type of actions performed by the engraver is preserved. They can be formally described compared with other engraving evidence through microscopic analysis by studying the internal cross section of individual lines, junctions and crossings individual lines make with each other in an engraved pattern. This information can be used to interpret technical information such as type of tool used, use of multiple tools, chronology of individual lines, engravers laterality, changes in orientation of engraved surface and kind of gestures employed to make that pattern etc. (Cremades, 1991, 1994; d'Errico, 1988a, 1988b, 1995a, 1995b, 1996; Fritz, 1999; d'Errico and Cacho, 1994; d'Errico and Nowell, 2000; Soressi and d'Errico, 2007). This information combined with the experimental reproduction of the engravings can help us in deciphering the kind of activity which left such marks/designs, the technical competence of the engraver, the laterality of the engraver and in some cases, if the engraver followed any mental template in making them.

The presence of marks on bones, ochre and cortical surfaces of stones which can be attributed to be of ancient anthropogenic origin (d'Errico, 1993; Fisher, 1995; d'Errico and Villa, 1997; d'Errico and Nowell, 2000; Brumm et al.,2006, Nowell and d'Errico, 2007) does not directly imply symbolic behavior. Interpretation of such marks can be difficult especially in Middle Paleolithic/ Middle Stone Age context where such engravings are scarce, and the patterns found are very simplistic or abstract in nature which may include parallel, crisscrossing, conjoining, and fanning line motifs with some examples of zigzag or circular pattern. Figurative and iconographic representations on bones or stones have never been identified in MP/MSA contexts (d'Errico et al., 2009). From microscopic analysis we can get the technical information which helps in describing and comparing the engraving marks but still it is difficult to correctly identify their aim and function. Many utilitarian activities such as – flesh/skin processing activities on bone, scraping the cortex of a nodule for testing the properties of the raw material or clean the nodule or collecting the powder generated or reducing the thickness of the nodule for better flaking/ prehension/ hafting purposes, incision marks on a flat nodule as a result of using the flat surface as a cutting board and using the nodule as a hammerstone can be the reason for the production of some of such archeological evidence of engravings on bones and stones (Peresani et al. 2014; Makjic et al. 2018a). Even if the marks do represent non utilitarian activity, assigning meaning to non-utilitarian engravings is difficult as it is hard to demonstrate what we today consider abstract designs had some symbolic/artistic meaning for the Middle Paleolithic/Middle Stone Age societies. These non-utilitarian engravings could be for representational purposes (Mellet et al.,2019a, 2019b) or could be seen as "proto aesthetic" behavior (Hodgson, 2006; 2019) or a primitive notation system (d'Errico et al., 2018) or doodling/playing activity or marking individual possession (Henshilwood et al., 2009). The current method of assigning a symbolic meaning to an engraved design requires ruling out all the other possibilities which could be responsible to produce such marks. This is achieved through a combination of several observations and inferences such as – ruling out the functional/utilitarian reasons for engravings, the type of material used for engravings, preparation of the surface prior to engraving, use of same tool for the whole pattern, changes in tool type which might represent accumulation of the engravings over time for a "notational purpose", the symmetry or regularity of the pattern engraved, the repetition of similar pattern on other objects, number of archeological objects showing such marks, intra/inter sites variability in the type of patterns observed, temporal or regional continuity in the type of patterns observed etc (Henshilwood et al., 2009; Henshilwood and d'Errico, 2011; d'Errico and Vanhaeren, 2008; d'Errico et al., 2012).

2.2 Engravings associated with Middle Paleolithic/ Mousterian context:

There are many reported evidence of the engraved artefacts in Eurasia or in a Middle Paleolithic/Mousterian context. The oldest evidence in Europe is dates to 300 Kya from Bilzingsleben, Germany (Mania and Mania, 1988) where fragments of bone are covered with parallel/sub parallel lines, in some cases lines forming a rectangle like designs and a possible indeterminate zoomorph. The examples of engraved artefacts in Middle Paleolithic/Mousterian appear first at around the 250 Kya mark (MIS 7 – 6) and their numbers increase in the time period of around 70 – 60 Kya. Table 2.1, while not exhaustive, includes many reported instances of engraved artefacts found in Europe and the Near East from Middle Paleolithic/ Mousterian context. It should be kept in mind that most of the evidence regarding engraved artefacts is very old and requires a reevaluation or a detailed microscopic study to ascertain the antiquity of the marks, and evaluate the degree of 'deliberateness' as many bone objects from sites like Pech-de-l'Aze II, France; Cueva Morin, Spain; Stranska Skala, Czech Republic; Schulen, Belgium; and Molodova IV, Ukraine and the incised sub-circular nummulite fossil from Tata (Hungary), which were thought to be previously engraved or showed ancient anthropic modification, on reevaluation turned out to be natural marks (blood vessel impressions) or post depositional damage (trampling, root etchings, regurgitation by hyenas, carnivore gnawing) or recent damage (excavation and storage) (d'Errico and Villa, 1997; Steguweit, 2003; Nowell and d'Errico, 2007).

Site	*Country*	*Material*	*Cultural attribution*	*Age (Kya)*	*References*
Les Pradelles	France	Bone	Mousterian	72 - 50	d'Errico et al., 2018
Temnata Dupka	Bulgaria	Stone Slab	Middle Paleolithic	50	Cremades et al.,1995; Tsanova, 2006
Bacho Kiro	Bulgaria	Bone	Middle Paleolithic/ Mousterian	>47	Bahn, 1997; Marshack 1976
Bilzingsleben	German	Bone	Lower Paleolithic	412 -320	Mania and Mania, 1988
Ermitage	France	Bone	Middle Paleolithic/ Mousterian	31	Pradel and Pradel, 1954
Gorham's Cave	Gibraltar	Bedrock	Middle Paleolithic/ Mousterian	>39	Rodriguez – Vidal et al., 2014
Grotte du Renne	France	Bone	Chatelperronian	41 - 36	d'Errico et al. 2003
Kiik Koba	Ukraine	Flint	Middle Paleolithic/ Para Micoquian	32	Majkic et al., 2018a
Krapina	Croatia	Bone	Middle Paleolithic	130	Frayer et al., 2006
La Chapelle aux Saints	France	Bone	Middle Paleolithic / Late Mousterian	60	d'Errico et al.,2009
La Ferrassie	France	Bone	Middle Paleolithic/ Mousterian	65	Zilhao, 2007
La Quina	France	Bone	Middle Paleolithic/ Mousterian	39	Marshack, 1991; d'Errico et al., 2011
Le Moustier	France	Bone	Middle Paleolithic/ Mousterian	40	d'Errico et al., 2012
Mamontovaya Kurya	Russia	Tusk	Middle Paleolithic/ Mousterian	36	Pavlov et al.,2001
Marillac	France	Bone	Middle Paleolithic/ Late Mousterian	46	d'Errico et al.,2009
Pesturina	Serbia	Bone	Middle Paleolithic	95 - 64	Majkic et al., 2018b
Roe de Combe	France	Bone	Chatelperronian	40	d'Errico et al., 1998
Roche au Loop	France	Bone	Chatelperronian	40	d'Errico et al., 1998
Prolom II	Ukraine	Bone	Middle Paleolithic	41 - 28	Stepanchuk, 1993, 1998
Unikote	France	Bone	Middle Paleolithic / Late Mousterian	>30	d'Errico et al., 2009

Vaufrey	France	Bone	Middle Paleolithic/ Mousterian	120	d'Errico et al., 2009
Vergisson IV	France	Bone	Middle Paleolithic/ Mousterian	Unknown	d'Errico et al., 2009
Zaskalnaya V	Ukraine	Ochre	Middle Paleolithic/ Mousterian	>47	Stepanchuk, 2006
Zaskalnaya VI	Ukraine	Bone	Middle Paleolithic	39	Stepanchuk, 2006
Qafzeh	Israel	Flint	Middle Paleolithic/ Mousterian	100	Hovers et al., 1997
Quneitra	Israel	Stone slab, Bone	Middle Paleolithic/ Mousterian	60	Goren – Inbar 1990; d'Errico et al., 2003; Shaham et al., 2019
Axlor	Spain	Pebble	Middle Paleolithic	47.5	Garcia – Diez et al., 2013
Manot Cave	Israel	Flint	Middle Paleolithic	60 – 50	Marder et al., 2017
Chez – Pourre – Chez - Comte	France	Pebbles	Middle Paleolithic/ Mousterian	Unknown	Lhomme and Normand, 1993
Champlost	France	Flint	Middle Paleolithic/ Mousterian	Unknown	Lhomme and Normand, 1993
El Castillo	Spain	Stone slab	Middle Paleolithic	40	Cabrera et al., 2001; Rivero et al., 2021
Grotta Fumane	Italy	Flint, Pebbles	Middle Paleolithic/ Mousterian	MIS 5 - 3	Peresani et al., 2014
Riparo Tagliente	Italy	Flint, Pebbles	Middle Paleolithic/ Mousterian	MIS 5 - 3	Peresani et al., 2014
Grotta Maggiore di San Bernardino	Italy	Flint	Middle Paleolithic/ Mousterian	59 - 44	Peresani et al., 2014
Einhornhöhle	Germany	Bone	Middle Paleolithic/ Mousterian	51	Leder et al., 2021
Grotta dell Alto	Italy	Pebble	Middle Paleolithic/ Mousterian	MIS 3	Martini et al., 2004
Grotta del Cavallo	Italy	Flint, Stone slab, Pebbles	Middle Paleolithic/ Mousterian	MIS 3	Martini et al., 2004
Nasher Ramla	Israel	Bone	Middle Paleolithic	120	Prevost et al., 2022
La Roche-Cotard cave	France	Cave walls	Mousterian	60 - 54	Marquet et al., 2023
Abri Suard	France	Bone	Mousterian	MIS 6 - 5	Cremades, 1996
Mar Tarik	Iran	Stone Slab	Middle Paleolithic	123	Jaubert et al.,2009
Terra Amata	France	Pebbles	Lower Paleolithic	380	Lorblanchet and Bahn, 2017

Table 2-1: List of Middle Paleolithic sites in Europe and Middle East having evidence of early engravings in a Middle Paleolithic context.

Below are some examples of important studies where authors of respective studies have proposed different hypothesis for the aim and function of the engravings observed (utilitarian or non-utilitarian) based on the microscopic and morphometric analysis of individual grooves and overall pattern combined with experimental replication studies:

2.2.1 Engraved giant deer phalanx, Einhornhöhle, Germany (Leder et al., 2021):

An engraved giant deer phalanx (Fig 2.1) was discovered in a Middle Paleolithic context associated with Neanderthals at a former cave entrance of Einhornhöhle, Germany which is dated at about 51 Kya. The deer phalanx shows 10 engravings on the sinistral side of the phalanx, out of which 6 lines form five stacked offset chevrons which is the dominant pattern. A secondary pattern consists of four short lines. Through microscopic and experimental studies, it was determined that the engraved lines forming the main pattern differ in location, depth and profile from unintentional/accidental modifications such as butchering, percussion and trampling marks. The shape profile of the engraved lines presents an L - shape which is different from the usual V and U-shaped incisions. Experimental traces combining cutting and scraping techniques achieve an L – shaped pattern which resembles the one on the phalanx.

The giant deer phalanx shows no utilitarian use as it is quite small and uneven in nature to be used as a cutting board. Other observations such as -

- The main pattern being geometric and systematic in nature with the 3 lines on each side being parallel and equidistant from each other.
- A complex production process of the L – shape profile of the engraved lines and all lines having comparable dimensions.

These observations indicate the intentionality of the engraver and the symbolic meaning behind the production of the engraved artefact made by Neanderthals.

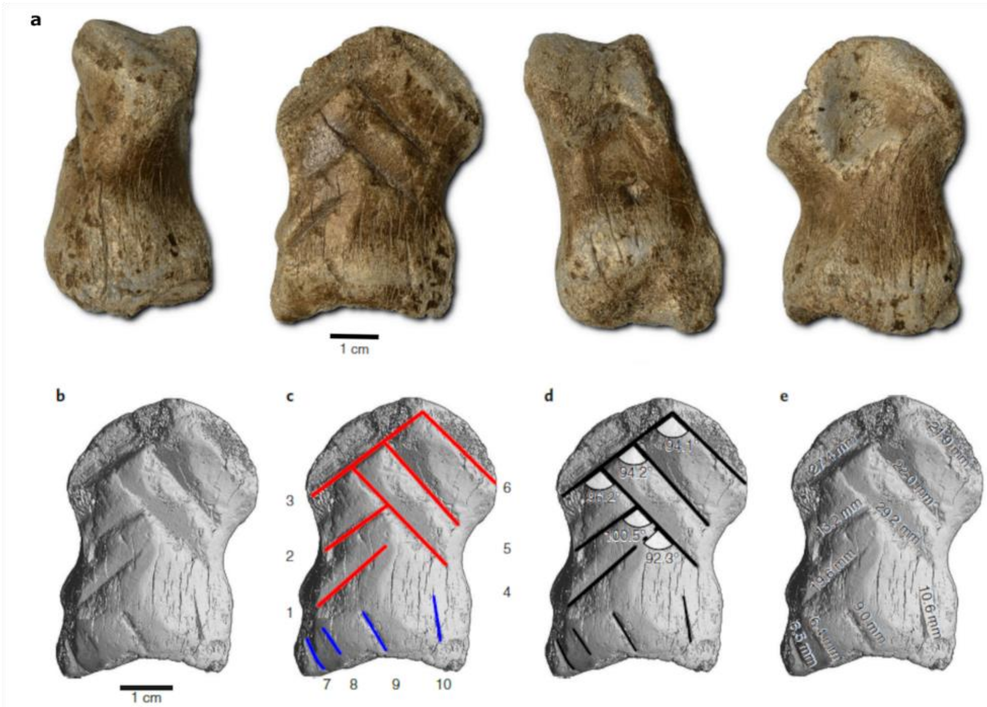

Figure 2-1: Engraved giant deer phalanx from a late Middle Paleolithic context at Einhornhöhle, Lower Saxony, Germany. a) Six standard views of the same bone generated from micro-CT scans, b) blank view of the engraved side. c) line interpretation and line numbers. d) surface angles between individual lines. e) line lengths. (Modified from (Leder et al., 2021))

2.2.2 Engraved Bedrock, Gorhams Cave, Gibraltar (Rodríguez-Vidal et al., 2014):

In Gorham's Cave (Gibraltar), on the bedrock a cross hatching pattern was discovered (Fig 2.2) below an undisturbed archeological level IV containing Mousterian lithic artefacts older than 39 Kya. The incised pattern consists of 8 deeply engraved lines forming an incomplete criss - cross pattern obliquely intersected by groups of 3 and 2 short thin lines. (fig). The morphology of the said incisions was observed to be very different from the natural cracks and fissures which appear on the rocks of the cave. The individual grooves present pointed starting points and fringed ends with variable section profiles and internal striations. The order of the individual grooves can be identified through the intersections they make with each other. The ancient origin of the engravings was proved by geochemical analysis where the unaltered surface is covered by 3 layers formed due to chemical alteration over time while inside part of the engravings is only covered by the uppermost layer 3. The engravings were made on an already weathering bedrock which was then covered by sediments forming layer IV (consisting Mousterian lithic finds) of the archeological strata. Through morphometric and microscopic analysis along with experimental replication on weathered Gorham cave's blocks it was inferred that most of the grooves were made by carefully performed repeated strokes of a robust tool tip or cutting edge in the same groove (8 deep incised lines). Singular strokes by the tool tip leads to very superficial striations due to the hard nature of the bed rock. To and fro motion of a tool tip creates grooves which are not straight and are wavy which leads to widening of the grooves with less depth, frayed ends and side striations which are not observable on the individual lines. Incisions produced from cutting fresh pork skin using the weathered blocks as cutting board were also different as they were thin and presented sinuous and discontinuous outlines. Looking at the evidence, the authors concluded that the geometric pattern is neither accidental nor from utilitarian use, but it represents something abstract and non-utilitarian which was deliberately incised by the Neanderthal population.

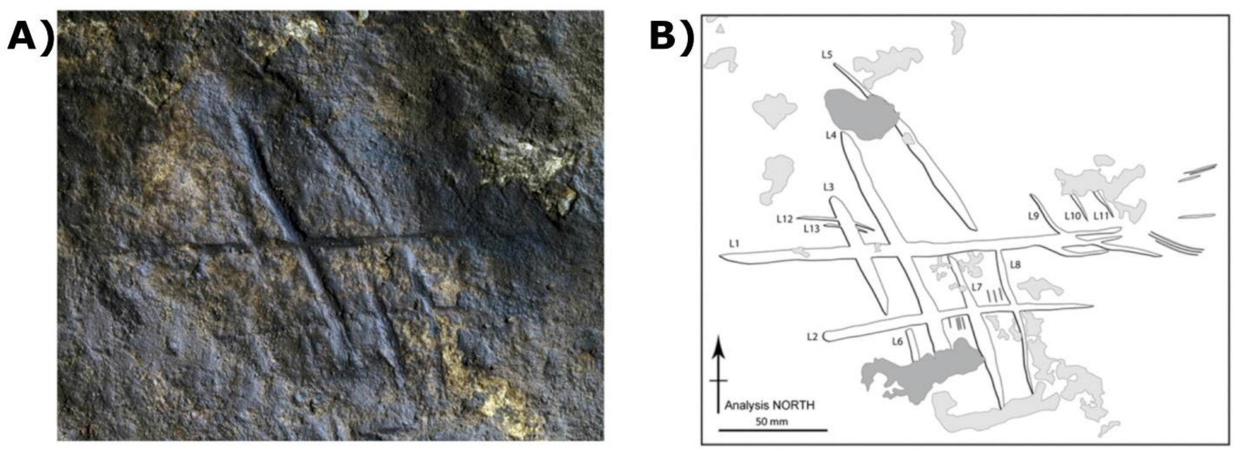

Figure 2-2: (A) Engraving from Gorham's Cave. (B) Engraved lines L1–L13. Dark grey and light grey represent old and new breakages respectively. (Modified from (Rodríguez-Vidal et al., 2014))

2.2.3 Engraved cortical flake from Kiik Koba, Crimea (Majkic et al., 2018a):

A flake from the Layer IV of the archeological strata of the Kiik Koba cave shows incision marks on its cortical surface (Fig 2.3). Layer IV consists of lithic artefacts of para – Micoquian industry dated in between 37 – 35 Kya. A Neanderthal child burial was also found in this layer. The cortex of the flake presents a group of sub parallel incisions which have the same patina coloration as the rest of the cortex, demonstrating their ancient origin. The individual grooves show sharp edges/walls with internal micro striations. The incisions on the cortex do not reach the edges of the flake which means that they are complete and were incised after the flake was taken out. Studying the internal morphology and the intersections between the individual grooves, the chronological order of the grooves as well as the different tools used for incising the lines were identified. The incisions show a comet morphology with more depth at one end which is interpreted as the starting points of the incisions. The laterality of the engraver being right-handed was identified from the asymmetrical outlines of some of the grooves. The hypothesis of utilitarian origin of these incisions was rejected by the authors as the cortical surface is too small to be used as a cutting board, also the internal morphology of the grooves suggests the type of tool used to be a tool tip rather than a cutting edge. Other utilitarian activities such as incising to get the powder, to thin the cortex for retouching or hafting were also rejected based on the small size and thinness of the flake. The authors suggest the purpose of the incisions to be representational or symbolic as all the lines start and finish inside the small cortical area testifying a well-controlled motion with focused attention and these incisions cannot be explained by other utilitarian activities or activities such as doodling, which is defined as aimless production of patterns without focus and without any purpose which is not the case here in this flake.

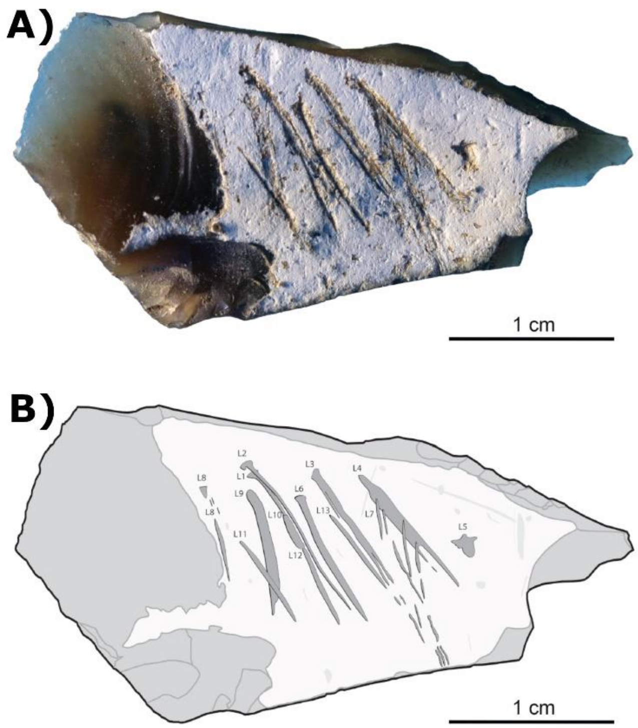

Figure 2-3: The engraved flint flake from Kiik-Koba, layer IV. Photo (top) and tracing (bottom). Engraved lines are indicated by dark-grey areas outlined in black (Taken from Majkic et al., 2018a)

2.2.4 Engraved Bone Fragment and Flat Cortex Plate (Goren – Inbar 1990; d'Errico et al., 2003; Shaham et al., 2019):

Quneitra, Israel is a Middle Paleolithic open air site dated at 56 – 51 Kya which consists of lithic artefacts typical of Levantine Mousterian which could be associated with Neanderthals or Modern humans as no human remains have been found at the site. Here two objects, one on bone (Fig 2.4 a) and one on flat cortex plate (Fig 2.4 b) present symmetrical concentric arcs pattern deliberately engraved with each arc comprising of several curving lines rather than a single continuous one, representing well-controlled and focused motion. These two objects stand out from the other evidence of engraved objects in the same time period in Africa or Eurasia as they present complex semicircular pattern showcasing the artistic qualities of the homonins who made it, while on other comparable sites the most complex pattern which could be found is crisscross pattern made with linear incisions (Henshilwood et al., 2009).

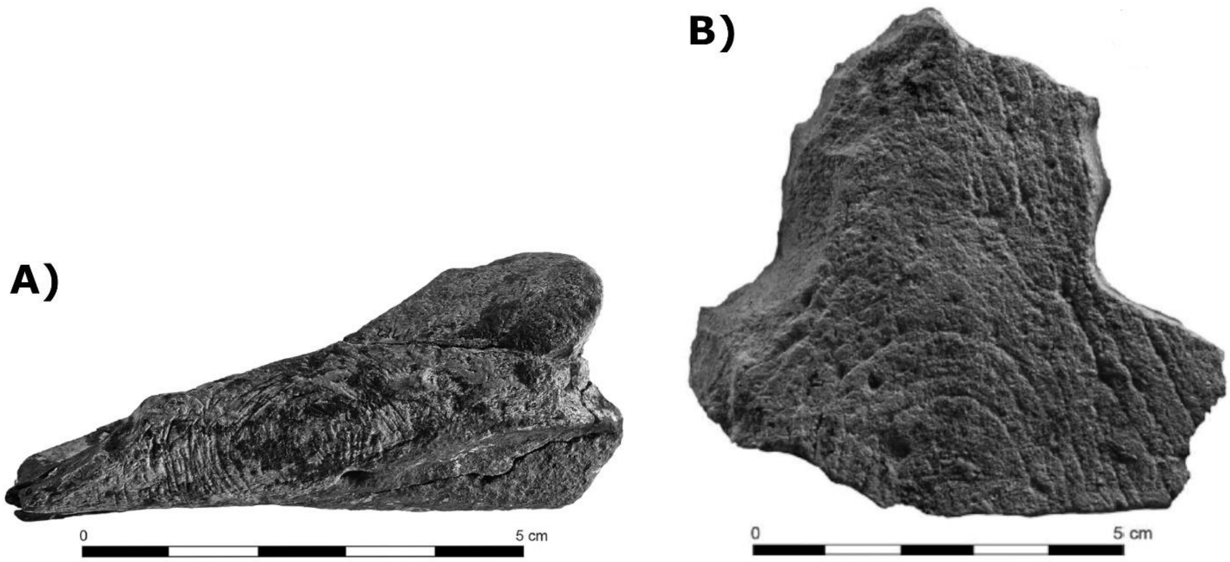

Figure 2-4: A) The engraved bone from Quneitra, B) The engraved stone plaque from Quneitra

2.2.5 Engraved Schist from Temnata Dupka, Bulgaria (Crémades et al., 1995):

From the cave site of Temnata Dupka, from Layer VI, dated at around 50 Kya, a quadrangular-shaped schist with accidental fracture on three sides, was recovered with engraved lines (Fig 2.5). The lithic assemblage present in this layer shows attributes of Balkan leaf-point Mousterian, associating the engraved schist with Neanderthals. The engravings on this object can be groups into 2 sets of parallel engraved lines present on two different faces of the object. From microscopic/technological analysis of the lines, it was inferred that all lines were made from the same tool in one sitting, all lines were made in the same direction. The lines are spaced at equal intervals, further suggesting its intentionality. This study confirms the anthropic origin of the engravings which pertain to some non-utilitarian activity. The study rules out the function of the engravings as a primitive calendar as they were made by same tool in probably same time but does not propose another hypothesis for the aim and function of the engravings.

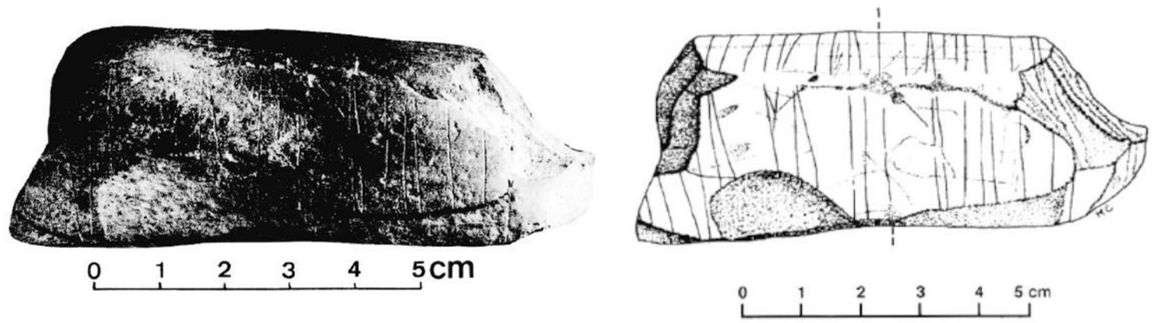

Figure 2-5: The quadrangular-shaped schist showing engravings at regular intervals. (Modified from Cremades et al., 1995)

2.3 Engraved objects in Italian Middle Paleolithic context:

In the Italian context, several Middle Paleolithic sites have reported objects on bones and stones which show marks of anthropic origin. The site of Riparo Tagliente, in the Lessini mountain range has yielded many bone fragments with linear incisions which the author Leonardi, 1983 attributed to being anthropic in origin while others (d'Errico and Villa, 1997) consider those markings to be of natural origins (vascular impressions). Other sites in Italy which have reported bone engravings are Madonna di Valle Radice near Sora nel Frusinate with a fragment of horn with deep parallel incisions and Grotta Costantini, where an equid rib has three groups of parallel lines engraved in its mesial section which could indicate a graphic design (Martini et al, 2004). In terms of lithic objects, in Salento peninsula two sites - Grotta del cavallo and Grotta Del Alto have reported cortical surfaces/pebbles bearing engravings. Grotta del Cavallo consists of three small stones which show engravings. It includes a flat stone crossed by fine striations, a flake fragment with 14 short parallel/sub parallel lines and an irregular pebble with 16 thin sub parallel lines. Grotta del Alto contains a limestone elliptical pebble, where on one face very fine striations are present and on the other face some deep incision marks which may form a zoomorphic profile (Borzatti von Löwenstern, 1967). More detailed analysis of the engraved objects from the above-mentioned sites is required to judge the origin and significance of the reported incisions. In Northern Italy from the site Riparo Tagliente, along with the incised bones Leonardi, 1983 also reported incision marks on the cortical surface of flakes and pebble. Leonardi, 1983 divided the lithic artefacts into two categories - flint and pebble with linear incisions and siliceous flakes with parallel/sub parallel incisions. For the pebble, a utilitarian hypothesis was proposed as it being used for support for cutting materials while for the flake no hypothesis was provided. Recent studies Dallatore, 2011 and Peresani et al., 2014 provide a detailed analysis of new evidence of engraved cortical flakes and pebbles from sites – Grotta di Fumane (on southern edge of Venetian pre-Alps) (8 artefacts (2 pebble, 1 scraper, 1 core, 4 flakes/blades/flake fragments) and Grotta Maggiore di San Bernardino (on the edge of the Monti Berici karst plateau) (2 artefacts:1 scraper and a 1 flake fragment) and reassessment of 1 scraper from Riparo Tagliente. The study divides the type of incisions on the artefacts from two activities -

- Engravings: these are the linear incisions present on the flat surfaces of the 2 pebbles from Grotta di Fumane, which might have a utilitarian function/aim of being used as a support for cutting activities from an unretouched edge (Fig 2.6).
- Scraping: groups of parallel/sub parallel incisions of variable depth produced by scraping activity which could serve the purpose of cleaning the cortical surface, thinning the cortical surface for better flaking/retouching. One scraper from Grotta Maggiore di San Bernardino and another one from Grotta di Fumane which show scraping marks also shows alterations attributable to contact of tool with a haft which supports the functional hypothesis where the scraping is done as a preparatory action for hafting purposes, although no residue of the possible adhesives used was detected (Fig 2.7).

Overall, the studies of Dallatore, 2011 and Peresani et al., 2014 provide a functional/utilitarian origin of the incisions present on the lithic artefacts from Grotta di Fumane, Riparo Tagliente and Grotta Maggiore di San Bernardino.

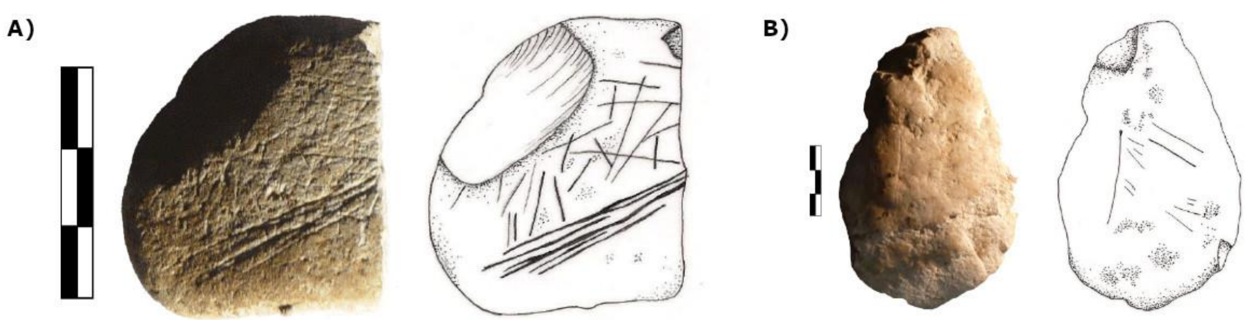

Figure 2-6: The pebble (A) and the stone (B) from Grotta di Fumane showing liner incisions. (Modified from Dallatore, 2011)

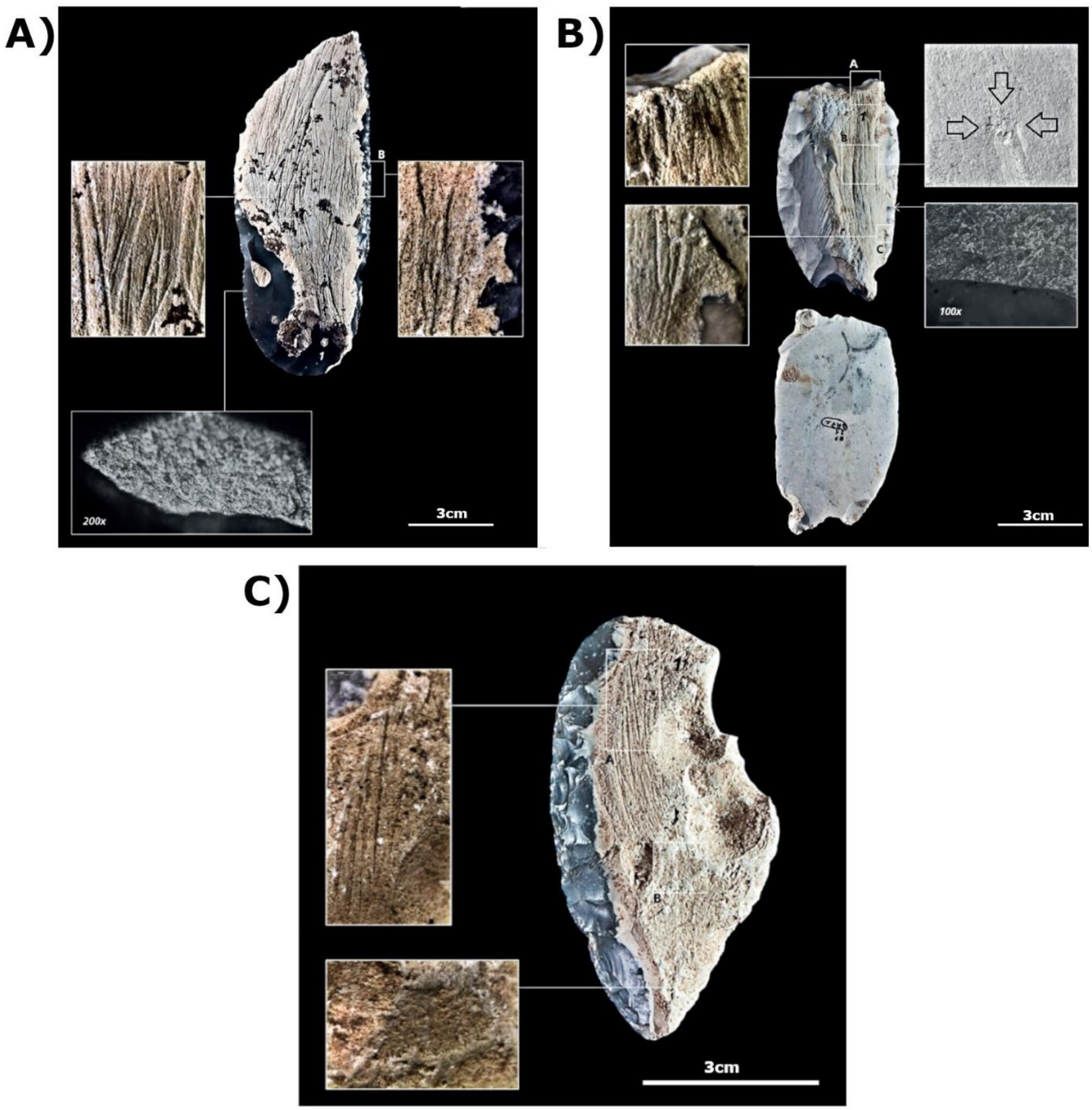

Figure 2-7: A) Riparo Tagliente, scraper with totally engraved cortex. Left and right, close-ups of the artefact surface, Below, polishing attributable to contact with animal tissues observed at high magnification on the left edge. B) Grotta Fumane, scraper with engraved cortex. On left - close up of the striations, on right – (above) Comet shape morphology observed by SEM, (below) Patch of polishing attributed to the presence of a hafting system, observed at high magnification on the right edge. C) Grotta Maggiore San Bernardino, scraper with partially engraved cortex. Left, close-ups of the striae (above) and the smoothed surface visible on the proximal cortical zone (below). (Modified from Peresani et al.,2014)

3 The site of Riparo Tagliente

Riparo Tagliente rock shelter (Stallavena di Grezzana, Verona, Italy) (Fig 3.1) is located on the left slope of the Valpentena valley, a few meters above the floodplains of the Progno river, at the base of a massive cliff made up of oolithic limestone from the Jurassic Period. The Rock shelter sits at an altitude of 250m above sea level in the pre-alpine region of Lessini Mountain Range in between the plains (100 m a.s.l) and the limestone plateau (2000 m a.s.l). The formation of the rockshelter can be traced back to the Eemian interglacial period when the river (still flowing at the bottom of the valley) cut at the base of the limestone cliff and created a deep cavity/shelter before changing its course. This shelter became a prime spot for the occupation by Neanderthals and later Modern Humans during the Middle and Upper paleolithic time periods due to its location - at the crossroads of different topographical features which provided a wealth of different floral and faunal resources as well as the karstic cavities in the limestone cliff which provided an easy access to the flint outcrops for exploitation (Arzarello 2003, Fontana et al. 2009).

Identified by G. Solinas, it was reported to the Civic Museum of Natural History of Verona by Francesco Tagliente in 1958. The site was first investigated by the Museo Civico di Storia Naturale di Verona from 1962 to 1964 and later from 1967, the excavations were undertaken by the Department of Geological and Paleontological Sciences, University of Ferrara in collaboration with the Civic Museum of Natural History of Verona (Arzarello 2003). The initial excavations at Riparo Tagliente focused on a deep trench running transversally to the shelter which revealed a 4.50-meter stratigraphic sequence consisting of anthropological remains (Fig 3.2). The whole stratigraphic sequence can be divided into two deposits separated by an erosion surface. According to Paleoenvironmental data, the lower deposit corresponds to Marine isotopic stage 3, a part of the glacial event known as Würm glaciation between 60 – 30 kya. The lower deposits comprise of Mousterian Industry artefacts (Middle Paleolithic) overlapped by the Aurignacian Industry artefacts (Early Upper Paleolithic). This lower deposit is truncated due to erosion by the river (currently at the bottom of the valley) which marks a hiatus in the stratigraphic sequence. The upper deposit directly overlaps the erosion surface of the lower deposit and corresponds to Marine Isotopic stage 2, terminal phase of the Würm glaciation dated between 17 – 11.5 kya. It consists of artefacts from the Late Epigravettian Industry (Late Upper Paleolithic) (Bartolomei et al., 1982, 1984). The stratigraphic sequence is sealed off on the top by sterile Holocene deposits.

Later in the 1970’s excavation area was extended to gain better insights into the spatial organization of the shelter during different occupational phases. The excavations are still ongoing at the site. It is to be noted that Riparo Tagliente shelter was also used during medieval times where a large portion of the shelter was dug up which disturbed the upper deposits as well as the some of the lower deposits. The stratigraphic sequence, although discontinuous due to river erosion, represents one of the longest and most complete occupation of the Po valley (Arzarello 2003, Fontana et al. 2009).

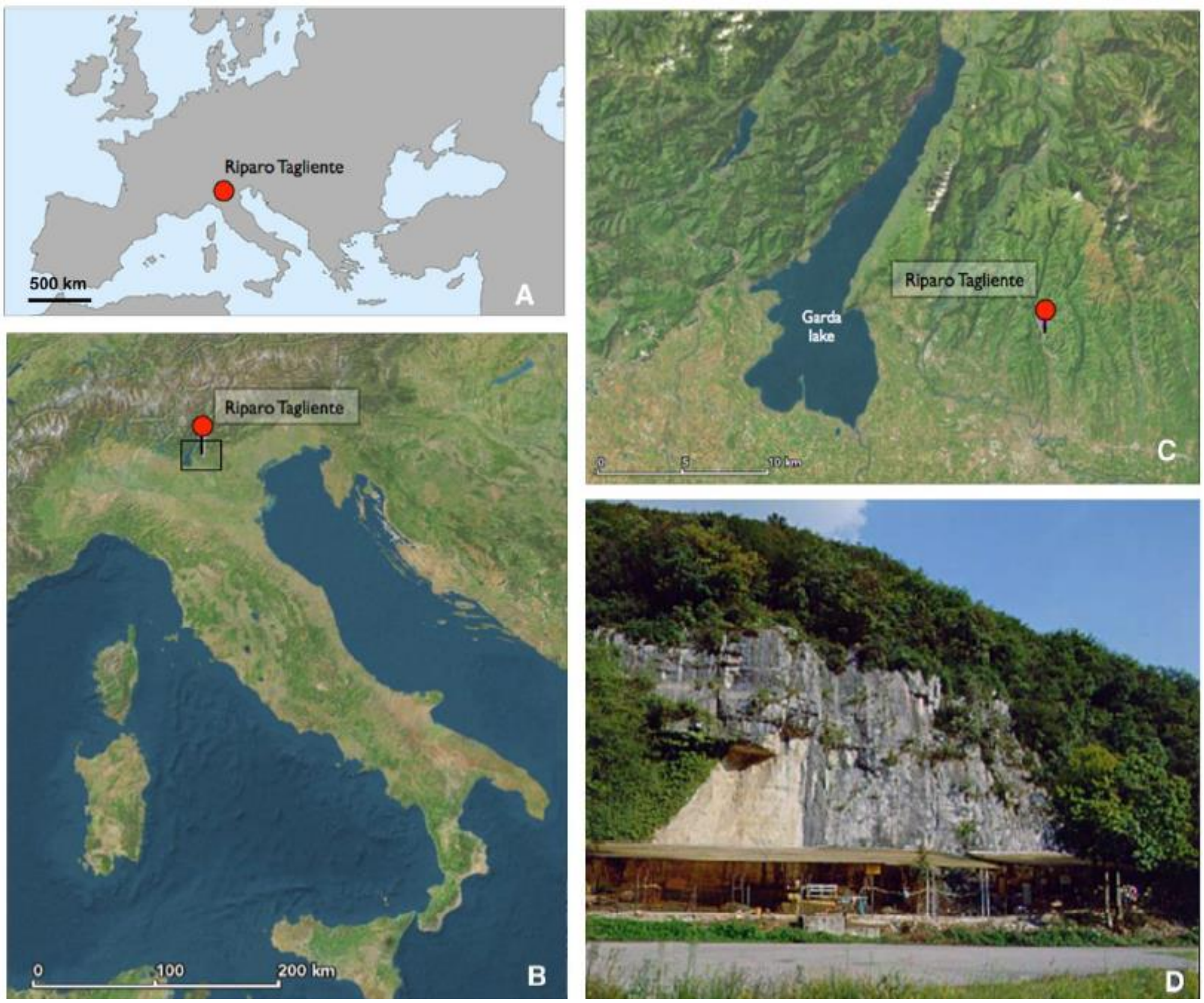

Figure 3-1: (A, B, C) Maps showing the position of Riparo Tagliente (from Carmignani, L. 2017); (D) view of Riparo Tagliente (from Arzarello 2003).

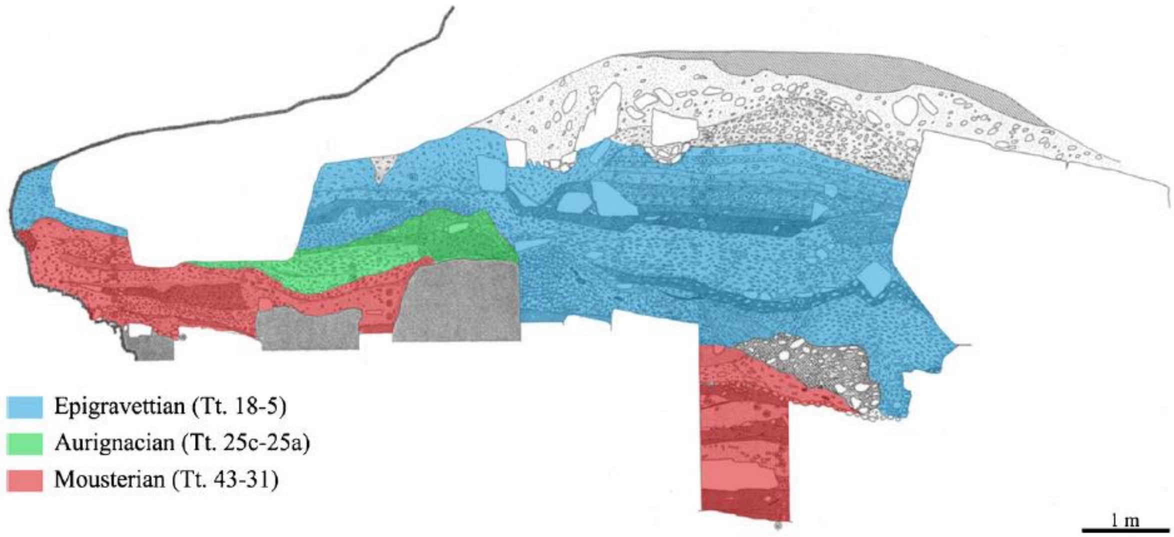

Figure 3-2: Stratigraphy of the Riparo Tagliente rock shelter (Taken from Cavallo et al., 2017)

3.1 Mousterian occupation of Riparo Tagliente:

Riparo Tagliente was first occupied by the Neanderthals as attested by the presence of the Mousterian lithic industry. Although Mousterian layers have been found in a larger area of the shelter, most of it suffers from contamination by the Epigravettian layers. This contamination makes it very difficult to analyze the anthropological data especially from the upper most levels/cuts of the Mousterian occupation. Most of the studied material of the Mousterian occupation of Riparo Tagliente comes from a 2x2 meter test pit dug in 1976, in the internal part of the shelter (Fig 3.3) (Arzarello 2003).

Although direct dating of the Mousterian levels of the site is not available, a good assessment of its chronological age (60 – 30 Kya) can be made based on the direct overlap of the Mousterian Layers by Aurignacian layers corresponding to Initial Upper Paleolithic. Other than that direct chronological and cultural correlations of the stratigraphy of Riparo Tagliente with other sites in Veneto region such as – Grotta di Fumane, Grotta della Ghiacciaia, Grotta del Broion and Grotta di San Bernardino gives a good idea about how the Neanderthals adapted in the region of Italian Pre Alps bounded by Alps to the north and the Po Plain to the south where the geographic and ecological contexts differ at a very small scale. (Peresani 2011).

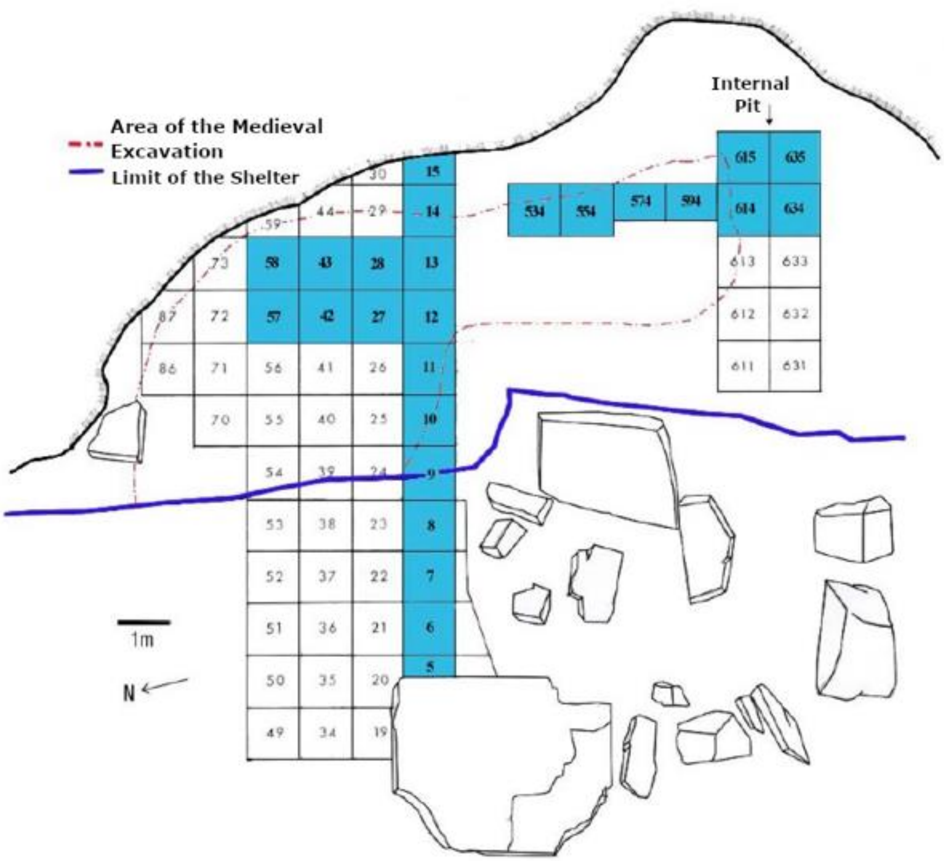

Figure 3-3: Plan of the Excavation Area. Blue marked squares represent the areas where Mousterian artefacts were found (Modified from Arzarello, M. (2003))

3.1.1 Stratigraphy of the Mousterian Layers of Riparo Tagliente:

As explained above, the stratigraphy of the Riparo Tagliente site is divided into two deposits separated by an erosion surface. The lower stratigraphic unit can be found in both internal part as well as the external part of the shelter but in the internal pit (Fig 3.3) we see a more complete, uninterrupted stratigraphy of 2.80 meters in height. It comprises of the Mousterian lithic industry, overlapped by the Aurignacian layers. The homogeneity of the sediments in the lower deposits forced the excavations to proceed by making arbitrary levels/cuts in both internal and external part of the shelter. Not all levels/cuts correspond to human activity. A correlation between the levels/cuts in the external and the internal part of the shelter is established based on presence/absence of reduction sequences and type of formal tool types present.

Sedimentological and petrographic analysis of the lower stratigraphical unit (from the internal part of the shelter) gives insight into the climatic changes which led to the formation of the deposit. The inferences gathered about the paleoclimate from the stratigraphy are further corroborated by the faunal and pollen data. The lower deposit can be subdivided into two-units (Cremaschi, 1982) -

- Unit 1a – (corresponding to level/cut 52 – 44) At the base we have layers of breccia in a red clayey soil of colluvial origin and formed by the soil erosion outside the shelter. In between we see thin layers of anthropological origin. On the top of this unit there are a lot of limestone fragments present in the sediment which probably correspond to the thermoclastic phenomenon, signaling cold, rainy winters and dry summers. (Bartolomei et al. 1982, Arzarello 2003)
- Unit 1b - (corresponding to level/cut 43 – 25) At the base, we see large boulders and cryoclasts probably from the deterioration of the shelter roof and walls. Superimposing this are layers formed by silt and clay containing limestone fragments and anthropological material. Climate at this junction can be interpreted as having cold winters with temperate summers. This is followed by sterile loess layers devoid of any boulders or clasts indicating an arid periglacial environment. In the upper levels/cuts (37 - 31) aeolian sediments continue, alternating with limestone fragments corresponding to thermoclastic activity, indicating alternating arid and wet phases. For the uppermost levels (31 – 25) we see similar characteristics with the erosion surface forming the upper limit of the lower stratigraphic unit (Bartolomei et al. 1982).

3.1.2 Faunal assemblage: Paleoenvironmental and Archeozoological analysis:

Inferences on the environmental conditions during the Mousterian occupation of Riparo Tagliente can be made through analyses of Pollen and micromammals data (Table 3.1). In the Lower levels (52 – 44) the micromammals species found (*Apodemus sylvaticus, Microtus arvalis-incertus, Dolomys sp*., *Gilis gilis, Cricetus cricetus, Sorex araneus* and *Crocidura sp.*) point towards an environment typical of Mountain Prairie. The pollen data from these levels is abundant in tree species such as *Pinus silvestris* , *Juneprus* and *Betula,* Herbaceous plants such as *Poaceae* and *Compositae Liguliflorae* which point towards a glacial grassland type of environment. For the levels/cuts 43 – 40, pollen data suggest a decrease in the number of trees while there is an increase in the herbaceous plant category of *Compositae Liguliflorae* typical of a Steppe environment. In Micromammals, *Microtus agrestis* and *Microtus arvalis* associated with Asian steppes like environment are well represented. For the upper most levels/cuts, the conditions still resemble that of a continental steppe but a change in the environmental conditions towards more temperate and humid conditions can be seen as in micromammals there is a turnover of species which marks disappearance of *Microtus ratticeps* and increase of *Microtus nivalis* and *Apodemus sylvaticus.* The Paleobotanical data reveals a decrease in the populations of *Pinus* while *Quercus robur* type of trees appear (Bartolomei et al., 1982, Arzarello, 2003)

The archeozoological data on Macrofauna (Table 1) from the Mousterian layers of Riparo Tagliente attests to the fact that the shelter was subjected to intense anthropic activity. The faunal assemblage in the Mousterian levels consists mainly of teeth, mandible fragments, limb elements, vertebrae and sesamoids belonging to adult and sub-adult ungulates (*Capreolus capreolus*, *Cervus elaphus, Rupicapra rupicapra*, *Capra ibex*, wild boar and bovids) which were exploited by the Neanderthals. Taphonomic analysis of the faunal remains revealed no preference of choice of prey but from the parts of skeleton present of different animals it could be said that the medium sized animals such as roe deer were hunted and whole carcass was brought to the site for processing while for large cervids only parts of the carcass was transported to the site. The presence of cut marks on neonatal or fetal cervids remains suggests that Neanderthals occupied the rock shelter mainly during spring (March – June). The carnivore assemblage is dominated by *Canis lupus, Ursus arctos* followed by *Vulpes Vulpes.* Other carnivores include *Panthera pardus*, *Meles meles, Martes martes.* Evidence of carnivores being killed by Neanderthals is not sufficient although exploitation of the fur of carnivores cannot be ruled out. Among rodents, marmots are frequently represented. At the lower levels/cuts (52 – 44), the number of remains and the traces on faunal assemblages related to carnivores exceeds anthropological traces but clear differentiation between the two can be clearly observed. At upper levels/cuts of the Mousterian occupation (42 – 35), there is a drastic increase in the traces related to anthropological activity while subsequently the carnivore remains decrease suggesting a more permanent Neanderthal presence (Thun Hohenstein and Peretto, 2005; Thun Hohenstein, 2006). The few remains of *Homo neanderthalensis* recovered from the Mousterian occupation layers come from the levels/cuts 36 and 37 which include a phalanx of the first finger, an upper second molar deciduous as well as a deciduous upper canine (Arnaud et al.2016, Villa et al. 2001).

Cut/ Level	Microfauna	Macrofauna	Flora	Paleo-Environment
39 - 30	*Microtus nivalis* *Apodemus sylvaticus*	*Capreolus capreolus* *Cervus elaphus* *Rupicapra rupicapra* *Capra Ibex* *Sus scrofa* Cervus canadensis	Decrease of *Pinus Pinus* *Quercus robur*	Continental steppe, transition towards a more temperate and humid climate
43 - 40	*Microtus agrestis* *Microtus arvalis* *Microtus gregalis* *Sicista sp.* *Cricetus cricetus*		Reduction of trees Compositae Liguliflorae	Steppe
52 - 44	*Apodemus sylvaticus* *Microtus arvalis-incertus* *Dolomys sp.* *Glis glis* *Cricetus cricetus* *Sorex araneus* *Crocidura sp.*	*Rupicapra rupicapra* *Capreolus capreolus* *Cervus elaphus* *Vulpes vulpes* *Canis lupus* Artiodactyla	*Pinus silvestris* *Juneprus* *Betula* *Poaceae* *Compositae* *Liguliflorae*	Glacial continental steppe

Table 3-1: Archeozoological data and Paleoenvironmental inference of the Mousterian Layers of Riparo Tagliente. (Modified from Arzarello, 2003)

3.1.3 Lithic raw material utilized:

The flint used by the Neanderthal population of Riparo Tagliente was locally sourced, rarely from the primary outcrops but near the Progno di Valpantena (a few meters away from the shelter) as whole pebbles of varying sizes (Fig 3.4). The flint used consists of 4 varieties - Tenno, Biancone, Scaglia Rossa and Scaglia Variegata with the first 2 being more common than last two. The representation of the type of raw material in the flint artefacts is like what one can find in the primary outcrops and around the Progno di Valpantena. Only the best quality flint was brought inside the shelter for use, representing careful selection of the pebbles from the Progno di Valpantena. The excellent quality and abundance of raw material around the shelter meant that Neanderthals had to travel less than a kilometer for good quality raw material, which in part explains the long occupation of the shelter throughout the prehistory (Arzarello, 2003; Arzarello and Peretto, 2005).

Figure 3-4: (Left) The Progno/River next to the shelter, (Right) Pebbles of different sizes in the riverbed which were exploited by the Neanderthals. (From Arzarello 2003)

3.1.4 Lithic Assemblage:

Most of the studied anthropological material from the Mousterian levels of the shelter comes from the smaller pit inside the shelter as is not disturbed by the medieval excavations. With respect to the number of lithic artefacts recovered, it can be said that for the arbitrary lower levels/cuts in the internal part of the shelter (52 – 50 and 44 – 42) the occupation of the shelter by Neanderthals was not frequent as compared to the upper levels/cuts (37 – 34), where the number of lithic artefacts as well as faunal remains were found in a greater quantity. The Mousterian lithic assemblage of Riparo Tagliente presents numerous types of reduction sequences (Fig 3.5) out of which opportunistic debitage reduction method (c.f S.S.D.A, Forestier, 1993) is most represented in both the upper and lower levels/cuts. Opportunistic debitage method here can be considered as the most optimum way of exploiting raw material (pebbles/cobbles) of different shape and sizes as application of this method was also observed towards the end of *chaine operatoire* of other reduction sequences such as Levallois and Discoid. No preference of raw material is observed for Opportunistic debitage method. Other than opportunistic debitage, Levallois (Boeda, 1993) and Discoid reduction (Boeda, 1993; Peresani, 2003) sequences are also observed throughout the Mousterian occupation. In the lower levels/cuts centripetal recurrent Levallois method is more prominent while in the upper levels/cuts Unipolar and Bipolar Levallois reduction strategy is adopted. The preferential Levallois flaking method as an independent reduction strategy is not represented in Mousterian lithic assemblage of Riparo Tagliente. As for the preference of raw material for the Levallois products, no such preference is observed in the lower levels, but it changes in the upper levels for the Unipolar and Bipolar Levallois products where marked preference of the rare flint types - Scaglia Rossa and Scaglia Variegata is observed. This preference could be explained by the high quality of the material itself as well as the smaller size of the raw material. Discoid reduction strategy is not as frequent and is observed to be applied independently but mainly as the final step in exploitation of Levallois cores, utilizing them completely. In the upper levels/cuts starting from level 37, volumetric laminar debitage is also observed as an independent reduction sequence where the exploitation of the core is predominantly done from a single striking platform. The second striking platform, if present is used for maintenance of distal convexity only. The number of blade cores in the assemblage are very few, it could be assumed that they were reduced further using other reduction sequences. Laminar reduction sequence becomes the second most represented sequence after Opportunistic debitage in the upper most levels. The raw materials used exclusively for laminar debitage are Biancone and Tenno, due to their abundance as well as the elongated and flat shape of the pebbles which could be exploited easily for the blades without initial complex shaping of the pebble (Arzarello, 2003; Arzarello and Peretto, 2005).

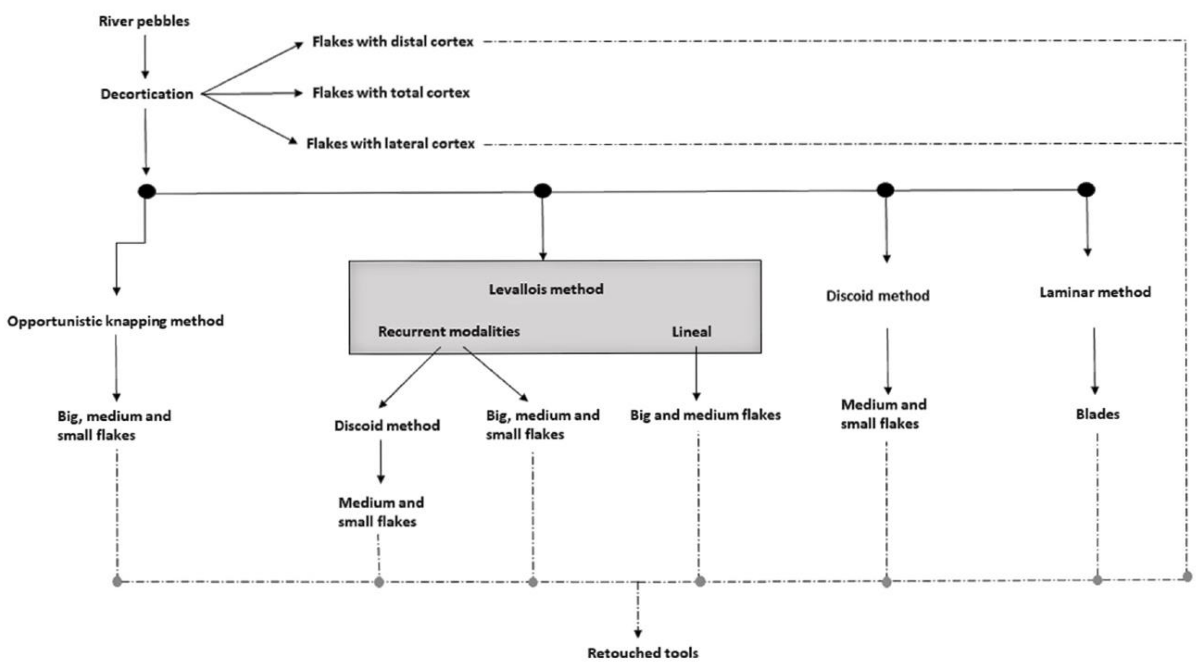

Figure 3-5: Different reduction sequences and their end products (Taken from Berruti, G.L.F et al. 2020, modified from Arzarello 2003)

Formal tool types present in the lithic assemblage are dominated by scrapers (convex side scrapers). There are only a few examples of denticulates and notches, none from the lower levels. Other than that, examples of Mousterian points, Levallois points and Pseudo levallois points are also present in the levels/cuts 37 – 34. The flakes used to make scrapers are majorly from opportunistic debitage method and then from the recurrent levallois sequence. Retouched tools represent 10% of all the artifacts over

2cm. Recovery of all phases of different *chaine operatoire* applied as well as good number of stone hammerstones as well as bone retouchers (Thun Hohenstein, 2001), attest to the fact that the raw material in form of pebbles and cobbles was brought into the shelter and all the debitage activity took place inside the shelter (Arzarello, 2003; Arzarello and Peretto, 2005).

3.1.5 Conclusion:

Despite there being only limited data on the Mousterian lithic assemblage, analysis of the lithic data as well as the archeozoological data of the Mousterian layers of Riparo Tagliente points towards the fact that the first occupations of the shelter by Neanderthals were sporadic and limited. No preference of the raw material can be associated with the reduction sequences applied or the tool types in the lower levels, while in the upper levels especially from level 37, we see a positive correlation between the raw material type and the reduction sequence applied (Levallois and Laminar). The theme of complete exploitation of the raw material is prevalent in all the layers but in the upper layers separate reduction sequences are more characterized and an evolution of the debitage methods is observable. Even the number of formal tool types such as denticulate and notches are found in the upper levels. The exponential increase in the number of lithic materials and faunal remains with traces of anthropological activity in the upper levels suggests a more permanent settlement than the previous ones.

4 Materials and Methods

4.1 Materials:

The artefacts analyzed in this study come from the Mousterian lithic assemblage of the site Riparo Tagliente. The objective of the study is to analyze the part of the Mousterian lithic assemblage present in the University of Ferrara, looking for the evidence of engraved cortical surfaces and compare the incisions to the side scraper previously described in the papers of (Arzarello, 2003; Dallatore, 2011; Peresani et al., 2014). The artefacts taken into consideration were those which presented cortical surface (partial or full), regardless of degree of fragmentation. In total 429 artefacts were analyzed. The first phase of screening consisted of manual observation by naked eye where the artefacts which did not show traces of human modification were excluded from the analysis. The methodology followed is explained below for differentiating man-made traces of ancient origin, natural traces, sin or post depositional traces and recent damages. Out of the 429 artefacts only 3 (1 side scraper and 2 flakes) showed traces of human modification (related to either utilitarian or non-utilitarian actions) other than the side scraper described/analyzed before (Arzarello, 2003; Peresani et al., 2014) (Table 4.1). These artefacts were further subjected to microscopic analysis, under the microscope Leica LAS EZ4 HD (8x-35x magnification) with built-in digital camera to find out the technical details such as type of tool used, direction of motion, chronology of multiple grooves and identification of grooves made from same tool to interpret the aim and function (utilitarian or non-utilitarian) of the incisions. Alongside 7 more artefacts with cortical surface were selected and analyzed under the microscope which showed signs of weathering (exfoliation and disintegration), sin or post depositional damage and recent damages on the cortex for descriptive and comparative purposes.

Artefact Number	*Artefact type*	*Length (mm)*	*Width (mm)*	*Thickness (mm)*	*Figure Number*
	Anthropogenic Marks				
RT 100	Side Scraper	123	49	12	5.31
RT 167	Side Scraper	55	36	13	5.24
RT 11	Flake	44	30	6	5.23
RT 76	Flake	37	33	11	5.20
	Natural Marks, Sin/post depositional damage, Recent damage				
RT 574	Side Scraper	87	60	28	5.16
RT 209	Flake	23	32	4	5.18

RT 140	Flake	46	31	15	5.15
RT 595	Flake	67	45	11	5.14
RT 306	Flake fragment	59	43	10	5.12
RT 81	Flake	42	30	9	5.19
RT 2	Flake fragment	40	38	17	5.13

Table 4-1: Metric attributes of the selected artefacts

4.2 Methods:

4.2.1 Microscopic and Morphometric analysis:

4.2.1.1 Differentiating between the natural cracks, post depositional damage (Trampling, root etchings), recent damage and marks with anthropic origin:

Many experimental studies and detailed studies of archeological material consisting of probable engraved bones and lithic material (d'Errico, 1993; Fisher, 1995; d'Errico and Villa, 1997; d'Errico and Nowell, 2000; Brumm et al.,2006, Nowell and d'Errico, 2007) have been conducted in the past to try and establish the criteria to identify features of the markings which can be used to identity the cause (Natural, post depositional or Anthropic).

Usually, the anthropogenic marks made by a stone tool can be differentiated from other kinds of marks based on the presence of micro striations on the bottom part of the mark as well as on the walls/edges of the mark. The mark usually shows clean, sharp edges/walls and an angular section profile. Microscopically observing the internal section of a mark created by stone tool shows a more homogeneous texture than the outside of the mark on the cortex, especially when multiple strokes pass through the same area as it creates a flat surface at the bottom of the section due to grinding of tool edge/tip against the cortex. (d'Errico and Nowell, 2000). Additional evidence such as presence of single or multiple parallel striae (parasitic lines) running alongside the main groove caused due to double contact of the tool tip/edge or the groove showing frayed ends at the beginning, or the termination of the groove caused due to small, inadvertent motions of the hand either in initiating or in terminating a stroke or multiple grooves originating from the same main groove and diverging from that groove because of slipping of the tool edge/tip from the main groove, if present can be used to identify anthropogenic marks (Fisher, 1995).

Although this criterion as well as the criteria to further define the type of tool used and activity performed (grinding, scraping or deliberate incision) exists, no single attribute can be adjudged as the signature feature of a single groove/striation/stria being made by stone. Many human and natural factors can mimic the same kind of groove/striation/striae as made by stone tool (Fisher, 1995).

Natural processes such as physical or chemical weathering can produce effects like exfoliation and disintegration of the cortical surface which can alter or erase the anthropogenic marks, depending on the local environment conditions and how long the surface was exposed before getting buried (Fisher, 1995). Relative movement of the artifacts with respect to the sediments after deposition (Sediment abrasion) due to various factors such as – bioturbation, freezing, thawing, or swelling of the sediments, trampling etc. can certainly create singular striae with a V or U-shaped internal profile which might resemble a deliberate incision or multiple parallel or sub parallel striations in same or multiple orientations which might resemble scraping activity (Fisher, 1995). Other than that, the action of roots on the cortical surface leaves behind multiple grooves which are U shaped and with rounded edges and having sinuous/wavy configurations that are macroscopically visible (d'Errico and Villa, 1997).

Other factors such as position and orientation of marks on the cortical surface and with respect to each other can also help us to judge the regularity and intentionality of those marks and can help us differentiate between marks of anthropic origin and post depositional damage.

Recent marks can appear on the cortical surface while excavating, transport or storage, which resemble the marks made by stone tools but can be differentiated on the bases of difference of patina coloration inside of the groove or relative freshness of the marks with respect to the overall condition of the artefact surface (d'Errico, 1993; Nowell and d’Errico, 2007).

4.2.1.2 Identifying type of tool used, direction of motion, chronology of multiple grooves and identification of grooves made by same tool type:

Further analysis of the chosen 3 flakes and the side scraper dealt with identifying the type of tool used, direction of incision, chronology of multiple incisions and identification of incisions made by the same tool based on previous experimental studies and studies on examination of archeological engravings. Most of these studies were performed for analyzing Upper Paleolithic period engravings or on bone surfaces, using many different stone tool types but the findings can be applied for simple tool type such as simple flake, retouched flake or pointed end of a flake as the general morphology of the groove plays very little role in determining the type of groove formed and depends on the shape/size of the functional area of the tool tip/edge in contact with the engraving surface (Cremades, 1991, 1994; d’Errico F., 1988a, 1988b, 1995a, 1995b, 1996; Fritz, 1999; d'Errico and Cacho, 1994; d’Errico and Nowell, 2000; Soressi and d’Errico, 2007; Hodgskiss, 2010, Rifkin, 2012).

Type of tool used:

Simple flake edge - Grooves produced through an incision action by an edge of a simple flake produce V shaped marks which have a narrow valley bottom and whose walls make a very acute angle with each other (d'Errico and Nowell, 2000). If the edge of the flake is not sharp, it can also create U shaped internal section morphology.

Retouched flake edge – Retouching the edge of the flake, creates a very variable edge profile with multiple points of contact unlike an unretouched edge which generally produces grooves which show one straight and one convex, concave, or irregular wall, and often have U shaped internal section. Also, the angle between the walls is greater than that of the unretouched edge (d'Errico and Nowell, 2000).

Generally, the type of tool used to make incisions does not matter as only a small functional area of the tool tip/edge is in contact with the surface and morphology of that specific area will define the groove profile. Additional factors such as changing the angle of the tool, rotation of the tool, force applied, morphology of the edge/tip which is in contact with the surface, and which is subjected to change because of wear and tear will change the morphology of the groove itself (Fig 1a, b) (d'Errico F., 1995a; Hodgskiss, 2010). Additionally multiple strokes or movement in back-and-forth motion in the same groove can change the profile of the grooves and can be easily identified through frayed ends of the groove, increase in the width and depth of the groove and slipping of the tool edge/tip out of the groove to create an addition groove. (d'Errico F., 1995a; Hodgskiss, 2010).

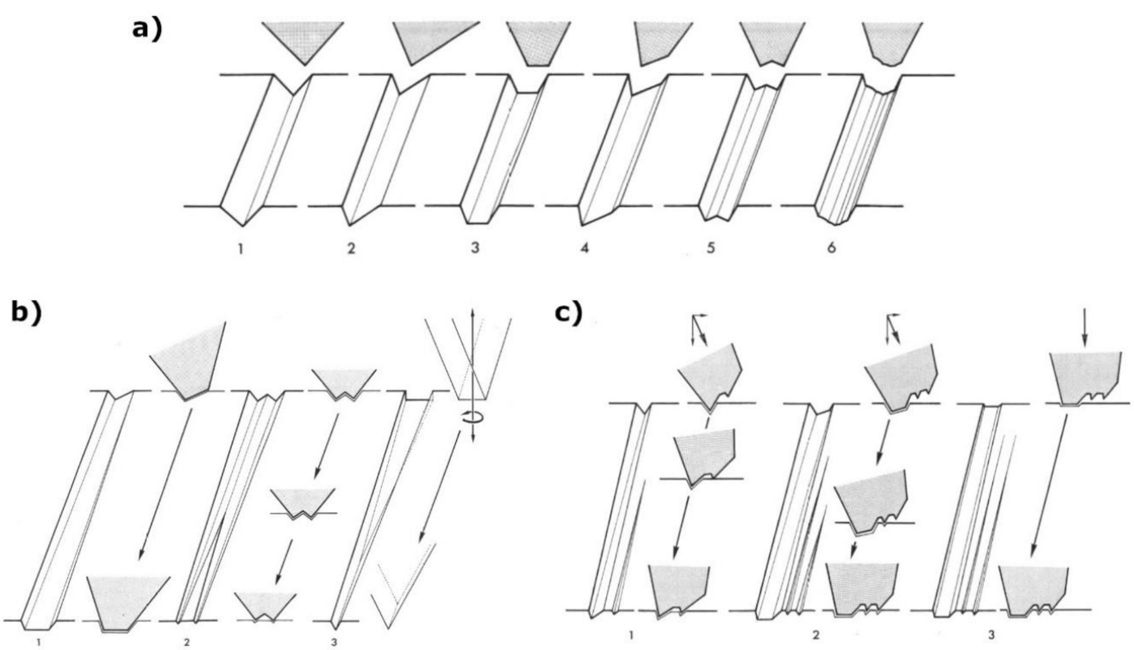

Figure 4-1: a) Examples of sections of an incised line: 1. symmetrical V; 2. asymmetric V; 3. _/ shaped; 4. _/ shaped with valley at an angle; 5. W Shaped; 6. U shaped. b) Examples of line section modifications during incision: 1. change from a V section to a

_/ section caused by tilting of the tool axis; 2. splitting of a W-section cut due to a decrease in the pressure exerted on the tool; 3. passage from a rectangular section to a V section by rotation of the axis of the tool. c) Modes of formation of lateral parasitic streaks: single (1) and double (2) due to tilting of the tool axis; double lateral parasitic streak produced by an increase in the pressure exerted (3) (Taken from d'Errico, 1995a).

Differentiation can be made between the grooves created by unretouched or retouched edge to that of created by a pointed end of a flake as grooves created by the edge shows same characteristics throughout as the elongated edge morphology provides stability and they do not follow the contour of the surface which might result in skipping of the low-lying areas of the surface. In contrast, the grooves created by a pointed end of a flake follow the contour of the surface changing directions without change in width of the groove while passing a micro depression or another groove, show sudden change in groove morphology if the tip breaks and show a strong morphological variability owing to changes in the orientation of the tool tip during the grooving process (d'Errico, 1995a; d'Errico and Nowell, 2000; d'Errico et al. 2001). Pointed end of a flake might create V shaped grooves or _/ shaped grooves. Blunt pointed end of a flake might create U - shaped grooves.

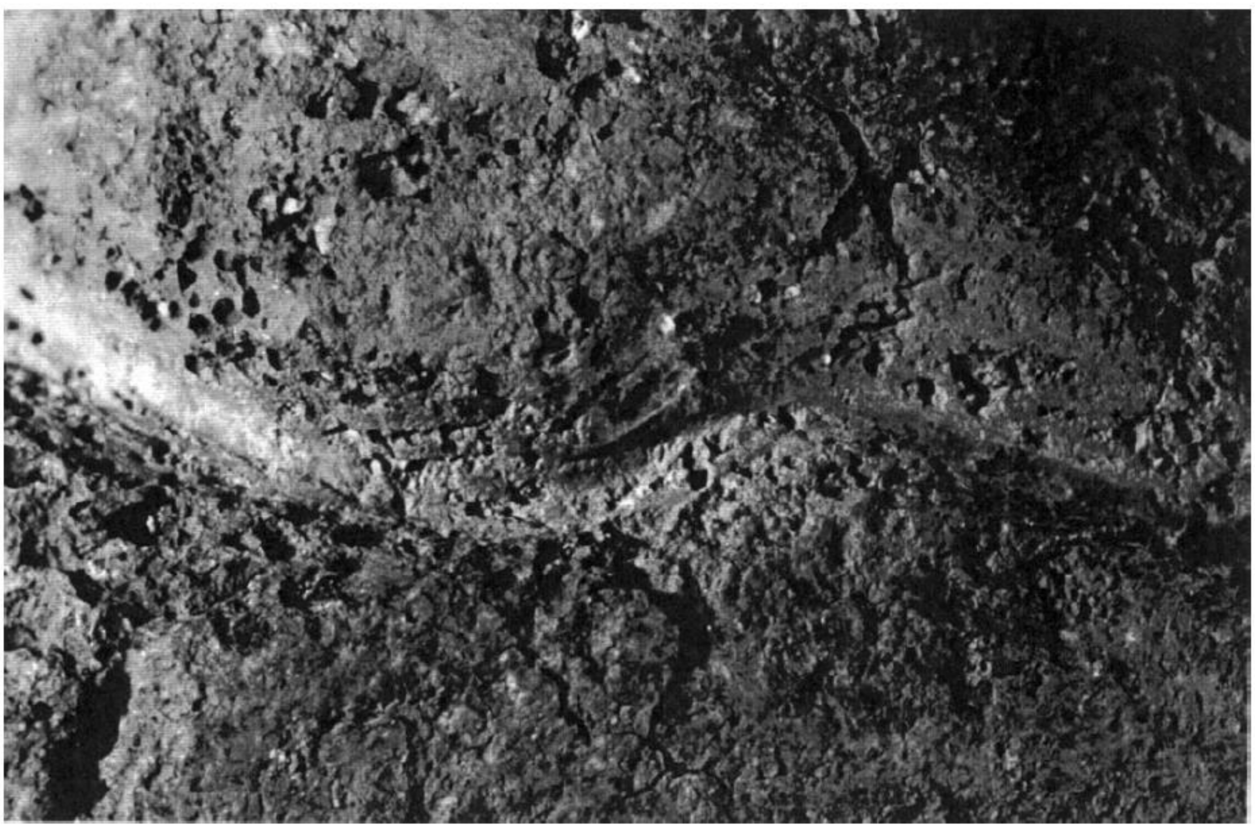

Figure 4-2: Curved profile of a groove made by pointed end of a flake. (Taken from d'Errico and Nowell, 2000)

Direction of incision and Chronology of multiple incisions:

For a groove made by single incision by a pointed end of a flake, the start of the line shows a microcavity which is often termed as having the "comet head appearance". It happens due to more pressure applied at the start of the groove, also the groove is deeper and wider at the start of the groove and decreases in width and depth towards the end due to decrease in pressure. Easily observable under the Scanning Electron Microscope (Fig 4.4) (d'Errico, 1995a).

For finding out the direction of the engraving, various criteria exist looking at the internal section of the grooves under a Scanning Electron microscope but under optical microscope it is not visible. G. Bosinski and J. Fischer (1974) defined the direction of V shaped fractures along the edge with their apex oriented opposite the direction of movement but as d'Errico, (1995a) states that these fractures are not present everywhere, can get easily removed and can lead to wrong interpretation of the direction of the groove.

In general, the methods used to identify the order of the incisions also tell us about the direction of the movement. It is possible to establish the chronology and direction of multiple grooves by looking at their intersection points or junction points as (d'Errico, F., 1995a; d'Errico and Cacho, 1994) –

- When a groove crosses another groove, it erases a part of the first groove partially or completely which can help us determine the order of the grooves, but such feature do not present itself clearly under a microscope if the second groove is made with less pressure or equal pressure to the first groove (Fig 4.3 (1), (2), 4.5 (b)).
- The second groove when exiting the first groove creates a microfracture (observable clearly under SEM) can help in determining the chronology and the direction of the second groove (Fig 4.3 (2), 4.4).
- Sometimes the second groove shows a deviation from its original direction when crossing the first groove which can help in establishing the chronology of the grooves (Fig 4.3 (3),4.3 (4), 4.5 (a), 4.5 (b)).
- When a groove enters another already engraved groove, the second groove sometime shows a slight change in direction. From it we can tell the direction of the second groove (Fig 4.5 (c), (d)).
- If it continues inside the first groove for its whole length, we can identify the second groove as it will stop extending in its original direction. We can also get the direction of the second groove (Fig 4.3 (8)).

- If the second groove exits the first groove at some point, observing the bifurcation point under microscope or looking at the groove which shows major deviation from the preceding joint groove the chronological order of that groove can be adjudged as second (Fig 4.3(6)).

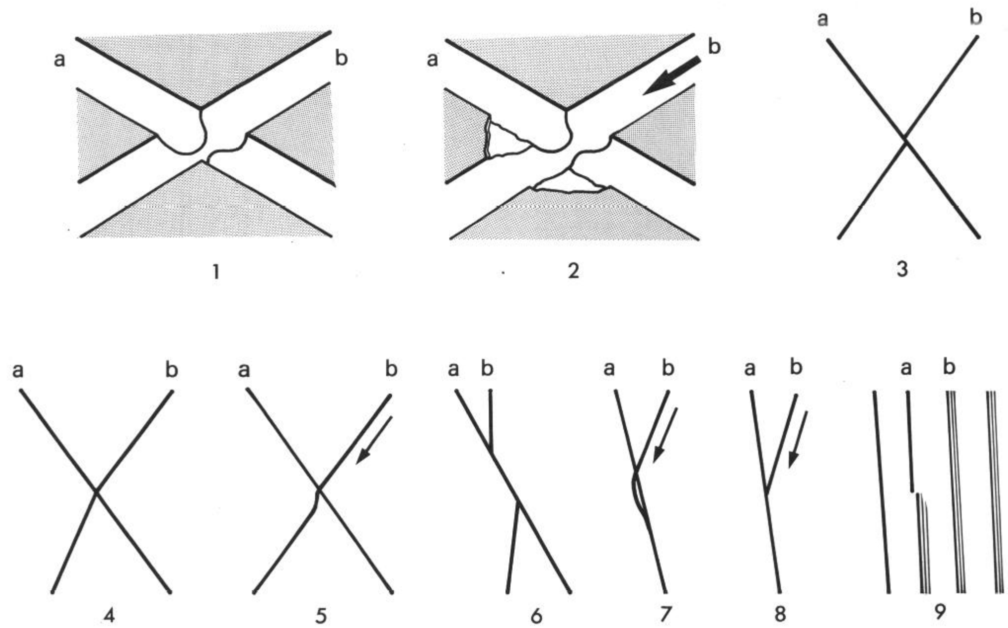

Figure 4-3: Line Diagram for the microscopic features that can help in identifying the chronology and direction of the incisions 1) removal of part of the first line (a) by the passage of the second (b) during a crossing; 2) fractures visible at the exit of the crossing of the line engraved second; 3) offset of the direction of the second stroke; 4) change of direction of the second line; 5) gradual shift in the direction of the second stroke; 6) junction followed by separation; 7), 8) junctions; 9) fracture of the functional part of the tool with shift in direction and increase in the contact surface. The arrows indicate the indices which also make it possible to establish the direction of the movement of the tool (Taken from d'Errico, 1995a)

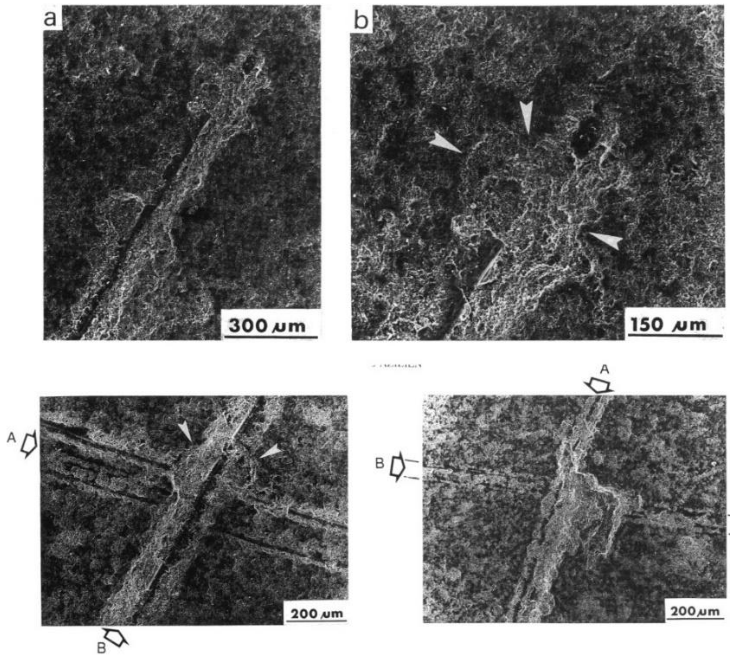

Figure 4-4: (On the top) a) SEM photo of the beginning of an experimental incision; b) enlargement of a), the arrows indicate the circular depression "comet head". (On the bottom) SEM photos of intersection of experimentally engraved lines. The second line (B) intersects the compact bands of the first line (A) and produces a fracture. (Modified from d'Errico, 1995a)

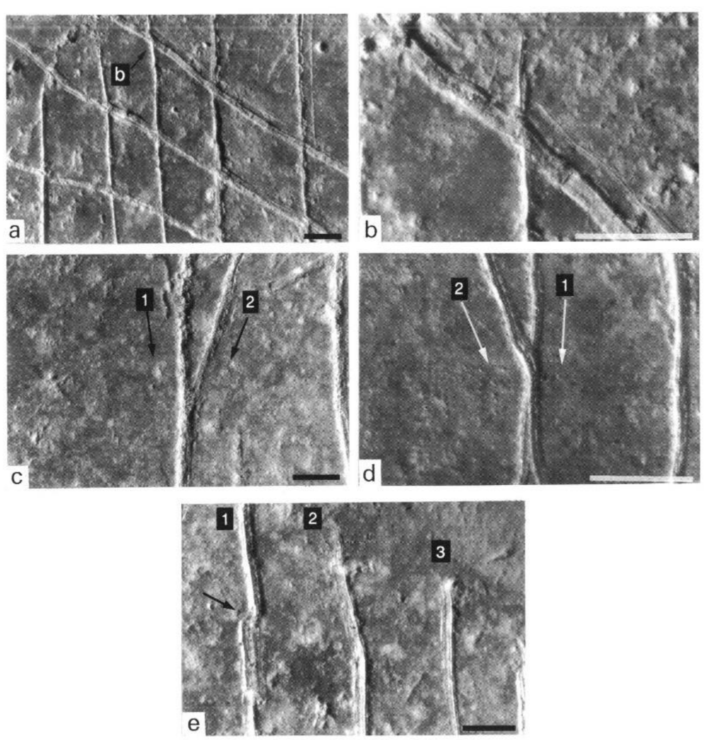

Figure 4-5: Experimental engravings showing microscopic indications of the order of the engravings: a) the slight change of direction of the oblique lines as it crosses the vertical lines. b) close up of a) the second engraved line did not entirely eliminate

the groove of the first. c), d) junctions showing a change in direction of the second etched line. e) change of direction and morphology of the line during a fracture of the functional part of the tool (arrow), the other two lines show the same internal section morphology identical to the one after fracture. Scales = 1 mm (Modified from d'Errico, 1995a)

If there are no intersections or junctions present, it is not possible to judge the order of the grooves. Direction of the grooves can still be identified as sometimes while incising by a pointed end of flake, the tip might break which results in sudden change in morphology of the internal section of the groove as the contact surface between the tool and the surface increases, there is change in direction of the groove (Fig 4.3 (9), 4.5 (e)).

Identifying grooves made by the same tool:

Grooves created by same tool can be identified based on the internal groove morphology "barcode" (Double-sectioned, serrated, and flat-bottomed lines) and having similar widths and lengths (d' Errico 1995a, Fritz, 1999). Other features such as lateral parasitic lines which are formed due to momentary contact of some lateral part of the tool with the surface can be used as an identifying feature in multiple grooves (Fig 4.1(c)). These parasitic lines can be parallel or join the main groove at some point depending on the rotation of the tool during engraving.

However, it's important to know that same tool can produce different morphologies due to (resharpening, change in orientation, change in point of contact, change of functional part of the tool, damage while engraving etc.).

4.2.1.3 Identifying the type of activity from the groove marks:

Anthropic marks on the surface pertaining to this study can be attributed to 3 activities –

Grinding - Grinding marks are created when a cortical surface is abraded against a rough surface. It consists of parallel or group of parallel striations in different orientations at angles to each other. The frequency of striations and micro striations depends on how coarse or smooth the processing surfaces are. The striations cover the whole surface and do not show frayed terminations. In terms of internal profile shapes U shaped profiles are most common followed by V shaped profiles, some grooves might show more depth due to protruded particles on the abrasion surface. Grinding does not change the morphology of a flat cortical surface but on convex surfaces or uneven surfaces it flattens the area with a higher elevation and lower elevation area remains unchanged. While most of the striations are in parallel groups, some might be oriented in random direction which might look like deliberate incisions (Hodgkiss, 2010; Rifkin, 2012).

Scraping – Scraping activity consists of the movement of the tool edge (unretouched or retouched) across a cortical surface in a direction perpendicular to direction of the edge axis. It produces closely spaced parallel/sub parallel striations in a singular orientation or multiple orientations across the cortical surface. Scraping produces variable groove profiles in terms of width, depth, length, and internal groove morphologies (Henshilwood et al., 2001; Hodgkiss, 2010; Rifkin, 2012). Scraping by a retouched edge produces regular and deep groove profiles than from an unretouched edge. Scraping in a back-and-forth direction is more effective than in one direction (Peresani et al., 2014). In terms of differentiating the scrapping marks from grinding marks, scraping marks show frayed terminations and usually do not reach the edge of the surface.

Deliberate incision – Grooves made by deliberate cutting and incisions can be separated from the scraping activity as they show controlled orientation. They always present internal micro striations. The interstitial ridges/ plateaus in between the grooves are often unprocessed. Technical analysis of the individual grooves can be done separately to determine the direction and order of the incisions. Can produce variable profiles depending on the morphology of the edge/tip of the tool (Henshilwood et al., 2009; Hodgkiss, 2010; Rifkin, 2012).

4.2.2 Reference Experimental Collection:

Further for comparison purposes and supporting the microscopic and morphometric analyses, a reference experimental collection was built to get an idea of how different areas of a simple flake (flake edge, pointed end) or a retouched flake interact with the cortex of local flint angular clasts while in use for different activities of utilitarian and non-utilitarian nature such as scraping, scoring/engraving and cutting soft and hard material using the cortical flint clasts as a cutting board. To develop an experimental protocol suitable for the objectives of the study previous experimental studies (d'Errico, 1995a; 1995b; d'Errico and Cacho, 1994; Fritz, 1999; d'Errico and Nowell, 2000; Hodgkiss, 2010; Kaufman et al., 2014) were consulted. Experiments related to grinding activity were not performed as none of the lithic artefacts showed marks which showed grinding like striations. Experiments combining first scraping and then deliberate incision with a pointed end of a flake or scraping and then using the surface as a cutting board were performed to replicate the type of pattern observed in one of the archeological side scraper from Layer 34 (Fig). This was performed to define the criteria on which grooves created by scraping and deliberate incision/cutting can be differentiated correctly. Table (4.1) describes the number of experiments performed and the detail of each activity. In total 12 flakes were used for the experimental studies which were knapped by Shantanu Katiyar (the author). The morphologies of the flakes produced were varied but within the range of variability found in the Mousterian lithic assemblage of Riparo Tagliente. Out of the 12 flakes used, 3 were modified by simple retouching on the distal and lateral ends of the flakes (Fig 4.6). For the experiments regarding deliberate incisions with a pointed end, the corners of the flakes which had a pointed morphology were utilized. For the experiments requiring a blunt edge or blunt pointed end, same flakes which were used for previous experiments requiring sharp edge or sharp pointed end were utilized. (Example – The unretouched edge of a flake which was used for scraping experiment was later utilized for incision experiment). The experimental activities were carried out by Shantanu Katiyar (Author), Trisha Palconit (PhD student, University of Ferrara) and Theresia Risa (fellow IMQP master's student). Experiments regarding deliberate incisions (Single stroke, Multiple Strokes) did not require much time and were not time bound. For multiple strokes, the maximum limit was set to 5 strokes, this number was chosen arbitrary where the main motive was to see the difference between the groove profiles of single stroke and multiple strokes. For scraping experiments, the time limit was set to 2 minutes as the cortex present on the flint nodules could be easily scraped off and carrying on scraping activity for an extended time period would just erase old striations replacing them by the new ones, only reducing the thickness of the cortex. For the experiment - scraping and then deliberate incision and for scraping and then using the surface as a cutting board the time limit was set at 5 min with no specific instructions regarding the direction of motion and the orientation of the cortical surface. All the experimental material, flakes used for cutting, scraping and engraving and cortical flint nodules on which these actions were conducted were taken from the collection of PhD Nicolo Fasser, University of Ferrara and belong to the Tenno, Biancone, Scaglia Rossa and Scaglia Variegata variety similar to the raw materials the Mousterian lithic industry was manufactured on. Further microscopic and morphometric analysis of the grooves created by each experiment was done using Leica LAS EZ4 HD (8x-35x magnification) with built-in digital camera to compare the features of the grooves created on the experimental cortical surface with the grooves present on the archeological material.

TYPE OF AGENT	TOOL ACTIVE AREA	ACTIVITY	ACTIVITY DETAILS	TIME PERIOD
	The unretouched edge	Scraping	Unidirectional scraping.	2 minutes
	The unretouched edge	Scraping	Bidirectional (back and forth) scraping.	2 minutes
	Sharp unretouched edge	Incision	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).	N/A
	Blunt edge (used before for scraping)	Incision	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).	N/A
SIMPLE FLAKE	Sharp pointed edge of the flake	Incision	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).	N/A
	Used/blunt pointed edge	Incision	Intentional scoring the cortex in one direction – one time and multiple times (in the same position).	N/A
	The unretouched edge	Cutting soft material (Chicken breast)	Using an almost flat cortical nodule as a cutting board, to check for the type of marks made on the nodule during the cutting activity.	5 minutes
	The retouched edge	Scraping	Unidirectional scraping	2 minutes

RETOUCHED FLAKE	The retouched edge	Scraping	Bidirectional scraping (back and forth)	2 minutes
	The retouched edge	Incision	Intentional scoring of the cortex in one direction	N/A
RETOUCHED FLAKE, SIMPLE FLAKE	The retouched edge, pointed edge of either retouched or simple flake	Scraping then Incision	Scraping the nodule using a retouched flake in a bidirectional manner (back and forth) and then intentionally engraving it using pointed end of a flake.	5 Minutes
	The retouched edge, the unretouched edge	Scraping then cutting hard material	Scraping the nodule using a retouched edge in a bidirectional manner (back and forth) and then using the scraped cortical surface as a cutting board to cut dried leather using a simple flake.	5 Minutes

Table 4-2: The experiments performed.

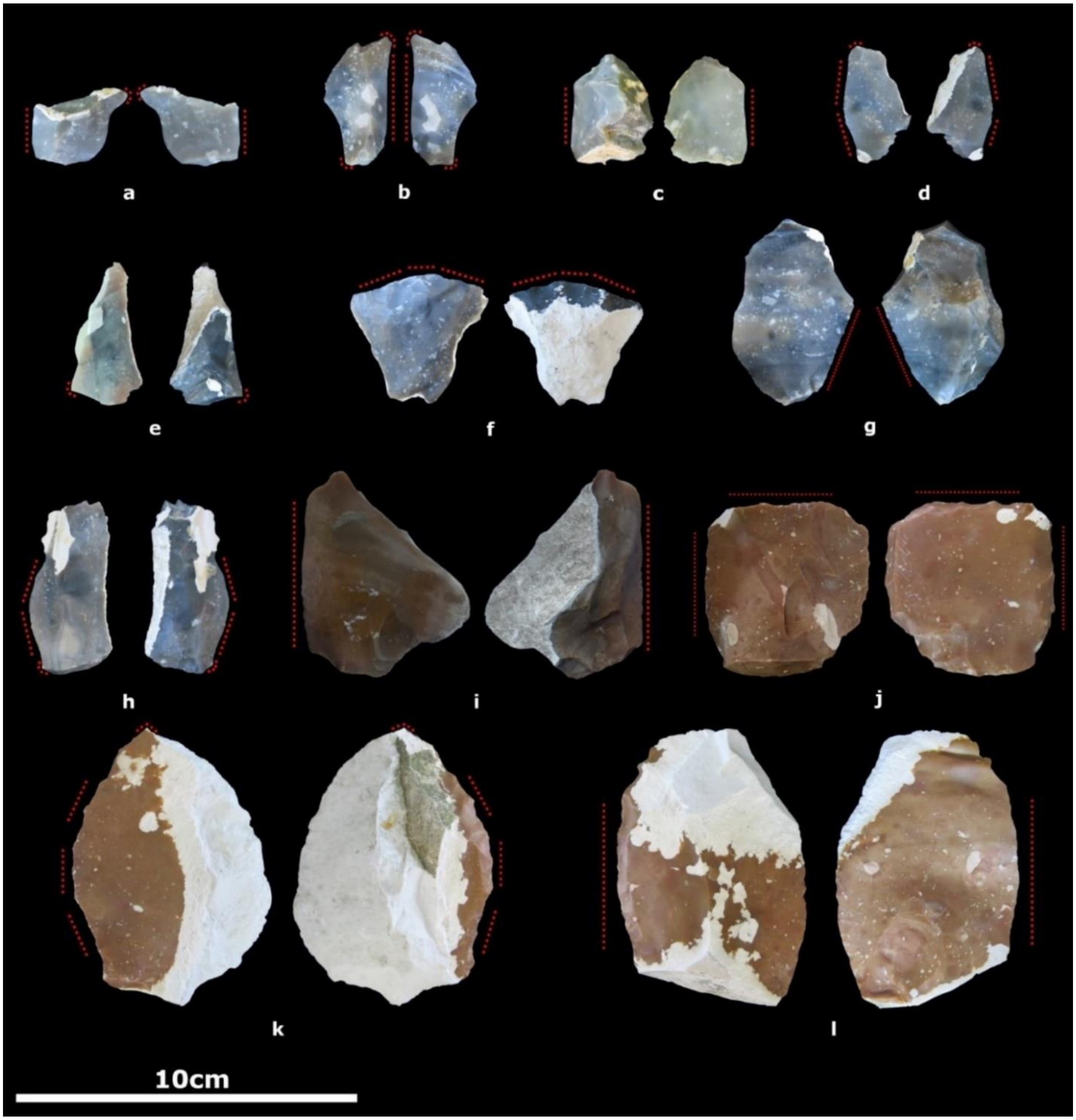

Figure 4-6: The flakes used for all the experiments. The red dotted lines along the flakes represent the area of the flakes used for experiments. a), b), c), d), g), h), i) represent simple flakes whose unretouched edge was used for scraping, scoring and cutting experiments. f), j), k) represent flakes with a retouched edge which was used for scraping and scoring experiments. The pointed end/edge of the flakes a), b), d), e), h), k) was used for scoring experiments as well, represented by the curved dotted lines.

Figure 4-7: Examples of some of the experiments conducted. a) Scraping with a simple flake, b) Scoring with a simple flake, c) Scoring with a pointed end of the flake, d) Scraping with a retouched flake, e) Scoring with a retouched flake.

The experimental replication studies conducted here do not cover the effects of pre or post depositional damage or taphonomic processes which might alter or erase the original wear traces and might create new traces not related to anthropogenic activity which can mimic anthropogenic use wear traces (Shea and Klenck, 1993; Hodgskiss, 2010).

Figure 4-8: (On the left) Trisha Palconit cutting chicken breast with a simple flake using a flat flint nodule as a cutting board/support. (On the right) Myself scoring the cortex of a flint nodule with the pointed end of a flake.

4.2.3 Definitions, Documentation through processing photographs taken under the microscope and making tracings of the anthropogenic marks on the cortex's of archeological material:

For indicating the artefact number for the selected artefacts, the full information (the square number, quadrant number and layer number) was missing for some of them so only the artefact number is used to indicate them. Additional information is provided wherever available. In previous lithic studies, the wear traces due to grinding, scraping or engraving have been termed usually as grooves, striations and striae. Other terms used for such traces have been scratches, furrows, sleeks, liner depressions and abrasion marks. In this study the definitions developed in previous experimental studies on grinding, scraping and engraving ochre in South African MSA context such as Hogskiss, (2010) and Riftkin, (2012) have been used to avoid confusion.

- Grooves in general include all kinds of traces made from scraping and scoring activity. No method of creation is implied by the term.
- Striations are defined as multiple, parallel grooves formed by scraping.
- Striae or micro striations refer to the microscopic parallel, sub parallel striations which occur inside the grooves.

Other than these definitions, the lowest part of the groove is defined as valley of the groove. The term 'engraving' is avoided initially in the analysis of the traces as this term inherently implies a symbolic meaning, so to avoid that confusion, the term 'scoring' or 'incision' is preferred (Mackay and Welz, 2008).

Metric attributes of the lithic artefacts were taken from vernier calipers. For the experimental reference collection, a recording form was not maintained as all the documentation of the experimental pieces was done through observation under the microscope. The participants were free to use any of the flakes and specific instructions were given on the type of edge to be used (unretouched, retouched or pointed end of a flake) and the direction of motion. This was done to maintain high variability in the types of grooves/striations/striae created especially for the scraping experiments. The experiments and their observation/taking photographs under the microscope were completed the same day.

For taking clear and detailed images of whole cortical surfaces of the selected archeological material as well as the experimental cortical surfaces, multiple images at different focus, at 8x magnification, of different sections of cortical surfaces were taken using the in - built camera of Leica LAS EZ4 HD microscope and the Microscope Imaging Software - Leica LAS EZ. This process was repeated until the whole cortical surface of each individual artefact and experimental flint nodules was covered. These images were edited in the trial version of the raster graphics editor Affinity Photo 2, developed by Serif Ltd. for iOS, macOS, and Windows. Firstly, a composite image of each section was created using the focus stacking feature of the Affinity Photo 2 software and then using the Panoramic feature, the composite images of each section of the cortical surface were stitched together to create detailed images of the whole cortical surface. Further, images of specific areas of interest were taken at higher magnification (16x – 35x) at different focus and were compiled in the Affinity Photo 2 software to create clear and detailed images. Grooves width was measured through the Microscope Imaging Software - Leica LAS EZ. Oblique lighting was used for microscopic examination which allows the striations to be highlighted but the drawback of it is that it creates shadows in some other parts of the cortical surface being examined. To overcome that, additional tracings for the artefacts with anthropogenic traces of the suspected anthropogenic marks on cortical surfaces were done in the free cross-platform digital image processing software GIMP (GNU image manipulation program) using a Wacom graphic tablet with extremely helpful suggestions from Dario Sigari, Rock Art specialist, University of Ferrara.

5 Results:

5.1 Experimental Reference Collection:

To support the microscopic and morphological analysis of the anthropogenic marks, 12 experimental studies were conducted including various activities such as scraping, using the cortical nodules as a cutting board to cut soft and hard material and lastly deliberate incisions. These activities were performed with various tool types such as the pointed end of a flake, unretouched edge of a flake and retouched edge of a flake of different size and robustness. The raw material utilized belongs are Tenno, Biancone, Scaglia Rossa and Scaglia Variegata variety and was taken from the collection of Ph.D. Nicolo Fasser, University of Ferrara, consisting of the same varieties on which the Mousterian lithic industry of Riparo Tagliente was manufactured on. The cortex present on the surface of flint nodules is formed by silicified limestone and can vary in thickness and compactness from being very thick, chalky, and crumbly to being thin and very compact/hard (Arzarello, 2003, Arzarello et al. 2011). Usually due to limestone or silicified limestone being soft in nature as they are made up of calcium carbonate ($CaCO3$), it is very easy to remove the top patinated layer by scraping, cutting, deliberate incisions or abrading, revealing the underlying bright white layer (Dallatorre, 2011).

Type of Agent	**Tool active area**	**Activity**	**Activity details**
Simple flake	The unretouched edge	Scraping	Unidirectional scraping.
	The unretouched edge	Scraping	Bidirectional (back and forth) scraping.
	Sharp unretouched edge	Scoring	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).

	Blunt edge (used before for scraping)	Scoring	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).
	Sharp pointed edge of the flake	Scoring	Intentional scoring the cortex in one direction – one stroke and multiple strokes (in the same position).
	Used/blunt pointed edge	Scoring	Intentional scoring the cortex in one direction – one time and multiple times (in the same position).
Simple flake	The unretouched edge	Cutting soft material (Chicken breast)	Using an almost flat cortical nodule as a cutting board, to check for the type of marks made on the nodule during the cutting activity.
	The retouched edge	Scraping	Unidirectional scraping
Retouched flake	The retouched edge	Scraping	Bidirectional scraping (back and forth)
	The retouched edge	Scraping	Bidirectional scraping in two directions
Retouched flake, Simple flake	The retouched edge, pointed edge of either retouched or simple flake	Scraping then Scoring	Scraping the nodule using a retouched flake in a bidirectional manner (back and forth) and then intentionally engraving it using pointed end of a simple or retouched flake.
	The retouched edge, the unretouched edge	Scraping then cutting hard material	Scraping the nodule using a retouched edge in a bidirectional manner (back and forth) and then using the scraped cortical surface as a cutting board to cut dried leather using a simple flake.

Table 5-1: The experimental activity performed.

5.1.1 Scraping experiments:

Simple flake Unidirectional: Scraping in a unidirectional motion by a simple flake led to the formation of parallel/sub-parallel striations of variable profile all over the surface (Fig 5.1), with interstitial ridges showing the presence of micro striations (Fig 5.1a, b) (showing signs of being processed which could also be gathered from the fact that the patinated layer was completely removed). Passing of the tool many times over the surface did not deepen the grooves but made them shallower (internal micro striations still present) giving the surface a flat appearance. Every new stroke erased the striations made by the previous strokes. The motion of every new stroke was not exactly in the same direction, minor changes caused by human error or due to the undulating surface of the cortex created more intersections between individual grooves forming many X-shaped or V-shaped patterns over the surface (Fig 5.1c, d, e).

Simple flake Bidirectional: The type of striations created by the bidirectional (back and forth) movement is very similar to what we see in unidirectional scraping. Variable profile, parallel/ subparallel striations, the interstitial ridges showing signs of being processed, and creation of flat surfaces with very shallow parallel/sub-parallel striations. In this experiment, the frequency of X-shaped, or V-shaped patterns was less. The reason could be a more continuous movement of the tool (back and forth) where the tool is in contact with the surface thus less chance of change in the orientation of motion, although the undulating cortical surface might still create those minor changes in orientation. Fig 5.2 shows the cortical surface which has been scraped for 2 minutes in a bidirectional (back and forth) movement. The areas at the edges which are a little higher in elevation (Fig 5.2a) preserve the striations caused by a singular stroke (more deep and clear groove profile) while in the middle area (Fig 5.2b) where the tool passes many times as compared to (Fig 5.2a), the striations (still visible) are shallower, giving the surface a flat appearance. In Fig 5.2c we can see the frayed ends of the striations. The reason for their curved nature is the sudden height elevation in the surface which causes a change in direction of motion.

The results produced by scraping experiments with an unretouched edge were consistent with other experimental studies (Hodgkiss, 2010; Rifkin, 2012; Kaufman et al., 2018).

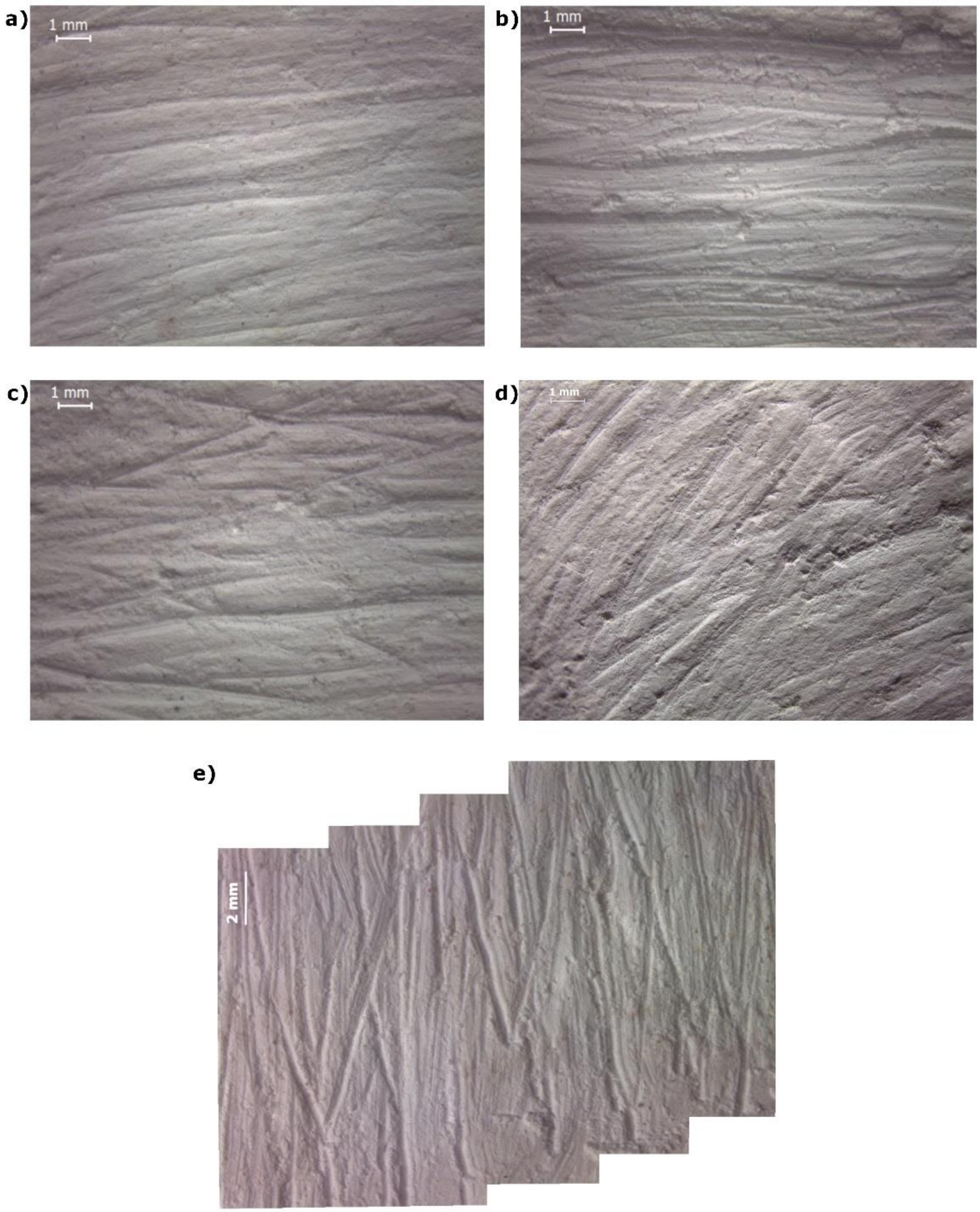

Figure 5-1: Patterns observed in unidirectional scraping of the cortical surface by an unretouched edge. A), B) parallel striations, C), D), E) subparallel striations forming X or V shaped pattern.

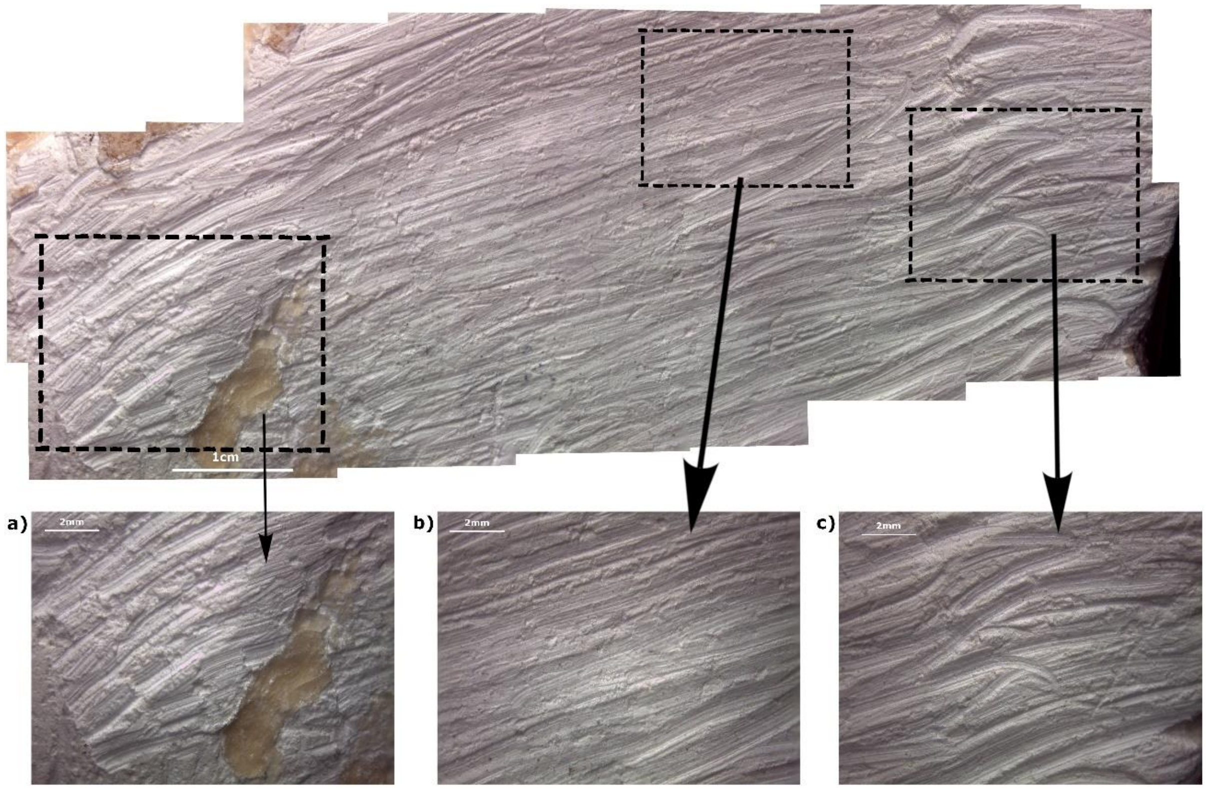

Figure 5-2: Pattern observed in scraping a surface in a back-and-forth motion with a simple flake. A) groove profiles are more prominent near the edge, B) shallow parallel/sub parallel striations creating a flat surface. C) Frayed ends of the termination of striations.

In the case of retouched flake, retouching increases the area of contact with the surface, and creates a lot of points of contact along the edge, which can vary in shape and size and according to that the depth, length and even shape of the internal cross-section of the striations varies (Fig 5.3 a, b).

Retouched flake unidirectional: Scraping in unidirectional motion with a retouched flake creates deeper and wider striations in a parallel/sub-parallel orientation than an unretouched edge. The internal cross-section of the grooves created is usually U-shaped or _/ shaped with internal micro striations. Most of the individual groove profiles can be seen clearly even on flat surfaces. In the case of unidirectional motion, the striations created are not homogenous (unprocessed interstitial ridges/ plateaus). In Fig 5.4 (a), (b), we can see that the underlying striations created by scraping (back and forth) are visible in between the overlying striations made by unidirectional scraping. This could be due to unevenness in the cortical surface where the low-lying areas (Fig 5.4 b) are skipped by the flake or due to uneven application of force/ pressure (Fig 5.4 a).

Retouched flake bidirectional: The difference between unidirectional and bidirectional engraving is that a surface scraped in a back-and-forth motion has a more homogeneous, organized distribution of the striations. Continuous back-and-forth scraping erases grooves made before but does not lead to the creation of flat surfaces as in the case of unretouched edges. Continuous scraping back and forth with force leads to the formation of very deep and wide grooves with a U-shaped cross-section with internal micro striations (Fig 5.3 c).

Figure 5.4 represents the differences between unidirectional and bidirectional scraping with a retouched edge, the surface which was first scraped in a horizontal direction by back-and-forth movement of a retouched flake was again scraped in a different orientation by the same flake in a unidirectional motion. The striations made by unidirectional motion leave a lot of interstitial ridges/ plateaus unprocessed in between them (the striations made by back-and-forth scraping are not completely erased in some places) while in the case of back-and-forth motion, the surface looks more homogeneously scraped. With back-and-forth motion, the low-lying areas of the surface are also covered while in unidirectional motion they are skipped.

Overall, the results obtained for scraping with a retouched edge are in line with the previous experimental studies (Henshilwood et al., 2001; Hodgkiss, 2010; Rifkin, 2012; Peresani et al., 2014, Kaufman et al. 2018)

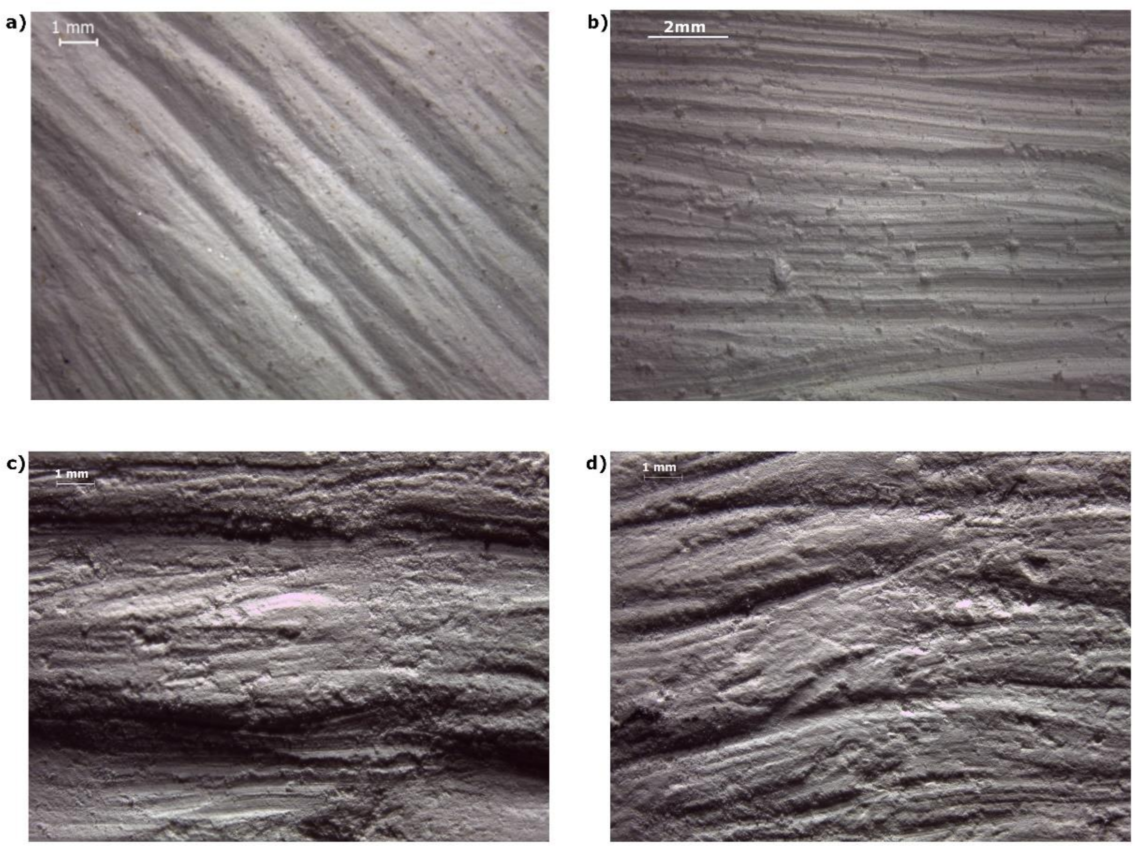

Figure 5-3: a) b) Difference in the type of grooves from different retouched flakes, c) creation of deep and wide grooves in back and forth scraping with a retouched edge with internal micro striations, d) frayed ends produced in scraping with a retouched edge.

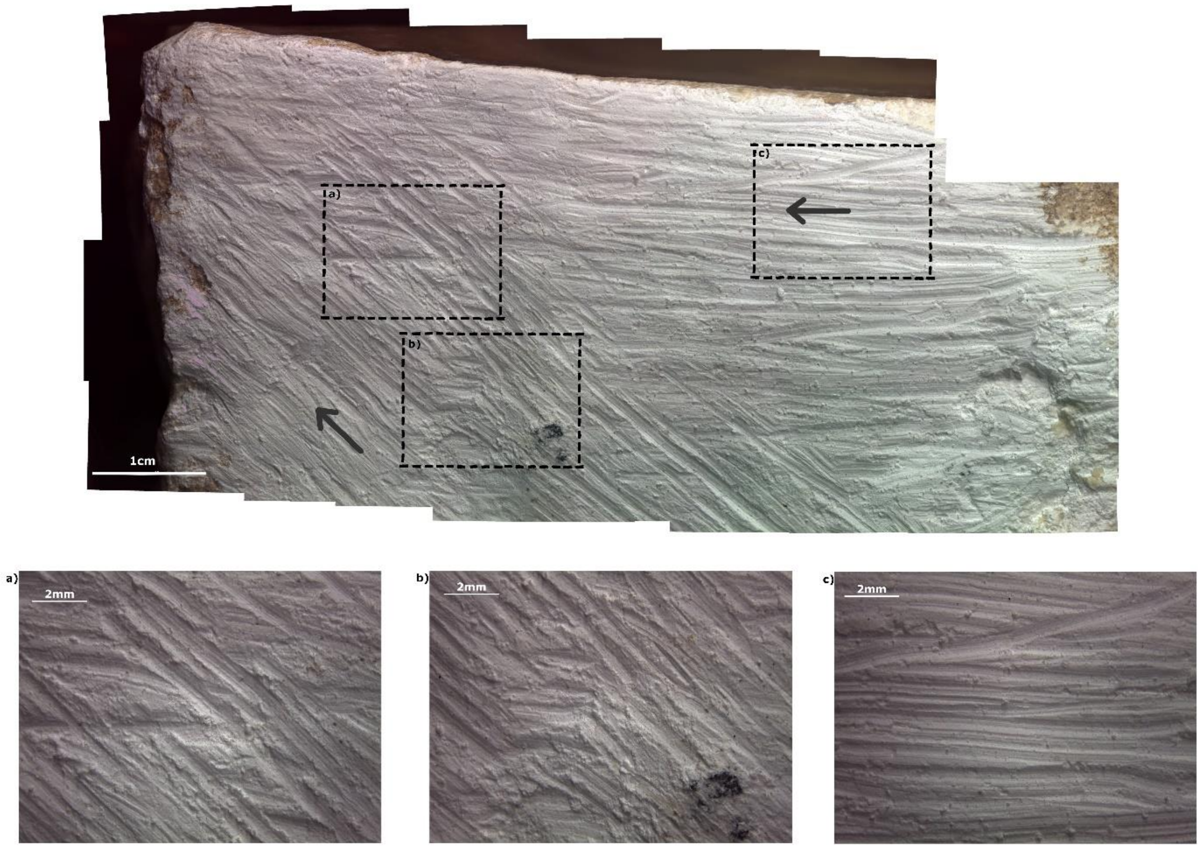

Figure 5-4: Scraping done in two orientations by a retouched flake. The black arrows represent the direction of scraping. a) b) The striations made by horizontal back and forth scraping are still visible below the unidirectional scraping marks. In b) the black spot is the underlying flint exposed because of scraping. c) close up of back and forth scraping striations.

5.1.2 Deliberate Incisions experiments:

Incision experiments (Table 5.1) were performed by 5 tooltip/edge morphologies - sharp pointed end of a flake, blunt pointed end of a flake, sharp unretouched edge, blunt unretouched edge, and a retouched edge (Table 5.1). Each tooltip/edge morphology was used to make a single incision and multiple incisions (5 strokes).

The sharp pointed end of a flake - (Single incision) the internal cross-section of the groove shows a _/ shaped morphology with a flat valley bottom and straight walls at an angle (Fig 5.5 a). (Multiple incisions) The groove becomes wider and deeper with the area of the flat valley increasing and the walls becoming more vertical (Fig 5.6 a). The micro striations are very faintly visible along the walls/edges of the grooves.

Blunt pointed end of a flake – (Single incision) the internal cross-section of the groove presents a U-shaped morphology with a rounded valley shape and straight vertical walls (Fig 5.5 b). (Multiple incisions) The groove becomes wider, with no noticeable change in depth in this experiment (Fig 5.6 b).

Sharp unretouched edge – (Single incision) The internal cross-section of the groove shows a V-shaped morphology, with a narrow valley and straight walls forming an acute angle (Fig 5.5 c). (Multiple incisions) the groove becomes deeper and wider and its internal morphology changes from V-shaped to U-shaped due to multiple passing of the flake. The walls are straight and still at an angle although more than that of a single incision (Fig 5.6 c). The internal cross-section in case of multiple strokes can be _/as well with a flat valley bottom.

Blunt unretouched edge – (Single incision) The internal cross-section of the groove shows a U-shaped morphology with straight vertical walls and a rounded bottom. The incision is shallower than by a sharp unretouched edge, very similar to the groove of the blunt pointed edge of the flake (Fig 5.5 d). (Multiple incisions) groove profile is very similar to that of the single incision by a blunt unretouched edge, U-shaped internal cross-section with straight walls and a rounded bottom (Fig 5.6 d).

In all the incision experiments, the cortex along the edges shows signs of microchipping or micro flaking all along the groove. These kinds of marks have been studied before in bones where such continuous exfoliations along the edges/walls have been associated with a robust and not linear edge like in a retouched flake (Domínguez-Rodrigo et al., 2009, Prevost et al. 2022). However, in this experimental activity, these marks are present in all the grooves produced by different tool edge/tip morphologies. The reason behind this could be the soft, crumbly texture of the cortical surface which breaks or crumbles easily. Indeed, in incisions made on surfaces with a hard and compact cortex, the frequency of the microchipping along the edges is less (Fig 5.7 a). The grooves incised with the pointed end (blunt or sharp) did not present the typical ‘comet head’ morphology associated with the pointed ends of the flake (Fig 5.7 b, d) (d’Errico, 1995a). Again, its reason could be the soft nature of the cortical surface which produces such intense microchipping all along the edges/grooves that separately the comet head morphology could not be identified. Maybe it requires a more detailed/magnified image (under SEM) so that the “comet head” shape can be seen clearly. Faint signs of starting points of multiple strokes were observed in some cases (Fig 5.7 c). The micro striations inside the grooves were very faintly visible on the bottom valley or alongside the edges/walls of the grooves. In these experiments the incisions with various tool types were made to leave the cortical surface edge at one end and in most of the incisions (Single stroke or multiple stroke), an increase in the depth was observed when comparing it with the rest of the profile of the grooves (Fig 5.5, 5.6).

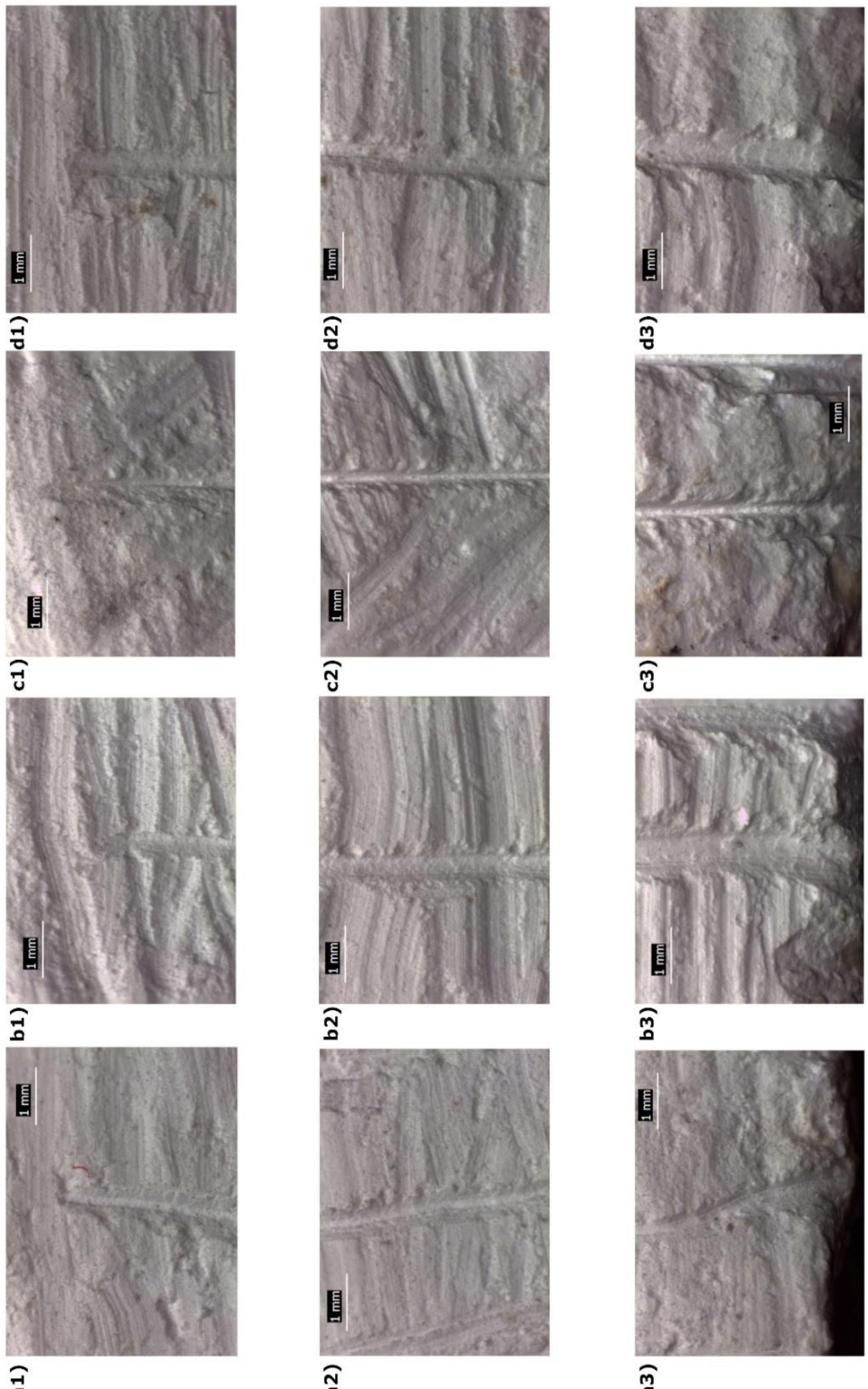

Figure 5-5: Starting, middle and end points of single incisions made by - a) sharp pointed end of a flake, b) blunt pointed end of a flake, c) sharp unretouched edge, d) blunt unretouched edge.

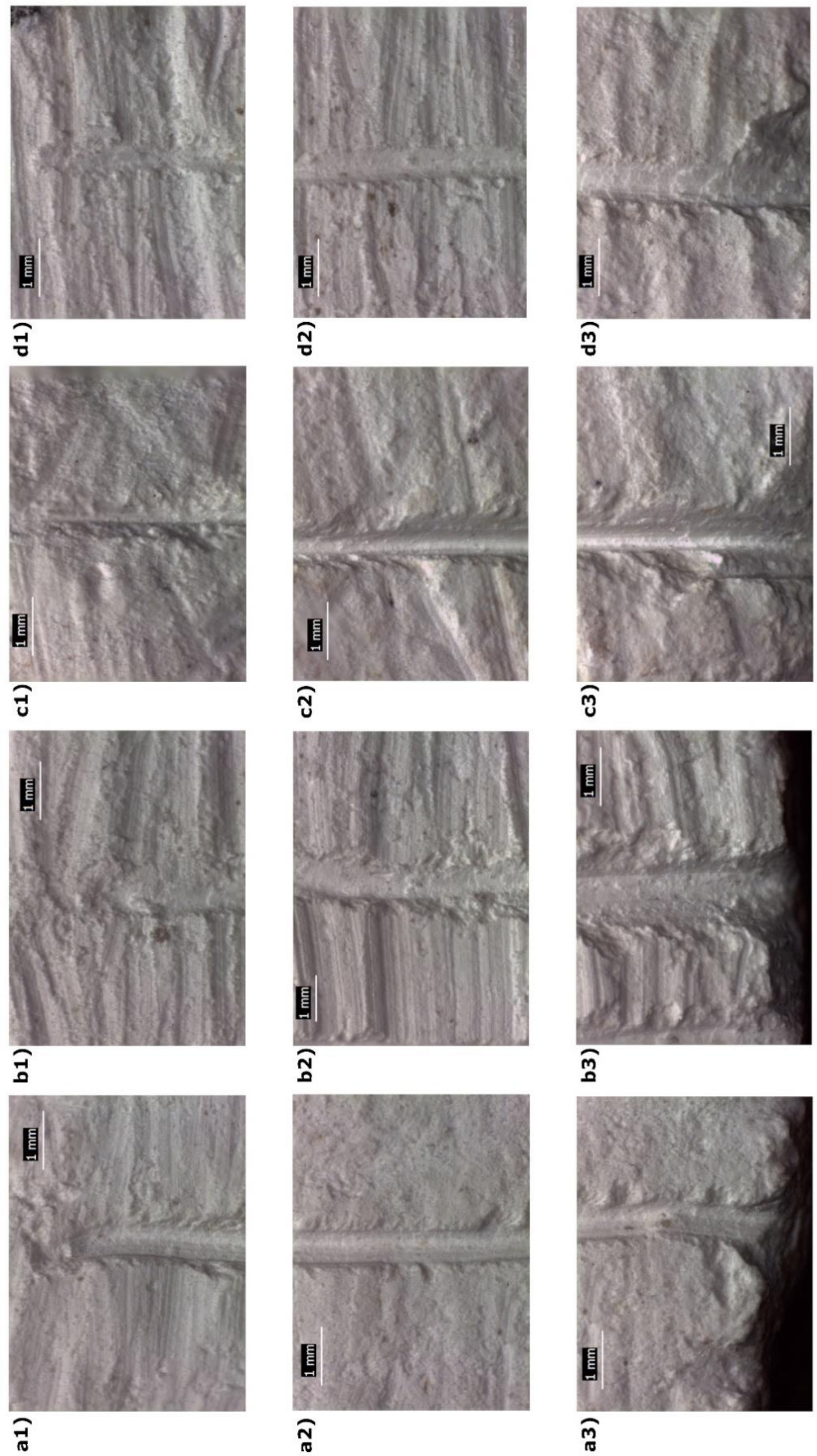

Figure 5-6: : Internal cross sections of the starting, middle and end points (where it exits the cortex) of incisions made by mutiple strokes. a) sharp pointed end of a flake, b) blunt pointed end of a flake, c) sharp unretouched edge, d) blunt unretouched edge.

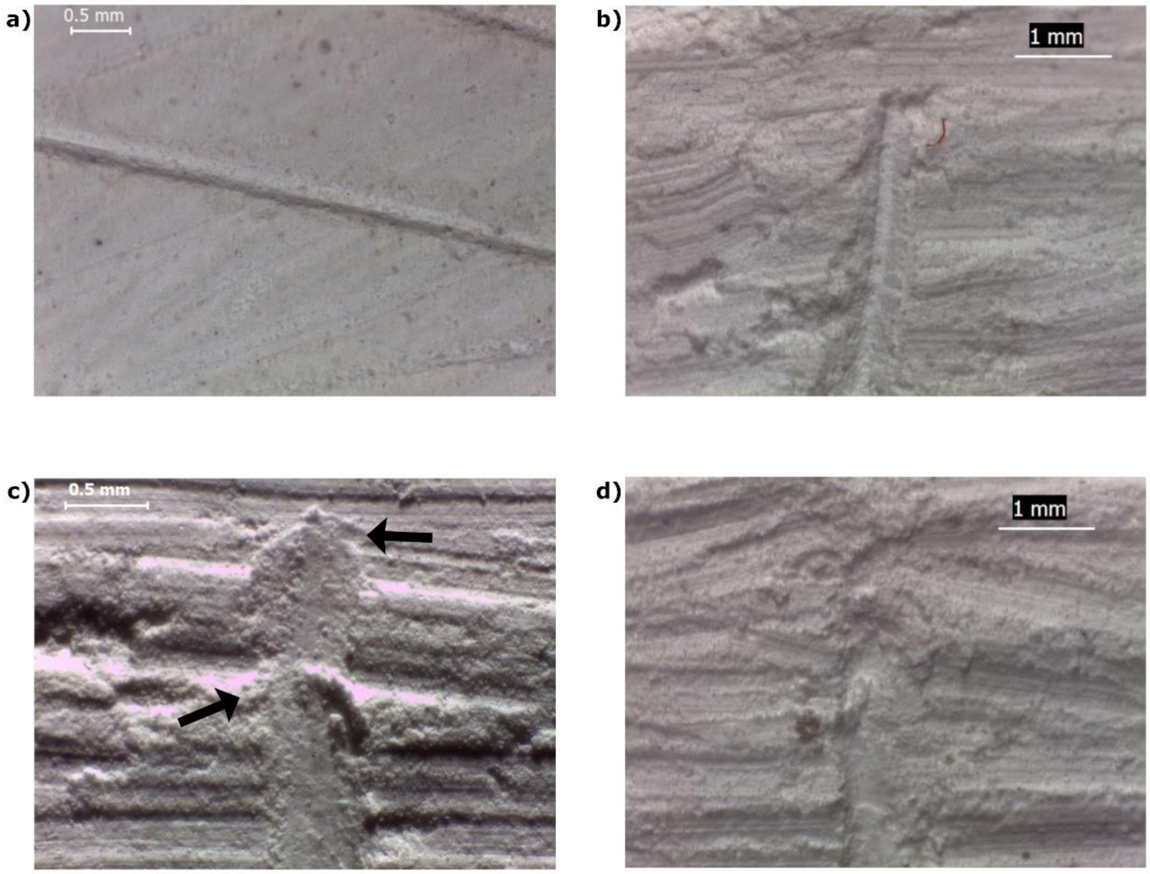

Figure 5-7: a) Incision made on a thin compact cortex by a pointed end of a flake with no microchipping along the edges, b) d) close up of the starting points of sharp and blunt pointed edge of a flake with no comet shaped morphology. c) two separate starting points visible inside the same groove (Black arrows).

Retouched edge – In case of a retouched edge, the internal cross section of the groove presents multiple internal micro striations, the walls are not straight but they curve along the length of the groove. Microchipping along the edges can be observed. In Fig 5.8, small side branches also appear which merge in the main groove, on the bottom side, formation of a parasitic line can be seen as well.

Figure 5-8: Single incision from a retouched flake.

5.1.3 Using the cortical surface as a base to cut soft material:

The activity was performed using a flat flint cortical cobble as a base on top of which the soft material (chicken breast) was cut into smaller strips using a sharp unretouched edge. The direction of motion was unidirectional, but the orientation of the cobble was adjusted according to the comfortability of the person cutting the soft material. The pattern developed on the surface consisted of groups of parallel/sub parallel grooves intersecting each other at angles (Fig 5.9, Fig 5.10 a, b). Most of the grooves present show a V-shaped internal cross section typical of the cutting marks (Fig 5.10 c, f, g, h). In some places we can observe that one V-shaped groove enters the already incised groove and changes the internal morphology of the groove, making it wider, more U-shaped with internal micro striations (Fig 5.10 d, e). Some grooves presented a _/ shaped morphology (Fig 5.10 h, i) which could be due to multiple passing of the flake edge from the same area (i) or holding the flake at an angle which can bring other parts of the flake, rather than the cutting edge in contact with the surface resulting in _/ shaped grooves (h). The results are mostly consistent with the experiments conducted in other studies (Dallatorre, 2011; Peresani et al. 2014).

Figure 5-9: Marks created on the cortical surface when used as a base for cutting soft material.

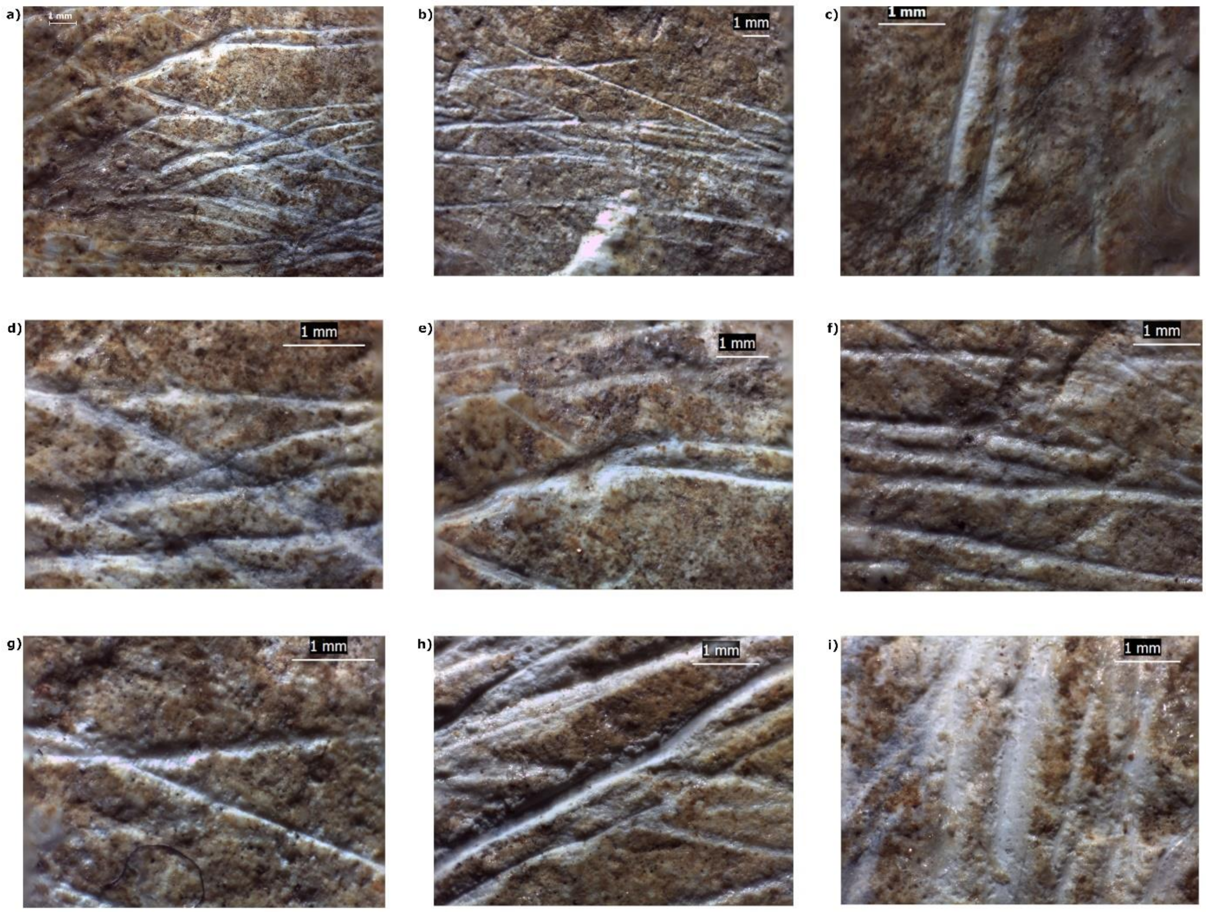

Figure 5-10: a) b) Showing the pattern formed by the engraved lines, c) f) g) V – Shaped internal cross section of the grooves created, d) e) two singular V shaped grooves merging to form a U-shaped groove. h) a _/ shaped groove, i) A deep _/ shaped groove probably formed by multiple passing of the cutting edge.

5.1.4 Using a scrapped surface as a base to cut hard material (dry skin):

The activity was performed using a flat cortical flint nodule, which was scrapped before and then used as a base for cutting a piece of dry skin into smaller strips using a simple unretouched edge of a flake. The direction of motion was unidirectional, but the orientation of the flint nodule was adjusted from time to time according to the comfortability of the person performing the experiment. As dry skin is tougher to cut, it requires more pressure/force and multiple strokes to cut through it. The grooves on the cortical surface consisted of parallel/sub-parallel grooves intersecting each other at different angles (Fig 5.11). The grooves show high variability in terms of length, depth, and type of internal cross-section. Grooves made by a singular stroke show a V-shaped cross section (Fig 5.12 a) but multiple strokes in the same groove change the shape of the groove's profile making it deeper, more U-shaped with internal micro striations (Fig 5.12 b, c, d). Fig 5.12 e shows a _/ shaped groove, the morphology of the groove cannot be explained by multiple passing of a flake edge as it is too shallow. The most probable origin of such morphology could be due to some other section of a flake instead of its sharp cutting edge coming in contact with the cortical surface as also seen in cutting soft material. The results are mostly consistent with the experiments conducted in other studies (Dallatorre, 2011; Peresani et al. 2014).

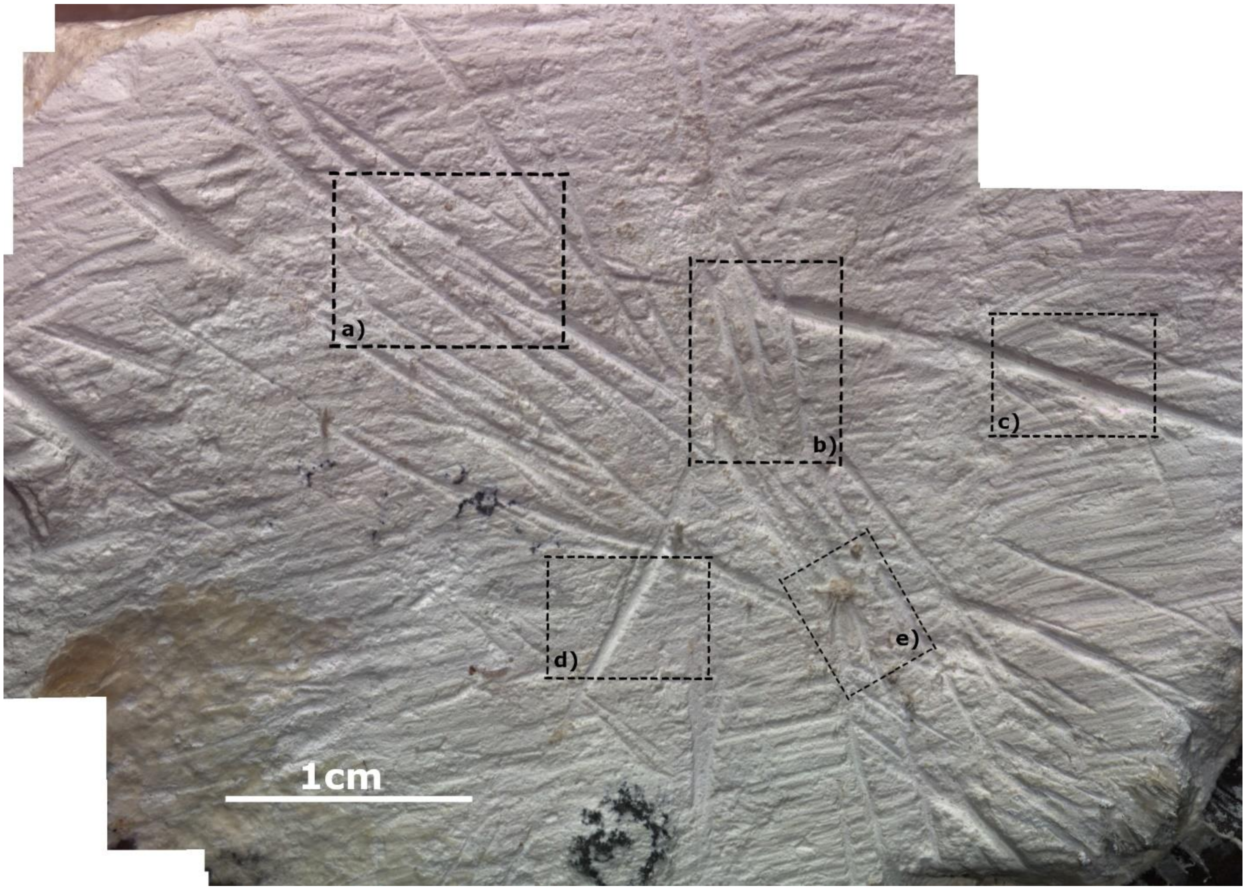

Figure 5-11: Using an already scraped surface as a base for cutting hard material (leather).

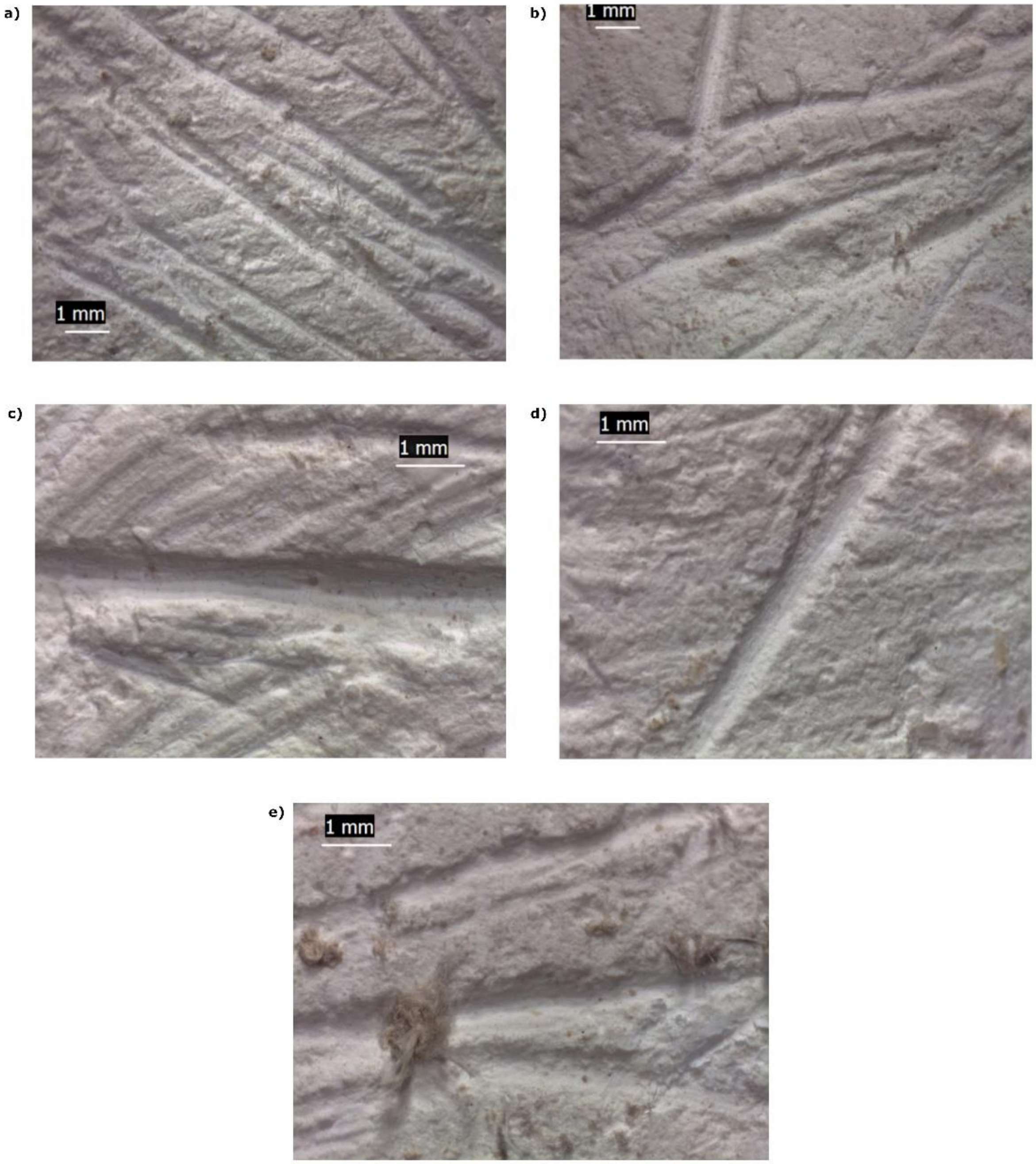

Figure 5-12: Close up of the variable groove profiles visible. a) V - shaped grooves, b) c) e) U shaped grooves, d) flat bottom groove with straight walls. c), d) show internal micro striations.

5.1.5 Deliberate incisions by a pointed end of a flake over a scraped surface:

This experimental activity was performed on a flat cortical nodule which was scraped with a retouched flake in a back-and-forth motion and then was incised by the pointed end of various flakes in a left-to-right direction. The objective of the experiment was to observe the groove profile made by the pointed end of the flake when incised over an uneven surface formed by the grooves made previously by scraping. In Fig 5.13 a) b) we can see the grooves made by the pointed end of the flake enter the large wide grooves made by scraping, change direction and run along the scraping groove before exiting through the other wall/edge. From it, the direction of the groove made by the pointed end of a flake can be identified as from left to right. In Fig 5.13 c), the wavy groove profile of an incision made by a pointed end of a flake can be observed which would not be possible to make with a cutting edge. In Fig 5.13d it can be observed that it becomes harder to differentiate the groove made by the pointed end of a flake (black arrow) and the striations made by intense scraping if they are in the same direction/orientation as it could be easily considered a striation made due to scraping (Mackay and Weltz, 2008, Henshilwood et al.,2009).

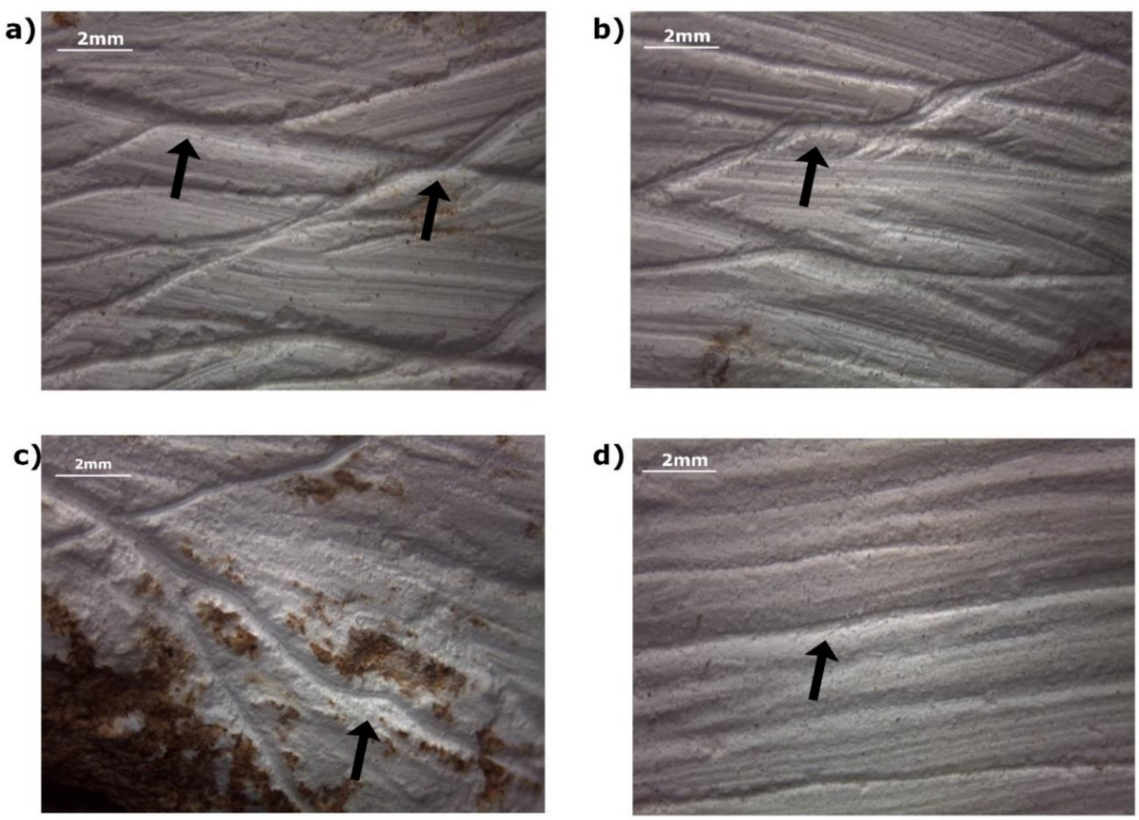

Figure 5-13: a) b) the black arrows point towards the change in direction of the grooves made by pointed end of the flake as they pass through the grooves made by scraping (the direction engraving was from left to right). c) the wavy curvy groove formed by the pointed end of a flake. d) grooves created by incision (black arrow) and scraping striations in same direction. (Hard to differentiate.

5.2 Description and technological analysis of the archaeological material:

In total 429 artefacts fully or partially covered with cortex were analyzed for marks of anthropic origin, first by manual selection by the naked eye and then by detailed technical analysis under the microscope. The criteria used to differentiate between marks of natural origin, sin/post-depositional damage and recent damage was based on previous experimental studies (see Chapter 4). In total 4 artefacts, 2 side scrapers and 2 flakes, showed markings which could be attributed to having an anthropic origin including the side scraper previously described (Arzarello, 2003; Dallatore, 2011; Peresani et al., 2014). For microscopic analysis, the 4 artefacts, and 7 more artefacts which showed examples of marks related to natural origin, sin – post-depositional damage and recent damage (Table 5.2) were subjected to microscopic analysis. From the microscopic analysis, we were able to differentiate between natural and anthropic markings based on the groove's internal profile, presence of internal micro striations, position, and orientation of the grooves on the cortex. Further, from the technical description of the grooves of anthropogenic origin, information on - the type of tool used, the direction of incisions, and chronology of incisions and grooves made by the same tool was obtained which is described below separately for each artefact:

Artefact Number	*Artefact type*	*Length (mm)*	*Width (mm)*	*Thickness (mm)*	*Figure Number*
	Possible Anthropogenic Marks				
RT 100	Side Scraper	123	49	12	5.33
RT 167	Side Scraper	55	36	13	5.26
RT 11	Flake	44	30	6	5.25
RT 76	Flake	37	33	11	5.22
	Natural Marks, Sin/post depositional damage, Recent damage				
RT 574	Side Scraper	87	60	28	5.18
RT 209	Flake	23	32	4	5.20
RT 140	Flake	46	31	15	5.17
RT 595	Flake	67	45	11	5.16
RT 306	Flake fragment	59	43	10	5.14
RT 81	Flake	42	30	9	5.21
RT 2	Flake fragment	40	38	17	5.15

Table 5-2: The artefacts analyzed

5.2.1 Naturally occurring marks on the cortex:

Figure 5-14: A flake fragment showing a sinuous _/ shaped crack in the cortex. On bottom left - the flint surface of the artefact is visible, On the top right - wider area of the groove with no internal striations.

Fig 5.14 shows an example of a naturally occurring mark in the cortical surface of a flake fragment from layer 41, numbered RT 306. The cortical surface of the flake shows a deep groove running in the middle of the cortex with an internal cross-section being _/ shaped. In the valley of the groove, the cortex is completely removed, and the underlying flint is visible. If this groove was made by incision activity, it would have required multiple strokes, which would have increased its width and left internal micro striations along the edges/walls of the grooves corresponding to the passage of different strokes, which is not present in this case. Other parts of the cortical surface show signs of exfoliation and abrasion as well. Overall, it could be confidently said that the groove was formed naturally over time due to weathering by physical or chemical causes (d'Errico and Villa, 1997).

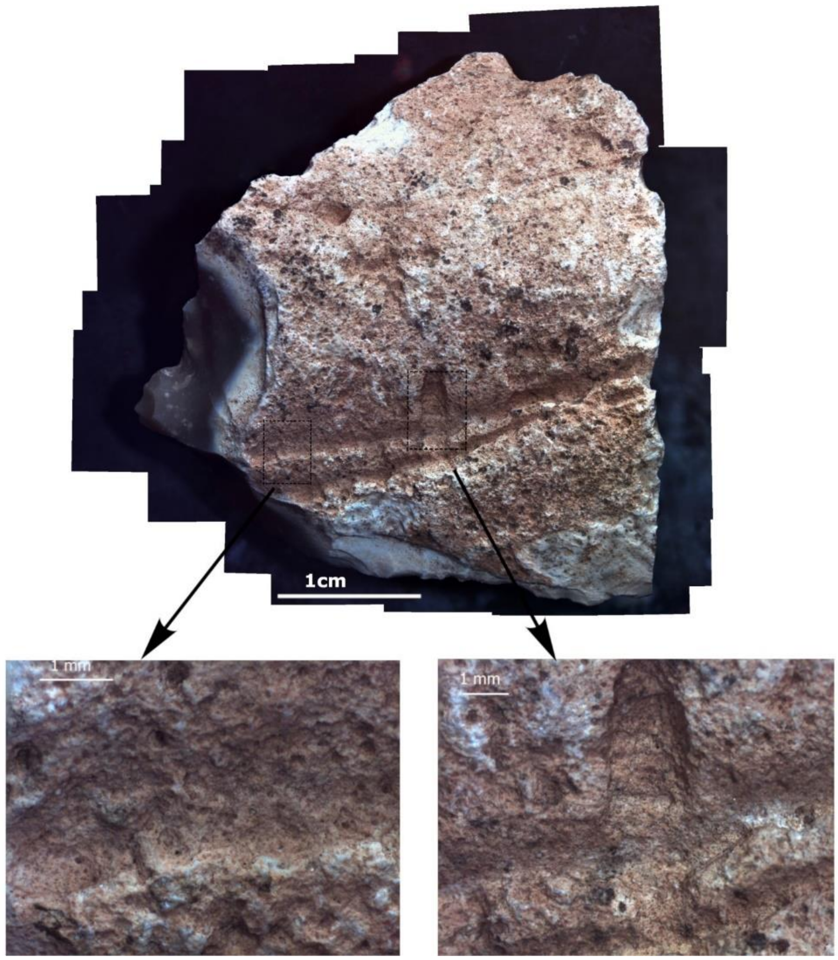

Figure 5-15: Flake fragment showing two parallel deep and wide U-shaped grooves

Fig 5.15 shows another example of naturally occurring marks formed due to weathering/erosion on the cortical surface of flake fragment from arbitrary cut 33, numbered RT 2. The cortical surface of the flake fragment shows two parallel U-shaped grooves with rounded edges/walls and no internal micro striations (d'Errico and Villa, 1997) as visible from the two zoomed in images of the sections of the groove. The grooves are very deep and wide and to make such a groove with a stone tool would require multiple incisions which would leave micro striations and/or a _/ shaped cross section. The whole surface area of the cortex is covered with round and elliptical shaped pits/holes formed due to dissolution of the more soluble part of the cortex. One of such natural pits overlaps one of the grooves as shown in the bottom right zoomed in Fig 5.15.

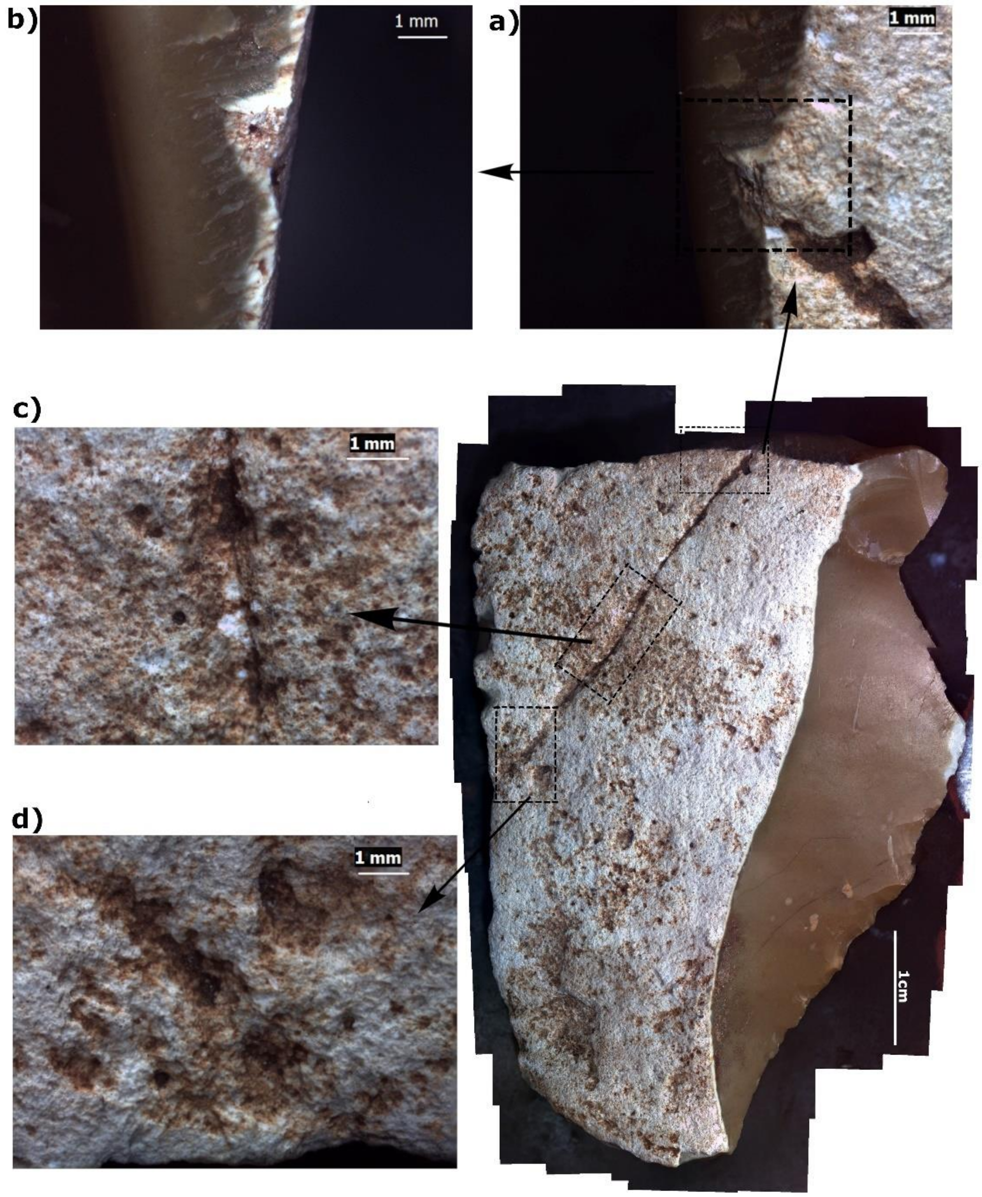

Figure 5-16: Flake showing a single groove crossing the cortical surface.

Fig 5.16 shows an example of a natural crack on the flake from arbitrary cut 33, numbered RT 595, which forms a V shaped groove which could be mistaken as being made by an unretouched edge (Fig 5.16 c). But on closer examination we see that the groove follows a natural deformation in the flint (Fig 5.16 a, b). The groove is not continuous and, in the places where it is broken up we can observe that the groove is made up of small depressions formed by dissolution of the cortex which have linked together over time to form a continuous groove (Fig 5.16 d).

5.2.2 Marks formed due to recent damage:

Figures 5.17 and 5.18 give examples of fresh incisions on the cortical surface of a flake from arbitrary cut 33, numbered RT 140 (Fig 5.17) and a side scraper from arbitrary cut 37, numbered RT 574 (Fig 5.18). These incisions are easily identifiable based on the colour difference with the rest of the cortical surface as the internal section of the grooves is bright white in colour, while the cortex has a reddish–brownish patina. The depth of the recent incisions is generally shallow, and they can show internal micro striations. The length and width of these types of incisions are highly variable and they can appear to form patterns such as an X shape, visible in the examples presented. The probable cause of these fresh incisions could be during the excavation (from the excavation tools) or after storage. The Mousterian lithic assemblage of Riparo Taglinete at the University of Ferrara is kept in large wooden crates where all the artefacts are in contact with each other and the sharp edges/ pointed ends of the stone tools can easily create accidental marks on the cortical surface of other stone tools (Fig 5.19) (d'Errico, F. 1993).

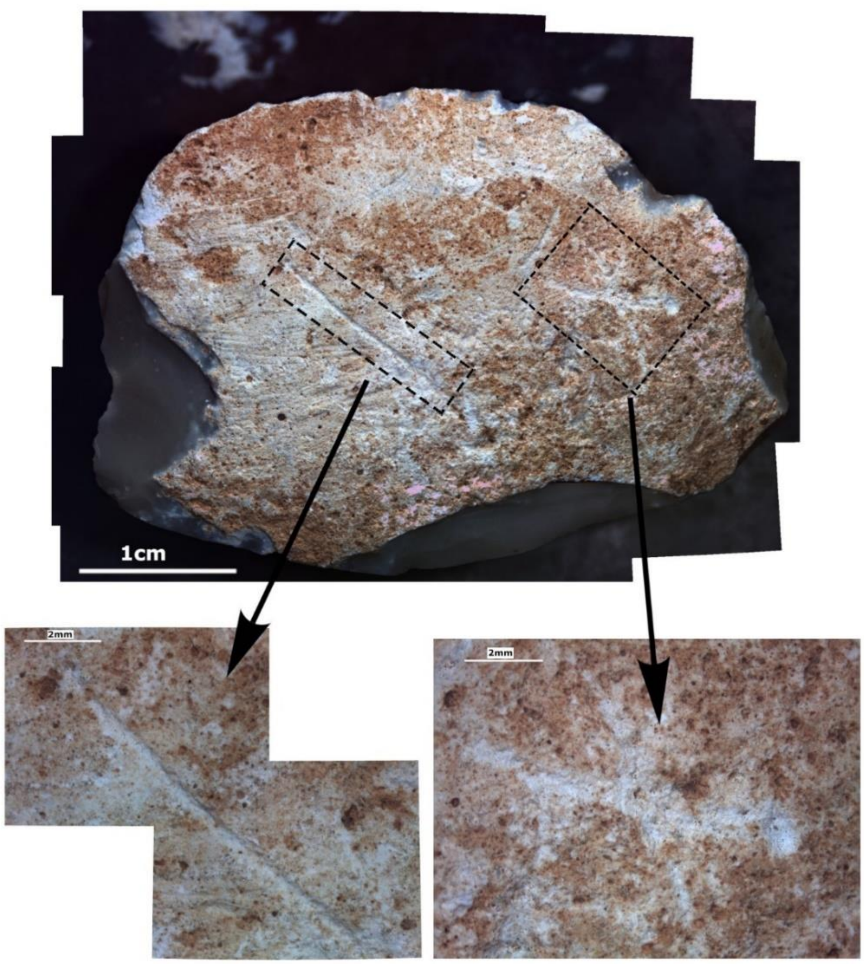

Figure 5-17: A cortical flake fragment showing fresh incisions identified based on the color difference inside and outside of the groove. (in the bottom right) – two recent incisions forming an X shape.

Figure 5-18: A scraper showing recent incisions on the cortical surface.

Figure 5-19: Storage of the Mousterian artifacts of Riparo Tagliente in big wooden crates.

5.2.3 Marks formed due to sin and post-depositional damage:

Processes such as sedimentary abrasion, trampling, superficial rolling, root etching etc. can create grooves which can mimic incisions made by stone tools (Fisher, 1995; d'Errico, 1995a, 1995b, d'Errico and Villa, 1997; d'Errico and Nowell, 2000). These incisions show the same patina coloration as the rest of the cortex which attests to their ancient origins. These incisions can show internal profiles like what one can expect from an incision made by a stone tool (comet-like shape, V/U shaped sections, internal micro striations) but are usually superficial in nature, have a short length and are randomly placed on the cortical surface and therefore cannot be attested to anthropogenic activity (utilitarian or non-utilitarian) (Fig 5.20, 5.21) (Fisher, 1995). Most of the raw material utilized by the Neanderthal population comes from the Progno di Valpantena (Arzarello, 2003), and such marks can easily develop due to contact between the cobbles and angular clasts and their movement with respect to each other in the river.

Figure 5-20: A cortical flake RT 209 from layer 40 with short, broad and shallow marks.

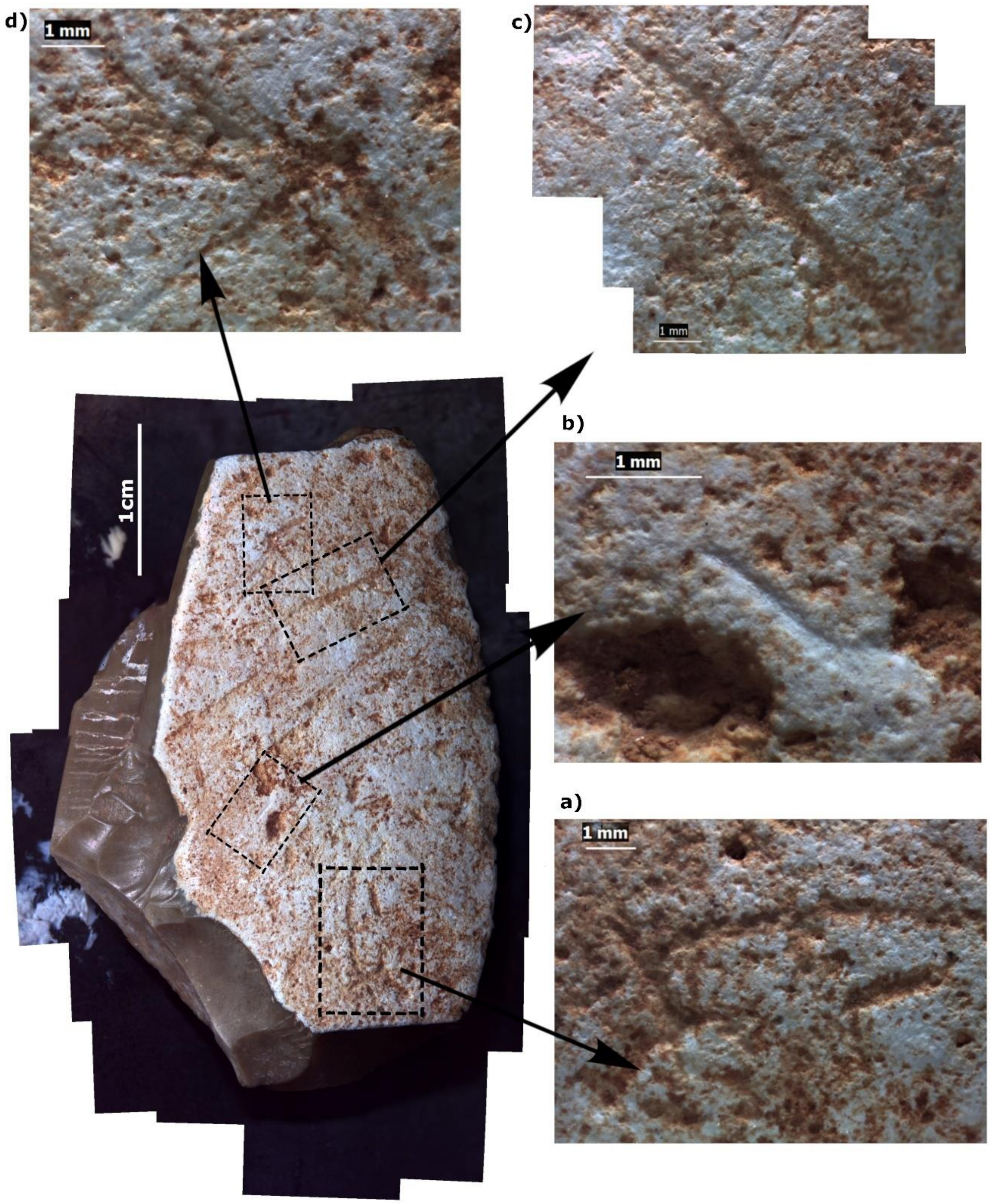

Figure 5-21: A cortical flake RT 81 from arbitrary cut 50, showing incisions which mimic incisions made by stone tools but are probably made due to sin and post depositional damage (a,c,d). b) shows a recent incision.

5.2.4 Marks formed due to anthropogenic activity:

5.2.4.1 Flake RT 76:

It is a partially cortical end flake from layer 36 with metric attributes - 35mm in length, 31mm wide and 15mm in thickness. The cortex is present in the distal part of the dorsal side of the flake (Fig 5.22). The cortex present is compact and hard in nature (Arzarello, 2003; Dallatore, 2011) and the cortical surface shows signs of weathering and abrasion. Despite that, one can observe a straight groove running across the cortical surface. No other such grooves are visible on the cortical surface. Patina colouration inside the groove is like the rest of the cortical surface and the presence of micro pits (caused by weathering) inside the groove (Fig 5.23b) as on the rest of the cortical surface demonstrates that the groove is ancient. In places where the groove walls are not affected by the micro pits, the groove presents a _/ shaped morphology with a flat valley bottom, and very sharp vertical edges/walls. The internal cross-section of the groove changes to U-shaped as one moves from the left to the right side of the groove. The width as well as the depth of the groove decreases from left to right as the groove curves following the curvature of the cortex (comet-like morphology) (d'Errico, 1988a, 1995b; Prévost et al., 2022) (Fig 5.23). The direction of the incision can be inferred from the profile of the groove to be running from left to right as the decrease in width (Fig 5.24) and thickness of the groove can be explained as a decrease in pressure as the incision tool was leaving the curved surface (d'Errico, 1988a, 1995b; Prévost et al., 2022). It can be said that the groove was engraved with a pointed end of a tool looking at the changes in the internal morphology of the groove and the presence of a parallel parasitic groove on the right side (Fig 5.23c). The parallel groove was probably formed due to secondary/ double contact of the tooltip as the main groove curves following the curvature of the cortical surface (d’Errico, 1995a). The comet-like morphology also confirms that the groove was formed by a single stroke. At the left end of the groove, it cannot be said if the incision was made before or after the flake was taken out because of weathering damage and mechanical abrasion (Fig 5.23b). On the right edge, one can observe the groove exiting the cortex, although that too is faded because of similar reasons. Microscopic analysis of the internal cross section of groove morphology shows no visible micro striations. Overall, the groove walls show clean, clear edges, the groove is not superficial in nature and although the internal micro-striations are missing, it can be said that this incision is not natural, and was not caused by post-depositional damage (trampling, root etching etc.) and has anthropogenic origins (d’Errico et al. 2001).

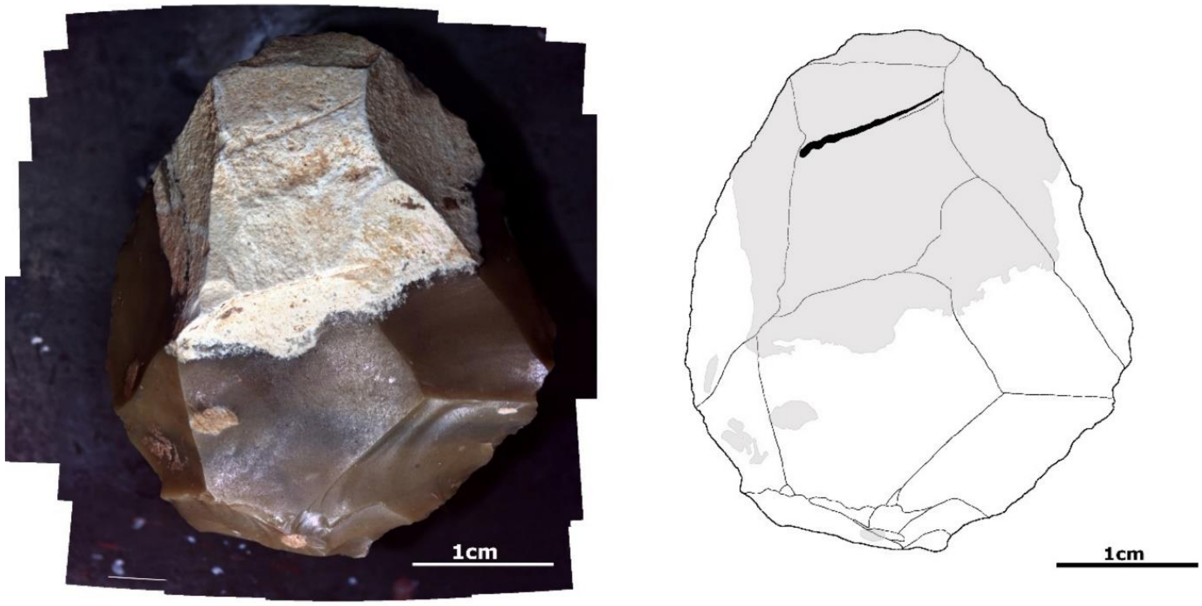

Figure 5-22: (on the left) A end flake from layer 34, which is partially covered by the cortex in the distal end of the flake and shows a singular scoring mark and associated parasitic line. (On the right) Tracing of the flake and the engraving (the light grey area represents the cortex and black lines represents the groove)

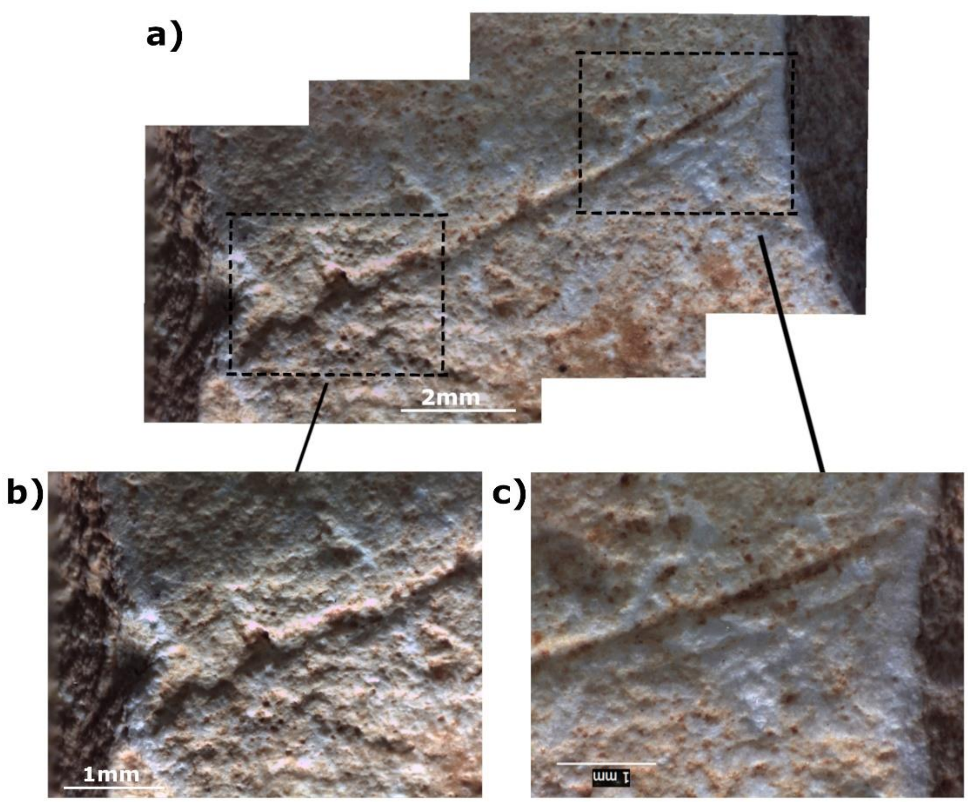

Figure 5-23: a) close up of the groove (inverted image), b) the groove shows a wavy/sinuous profile with a _/ shaped internal cross section, with presence of micropits inside the groove. c) the groove shows a U-shaped morphology on the left side, the parallel parasite striation is also visible.

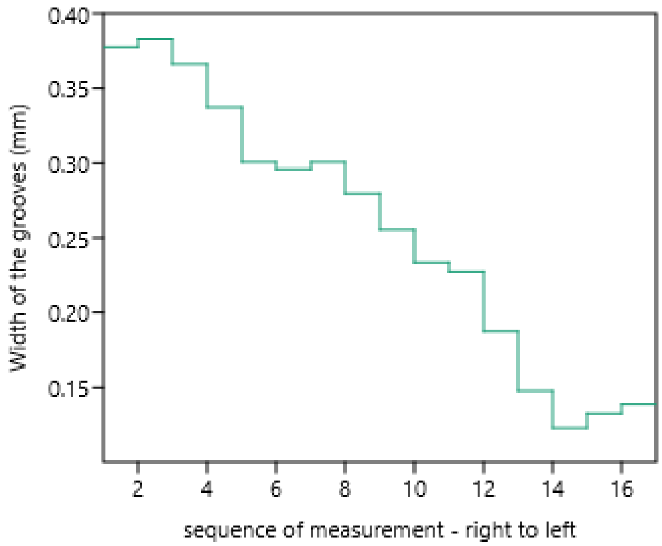

Figure 5-24: Gradual decrease in the width of the groove. Width measured at 16 points across the groove's length moving from right to left.

5.2.4.2 Flake RT 11:

It is a cortical flake with metric attributes – 37mm in length, 27mm wide and 7mm in thickness. It comes from layer 33 and shows partial direct retouching at one of the lateral edges (Fig 5.25). The cortical surface covers most of the dorsal side of the flake except in some part near the proximal end of the flake. The cortical surface has a porous texture, consisting of small pits all over the surface. The cortex shows 2 different colours of patina, one being reddish brown in the middle area while an off-white-coloured patina at one of the lateral edges (Fig 5.25b) and at the distal end of the flake (Fig 5.25a). Some part of the cortical surface in the middle is covered under the dark brown encrustations. From Fig 5.25b, we see that the cortex on the lateral edge presents a group of parallel/sub-parallel striations. These striations do not present frayed ends and continue throughout the lateral edge. The thickness of the cortex is very thin in that area, suggesting a homogenous reduction in the cortex thickness. These striations present individual grooves of varying length and width, the internal profile varies from V-shaped to _/ shaped with internal micro striations. These striations could be attributed to scraping activity or abrasion activity (Hodgkiss, 2010; Dallatore, 2011; Peresani et al. 2014). Fig 5.25a shows an area with very superficial parallel striations at the distal end of the flake. The striations are parallel and very close to each other, individual grooves show variable internal profile (mostly U shaped) (variable depth), are present mostly on the off white coloured patinated cortex and most importantly are covered by the dark brown encrustation proving their ancient origin. The origin of these striations is not so clear as they could be natural abrasion marks which formed before being covered by the dark brown encrustations or could be abrasion marks created due to anthropic activity . Although it seems an unnatural position for thinning the cortex for better flaking.

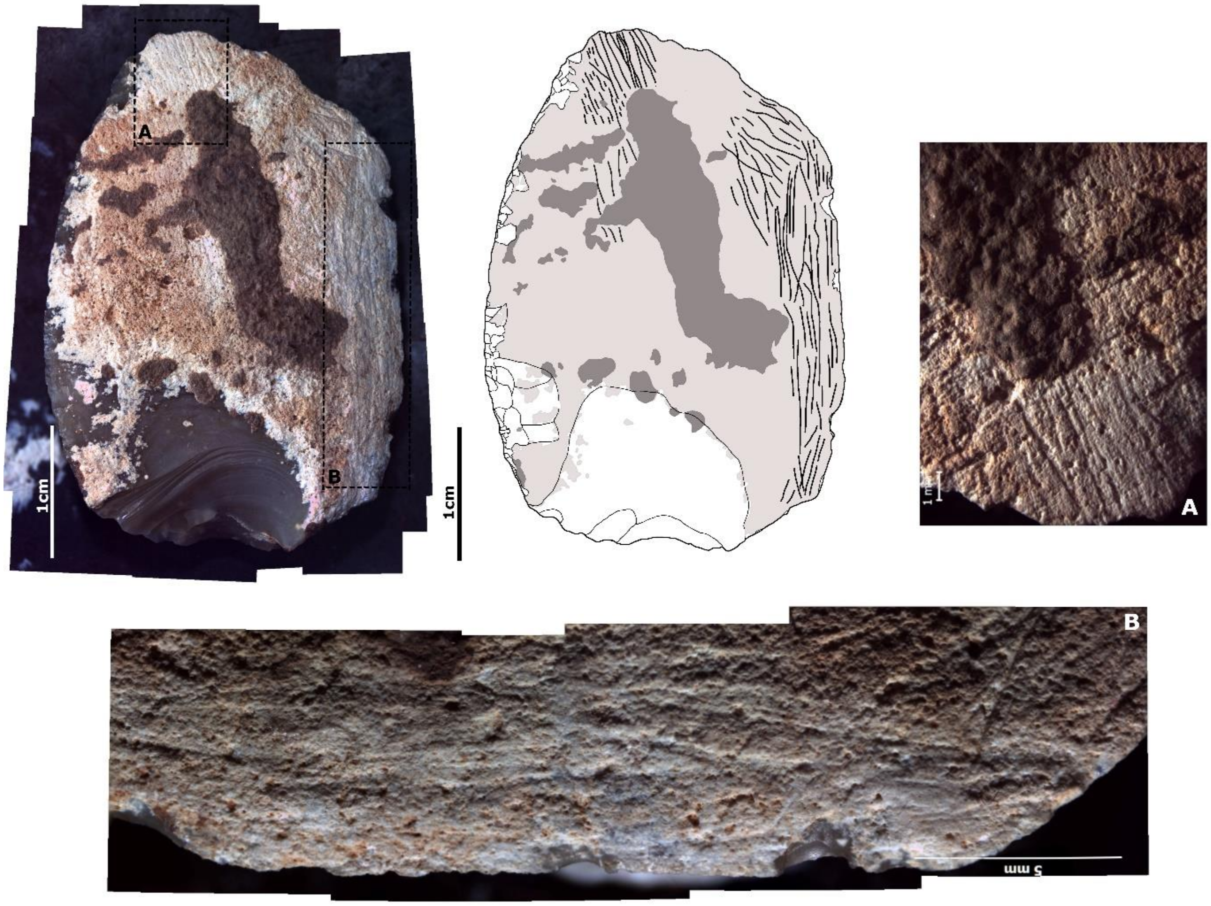

Figure 5-25: A cortical flake showing parallel/sub parallel striations in two different areas.

5.2.4.3 Side scraper RT 167:

It is a side scraper with metric attributes - 55mm in length, 36mm in width, and 13mm in thickness which comes from layer 33, whose one lateral edge shows partial simple direct retouch (Fig 5.26). The cortex on this flake is present only in the distal part of the scraper and is compact in nature (similar to Flake RT 11), has a flat topography and, on its surface, shows heavy weathering in terms of small dark stained pits which are formed due to dissolution of the cortex and some exfoliation damage which have removed the upper layer of the surface of the cortex in some places (Fisher, 1995, Brumm et al., 2006). Along with weathering marks, the cortex of the surface also presents a lot of short fine superficial striations randomly oriented across the surface. A broad area in between groove 2 and groove 4 shows superficial parallel striations, whose formation can be an attributed to post-depositional damage, more specifically - trampling as it can create short superficial parallel striations (Fig 5.26, 5.27) (Fisher 1993; d'Errico and Villa, 1997; d'Errico et al. 2001). The cortex shows recent abrasion marks on the edges of the cortex as well as examples of recently made short shallow V-shaped grooves which show discolouration of the patina in the internal part of the grooves (Fig 5.28). These recent marks can be attributed to mechanical abrasion and as mentioned before, all the Mousterian lithic material of Riparo Tagliente has been kept in large wooden crates where all the artefacts are in contact with each other, which might be the most probable reason for the creation of such marks (Fig 5.19).

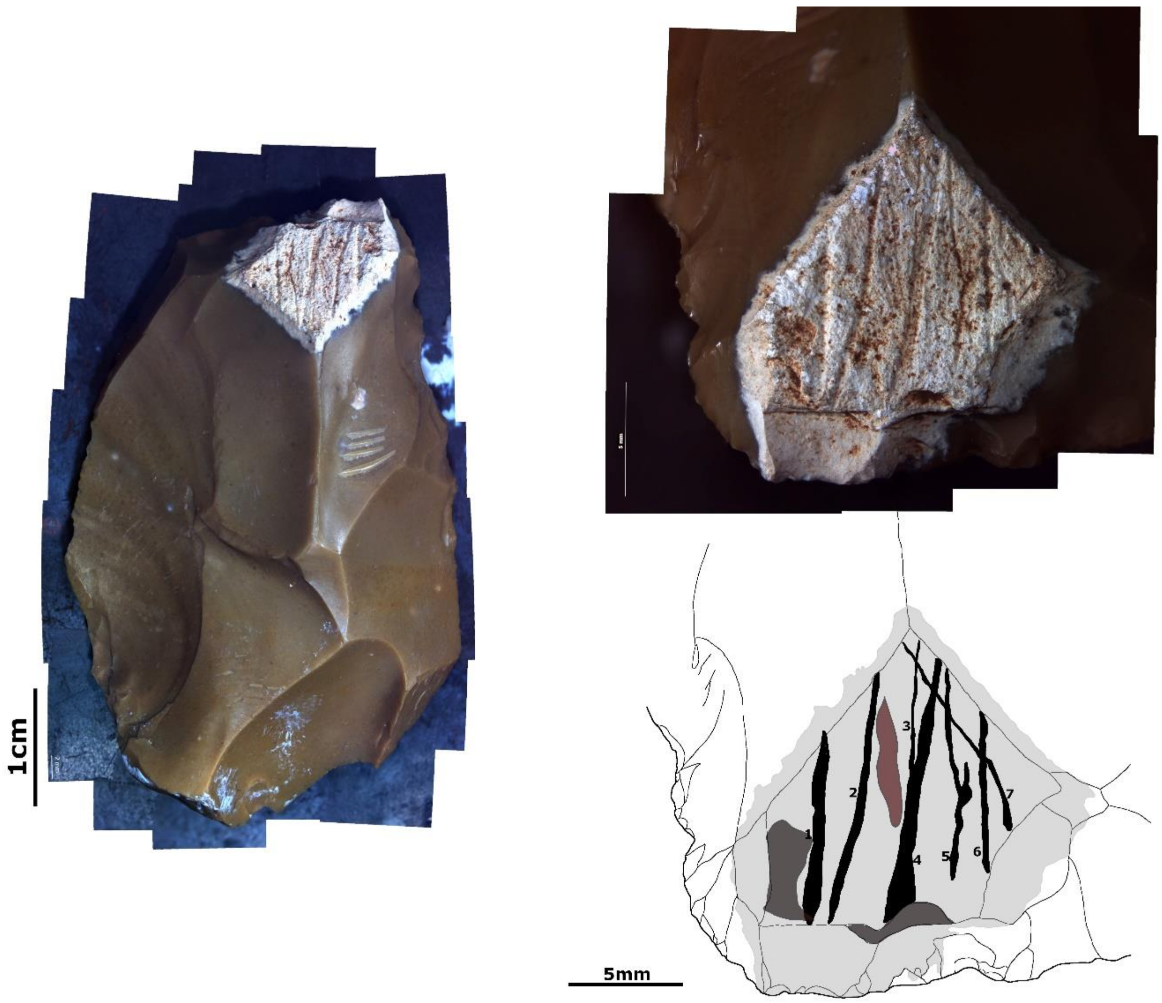

Figure 5-26: On the left - side scraper with cortex at the distal end. On the top right - close up of the incisions on the cortex. On the bottom right - tracings of the incisions (in black) (the numbers do not represent order), the exfoliated surface (in brown), probable trampling mark (in red), cortical surface (in light grey)

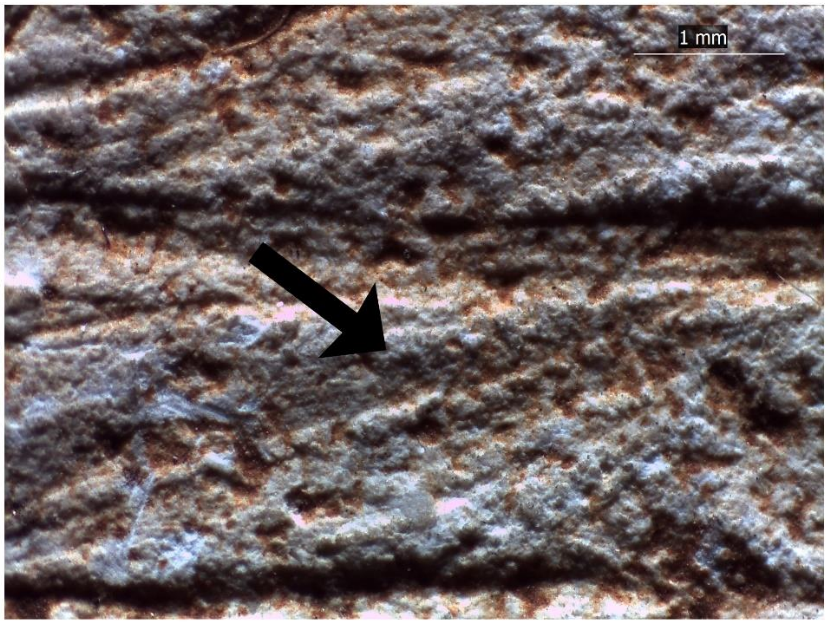

Figure 5-27: The superficial parallel striations in between groove 2 and 4, probably due to trampling

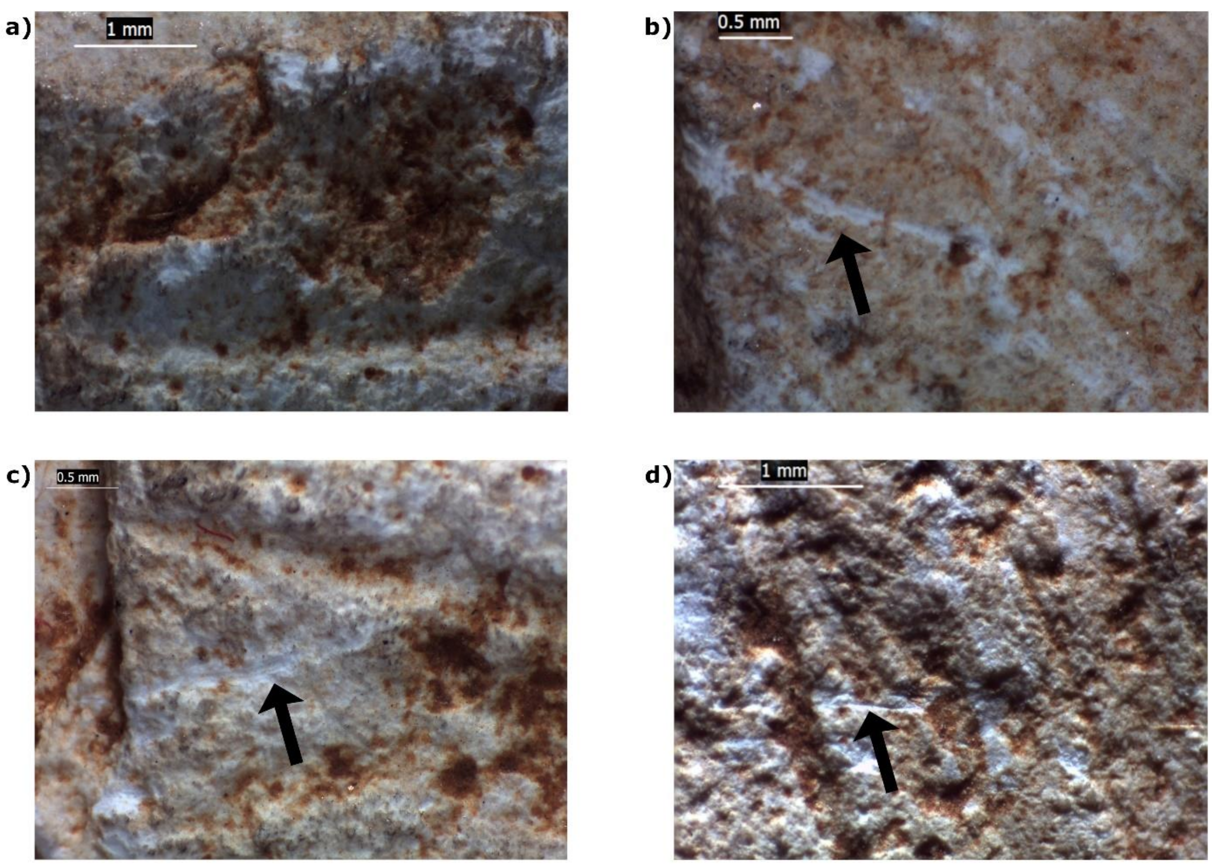

Figure 5-28: a) damaged cortical surface, b) c) d) recent short incisions (black arrows).

Despite the surface showing weathering and post-depositional damage, 7 distinct grooves show attributes which indicate being made by stone tools. These grooves can be seen clearly on the surface of the cortex, which are deeper than the superficial striations and most of them run across the surface of the cortex, which tells us that they were made before the flake was removed. All the grooves show the same colouration as the patina elsewhere on the cortex and show the presence of similar dark stained pits inside or on the edges/walls of the grooves, which proves the ancient origin of the grooves. Due to weathering, in many places, the profile of these grooves has been distorted. The technical description of each groove is given below (the image used as a reference for describing the directions and positions of grooves on the cortical surface is the inverted magnified image in Figure 5.26):

Groove 1 – Starting from the left side (Fig 5.26 (tracing of the cortical area)), this is the first incision which crosses the cortex in a top-to-bottom orientation. The internal profile of the groove presents a broad _/ shaped profile with a flat valley and faintly visible internal micro striations. Towards the bottom half of the cortical surface, one of the edges/walls of the groove is affected by the removal of the upper layer of the cortical surface (Fig 5.28 a). This groove does not intersect with any other grooves present on the cortical surface, so the direction and chronological order of this groove cannot be identified. The tool used for incising cannot be identified correctly as it could be a blunt simple flake edge or blunt pointed end of a flake or could have been made by multiple passing of a tool edge or pointed end through the same groove (d'Errico 1995a).

Groove 2 – This groove presents a V–shaped internal profile in the bottom half of the groove, most visible when it exits the cortex in the bottom (Fig 5.29a), but in the upper half, it shows a flat valley bottom with straight, vertical walls (Fig 5.29b). The tool used to incise the groove could be a pointed end of a flake as changes in the internal morphology are common especially when incised with a pointed end of a flake due to changes in the orientation/rotation of the tooltip while incising (d'Errico, 1995a; d'Errico and Nowell, 2000). The direction and chronology of the groove cannot be ascertained as it does not form an intersection or junction with any other groove.

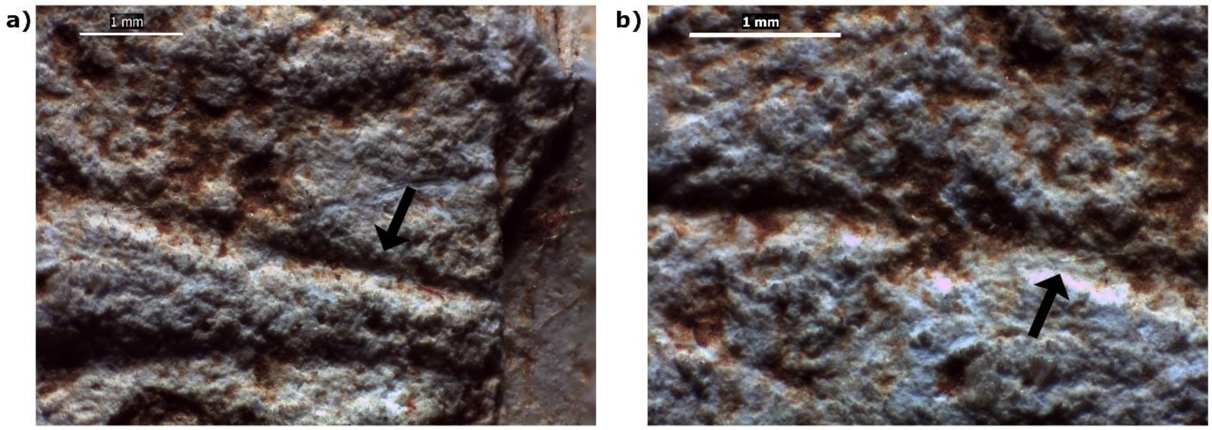

Figure 5-29: Groove 2 showing a) V shaped internal morphology (black arrow), b) showing a flat valley bottom and internal striations (black arrow).

Groove 3 – It is a narrow groove which presents a _/-shaped internal cross-section with a flat bottom valley and straight and vertical walls (Fig 5.30), which enters groove 4 midway. Looking at the junction of grooves 3 and 4 and the fact that it continues inside groove 4 along the edge/wall in the groove, we can tell the direction of the incision of groove 3 being top to bottom. Before merging into groove 4, this groove is intersected by groove 7 in the upper part of the cortex. The chronology of the groove can be ascertained based on its junction with groove 4 and its intersection with groove 7, being made after groove 4 (Fig 5.31 b) and before groove 7 (Fig 5.32a). The type of tool used could be a pointed end of a tool as it shows a sinuous profile before entering groove 4. (d'Errico 1995a, Majkic et al. 2018a).

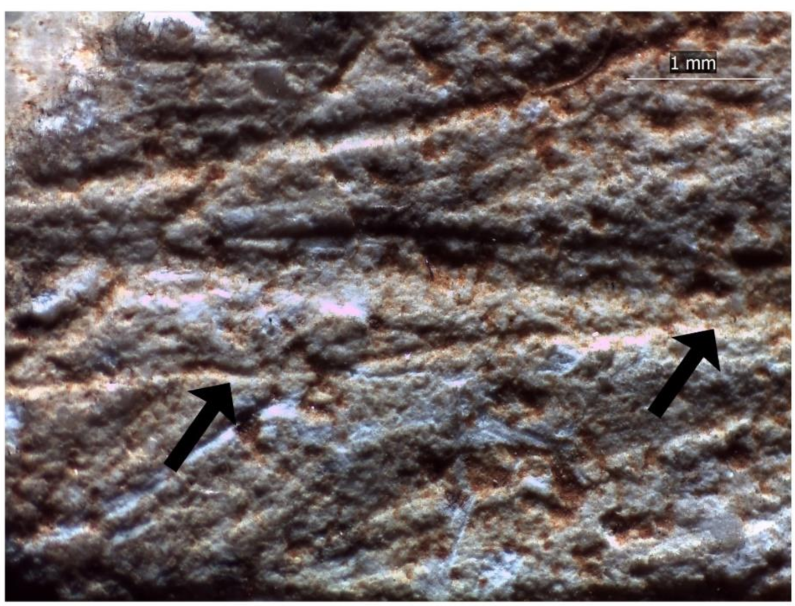

Figure 5-30: Showing groove 3 (black arrows)

Groove 4 – This groove presents a variable width along its profile, gradually increasing as we go from the top of the cortical surface to the bottom (Fig 5.31a). It presents a _/ shape morphology with a flat valley bottom with internal micro striations and vertical and straight walls. The formation of groove 4 can be interpreted as being formed by multiple strokes being incised in the same groove which eventually increased the width of the groove (d'Errico et al., 2001), Groove 3 presents an example of that and on the other edge/wall of groove 4, another groove with a narrow U shaped internal profile can be identified, running inside and along the edge/wall of the groove 4 (Fig 5.31b). As the widening of the groove happens in the lower half of the cortical surface (Fig 5.31c), the direction of the groove overall could be determined to be from top to bottom. It is crossed by groove 7 at the top and looking at the intersection, it could be inferred that groove 4 was made before groove 7 (Fig 5.32 a).

Groove 5 – It has a U-shaped internal profile with straight and vertical walls in the top half of the cortical surface with no visible internal micro striations (Fig 5.31 d). It gets crossed by groove 7, meaning that it was made before groove 7 (Fig 5.30a). In the lower half, its edges/walls are heavily damaged from the dark stained pits which are present on the cortical surface. It appears to form a junction in the middle with another short groove, but the chronological order and the direction of the groove cannot be identified (Fig 5.31 e). After that, it continues downwards and stops before the cortical surface ends, unlike the other grooves. It presents no frayed ends or a comet head shape-like morphology at that end point (Fig 5.31c (black arrow)). The depth of the groove also does not show any change throughout the length of the groove, so it cannot be determined if it's the starting point or the end point and also the direction of the groove cannot be identified. From the internal cross-section of the groove, it could be said that the type of tool used could be either a blunt unretouched edge or a blunt pointed end of a tool (d'Errico 1995a).

Groove 6 – Runs across the cortical surface from top to bottom, most affected/ deteriorated by weathering, making it difficult to judge the direction of the groove. It is crossed by groove 7 in the top part of the cortical surface and looking at the intersection, it can be said that it was made before groove 7 (Fig 5.32 a). In some places, it shows a _/ shaped profile and internal micro striations but it is difficult to interpret the type of tool used for incision of this groove

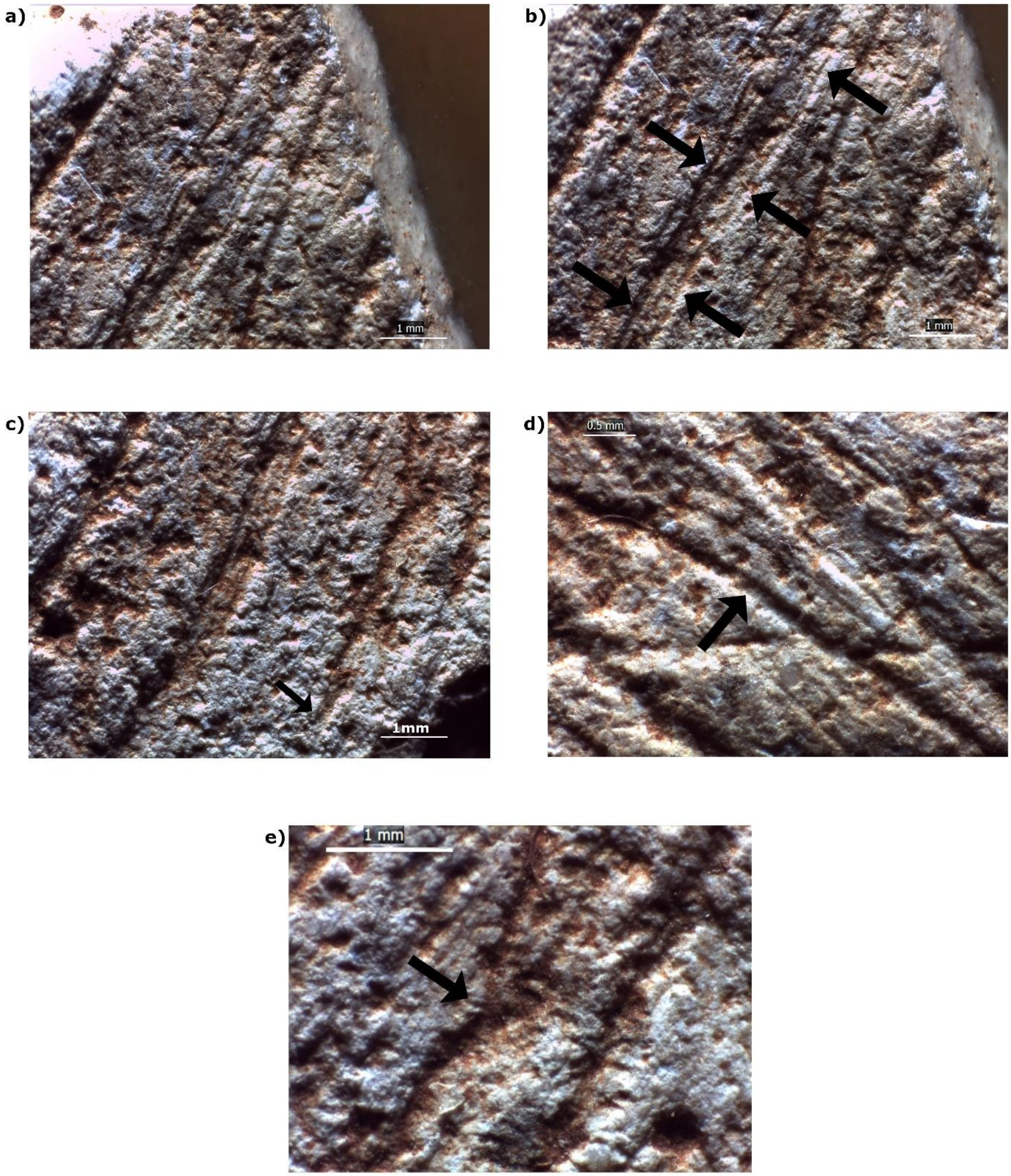

Figure 5-31: a) b) c) Showing the profile of wide groove 4. The black arrows in b) indicate the groove 3 (on the left) as it enters groove 4 and continues inside it and another groove (on the right) which could be seen along the right edge/wall of the groove 4. The black arrow in c) indicates the point where groove 5 ends. D) U shaped profile of groove 5 (black arrow), E) weathered junction of groove 5 with another short groove (black arrow), on the right of it is _/ shaped groove 6.

Groove 7 – While other grooves present on the cortex are placed in a top-to-bottom orientation, groove 7 runs across the other grooves in a left-right orientation (Fig 5.32 a). On microscopic analysis of the junctions created by groove 7 while crossing the other grooves, we can say that groove 7 was incised after the creation of other grooves (Fig 5.32b, c). The double change in direction of the groove 7 each time it crossed other grooves without any significant change in the width of the groove (Fig 5.30 b, c) (except when it crosses groove 6) points towards the fact that this groove was incised by a pointed end of a flake (d'Errico, 1995a; d'Errico and Nowell, 2000; d'Errico et al. 2001). The direction of the incision of groove 7 can be inferred to be from left to right (Fig 5.32a) based on the changes in its direction as it crosses the grooves (d'Errico, 1988a, d'Errico 1995a). While crossing groove 6, the width of the groove increases and the internal shape profile changes from being V-shaped with a narrow valley to being _/ shaped, flat-bottomed valley with semi-vertical edges and a lot of internal parallel micro-striations (Fig 5.32 c, d). Even the direction of the groove changes. This change in the groove profile and direction can be linked with rotation of the pointed end of the tool which is in contact while incising or breakage of the pointed end of the tool while incising, where the internal micro striations are caused by grinding of the tip pieces making the internal cross section flat in the process (d'Errico and Cacho, 1994; d'Errico, 1995 a).

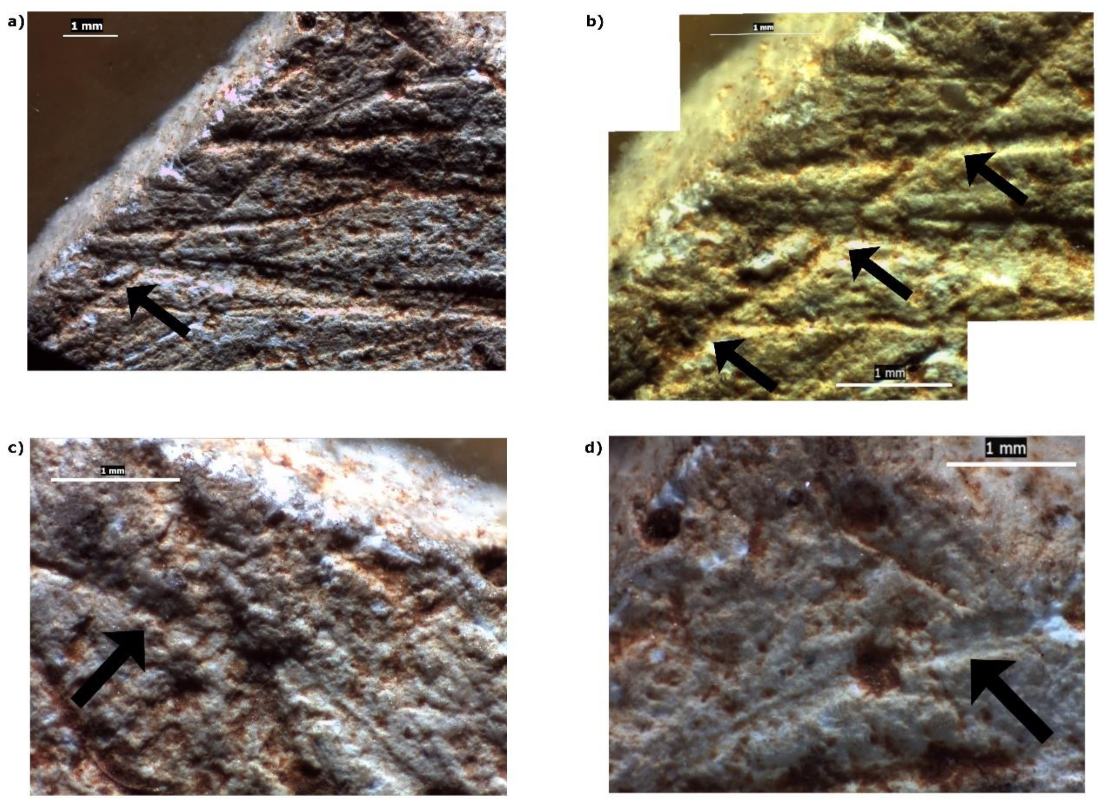

Figure 5-32: a) image highlighting groove 7 (black arrow points towards the groove), b) close up of groove 7 crossing the grooves 3,4,5 (black arrows) c) close up of groove 7 crossing groove 6 d) Showing internal striations after crossing groove 6.

Overall, it can be said that the 7 grooves presented above show features which link them to being individually incised rather than being made through scraping. Also, the interstitial ridges/plateaus (area in between the grooves) do not show signs of being processed (Hodgkiss, 2010, Rifkin, 2012).

5.2.4.4 Side Scraper RT 100:

The side scraper was recovered from layer 34, square 213, quadrant 9 of the excavation with metric attributes – 123mm in length, 49mm in width and 12mm in thickness. It is made on a large flake and is characterized by having partial simple direct retouching on both lateral edges of the scraper (Fig 5.33). From the use of wear analysis of the lateral and proximal margins of the scraper, the use of the scraper could be inferred as a multi-functional tool used for cutting or scrapping activities on semi-resistant materials (Peresani et al., 2014). The side scraper could not have been hafted as the use wear marks are present on all margins of the scraper (proximal, lateral), which suggests the use of all the margins for working (Peresani et al., 2014). The surface topography of the dorsal side of the scraper is not flat but it is slightly curved with the highest part of the surface being in the middle of the lateral edges. The cortical surface covers the whole dorsal side of the scraper except for some areas near the proximal part of the scraper and alongside the lateral edges because of the retouch. The cortical surface is homogeneous and compact in nature and is completely covered by parallel and sub-parallel striations. These striations were made before the retouch on the lateral edges and before the flake was taken out as the striations continue beyond the edges of the scraper and are interrupted by the retouch along both sides (Arzarello, 2003; Peresani et al., 2014). This scraper differs from the other artefacts mentioned in this study as well as the older reports of cortices bearing linear incisions from Riparo Tagliente (Leonardi 1975, 1979, 1983) as the striations on this scraper are more abundant and cover the whole surface of the scraper, unlike others which have such striations in only some part of the cortex. The striations can be demonstrated as being of ancient origin because of similar patina colouration as the rest of the cortex and the presence of dark brown incrustations which cover the cortex in some places, even covering the grooves in some sections (Fig 5.33). Marks due to recent damage while excavation or storage can be identified easily as they appear white in colour with respect to the surrounding cortex (Fig 5.34).

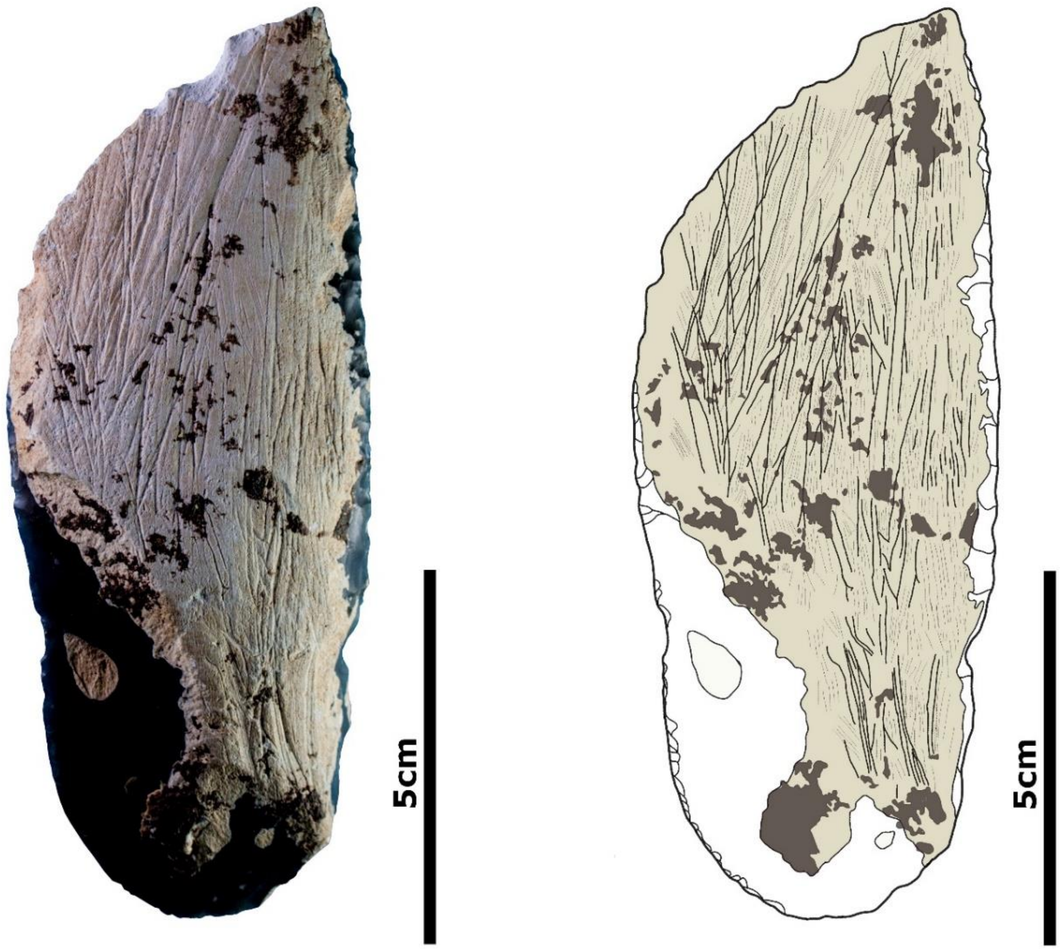

Figure 5-33: The side scraper from Layer 34 with marks associated with anthropogenic activity. On the right - The cortical area is represented by light yellowish-brown color, the encrustations are represented by the dark brown spots, bold black lines represent the deeper striations and thin black lines represent the fine striations present all over the surface.

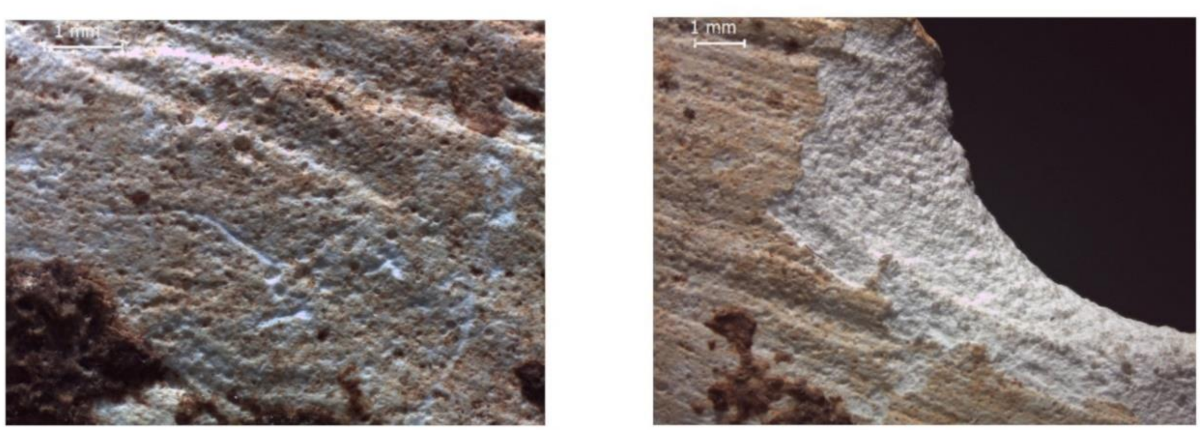

Figure 5-34: On the left - recently created marks can be identified by their white appearance with respect to the rest of the cortex. On the right - fresh breakage at the distal end of the scraper.

The striations are largely not affected by mechanical alteration or deterioration of the surface. Through microscopic analysis of these striations and the close resemblance of some of the features of the striations to those experimentally produced in this study and previous studies such as – clean, clear edges of the grooves with internal micro-striations, it can be confidently said that these striations are of anthropogenic origin (d'Errico and Villa, 1997; d'Errico and Nowell, 2000; d'Errico et al. 2001, Peresani et al., 2014). Although previously all the striations present on the cortex of this scraper have been attributed to scraping activity with a retouched flake (Dallatore, 2011; Peresani et al., 2014), in this study, on the left side of the cortical surface some grooves present features which could be related to individual incision activity and not scraping. The detailed discussion on grooves associated with scraping and deliberate incisions is presented below:

Marks associated with Scraping:

Most of the grooves present on the artefact can be grouped into two sets of parallel, sub-parallel striations oriented at an angle with each other (Fig 5.35). Although the direction of scraping cannot be identified because the cortex was scraped before the flake was taken out, through experimental replication it is possible to say that such regular, uniform, homogeneous, parallel striations are more observable when the scraping action is done in a back-and-forth manner instead of scraping in a unidirectional motion (Fig 5.4), also attested in previous experimental studies (Peresani et al., 2014, Kaufman et al., 2018). The two axes of groups of parallel/sub-parallel striations suggest that scraping action was performed in distributed movements/multiple orientations. The length of individual grooves, the width of the grooves, the depth of the grooves and the shape of the internal profile of the grooves created by scraping show high variability (Hodgkiss, 2010) (Fig 5.36). Fig 5.36a shows a close-up image of the parallel striations which cover the left half of the cortical surface. Other images of Fig 5.36 showcase the high variability in the overall profile of the grooves created by scraping, as they show U-shaped (Fig 5.36 b, c) and _/ shaped (Fig 5.36 b, f) internal cross sections, variable depth, width, and length of the individual grooves (Fig 5.36 b, c, e, f). In Fig 5.36 (d) we can see that here the cortical layer has been almost removed and the flint beneath is visible, the reason for it could be due to intense scraping or mechanical abrasion (post depositional damage). Internal micro striations can be observed in Fig 5.36 (b)(f). Fig 5.36 (e) shows 3 V-shaped grooves vertically aligned; this V-shaped pattern was also observed in the experimental activity of back-and-forth scraping with a simple flake, (Fig 5.1 d, e) although not vertically aligned as seen in Fig 5.36 (e). The most probable reason for the appearance of such marks can be changes in the direction of motion (not in a straight line) of the flake's edge because of human error or the topography of the surface not being completely flat, which is the case here (Kaufman et al., 2018). Near the proximal part of the scraper, two parallel grooves which are very wide, deep and show internal micro striations (Fig 5.36 f) show similarity to the grooves produced by scraping with a retouched edge in a back and forth motion performed in this study (Fig 5.3c). Overall, it can be said that the cortical surface of the scraper was scraped in minimum 2 orientations (Fig 5.35) and the type of edge used was a retouched flake edge in a bidirectional motion. A similar interpretation was made for the striations on this side scraper in the previous experimental studies (Dallatore 2011; Peresani et al., 2014).

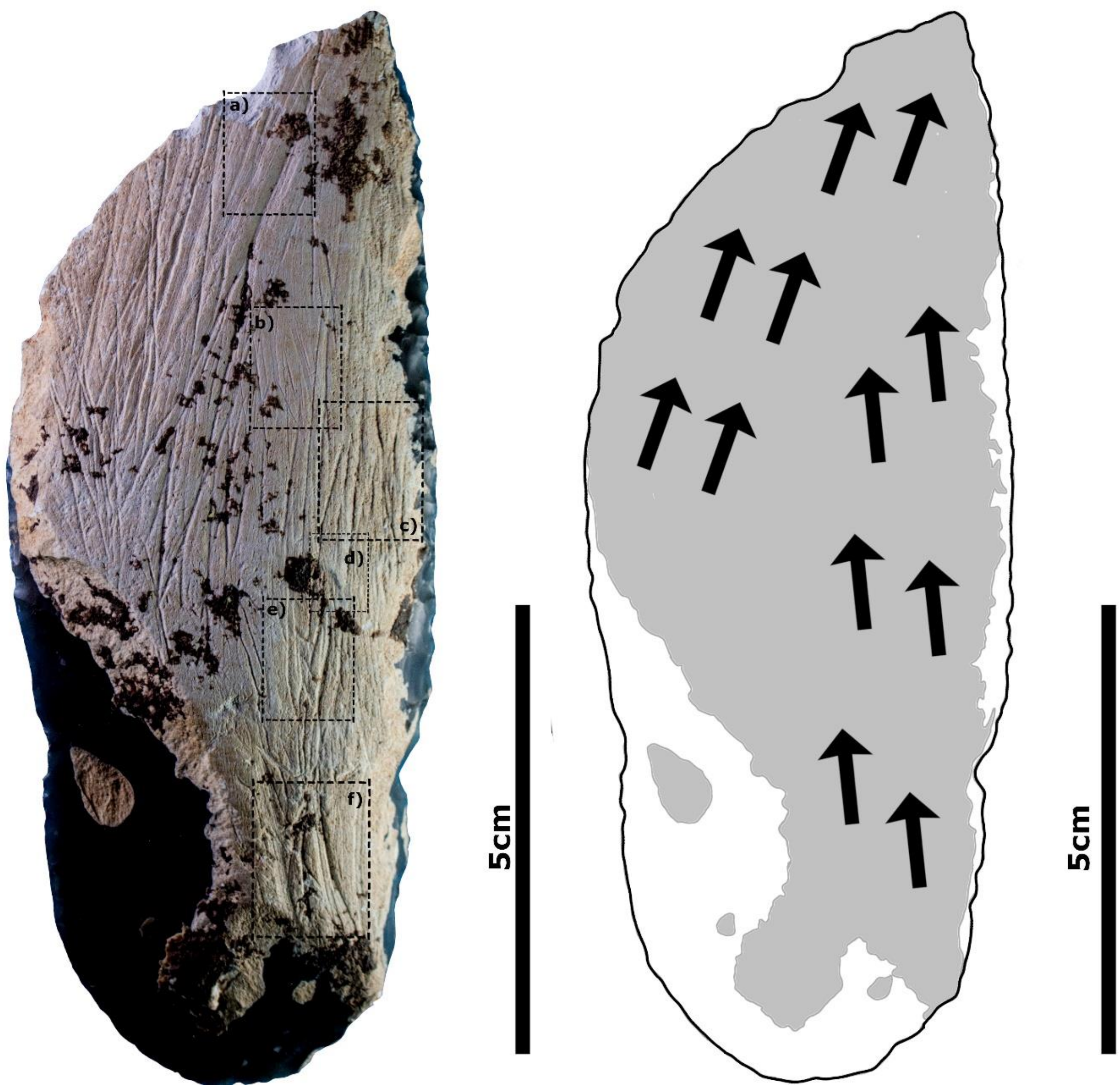

Figure 5-35: On the left – Different areas showcasing the variability in the groove profile made by bidirectional scraping with a retouched edge. On the right - Outline of the scraper with arrows depicting the two main orientation of scraping striations. (The head of the arrows do not represent unidirectional motion)

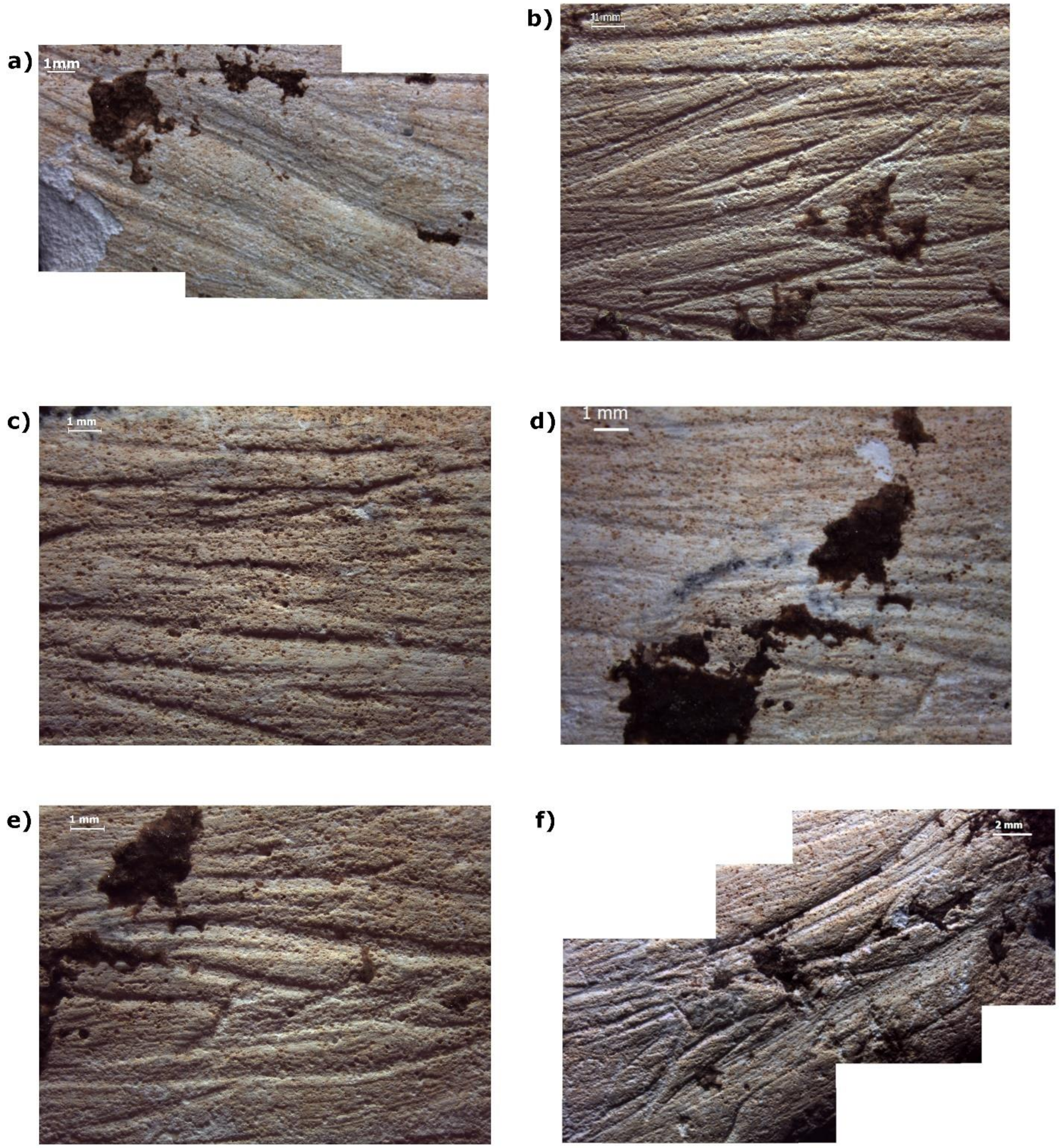

Figure 5-36: Close up images of areas marked in Figure 5.35

Marks which can be associated with incision activity:

Along with the parallel/sub-parallel striations created by scraping, some of the grooves in the left section of the scraper present characteristics of being deliberately incised. Differentiating between the grooves made from scraping action or individual incisions produced by a cutting edge or pointed end of a tool is problematic (Mackay and Welz, 2008; Henshilwood et al.,2009) because the grooves visible are incomplete (they extend beyond the cortical surface of the scraper, starting and end points are not visible) and scraping especially with a retouched edge creates many points of contact of irregular shape and size on the edge which are not at similar height and can create grooves of different width, depth, and even different internal section profiles (as seen in Fig 5.36). Along with it, based on experiments conducted on ochre by Hodgkiss, 2010 using volunteers, it was noticed that the identification of the type of tool used based on the internal section profile of the grooves is problematic as - how a tool is held (at an angle, straight), if the sharpest/pointed edge is used or not etc. changes the shape of the internal cross-section of the grooves created by the same tool. Therefore, using the internal profile shape, width and depth is not very helpful in deciphering the type of tool used or in this case, differentiating between the grooves made by scraping with a retouched edge and individual incisions when both are present in the same region. One of the ways by which the individual incisions can be identified is if the orientation/ direction of the individual grooves is different from the orientation/direction of the scraping striations. While scraping may create one or two such striations which do not follow the general direction of other scraping striations, if the number of such grooves is more as it is in this scraper then those grooves might represent being made by incising rather than scraping (Henshilwood et al., 2009; Hodgkiss, 2010; Rifkin, 2012). In Fig 5.37 a), a rotated close-up photograph of the left section of the cortical surface of the scraper, we can see that some of the grooves do not follow the orientation of the parallel, sub-parallel scraping striations and do not present evidence of processed interstitial ridges/plateaus between them (meaning if these grooves were from scraping, the area in between individual grooves should have presented more striations/ micro striations in that orientation in between them, erasing the still visible striations in another orientation). Also observing the intersections of some of the incision grooves made with scraping striations, it becomes clear that these grooves were made after the surface was scraped.

In Fig 5.37 (a)(b), the grooves which are suspected of being incised are traced to show their orientation and position and their merit of being incised or not discussed below with the help of magnified images of specific sections of each groove (The orientation/direction and position of the grooves discussed below is according to the rotated enlarged image in Figure 5.37) :

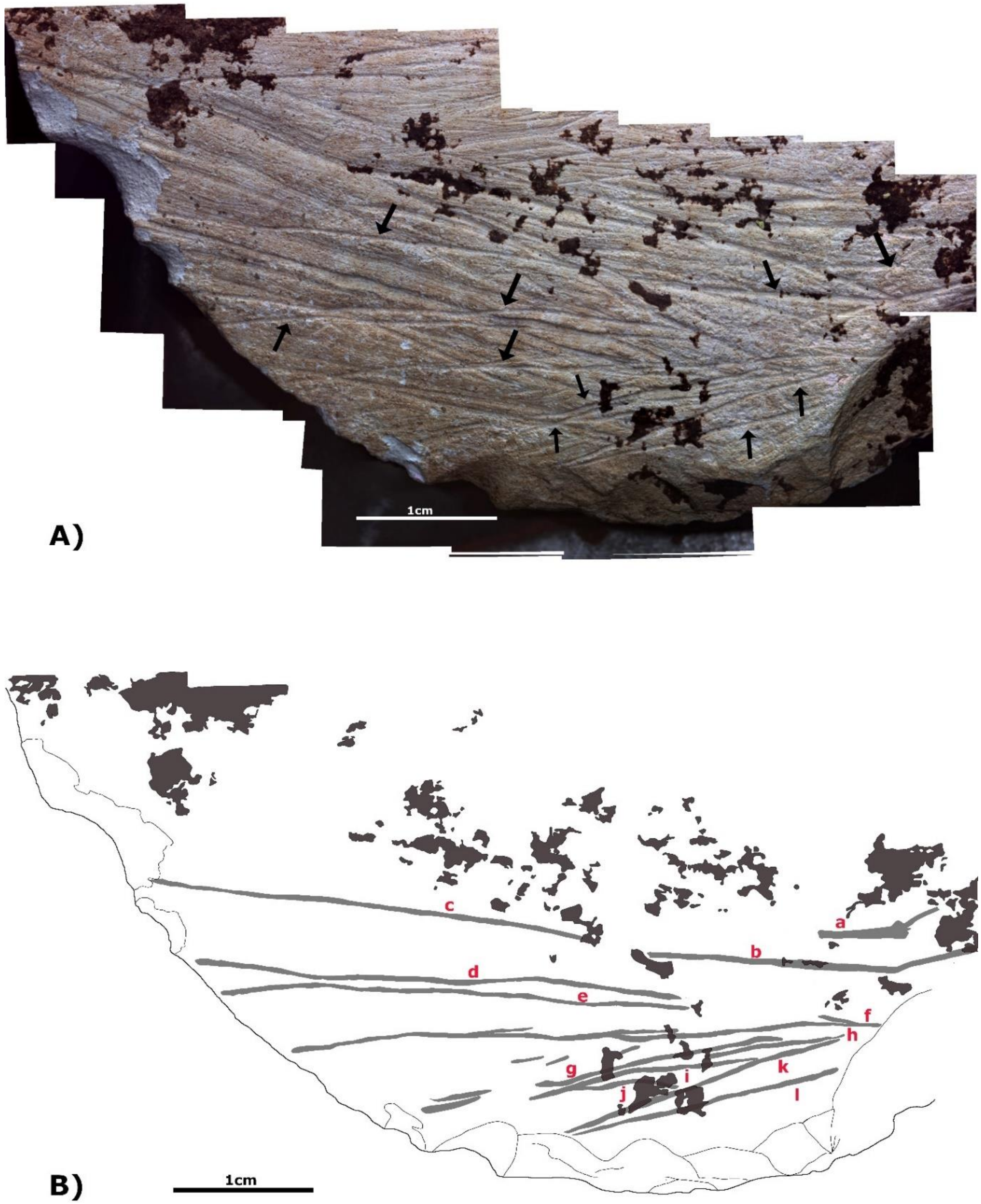

Figure 5-37: a) rotated photograph of the left section of the cortical scraper (Fig 5.33), the arrows represent grooves which could have been made by the incision activity rather than scraping. B) tracings of the grooves which could have been made by the incision activity rather than scraping.

- *Groove A:*

While the orientation of this groove is similar to the scraping striations present on both sides of it, it shows some features which could be related to being incised by a pointed end of a tool rather than being a scraping striation. This is the only groove which presents a comet head shape morphology, giving a sense of direction in which it was engraved (right to left). It also shows a smaller groove with a serrated internal cross-section extending in the other direction from the starting point which is an example of a frayed end which develops at the beginning or end of an incision due to inadvertent motion of hands (Fig 5.38b, black arrow) (Fisher, 1995). The internal cross-section of the groove presents a U-shaped morphology with micro striations, with greater width and depth visible at the start of the groove after which it decreases. This groove then joins another groove forming a junction. The width and depth of the two grooves are similar and the chronology of the two grooves can be identified only from the fact that this groove (a), stops extending in its own direction after the junction and, therefore was made after the other groove which it forms a junction with (d'Errico, 1995a). The trajectory of the groove (a) inside the other groove (made by incision or scraping) cannot be traced further, maybe it extends all the way towards the edge of the scraper or stops somewhere along the way, it cannot be stated or is ambiguous. Therefore, the profile of groove (a) after its merger with the other groove is not discussed. The comet head morphology and U-shaped internal cross-section are generally associated with incisions made by a blunt pointed end of a tool (d'Errico, 1995a, 1995b; Majik et al., 2018b; Prevost et al.,2022), but in experimental studies of Dallatore, 2011, Peresani et al.,2014, they have shown the presence of comet head morphology in the grooves made by scraping, according to their analysis. Therefore, the type of tool used for groove A is also ambiguous.

- *Groove B:*

Like groove (a) this groove is also oriented in the same direction as the nearby scraping striations and presents some clues which might suggest that it is incised with a pointed end of a tool. The internal cross-section of the groove (b) is _/ shaped with a flat valley bottom and straight, vertical edges/walls (Fig 5.39 b, c). It shows internal striations in some sections. At the intersection, groove (b) erases some parts of the two grooves, and is deeper than the other two grooves which suggests that it was made after those grooves (d'Errico 1995a). The change in direction of the groove while crossing another groove is generally associated with being incised with a pointed end of a tool (d'Errico and Nowell, 2000). The direction of the incision cannot be judged as one endpoint of the groove is covered by the brown encrustation (Fig 5.39 c) and the other endpoint (Fig 5.40) does not show any characteristics defining it as a starting point or endpoint. It is possible that some part of the groove (b) was made inside an already existing groove.

The V-shaped groove present below the groove (b) (Fig 5.39 b, black arrow) which gets overlapped might have been longer and multiple strokes might have changed the internal morphology of the original V-shaped groove from V-shaped to a more _/ shaped in that section. Groove (b) also appears deeper and wider than grooves it intersects but that is not sufficient evidence to say that it was made by multiple strokes (d'Errico, 1995a). After the change in direction, it continues in the same orientation as that of the scraping striations. There might be a connection between groove (b) and groove (c) (Fig 5.40) but the dark brown encrustations overlap key sections of the grooves which hinders a conclusive observation. Also, the chronological order at the intersections of groove (b) and groove (c) with the other grooves respectively (Fig 5.40, black arrows) in that area cannot be resolved under the optical microscope. This happens when the groove which is made after, is incised with less or equal pressure or made too quickly and does not erase the part of the groove made earlier (d'Errico, 1995a).

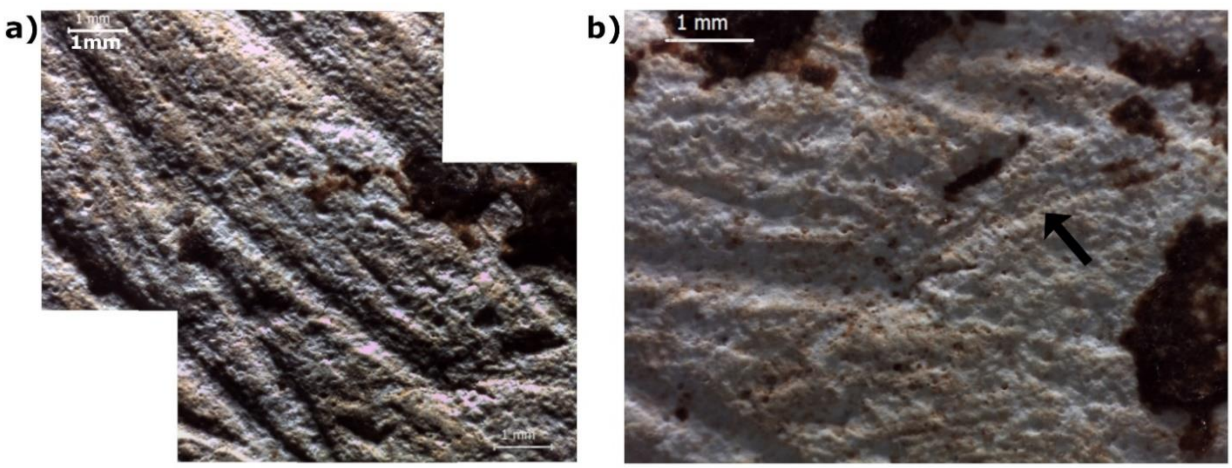

Figure 5-38: a) groove (a) with its junction with another groove, b) the comet head morphology of the groove (a), black arrow pointed towards the frayed end.

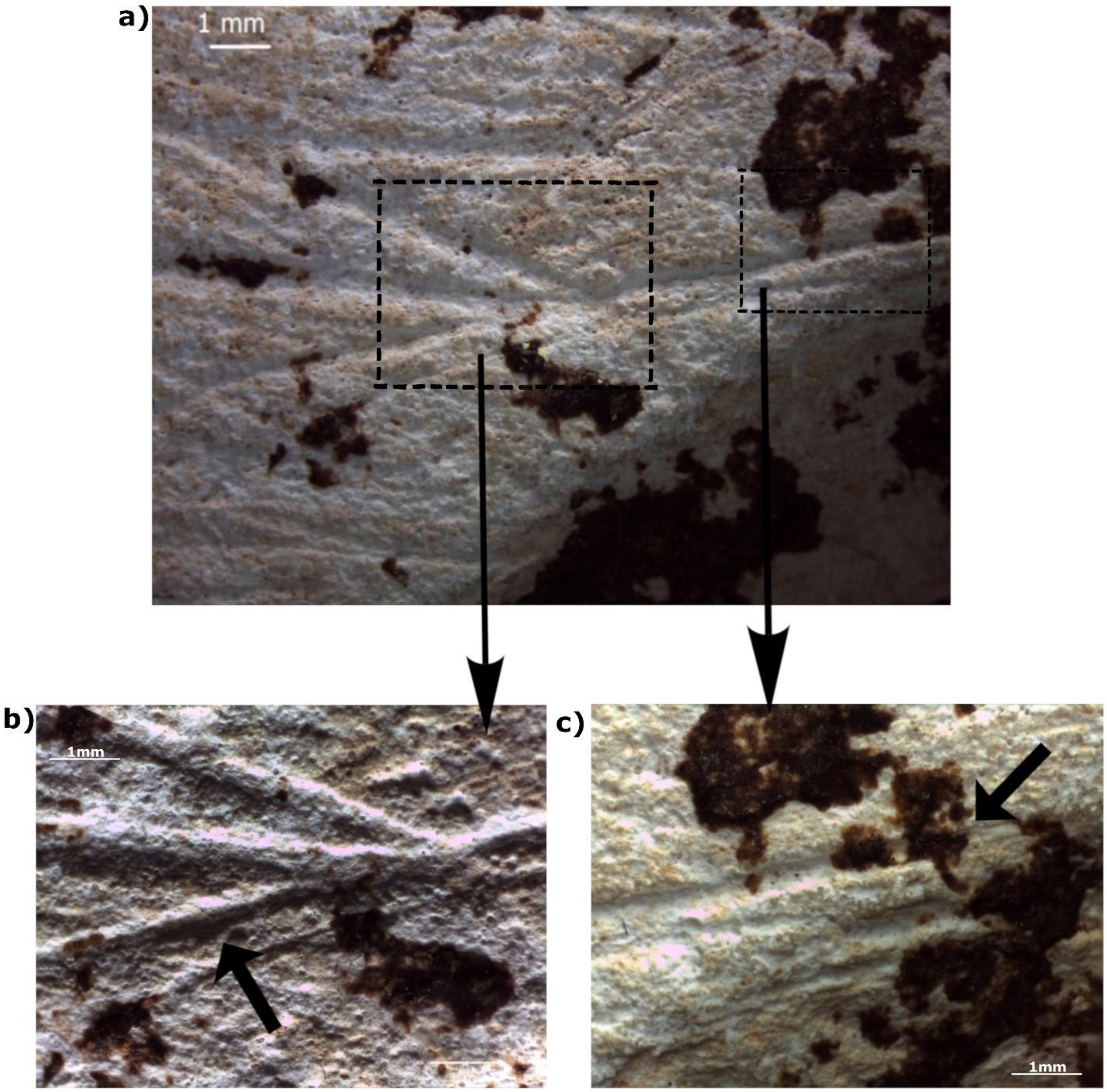

Figure 5-39: a) the overview of the area where groove b intersects two other grooves, b) magnified photo of the intersection of groove (b) under oblique lighting, black arrows point at one of the grooves located below groove (b) which shows a V shaped internal cross section c) one end of the groove (b) covered by the dark brown encrustations.

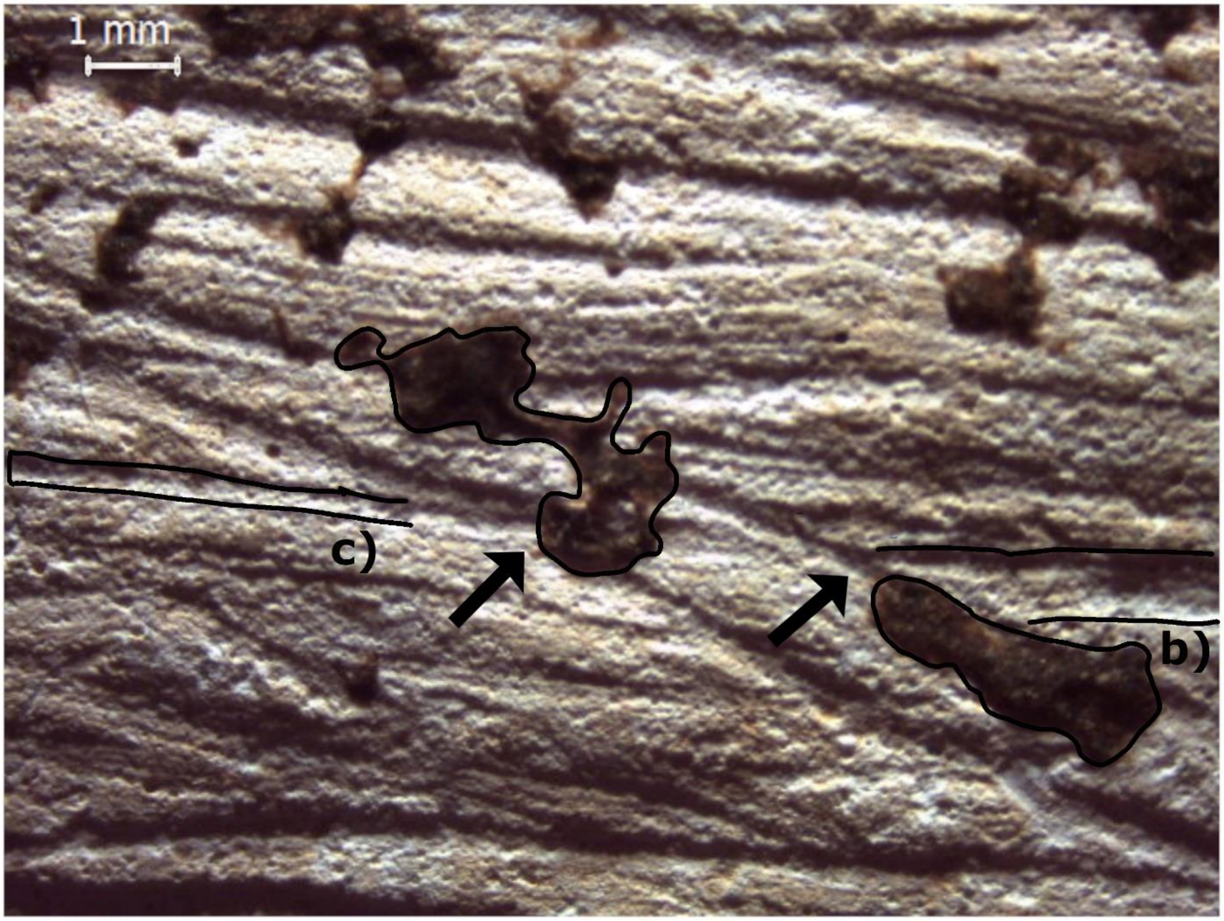

Figure 5-40: a possible connection in between groove (b) and (c), the outlines are to highlight groove (b) and groove (c), the arrows represent the intersection points of groove (b) and groove (c) with other striations. The dark brown encrustations (outlined) cover key areas hiding the chronological order of groove (b) and (c)

Groove C:

It represents one of the first grooves, which follows the curvature of the cortical surface. While its connection with groove (b) cannot be established, considering it individually it can be observed that groove (c) has a _/ shaped internal cross-section with straight vertical walls/edges (Fig 5.42 a). Internal micro striations are barely visible in some sections of the groove (c). At one of its endpoints (Fig 5.40), it has the same orientation as that of the scraping striations but as it moves along, we see that it curves downwards following the curvature of the cortical surface overlapping the striations made by scraping (Fig 5.41). In some sections near the edge, it presents a discontinuity where its depth becomes negligible but still, its outline can be traced before it exits the cortical surface (Fig 5.40 b). This could be due to variable pressure/force while incising (Mackay and Welz, 2008). The type of tool used for incising and the direction cannot be confidently interpreted as just the orientation of the groove and _/ shape of the internal cross-section is not enough evidence. Additional features such as changes in the direction of the groove while passing a micro depression or another groove, which can help in confirming that it was made by a pointed end of a tool are not present (d'Errico and Nowell, 2000).

Figure 5-41: A complete profile of the groove (c).

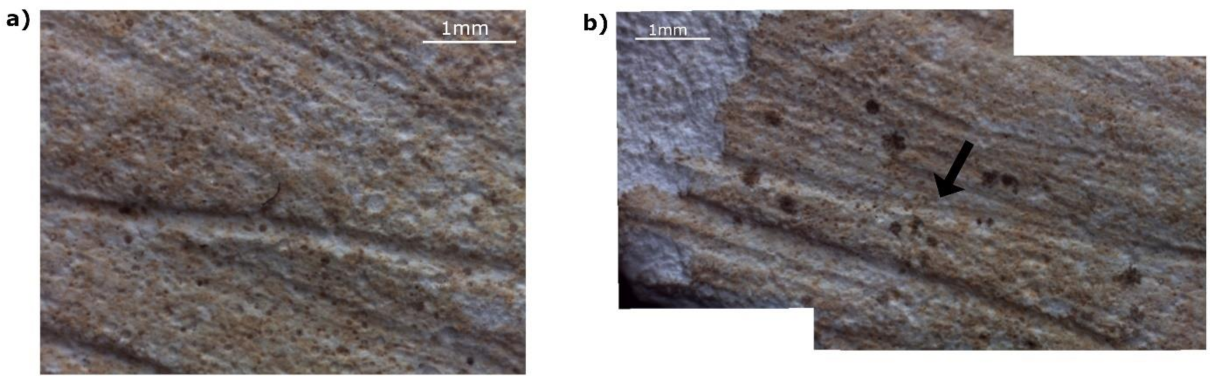

Figure 5-42: a) showing the _/ shaped cross section of the groove, b) the region where the depth becomes negligible of groove (c).

- *Groove D and E:*

Unlike grooves (c), grooves (d) and (e) show a sinuous profile with many changes in their direction along their profile (Fig 5.43). From the intersections in between the scraping striations and grooves (d) and (e) (Fig 5.45 c, e), it can be said that these grooves were made after the scraping striations (d'Errico, 1995a). The grooves show a change in direction every time they enter and exit the scraping striations (Fig 5.45 d, f) which indicates that the two grooves were incised by a pointed end of a tool. They show _/ shaped internal cross-section with vertical walls/edges (Fig 5.45 g). Groove (e) presents a discontinuity in its profile where its depth becomes negligible in between but its outline can still be traced to establish its continuity (Fig 5.45 b). From the change in directions of the grooves each time as they enter and exit the striations made by scraping, comparing it with the experimental replication activity involving incising by a pointed end of a tool after scraping (Fig 5.13) and previous experimental studies (d'Errico 1988; d'Errico 1995a, 1995b, d'Errico and Nowell, 2000) it can be said that the direction in which they were incised was from right to the left (Fig 5.43).

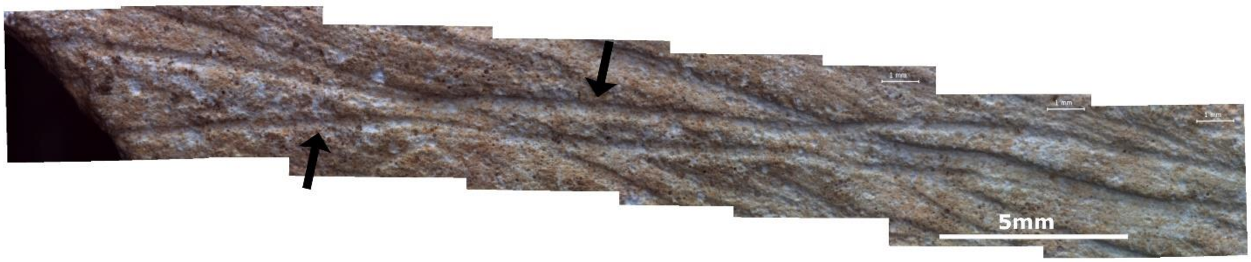

Figure 5-43: Complete profiles of groove (d) and (e)

- *Groove F:*

This groove also follows the same orientation as the groove (c), (d) and (e) along the curvature of the cortical surface but while others start or appear to start from the medial part of the cortical surface, groove (f) crosses the entire length of the cortical surface (Fig 5.43). It has a sinuous profile (5.46 e, f) and it presents a _/ and U-shaped internal cross-section along the groove. The depth of the groove also changes all along the groove profile. On the right edge of the cortical surface, the groove (f) is overlapped by a smaller groove (Fig 5.46 a, b) which signifies repeated strokes (at least twice) in the same groove. The groove crosses/intersects the scraping striations many times (Fig 5.46 g, h, i, j). It presents 2 parasitic lines on the same side (Fig 5.46 c, d, e, f) (black arrow) of the main groove (f) which merge into the main groove at different points. In Fig 5.46 (c), (d) we see that two grooves merge into the main groove. These *"lateral lines or parasitic lines are formed due to momentary contact of some lateral part of the tool with the surface, which can be parallel or meet the main groove at some point"* (d'Errico, 1995a) (Fig 4.1 c) which happens in this case. In Fig 5.46 (c), (d) The groove located below the main groove (outlined) can be a scraping striation, which is interested by groove (f), although it's not possible to tell the chronology as they present similar depths when they meet. In some places, the groove (g) shows internal striations. The type of tool used could be a blunt pointed end of a tool looking at the sinuous profile of the groove (f) (d'Errico, 1995a; d'Errico and Nowell, 2000).

Figure 5-44: Complete profile of groove (f).

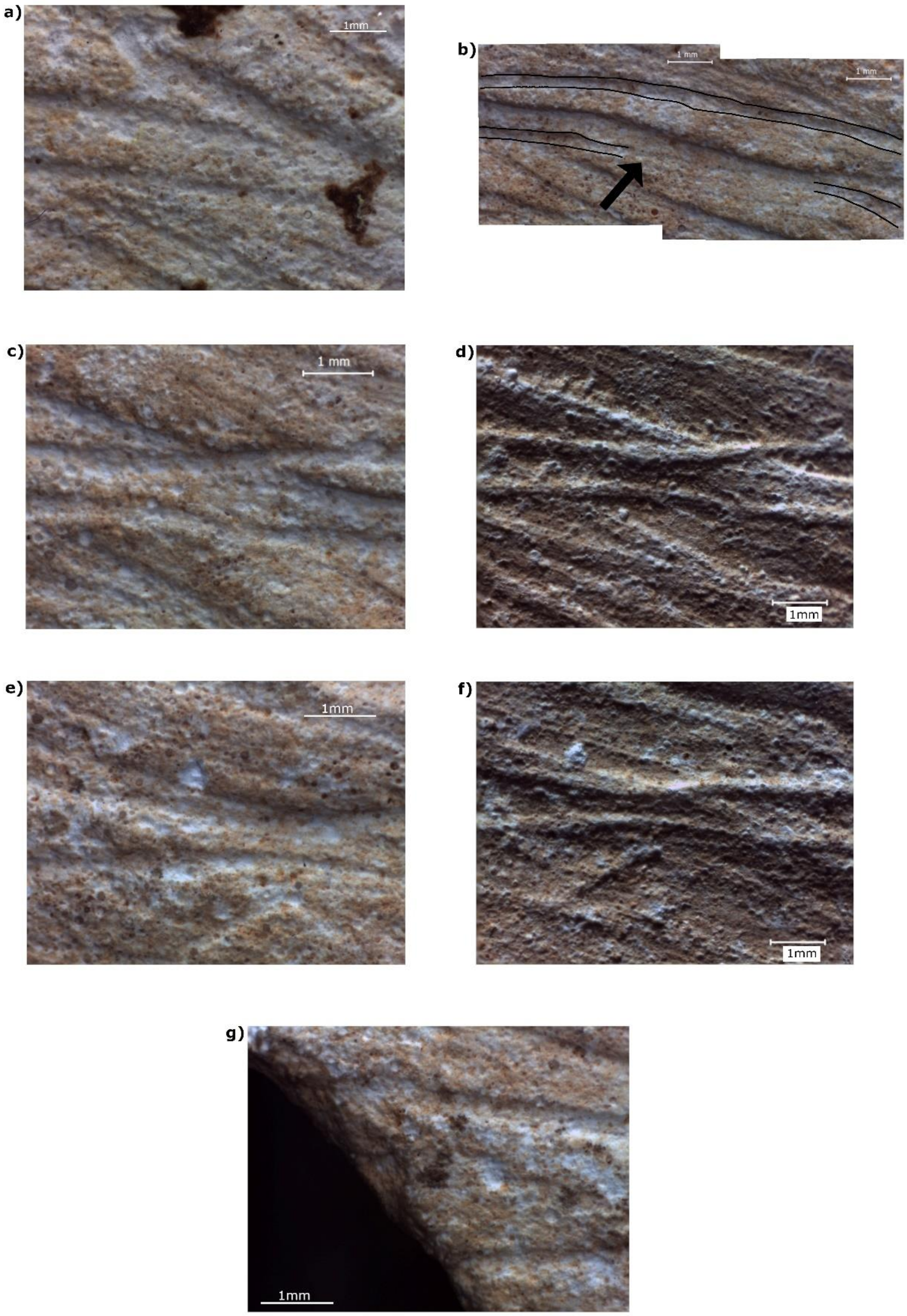

Figure 5-45: a) showing the starting point of groove (d) and (e). b) the outlines highlight groove (d) on top and groove (e) on bottom, the arrow indicates the area where the depth of groove (e) becomes negligible. c) d) e) f) showing the change in direction of the of the grooves as it intersects the scraping striations, d) and f) represent the same area in an oblique light. g) the two grooves exiting the cortical surface.

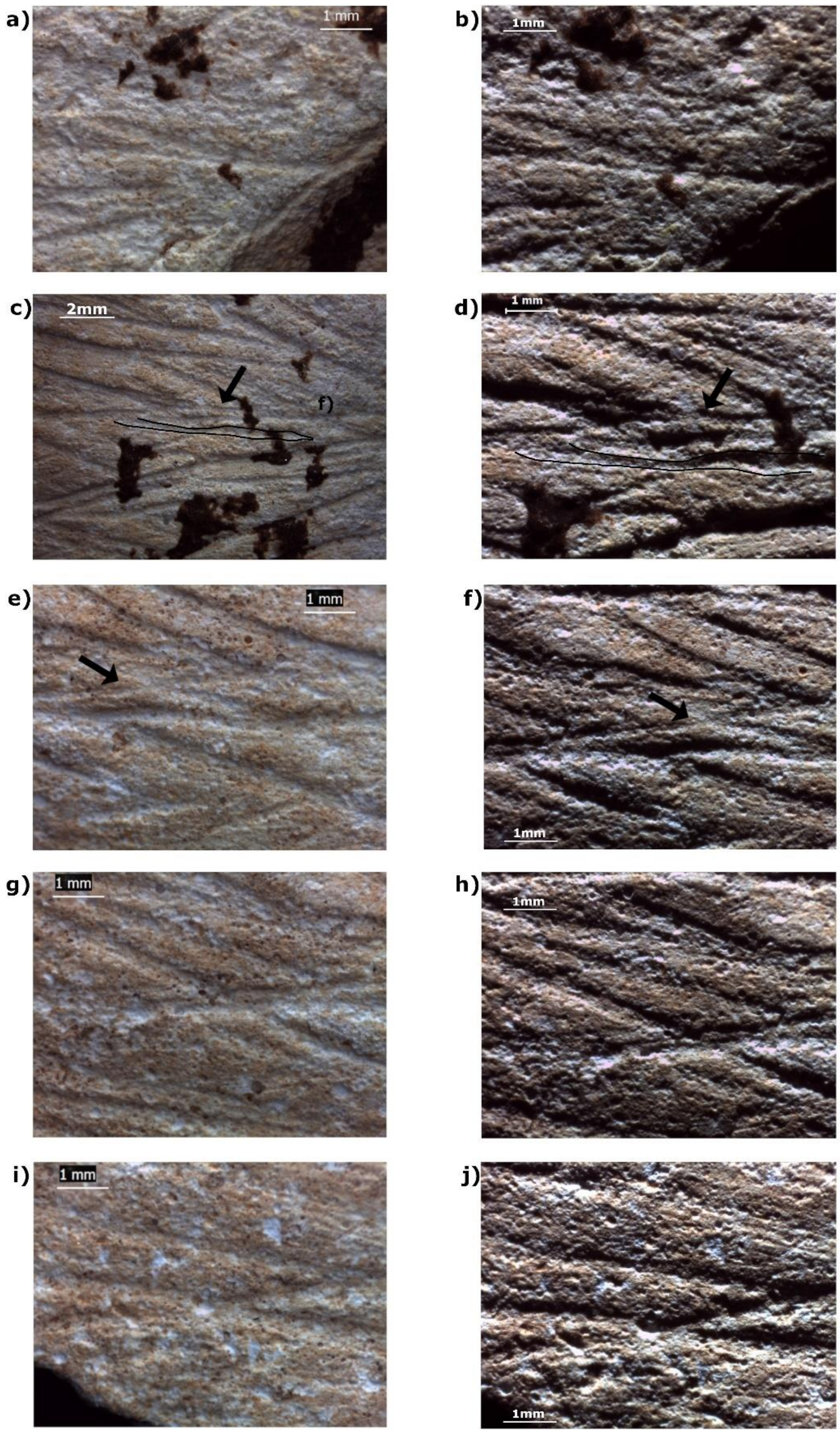

Figure 5-46: magnified photographs of sections of groove (f). a) a short groove overlapping groove (f), c) area where the parasitic branches meet the main groove, the groove marked with an arrow could be a scraping striation and not a parasitic line. e) showing sinuous profile of the groove, another parasitic line joins the groove (arrow), g) i) intersection of groove (f) with the scraping striations, b) d) f) h) j) are the same images as of a) c) e) g) i) under oblique lighting.

- *Groove G, H, I, J:*

Grooves (g), (h) and (i) present a _/-shaped internal cross-section with rounded bottom and straight vertical walls/edges near their starting points (Fig 5.47 b). Groove (j) is overlapped by a groove (k) near its starting point (Fig 5.47 b (dashed box frame)) meaning that groove (j) was made before groove (k). They also have orientations like the grooves (c), (d), (e), and (f) following the curvature of the cortical surface and overlapping the scraping striations. Groove (h) is discontinuous and cannot be traced after its depth becomes negligible (Fig 5.47 c (black arrow)). The grooves (i) and (j) merge together (form a junction) near the edge of the cortical surface (Fig 5.47 d). The depth of the grooves (g) and (i) increases near the edge of the groove. Groove (j) presents a sinuous profile while others have a straight profile. Near the edge of the cortical surface grooves (g) and merged (i) and (j) show their termination points which can be interpreted as the points where the tool leaves the curved cortical surface, with no frayed ends present (d'Errico 1995a).

- *Groove K, L:*

These two grooves have a straight profile, in the same orientation as that of the previous grooves defined above and not the scraping striations. They present a _/ shaped internal cross-section overall with a flat valley bottom and straight vertical walls with homogenous depth throughout their profile. A comet head morphology cannot be seen under an optical microscope at one of the endpoints of the grooves present on the cortical surface (Fig 5.47 e). The grooves start far apart and converge towards the edge of the scraper (Fig 5.47 d) before crossing the cortical surface. The area in between the grooves (l) and (m) (interstitial ridge or plateau) does not show any processing from which the individuality of the two grooves can be accessed (meaning they were incised separately rather than being a result of scraping) (Hodgkiss, 2010). The type of tool used cannot be determined just from the internal cross-section of the grooves (d'Errico 1995 a).

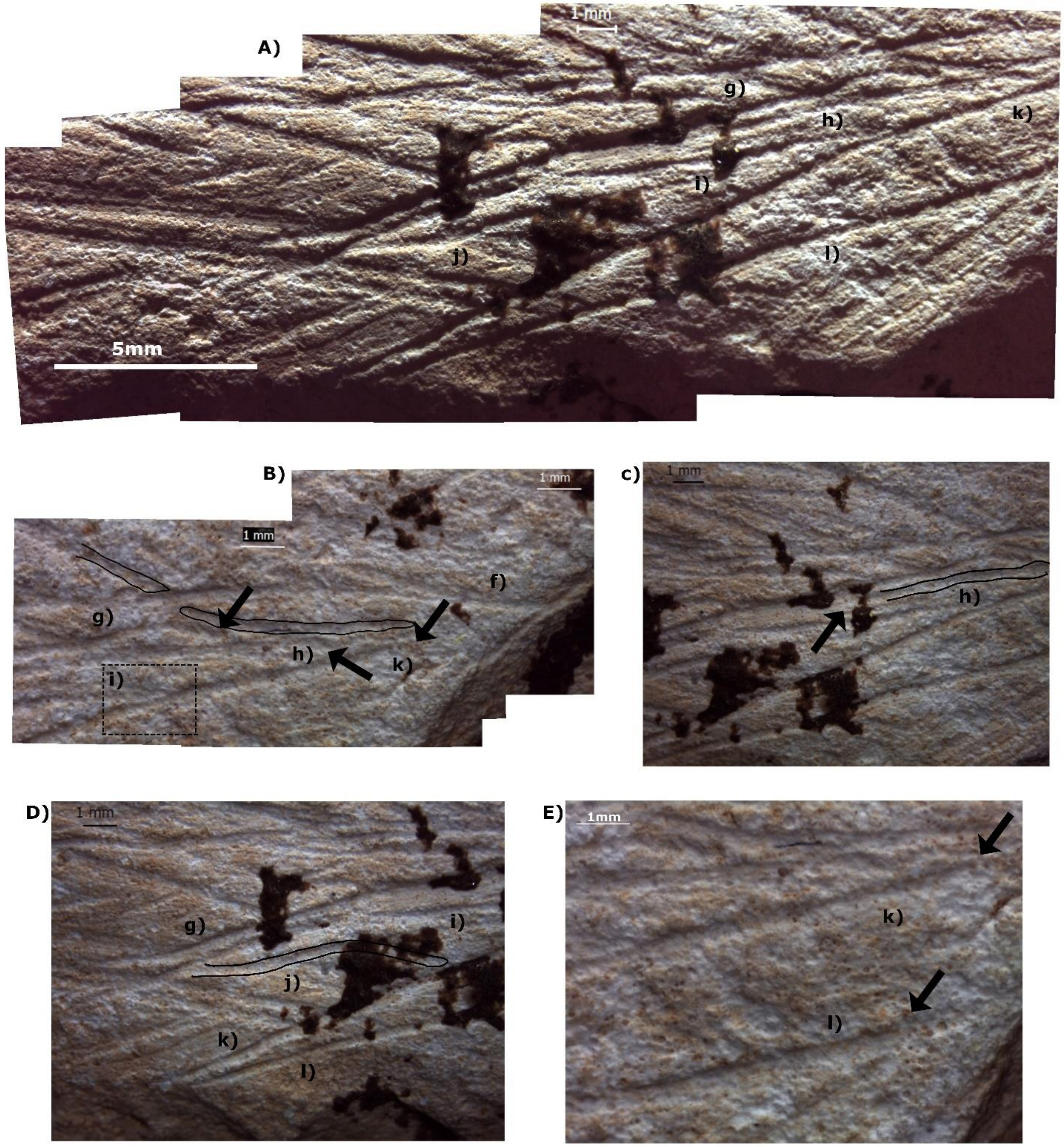

Figure 5-47: a) overview of the grooves (g),(h),(i),(j),(k),(l) under oblique lighting. b) presents probable starting points of the groove (g) (h) (k) (black arrows), the outlined groove starts very close to the other grooves but its orientation is similar to scraping striations (cannot tell if made by later incision or scraping), it gets overlapped by the groove (f), the area covered by the black dashed frame shows the intersection in between groove (i) and (k). c) black arrow pointing towards the discontinuity in groove (h). d) showing the groove profiles near the edge of the cortical surface, groove (j) is outlined. e) one of the end points of groove (k) and (l).

Overall, the grooves defined here which are identified as being deliberately incised are based mainly on their overall orientation which is different than that of the underlying scraping striations. Grooves (a) and (b) although have the same orientation as that of the scraping striations present features such as the comet head shape morphology (a) and change in direction (b) which could be the clues of them being incised after. Grooves (c), (d), (e), (f), (g), (h), (i), (j), (k), (l) follow the curvature of the cortical surface unlike the scraping striations and have similar orientation. Although the internal cross-section of the grooves varies along their profile, all of them show a _/ shaped internal cross-section with a flat valley bottom and straight vertical walls/edges. Some of the grooves present additional features/ clues such as sinuous profile and change in direction when entering and leaving grooves made by scraping which helps in associating the type of tool used to incise them being a pointed end of a tool.

6 Discussion:

Regarding the evidence presented above, the aim or goal of this study was to identify:

- If deliberate engravings are present on any of the artefacts.
- If the deliberate engravings were made with symbolic intent.

As discussed in Chapters 2 and 4, to even suggest a symbolic meaning/ degree of intentionality first all other possibilities need to be ruled out. The first hurdle in answering the questions stated above was proving that the marks presented on the 4 analyzed artefacts were indeed anthropogenic in origin. In this study, this problem was tackled by building a reference collection of the type of marks one can expect from weathering, sin/post-depositional damage or recent damage observed on the cortical surfaces of the Mousterian lithic assemblage and utilizing the information from the previous studies which specifically tackle these questions (d'Errico, 1993; Fisher, 1995; d'Errico and Villa, 1997; d’Errico and Nowell, 2000; Brumm et al.,2006, Nowell and d’Errico, 2007). A formal description of such kind of marks on 7 selected artefacts was provided in Chapter 5 (Fig 5.14, 5.15, 5.16, 5.17, 5.18, 5.19, 5.21). While identifying recent damage and damage due to weathering (physical or chemical) was relativity easier, marks produced by sin/post-depositional activities such as sedimentary abrasion (Fisher, 1995), trampling (Schiffer, 1983; Bednarik, 1995; McBrearty et al., 1998; Domínguez-Rodrigo et al., 2009) and root activities or root etching as responsible for the micro-dissolution of the surfaces (d’Errico and Villa, 1997) is a little difficult as they can mimic marks made from a stone tool. The common denominator in these kinds of striations is that they are superficial and randomly oriented and can be differentiated based on groove profiles and additional attributes/clues that an anthropic marking might present (d’Errico, 1995a). The next hurdle was to check if the markings/lines/striations are due to a functional or utilitarian cause with no representational purpose (Mackay and Welz, 2008; Peresani et al., 2014; Majkic et al., 2018a). This was done through microscopic and technical analysis of the individual grooves on the 4 artefacts (2 flakes, and 2 Side scrapers) complemented by experimental replication studies. If the markings could not be explained to be made by utilitarian actions artefacts then the possibility of the markings being of non-utilitarian in origin was explored. Non-utilitarian actions can also have various aims and functions such as:

- can represent a notational system where a notational system is defined as a “*marking system specifically conceived to record, store, and recover information outside the physical body*” (d’Errico and Nowell, 2001) where individual line/groove is discrete and carries specific information. The evidence of the markings/lines showing the use of different tools (accumulated over time) and having equidistant space between each other has been used in previous studies to prove or disprove this hypothesis (Cremades, 1995; d'Errico 1995b, 1998; d'Errico and Nowell, 2001, Henshilwood et al., 2009)

- can be a product of doodling activity where doodling is defined as making a design with no mental template in mind, without focused attention or absent–mindedly (Balter, 2002; Andrade, 2010). The groove profile showing constant depth, lines/markings confined in a specific area or basically any evidence showing greater neuromotor control (made carefully) has been used previously to discard this hypothesis (Henshilwood et al., 2009; Rodríguez-Vidal et al., 2014; Majkic et al.,2018a; 2018b; Leder et al., 2021; Prevost et al., 2022)
- Lastly can be for representational purposes/ convey a message which could be on a personal level (ownership) or at a collective societal level which is evidence of a symbolically mediated behaviour (Henshilwood et al., 2009; Henshilwood and d'Errico, 2011; d'Errico and Vanhaeren, 2008; d'Errico et al., 2012).

The road map presented above was used for each of the 4 artefacts (2 flakes, and 2 Side scrapers) to interpret their aim and function. Case by case analysis of individual artefacts is presented below:

6.1 Flake RT 76:

This flake presents only one striation in the distal part of the cortex (Fig 5.22). The _/ shaped internal cross-section, the constant reduction in its width from left to right probably due to a decrease in pressure while incising (Fig 5.22), the presence of a parasitic line on the right side as the main groove follows the curvature of the cortical surface present enough evidence that this groove was made by a pointed object (Fig 5.23) (d'Errico, 1995a). The problem which arises is that this is the only incision present on the cortical surface and previous experimental studies (Cremades, 1994; d'Errico, 1995a) have stated that technical analysis of a singular groove is not enough to prove its anthropic origin. Marks of post-depositional origin can mimic anthropic marks. If we do, consider it to have an anthropic origin it is difficult to assign a utilitarian or symbolic meaning to it. Some utilitarian actions can be ruled out such as its use as a base to cut materials as - the surface is not flat (it's curved) and the groove presents a morphology of being made by a pointed end of a stone tool (not so suitable for cutting activity), and a singular incision can't produce enough calcareous powder to be made for that purpose (Henshilwood et al., 2009; Peresani et al.,2014; Majkic et al.,2018a). The groove is made before the flake is taken out and is not confined to the cortical surface, therefore cannot be interpreted as deliberate/intentional incison (Majkic et al., 2018a, Prevost et al., 2022). Overall giving a certain interpretation to the formation of this singular groove is not possible as there is a good chance that this groove was made accidentally with no deliberate intentions.

6.2 Flake RT 11:

This flake presents parallel/subparallel striations at one of its lateral edges (Fig 5.25). The cortex in that area is very thin and has a lighter shade of patina as compared to the medial part of the flake. Observing the type of striations and comparing them with the marks produced by experimental scraping activity and their similarity to the striations found on the flake/flake fragments of Grotta di Fumane (Peresani et al.,2014) it could be said that they were made through either scraping (with a flake) or grinding/abrasion activity (with a hammerstone/retoucher) to reduce the thickness of the cortex. The striations cross the cortical surface; therefore, their direction cannot be identified. Scraping activity to reduce the thickness of the cortex on a flake can be attributed to many different utilitarian functions such as – facilitating prehension during the use of the flake, recovering the calcareous powder, removing the powder for hafting purposes, for retouching purposes etc. (Majkic et al., 2018a). In this case, looking at the position of the striations on the lateral edge, it seems that the aim of the activity was to reduce the thickness of the cortex to better retouch the flake`s edge. Previous experimental studies (Dallatore, 2011; Peresani et al., 2014) have demonstrated that thinning the cortex leads to better efficacy in further flaking or retouching.

The origin of the other set of parallel striations which are located at the distal end of the flake, to be anthropic is more doubtful (Fig 5.25a). They have an ancient origin as they are covered by brown encrustations in some regions. The striations are very superficial, present a U-shaped internal cross-section, are present only in that specific area, and can be attributed to abrasion activity to just clean the cortical surface by removing attached sediment/ the cortex's more powdery layer or to facilitate prehension during the use of the flake but it equally possible is that these marks were made due to natural abrasion (Fisher, 1995).

6.3 Side Scrapper RT 167

This side scraper presents a cortical surface in the distal part of the scraper. The cortical surface shows signs of weathering, post-depositional damage, and recent damage apparent from the superficial striations of both of ancient and recent origin and the areas where the upper layer of the cortical surface is missing due to exfoliation (Fig 5.26). A broad superficial striation present in between groove 2 and groove 4 can be attributed to trampling (Fig 5.27) (McBrearty et al., 1998; Domínguez-Rodrigo et al., 2009). Despite the cortical surface showing a weathered and damaged state, 7 incisions can be clearly separated based on their internal cross-section area (they are deeper, show clean and sharp edges/walls, and show internal micro striations in parts) (Fig 5.26) (d'Errico 1988, 1995a; d'Errico and Villa, 1997; d'Errico and Nowell, 2000). 6 of the grooves are in a similar orientation (top to bottom) (Fig 5.26b), out of which 4 cross the surface at both ends of the cortical surface, while groove 3 merges with groove 4 (Fig 5.30, 5.31b), and groove 5 does not reach the edge of the cortical surface at one end. Groove 4 shows a broader cross-sectional area with internal micro striations indicating being made by multiple strokes (Fig 5.31a,b,c)(d'Errico et al., 2001). While every groove is discussed in detail in the previous chapter, we can say that grooves show a considerable variation in the internal profile in terms of width and internal cross-section. The direction of some grooves can be identified such as groove 7 (left to right) from changes in its direction as it intersects grooves 3 – 6 (Fig 5.32), and groove 3 (top to bottom) from its merger/junction with groove 4 (Fig 5.32) (Cremades, 1994; d'Errico and Cacho, 1994; d'Errico 1995a, 1995b). Groove 4 gets broader towards the bottom half of the cortical surface which may indicate its direction being from top to bottom. For the type of tool used, Groove 2 which shows changes in its internal cross section without change in its width (Fig 5.29), and Groove 7 which changes directions each time it crosses the other grooves and changes its internal profile after crossing Groove 6 can be said to be have being made with a pointed end of a tool (d'Errico and Nowell, 2000). For others it's a bit difficult to resolve based on the width and the shape of internal cross-section as shown from the incision experimental activity (Fig 5.5, 5.6, 5.7, 5.8) . _/ shaped cross-section or a U-shaped cross-section can be made with various tool types, such as a sharp/blunt pointed end of the tool or a blunt unretouched edge or a sharp retouched edge (multiple strokes). The absence of additional features such as a sinuous profile (pointed end) or fringed ends (multiple strokes) makes it harder to correctly identify the type of tool used. The dark stained pits made possibly due to weathering distort the groove profile, especially groove 6 (5.31e) making it difficult to get the technical/descriptive information from the groove profiles (Majkic et al.,2018b). As for the chronological order, it can be said that groove 7 was made after grooves 3 – 6 based on their intersections, and the thin groove 3 was made after groove 4 as it enters groove 4 and continues inside it.

Before trying to interpret the aim and function of the incised grooves, it needs to be pointed out that the grooves only represent a fragment of a possibly larger cortical area on which the incisions probably occurred, which reduces our scope of trying to interpret the meaning behind the incisions. Although from the technical analysis of the individual grooves, some possibilities can be eliminated. The interstitial ridges/plateaus (area in between grooves) do not show signs of being processed indicating that the grooves made were not due to scraping activity but are a product of individual incision (Henshilwood et al., 2009; Hodgkiss, 2010; Rifkin, 2012). Utilitarian activities related to scraping of cortex (to clean, to get the calcareous powder, etc.) are probably not the reason for the incisions. Other utilitarian activity involving using the cortical surface as a base for cutting materials can be a possibility, but the incisions do not show a V-shaped internal cross section. According to Henshilwood et al., 2009, a pointed end of a tool is not suitable for repeated cutting activities as it gets blunt very quickly, yet it is effective for precisely engraving lines but later Hodgkiss, 2010 did point out that the human factor in such experiments can't be neglected. What this means is that one cannot expect everyone to use the best possible edge or hold the flake at the best possible angle, every time for cutting or incision activities. In the experimental activity of cutting soft material (chicken breast) (Fig 5.9) or hard material (dried leather skin) (Fig 5.10), while most of the incisions showed a V shape profile, other internal cross-section shapes were also visible, created due to multiple passing of the cutting edge through the same groove (U shaped or _/ shaped) or from a singular stroke due to contact with a different part of the edge than the cutting edge.

Also, the recurring problem of the incomplete nature of the engravings will make it more difficult to pinpoint any specific aim and function of the incisions. If we do consider a non-utilitarian origin of the incisions based on the number of incisions (7) in such a small space, orientation (almost parallel, first 6 grooves), and use of pointed end of a tool (Groove 2 and 7) to make the incisions, it could still have various functions – to convey a message (personal or conventional), doodling or notational system but the partial nature of the lines/incisions does not provide enough evidence to show that the incisions were part of an organized design or show symmetry. Maybe at the original scale, it might represent a cross-hatched pattern or a ladder-like motif but there is a possibility that the incisions were a part of a pattern (straight lines, sub-parallel, overlapping) made by cutting activity (Henshilwood et al.,2009) using the cortical surface of the original nodule as a base. At best, what can be said based on the evidence is that the incisions are not a part of scraping activity but individual occurrences whose aim and function cannot be judged due to the partial preservation of the cortical surface.

6.4 Side scraper RT 100:

This side scraper coming from layer 34 (Fig 5.35) from the external part of the shelter has been reported and analyzed in several previous studies (Leonardi, 1979, 1983; Arzarello, 2003; Dallatore, 2011; Peresani et al.,2014). While the initial reports of Leonardi, 1979, 1983 recognized the striations on the cortical surface as being of anthropic origin and its peculiarity in terms of the abundance of striations covering the whole cortical surface as compared to other similar evidence of cortical surfaces bearing linear incisions from Mousterian layers of Riparo Tagliente and sites such as Grotta di San Bernardino and Grotta di Fumane in the region of Italian Pre Alps (Arzarello, 2003), the aim and function of the striations was not clearly defined. The two possibilities for the origin of the striations that were proposed and discussed were - the use of the original nodule as a base for cutting activities or the use of the original nodule as a retoucher to regularize the edge of flakes. This interpretation was based on experimental replication and comparison with other similar evidence in Italian context and broader European context with sites such as Chez-Pourrè-Chez-Comte and Champlost (Lhomme & Normand,1993) in France (Leonardi, 1983; Arzarello, 2003). Later in the experimental studies of Dallatore, 2011 and especially Peresani et al., 2014 more possibilities which could have made these striations on the surface were considered such as -

- Scraping the surface for hafting purposes. This hypothesis was rejected for this side scraper as the use wear marks appear on distal as well as proximal margins of the scraper which indicates a systematic contact of the margins of the scraper with the working surface and no indication of presence of organic material from the XRD and FTIR analysis of the brown encrustations supporting the idea of use of adhesives for hafting.
- Scraping the surface to clean the cortex of the nodules.
- Scraping to reduce the thickness of the cortex for better efficiency in flaking and/ or retouching. This hypothesis was rejected as it seems unnecessary to scrape the cortical surface everywhere and not later use it as a striking platform.
- Scraping the cortical surface to use the calcareous white powder. The possibility of this hypothesis being true is negligible because of the absence of limestone blocks bearing such scraping traces in Mousterian sites (Peresani et al.,2014).

In this study, along with the marks produced by scraping by a retouched edge of a flake/tool, some grooves were identified based on their orientation/direction, which overlap the scraping striations suggesting they were made after the scraping activity took place and show attributes which can be associated with being made by a pointed end of a tool (Grooves A – L) (Fig 5.37). The grooves (A to L) show variable depth, variable width and variable internal cross section profiles which are similar to the grooves produced by scraping with a retouched edge (Fig 5.36, 5.13d). Therefore, these attributes could not be used for the differentiating between the grooves made by two different activities (Scraping and incision). Attested from the scraping activity performed (5.1, 5.2, 5.3, 5.4) and previous studies (Peresani et al., 2014; Kaufman et al.,2018) the bidirectional scraping from the retouched edge creates more homogeneous, organized distribution of the striations which are parallel/ sub parallel to each other and every stroke erases the striations made previously. This can be observed in the right-hand side of the cortical surface where all the striations are parallel/sub parallel and almost all have the same orientation. In the left part of the scraper, most of the striations follow the same orientation and are parallel to one another but some of the grooves (C - L) (Fig 5.37) do not follow the same orientation but follow the curvature of the cortical surface. Now if these striations were made due to scraping, the area in between the grooves (Interstitial ridges/plateaus) should show more of such striations in the same direction (signs of being processed) (Mackay and Welz, 2008; Henshilwood et al., 2009; Hodgkiss, 2010; Rifkin, 2012) which is not the case here. On top of that, by microscopic analysis of the intersections that grooves (C – L) make with the scraping striations it can be said that they were made after the scraping activity (Fig 5.45, 5.46, 5.47). The origin of these striations cannot be attributed to natural causes or recent damage or post depositional causes such as abrasion, trampling or root etching as - they are not superficial, have a considerable length, show a _/ shaped internal cross section with sharp vertical edges/walls with faintly visible internal striations in some sections of the grooves. They are of ancient origin as they show same patina coloration as the rest of the surface and are covered by the dark brown encrustations. The grooves (C – L) show similar widths which can be interpreted as being made by the same tool in a single setting. Some grooves (C, E , H) show discontinuity in their profile (the depth becomes negligible in some sections) which signifies that the grooves were not made with a greater neuro motor control or in simple terms – the grooves were not made carefully and with focus (Henshilwood et al.,2009; Majkic et al.,2018a). The grooves (C – L) do not present a comet head like morphology at one of their end points which is present on the cortical surface (even in the incision experiments performed, the lines made by a pointed end of a tool did not show a comet head shape (Fig 5.5, 5.6, 5.7)). But some of the grooves such as groove D and groove E present additional clues such as changes in direction as they enter and leave the scraping striations from which it can interpreted by that they were made by a pointed end of a flake/tool and the direction of engraving was from right to left (in the rotated Figure 5.37) (similar results were observed when incisions were made over the already scraped surface (Fig 5.13a,b,c)). Groove F shows a sinuous profile, on the right cortical edge (in the rotated Figure 5.37) is overlapped by a short groove which might signify multiple strokes in the same groove and has two parasitic grooves which are made due to additional contact with another part of the incising tool as the main groove curves downwards. It gives us the idea about the direction of the groove being from right to left (in the rotated Fig 5.37) (d'Errico 1995a). Grooves (G – K) are juxtaposed very close to each other, are not parallel and are not exactly the type of grooves/striations made by scraping based on the observation of experimental scraping activity which was performed with both unretouched and retouched edge (Fig 5.1, 5.2, 5.3, 5.4). Grooves A and B, although are in a similar orientation as that of the scraping striations some aspects of them such as a comet head shape of the Groove A (Fig 5.38) and the sudden change in direction of Groove B while intersecting other grooves (Fig 5.39) can be considered as attributes which might signify being made by a pointed end of a tool but it's not so clear. There might be other grooves which were made after scraping but it is very difficult to identify or differentiate between them and scraping striations based just on the individual groove profiles and in especially in this case where the incisions are incomplete.

The previous interpretations of the aim and function of the marks present on the cortical surface of this scraper were based on the perception that all the striations were made only by scraping or abrasion activity. The identification of possible grooves made by incision (C – L) after scraping changes the possibilities of why these marks were made on this scraper. The old hypothesis of use of the original nodule as a retoucher to regularize the edge of flakes does not fit the type of marks present on the cortical surface as most of the marks correspond to being made by intense scraping activity and it seems unnecessary to first scrape the original nodule and then use it as a retoucher. A hypothesis can be proposed in this case where scraping activity can be considered as a preparatory action to clean the cortical surface before the incisions by a pointed end of a tool were made (Cremades, 1991, 1994, Majkic et al., 2018). It should be kept in mind that no definite example of scraping as a preparatory action before making incisions on cortical surface exists in European Middle Paleolithic/Mousterian context while such examples from South African MSA context on ochre are available, where engravings have been made after conducting scraping activity – Blombos cave (Henshilwood etal., 2009), Klasies River (d'Errico et al., 2012), Klein Kliphuis (Mackay and Welz, 2008). The function of the incisions (Groove C – L) can be of utilitarian or non-utilitarian origin. The biggest hindrance in judging the aim of the incisions or in general for all the markings present on this scraper is the incomplete nature of the incisions. The incisions are interrupted in proximity to the margins of the scraper, denoting the fact that they were made before the flake was removed from the original nodule. Nonetheless, merits and demerits of different possibilities can be discussed.

The incisions being a product of cutting activity, using the original nodule as a base seems less likely as none of the grooves (A – L) have a V shaped internal cross section and some of the grooves show attributes (sinuous profile, changes in direction when crossing the scraping striations) which have been associated with being made with a pointed end of a tool (d'Errico 1995a; d'Errico and Nowell, 2000). Also, the cortical surface is not exactly flat but curved. These observations present evidence against the hypothesis of use of the cortical surface as a cutting board but in the previous section 6.4, it has been discussed that it's not necessary that the cutting marks made on a cortical surface always have a V shaped internal cross section and it's impossible to know the topography or the size of the original nodule so this hypothesis cannot be completely rejected. For considering a non-utilitarian function of the incisions, the pattern formed by the grooves (C – L) does not present much organizational consistency such as the presence of equispacing and symmetry (although overall it vaguely does present a fanning line pattern, Fig 5.37) which implies that the incisions may not have being made to represent a distinct design with a symbolic meaning (d'Errico et al.,2012). Invoking similar logic, the incisions were probably not made to represent a notational system as the individual incisions (C – L) cannot be visually identified as discrete signs (Henshilwood et al., 2009, Majkic et al.,2018a). Also from the microscopic analysis of individual grooves we can observe that some of the grooves (C, E, F, H) show a variable depth which translates into being engraved with variable applied pressure. Previous studies from African MSA context and Eurasian Mousterian context have used the argument of grooves being of constant depth or showing a regular profile throughout their length as markers of carefully controlled execution/greater neuro motor control which in turn suggests greater intentionality or having a mental template of the pattern to be incised beforehand in the mind of the engraver (Mackay and Welz, 2008; Henshilwood et al., 2009, Majkic et al.,2018a; Shaham et al.,2019; Prevost et al., 2022). This cannot be said with confidence here for grooves (C, E, F, H). Other possibilities of nonpurposive aim for the incisions such as - marking the completion of scraping the nodule or marking to signify the good quality of the flint nodule can be considered but in no other cortical surface of the analyzed 429 Mousterian lithic artefacts, marks of such kind were recognized. The possibility of these incisions being a product of doodling activity could be true here as doodling represents an act which does not require full attention of the engraver and not necessarily has to have a pattern (an abstract attempt to produce a pattern) (Andrade et al, 2010).

All the interpretations discussed here for the incised lines/grooves come with a caveat that the lines/grooves are incomplete, we cannot guess what the original whole pattern looked like. Also, if the incisions had a symbolic meaning behind them on the original nodule, then why would it be flaked making the representation redundant (Henshilwood et al., 2009). Therefore, no firm conclusion can be drawn about the aim or purpose of the markings present on this scraper.

7 Conclusions

This study presents 3 new lithic artefacts from the Mousterian assemblage of Riparo Tagliente whose cortical surfaces show modifications/traces attributed to anthropic origin. Identification of traces/marks related to scraping or incision activities was done through microscopic and technical analysis of the marks based on the criteria developed by previous studies (Cremades, 1991, 1994; d'Errico F., 1988a, 1988b, 1995a, 1995b, 1996; Fritz, 1999; d'Errico and Cacho, 1994; d'Errico and Nowell, 2000; Soressi and d'Errico, 2007; Hodgskiss, 2010, Rifkin, 2012) and comparison with the reference experimental collection. These 3 new findings add to the collection of such artefacts that show anthropogenic modifications, from the Mousterian assemblage of Riparo Tagliente (Leonardi, 1975, 1979, 1981, 1983, 1988). Out of the 3 artefacts, markings on one flake - RT 11 can be firmly attributed to a utilitarian activity (Abrasions or scraping to thin the cortex for better retouching) while for the other 2 artefacts firm conclusion cannot be reached for separate reasons. The single groove/mark on Flake RT 76 presents attributes of being incised by a pointed end of a lithic tool but identifying its purpose is impossible as it could have been accidentally made with no aim or function. Side scraper – RT 167 presents 7 grooves/ marks which were probably made by individual incision activity by a pointed end of a lithic tool, but its fragmentary nature and its poor state of preservation/weathered state hinders a firm conclusion of the purpose of the grooves.

Along with the 3 new findings, on previously identified and analyzed side scraper RT 100, marks made by two different kinds of activities – scraping with a retouched edge and incisions made by a pointed end of a tool (grooves C – L) which were made after the scraping activity took place were identified. While the act of first scraping the cortical surface and then incising in itself represents some intentionality on behalf of the engraver, from the technical analysis of the grooves (C – L) is not clear if they had a representational/ symbolic purpose. Merits and demerits of many possibilities/hypotheses are discussed in the previous chapter but overall, a confident interpretation of the markings to be of utilitarian or non-utilitarian origin cannot be reached due to its fragmentary/incomplete nature, lack of symmetry or a consistent pattern of the visible incisions made by the pointed end of a tool and most importantly - lack of comparable evidence in Italian as well as European Mousterian context where marks related to scraping and incision activity are both present on the same cortical surface. Italian evidence of engravings on cortical surfaces in the Mousterian/Middle Paleolithic context is sparse (as discussed in Chapter 2), many of the anthropogenic modifications observed on flakes, blades, pebbles and scrapers from various sites in the similar region of Italian Pre Alps either show marks related to scraping or incision and have been attributed to a functional/utilitarian activity. While other Italian evidence requires a reassessment to judge the degree of intentionality of the markings (Peresani et al., 2014). In a broader European context, while evidence exists that proves Neanderthals' ability to produce intentional engravings on bones and stones which might be symbolic in nature (Majkic et al., 2018a; Shaham et al., 2019; Leder et al., 2021, Prevost et al., 2022; Marquet et al., 2023), no such evidence for engraved cortexes is present where the marks on cortical surface belong to both scraping and incision activities, which makes it more difficult to access the nature of the markings on the scraper.

The ambiguities in interpretations of the markings on the side scraper are expected as many discoveries/evidence dealing with the question of the origin of symbolic behaviour are often obscure or doubtful. It does not mean that the presented evidence does not add to the debate on the origin of modern cognition and Mousterian symbolically mediated behaviours. It’s still a key piece of evidence whose importance might be realized when similar and contemporary evidence is discovered later. The Mousterian layers of Riparo Tagliente have not been fully excavated and in future may present more of such evidence.

Further analysis of the incision grooves on side scraper RT 100 using a 3D digital microscope and a Scanning Electron Microscope is required as a 3D elevation model of the incision grooves especially in areas where the incision grooves intersect with the scraping striations will give more accurate information about their individual depth and their chronological order where it is not so clear, for example Fig 5.40. SEM can help in identifying microscopic clues which are not visible or resolvable under a simple optical microscope but are present in the internal profile of a groove to determine the direction of incision grooves, look for comet head morphologies at the endpoints of the incision grooves and if the grooves have been formed by multiple strokes or not, based on the criteria developed by previous SEM studies (d’Errico 1988, 1995a). This information will allow a more detailed characterization of past actions which will strengthen and elaborate on the inferences made in this study.

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