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Abstract

Use-wear analysis of lithic artefacts is based on macro and microscopic observation of traces (such as scaling, rounding, striation and polish) that appear on objects when they are manufactured and used. Results are interpreted in terms of cinematics and worked materials through analogic reasoning in reference to experimental and ethnoarchaeological corpus. Since the 80's, following the pioneering work of S.A. Semenov, use-wear analysis was applied to Anatolian lithic assemblages. This paper presents an overview of the different approaches conducted. Goals are mainly to underline the link between stone production and human behaviors and to reconstruct of technological developments through time. The research aims to go beyond typology for instance re-interpreting 'cultural markers'. The chipped stone tools are, as well, contextualized, inserted into ancient activities related to subsistence or crafts. We approach human behaviors at ancient communities and data on the use of spaces within settlements are obtained. In Anatolia, studies were conducted mostly on early Neolithic contexts at a time in which agriculture and herding were incipient. In this context, documenting technical practices related to subsistence is essential. Furthermore, a multitude of activities showing different levels of specialization in craftsmanship were noted. These results illustrate the daily life and the regional cultural identities of Neolithic communities in Anatolia.

Introduction

Lithic tools fulfilled numerous needs in ancient societies as they were employed for different activities related to subsistence or crafts. The aim of technology is to define the modes of manufacture and use of these instruments. Since the 50's, the variability of the productions is studied with the help of an integrated approach including the raw material procurement, the manufacture of the tools and their utilization. Following the publication in english of the work of S.A. Semenov (1964, Longo, Skakun 2005), 'Prehistoric Technology', use-wear analysis developed worldwide. This methodology is based on the observation of wear traces (scaling, striation, smoothing and polish) seen at different scales from the naked-eye to high magnifications and their interpretation in terms of cinematics and worked materials. These technological marks are studied by analogical reasoning as they are compared to experimental and ethnographic corpus and taking into account the specific archaeological contexts. Since the beginning of this academic discipline, wear of ancient tools were not the final objective of the research. Among others, are the link between stone production and human behaviors and the reconstruction of technological developments. Artefacts are the results of technological, economical and social choices within the frame of cultural traditions. In this context, to reveal regional, chronological and/or cultural particularities, the main question is how the ancient groups choose to manufacture their toolkit and for which specific needs.

Since S.A. Semenov, this field of research has been particularly active. Generations of scholars pertaining to different academic traditions worked on the function of tools. They share common practices paying attention to post-depositional damages and macro and microscopic wear. Their aim is also to validate the modes of interpretation on the basis of either experimental and ethnoarchaeological references or using physical methods of wear characterization (with the use of SEM, confocal microscopy, rugosimetry, *etc.*, Anderson *et al.* 2006, Astruc *et al.* 2003, Ibáñez *et al.* 2016). Among others are the studies of Keeley (1980), Anderson-Gerfaud (1981), Plisson (1985), Caspar (1988), Van Gijn (1990, 2010), González Urquijo and Ibáñez Estévez (1994), Gassin (1996), Astruc 2002, Beyries and Rots (2008) based on strong methodological approaches to discuss major archaeological questions in Prehistory. In the recent years, colloquia brought different updates presenting a 'status quo of the discipline' (Longo, Skakun 2008, Marreiros *et al.* 2012, 2014). Meanwhile, a special issue in the Journal of Archaeological Science (Evans *et al.* 2014) considers the future directions in lithic microwear analysis seeking for methodological refinements to increase the reliability of results.

In this paper, we propose a short overview of lithic use-wear studies conducted in Anatolian prehistoric archaeology. Based on the literature, we present different kinds of approaches. Then, we put the emphasis on recent results in obsidian studies obtained for a period of time which is central in the development of the first agricultural societies, the early aceramic Neolithic. We finally choose to examine recent methodological improvements in the fields of subsistence activities and agricultural practices and in the field of stone-working showing different levels of technical specialization in ancient crafts.

From Kumartepe to Arslantepe

Beyond typology, the study of the drill bits of the Neolithic site of Kumartepe (Şalınurfa district, 7030-6680 BC, Calley and Grace 1988, Grace 1989-1990) stands as a precursor (see as well Ataman 1988a/b, *infra*). These tools were found in a bead workshop and the authors examined the relation between the morphology of the tool and its function and defined whether or not some form of mechanical drilling was involved in the manufacture of the cornelian beads. To reach this goal an experimental program was designed including perforation with mechanical drilling and perforation with a punch technique (Chevallier, Inizan, Tixier 1982). Experiments demonstrated that the microborers were used with the help of a mechanical device and that the punch technique was employed as a complement to drilling. Wear traces on the tools themselves, traces of manufacture on the beads and residue analysis were combined to reach this interpretation. This study testifies of the need to consider artefacts as processes as they are involved in complex technical practices seen, in this case, in the functioning of a specialized workshop.

Use-wear research in Anatolia owes a lot to the University of La Sapienza of Roma¹ with the work conducted at the Pre Pottery Neolithic site of Çayönü (Dyrbakır district, middle of the 9th to beginning of the 7th millennium BC) in collaboration with the Department of Prehistory of the Istanbul University and at the Chalcolithic and Bronze Age site of Arslantepe (5th to 3rd millennium BC, Malatya district). The excavations at Çayönü reveal the more detailed chronological sequence for the Pre Pottery Neolithic in the region. Several lithic use-wear approaches were conducted at the site to define what is the concept of tools in the community and to reach certain clues on the use of space within the village (Caneva *et al.* 1994). If we refer to the relation between the morphology of the tool and its function, three typological groups were investigated, the borers (Altınbilek *et al.* 2001), the scrapers (Altınbilek Algül 2016) and the arrowheads (Coşkunsu, Lemorini 2001). Different levels of inference were reached. The borers are made exclusively of flint as obsidian is considered in Çayönü as a too fragile raw material for this activity and experimental and ethnographic comparisons indicate that they were used to drill different rocks. In the case of endscrapers, the main result is to consider that the relation between typology and use is not necessarily strict as endscraper fronts might be used but also the lateral edges. We will emphasis here the work done on arrowheads. The results are particularly significant as they demonstrate that some of the arrowheads were used as projectile points but not all. Different others kinds of uses were observed (mainly cutting, but also whittling, sawing, scraping, engraving, piercing). These tools can then be considered as well as potentially multifunctional. Furthermore, the study underlines the fact that arrowheads are in some cases the result of curation (rejuvenation and recycling), the transformation by the retouch to shape the arrowhead being the latest. Beyond typology, use-wear analysis leads us to consider these ‘fossiles directeurs’ in another way (Astruc 2004). The functional approach was employed as well in a more global perspective on the basis of the selection of numerically important samples collected in two sub-phases, mainly the Channeled Building sub-phase (8600-8200 cal. BC) and the Cell building sub-phase (7500-7250 cal. BC) (Iovino, Lemorini 1999, Caneva *et al.* 2001). In both cases, lithic tools are used for a multiplicity of activities, ie. actions on worked materials. A complementarity between the flint and obsidian assemblages was noticed (Iovino, Lemorini 1999). The authors reported in a more detailed way on the Channeled building sub-phase. Flint was used in numerous activities (manufacture of objects) and in cereal harvesting, reeds and plant cutting or butchery whereas for obsidian no primary subsistence activities were identified. Some spatial differences were evidenced namely between buildings and open areas with, in the latter, workshops devoted to knapping or stone working. To conclude, the authors identified diachronic differences going together with a drastic change in the proportions of raw materials (as obsidian represents 20% of them in the earlier sub-phase and 40% in the later sub-phase), notably with an importance of cereal harvesting decreasing through time.

In the case of Arslantepe, the site has been excavated extensively and well-preserved archaeological levels have been exposed. The quality of the excavation and the detailed data gathering allow a multidisciplinary approach in which use-wear analysis is playing a significant role (Lemorini *et al.* in press). For instance, this analogical method based on experimental and ethnographical data sets was used to define in which way wood and plant working was done (Lemorini 2004). Moreover, the results of the use-wear analysis (samples are coming from levels VIA and VIB, dated of 3300-2009 BC) were employed to define the use of spaces during the Late Chalcolithic and the Early Bronze Age (Alvaro *et al.* 2008, Lemorini 2010, Piccione, Lemorini 2012). The methodology is based on the spatial integration of all the available data concerning notably the architecture -building, domestic features, specialized area (ex. metallurgy)-, the function of ceramics, chipped stone industry and macro-tools,

¹ See also the preliminary study of Yumuktepe (Iovino 2004).

and the botanical and zoological remains. Depending on the context, chipped stone implements were related to the daily life of the households, specialized activities such as butchery, hide/leather working, ceramic production, or, agricultural practices (harvesting or threshing). Each of the categories of materials brings its own results and they do not have the same significance if temples, storage rooms, garbage area, residential buildings are studied or, in other words, domestic, public or ritual spaces. This overview testifies of different approaches to obtain a wide range of results on Anatolian pre-urban societies. We will now focus on a specific field of research, use-wear on obsidian tools.

Obsidian studies

Obsidian sources are numerous in Anatolia with central and eastern Anatolian volcanic complexes (Balkan *et al.* 2011, Binder *et al.* 2011, Robin *et al.* 2016). Outcrops have been intensively exploited in Prehistory to produce lithic tools and stone objects such as prestige items. This raw material was used locally or diffused on broad distances, all over Near-East, through exchange networks, especially during the Neolithic (Cauvin *et al.* 1998, Delarue 2007, Balkan *et al.* 1999, Binder 2002). Therefore, obsidian is one of the specificities of Anatolian archaeology revealing important technical practices and human behaviors within peculiar socio-economic and cultural contexts.

These natural glasses have physical properties that are distinct from others rocks, notably from flint (Clemente Conte *et al.* 2014). Successive studies have demonstrated that wear on obsidian is in some ways different than on flint and deserves peculiar attention (Semenov 1972, Arazova 1986, Hurcombe 1992, Koronenko 2011). Thus, to enhance the methodological basis of the research, scholars working on Anatolian archaeology conducted new experiments using obsidian tools (Anderson 1994, Anderson and Formenti 1994, Coskunsu, Lemorini 2001, Altınbilek *et al.* 2001, Altınbilek Algül 2007). More recently, experiments have been conducted in different locations thanks to a collaboration between the CNRS/Institut Français d'Etudes Anatoliennes and the Department of Prehistory of the University of Istanbul (it includes cereal harvesting, vegetal, bone, antler, hide and stone working, Astruc *et al.* 2012) and by the University of La Sapienza on vegetal working in collaboration with the Center for Research and Experimentation on Agriculture and the Research center for cereal selection (Lemorini and D'Errico 2014, 2017).

The work of K. Ataman (1988b, unpublished PhD) at Can Hassan III (Karaman district., 7600-6650 BC) stands, in Central Anatolia, as a precursor and a large amount of technical processes were documented at the site. As new excavations are conducted in Cappadocia and in the Konya plain, new or more detailed methodologies are employed and among them is use-wear analysis. Several scholars are currently working on the chipped stone industries dated from the Epipalaeolithic to the Charcolithic at Pınarbaşı, Boncuklu, Aşıklı Höyük and Musular (Epipalaeolithic and Aceramic Neolithic, 11.000-7200 BC, Astruc *et al.* 2008, Astruc 2018, Astruc forthcoming), and at Tepecik-Çiftlik (Final Neolithic and Chalcolithic, 6300-6000 BC, Vinet, Guilbeau 2018, Vinet, Guilbeau forthcoming) and Çatalhöyük-est (Neolithic, 7400-5900 BC, Lemorini and D'Errico 2013, 2014, 2015, 2017, forthcoming), and Çatalhöyük-west (Ancient Chalcolithic, 5900-5600 BC, Vinet 2017, Vinet forthcoming).

Aşıklı Höyük is the earliest Neolithic village of Cappadocia and obsidian represents more than 99% of the assemblage. A recent study focusses on the obsidian use during the Level 4 occupations at Aşıklı Höyük (8400-8100 BC, Astruc 2018). The technological characteristics of the assemblage -orientated toward the production of bladelets- is defined and data on the utilization of tools are provided. The use-wear sample includes unretouched bladelets, microliths, truncations, backs, burins, microburins and splinters. A wide range of technical activities were identified such as rare hunting, cereal harvesting, work of plants, of animal tissues, butchery, scarce work of bone and rocks, and different motions on soft to hard materials. For the first time, the utilization of microliths has been studied and they were mainly used to cut soft animal tissues. Microlithism is one of the characteristics of Central Anatolian lithic assemblages at those periods and the role of microliths in technical systems will be further analyzed with the study of Pınarbaşı and Boncuklu in the Konya plain.

The inhabitants of the sites under study in Central Anatolia used there lithic tools in a wide range of technical activities related to daily sedentary life. To gather data on the way lithics were managed, obsidian clusters were recently characterized both with the help of the technological and functional approaches. In this way, cores, knapped products -central *débitage* or by-products-, typological and non-formal tools, and, used blanks were discriminated leading to an interpretation of the cluster in terms of sequence(s) of knapping, shaping and/or use of tools (Kayacan, Algül 2018). Furthermore, to reach data on the organization of households for instance in Aşıklı or Çatal, spatial differentiations are analyzed leading to the identification of diverse areas such as knapping workshops, multifunctional open areas and buildings (Altınbilek Algül 2014, Kayacan and Algül 2018, Lemorini and D'Errico 2013, 2014, 2015, 2017, forthcoming, Lemorini *et al.* in press). But, lithic tools are not necessarily related to daily sedentary life. On the contrary, one settlement can be defined, on the basis of

archaeological data and use-wear analysis, as a non-domestic, specialized site. Musular is a satellite of Aşıklı (aceramic Neolithic levels, 7570-7290 BC, Duru, Özbaşaran 2005, Astruc *et al.* 2008). Use-wear analysis showed that tools involved in hunting, butchery and hide working were particularly present in the layers of occupation. These results reinforce the interpretation of the site as an area dedicated to slaughtering.

Finally, a first approach of the Late Neolithic-Chalcolithic assemblages of Tepecik-Çiftlik is conducted. Obsidian is the common raw material at this site located at a few kilometers from the Göllüdağ and flint is exceptional. The study shows that flint and obsidian blades were used to harvest cereals and that all kinds of obsidian blanks -flakes and blades but also by-products of the *chaînes opératoires*- were used for multifunctional purposes with diverse operations such as plant and woodworking and treatments of hide or clay and rocks (Vinet, and Guilbeau 2018).

Improvements in methodology

We want now to illustrate how traditional use-wear analysis can be applied together with new technics of investigation or means of validation of the use-wear method. The first application is related to subsistence activities with cereal harvesting and the second one to handicraft with stone working. The discussion will focus on early Neolithic contexts making reference to sites as Aşıklı Höyük and Çayönü.

Unlike flint, obsidian tools when they are used to harvest cereals do not show a macroscopic gloss. Therefore, obsidian artefacts can be identified as sickle elements only through microscopic investigation. In the context of this early agricultural community, it was essential to identify sickle elements. Wear on the Aşıklı lithic tools were compared to a traditional experimental corpus including replica of different kinds of sickles and the archaeological traces of use correspond to the experimental ones. Sickles are composite instruments in which lithic elements are inserted in parallel to the haft. Several methodological researches were also applied at the time of the study. Experiments in laboratory using methods developed for industrial applications were conducted to build up a framework for understanding wear processes and to measure tribological interaction between the surface of the tool and that of the worked material (e.g. Anderson *et al.* 1998, Anderson *et al.* 2006; Astruc *et al.* 2003; Vargiolu *et al.* 2007). This research demonstrated the reliability of use-wear analysis to interpret tools as sickle elements (replication with tribological instruments of the development of polishes and striations, Astruc 2012, Vargiolu *et al.* forthcoming). Another type of experiment was used to evaluate the efficiency of ancient sickles (Astruc *et al.* 2012). It showed that parallel hafting was not the more efficient mode –oblique hafting is better- and it underlined the fact that a choice in favor of a parallel hafting with a slightly curved haft is due to cultural practices or preferences. To conclude, at Aşıklı Höyük, sickle elements were identified from the beginning of the archaeological sequence from level 4 to level 2 (8400 to 7500 cal. BC, Anderson 1996, Altınbilek Algül 2014, Astruc 2018, Kayacan and Altınbilek 2018), at the very beginning of agriculture in Cappadocia.

With stone-working, a completely different domain of study is reached, the levels of specialization in craftsmanship. ‘Traces of use on the tools, referred to as “Çayönü tools” after the site where they were first described, appear to the eye as marked linear abrasion traces on the bulbar or dorsal face, and the tool edges often have abrupt and/or dentate retouch carried out using the pressure technique’ (Anderson and Formenti 1994, 553). These artefacts were later recognized in Cafer Höyük (Cauvin *et al.* 1991, Malatya district, 8300-7450 BC) and in Magzaliya (Sinjar, Iraq, end of 8th-beginning of 7th millennium BC, Bader 1989). Experiments and elemental analysis of residues were conducted to interpret such wear. As a matter of fact, these tools were used to abrade, finish and decorate prestige items like marble bracelets or limestone bowls (Anderson 1994, Anderson and Formenti 1994). Blanks selected to perform this activity were mainly blades (including blades obtained by pressure flaking with a lever) but flakes were sometimes selected (Altınbilek *et al.* 2012). So, around 8600 cal. BC as they appear first in the Channeled building sub-phase, “Çayönü tools” are part of a specialized on site artisanal activity linked to the manufacture of prestige items while in parallel domestic stone working took place in the village. These tools show the high level of skills of the craftsmen at Çayönü and by extension at Cafer and Magzaliya.

Very ancient specialized stone working activities took place in the context of early Neolithic communities. In this matter, the polished obsidian bracelet of Aşıklı Höyük is worth mentioning (Astruc *et al.* 2011). The bracelet is a prestige item dated back to the 8th millennium BC. It has a complex morphology and testifies of remarkable craft skills. The morphological analysis of the object has been conducted by tribologists and was based on profile measurements and identification of wear variations indicated by surface topographic features and parameters. The artisan chose high quality

obsidian. He used different movements and abrasive materials for making the bracelet and created a complex form. The control of symmetry during the shaping indicates the use of mechanical devices for grinding and polishing and the near absence of manufacturing errors and the ability to deal with defects indicate that the craftsman was experienced and that the object was probably not isolated. The obsidian bracelet fragment was recovered from Building T of the “Public Area”, a communal space in the southern part of the site and the communal character of the structure let us hypothesize that this personal ornament was used to represent the user’s special status or role. To go further, research on polishing technics are still in process with the study of Domuztepe mirrors and pendants (Kahramanmaraş district, Halaf, Astruc 2012).

Conclusion

Researchers involved in use-wear analysis in Anatolia already conducted a multiplicity of approaches. Their aim is to go beyond typology and to document the use of artefacts before their abandonment at the sites. The final goal is to better understand human behaviors in a given socio-economic and cultural context. The specific toolkit of a community shows how the inhabitants of a settlement are involved in technical processes. In Anatolia, most of the studies were conducted on Neolithic assemblages. Subsistence strategies play an important role in the Neolithization and tools engaged in cereal harvesting and hunting can be identified. Sickle elements and arrowheads are often considered as ‘fossiles directeurs’, a concept based mainly on typology. With the help of use-wear analysis, these artefacts are reinterpreted in terms of activities and curation. They play a role in the village activities and are in some cases prestige items. Through a combination of functional and spatial analyses, domestic or specialized activities can be discriminated and the use of spaces in pre-urban settlements identified. In sum, data on the agricultural and cynegetic practices, the level of skills of artisans, the daily life of communities are collected.

From the Epipalaeolithic to the Charcolithic, the communities experienced drastic changes in their subsistence strategies and way of life from foragers to farmers and from hunters to herders. In parallel, changes in lithic assemblages are documented and the role of functional analysis is to appreciate how the ways of doing evolved within different socio-economic contexts. Recent researches in the Central Anatolia focusses on recognizing specific local identities and chronological evolution in the region. Lithic studies will show if there is an outstanding dichotomy between the archaeological data in the Konya plain and Cappadocia and will bring new light on the cultural development of Central Anatolia.