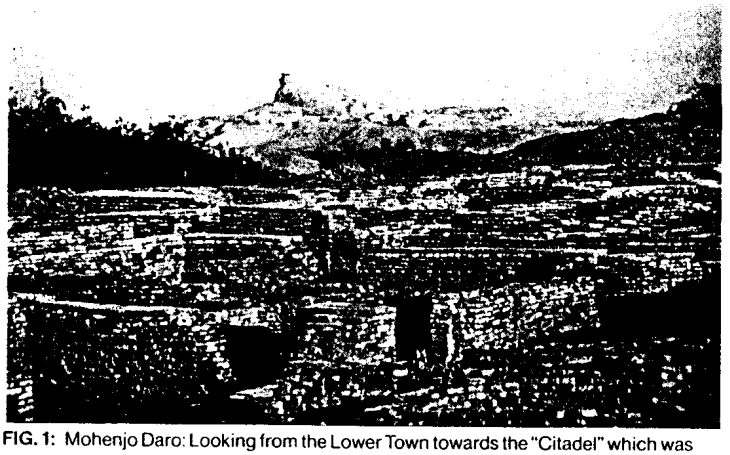


FIG. 1: Mohenjo Daro: Looking from the Lower Town towards the "Citadel" which was later the site of a Buddhist Stupa. Except where indicated, all photographs are by the author.

The Indus Bead Industry

Contributions to Bead Technology

*Jonathan Mark Kenoyer**

Archaeology and the study of ancient peoples always has been a fascinating topic, but it has changed greatly from the early treasure hunting and collecting expeditions to the more scientific study of how human culture developed and what causes human culture to change. Recent studies of the Indus Civilization and the developments that preceded it during the Neolithic and Early Chalcolithic in the Indus Valley and Baluchistan are revealing many new aspects of human culture in South Asia (Figs. 1, 2). The Indus Civilization is famous for its beads, which were traded as far as Mesopotamia, but only now are we beginning to understand the complex techniques used in their manufacture and the socio-economic structure of the industry.

Beads are a form of human culture with which most people throughout the world are familiar, yet few realize that beads are among the earliest evidence for something that is uniquely human — a symbolic expression of abstract ideas. We usually refer to beads as non-functional in terms of procuring food — you cannot kill a deer or dig up a tuber with a bead. But beads were evidently functional in a symbolic manner. A tiger tooth pendant might protect and guide the hunter; a coral and turquoise amulet might assist the mother in childbirth; or more simply, a beaded choker could symbolize beauty, love or prestige.

Whatever the specific symbol, ancient humans took time to manufacture beads as early as the last great ice age during the Upper Paleolithic period (35,000 - 10,000 years ago). In this early period, beads were made by shaping and perforating soft stone, bone, ivory, antler or shell. Some raw materials were used in their natural shape, while others were shaped by chipping or grinding and perforating with a sharply pointed stone tool. This technique continued for several thousand years until the Neolithic period (about 9000 years ago in South Asia), when people began to settle down in permanent camps or villages.

One of the most important sites from this period is the site of Mehrgarh in Pakistan (Fig. 1) where there is evidence for the production and trade of beads as early as the seventh and sixth millennia B.C. during the pre-ceramic occupation of the settlement (Jarrige and Meadow 1980). It is extremely interesting that before people began to make pottery, they had developed a bead industry, and not only at this site, but at most sites in southwest Asia. The beads produced in these early villages were traded with neighboring regions and eventually ended up 500 to 1000 kilometers from their place of origin (Kenoyer 1986). The only way that this can be determined is from careful studies of the beads in their archaeological context and from scientific studies of the raw materials and their possible source areas.

During the early Neolithic period at Mehrgarh (7000-5500 B.C.) bead technology had developed beyond the simple process of perforating a nice stone or shell to a concentrated effort of making specific shapes of beads

and pendants. Chipping techniques adapted from stone tool manufacture were used to shape stone, and stone blades were used to cut and shape softer materials like shell or bone. Beads were ground smooth on flat stones and perforated with short stone drills.

The Neolithic stone beads were primarily made from softer stones such as steatite (soapstone), alabaster/chlorite, lapis lazuli and turquoise. These beads were probably perforated with a chert drill set at the end of a reed or wooden shaft. Although it is often difficult to determine how the drills were turned, they may have been twirled by hand, or possibly a pump drill or bow drill may have been used.

Shell disc beads were also produced using a technique that is common in many parts of the world (Foreman, 1978). Shells are first broken into small chips which are then perforated and strung on a cord. Finally, a length of rough beads is ground on a flat piece of sandstone until they are perfectly circular. Beads made in this fashion result in sets of beads that are basically uniform in diameter, though the beads on a different length are generally slightly different in diameter. Since there was no shell manufacturing waste in the debris at the site of Mehrgarh it appears that the disc beads were traded from distant coastal areas on the Persian Gulf. These beads were evidently in great demand because most burials have at least one or two lengths of shell beads and additional anklets or bracelets made from steatite beads. Sometimes we even find various types of soft stone disc beads that may have been made to imitate the shell beads.

Additional bead shapes made from shell or stone include long cylinders, short barrel beads and a variety of tabular shapes. These techniques for shaping and drilling were used in the Indus Valley and adjacent regions throughout the Neolithic period and into the early Chalcolithic; and some of these techniques are still practiced today in the traditional bead industry of Khambhat (Cambay), western India (Trivedi 1964, Possehl 1981). Observations made in the modern workshops and further studies of drilling and polishing will help us to better understand not only the technology but also the socio-economic structure represented by the ancient bead industry (Figs. 10, 11).

During the Chalcolithic period (4500 B.C.) industries such as copper and bronze working, pottery making and bead manufacture became more specialized (Jarrige 1981). The bead drillers began using a very hard cylindrical drill that allowed them to efficiently perforate long agate beads, such as those found at the sites of Chanhu-Daro (Mackay 1943) and Mohenjo Daro (Marshall 1931, Mackay 1938) (Figs. 3, 7). The early form of short chert drills were not suitable for drilling agate, but the new drills, made of a more resilient chert/jasper were quite effective. Agate and jasper have about the same hardness, but agate has a fibrous crystalline structure and jasper has a

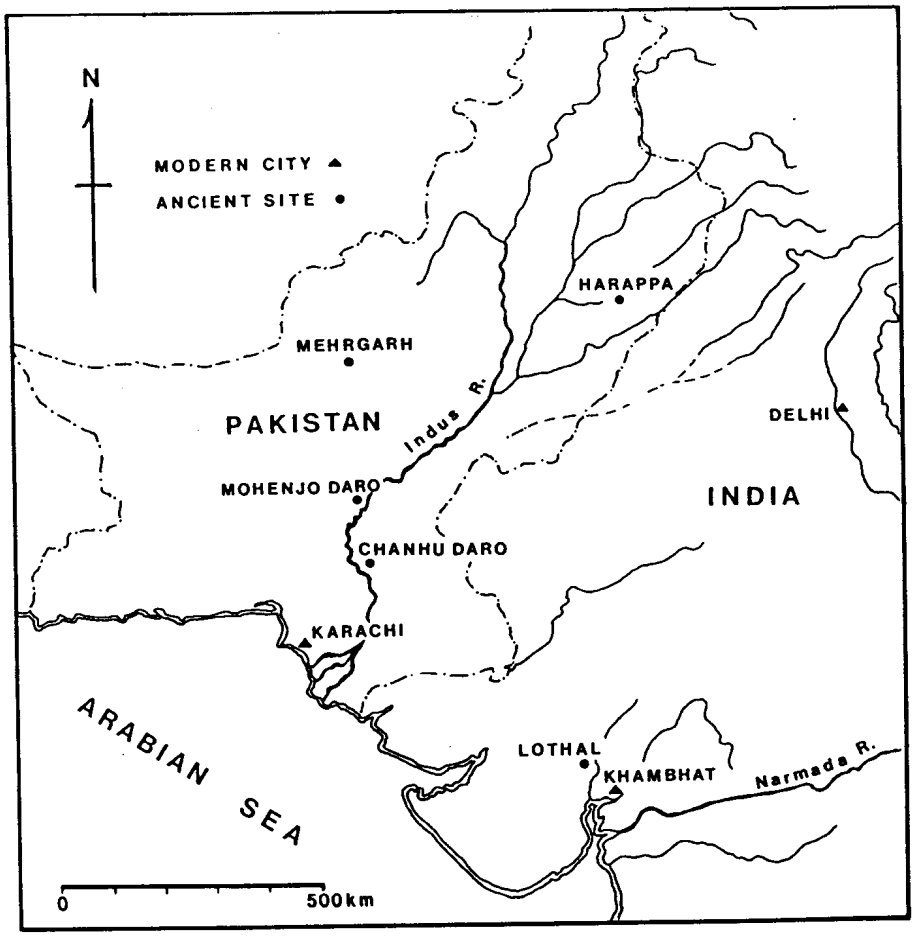
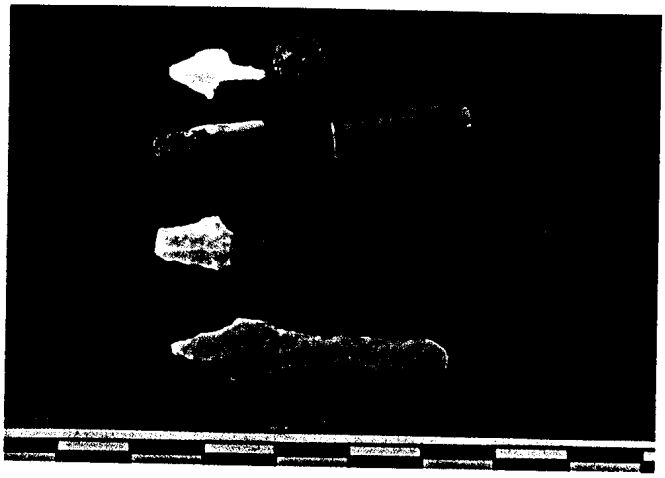
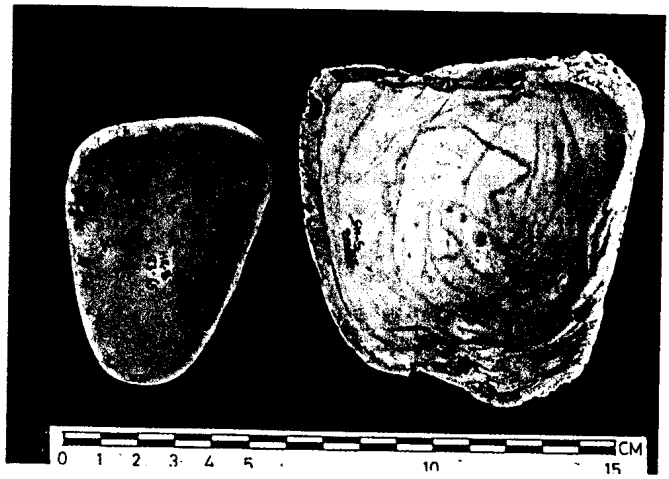


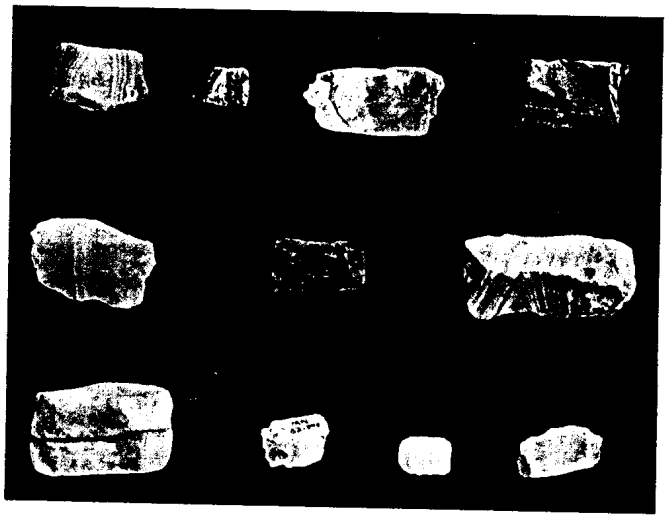
FIG. 2: Map of Indus Valley including Mehrgarh, MD, Chanhudaro, Harappa, Lothal, Khambhat.



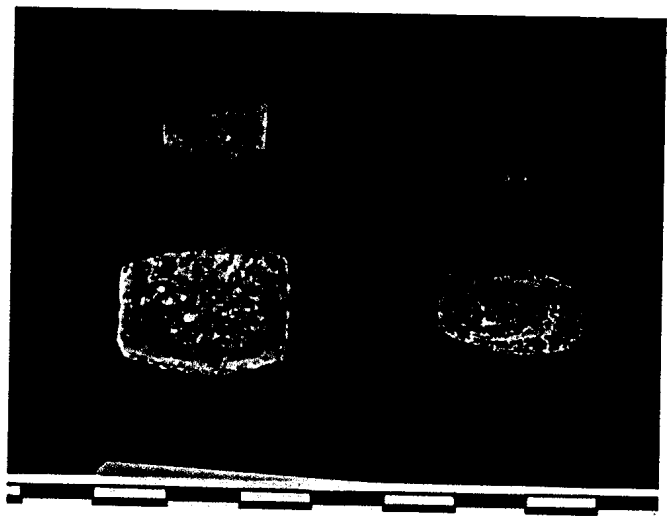
3



4



5



6

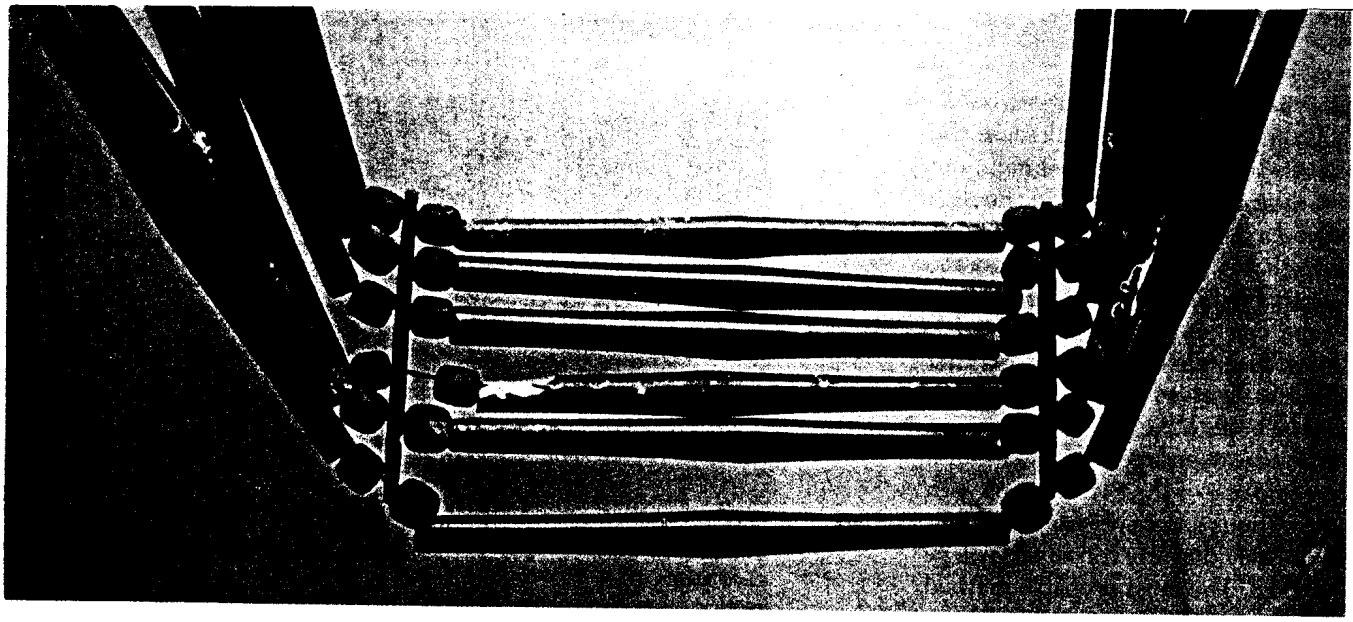
granular one. The drill bit was set at the end of a reed or wooden shaft and turned with a bow drill. The evidence for the use of a bow drill has been found at several Indus sites and consists of the drill back that is held in the hand to allow the driller to press down and stabilize the drill as it turns without injuring his hand. At Mohenjo Daro and Harappa several such pieces made from hard shell have been found (Kenoyer 1984: 108) (Fig. 4). It is also possible that other examples were made from more perishable materials such as coconut shell, which is still used in Khambhat today.

Drilling with these stone drills may have been slow, but their relative efficiency should not be underestimated. At the tip of the drill is a slight depression that forms as the drill is used. The outside edge of the drill cuts a circular groove into the stone and the central raised area is gradually chipped and ground away. The ground agate dust assists as a natural abrasive that is continuously replenished as the lubricating water washes it away.

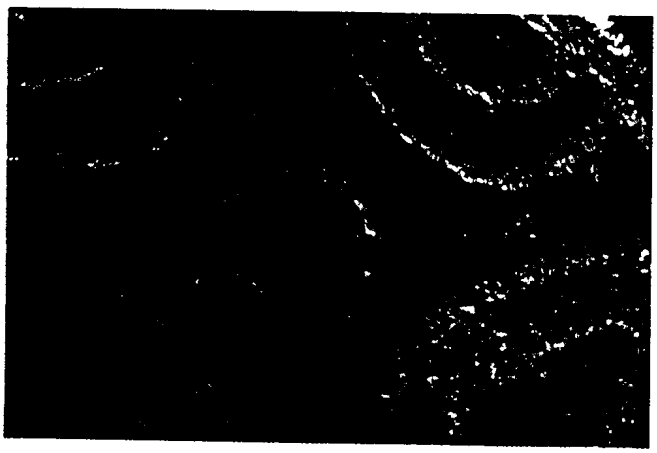
Short round or flat beads could be drilled by setting them firmly in a depression on a board, but long beads were probably held in a simple vise. We can get an idea of how this might have looked by observing the traditional bead drillers of Khambhat.

The technique for using this type of drill continued into the Indus or Harappan period and was used to drill extremely long and narrow beads of carnelian (Fig. 7). Some scholars have suggested that these long carnelian beads were drilled with copper drills and abrasives, but the discovery of the specialized stone drills associated with partially drilled beads and the internal striae of the drilled beads indicate that the stone drills were used for agate drilling (Mackay 1937; 1943). During both the Neolithic and later periods, beads were ground on fine-grained sandstone or quartzite and were then individually polished by hand, probably using a fine silica dust on a wooden board. This technique is still used today for the final polish of faceted beads in Khambhat (Figs. 9, 12). The presence of micro-facets on the polished surface and sharp edges at both ends indicates that most of the Indus beads were not polished by tumbling.

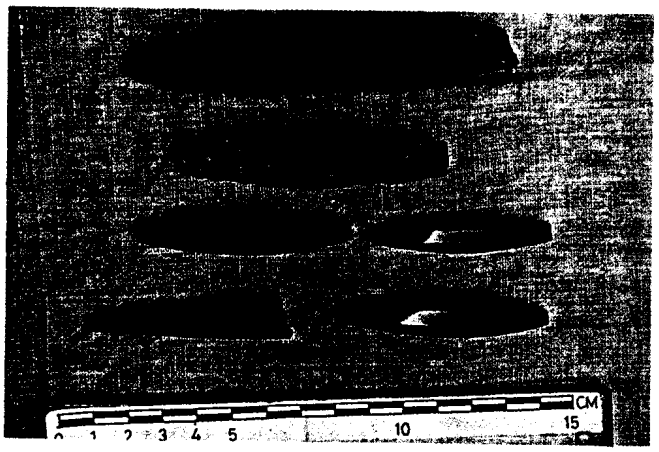
The shapes of Indus agate beads are more standardized than those of the Neolithic; there are long tapered barrel beads, short barrel beads, and various tabular shapes along with the



7



8



9

standard short cylindrical and short bicone forms. A wide range of raw materials was also used, including agate, carnelian, jasper, lapis lazuli, turquoise, serpentine and green aventurine (Vidale 1985) (Figs. 5, 6). Banded agates were made in such a way as to accentuate their banding, particularly if there were concentric circles or eyes in the stone. Jasper was also used quite commonly because of its many shapes and colors, but the most desirable appears to have been carnelian with white banding. Evidently there were not enough of these banded agates and jasper to go around because the bead makers turned out a lot of imitations made with clay and paint, or by incising soft steatite beads and filling the lines with paste, or even joining layers of carnelian with white alabaster.

FIG. 3: Mohenjo Daro: Drills and types of beads; from top, short chert drill and hematite bead, subcylindrical chert/jasper drill and hard carnelian beads, other long chert drills and carnelian beads. *Published with permission from IsMEO-RWTH.*

FIG. 4: Mohenjo Daro: *Lambis* shell drill backs, with numerous shallow depressions from the upper pivot of the drill. *Photo published with permission from IsMEO-RWTH.*

FIG. 5: Mohenjo Daro: Rough blocklets of quartz, banded agate and jasper. *Published with permission from IsMEO-RWTH.*

FIG. 6: Mohenjo Daro: Finished and unfinished beads, clockwise from top, serpentine (?), hematite, lapis lazuli, aventurine. *Published with permission from IsMEO-RWTH.*

FIG. 7: Mohenjo Daro: Long carnelian beads in a girdle or necklace. *Published with permission Mohenjo Daro Museum.*

FIG. 8: Bleached or "etched" carnelian bead. *Photo by Patrick Craig.*

FIG. 9: Khambhat: Rough and finished faceted carnelian beads. *Courtesy of Kesari Singh.*

The high demand for carnelian with white designs resulted in the development of special techniques to color stones and to paint them with specific designs. First, the agate or carnelian was heated to deepen the color of red, and this heating process was done either in shallow pits or more controlled kilns. The bleaching process, also referred to as etching, has been the topic of much discussion and some experimentation, but until we find one of their workshops with the various stages of manufacture it is unlikely that any consensus will be reached. The most probable method (Mackay 1937), and one that I have been able to reproduce using traditional ingredients and techniques, was to make a paste of carbonate of soda mixed with water and the pulp of a desert caper plant called *kirir* in Sindhi. The bead must be completely dry, without any internal moisture, and then the paste is painted onto the bead and allowed to dry. When the paint is dry the bead is rapidly heated by placing it in glowing coals. This rapid heat fuses the carbonate into the stone leaving a white line.

Unfortunately, the effect of this chemical breaks down the hard surface and over millennia, the salts in the soil eat away at the softer surface, effectively etching the stone (Fig. 8). This is why the earlier scholars called these etched beads. Another natural process that has resulted in some confusion is accidental burning. Bleached carnelian, red and white beads will turn white with black lines if they are burned in a smoky fire such as a trash dump. This is documented from the recovery of such beads in contexts where there is evidence for burning.

Another important development in the Indus period is the manufacture of paste beads. Paste beads were made from ground steatite or soapstone powder that was baked to about 850°C. and hardened to between six and seven on the Moh's scale (Hegde 1983). The manufacturing techniques are still being researched but it is quite probable that the Harappans also used salt glazes to harden the soft stone.

Faience beads were also very common and were mass produced to use in girdles, necklaces and torques. The

FIG. 10: Khambhat: Young boys sitting on mounds of debris, chipping agate bead blanks.

FIG. 11: Khambhat: Bead blanks, buffalo horn and wooden mallets used in chipping the stone.

bead shapes were either cylindrical, short cylindrical or segmented, though occasionally we do find spacers and spherical beads. A wide variety of pendants and specially shaped beads were made in the shape of tablets, leaves, hollow cones and miniature figurines. Faience production is another aspect of the Indus technology about which we are learning important new data. Many of the beads appear to have been made by forming on a stick and then pared or burnished to finish the shape. A relatively fine silica was used and high quality ornaments were produced in a range of colors, including blue-green, blue, white, yellow, and brown. One technique of glazing appears to have been through efflorescence (Pamela Vandiver, *per. comm.* through other techniques may be revealed in the study of excavated workshops that have been discovered recently at Mohenjo Daro (M. Vidale *pers. comm.*) and Harappa.

It is interesting that even in the context of all of these fancy techniques and specialized workshops, some craftsmen were still making tiny disc beads from lapis and turquoise or steatite (Vidale, 1985) just as they had during the Neolithic. The presence of numerous tiny steatite disc beads at most Indus period sites suggests that this easily worked stone replaced the shell disc beads of the Neolithic period. From the examination of some manufacturing debris from one workshop at Mohenjo Daro, it appears that the soft steatite was sawn into short bars which were then drilled along the long axis. Next, thin slices were sawn off with copper or bronze saws to produce the bead blanks. These would have been strung on a cord and ground to make uniform diameters; then the whole set of beads would be fired possibly with a salt glaze.

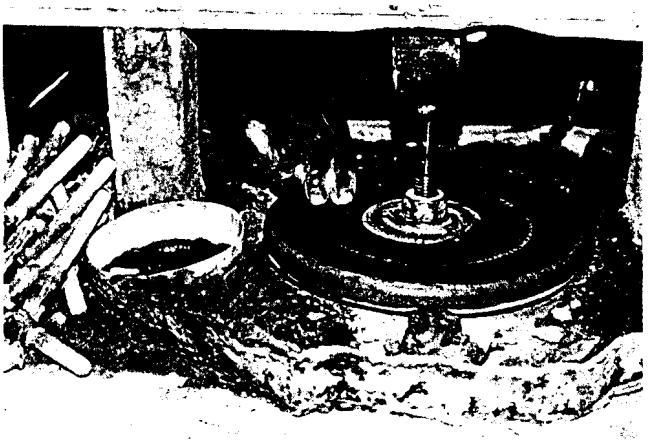


FIG. 12: Khambhat: Final polishing of long faceted beads on wooden discs covered with lac and chalcedony dust. *Courtesy of Hira Bhai.*

FIG. 13: Khambhat: Single and double diamond drill bits. *Photo by Patrick Craig.*

The introduction of copper-bronze tools and specialized kilns allowed for the mass production of steatite disc beads in the Indus Period, but the basic process of drilling and grinding the beads remained the same. Similarly, the present day manufacture of stone beads in India has been revolutionized by polishing and grinding machinery but the simple chipping and drilling process has not been altered. Shaping the beads by chipping is much faster than by any mechanical saw; and the drilling of individual beads by hand is also much faster.

Various aspects of the bead industry show significant continuities in technological traditions with the ancient Indus Period. The most obvious examples are the chipping processes which are still quite efficient and the more traditional hand polishing. Probably the most important continuity is seen in the drilling process. Whereas the present drill is made from iron and has diamond bits, the shape of the drill and the way in which it cuts the stone suggests that this form was copied from the earlier stone drills. In the present drills there are two tiny diamond chips set at either edge of the drill bit (Fig. 13). The positioning of these bits results in the same cutting process that was performed by a jasper drill, only it happens much faster. The use of a double diamond bit in Khambhat appears to be unique to this region, because in Baluchistan, bead drillers still use a single diamond drill to perforate agates (Wright 1982). At present we do not know exactly when diamond drills were invented, but since there has been a continuity in other aspects of the tradition it can be suggested that the form of the diamond drill with two bits was modeled after the earlier stone drills.

Another area where it is possible that we may find evidence of this type of continuity is in the glass bead tradition. At this point we do not know enough about the methods used by the ancient Indus faience and paste bead makers, but a detailed study of this tradition and the later historical developments is extremely important. Only through such problem oriented studies will we be able to understand the important contributions of early craftspeople to the industries that we take for granted today. ■

*Madison, Wisconsin

BIBLIOGRAPHY

Foreman, Richard 1978 "Disc Beads: Production by Primitive Techniques," *The Bead Journal*, Vol. 3(3, 4)): 17-22. Los Angeles.

Hegde, K. 1983 "The Art of the Harappan Microbead," *Archaeology*, May/June 36(3): 68-72.

Jarrige, J. F. 1981 "Economy and Society in the Early Chalcolithic/Bronze Age of Baluchistan: New Perspective from Recent Excavations at Mehrgarh," *South Asian Archaeology 1979*, H. Härtel ed. Berlin.

— **and R. Meadow** 1980 "The Antecedents of Civilization in the Indus Valley," *Scientific American*, Vol. 243(2): 122-133.

Kenoyer, J. Mark 1984 'Shell Industries at Mohenjo Daro, Pakistan," in *Interim Reports:* IsMEO-Aachen-University Mission, Vol. 1, M. Jansen and G. Urban eds., Aachen, pp. 99-116.

— 1986 "Shell Trade and Shell Working in the Neolithic and Early Chalcolithic at Mehrgarh Pakistan, in press C.N.R.S. Parts.

Mackay, E.J. 1937 "Beadmaking in Ancient Sind," *Journal of the American Oriental Society*, Vol. 57: 1-15.

— 1938 *Further Excavations At Mohenjo-Daro*, Vol. I-II, New Dehli.

— 1943 *Chanhu-Daro Excavations, 1935-36*, New Haven.

Marshall, Sir J. 1931 *Mohenjo-Daro and the Indus Civilization*, Vol. I-III, New Delhi.

Possehl, G.L. 1981 "Cambay Beadmaking," *Expedition* Vol. 23(4): 390-47.

Trivedi, R.K. 1964 "Agate Industry of Cambay," *Census of India 1961*, Vol. V, Part VII-A(1).

Vidale, Massimo 1985 "Some Aspects of Lapidary Craft at Mohenjodaro: in light of recent surface record of the Moneer southeast area," in *Interim Reports:* IsMEO-Aachen-University Mission, Vol. 2, M. Jansen and G. Urban eds., Aachen.

Wright, P.W.M. 1982 "The Bow Drill and the Drilling of Beads, Kabul, 1981," *Afghan Studies*, Vol. 3&4: 95-101.

ACKNOWLEDGEMENTS

Special thanks to the Pakistan Department of Archaeology and the Italian (IsMEO) and German (RWTH) University Mission at Mohenjo Daro for inviting me to work with them on their survey of the site in 1983.