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MANUFACTURE OF BEADS AND SPINDLE WHORLS IN PREHISPANIC PERU

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Careful examination of artifacts can sometimes reveal to the archaeologist skills and ingenuities exercised in their manufacture. The author has recently studied selected items from the extensive collection of Peruvian artifacts acquired by S. K. Lothrop, which collection is presently housed in the Peabody Museum of Archaeology and Ethnology at Harvard University. The objects discussed in this paper include two sets of metal beads, a set of stone spindle whorls, and an interesting bead and tube assembly.

The natives of prehispanic Peru, in common with many other peoples of the world, used beads for personal adornment. The author selected for examination a partial string of small beads (Catalog #46-77-30/6111) from San Antonio in the Supe valley on the central coast of Peru, and also strings of somewhat larger beads associated with a fragment of coarsely woven textile (Catalog #46-77-30/5866) from Sausal in the Chicama valley on the north coast. The smaller beads are barrel-shaped, about 1.5 mm in diameter and 3.2 mm in length (see Figure 1); the larger beads are doughnut-shaped, about 3.9 mm in diameter and 2.1 mm in length (see Figure 2). Both types have been shown by x-ray fluorescence analysis to have been fashioned from pure silver.[1]

Inspection at low magnification disclosed that the smaller beads were made from sheet or strip only 0.12 mm in thickness, so thin that it was possible to emboss the metal by hand pressure using simple tools. The author determined by experimentation that the barrel shape could be achieved by forcing a rectangular blank of thin metal to conform with a hemispherical die using a tool the tip of which was rounded to a smaller radius (see Figure 3). Once an open configuration approaching the barrel shape had been achieved, the peripheral gap could be closed and the bead brought to a predetermined diameter by passing it through a conical orifice (see Figure 4). Opposing edges commonly overlapped to some degree along the closure (see Figure 5, which shows a native bead on the left and one of copper fashioned by the author in the manner described on the right).

Considering the small size of these beads and their identical appearance, it follows that the thin metal blanks from which they were fashioned conformed closely to a dimensional standard. Just how this was achieved cannot be stated with certainty. Perhaps small ingots (buttons) of silver were hammered out into wire, which was then flattened (again by hammering) to produce thin strips of uniform width. These strips in turn could have been cut into short pieces of equal length to serve as rectangular blanks from which to form the beads. Minor differences in blank length would likely have been obscured in the finished bead, as opposing edges commonly overlapped to some degree along the line of closure.

The larger beads differed in design from the smaller ones and must have been made by another method. The author, lacking a simpler explanation, suggests that each bead was fashioned from a short length of wire which was formed into an open ring. The ring was next mounted on a stepped mandrel and forced through a conical die, which served to constrict the ring about the

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mandrel, butt its ends tightly together, and impart a cylindrical inner surface (see Figure 6). The closed ring was then burnished (probably while mounted on a mandrel) in order to smooth and round its outer surface and produce the finished bead.

Both S. K. Lothrop (1950) and J. W. Grossman (1972) have reported discoveries of stone hammers for fabricating sheet metal artifacts in prehispanic Peru. Crudely cut edges and perforations on some sheet metal artifacts have indicated the use of chisels and awls (see Tushingham et al. 1979). The author knows of no reports documenting the use of other tools by Peruvian metalsmiths. Accordingly, their ability to maintain precise dimensional control in quantity production of these tiny beads is indeed remarkable.

The author also selected a number of stone spindle whorls from the Peruvian collection (Catalog #42-12-30/3644). Although the provenience of these whorls was not reported, their cultural identification was indicated in the catalog as "probably Inca".[2] Whereas one whorl is of greyish, translucent stone and another is apparently of baked clay, the majority are of a black mineral, possibly coal.[3] The whorls are oblately spheroidal or lenticular in shape with flattened areas at both ends of the axial hole. A number of the black whorls are engraved with two to four shallow circles, each with a small hole at its very center. All circles are positioned equidistant from one opening, the opposite surface (around the other opening) being undecorated. The circular incisions were filled with white or red pigment readily visible against the dark background (see Figure 7).

The dimensional data for a number of these whorls appear in Table 1. The bore diameters seem greater than necessary for stringing, an indication that the items are whorls, not beads. The fact that the circular decorations were grouped about the bore opening of only one hemisphere seems consistent with the apparent practice of leaving one surface of a spindle whorl undecorated.

The author chose to study the whorls to determine whether the technology of prehispanic Peru included the use of metal tubular drills.[4] Although evidence for hollow drills from prehispanic Peru had been reported for the site of Pashash (Grieder 1978), the excavator, Terence Grieder, felt that the drills had been made of organic materials such as reed or bone. A drill capable of cutting stone because of superior hardness must also possess the strength and toughness to hold its edge and withstand operating loads. Such a combination of properties is difficult to achieve, but the natives of ancient Peru apparently avoided the problem by using an abrasive, probably fine sand. Sharp edges of hard abrasive particles, squeezed between rotating drill and stationary work-piece, wear both away simultaneously. Drills could have been fashioned of wood, bone, or metal, but the former wear away more rapidly than the last. Wear is a function of relative movement and pressure: at the end of the drill, that portion furthest from the axis of rotation experiences the greatest relative movement and wears most rapidly. Accordingly, when a solid drill penetrates the work-piece, the hole at the exit is smaller in diameter than at the point of entry. The annular edge at the end of a thin-walled tubular drill is essentially at a fixed distance from the axis of rotation, so that its contour does not change appreciably as it undergoes abrasive wear: on penetration of the work-piece the bore of the hole is quite uniform in diameter (see Figure 8).

Table 1. Dimensions in centimeters of stone spindle whorls from this study.

#	h	d_o	D	d_c	id_1	id_2	material
1	0.655	1.104	3c	0.388	0.444	0.398	bs
2	0.685	1.056	4c	o.342	0.406	0.347	bs
3	0.599	0.967	2c	0.314	0.358	0.325	bs
4	0.563	1.145	r	-	0.487	0.462	bs
5	0.640	1.193	-	-	0.436	0.408	bs
6	0.541	1.016	-	-	0.419	0.386	bs
7	0.825	1.108	-	-	0.447	0.355	gs
8	0.914	1.076	-	-	0.472	0.411	bc

Key

h: height
d_o: outside diameter
D: decorations, circle-dot (c) or radial groove (r)
d_c: diameter of circular decorations
id_1: larger bore diameter
id_2: smaller bore diameter
bs: black stone
gs: green stone
bc: baked clay

Figure 8 shows how the trepanning action of a tubular drill leaves a solid core of material (which can be broken off and removed at intervals, if so desired, facilitating introduction of abrasive at the cutting surface). Since, with a tubular drill, the amount of material to be ground away from the work-piece in order to achieve penetration is reduced by the volume of the residual core, the tubular drill cuts much faster than a solid drill and requires less abrasive. Figure 9 shows how a crude tubular drill can be fashioned from ductile metal sheet.

Inspection suggests that a tubular drill was used to fashion the whorls under study. Precisely concentric scoring marks visible at magnification in the circular designs cut into the surfaces of several whorls indicate use of a rotary tool (see Figure 10). The circles are so concentric with the small central holes that the author concluded that they were cut concurrently, using a solid center drill mounted coaxially within a tube (see Figure 11). It would not appear possible within the constraints of ancient Peruvian technology to construct such a drill to these small dimensions using a material other than metal.

Additional support for the metal tubular drill hypothesis may be drawn from an assembly (Catalog #42-28-30/4701) consisting of a round bead of blue stone and a conical bead of green stone which are both mounted on a thin tube of silvery metal (see Figures 12-14). The author believes that the blue bead may be azurite, a secondary copper mineral (see Hurlbut and Switzer 1979: 186). This bead measures 1.04 cm outside diameter and 0.66 cm high. (The inside diameter was not measured to avoid disassembly from the tube.) The green bead appears to be chrysocolla, another secondary mineral found in oxidized zones of copper deposits in association with azurite, malachite, and native copper (ibid.: 174-175). The outside diameters of the truncated cone measure 0.77 and 0.51 cm; its inside diameter measures 0.29 cm; the height is 0.78 cm. The metal tube measures 0.21 cm outside diameter by about 1.5 cm in length; wall thickness approximates 0.3 mm. The conical bead is set with a number of small, golden, hemispherical granules which, under magnification, are revealed as tiny cups embossed from metal foil and attached to the bead with adhesive (see Figure 15). The central tube has an open, overlapping longitudinal seam and is splayed to form a modest flange as it exits the bore of the round bead. A fragment broken from the flange exposes reddish core metal indicating a "mise-en-coleur" alloy, probably copper-silver.[5] The tube, which is nearly the length of the assembly, appears to have been broken off at its other end. Not only do the holes through the beads appear to have been cut with a metal tubular drill, but a section of the tubing adequate for the purpose is provided, demonstrating native capability to fashion such a tool. The provenience of this interesting assembly is not known, aside from its Peruvian origin. The tumbaga (copper-silver) tube is an indication of prehispanic manufacture; no further identification appears possible.

The author knows of no report in the archaeological literature of prehispanic Peru which mentions tubular metal drills. Items fashioned from thin sheets of copper, bronze, mise-en-coleur alloys, even silver, have not infrequently corroded beyond recognition during the period since their manufacture, use, deposition, and potential excavation by archaeologists. Precious gold, which does not corrode, would not likely have been used for this mundane purpose. Further, if small metal tubes *had* been found, it does not follow that their application as drills would have been recognized and the discovery recorded. However, as mentioned above, Grieder (1978) has found evidence from the site of Pashash, in Ancash, Peru, indicating the *use* of rotary tools for stoneworking. These tools included "a solid drill; a hollow drill, presumably made of reed or bamboo or perhaps bone; and a lathe" (ibid.: 109). Grieder goes on to state, however, that no traces of the tools themselves were found. Pashash dates to the Early Intermediate Period, between about 200 and 700 A.D..

The fact that each bead or spindle whorl in the study collection possessed rotational symmetry about its central passage is worthy of comment. It suggests that the stone blank from which a bead was to be fashioned was first drilled and then mounted securely upon a mandrel. By holding this assembly against an abrasive tool (e.g., a piece of coarse sandstone) and rotating the mandrel, the blank was ground to a final shape symmetrical with the axis of rotation. This is the principle of the lathe. It is remarkable that this principle, which proved so important in many cultures, found relatively little application or development in prehispanic Peru.

Endnotes

1. Some silver artifacts from the Chavín culture (800-450 B.C.) have been reported (see Lothrop 1951). Lothrop indicates, however, that silver objects were rare on the north coast until about 500 A.D..

2. These artifacts were apparently acquired from *huaqueros* or middlemen. Just where they were unearthed is unknown. Survey of stone whorls in the lithics collection at the Peabody Museum of Archaeology and Ethnology, Harvard University, disclosed a limited variety of shapes and relatively few whorls with incised decorations. A number of black stone whorls with circle-dot decorations (similar to those reported in this paper) are documented as deriving from the Sausal site in the Chicama valley on the north coast of Peru. However, beads and spindle whorls may have been traded or carried far from their place of origin as spoils of war.

3. Donnan and Mackey (1978: 18) report mirrors fashioned of anthracite.

4. By way of background, during the spring of 1977, the author participated in a study of cylinder seals then under way at the Harvard Semitic Museum. Carved stone seals of cylindrical shape appeared in southern Mesopotamia ca. 3000 B.C. and were used to impress the insignia of their owners on wet clay of cuneiform tablets which, when hardened, became durable records of business inventories, legal transactions, etc.. By dimensional analysis and microscopic examination of one such seal, the author concluded that it had been trepanned from solid stone using tubular metal drills, presumably of copper. He supported this hypothesis by making such a drill from copper foil and employing it to fashion a seal from steatite in the manner proposed (Arnold 1977).

5. Of the three elements copper, silver, and gold, the exposed surface of copper oxidizes most readily at an elevated temperature and gold least readily. When copper-gold or copper-silver binary alloys undergo a series of annealing and pickling operations, the surface gradually becomes depleted of copper, causing a

change in color to that of the remaining constituent. Likewise, the surface of copper-silver-gold ternary alloys becomes depleted first of copper, then of silver, finally to give the appearance of gold (Lechtman 1971).

References

Arnold, Stuart V.
1977 Fabrication of Cylinder seals. Seminar on Nuzi Studies. Ms. on file, Harvard Semitic Museum, Harvard University.

Donnan, Christopher B. and Carol J. Mackey
1978 *Ancient Burial Patterns of the Moche Valley, Peru.* Austin: University of Texas Press.

Grieder, Terence
1978 *The Art and Archaeology of Pashash.* Austin: University of Texas Press.

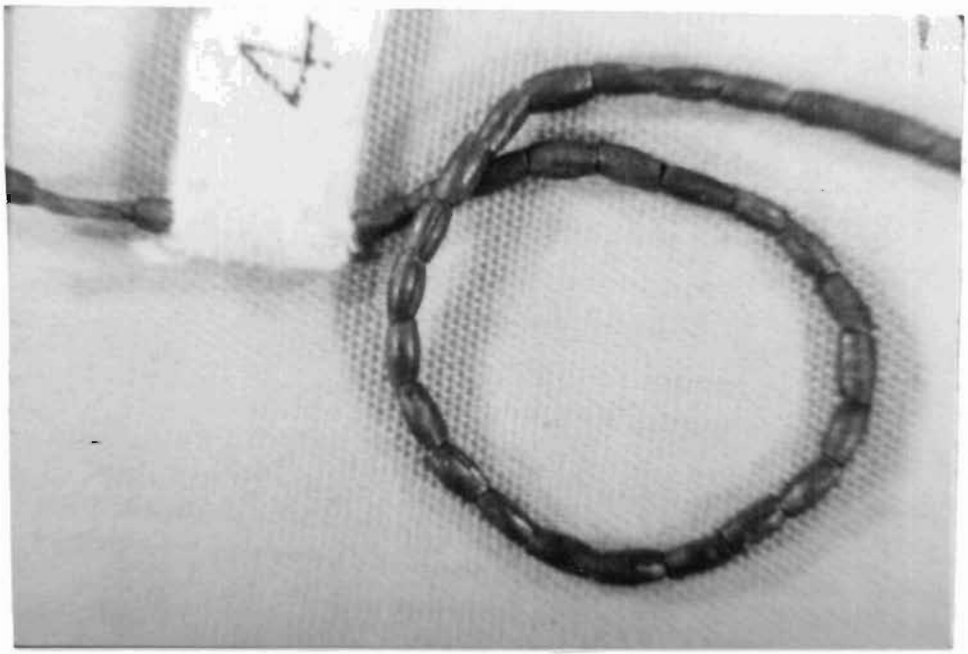
Grossman, Joel W.
1972 An Ancient Goldworker's Tool Kit. *Archaeology* 25(4): 270-274.

Hurlbut, C. S. and G. S. Switzer
1979 *Gemology*. New York: John Wiley & Sons.

Lechtman, Heather N.
1971 Ancient Methods of Gilding Silver--Examples from the Old and New Worlds. In *Science and Technology*, edited by R. H. Brill, pp. 2-30. Cambridge, MA: MIT Press.

Lothrop, Samuel K.
1950 Metalworking Tools from the Central Coast of Peru. *American Antiquity* 16: 160-163.
1951 Peruvian Metallurgy. *The Civilizations of Ancient America.* XXIX International Congress of Americanists.

Tushingham, A. D., V. M. Franklin, and C. Toogood
1979 Studies in Peruvian Metalworking. *History, Technology and Art, Monograph* 3. Toronto: Royal Ontario Museum, Alger Press.



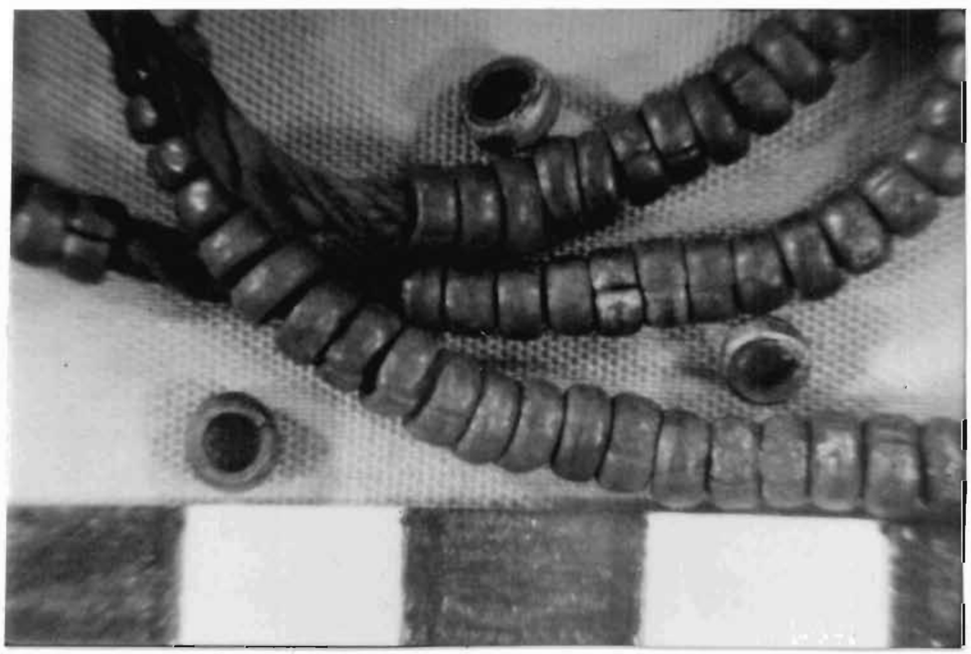


Figure 1 (above). Small silver beads from San Antonio, Supe, Peru, magnified 3.3 x to show longitudinal lap seams. *Note*: All of the objects in this study are from the collections of the Harvard Peabody Museum.
Figure 2 (below). Larger beads from Sausal, Chicama valley, Peru, magnified 3.3 x to show butt seams.
Editor's note: Due to poor health, the author was unable to provide clearer photographs of the objects discussed in this paper.

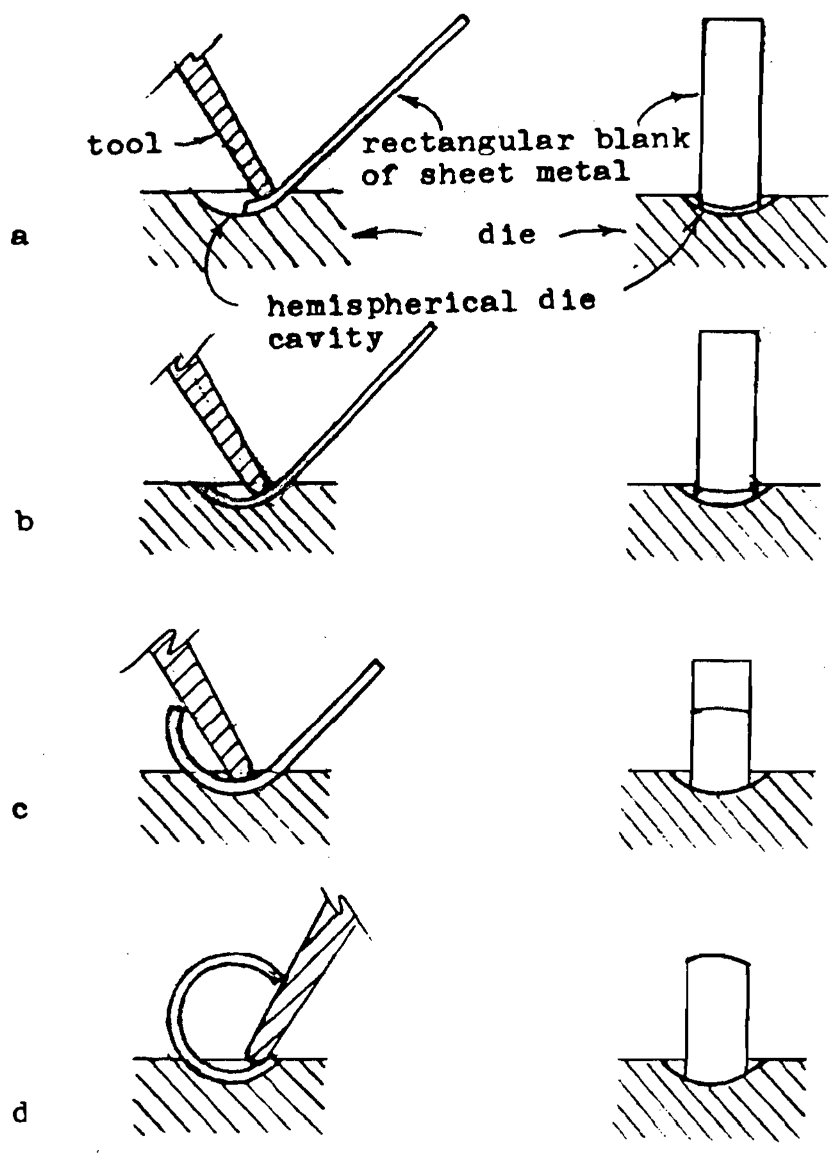
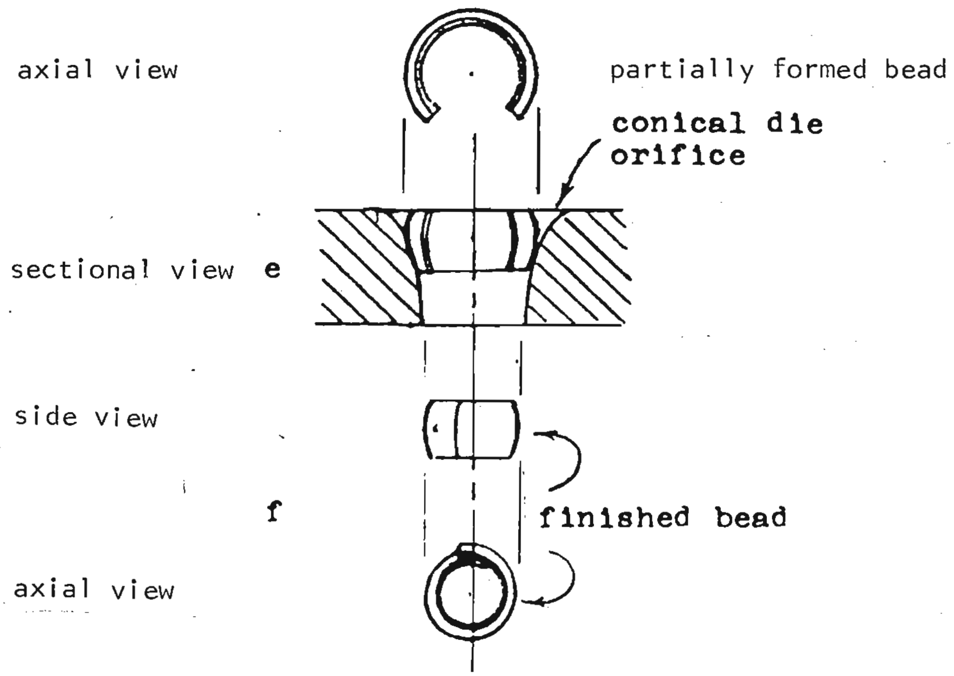


Figure 3. Sequence of steps in the partial formation of a barrel-shaped bead from a rectangular blank of thin sheet metal.



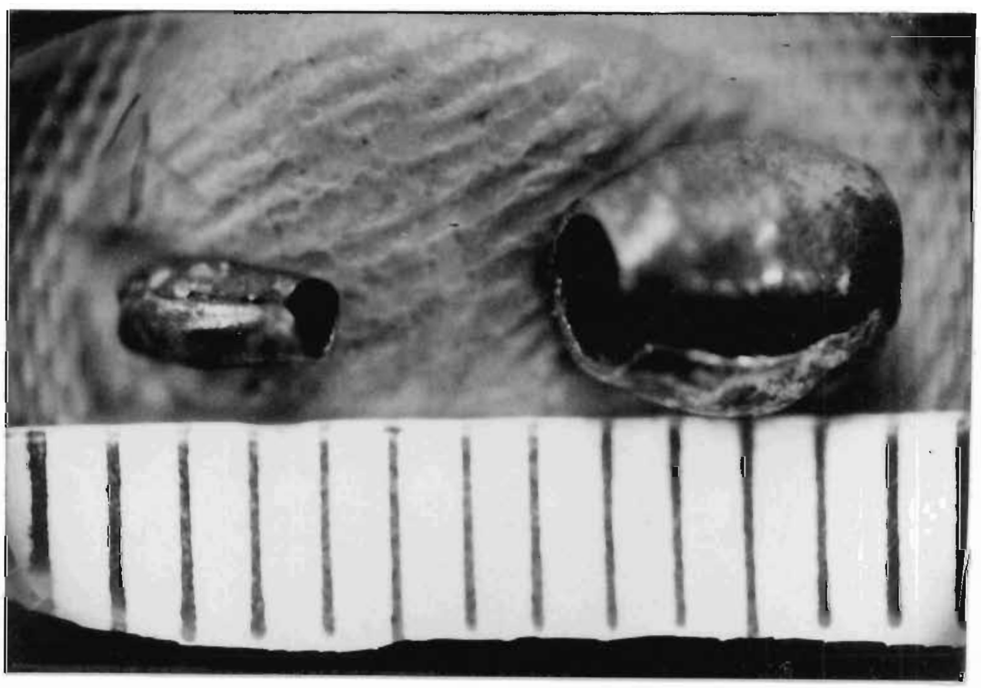


Figure 4 (above). Method for closing a partially formed bead by forcing it through a conical orifice.
Figure 5 (below). Small silver bead (left) and copper bead fabricated experimentally by the author. 10.5 magnification.

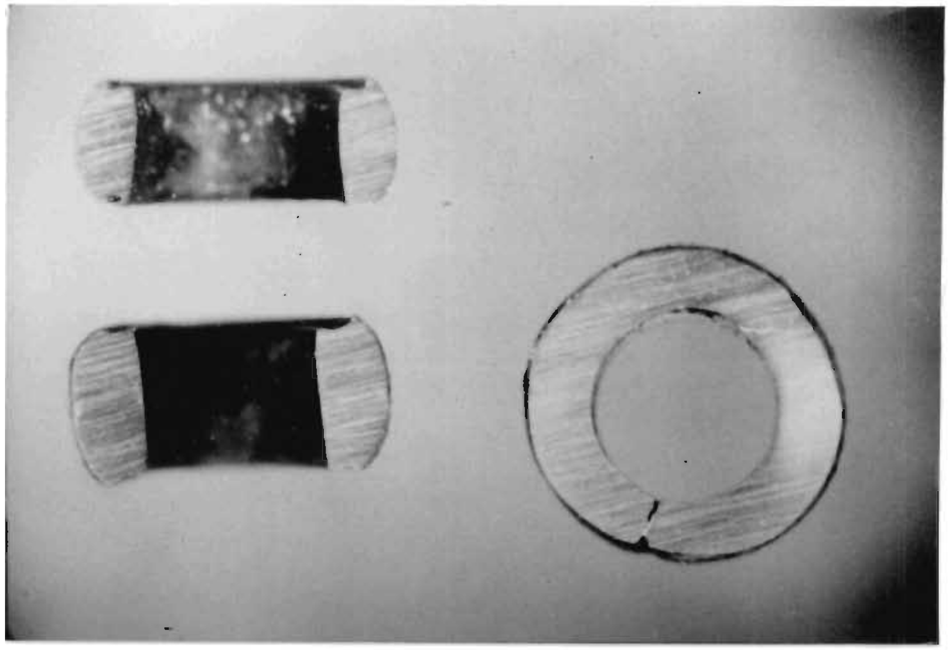


Figure 6 (above). Sections of the larger silver beads shown in Figure 2. Note the tightly butted seam of the planar section (lower right) and the rounding of the exterior shoulders of axial sections (left). 10.5 x magnification.
Figure 7 (below). Stone spindle whorls from Peru, some engraved with circle-dot designs. 1.6 x magnification. Specific provenience unknown.

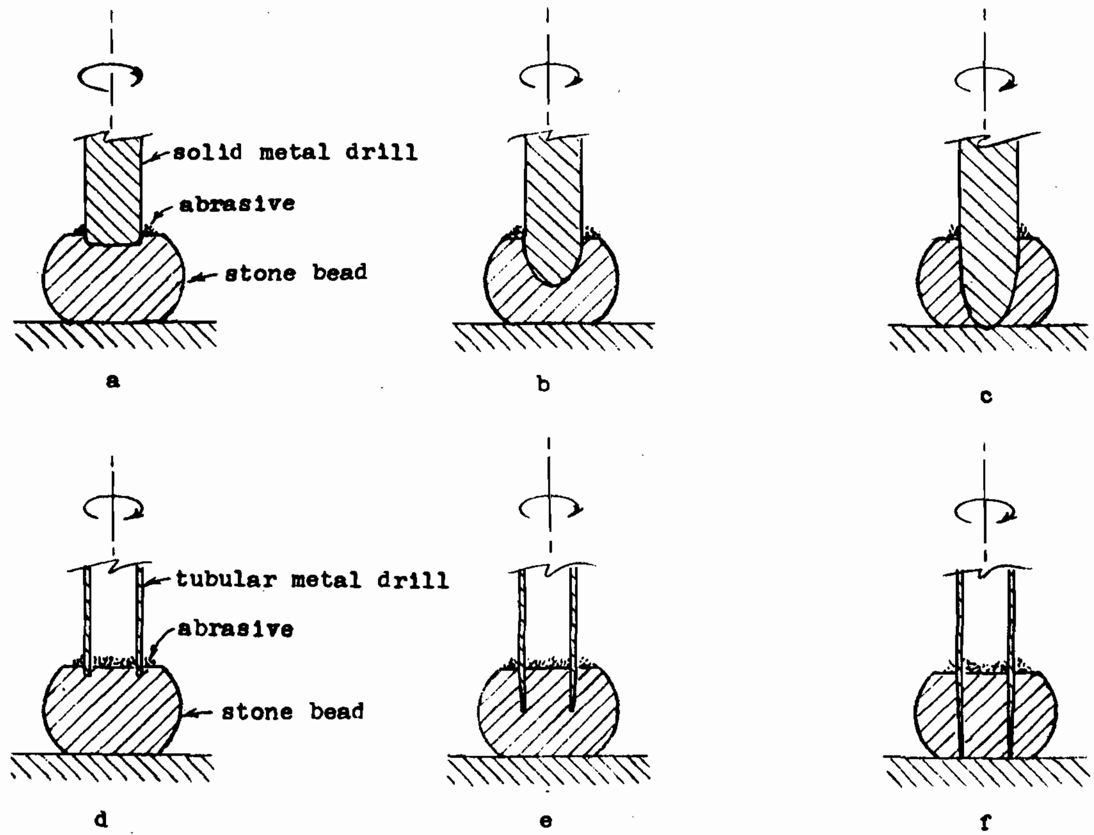


Figure 8. Abrasive wear of solid metal drills (a, b, c) in comparison with that of tubular metal drills (d, e, f).

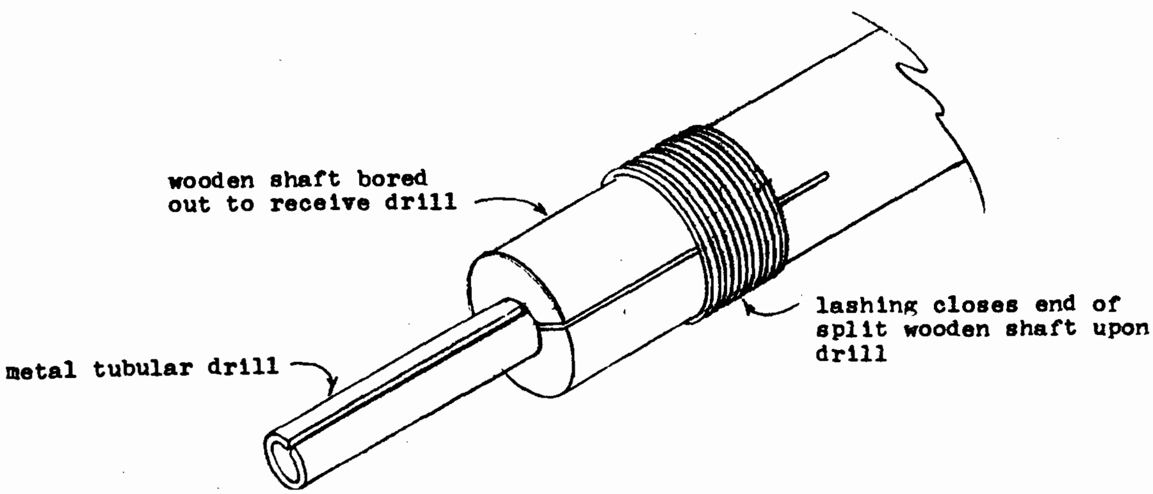


Figure 9. Suggested design of a tubular drill fashioned from thin metal sheet and mounted in a wooden shaft.

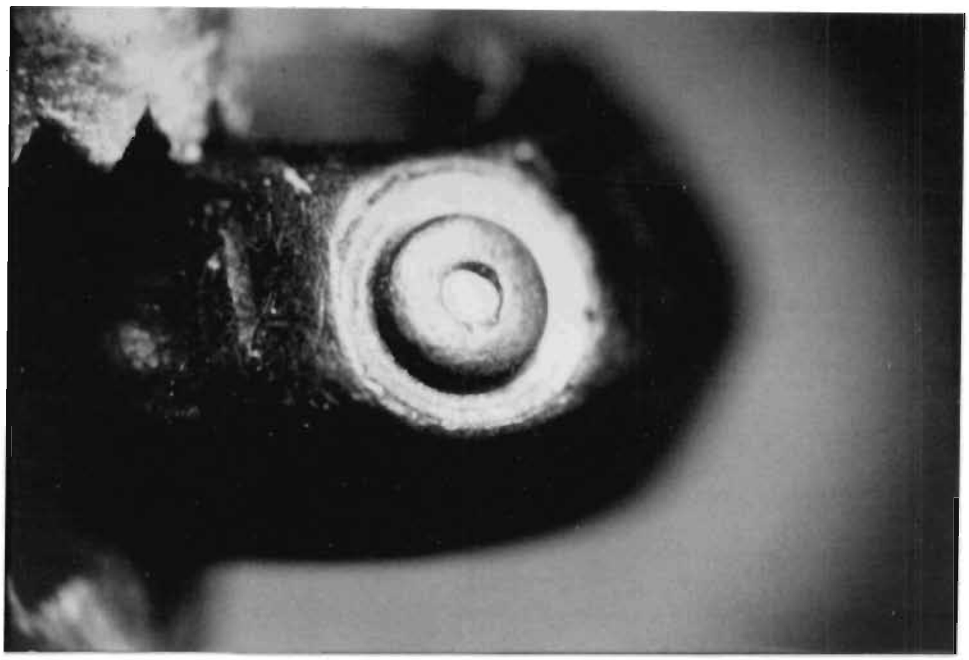


Figure 10. Circular design on a whorl from the group shown in Figure 7, showing parallel scoring left by a rotary tool. 8 x magnification.

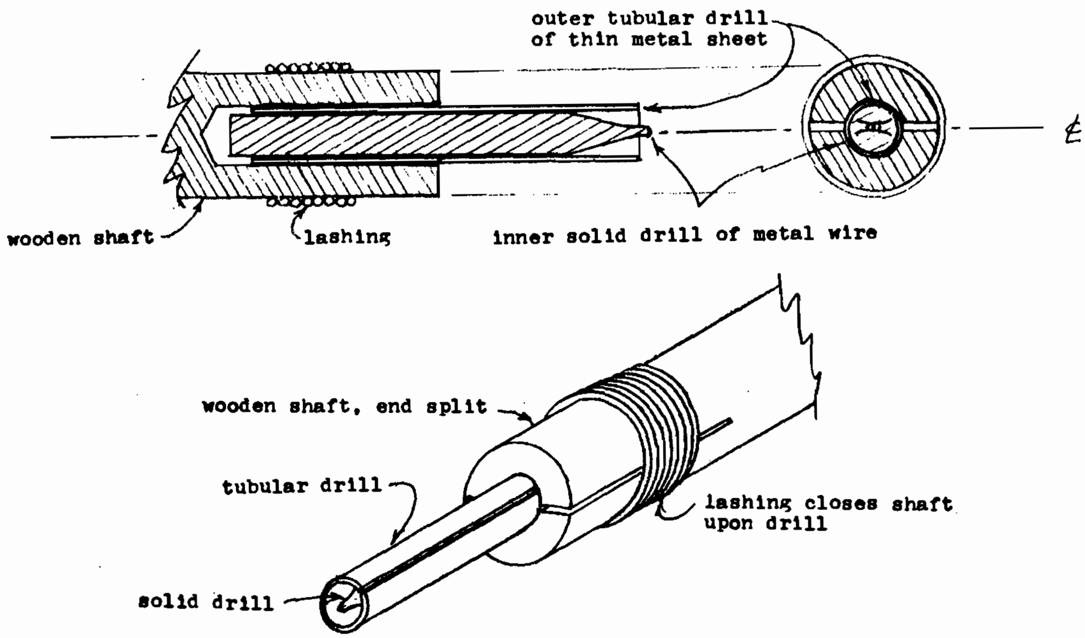


Figure 11. Suggested design of a composite drill with outer (tubular) and inner (solid) elements mounted coaxially.

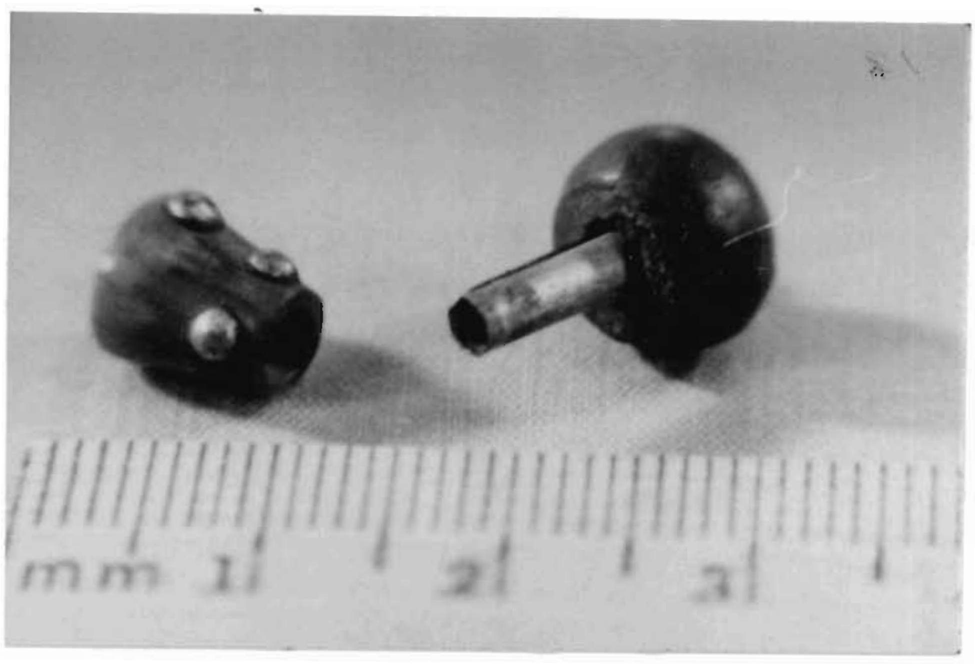


Figure 12 (above). Assembly consisting of a round blue bead and a conical green bead mounted on a central metal tube. 3.2 x magnification. From Peru, specific provenience unknown.
Figure 13 (below). Conical bead removed from the above assembly to show metal tube. 3.2 x magnification.

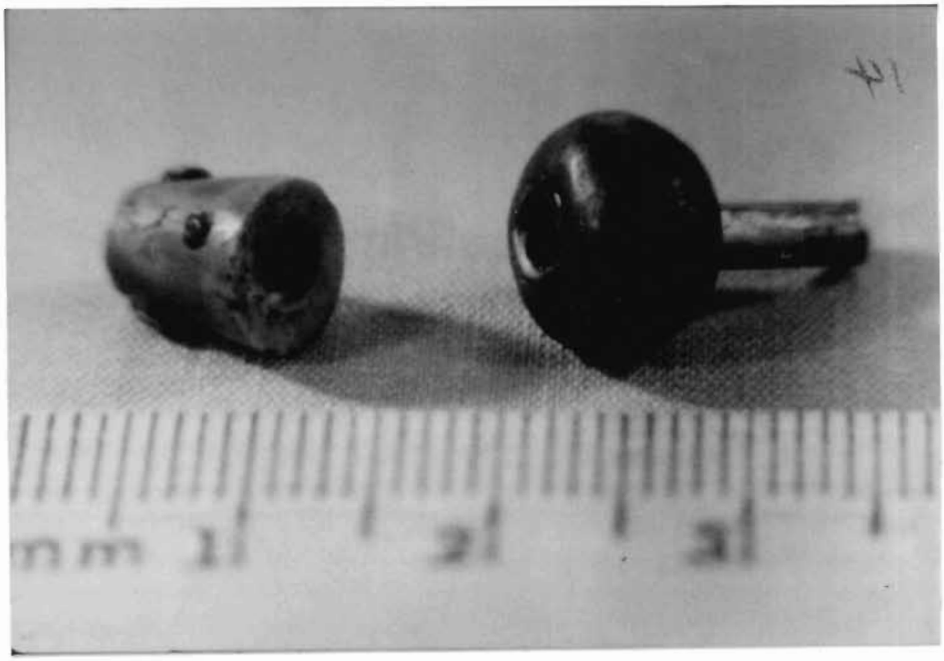


Figure 14 (above). Components of the assembly shown in Figures 12 and 13 positioned to show the flange at the end of the metal tube. 3.2 x magnification.
Figure 15 (below). Tiny cups of metal foil attached adhesive to the conical bead from the assembly shown in Figures 12-14.