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Chapter 11

THREE END-SCRAPERS FROM MOHENJO-DARO (PAKISTAN)

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Abstract

Three chert end-scrapers found on the surface of Mohenjo-Daro (Sindh, Pakistan, second half of the 3rd millennium cal BC) are described in detail. Wear/use traces, as observed with an optical microscope, are selectively distributed on their edges. Two of them retain traces of an organic substance probably related to their original specialized function. A new technique of digital photography, SEM and Micro-FTIR tests were applied for a preliminary characterization of the shape and the composition of these residues. The substance is a proteinaceous product, possibly a glue or another paste-like material of animal origin. However, we could also and more simply be dealing with the evidence of cutting meat and bones, disarticulating finger bones and/or skinning, more traditionally linked with this type of retouched lithic tool. The study stresses the scientific potential of similar studies in the arid and semi-arid plains of Middle and South Asia, where organic matter may be very well preserved, if lithics are properly treated and stored after their recovery.

Key words: Mohenjo-Daro, Indus crafts, end-scrapers, lithic tools, organic residues

Introduction

The archaeology of the Indus Valley owes an enormous debt to Paolo Biagi and his co-workers. The IsMEO (presently IsIAO) teams started working at Mohenjo-Daro (Sindh, Pakistan), the most important and famous urban site of the Indus Basin, in 1981. In the following years, many of us visited the edges of the Rohri Hills and were impressed by the outstanding relevance and potential of the chert extraction and processing sites, and bitterly shocked by their fast ongoing destruction. But only Paolo was intelligent, generous and stubborn enough to act practically, and started a major archaeological effort to attempt to record the gigantic evidence of the Rohri stations, a task much heavier and demanding than the lives of all of us and of many future scholars. I have always wondered for which unfathomable reasons an expert on the Neolithic of the Po Plain, in Italy, fell suddenly and so deeply in love with the silvery-grey, salty and bitter alluvial plains of the Indus; but this is the kind of question you rarely ask a colleague.

Those of us who have a firsthand knowledge of the social, human and logistic environment of Khairpur may perhaps understand better than others how exhausting it must have been to work there and collect such a tremendous load of information (among others, Biagi and Cremaschi 1990, 1991; Biagi and Shaik 1994; Biagi *et al*. 1995; Negrino and Starnini 1995, 1996; Negrino *et al*. 1996; Biagi 1997; Shaikh and Biagi 1997; Biagi and Veesar 1998–1999). The following short note, in its strongly reductionist approach, stresses the importance of the identification of organic remains on the surfaces of the lithic tools of the Chalcolithic and Bronze Age sites of Middle Asia. It is at the same time a long-due acknowledgment of the information we owe to our friend, and a simple but important promise; while Paolo spent years of his life to document the first steps of chert exploitation in the lower Indus Basin, we may now plan to go back to the urban, early industrial environment of the Indus capital of Sindh and observe the opposite end of the sequence: the use, exhaustion, discard and recycling of chert and flint tools at Mohenjo-Daro.

The need for re-studying an old collection

The promise (one we cannot miss) is the study of the materials collected in 1982–1985 on the surface of the so-called Moneer South East Area (MNSE) of the town (Figure 11.1), part of a more general surface survey of the craft areas of the ancient urban settlement (Bondioli *et al*. 1984; Pracchia *et al*. 1985). For the study, a team pin-pointed on the ground and mapped with centimetric coordinates more than 7000 objects, more than 4000 of which were lithics (Figure 11.2). They included chert debitage, few cores,

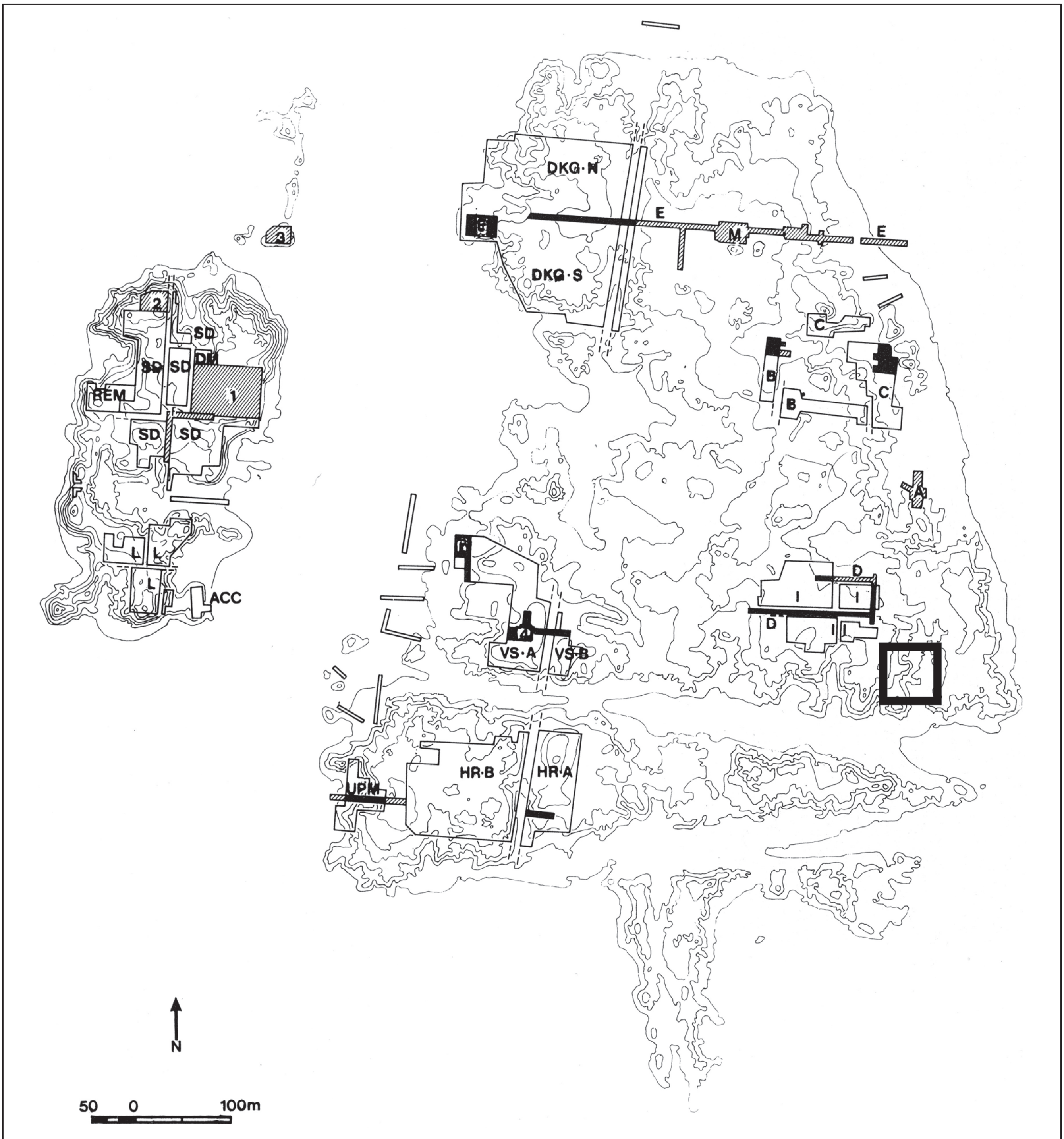

Figure 11.1. Map of Mohenjo-Daro with the location of the Moneer South East Area (the empty square). The southeastern extensions of Indus cities might have been a preferential location for the manufacturing areas (from Vidale 2010).

bladelets (simple or retouched) and their fragments, different types of drill-heads, flakes of chalcedony/agate, jasper, green grossular and other stones, and a certain number of unfinished beads (Vidale 1987a). The collection, done at the time with traditional means, was quite long and exhausting; on the whole it took not less than 5 months of fieldwork for a team of 3–4 people. At the end, one of the authors (MV) was instructed to give an inventory number even to the smallest stone flake; all microliths had to be fixed to a paper tag with transparent tape onto special file cards, finally delivered one by one to the Department of Archaeology of the Government of Pakistan.

However, when each minute flake, following the instructions by M. Tosi, had been labelled, inventoried and stored in individual containers, it was found that to handle them for study had become rather impractical. At the end of the research, we had permission to carry out a series of subsurface excavations (down to a maximum depth of 20cm) on the clusters of objects mapped on surface. During this test, we found that most lithics came from a buried dump with counter-sloping, multi-stratified lenses alternating with water-laid sediments, most probably formed by rain erosion of mudbrick architecture. Computer simulations of the downslope erosion/mudflow processes revealed that the

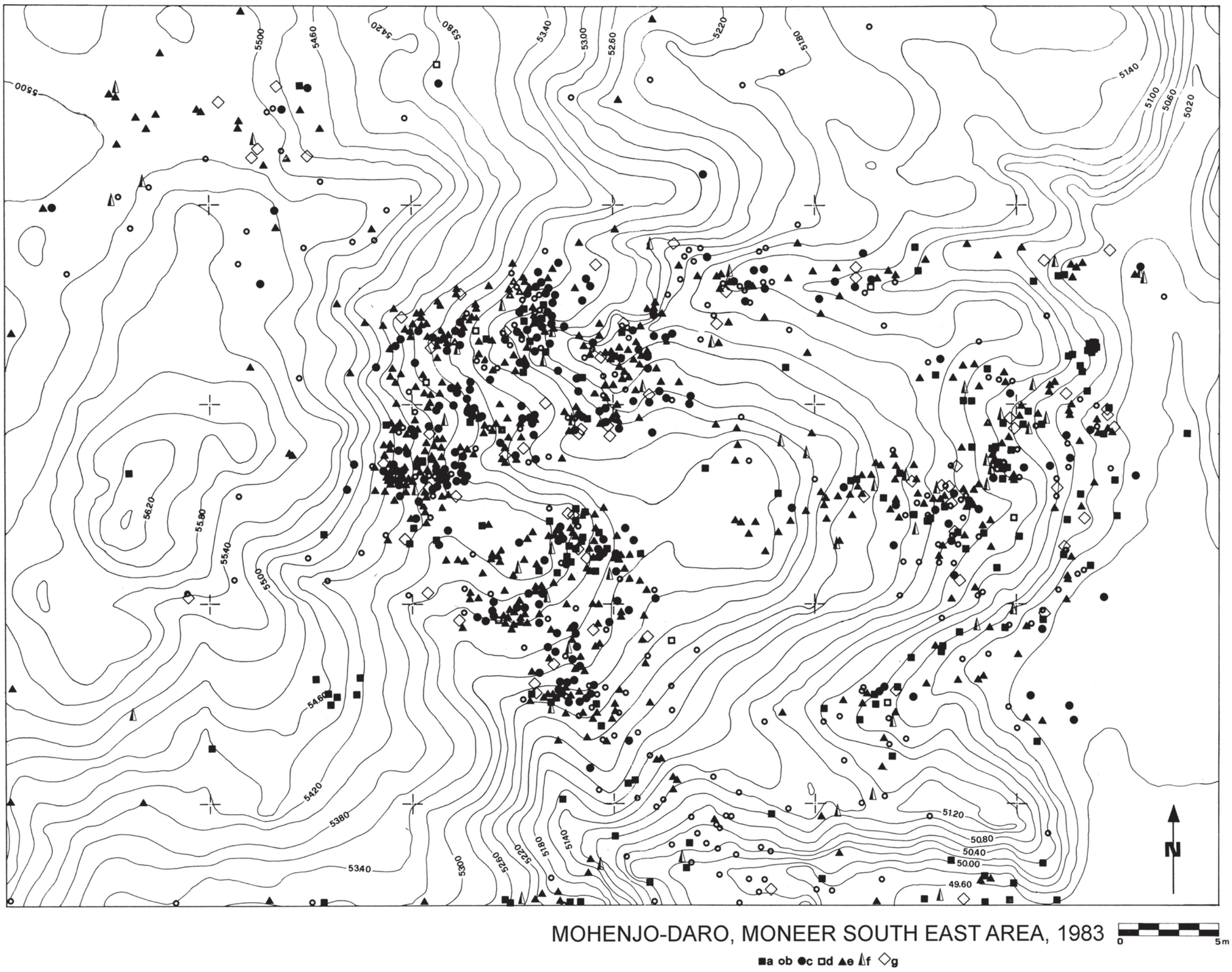

Figure 11.2. Mohenjo-Daro. Map of the Moneer South East Area showing with different symbols the location of different types of lithic indicators found on surface (from Vidale 1987a: Fig. 4). Squares: quartzite flakes. Empty circles: chert blades. Full circles: drill-heads. Empty squares: unfinished drill-heads. Black triangles: chalcedony/agate flakes. Long split triangles: jasper flakes. Lozenge: grossular flakes and unfinished beads.

local slope morphology, as recorded 30 years ago, did not explain the recorded clusters of artefacts. Therefore, we had to hypothesize that the erosive dismantling of the local architecture and the contained deposits had developed through discontinuous steps and at variable speed from point to point, rather than as a uniform gradual and easily predictable process (Bondioli and Vidale 1995).

The excavated dumping layers were sampled by wet sieving and flotation and this allowed the recovery of a rich collection of stone debitage, tools and some unfinished beads (Figure 11.4). The three scrapers discussed in this paper (Figure 11.5) come from the flotation. When Grazia Bulgarelli (1986) carried out a first preliminary study of the lithics from the Moneer South East Area, she found it much faster and less demanding to study the collection recovered by the sub-surface sounding. This is why the objects collected on the surface, for the last 30 years have never been studied and should still be waiting for us in some trunk of the Exploration Branch in Karachi.

The MNSE research was the subject of a research doctorate at the University of Naples (Vidale 1987b, 1990a, 1990b). The story of this project is complex and the results were somehow controversial, and everything will be discussed in detail on a future occasion. The three end-scrapers we present in this note have a special place in the history of MNSE research. Sandro Salvatori will certainly remember that when they were found, while mapping the objects on surface with very traditional means, it was realized that such tools clearly clustered in a restricted area of the site (Figure 11.3). Thus – we reasoned – they may have been discarded not far from where they had been used; their location, in other words, could have been sub-primary – they may have formed on the surface an ‘activity area’. This encouraged the team to continue to map the location of each object by individual centimetric coordinates.

While it is entirely possible that the cluster of end-scrapers in MNSE was actually sub-primary, these tools were somehow deceptive: it was found later that the bulk of the other lithics were dumped after a complex sequence of industrial occupations, then scattered and moved downslope on the surface by complex processes of saline weathering and mud flows (Vidale and Balista 1988; Vidale 1990b), so that the final distributional pattern was completely secondary. In fact, when the team applied sophisticated spatial studies –

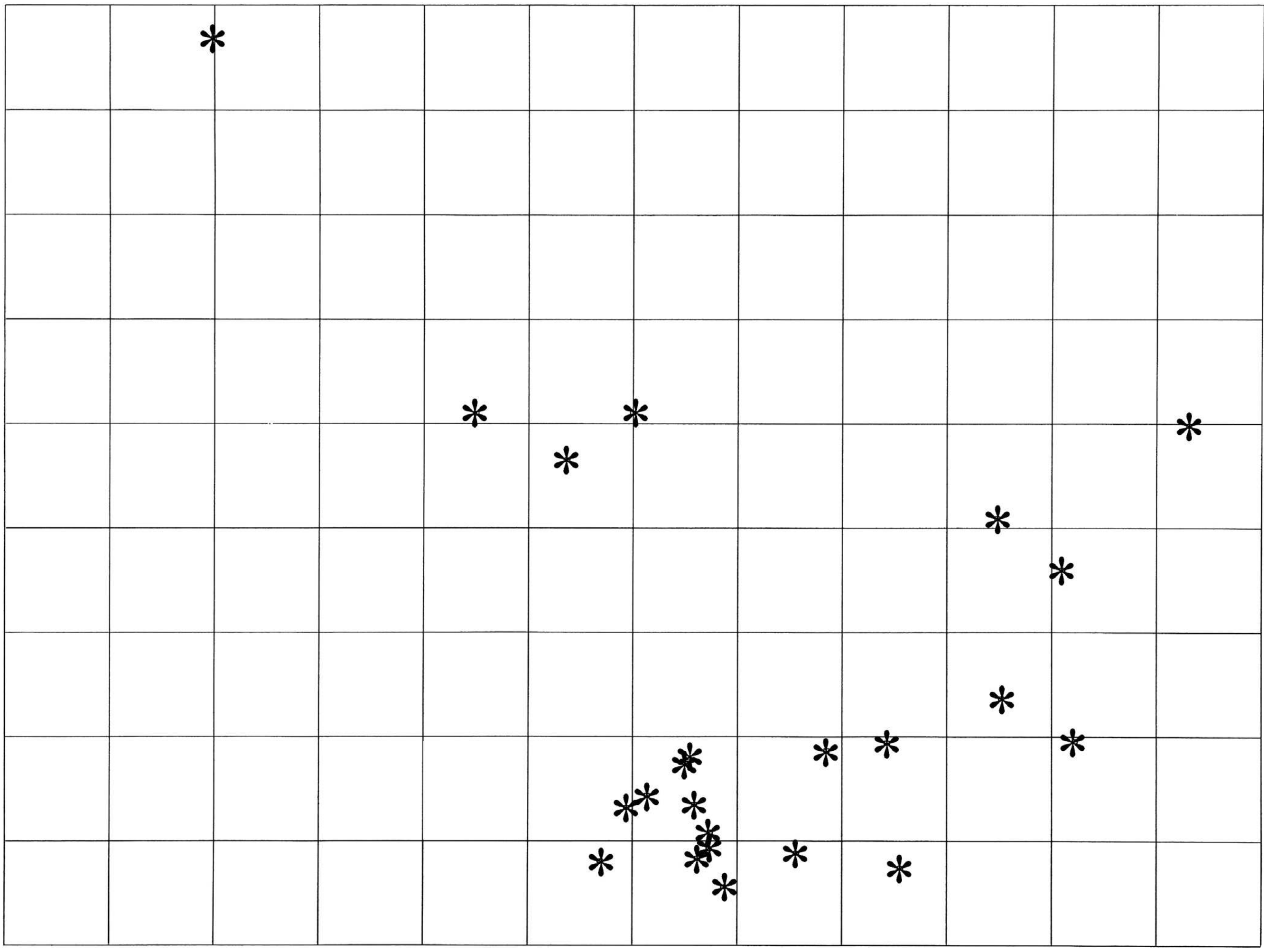

Figure 11.3. Mohenjo-Daro. Map of the Moneer South East Area with the location (stars) of the end-scrapers discussed in the text. The tools were found clustered in a restricted area of the site and this matches with their specialized technical character. The scale and orientation are the same as Figure 11.2.

space trend and point-based analysis (Bondioli and Vidale 1986, 1995; Bondioli *et al.* 1984) – it became clear that the overall spatial distribution of the objects on the surface, beyond the most obvious trends to cluster in various discrete spaces, had no other meaningful inner structure.

Figure 11.4. Mohenjo-Daro, Moneer South East Area. Stone debitage and tools found by wet sieving and flotation in the stone cutters' dumps.

Like the moon of R.A. Heinlein, Mohenjo-Daro was a harsh mistress, and the lesson we had was clear; to a great extent, the effort in pinpointing each object on the ground had been quite fruitless, because the same information could have been gathered much more expediently collecting the surface finds by areal units of 1x1m. Yet, the end-scrapers did form a cluster. It was for this reason that three of them, found by wet sieving and flotation were brought to Italy for closer analytical inspection.

However, with the closing of the joint German–Italian surface survey at Mohenjo-Daro in 1987, our attention shifted to something else and the present study was delayed. What follows will hopefully represent a first step towards a re-study of the whole collection kept in Karachi, a project that at present we cannot imagine without the direct contribution of Paolo Biagi and his co-workers.

Description of the chert tools

The three tools are made with the light grey/brown banded chert of the Rohri Hills. In the typology of Laplace (1964) these blade tools (Figure 11.5) belong to the category G1 (long end-scrapers). Of the three tools considered here, only one, MD28, is complete (length 5.5cm, width 1.1cm, thickness 0.3cm). The other two are fragmentary (Laplace

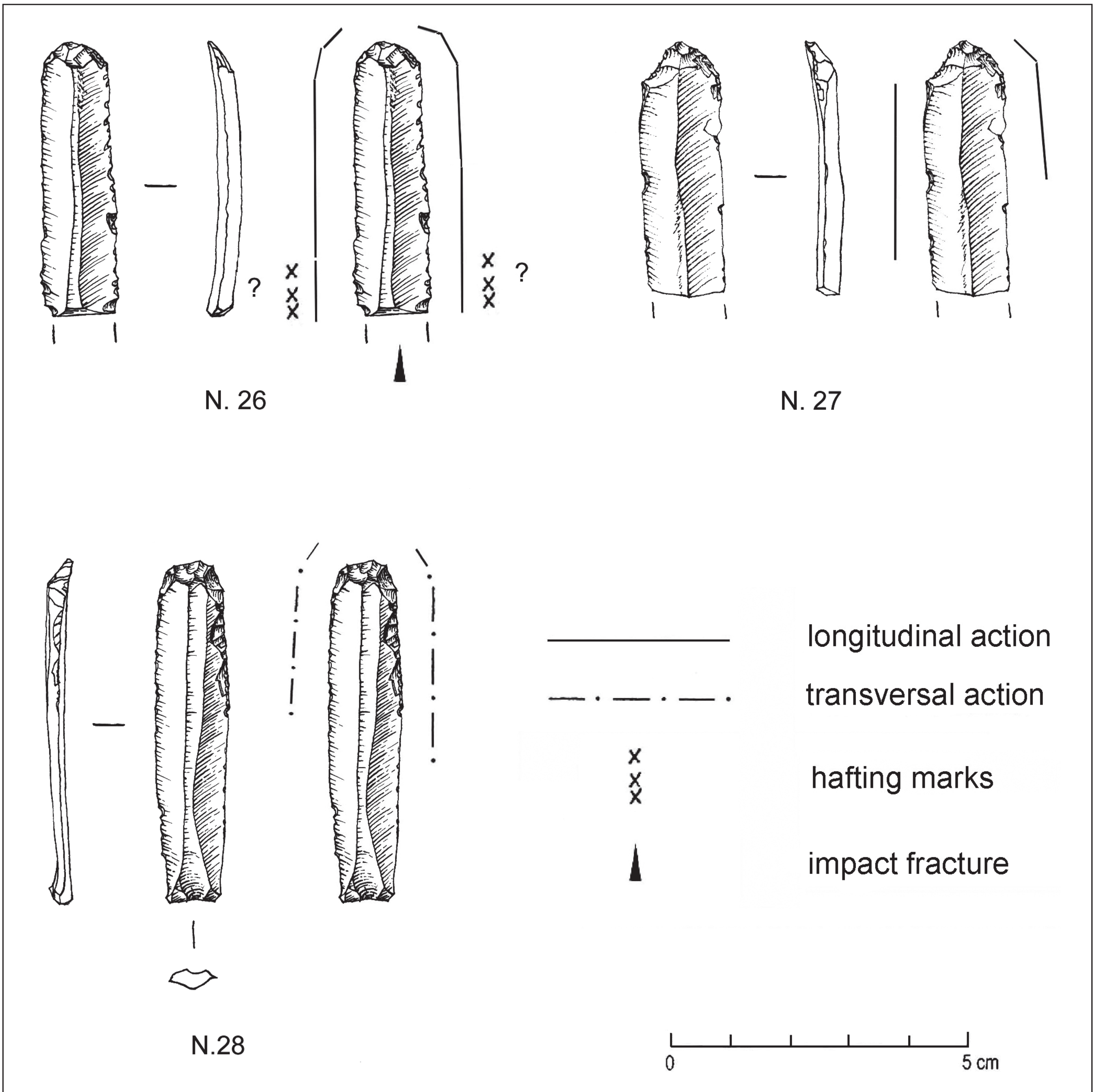

Figure 11.5. Mohenjo-Daro, Moneer South East Area. MD26, MD27, MD28, the three end-scrapers discussed in the text and interpretation of the use-wear and exhaustion traces observed and discussed in this article (drawing by A. Siviero).

fG1) and only the distal-medial parts are present (MD26, length of the distal part 4.3cm, width 1.1cm, thickness 0.3cm); MD27, length of the distal part 4.1cm, width 1.3cm, thickness 0.3cm). In spite of the fragmentary state of the latter two objects, the size of these three specimens suggests that those found on the surface (Figure 11.3) were a homogeneous group, possibly as a consequence of their use in the same standardized technical process.

A preliminary observation of the three tools under a low-magnification microscope shows the presence of some wear/use traces. MD26 (Figure 11.5, upper left; Figure 11.6, left) has on both the unretouched sides a limited, irregular edge damage, both on the dorsal and ventral faces (see below, Figure 11.7). The crescent-like shape of many marks is a typical evidence of longitudinal actions.

On the right side of the retouched front there are evident reddish particles that are also present on the ventral face of the tool. Near the fracture of the blade, at the same height and on both sides, one sees groups of small marks that may have been caused by the friction and stress of the stone blade with the (wooden?) handle.

The fracture here shows a simple *en languette* form, that (in this proximal location) supports the hypothesis that the tool was broken while in actual use. In fact, similar fractures are due to inflection efforts, in which pressure is exerted along the whole length of the blade; and in such cases the fracture does not necessarily fall near the point of contact with the modified material. More or less visible fractures *en languette* may end in step-like, hinge-like or simple 'feathered' features.

Figure 11.6. Mohenjo-Daro, Moneer South East Area. Dorsal and ventral views of MD26 (left), MD27 (centre) and MD28 (right). Photographs by Federica Aghadian.

Flection fractures, more generally, are due to impact dynamics (as, for example, in thrown points), but can also be encountered in processes involving indirect percussion, as frequently happens with handled tools.

The observation of MD27 (Figure 11.5, upper right; Figure 11.6, centre) reveals a series of marks on the unretouched right edge, on the ventral face; small and shallow, these traces might also be ascribed to longitudinal friction. In this piece the fracture left by the breakage of the proximal part has a straight trend and therefore is not particularly informative.

MD28 (Figure 11.5, below; Figure 11.6, right), too, shows strong marks of the same type on the right unretouched side: they are superimposed one to another, end in step-like forms and are only visible on the dorsal face. Their occurrence on a selected side of the tool suggests a transversal action, probably scraping. At the same time, the step-like marks and their superimposition suggest the protracted modification of a medium-hard unidentified material. The described wear traces are mapped and interpreted in Figure 11.5.

However, while the use of scrapers of this type cannot be limited to the unmodified edges, in the three cases considered here we are still unable to distinguish with certainty and everywhere the mechanical damage caused by the use from the scars of the actual intentional retouch. The detail of Figures 11.7–11.10 clearly show organic residues above the step-like scars of the edge, and this suggests that the last negative interfaces on this part of the edge must have been produced by use on a softer organic material, rather than by retouch alone.

Tools of this kind were probably used on all their margins, the retouched end being probably the most important (but not the only) active part. This recalls comments made in another cultural and archaeological context by Ibanez and Gonzalez (1996: 26):

> In all the cases studied the retouched front of the end scrapers was moved transversally on the material worked... In general, the data observed coincide with those from other assemblages of end-scrapers of the Upper Palaeolithic and the first Epipalaeolithic in Europe, indicating the fundamental first use of these tools for scraping hide and their more marginal use on other materials, such as antler, bone or wood. [...] The end-scrapers were used not only on the retouched front, but also a high proportion of them have use-traces on the lateral edges and in the distal zone.[...] The different active zones of the end scrapers were used in a complementary way within the same task.

For similar remarks and discussion, see Keeley (1980, 1988), Moss (1983), Plisson (1985), Vaughan (1985), Symens (1986), Winiarska-Kabacinska (1988), Rodriguez (1993a, 1993b), Van Noten *et al*. 1978 and Philibert (1993, 1995).

Traces of organic residues: digital micro-photography and SEM study

The organic residues found on scraper MD26 (Figure 11.6, left), appeared like small orange-brown, slightly translucent particles still adhering to the front part, to part of the retouched edge and to a lesser extent to the rear (ventral face) of the tool. Besides digital photographs and micro-photographs, the micro-morphology of the organic residues was studied by the means of a special image processing system named Leica Application Suite (LAS) Montage 3D, previously used in a preliminary study of the steatite industry of Tepe Hissar (for a detailed description, see Priori and Vidale 2009). It is well known that the main problem of analogical micro-photography is a very limited field depth when observing very small details. The software Leica LAS multifocus, managing the movement on the Z axis of the stereo-microscope, allows the assembling on the same vertical axis of the focus plain, therefore on the same photograph, the points that the physical constraints of optical images would exclude. The results are virtual three-dimensional details or complete pictures entirely measurable along three Cartesian axes.

Figures 11.7–11.9 are multi-focused digital pictures of the functional end of MD26. Figure 11.8 shows the detail of the

Figure 11.7. MD26, detail of the distal end (multi-focused digital picture by Gianfranco Priori with LAS Montage 3D).

Figure 11.8. MD26, the retouched end with detail of the organic remains (multi-focused digital picture by Gianfranco Priori with LAS Montage 3D).

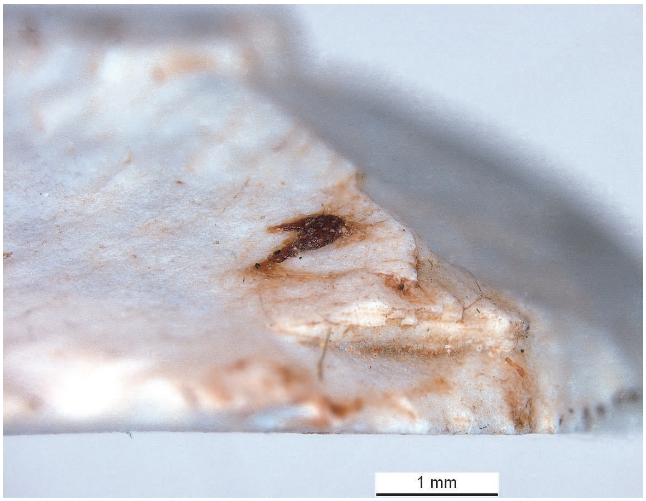

Figure 11.9. MD26, detail of the retouched extremity with the organic remains (multi-focused digital picture by Gianfranco Priori with LAS Montage 3D).

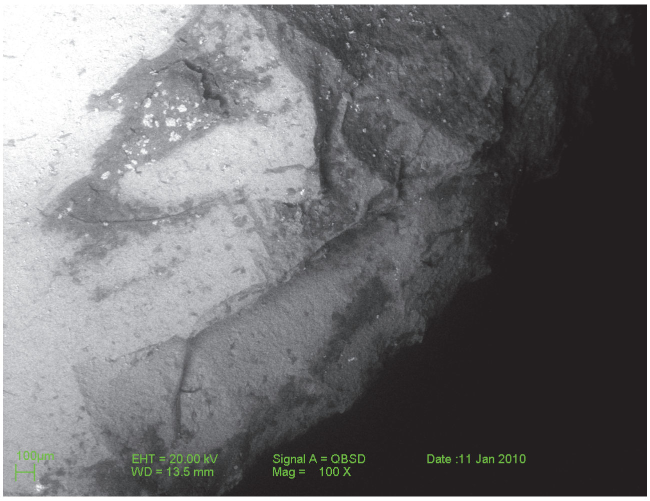

Figure 11.10. MD26, SEM image with detail of the organic remains (in dark) on the retouched end surface (SEM image by Giuseppe Guida).

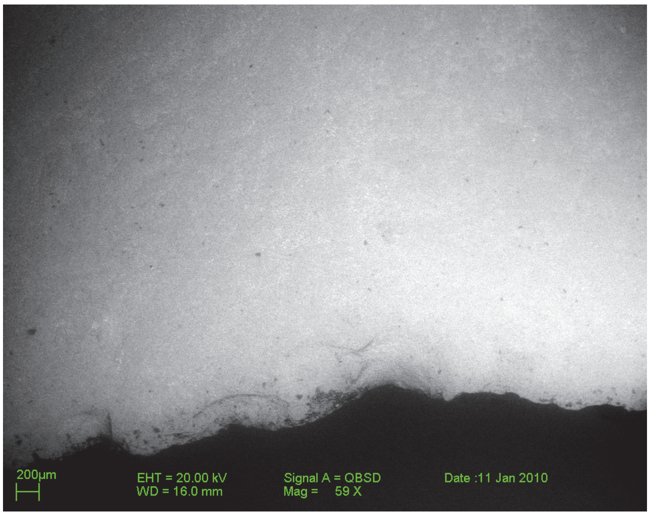

Figure 11.11. MD26, detail of the damaged edge of the tool and of the organic stains analyzed (ventral view, SEM image by Giuseppe Guida).

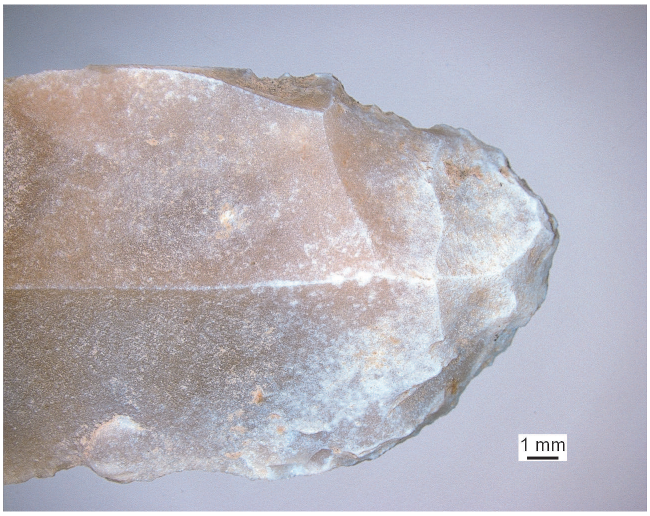

Figure 11.12. MD27, detail of the distal end with faint traces organic residues (multi-focused digital picture by Gianfranco Priori with LAS Montage 3D).

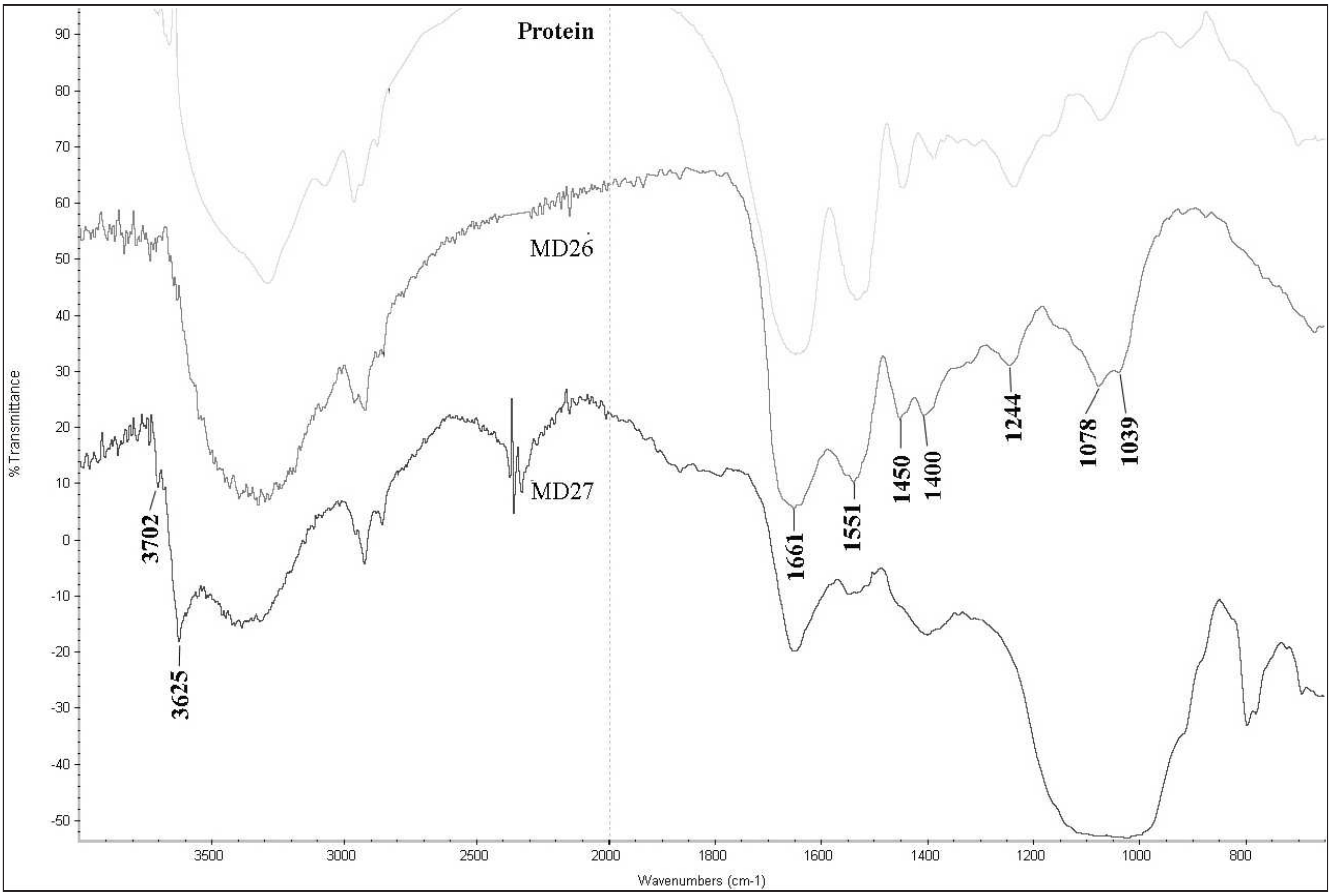

Figure 11.13. Micro-FTIR spectra of the organic residues found on MD26 and MD27, compared with a protein spectrum (in pale grey, above).

main particle of the brown-orange substance near the retouched end, while Figure 11.9 shows how the same substance entirely covers the superimposed, stepped retouch scars. SEM pictures in Figures 11.10–11.11 show the same areas and details of the substance's appearance on the functional part of the tool. It looks amorphous and homogeneous; there was no evidence of fibres or other preserved tissues of animal or vegetal origin. Note how the material is directly smeared on wide portions of the retouched edge of the tool. Besides the use/retouch scars, here are no visible striations or recognizable negative interfaces affecting the retouched edge.

The application of the organic substance, or the contact of the tool's edge with it, was probably the last technical event of the involved part of the technical sequence. SEM-microprobe analysis and elemental mappings did not reveal any anomalous component. The orange-brown, translucent particles turned out, as expected, to be rich in oxygen and carbon, with evidence of soil contamination (traces of calcium, potassium, sodium) but very low in iron. The white particles you see on the surface of the material in the SEM images are to a large extent composed of salt (NaCl).

In scraper MD27 we observed other areas and particles of a similar description, but much less preserved (faint traces in Figure 11.12). MD28, in contrast – the best preserved scraper – did not show any residue of the same kind.

Preliminary analytical observations on the organic residues

Figure 11.13 shows the micro-FTIR spectra of the organic matter detached from lithic tools MD26 (the larger particle in Figures 11.7–11.9) and MD27 (the brownish patch in Figure 11.12) together with a reference protein spectrum. In the spectrum of MD26 are clearly recognizable the C=O stretching band at 1661cm^{-1} (amide I), the C-N-H in-plane bending band at 1551cm^{-1} (amide II), the C-H bending band at 1450cm^{-1} and the amide III band at 1244cm^{-1}, all characteristic of protein. In the MD27 spectrum we can see clearly only the amide I and II bands, with other bands indicating the association with clay.

IR analysis cannot differentiate between various proteinaceous media, such as blood, collagen (gelatine or leather), casein or albumin, especially if very degraded. Therefore, at present, we can only say that the end-scrapers (and more positively MD26) were used in contact with an unidentified organic material of animal origin. Since the elemental maps we made at SEM do not show, in correspondence with the organic residues, particular concentrations of iron, blood is not a likely identification.

Visually, the organic residues on MD26 resemble some kind of paste or glue rather than skin or leather particles, and fats are not represented in the spectra we obtained. The end-scrapers from the MNSE, in this light, could have been used for spreading some kind of glue or organic coating onto another material. However, in spite of the absence of tissue fragments with a recognizable morphology, the use of these retouched flint tools for cutting meat and bones, disarticulating finger bones and/or skinning, more traditionally envisaged for the functional type, cannot be ruled out, because collagen is the most important component of skin, leather and different types of ligaments.

Conclusions

In the past, the study of the lithic industry of the Indus basin was mainly centred on typology (Hofmann and Cleland 1977; Kenoyer 1984), special function studies, mostly devoted to ancient bead making (Mackay 1937, 1943; other examples in Vidale 1987a, 2000; Kenoyer and Vidale 1992; Kenoyer 1997) or wider scope palaeo-technological studies (Inizan and Lechevallier 1985, 1990, 1996; Marcon and Lechevallier 2000). In the last years, there was a growing emphasis on the reconstruction of the extended networks of extraction and distribution activities that provided the largest centres of the Indus plains with lithic raw materials and finished or semi-finished chert tools (see the cited papers of Biagi's teams on the Rohri hills, and Law 2005, 2006). A ground-breaking discovery was the identification on the striking platforms of blade debitage, in the 5th millennium cal BC site of Sheri Khan Tarakai, of micro-residues of copper, demonstrating the use of a copper punch in an indirect pressure or percussion process (Inizan *et al*. 1994).

On the same lines, S. Méry (1994) commented on the use of long flint blades for turning the lower body of unfired clay vessels in an Indus potter's workshop at Nausharo (Mehrgarh, Pakistan). These blades, found on the floor of the workshop together with abundant scraps of unbaked clay cut from the lower bases of vessels, had a distinctive highly worn, blunt edge. In both cases the key is the technical intersection between chert/flint technologies and production cycles based upon different raw materials; there is little doubt that with the development of research such forms of techno-economical intersection will turn out to be the most important aspect of the urban socio-technical environment of the earliest South Asian cities.

Going back to Mohenjo-Daro, perhaps the greatest 'sleeping giant' of world archaeology, the evidence shows that here, too, technical intersection is the most intriguing research perspective for the next future. Although micro-residues on the Mohenjo-Daro lithics should be looked for in larger samples, and systematically investigated with more complex and sensitive analytical techniques (primarily, GC-MS), the initial tests are quite encouraging. Mohenjo-Daro does retain this kind of material record.

One of us (MV) also remembers very well that many drill-heads found in the MNSE area of the city had quite visible traces, in the hafting section, of the glue or resin originally applied to fix the point to its wooden handle. In contrast, no trace of this type, so far, was reported in the abundant collection of drill-heads from the lapis lazuli workshops of Shahr-i Sokhta (MV, ongoing research) or in another collection of drill-heads from Konar Sandal South (Jiroft, Kerman, Iran) recently described (Rafifar *et al*. 2008). In the late 1980s, samples of this substance (or substances) were preliminarily analyzed at the CAL, Smithsonian Institution (USA), by Rosemary Gianno and MV using FTIR. The micro-FTIR spectra then preliminarily identified this material as a vegetal resin-like compound, but no further research followed. The practice of fixing even the smallest lithic to paper tags with plastic tape, however, may have contaminated beyond remedy part of the systematic collection.

While Paolo's research on the Rohri extraction areas focused on core aspects of flint or chert knapping technology, such as the preliminary reduction sequences and local blade production, the picture at the craft workshops at Mohenjo-Daro will probably involve different contexts of research and approaches. We cannot reasonably expect to use at Mohenjo-Daro the simple functional categories commonly applied in the hunter-gatherer sites of the Upper Palaeolithic, Epipalaeolithic or Mesolithic periods. Skilled craftpersons used stone microliths not only for processing meat and for fabricating stone and shell ornaments, but also for producing complex composite artefacts like furniture, inlaid objects, chariots or musical instruments. What we may learn from the 'deceptive' three scrapers found 20 years ago in the Moneer Area and resurrected from a dusty drawer points in the same direction, and might prefigure unexpected discoveries (other examples were discussed, for steatite, in Vidale 1987c, 1987d, 2000).

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