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Technical microwear and residues in identifying bipolar knapping on an anvil: experimental data

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ABSTRACT

The functional study of the stone tool artefacts from the Middle Pleistocene site of Isernia la Pineta (Molise, central Italy) revealed microtraces that display certain features that did not fit in with what we know as use-wear traces. The suspicion that these microtraces may be technical traces derived from bipolar flaking, which is prevalent at this site, led us to initiate an experimental programme to check our hypothesis. The experiments conducted allowed us to identify residues associated with bipolar flaking on an anvil and to characterise the microscopic traces derived from this production technique. Our results proved very useful in identifying the artefacts produced by bipolar flaking, as well as in determining the basic lithological features of the anvil. Moreover, these experiments allowed us to assess the possible interferences that these kinds of technical traces can cause when performing the functional analyses of lithic assemblages produced by the bipolar technique.

1. Introduction

Bipolar knapping on an anvil is a widespread practice, both chronologically and geographically. It was one of the first tool production techniques used by hominins, recorded for example at Omo (Semaw, 2000; de la Torre, 2004), Fejej (de Lumley et al., 2004), Dmanisi (Cauche, 2009; de Lumley et al., 2005) and Zhoukoudian (Breuil and Lantier, 1951; Gao, 2000). The technique is documented throughout the Pleistocene and continued up until the historical epoch in several parts of the world. It is a common part of the archaeological and the ethnographic records from Africa (Barham, 1987; MacCalman and Grobelaar, 1965; Masao, 1982; Robinson, 1938; Wadley, 1993), Asia (Feng, 2008; Kuijt and Rusell, 1993; Lee and Kong, 2006; Xie and Bodin, 2007), Europe (Martínez et al., 2010; Méndez, 2007; Mourre, 1996a,b, 2004), Australia and New Guinea (Gould et al., 1971; Hayden, 1979; Sillitoe, 1982; Strathern, 1969; Watson, 1995; White, 1968; White et al., 1977), North America (Brose, 1970; Flenniken, 1981; Goodyear, 1993; Lothrop and Gramly, 1982; MacDonald, 1968; McPherron, 1967; Parry and Kelly, 1987; Shott, 1989; White, 1968; Jeske, 1992; Morice, 1893; Teit, 1900) and South America (Curtoni, 1996; Miller, 1979; Roth, 1924).

The technique is usually related to the exploitation of small cobbles and pebbles that are difficult to knap (Andrefsky, 1994, 1998; Binford and Quimby, 1963; Breuil, 1954; Crabtree, 1982; Flenniken, 1981; Parry and Kelly, 1987; Patterson, 1979; Prous and Alonso, 1990; White and Thomas, 1972). The bipolar technique is also used to flake bigger cores of heterogeneous raw materials, which often shatter into small fragments when they are struck by the percussor. Likewise, the method is used to flake highly tenacious rocks of less than 10 cm.

In fact, bipolar knapping is basically used as an exploitation technique when it is difficult to keep a firm hold on the blank at the time of percussion, either because of gripping difficulties, the blank's lack of mass or the excessive tenacity of the rock. In these cases, much of the power of the impact dissipates through the backward movement of the arm and the hand, and also through the absorption of the energy by the elastic deformation of the tissues of the hand. This effect prevents or hinders the core from fracturing. The best solution to this problem is to place the nodule on an anvil to provide a hard, fixed and rigid support.

A different case is the use of the anvil as a retouch tool, often with high quality raw materials. In this case, the use of the anvil offers greater precision in retouching by the counterstrike technique or through direct percussion on a well supported blank.

Bipolar knapping was initially described as an exploitation technique by Breuil and Lantier (1951), together with the *taille par contre-coup* (counterstrike knapping) (de Mortillet, 1883) and the *taille appuyée* – equivalent to Bordes's *percussion écrasée* or *percussion sur*

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enclume (Bordes, 1947) – as one of the variants in the group of knapping techniques involving three elements (*taille à trois éléments*) including an anvil. In cases involving a counterstrike, Mourre (1996a,b, 2004) distinguishes between the *taille sur enclume axiale* (axial knapping on an anvil), where the strike and the counterstrike are situated on the same axis, and the non-axial version, where the two impacts are not on the same axis.

To avoid confusion, it is worth recalling that the French term *taille sur enclume* has recently been used to refer to the entire set of techniques involving an anvil (Mourre op. cit.), whereas Bordes (op. cit.) and Breuil and Lantier (op. cit.) originally used it only to refer to the knapping technique involving a static hammer. In fact, this is the prevalent sense in the English literature, where the term "anvil technique" is used to refer to cases in which the core is the active member that strikes a stationary block of stone, and the term "bipolar technique" is used to refer to what in this paper we call bipolar knapping on an anvil (Crabtree, 1982; Odell, 2000, 2004; Schick and Toth, 1993; Whittaker, 1994). In any case, in this study we do not take into account cases where the anvil works simply as a static hammer with the core playing the active role.

Different authors have studied bipolar knapping on an anvil using ethnographic models and experimental programmes (Barham, 1987; Callahan, 1996; Cancellieri et al., 2001; Crabtree, 1982; Crovetto et al., 1994; Hardaker, 1979; Kuijt et al., 1995; Mourre, 1996a,b, 2004; Prous and Alonso, 1990; Peretto, 1994; Shott, 1989). The aim of these studies has been to characterise the products of bipolar knapping at a morphotechnical level, in order to obtain valid criteria with which to identify them in the archaeological record.

Despite the intense research carried out with regard to this knapping technique, nobody has studied either the microscopic deformations that it causes on the surfaces of its products, or the residues that the percussor and the anvil can leave attached to those products. Even in discussions of whether *pièces esquillées* (chipped stone tools or splintered pieces) were wedges or cores from bipolar knapping on an anvil, authors mostly use ethnographical parallels and macroscopic observations rather than traceological or residue analyses (Le Brun-Ricalens, 2006; Hayden, 1980; Shott, 1989, 1999).

During the functional study of the lithic assemblage from the Early Middle Pleistocene site of Isernia la Pineta (Molise region, central Italy), where bipolar knapping on an anvil had been well documented (Crovetto et al., 1994; Peretto, 1994), we recorded some unusual micro-deformations on the supposed contact faces of the pieces with the anvil. These traces were quite similar to use-wear traces, but their distribution as well as other certain features were atypical. The suspicion that these microtraces may have a technical origin led us to initiate an experimental programme aimed at identifying the traces left by bipolar knapping on an anvil, and to characterise the residues derived from it that could have remained attached to the artefacts produced using that technique.

2. Materials and methods

In order to reproduce the knapping methods recognised at Isernia la Pineta (Crovetto et al., 1994; Peretto, 1994) we used local limestone anvils and percussors. The flint we flaked comes from the *Diaspri varicolori formation*, in the *Facies Molisana*, attributed to the Cretaceous (Albian–Cenomanian) (Sozzi et al., 1994), and the blocks used were collected on the current terraces of the Carpino river near Isernia. The flint blocks are tabular in shape and have abundant internal fissures which often guide the fracturing in unpredictable ways, leading to small, cubic products (smaller than 10 cm).

The knapping process was reproduced taking into account the results of the experiments conducted by Milliken et al. (1998); Peretto (1994), and in keeping with our observations from the morphotechnical study of the archaeological assemblage.

Some of the products obtained during the knapping process (15 cores and 5 flakes) were chosen for a microscopic study of their surfaces. We focused our interest on the cores as, according to the experience with the archaeological materials, we assumed that they would record most of the diagnostic technical traces. The study was done using both a low magnification (with an Olympus SZ-11 stereomicroscope, from 6,5 to 110×) and high magnification approaches (usually working between 100 and 3,000×, with an SEM JEOL JSM-6400, equipped with EDX-EXL II system Link Analytical, Oxford).

For the first examination under the SEM we performed a soft cleaning consisting of an ultrasonic bath with acetone for 2 min. This allowed us to eliminate only the elements that can make observation difficult, such as greasy oily residues resulting from handling or particles not adhered to the surface of the flint resulting from knapping. We had previously used a pilot probe to verify that this cleaning process would preserve the deposits of adhered material (Vergès, 2003). We applied a coating to the artefacts before we examined them. We used gold or carbon (depending on whether the priority was producing micrographs or performing the microanalysis). Once documented, the adhered materials were eliminated in order to analyse in detail the deformations that had occurred on the surface of the flint. When a gold coating was used, the sample was cleaned with *acqua regia* (an acid mixture containing 3 parts HCL and 1 part HNO_3), which simultaneously removed the coating as well as the residues after less than 10 s of immersion. This procedure, as has been shown in experiments carried out on various types of siliceous rocks (Ollé and Vergès, 2008), does not cause any damage or microscopic alterations to flint surfaces. When the sample had been coated with carbon, a simple ultrasonic bath in the neutral phosphate-free detergent Derquim® for 15 min was enough to remove both the coating and the residues.

3. The mechanics of knapping

One of the main observations that can be deduced from our experiments is that, strictly speaking, bipolar knapping does not exist. That is, only rarely does one find evidence for simultaneous fracture and detachment at both ends of the core. This idea has also been implied through the experimental data of other authors, who point to the existence of a wide variability of behaviours during the process of bipolar knapping on an anvil. In this respect, it has already been stated that "contrary to popular belief, bulbs of force are not present on both ends of bipolar flakes or blades" (Crabtree, 1982:16). It was also clear that sometimes the strike of the percussor prevailed over the counterstrike and produced a bulb of percussion at the point where the percussor hit (Cancellieri et al., 2001), as occurs with the platform on anvil technique (Callahan, 1996), or to the contrary, that the removals coming from the anvil were predominant (Crovetto et al., 1994), as occurs in counterstrike knapping.

The compression of the core between two vertically opposed forces occurs only in very specific cases, principally when the cobbles or fragments to be flaked are very small and the morphologies of their resting and percussion areas are convex or pointed. Only in these cases are the contact points small and well delimited. When one or both contact points are larger platforms, the relationship between the percussor's impact point and the resting point can vary, leading to phenomena of both counterstrike and platform on anvil techniques. When a body (the core) is compressed by two forces that do not meet in the vertical, the fracture appears where there is less mass to be detached, and it is these fractures that are usually eccentrically located in relation to the gravity axis of the core (Fig. 1).