TECHNOLOGY AND FUNCTION OF MICRO-BORERS FROM KUMARTEPE (TURKEY)

Sylvie CALLEY and Roger GRACE***

ABSTRACT:

This paper is a preliminary report on a bead workshop which is dated to the sixth millennium. All the stages of bead manufacture are present on the site.

The technological study concerns the reconstruction of the complete production sequence of the flint micro-borers. This includes the core reduction sequence to produce suitable bladelets. The study of the by-products allows for the reconstruction of the manufacture of the micro-borers, which are the most numerous tools in the assemblage. The bead blanks are small discs made from cornelian flakes detached from small cores and prepared by abrupt retouch.

A microwear analysis, in conjunction with a preliminary experimental programme, was carried out to study the techniques used to perforate the beads. In particular to ascertain whether or not a mechanical drilling action was involved.

RÉSUMÉ:

Il s'agit là d'un rapport préliminaire concernant un atelier de fabrication de perles de cornaline datant du 6e millénaire. Toutes les étapes de fabrication de ces perles sont représentées dans le site.

L'analyse technologique concerne la reconstitution de la chaîne opératoire, aboutissant à la production de micro-perçoirs.

Cela inclut la chaîne opératoire nécessaire à la production de lamelles adaptées. L'étude du débitage permet la reconstitution de la fabrication des micro-perçoirs, qui sont les outils les plus nombreux de l'ensemble lithique.

Les supports des perles sont constitués de petits disques façonnés par retouches abruptes dans des petits éclats de cornaline détachés eux-mêmes de petits nucléus.

Une étude des traces d'utilisation en liaison avec un programme expérimental préliminaire a été engagée pour étudier les techniques de perforation des perles, en particulier pour vérifier si oui ou non un procédé mécanique était employé pour le façonnage.

Kumartepe is a Neolithic site discovered in 1982 by T.J. Wilkinson and G. Stein during a survey of the Samsat area in south-eastern Turkey. This survey was conducted in advance of flooding to be caused by the construction of the Atatürk Dam. It is located on the left bank of the Euphrates. It was excavated in 1983 by a joint team directed by J.J. Roodenberg (Roodenberg *et al.* 1984). The preliminary report gives a provisional date of the middle or the second half of the 6th millennium.

This paper is a preliminary presentation of a bead workshop which was discovered in Trench 'A' on the top of a pebble paved surface. A large concentration of flint tools, chips and cores was found. Within this concentration were several thousand micro-borers. The fact that the vast majority of the tools present were of a single type suggested

* *U.R.A. 17 du C.R.A.du C.N.R.S., Maison de l'Orient méditerranéen, 7 rue Raulin, 69007 Lyon, France.*

** *Institute of Archaeology, 31-34 Gordon Square, London WC1H, England.*

that this area was specifically used to manufacture this kind of tool. The systematic sieving of all the material permitted the recovery of a great number of by-products of manufacture and several broken beads. This prompted us to study the relationship between the micro-borers and the beads. It is notable that nowhere else on the site was such a concentration of bead blanks and micro-borers found.

A complete technological and functional study will be published in the monograph of Kumartepe. The following study is limited to a sample based on archaeological observation and preliminary experiments into the manufacture of micro-borers and their use for bead perforation.

A technological study demonstrated that all stages of the manufacturing process were carried out in this area of the site : blade core reduction, tool production and bead manufacture.

TECHNOLOGY

Core reduction techniques

The whole assemblage is made of flint except for the cornelian cores used to produce blanks for the manufacture of beads. There are various kinds of flint in the assemblage, but the one most often used to manufacture piercing tools is a light brown, slightly coarse grained flint. The dark brown, fine grained flint is never manufactured into micro-borers, sometimes but rarely into piercers. The raw material is available locally on the banks of the Euphrates.

Most of the cores are small and prismatic with one or two platforms. The longest blade in the assemblage has a maximum dimension of 80 mm. The trimming and re-shaping elements (fig. 2, no. 2 and 3) are very rare. It shows that there was no special preparation before the blades were detached. Cores often have an irregular shape and most of them have cortex remaining on the surface (fig. 1, no. 21 and fig. 2, no. 4), but the blade production is intensive. A rough estimation of blade production suggests that up to 24 blades may have been produced from each core. Many of the blades (44%) are double ridged. This means that blade removal was quite systematic. The desired blade shape was rather narrow (between 7 and 18 mm) and thick (between 2 and 4 mm). This desired blade shape raises several questions concerning the process of their production. For example, some of the cores which are made on flakes have features which resemble burins (fig. 1, no. 21). The bladelets detached from these cores have a burin spall-like appearance ; the cross section is rather thick in relation to the width and the distal end is hinged. These hinge fractures do not appear solely on this type of core however, many of the other cores also have hinging scars on the flaking surface (fig. 1, no. 20, 21, 22 and fig. 2, no. 1 and 4). The most typical cores of the lithic assemblage from the workshop are bi-polar cores with two flaking surfaces (fig. 1, no. 20, 22 and fig. 2, no. 1, 4). In plan these flaking surfaces do not have the same orientation. This bi-polar flaking technique seems to be the result of using each platform independently from the other. These cores also frequently exhibit scars with hinge fracture terminations.

The presence of hinge fractures, which are generally considered to be accidental, does not seem to hinder the core reduction process. On the contrary in some cases it would be possible to refresh the flaking surfaces by removing a flake from the opposite platform, but the flint knapper went on to detach bladelets terminating in hinge fractures. It has

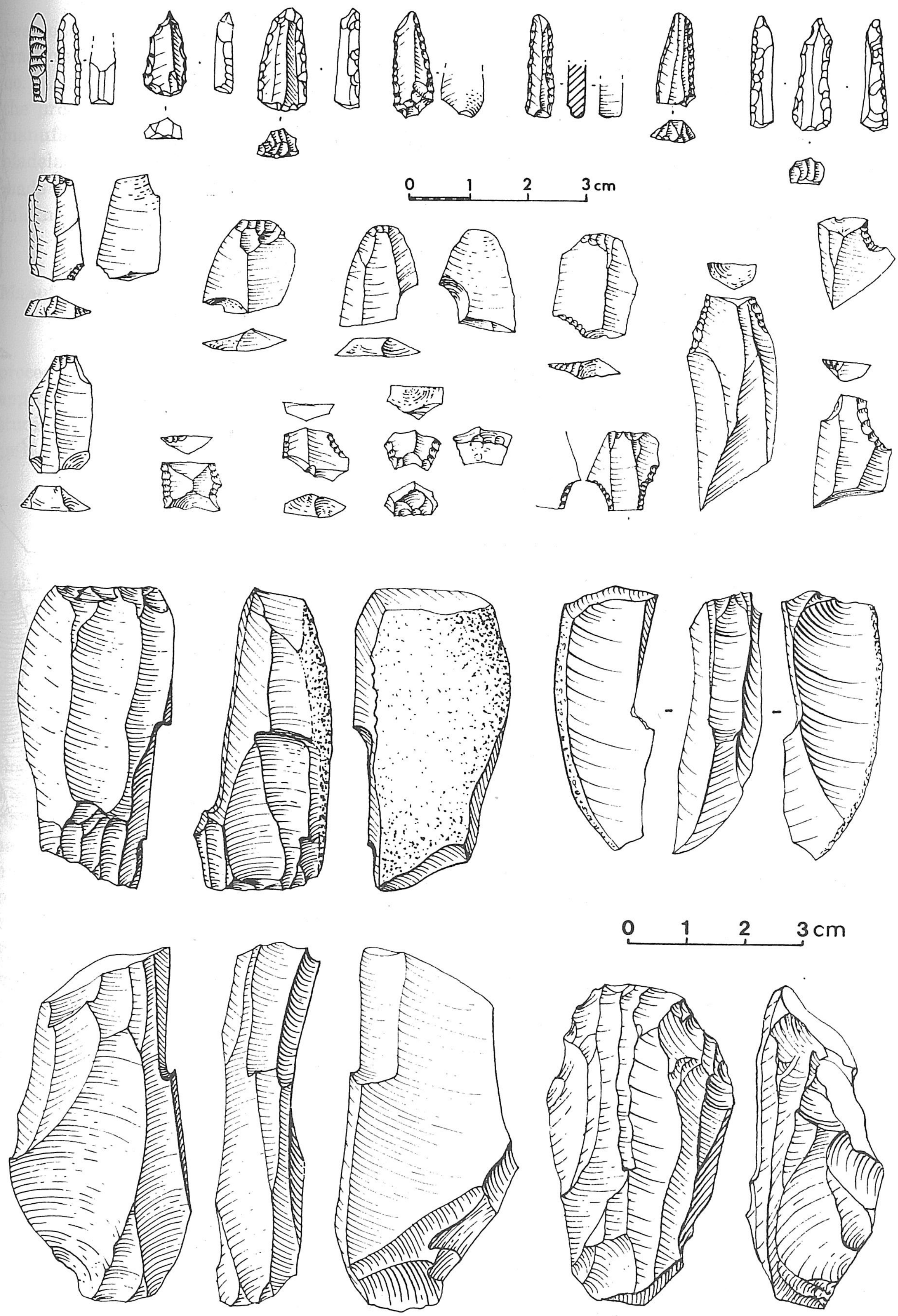


Fig. 1 : 1-7 : Micro-borers ; 8-19 : By-products of manufacture ; 20-22-23 : Bi-polar cores ; 21 : « Burin-like-core ».

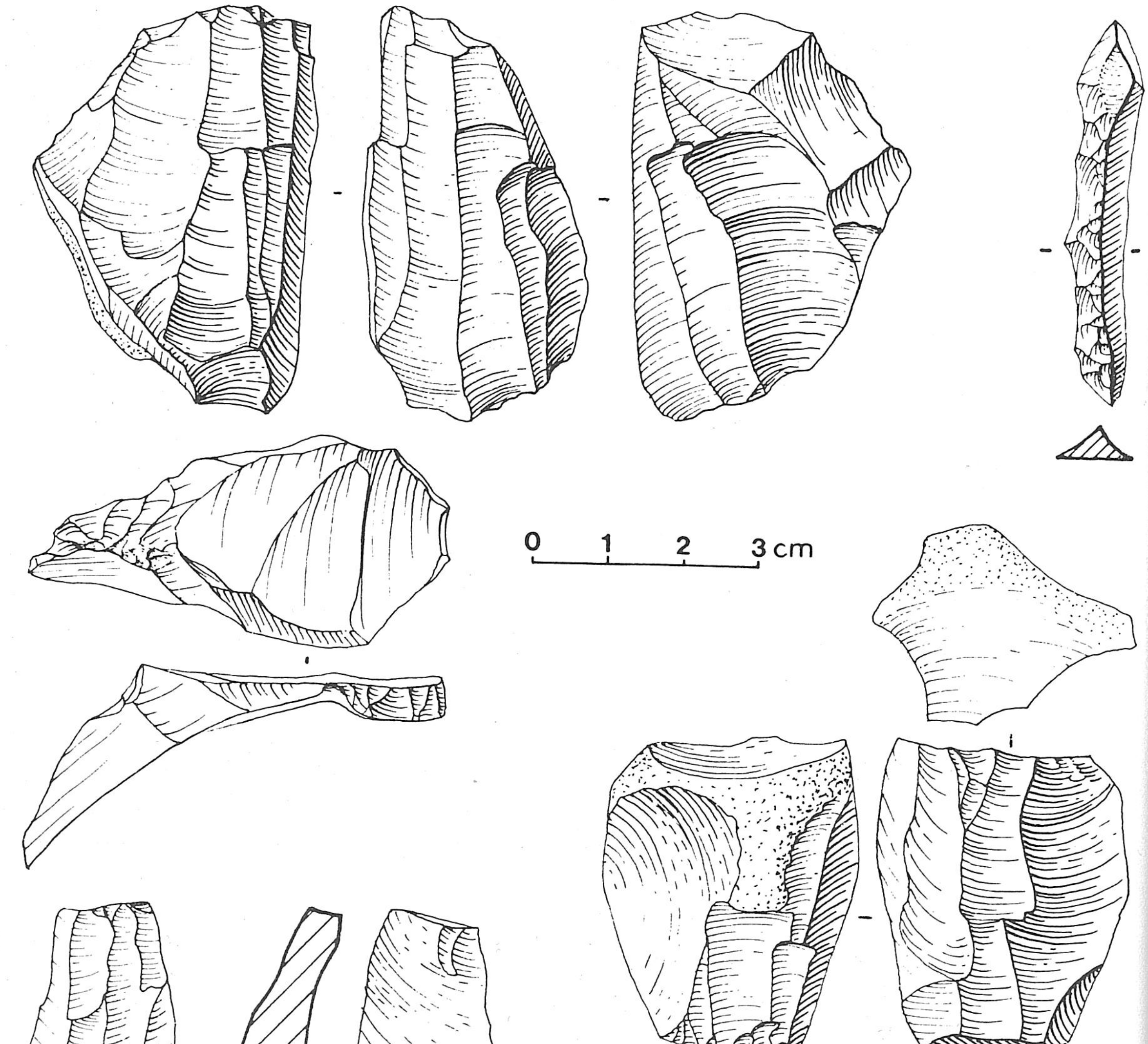


Fig. 2 : 1 and 4 : Bi-polar cores ; 2 : Core trimming element ; 3 : Core tablet ; 5 : Cornelian blade ; 6 : Cornelian core ; 7 : Steps of bead manufacture.

been observed that some of the micro-borers were manufactured on bladelets with hinge fractures, the hinged terminations being utilised as the base of the micro-borers (fig. 1, no. 5). It would seem that the core reduction sequences at Kumartepe are well adapted to the production of short thick bladelets, which are used exclusively as blanks for the manufacture of micro-borers and piercers. These techniques for the production of bladelets with hinge fractures is similar to « burin technique » ; the products are then made into micro-borers. This method may well have been used to control the length and thickness of the blanks.

Manufacture of the micro-borers

The manufacture of the tools represents a very important stage in the technological process of the workshop. The weight of the micro-borers and piercers (of which there are approximately 1 200 pieces) represents 6.1% of the total weight of the whole sample studied. With the exception of a few multiple borers made on flakes all the tools are made on blades and bladelets.

1 – description

There are two main tool types : borers and piercers. The present paper deals only with the micro-borers on which the wear traces were analysed. There are two main types of borers. The first type are long borers with unretouched bases (Cauvin 1968, p. 154-156). These are well known in the Near East, but are rare at Kumartepe (7.1% of the borers). The borers have tips with either direct or alternate retouch, and prominant shoulders. Most of them are broken, therefore it is difficult to study their technology.

The second type of borer, the micro-borer, is short and retouched all round the edges (Roodenberg *et al* 1984, fig. 6 no. 11-14). This type is less well known in the Near East but is abundant at Kumartepe (81.5% of the borers and 51.7% of the tool assemblage). The tip, edges and base are fashioned with direct abrupt retouch (fig 1, no. 1 to 7). These tools are made of coarse grained, homogeneous flint. The fine grained flint is never used to make this type of borer at Kumartepe. The tip is usually on the central axis of the body of the borer. The tips are often thinned by inverse retouch at the shoulders, and the distance between the shoulders and the point of the tip never exceeds 3 mm. The backed edges are parallel or sometimes convergent from the base to the tip. The transversal section is triangular, trapezoidal, rectangular or polygonal. Polygonal is the most common. The profile of the ventral surface is usually flat, with some examples of curved and twisted profiles. The base is abruptly retouched, direct or bi-polar on an anvil. It is sometimes thinned by inverse retouch. When the base is not retouched it is sometimes formed by a break, a butt (fig. 1, no. 4) or a hinge fracture (fig. 1, no. 5). The orientation of the tool is independent of the blank axis. 25% of the bases are formed on the proximal ends of blanks, 2.6% on the distal and remainder are indeterminate. The dimensions of the borers are very regular having a mean length of 16.7mm, width 5.7mm and thickness of 3.2 mm. The length/width ratio has an average of 3.1, and the width/thickness ratio is 1.8. To control the length of the tools a number of techniques were used.

2 – Technological processes of manufacture

The first steps of the manufacture of the micro-borers cannot always be seen on the tools themselves, and the technological processes were reconstructed from the fragments of blades and the by-products of manufacture. More than one hundred of these by-products were found in the sample studied.

The most frequent technological features seen on blade fragments are evidence for breakage on an anvil ; the ventral surface shows a mark of impact, and the dorsal surface has traces of crushing on the ridges with radiant micro-cracks. This kind of breakage, which can be observed on both distal and proximal blade fragments, is not prepared by a notch. Sometimes the blank was broken before the tool was properly retouched. This first process occurs on a good percentage of the broken blanks (about 20%). The blanks broken during the core reduction process were probably used as well. In other cases, the breakage is controlled by a notch, direct or inverse (fig 1, no. 9 and 10), or by two notches (fig. 1, no. 13). The breakage is perpendicular to the axis of the blank, unlike the oblique breaks that occur with micro-burin technique. This is in order to make the abrupt or bipolar retouch of the straight base easier (fig. 1, no. 7). On some of the by-products, the difference between retouched notches and backing retouch is difficult to distinguish (fig. 1, no. 8, 11, 12).

The second most frequent technological process is the manufacture of micro-borers on blanks by backing the edges before breakage on an anvil (fig. 1, no. 17 and 18). Sometimes the blow is so hard that the prepared blank may be broken in several fragments (fig. 1, no. 14, 15 and 16). It is also possible to find on the same fragment a notch and a small part of the backed edge (fig. 1, no. 19). Some bladelets were rejected before the edges were entirely retouched. Experimental replication of these various techniques demonstrated that the easiest way was to back the edge before breaking the blank on an anvil.

Supposed function of the micro-borers

It is an advantage if the technological study prepares the ground for the micro-wear analyst, who may confirm or reject an hypothesis proposed by the technologist. A collaboration between them is of great interest. The morphology of the tool and the manufacturing processes may indicate the way in which the tool was used. For the micro-borers of Kumartepe, the previous observations and the evidence from the beads suggest that these tools were used as drill-bits.

The shape of the tools suggests that they could have been hafted in a wooden dowel and used with a rotary motion. This hypothesis is suggested by the morphology of the micro-borers themselves. The parallel edges of the body, the points being centred on the axis of the body, the lateral profile formed by the two parallel faces of the blank and the abrupt shape of the base combine to give the tool a good balance. Such an object can be inserted into a wooden dowel and used with the minimum risk of breakage. The transversal section of the body, which is always wider than it is thick, prevents the tool from moving in the dowel. The tip, when it is possible to measure it, is the only part of the tool which has a circular section. Some of the drill-bits are very long and thin with a rounded section and may have been used as reamers. Finally, some drill-bits with burin like breakages may have been used as punches. Perhaps the drill bits were used to detach the conical flakes (fig. 2, no. 7d), which is the second step in the perforation of the hole.

Manufacture of the beads

As seen above, the beads were made of cornelian. The source is not known, but this stone is not rare in Turkey. In the workshop, the blocks of cornelian are small (never more than 80 mm long) ; there are chunks, fragments with natural breakages, cores and flakes. The beads are not numerous and most are broken, but it is possible to reconstruct the manufacturing process. The most important morphological characteristic of the blanks is that the ventral and dorsal surfaces must be parallel. In order to get small flakes, the lapidaries of Kumartepe used different core reduction techniques which do not seem to be systematic. There is one cornelian core of discoidal type in the sample studied (fig. 2, no. 5). These flakes were manufactured into disks by abrupt or semi-abrupt retouch, always direct. The dimensions of these discs are between 7 to 10mm in diameter and between 3 to 4mm in thickness. The perforation of the hole was always begun on the ventral surface of the blank (fig. 2, no. 7a,b,c). The hole is made in two stages, 1) the perforation of half the thickness of the disc and 2) the detachment of a small conical flake. The analysis of the micro-wear traces was done to state precisely the perforating processes.

Functional analysis

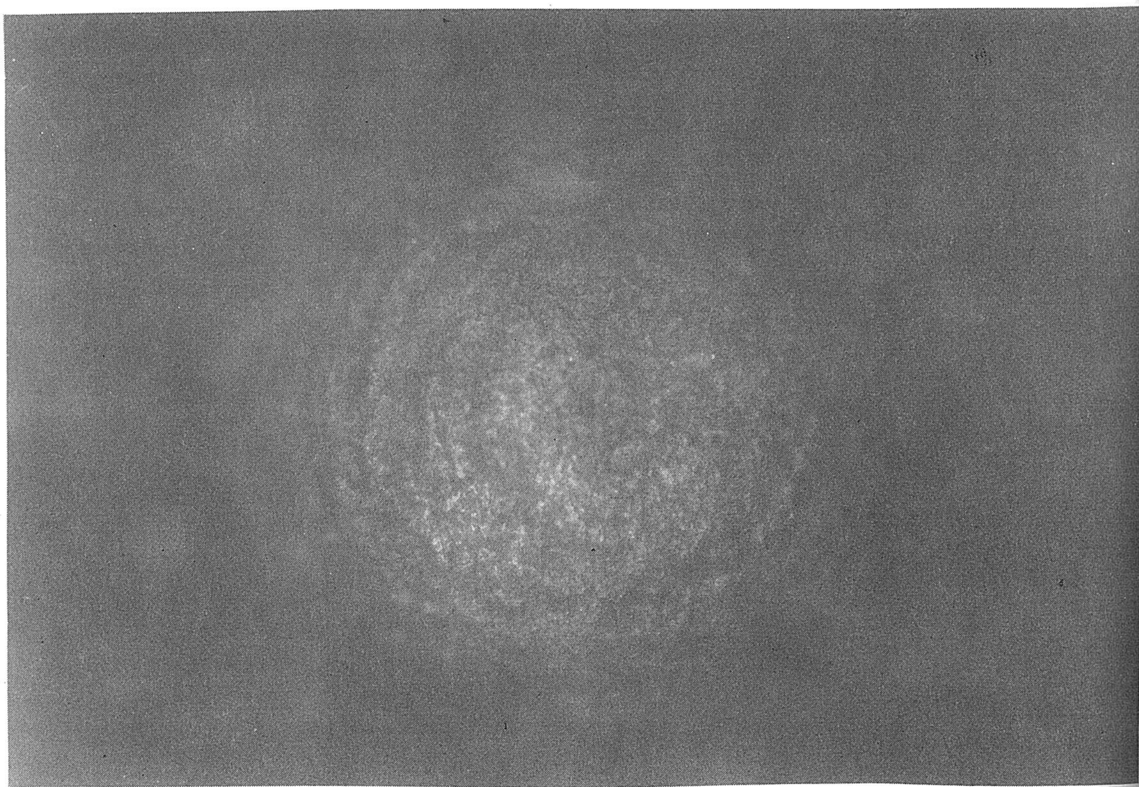
The microwear analysis of the micro-borers was designed to answer one major question. That was whether or not some form of mechanical drilling was involved in the manufacture of the cornelian beads. This study was carried out in two stages. First a sample of the micro-borers was examined and the wear traces recorded and photographed. Then a small experimental programme was carried out to try and replicate the wear traces present on the archaeological material.

It has been demonstrated that cornelian beads can be perforated by a punch technique (Chevalier, Inizan and Tixier 1982), that does not involve drilling at all. So the experimental programme included attempts to replicate this punch technique as well as using a mechanical drilling action. In fact the preliminary attempts to punch a hole through cornelian by using replicas of the drill bits and striking them with a wooden hammer proved unsuccessful. The drill bit replicas broke almost immediately, within two or three blows. The breakage consisted of either a large burin type break over the entire length of the tool, or the drill bits were completely shattered. The penetration of the cornelian was minimal.

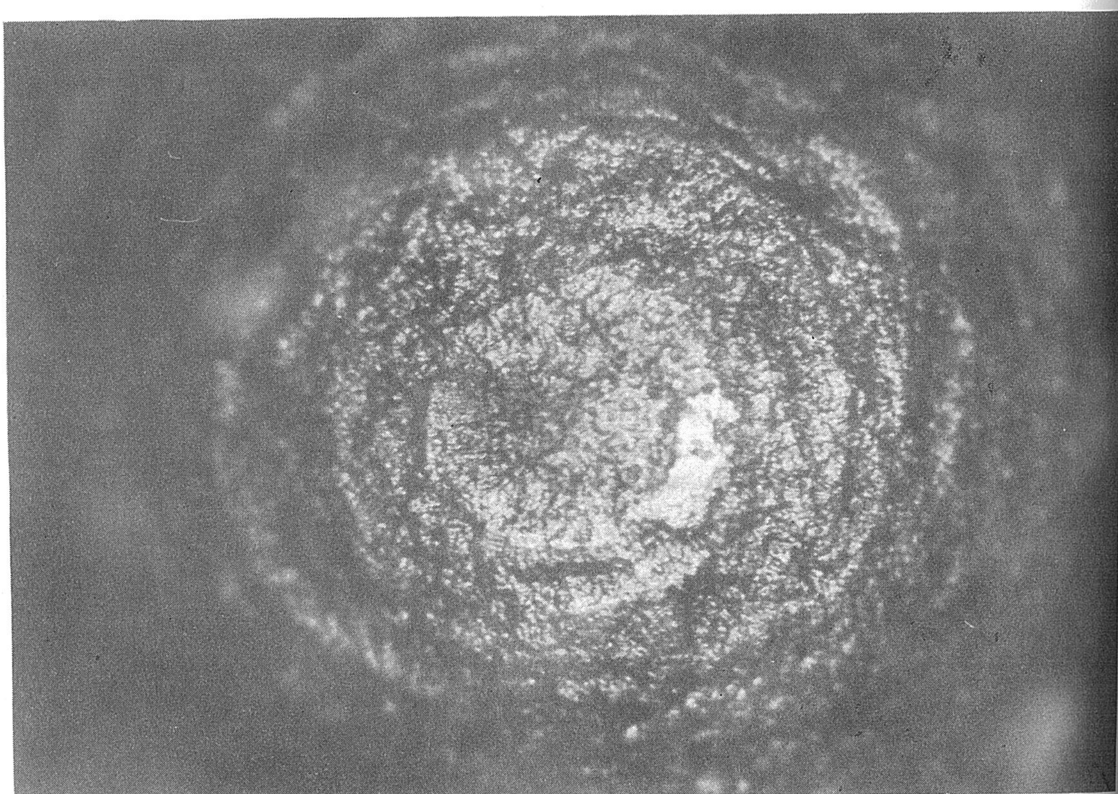
When the drill bits were hafted and used with a bow drill the results were more satisfactory. The initial difficulty was in centring the drill bit, because it has a tendency to skid away until a small indentation has been created. Once the drill bit is seated on the surface of the cornelian, drilling can proceed quite smoothly. During the experimental programme it was observed that the more pointed, narrower drill bits tended to break, either in the form of burin breaks at the tip or the whole tip breaking away.

The blunter tipped drills tended to work more efficiently and could achieve a penetration of 1mm in 10 minutes. It was further noted that the addition of sand placed in the hole acted as an abrasive and decreased the amount of time necessary to achieve the desired depth of penetration. Microwear analysis of the experimental drill bits demonstrated that the resulting wear traces bore a remarkable similarity to the wear traces observed on the archaeological specimens (fig. 3a-d).

All of the experimental drill bits exhibited the rounding, polish and circular striation pattern. Often the rounding would form and then break away leaving small areas of polish with striations on the sides of the drill bits, most of the tip having been lost. This was also observed on the archaeological drill bits (fig. 4a,b).

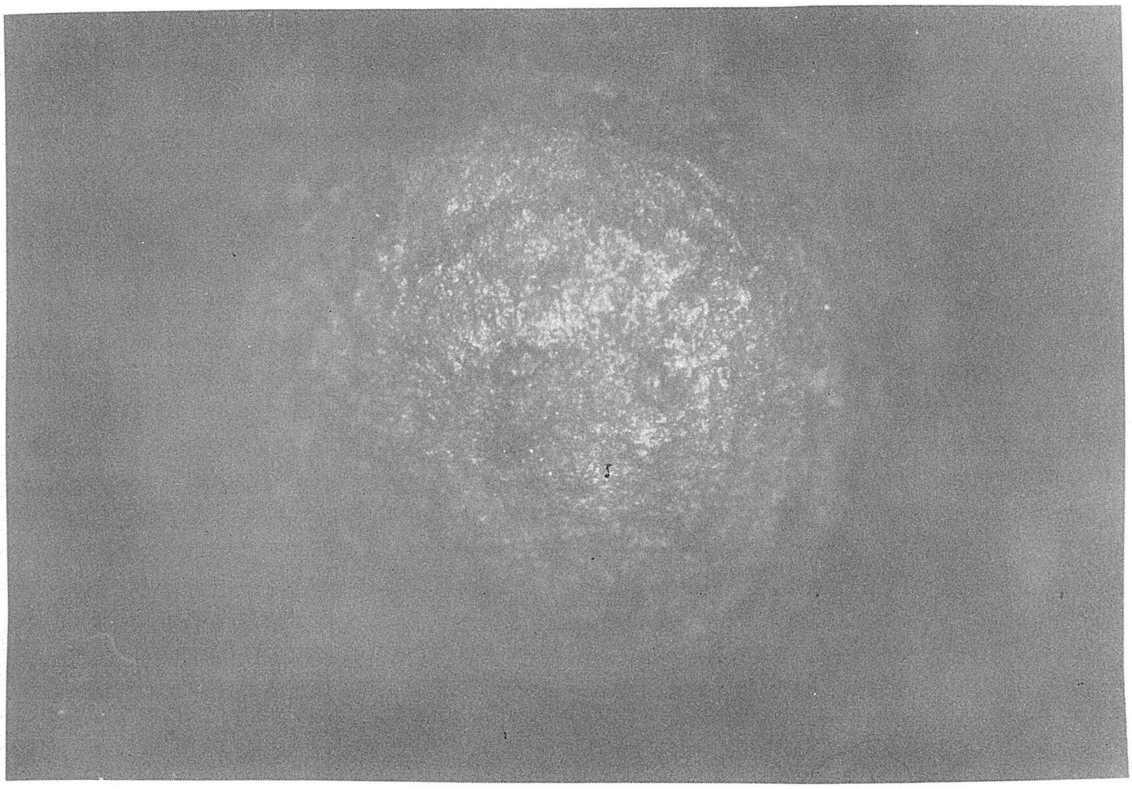


A

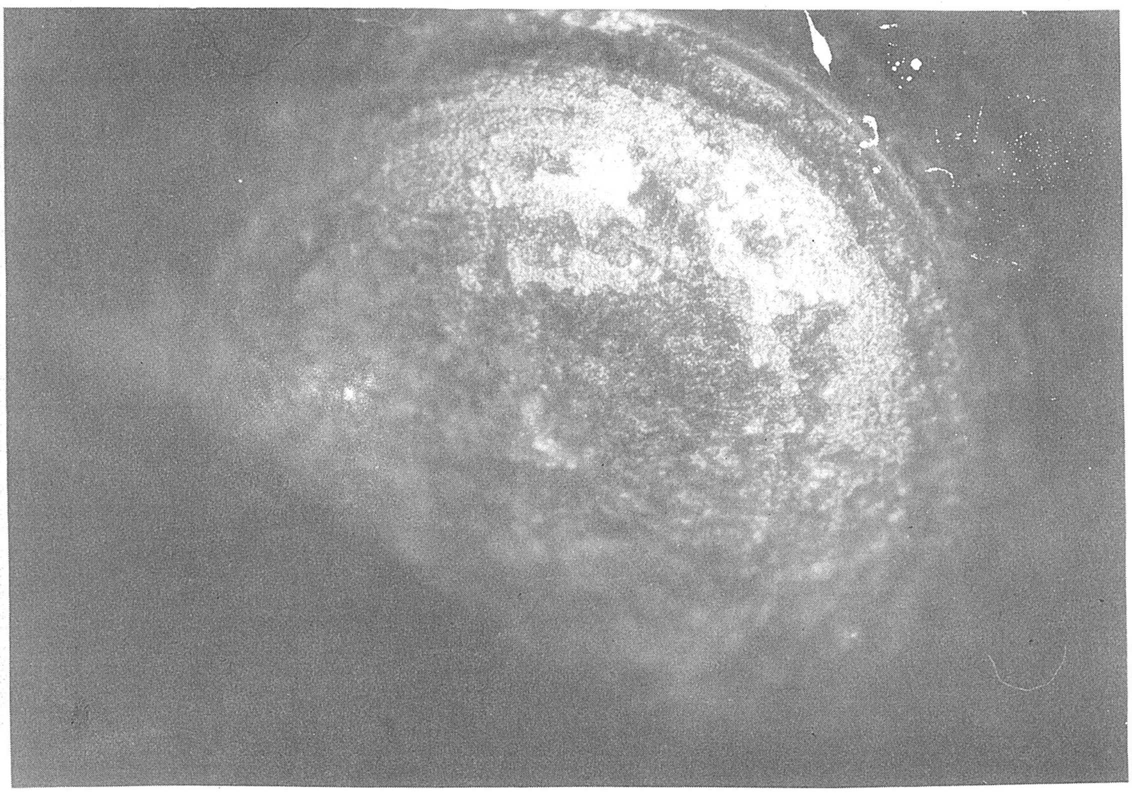


B

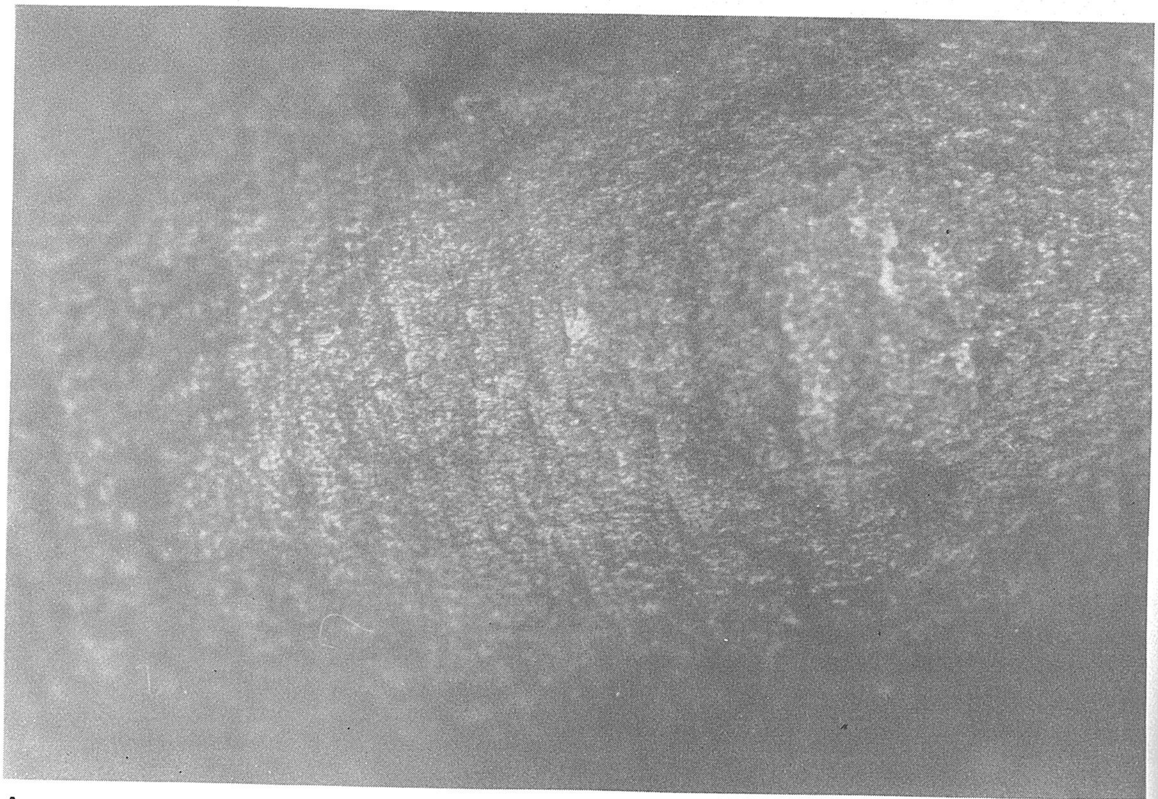
Fig. 3 : a and b : Archaeological drill tips. ; c and d : Experimental drill tips. (magnification 100x).



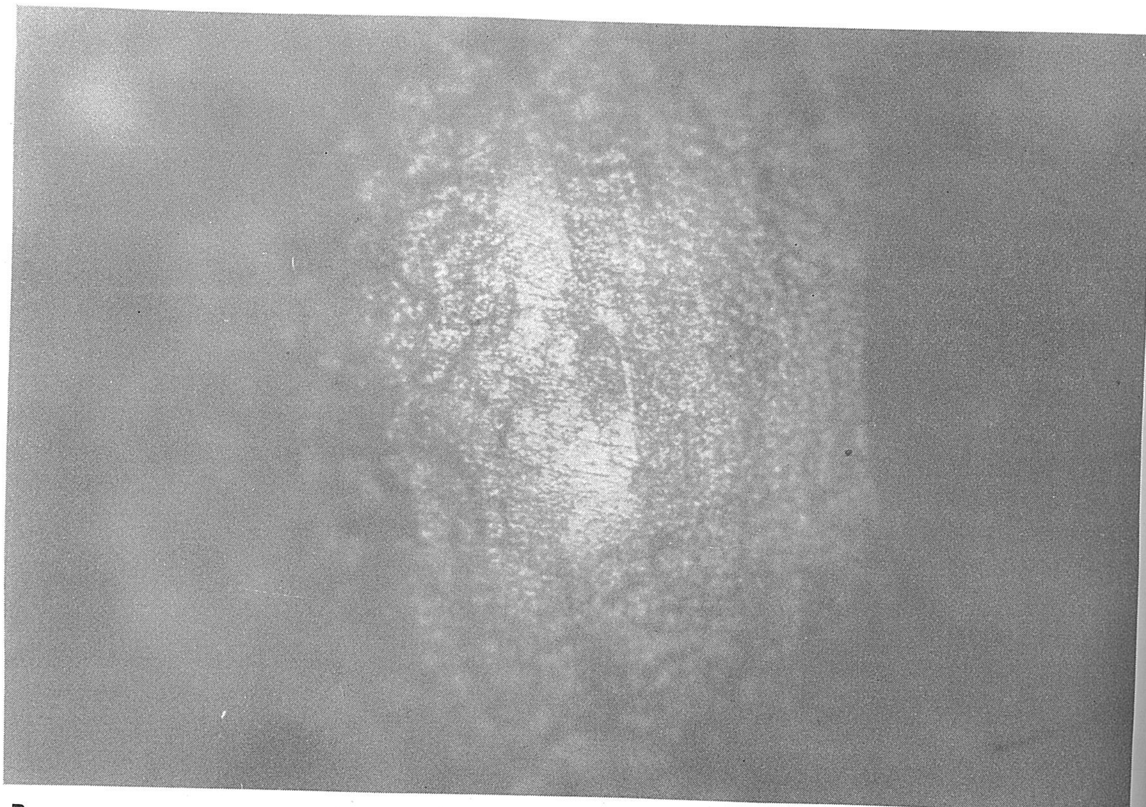
C



D



A



B

Fig. 4 : a and b : Side view of archaeological drill tips. (magnification 100x).

Having established the kind of wear traces produced by drilling and by punch techniques, a larger sample of drill bits was analysed. In all 518 drill bits have been examined microscopically. 62 of these have been examined in great detail. That is, every area from the tip to the base on both surfaces has been scrutinised, drawn, and all wear traces noted. The remainder have been examined at magnifications of up to 200x, though 100x was usually sufficient to note any wear trace. Observation was concentrated on the tips.

Of the 62 submitted to a full detailed analysis, 38 had either rounding polish or circular striations or a combination of these features. This indicates that they were used with a mechanical drill, as the wear traces were the same as those found on the experimental drill bits used with a bow drill. 7 had their tips broken off, and so no traces could be observed. The remaining 17 had breaks at the tips that meant only the very tip was intact constituting areas that were too small on which to make reliable observations. Of the 456 examined microscopically, but not in detail, 126 had clear traces of polish, rounding or circular striations, so that of the total sample of 518, 31% had evidence of being used in a mechanical drill. Most of the rest of the drill bits had their tips removed by breakage which was consistant with the breakage patterns seen on the experimental drill bits. Either the tips completely broke off or torsion breaks occurred that removed so much of the tip that polish and striations would not remain. A few drill bits had fluting or burin type breaks probably resulting from use as punches.

Further evidence of the use of a mechanical drill was provided by the microscopic examination of the cornelian bead blanks. 31 partially perforated bead blanks were examined, of these a clear differentiation could be made between those that broke during the initial pecking of the blanks and those that broke during drilling. 20 of the broken blanks exhibited traces of pecking only. That is, conchoidal fracture scars and an irregular outline to the hole. The depth of the holes ranged from 0.07 to 0.27 mm. The 7 blanks that broke during drilling had circular holes of regular outline with striations around the rim of the holes as well as in the hole (fig. 5).

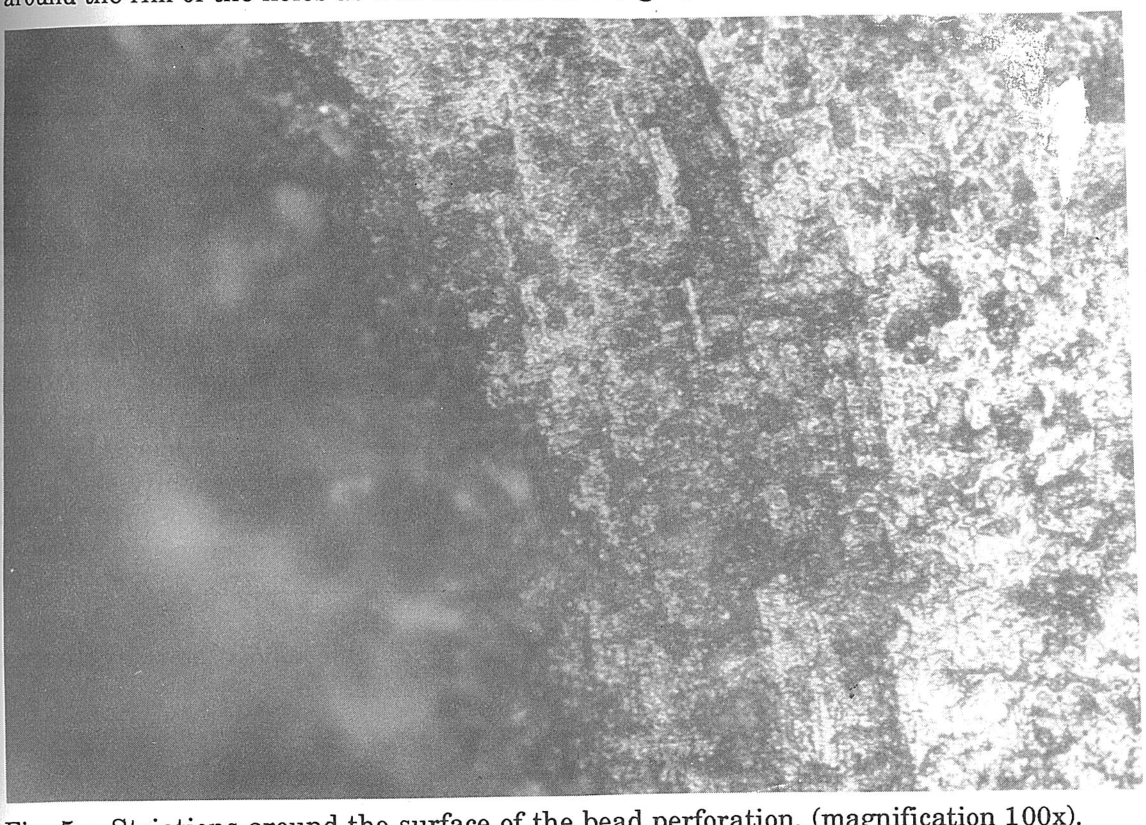


Fig. 5 : Striations around the surface of the bead perforation. (magnification 100x).

The cross section of the blanks was conical and extremely regular. There were 3 blanks that had been drilled and then abandoned, even though they were unbroken. The bases of the holes of these blanks were observable and matched the size of the tips of the drill bits, and were polished in the same way. The depth of the holes created by drilling ranged from 0.92 to 1.3 mm. One unbroken blank was abandoned after pecking only.

Other evidence for the drill bits being used in a mechanical drill is the presence of a residue on 40 of the 62 drill bits examined in detail. The residue appears to be some kind of mastic and is predominantly on the base end of the bits and possibly represents a residual mastic used for hafting the drill bits. Of 19 piercers examined only 2 had spots of residue on them and no waste flakes had any of the residue. This indicates that the residue is not a natural deposit found on the site, but its existence on the drill bits suggest its presence is due to human activity. The residual material is being analysed and its constituents may clarify whether or not the residue is a material suitable for hafting the drill bits.

These observations of the drill bits and the carnelian bead blanks allow for the reconstruction of the technique used in perforating the beads. After the blanks were prepared pecking would have been used to provide a slight indentation in the centre of the blank, (the majority of the blanks broke at this stage i.e. when a percussive action was being used). The indentation would then allow the drill to be placed in position at the centre of the blank without skidding away across the surface. Drilling would then be used to perforate approximately half way through the blank. The completion of the perforation seems to have been achieved by the removal of a conical flake as suggested by Chevalier, Inizan and Tixier (1982, fig. 1). That is a drill bit is placed in the hole and struck, producing a conical fracture scar, and this completes the perforation. There is one example of a broken blank that was drilled to a depth of 0.92 mm and then broke during the final blow intended to remove the conical flake. 5 conical flakes were recovered during this analysis. Unfortunately no complete beads have been recovered so that we have no information on the final polishing of the beads.

These results are based on a preliminary experimental programme. Further experimentation will be carried out using drill bit replicas on a variety of materials. This will be to test whether it is possible to create similar wear traces to those on the archaeological material by use on other materials rather than hard stone like cornelian. Kumartepe is a rare example of a bead workshop because of its early date and the huge concentration of all the materials required for the manufacture of beads. Similar techniques for the production of micro-borer blanks are found elsewhere. More systematic use of burin technique is found in the African Neolithic of the Goa region (Lhote 1942, 1943) and in Mali (Gaussen M. and J. 1965), or in the third millennium in Iran at Tepe Hisar (Bulgarelli 1974). There is no evidence of this technique at Larsa (Chevalier *et al* 1982) or at Abu Salabikh (Unger-Hamilton *et al* in press) in Iraq, where the debitage is by pressure flaking. The morphology of the drill bits is comparable to that at Larsa and Tepe Hisar, being short and abruptly retouched with slightly shouldered tips. The absence of any complete bead and the presence of thousands of drill bits and large amounts of cornelian debris in such a small area at Kumartepe suggest that the material represents a specialist bead manufacturing site.

The authors would like to acknowledge the invaluable advice and assistance of Jacob Roodenberg, of the Dutch Institute of Archaeology, Istanbul.

The technological study was supported by a grant of the Ministère des Relations Extérieures français.

BIBLIOGRAPHY

CAUVIN, (J.), 1968.– *Les outillages néolithiques de Byblos et du littoral libanais (fouilles de Byblos,* 4). Paris : Maisonneuve.

CHEVALIER, (J.), INIZAN, (M.-L.) and TIXIER, (J.), 1982.– Une technique de perforation par percussion de perles en cornaline (Larsa, Iraq). *Paléorient,* 8(2) : 55-65.

LHOTE, (H), 1942.– Découverte d'un atelier de perles néolithiques dans la région de Gao (Soudan francais). *Bulletin de la Société Préhistorique Française* 39 : 277-297.

LHOTE, (H.), 1943.– Découverte d'un atelier de perles néolithiques dans la région de Gao (Soudan francais). (suite et fin). *Bulletin de la Société Préhistorique Française* 40 : 24-35.

ROODENBERG, (J.J.), WILKINSON, (J.J.) and BAYRI-BAYKAN, (S.), 1984.– Surveys and soundings at Kumartepe : an interim report. *Anatolica* 11 : 1-16.

UNGER-HAMILTON, (R.), GRACE, (R.), MILLER,, (R.) and BERGMAN, (C.) (à paraître). Drill bits from Abu Salabikh, Iraq. Table ronde du CNRS. *Manches and emmanchements préhistoriques. Lyon Maison de l'Orient* (27-29 novembre 1984).