Experimental replication of stone, bone and shell beads from Early Neolithic sites in Southeast Europe

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Not Just for Show: The archaeology of beads, beadwork and personal ornaments

Edited by

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Table of Contents

Part 4: Experimentation And Technology

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Experimental replication of stone, bone and shell beads from Early Neolithic sites in Southeast Europe

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Abstract

Flat disk beads made from a wide variety of biominerals, minerals and other stones are widely distributed on Early Neolithic sites throughout the Balkans. Replicative experiments indicate that hardness was a critical factor affecting drilling times and, presumably, the choice of materials for bead production. Using a pump drill and schist grindstone it was found that beads could be manufactured relatively easily from materials of less than 5 on Mohs hardness scale; materials harder than 5.5 either proved very difficult to drill or were not drilled successfully. The experiments suggest that, while some beads and necklaces were evidently specialist products, bead making could have been a normal household activity among early farming communities in Southeast Europe.

Key words: *experimental drilling, beads, Early Neolithic, Southeast Europe*

Introduction

Among the novel features of the Early Neolithic in Southeast Europe is the appearance of flat disk beads made of stone and other materials, which have close parallels at sites in the Near East where stone bead production underwent a significant expansion in the PPNA period (Wright and Garrard 2003). This bead type contrasts in form and technique with those found in Upper Paleolithic and Mesolithic sites in the Balkans, which often were made from whole shells and animal teeth (e.g., Cristiani and Borić 2012; Komšo and Vukosavljević 2011; Vanhaeren and d'Errico 2006).

Disk beads have been found in a number of early farming sites, including Franchthi and Nea Nikomedia in Greece (Miller 1996; Shackleton 1988), Galabnik in Bulgaria (Gurova et al. 2013), Anza in Macedonia (Gimbutas 1974), Blagotin, Divostin, Drenovac and Lepenski Vir in Serbia (Srejović 1972; Srejović and Babović 1983; Vitezović 2012) and Schela Cladovei in Romania (Bonsall and Boroneanț 2009). Their presence in 'Final Mesolithic' (cf. Bonsall 2008) burials at Lepenski Vir and Vlasac (Borić and Price 2013) may reflect contacts between fishing communities in the Iron Gates and Early Neolithic farmers around 6000 cal BC (Figure 13.1). A variety of materials were used for the production of these beads, including marine shell, various green- and blue-colored minerals such as azurite, malachite and serpentinite, and 'limestone' (Figure 13.2).

Actual evidence of on-site production, in the form of production debitage or tools used in bead making, has been found in only a few sites in the Balkans. In Early Neolithic levels at Franchthi beads made from the shells of *Cerastoderma glaucum* (lagoon cockle) were found in association with broken bead blanks and flint microdrills (Figure 13.3a; Perlès 2001). Morphologically similar microdrills of high quality flint (Figure 13.3b) were recovered in large numbers from the site of Kovačevo in southwest Bulgaria, although not in direct association with beads or other perforated objects (Gurova et al. 2013). At Schela Cladovei stone disk beads occurred in association with micro-borers of high quality 'Balkan flint', broken bead blanks and other production debitage (Bonsall and Boroneanț 2009).

An experimental program was devised to investigate various practical and technical aspects of the production of disk beads as represented in Southeast European Early Neolithic sites. Among the questions we sought to address were:

- How effective are the chert micro-borers found in some Early Neolithic sites in making holes in the various materials that were used for bead production?
- How much time is required to drill the holes and to produce beads?
- How do these factors affect the choice of materials for bead making?

Details of the experimental program have been provided by Gurova et al. (2011, 2013). In the present paper we summarize the results of the experiments and offer some further observations on the lessons learned.

Materials and Methods

Replicas of micro-borers from Early Neolithic sites were made using high quality cherts from Bulgaria, southern Romania and southern England (Figure 13.4a). Samples of various rocks, minerals and biominerals that would have been available to Neolithic peoples in Southeast Europe were selected for experimental bead production. On Mohs scale of mineral hardness the materials ranged from 6.5 to 2.5 (Table 13.1).

Tabular blanks were prepared by sawing, flaking and/or splitting of the samples to the required size. The blanks were then reduced in thickness by abrasion/grinding on a schist slab with fine sand and water, to form thin plates 2–4 mm thick, with flat, smooth surfaces. The plates were then drilled from one or both faces. The final rounding and polishing (finishing) of the beads was achieved by abrasion on a grinding slab with fine sand and water (Fig 4b). Where very large tabular fragments could be obtained (from, e.g., bone and serpentinite) thinning and drilling were usually carried out before the blank was divided into smaller, bead-sized blanks (Figure 13.4c-d).

Two forms of drill were used in the experiments – a pump drill and a thumb drill. The pump drill (Figure 13.5a) has four components: a vertical drill shaft (spindle) and bit, a horizontal bar (crosspiece) with a hole in the center allowing it to slide up and down the spindle, a weighted disk or flywheel which is fixed to the lower end of the drill shaft, and a cord that is strung from either end of the crosspiece through a hole near the top of the drill shaft and twisted around the shaft. When downward pressure is applied to the crosspiece, the drill rotates. The flywheel captures this momentum, which when released at the end of the cycle rotates the drill shaft in the opposite direction as the cord is rewound. Thus a continuous alternating rotation is generated (Follari 1993). A 'thumb drill' is a much simpler device; the flint drill bit is held between thumb and fingertips and rotated back and forth with pressure (Figure 13.5b). While the thumb drill is simple to use, it does not offer the speed or precision of a pump drill and there is less control over the verticality of rotation. Moreover the drill bit needs to have a short, thick tip in order to resist breakage and a long, broad proximal end (shank) for grasping. The resulting perforation tends to be larger and less symmetrical than can be achieved with a pump drill.

A photographic record (still images and videos) was kept of the actual experiments, and microphotographs of manufacturing traces on beads/blanks and of use wear traces on drill bits were taken at magnifications of x20 to x100 using a Keyence VHX-100 digital microscope.

Results

Drilling and Shaping

Table 13.1 summarizes the results of the experiments in drilling different materials. Attempts to produce beads from the hardest materials used in the experiments, amazonite and nephrite (Mohs 6–6.5), were only partially successful; drilling for up to 160 minutes with a pump drill made little impression on a piece of nephrite, while it took a total of 130 minutes to make a hole in amazonite at which point the bead broke in two.

Lazurite (Mohs 5.5) proved somewhat easier, but it still required a total of 197 minutes mechanical drilling in both directions with sand and water additives, replacing the drill bit once, in order to produce a biconical hole. A further 5 minutes of manual drilling were needed to enlarge the hole sufficiently.

The best results were achieved using materials with a hardness of less than 5 on Mohs scale. Bone blanks 2 mm thick were produced by sawing with an unretouched flint blade followed by abrasion on a schist slab. Three holes were drilled – one with a pump drill and two with a thumb drill – in 38 minutes. Sawing of the bone took 30 minutes, and 35 minutes were required for shaping the beads. Shell, malachite and serpentinite are all of similar hardness (Mohs 4). Drilling a hole through blanks 3–4 mm thick of these materials took no more than 10 minutes, using a pump drill.

The hardness of the material worked inevitably influenced the efficiency of shaping beads. Easiest to fashion were limestone beads (six were made in the experiments) while the four discoid beads of serpentinite (the most refined examples produced in our experiments) took twice as long to make.

In the case of the softest materials used in the experiments, marble and limestone (Mohs 3–4), a hole could be drilled in 3–8 minutes with a pump drill.

Use-wear and Technological Traces

Drill bits broke quite frequently, but on those that withstood prolonged use distinct wear traces could be observed. A drill bit used on malachite for 10 minutes with water added as a lubricant exhibited noticeable rounding of the tip, with numerous mineral residues on the tool and many microchips of flint in the hole created (Figure 13.6a). A flint drill bit used for 30 minutes to make four holes in a plate of serpentinite showed noticeable rounding and smoothing of the active part of the tool (Figure 13.6b). A drill bit used on amazonite for 15 minutes developed a small area of polish on the tip; more extensive micropolish was produced on a second drill bit, which was used for 130 minutes. Very pronounced smoothing and rounding of the drill tip and areas of polish also developed on a drill bit that was used to drill lazurite for 202 minutes (Figure 13.6c). Twelve minutes drilling through marble produced significant microfeatures of use on the drill bit, in the form of rounding, smoothing and bright spotted polish with transverse striations (Figure 13.6d). There were striking differences in the time taken for micropolish to form on the borer tips – from 12 minutes (on marble) to 202 minutes (on lazurite).

Apart from the hardness of the material being worked (from 2.5 to 6.5 on Mohs scale), the appearance of microwear traces was also found to vary according to the raw material of the drills – the polish resulting from drilling marble for a short time appeared on a *jasper* borer, while the drilling of amazonite and lazurite was done using *flint* drill bits with much slower development of micropolish on their edges and tips.

Holes drilled in some materials, most notably biominerals (bone and shell), showed pronounced rotational striations (Figure 13.7a, b). In the case of serpentinite, manufacturing traces (abrasion) were readily observable on the perimeters of the experimental beads after rounding, although in our experiments no 'rolling' of the beads on a grinding slab (as described by Wright et al. 2008) was performed for additional smoothing and faceting of their edges (Figure 13.7c).

Discussion

Experimental studies of bead making using ancient technologies are by no means new. Many researchers worldwide have shown interest in the social and technical aspects of beads made from stone, shells and other materials. There have been some notable studies aimed at a better understanding of Neolithic bead manufacturing in Anatolia and the Levant (e.g. Bains 2012; Coşkunsu 2008; Wright and Garrard 2003;

Wright et al. 2008). However, the experiments described in this paper are among the first concerned with bead manufacturing technology in the Early Neolithic of Southeast Europe.

A number of general observations arose from this limited series of experiments. The hardest materials that were drilled successfully were amazonite and lazurite (Mohs 6.5-5.5). However, drilling of these materials took a considerable time and involved several changes of the drill bit. Much easier to drill and shape into beads were bone, shell, malachite, serpentinite, marble and limestone (Mohs 5-2.5). Although nephrite and amazonite have similar rankings on Mohs scale, attempts to drill nephrite were unsuccessful. This may reflect differences in the *absolute* hardness of the samples used in our experiments and/or variations in other experimental conditions.

In general, however, the harder the material on Mohs scale, the longer it took to drill a hole. The process could be accelerated with the addition of water and fine sand, and these were found to be essential additives for bead/blank thinning and shaping by abrasion. The skill and experience of the drill operator was also a significant factor – in one experiment involving two individuals, one was able to drill a hole in a plate of gray marble in 8 minutes, while the other took 12 minutes to drill through a blank of the same material and thickness.

Drill bits used in the pump drill broke quite frequently, although there was no obvious correlation between breakage and the hardness of the material worked.

In terms of use wear, rounding and matt smoothing are typical microwear features appearing on chert drill bits after prolonged friction with the worked material. Bright polish appeared in only three cases – in drilling marble (for 12 minutes), amazonite (polish spots starting to appear after 15 minutes) and lazurite with very pronounced rounding and polish on the drill tip after 202 minutes.

Conclusions

The results of the experimental program conducted by Gurova et al. (2013) and summarized here have provided useful insights into various aspects of disk bead production in the Southeast European Early Neolithic.

In these experiments micro-borers made from high quality cherts (Mohs 7), and either used in combination with a pump drill or as simple thumb drills, proved effective in making holes in materials of less than 5.5 on Mohs scale of hardness. In general, the harder the material the more time was taken to drill a hole or to shape the bead. It was also observed that the addition of water and/or sand during drilling and shaping by abrasion usually accelerated both processes.

The technology available and the hardness of the drill bit are two factors likely to have influenced the choice of raw materials for bead making. Of the bead materials recorded from Early Neolithic sites, only nephrite is harder than the materials successfully drilled in our experiments. Other factors that probably influenced the choice of materials for bead making were availability and susceptibility to breakage of the material, along with the skill and experience of the bead maker.

The bead makers in our experiments all had little or no previous experience of bead making yet were able to produce beads that are comparable in style and quality to some of those found in Early Neolithic contexts. Beads are often regarded as 'prestige goods' and indicative of craft specialization. Some Early Neolithic examples from Southeast Europe, such as the bead necklaces from Galabnik, may well be the work of specialist craftsmen. It is possible, however, that bead making in the Neolithic was also a common household activity, like weaving or pottery manufacture, although this need not imply that it was always done for household consumption.

The experiments described in this paper represent the first stage of a longer-term study of bead making in Early Neolithic Southeast Europe. Further steps in the research will involve experiments with other forms of hand- and mechanical drills, and use-wear analysis of archaeological chert micro-borers for comparison with experimental drill bits.

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FIGURE CAPTIONS

Figure 13.1. Locations of sites mentioned in the text. *Drawing by C. Bonsall.*

Figure 13.2. Necklaces of disk beads from the Early Neolithic site of Galabnik (western Bulgaria). The materials used include shells, limestone, nephrite and serpentinite (Kostov 2007; Kostov and Bakamska 2004). The perforations consistently have a diameter of 1.2 mm. Photos: M. Gurova, published with the permission of A. Bakamska.

Figure 13.3. Archaeological micro-borers from Early Neolithic sites in Southeast Europe: (a) Franchthi Cave, Greece, reproduced from Perlès 2004:Figure 6.4, with permission from Indiana University Press; (b) Kovačevo, southwest Bulgaria. Drawings by M. Gurova.

Figure 13.4. Equipment used in the experiments: (a) experimental chert drill bits; (b) preparing a bead blank on a grinding slab; (c) producing beads from a bone plate; (d) producing beads from a serpentinite plate. Photos: M. Gurova.

Figure 13.5. Drilling equipment used in the experiments: a) pump drill; b) thumb drill. Photos: M. Gurova.

Figure 13.6. Photomicrographs of experimental drill bits showing microwear traces resulting from perforating: (a) malachite (including the hole with flint chips from the drill); (b) serpentinite (x25); (c) lazurite (1 – x25, 2 – x50, 3 – x75); d) marble(1 – x25, 2-4 – x75). Photos: M. Gurova.

Figure 13.7. Photomicrographs of manufacturing traces: (a) bone (x50); (b) shell (x50); (c) serpentinite (higher row – x50; lower row – x40 and x 25 in the middle). Photos: M. Gurova.

Table Captions

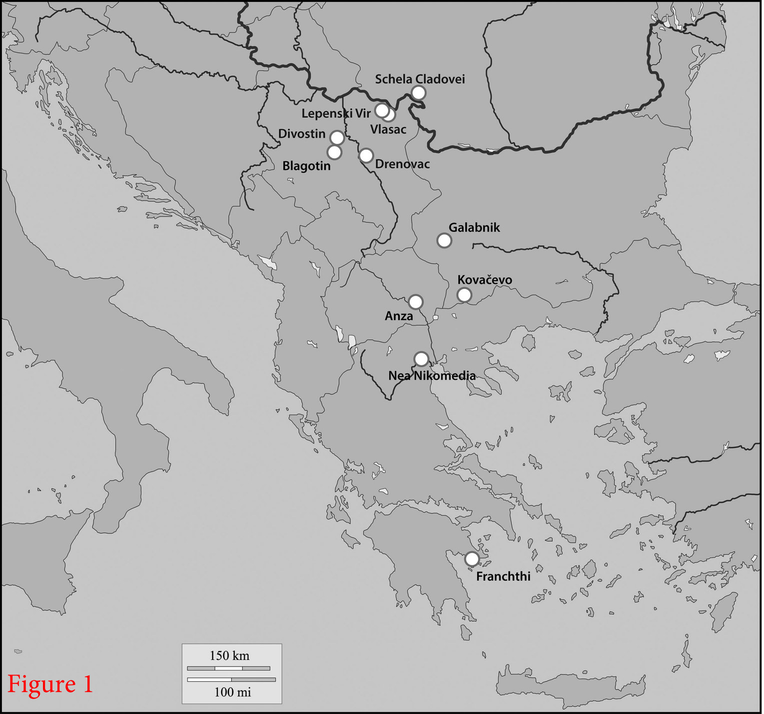
Table 13.1. Materials used in the bead-making experiments and drilling times. After Gurova et al. 2013, with Mohs hardness information from Henn (2004), Thomas (2009) and Lazzarelli (2012).

Table 13.1. Materials used in the bead-making experiments and drilling times. After Gurova et al. 2013, with Mohs hardness information from Henn (2004), Thomas (2009) and Internet sources.

Material	**Color**	**Mohs hardness**	**Thickness (blank)**	**Drilling time (one hole)**
Nephrite	Variable	6.6–6	3 mm	No hole produced
Amazonite	Pale green	6.5–6	3 mm	130 min
Lazurite	Dark blue	5.5	3 mm	202 min
Bone		5	2 mm	12 min
Shell (bivalve) [1]		4	2–3 mm	10 min
Malachite	Green	4–3.5	3.5–4 mm	10 min
Marble	Pale gray	4–3	2.5–3 mm	12 min
Serpentinite [2]	Green	4–2.5	3 mm	7–8 min
Limestone	Yellow	3	3 mm	3 min

1. Shells of two bivalve species, one freshwater (*Anodonta cygnea*, swan mussel) and one marine (*Mytilus galloprovincialis*, Mediterranean mussel) were used in the experiments.

2. Serpentinite is a metamorphic rock composed of one or more serpentine group minerals and can have variable hardness.


Schela Cladovei
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Vlasac
Divostin
Blagotin
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Galabnik
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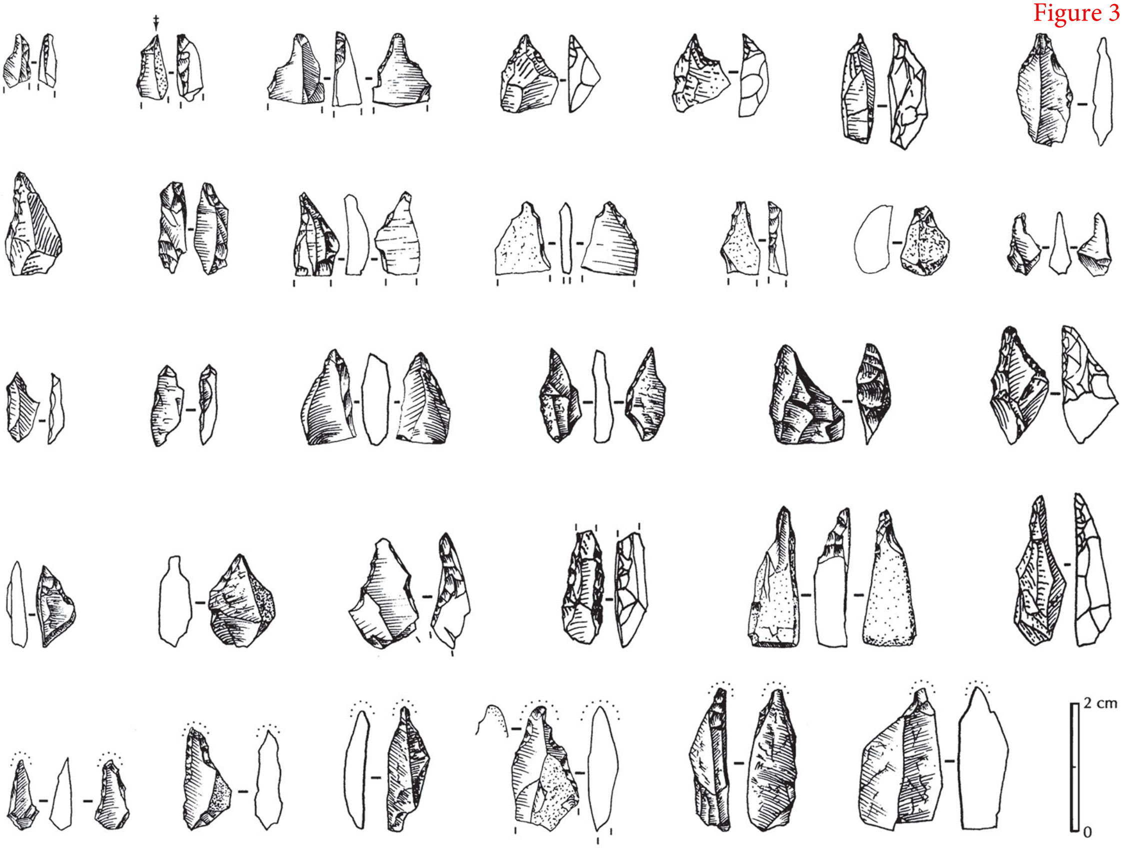
Nea Nikomedia
Franchthi
150 km
100 mi
Figure 1

Figure 2

Figure 3



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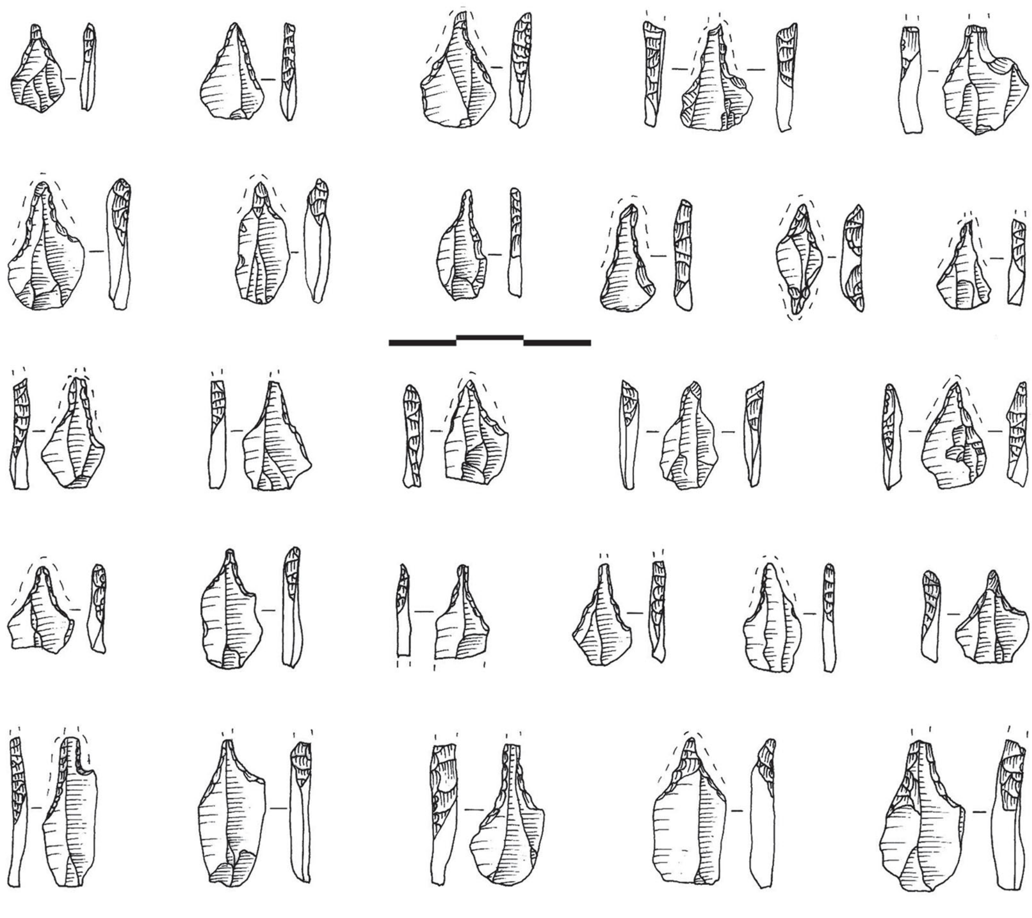

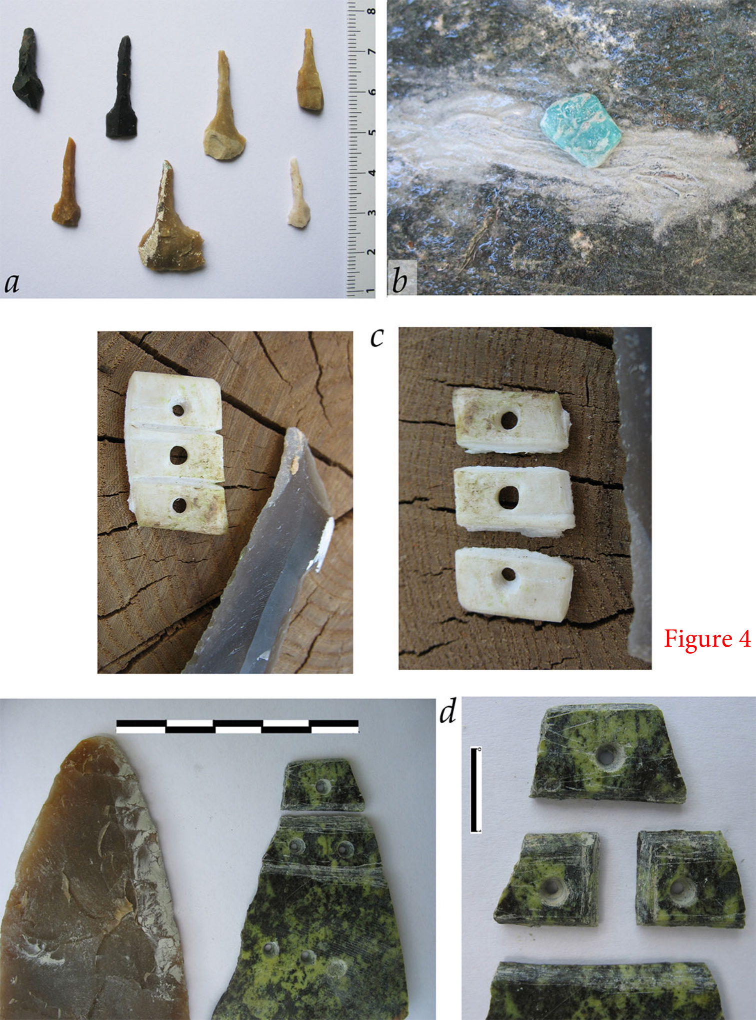

Figure 4

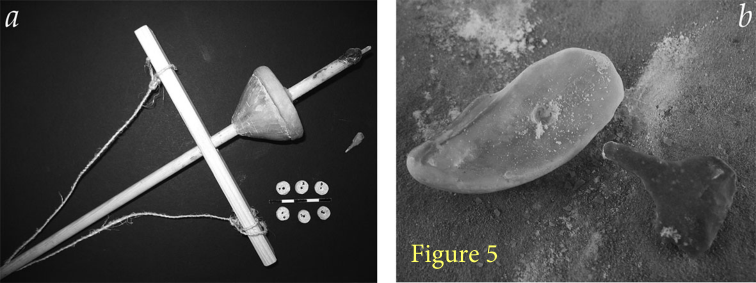

Figure 5

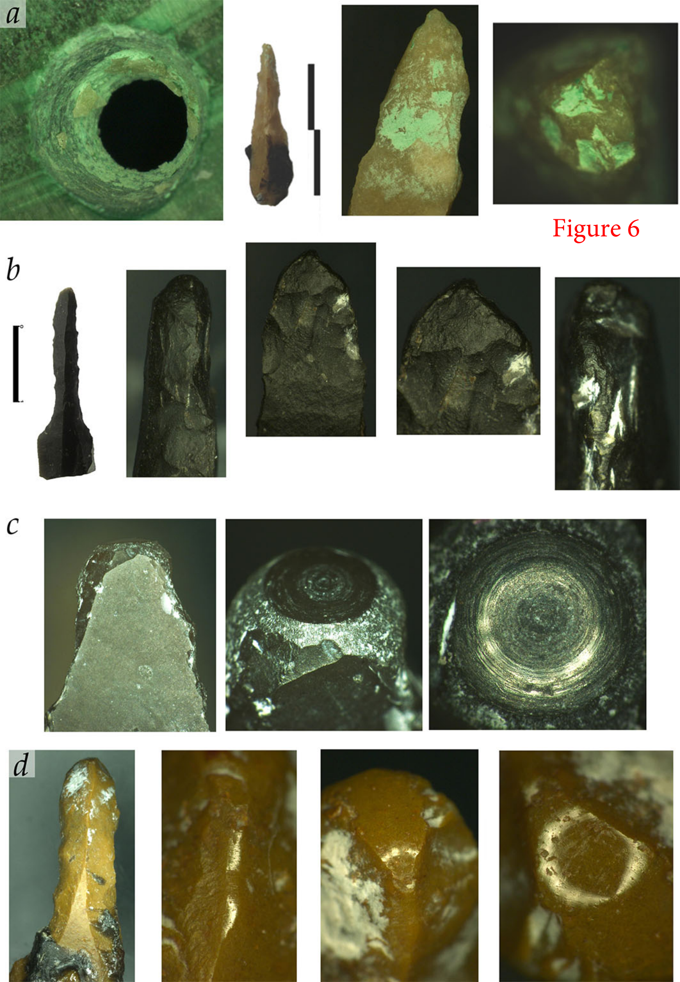

Figure 6

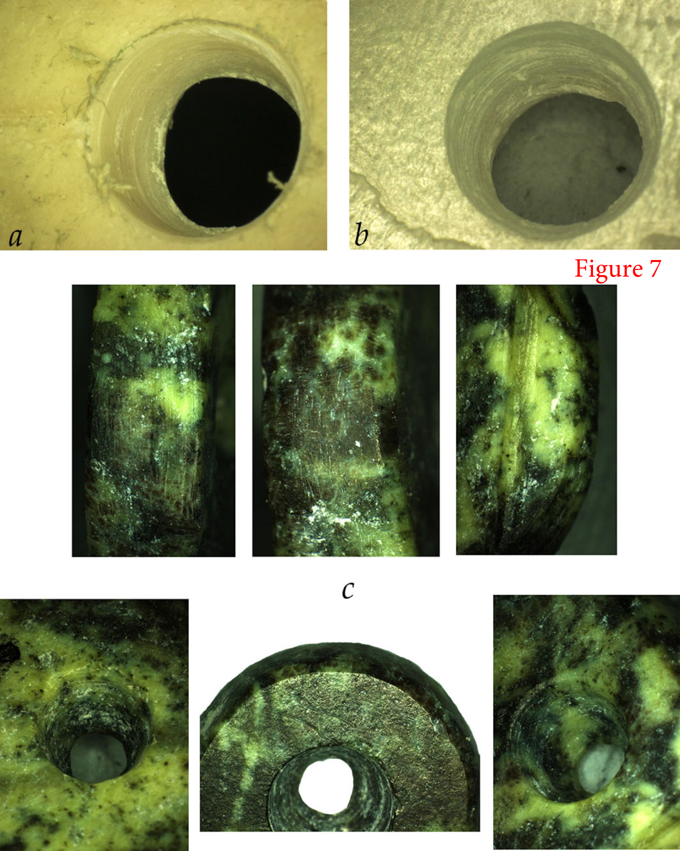

Figure 7