THE ORIGIN AND DEVELOPMENT OF THE ANCIENT NEAR EASTERN CYLINDER SEAL

A Hypothetical Reconstruction

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One purpose of this paper is to discuss and speculate on the origin and development of one of the most unusual and important lapidary artifacts in mankind's history, the cylinder seals of the ancient Near East.

1a-d
Both cylinder seals (a, b) and both stamp seals (c, d) depict scenes that are both representational and non-representational. This dual tradition goes back to the Stone Age (see Fig. 6). Many scholars believe that not only is the representational scene symbolic, but that the non-representational, decorative scene may be symbolic, as well. Note that the cuneiform signs on the representational cylinder seal impression from the Akkad period, ca. 2300 B.C., read directly and were, therefore, engraved in a reverse direction.

On seal impressions from the 3rd Dynasty of Ur and the Old Babylonian period, the king invariably faced toward the left and the other figures faced him. Clearly then the entire scene was conceived and engraved as a mirror image.

Heights: a, 2.5 cm.; b, 4 cm.; c1, 1.5 cm.; c2, 1.5 cm.; d, 3.5 cm.

They were part of the burst of creative energy and invention that accompanied urbanization in Mesopotamia around 3300 B.C. Rolled on clay, the engraved image of the cylinder seals formed reliefs which Professor Edith Porada has called "Sumerian Art in Miniature." They were, she wrote, "the most characteristic object created by the Sumerians and the most numerous. About two thousand [are known] from about 3300 to 2300 B.C." She suggested tentatively that "the makers of stone vessels may have developed the cylinder seal (and the crudely drilled stamp seals of related style) ..." Rolled on clay bullae or clay that sealed storage jars, and later on clay tablets, they were used to designate ownership and signature, characterized as "The Mark of Ancient Man." by Madeline Noveck, additional uses were amuletic, ornamental, and votive. Next to writing, sealing was a most important part of the controlling mechanisms of the economy.

It is of interest that as a new art form, this was the first time that engraving was conceived of, both in the negative and in reverse. This meant that when the cylinder was rolled out on clay the image, frequently representing the myths and rituals of the time, could be read in the positive and forward. Cuneiform writing on the early seals is engraved in reverse. On the impression it can be read directly.

Where did the cylinder seal come from? What were its antecedents in form (a drilled cylinder), in function (imprinting), and in concept (communication through symbolic and/or decorative engraving)? (Fig. 1). After all, no matter how important this art form was to the newly urbanized society, the technology had to be present for it to become a fact of life. Our argument will be that the concept and function of cylinder seals and the methods needed to make them did not arise fresh, cut from the whole cloth; rather, that the function and
concept were extant and that most, but not all, of the tools and methods were already present. These had developed slowly, in a time frame difficult to comprehend, going back hundreds of thousands of years to the very roots of civilization. Without the remarkable accomplishments of the first lapidary, Stone Age man, cylinder seals could not have happened.

Let us start with the cylinder seal and look backwards in time. What were the immediate antecedents of its form? In our opinion, these were a combination of the engraved stone stamp seal and the cylindrical bead. The manufacture of the cylinder seal required, for the most part, a merging of the technologies needed to manufacture each. Beads were in continuing manufacture since the Early Neolithic period, having been in the Upper Paleolithic period when natural objects such as teeth, bone, and shell were perforated in order to be worn. By 3600 B.C., when cylinder seals were invented, stone beads in all sizes, shapes and hardness, many with decorative incisions, were being made by the thousands by stone tool specialists. One such workshop was excavated at Beidha, a pre-pottery Neolithic B settlement, ca. 5900 B.C., south of Jericho. Bead-making tools, raw materials, and both finished and unfinished beads were found there in situ. Beginning in the late Neolithic period, stone stamp seals with functions somewhat similar to those of cylinder seals were being engraved by specialists as well. The marriage was fortunate and prolific.

**IMPRINTING**

An early use of seals was for imprinting on clay bulbas which were hollow balls of clay or envelopes that enclosed small clay objects called 'tokens'. These tokens, Schmandt-Besserat [1977] hypothesized, were the origins of writing. She suggested that they represented the type and quantity of objects being traded and that they were frequently imprinted on the outside of the clay envelopes to communicate to the trading partners what was inside.

What is significant here, for our argument, is that those tokens and envelopes, like the stamp seals themselves, demonstrate further the importance and development of imprinting as a means of communication. While imprinting took place literally on clay, it was figuratively in the very air of the Neolithic period. The tokens, as Professor Schmandt-Besserat has shown, were found over a wide area and went back to the ninth millennium B.C. She documented more than twenty-five Neolithic sites, from the fifth to the ninth millennium B.C., where tokens were excavated. Many of them had incisions that were not decorative but symbolized additional types of objects. This use of engraving on the tokens, occurring even earlier than the engraved stamp seal, also demonstrates the importance and development of engraving as a means of symbolic communication.

Parallel to the development of stamp seals in the sixth millennium B.C. and related to their function as amulets (and to the latter amuletic function of cylinder seals) was the development of the small clay and stone amulets. It is relevant to our argument that the stone animal amulets of the Neolithic period were modified at the end of the fourth millennium B.C. by engraving on their base so that they too may have had sealing as a function. It is also relevant that certain of the varied shapes of the stamp seals resemble certain earlier stone bead shapes such as the hemisphere, the disc, the lentoid and biconoid, as well as certain tokens (Fig. 2).

The flat-bottomed, button-shaped stone stamp seal with a handle may derive from earlier clay stamps whose function was perhaps quite different from that of stamp seals. These have been described by Schmandt-Besserat [1977] as excavated at Tell Abu Hureya, and by Melliair [1965] at Catal Huyuk. They suggest that these clay and stone stamp seals may have been used to stamp cloth or skin. The decorative design of clay stamps may have influenced the design of certain later stamp seals [Fig. 3]. A similar suggestion was made by Noy [1978] about an unusual stamp made of limestone with a long handle that had noticeable traces of red color on both the stamp and its handle. It was excavated at Megharet el Kabarah, a Natufian site. She noted the resemblance of the geometric design to that on stamp
remarkable engravings 'the roots of civilization' (1973).
Is it not conceivable that the engraving that we have been describing, both decorative and symbolic, all contributed to the more varied decorative and symbolic engraving on both standard and cylinder seals?
We have discussed the possible antecedents of the cylinder seal from the viewpoint of its cylindrical form, its function of imprinting and the concept of communicating by symbolic or decorative engraving (Fig. 5). What were some of its technological ancestors? The evidence to be described stems from the work of such Paleolithic scholars as Bordas, Semenov, Marshack, as well as from our own experimentation.
To fashion a cylinder seal required three separate procedures, namely, shaping of the cylindrical form, drilling a center hole and engraving the outer surface. Each of these procedures developed over a different time frame, at a different pace and for different reasons. Each procedure required different tools and methods. All go back to the Stone Age. It is useful to examine them separately.

**HYPOTHETICAL DEVELOPMENT OF CYLINDER SEALS**

**EARLY BRONZE**
3500

**CHALCOLITHIC**
5000

**NEOLITHIC**
8000

**MESOLITHIC**
10000

**UPPER PALEOLITHIC**
25000

**DEVELOPMENT**
- **CLAY TABLETS** with seal impressions
- **CLAY VESSEL COVERS** with seal impressions
- **HOLLOW CLAY BULLAE** with seal impressions
- **CLAY POTTERY** with impressed decorations
- **CLAY STAMP SEALS** decorative, button shaped
- **CLAY FIGURES** with impressed decorations
- **IMPRINTING**
- **INCISED CLAY TOKENS**

**DEVELOPMENT OF THE TECHNIQUES**

**SHAPING**
The technology of shaping stone is as old as man himself. It is probable that the first crude step, over two million years ago, was simply smashing rocks and picking up the right pieces. Subsequently, there followed a fairly well documented evolution that included such procedures as percussion pecking, flaking, abrading, sawing. Between the time of simply smashing rocks and the development of the techniques of flaking, something else was learned by prehistoric man, namely, that there were significant differences between rocks.

According to Bordas, "The first major technological achievement of prehistoric man was the discovery, by experimentation, of all suitable mineral and rock material from which he could shape his implements." It is clear that prehistoric man, from Lower Paleolithic times onward, knew the differences between the hardness, tenacity and mode of fracture of various stones. Indeed, his very life depended on knowing that micro-crystalline quartz such as flint, or non-crystalline obsidian, could be chipped with ease but abraded with difficulty. The Moba scale of hardness, by whatever name or sign he used, was undoubtedly second nature to him.

Shaping by flaking was the basic mode for hundreds of thousands of years until shaping by grinding came into regular use. In the Near East this took place in the Early Neolithic period ca. 8000 B.C. For example, the axe and the adze were now made, or at least finished, by grinding. They were much more efficient for woodworking than axes made by flaking, which were more likely to break. According to Semenov (1964: 204),

...this narrow technical achievement (of grinding) opened a new era in the history of humanity. Vast tracts of the globe bittern uninhabitable became accessible for settlement... The Paleolithic and Mesolithic techniques of flaking permitted the use only of flinty rocks... which are not abundant in nature... The grinding technique allowed man to employ... different volcanic granular rocks and even the softer shales and slates.

The technique of grinding introduced the consistent use of sand and sandstones as abrasives. Quartz sand has a Mohs hardness of 7 and is able to reduce all of the stones used at that time. It is our speculation that quartz sand was the abrasive commonly used. Sand is ubiquitous whereas corundum (Mobs 9) is not. Also, no seals or beads harder than quartz are found. It is likely that a loose sand abrasive was used on all hard stones, not only for shaping but also for drilling and, possibly, for engraving. It is our experience that sand is not needed and may not have been used for soft stones.

It does not seem accidental that it was at this time, in the Neolithic period, that stone beads were made consistently. Even hard micro-crystalline stones were used. The latter may have been pebbles or pieces that were shaped first by sawing and chipping and then ground, using loose sand and sandstone plaques. Grooved sandstones expedited the shaping of the cylindrical beads. According to Semenov, "the working areas of the sandstone plaques were given a shape corresponding to the object worked." The same steps, including faceting, used to shape cylindrical beads would logically have been used to fashion cylindrical seals.

Stone sawing was also used in Neolithic times. It was used to divide stones into rough-outs which were then completed by chipping and/or grinding. This sequence has been documented for early Bronze Age bead manufacture (Tosi and Piperno 1973). In summary then, by 3000 B.C., the technology needed to shape a cylinder seal was well known and well tried.

**DRILLING**
When did drilling start and how was it done? Drilling started in Upper Paleolithic times. Perforated teeth were common ornaments for Cro-Magnon man. Drilled shell and bone have been found as well.

According to Semenov, "... (drilling) is to be traced to the need for uniting two or more objects either as working tools (i.e., a hafted axe) or as adornments to be worn on the body. Boring of stones for adornment evidently proceeds its use on tools..."
Expedition

(a) The earliest depiction of the drilling of a cylinder seal is from the 6th dynasty Egyptian wall painting, from Saqqara ca. 2500 B.C. Both the seal maker using a bow drill and the standing laborer hold a bag which may contain an abrasive. (b) The craftsman using a bow drill is from a 6th dynasty wall painting. The left hand pressure on the cap stone (arrow). The right hand wields the bow.

as a means of work. Originally, no doubt, it was done by a circular movement of the hand.”

The use of a hand drill may be deduced from the eccentric perforations on shell beads of the Paleolithic period. An off-centered perforated shape may be explained by the back and forth incomplete turns of the hand drill. The use of a mechanical rotary drill may be deduced from a circular perforation. However, it is sometimes difficult to distinguish between a completely circular and nearly circular or eccentric perforation. We have devised a method to help make this determination by taking a silicone impression of the drilling (Gorelick and Gwinnell 1978). The imprint is then sliced horizontally so that it can be viewed in cross section (manuscript in preparation).

A circular perforation does not tell whether the discontinuous rotational movements were effected by palm drilling, pump drilling or bow drilling. A method for a differential diagnosis is still to be developed. Evidence that hand drilling was used, at times, for cylinder seals, is seen on an Egyptian wall painting of the 6th dynasty (ca. 2500 B.C.) which shows this quite clearly. In addition, the hieroglyphic writing reads, “drilling a cylinder seal by a seal maker” (Fig. 9). The use of a bow drill is also shown on a 6th dynasty Egyptian wall painting (ca. 2000 B.C.) as shown by Hodges (1976) for making a stone vessel (Fig. 9) and on an 18th dynasty wall painting from the tomb of Rekh-Mir-Re (ca. 1450 B.C.), for bead making.

Stone Age bow drills have not been found. However, the development of the bow drill is suggested and seems related to several other innovations that took place in the later Paleolithic and Mesolithic periods. These were the bow and arrow, the microolith and the haft. The microolith was the smallest and sharpest of the blade tools. To be used, it had to be hafted. For rotational purposes the haft, in this instance a spindle, had to be straight, long and sturdy. Wooden arrow-shafts had all of these characteristics. The transition from a wooden arrow to a wooden spindle is not difficult to imagine. Another less appreciated part of the bow drill is the cap stone (Fig. 9).
Another important detail concerns the start of drilling. In order to keep the drill from skidding, the procedure of pecking was used. This was done with a pointed pecking stone which created a series of small cavities. The roughened, depressed surface helped confine the loose abrasive and minimize skidding. Pecking may have been followed by hand drilling (Fig. 9) to create a well to confine the abrasive and the rotary drill.

In his experimentation, Semenov found that the hand drill, due to its rotational speed, was twenty times more efficient than palm drilling and forty to sixty times more efficient than one-handed drilling.

Knochback in his well-controlled experiments with a bow drill found that a spindle 0.55 inch in diameter turned eleven times with each back and forth movement of the bow. He clocked the rotational speed at about 850 rotations per minute. It is interesting that significant increases in RPM did not occur until electrification and gearing pulleys. Even here, the use of a bow was directly in the lineage of the bow string.

There is still a great deal that is unknown about ancient drilling. How, for example, were the small holes held and how were the tiny holes in some of the Neolithic beads of hard stone made? Mellaart, in describing beads of ca. 6500-5500 B.C. found at Catal Huyuk, wrote, “... One is better informed about artifacts which these people used than about the technology of their manufacturing processes, many of which remain to be studied. How did they drill holes through stone, including obsidian, holes so small that no fine modern steel needle can penetrate?”

In summary, then, drilling required for cylinder seals had a background of tools and methods that evolved over thousands of years. Were new tools involving bronze used for drilling cylinder seals? Did earlier ones continue? In our own research we have reported preliminary findings of the use of bit for drilling the center hole of a cylinder seal as late as the neo-Assyrian period, ca. 700 B.C., well into the Iron Age. Was this the exception or the rule? Here again, more research is needed.

ENGRAVING

The third and last category to be discussed is engraving. It was frequently, but not invariably, the last step in the manufacture of a cylinder seal. When did engraving start and what tools were involved? Engraving started in the Upper Paleolithic period with the equivalent of a contemporary engraving chisel called a burin or graver, sometimes as small as half an inch. Stemming from a few multipurpose burins of the Middle Paleolithic, burins were modified into a variety of special shapes during the Upper Paleolithic and Mesolithic periods.

The unusual shallow, incised engravings of flora and fauna found on bone, shell and ivory of the Upper Paleolithic period were made with burins. Some of the fine incised lines require excellent vision or magnification to appreciate. The engravings are often so skilful that it is difficult to understand how they could have been made without some sort of specialization. Certainly, the tools were specialized (Fig. 11). One researcher, Gorodstov (Semenov 1964) classified burins into thirteen groups and seventy-five subtypes. The continuity of burin manufacture is evident from their presence in Early Bronze Age sites. Again the question arises, what changes in the tools and methods for engraving occurred with the development of the cylinder seal? Here too, more research is needed.

Relevant, rare and unusual artifacts excavated by Wootly at Ur, ca. 2000 B.C., were a cylinder seal maker’s trial pieces of limestone (Fig. 12). These seem to be sketches in preparation for engraving. It is logical, but unproven, that sketches on clay and working impressions to check the progress of engraving were used in a manner comparable to the methods of modern lapidary engravers.

It would seem logical that, in order for the design to conform to a cylinder of given size, a completed horizontal model on clay, to scale and in reverse, would be needed. This too requires proof.

A good example of the start of engraving is present on a seal published by Frankfort. In it a standing figure is blocked out by thirteen small drillings. These follow a previously scratched outline. Presumably, the drill holes would then be connected to complete the figure. It would seem likely that bronze engraving tools would supersede burins. The problem is that bronze engraving tools have rarely been excavated in the context of cylinder seals and there is no ancient writing on the subject. The instructive Egyptian wall paintings also offer no clue in this direction. Even those showing drilling do not indicate the material of the drill tip, i.e., stone, metal, wood, bone, etc. One important clue about changes in engraving methods for the cylinder seal stems from...
our own research using scanning electron microscopy and experimentation.

We have found that tool marks made by a rotating disc were present on the rounder tool made of stone. Since a disc can be used conveniently for engraving only on a horizontal spindle, we concluded provisionally that the horizontal bow lathe was invented at this time. It was as logical a development as any of the previous developments that we have described because it required only that the vertical bowl be turned sideways and be supported at both ends. It would be driven by the same kind of beam around the same kind of spindle, but it would permit the use of discs and wheels of various sizes and shapes.

It is our guess that the first discs and wheels were made by shaping stones in the same way that disc-shaped and wheel-shaped beads were made. By this time, there were all sizes and a variety of stones being made routinely. Another difficult question was how wheels and discs were turned. This remains to be determined. A clue may come from the manner in which weighted stone fly wheels were connected to axles so that the axle turned with the wheel. The horizontal bow lathe was highly desirable because it increased visibility and the speed of engraving. It also permitted variations in the shapes that were engraved. Indeed, it has been used with contemporaneous variations by lapidaries and other craftsmen ever since its invention.

While no ancient horizontal bow lathes have been found, there are several ethnographic parallels. There are engravings from Medieval times depicting its use. A Chinese version has been described by Whitlock (1940). It shows a craftsman using his feet to effect back and forth rotation, leaving both hands available. It is interesting that the wheel shown is quite large. The linear rotational speed is thereby increased tremendously. It is possible that this simple expedient was known by the Early Bronze Age. Wolf (1980) showed a horizontal bow lathe being used in Iran in the 1950s (Fig. 13). In the Near East, the introduction of bronze followed not long after the invention of the cylinder seal. How, when and what kind of bronze tools were used for cylinder seals requires further research. We feel that the method that we have previously reported has the potential for determining this. In brief, we feel that it is possible to determine the tool from the tool mark. This requires first, identifying the tool mark with the scanning electron microscope and then duplicating that tool mark experimentally on a similar stone. This is basically like ballistics and is a variation of Semenov’s functional analysis. Semenov started with the tool (bullet). We start with the artifact (bullet hole). Experimental duplication is common to both.

In conclusion then, we feel that the cylinder seal is an excellent paradigm for the study of ancient lapidary methods and that the tools and technology needed to manufacture the cylinder seal derived from the past and anticipated the future (Figs. 14 and 15). Both require much further research.
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