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Stamp and Cylinder Seal Techniques in Jordan

Stamp and cylinder seals are most valuable documents to date archaeological levels. They often give chronological and geographical information and are generally studied for their historical and iconographic evolution. But by observing and interpreting the tool traces left by the seal cutters or by looking at their manufacturing processes, we can also find precious information on the different techniques used for their creation. This aspect is rarely examined in the ancient Near East, even in Mesopotamia, where the glyptic art is best known. When studying the way in which the ancient craftsmen worked in Jordan,[1] we will have to refer mainly to those Mesopotamian prototypes.

The beautiful agate seal of Darius I (521-486 BC), discovered in Egypt and contemporary with the Ṭawīlān tablet, shows the Persian king in his chariot, hunting an impressive and threatening lion, under the protection of his national god Ahura Mazda.[2] Iranian and Mesopotamian influences are easy to recognize; the theme of the seal is well known and allows us to reconstruct the daily and religious life of the king as well as the languages in use in his time. Historical and social information can thus be discovered in the seal, but the manner of manufacturing seals has never been analyzed. The tools used to render the volume in the body of the king, the lion and the horse, and the ones used to cut the palms, the feathers of Ahura Mazda, the crown of the king, or the cuneiform inscriptions were surely as specific in antiquity as in modern times. Seals are normally carved in deep relief or in intaglio; they have the same role as a mould: the impression left in the wet clay of a tablet in Mesopotamia or a vessel in Jordan always shows a reverse design. The Old Persian, Elamite, and Neo-Babylonian inscription in our example had to be read in the right direction on the support. This peculiarity must have presented a problem to text engravers, who seem have been different from the craftsmen of the design. The function of stamp and cylinder seals is identical in the ancient Near East: they authenticate a document. They have the legal status of a signature and testify to someone's property; they can be indicators of contents or have medical or magic purposes and can also be worn as amulets. The location of their design on a clay support can differ from period to period and from region to region.

Stamp seals were invented in Mesopotamia in the protohistoric period (fifth millennium BC; Homès-Fredericq 1970), and were in use until the beginning of the third millennium, when they were progressively replaced by cylinder seals, but they reappeared in the first millennium BC. In Jordan stamp and cylinder seals came into use in the Early Bronze Age, probably under Mesopotamian influence. They were also attested at the same period in Palestine (Ben-Tor 1978: 2), and were used continuously until the Iron Age, showing Mesopotamian, Syrian, Egyptian, or Hittite influences, depending on changes in international trade or domination. The shapes of the stamp seals vary, depending on the periods in which they were in use.[3] They are mostly small, with one flat surface, decorated with a design, and sometimes completed by an inscription, as in the Late Bronze or Iron Ages in Jordan.[4] Their impressions are well defined and show the original shape of the seals.

The cylinder seals are quite different: they are shaped like small cylindrical tubes carved with an intaglio design. They appear in the Uruk period in Mesopotamia (second half of the fourth millennium BC), and in the Early Bronze period in Jordan, where they are in use at the same time as the stamp seals.

[1] The most striking difficulty in studying the glyptic art in Jordan is the fact that only few seals have been excavated, compared to the thousands discovered in Mesopotamia.

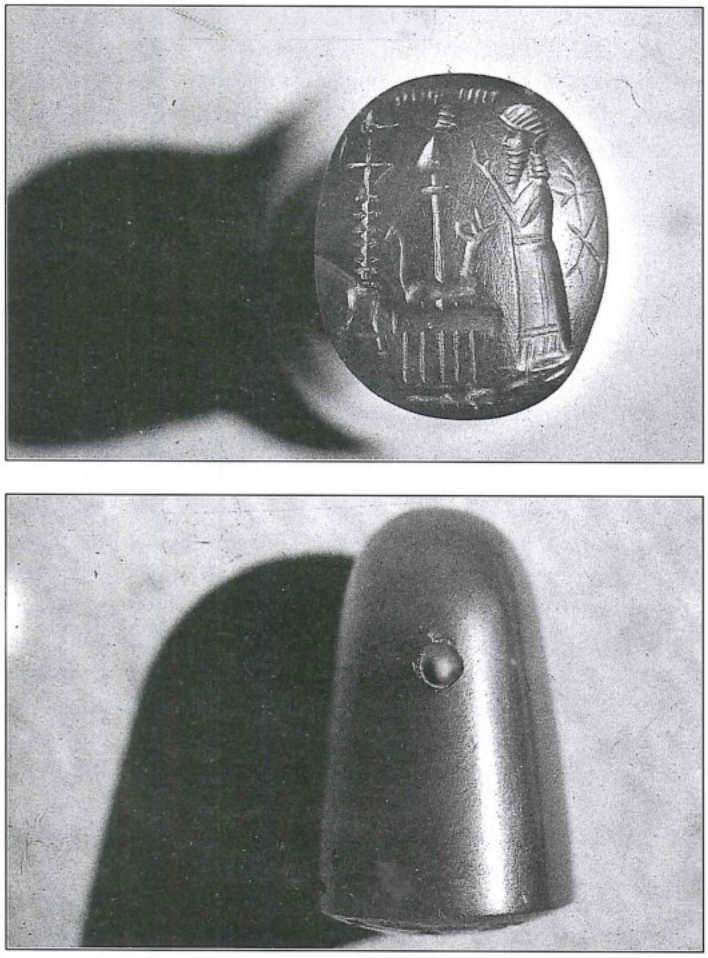
[2] Inscribed agate cylinder seal, found in Thebes (Egypt), 37 mm length, 16 mm height, British Museum no. BM 89132. Wiseman 1959: no. 100; Collon 1987: 130, no. 558.

[3] Stamp seals can have various shapes: dome, hemispheroid, lentoid, conical, conoid, pyramidal, or gabled. In Mesopotamia they sometimes have the shape of a kidney, a foot, a spool, a bead, a lying animal, or its head (lion, bull, hare). In Jordan, scarab or scaraboid seals are numerous. Others are barrel-shaped, lenticular, conoid, or conical.

[4] See the inscribed Moabite, Edomite, and Ammonite seals. Compare with the seals of the Assyrian and Neo-Babylonian periods in Mesopotamia.

Both stamp and cylinder seals have a longitudinal perforation, bored vertically in the cylinder seals and horizontally in the stamp seals. The perforations are especially interesting for our study, because this part of the seal remained unpolished, showing the marks of the tools and abrasives used to drill the holes. These perforations are for suspending the seal on a string or within a bead necklace. The seals can also be part of a bracelet or worn on a pin or fibula to close garments such as those used by the ladies of Mari. In Jordan too, women can have their personal seals, as we know through the texts (Millard 1991: 142).

A chalcedony stamp seal (FIG. 1)[5] is said to come from the Iron Age II Tomb of Adoni Nur in 'Ammān.[6] It represents a worshipper, with long hair and beard, a skirt descending to his ankles, a spade of the god Marduk on the altar, and the Mushrushu dragon, the special lamp of Nusku above the tripod standard, and cuneiform-shaped signs. The whole composition is in the tradition of the Neo-Babylonian seals in the "drilled" and the "cut" style of Mesopotamian (Porada 1948: 71-99), Palestinian (Tushingham 1992), and Jordanian glyptic art (Yassine 1984: FIG. 57, seal no. 184). Nevertheless when analyzing the regular octagonal faceting of the stamp, the tool marks in the cylindrical suspension hole and the iconographic details, as well as the inscription, one can determine that the seal has been made with modern tools.



1. Chalcedony stamp seal, purchased, Iron Age II, Jordan Archaeological Museum, no. J.6021. (Courtesy Department of Antiquities of Jordan).

In contrast with Mesopotamia, where the seals were pressed on clay tablets, in Jordan, from the Early Bronze Age on, seal impressions on pottery (essentially jars and containers), are known from examples from al-Lāhūn, Numayra, Bāb adh-Dhrā', and other sites.[7] These types of impressions also appeared in Palestine (Ben Tor 1978: 40-42), and Syria (Mazzoni 1984: 18-45). An Early Bronze I juglet, found in a family tomb in al-Lāhūn on Wādī al-Mūjib, preserves a deep linear, geometric incision, pressed in the soft clay before firing, near the neck of the vessel (FIG. 2).[8] The design of the stamp seal shows concentric circles, a motif also used on cylinder seals with geometric patterns (Ben Tor 1978: PLS. 2-5). It brings to mind an EB III jug shoulder from Bāb adh-Dhrā', made either by a cylinder or stamp seal (Lapp 1989: 7, FIG. 6). Seals from Palestine are engraved with the same pattern of concentric circles or spirals, made by V-shaped tools (Ben Tor 1978: 39). The stone with which the stamp seal at al-Lāhūn was made must have been quite soft, as the grooves are deep, showing that the engraver had no difficulty embellishing it with a pointed instrument. Its original shape probably presented a dome or a button, like the first examples in Mesopotamia (Homès-Fredericq 1970: 11, 18, 24, 84). In a cylinder impression from Numayra (FIG. 3) on the neck of jar 1301,[9] a lion attacking an ibex or a gazelle with long horns shows Mesopotamian inspiration, although the seal was engraved by a local artist.

The information we have on the original seals and their manufacturing process is often hypothetical for Jordan, because we have no texts about corporations of seal cutters. We have no representation of craftsmen, who remained anonymous and, as far as I know, no hoards have been discovered in this region. Once more, in order to get information, we have to look at the documentation of

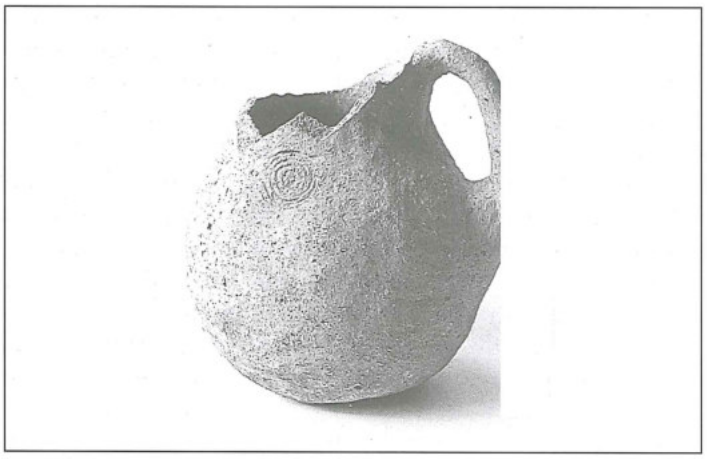
[5] Chalcedony stamp seal, Jordan Archaeological Museum, no. J.6021, Iron Age II, not published.

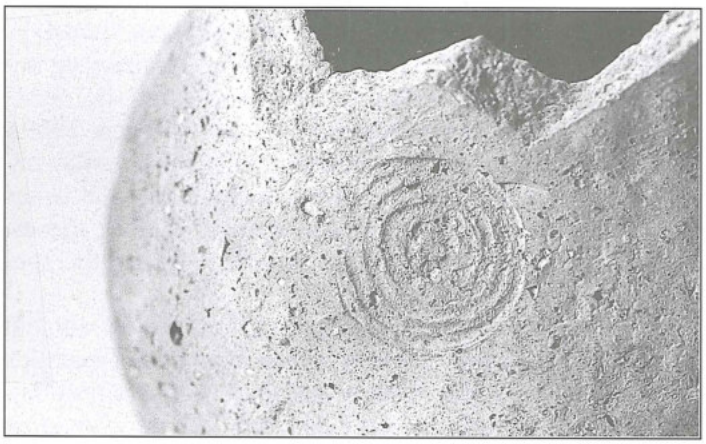
[6] I would like to thank Mr. Moussa Zayyat and Miss Seeham Balqar, of the Jordan Archaeological Museum, who allowed me to present this unpublished stamp here, as well as Dr. Joseph Greene who made the excellent photographs.

[7] Abū al-Kharaz, 'Ammān, 'Arqūb aẓ-Ẓahr, Bāb adh-Dhrā', al-Bālū', al-Baq'ah valley, Buṣayra, Dhībān, al-Ghassūl, al-Ḥandaqūq, Jāwa, Katarat as-Samra, al-Lāhūn, al-Maflūq, Numayra, Petra, Rabbat 'Ammon, Ṣāfūṭ, as-Sa'īdiyya, Sbayla, Ṭiwāl ash-Sharqī, Umm Ḥammad ash-Ṣharqī, 'Umayrī, az-Zayraqūn, etc.

[8] Stamp impression on juglet no. L.82/64, al-Lāhūn, sector 3, EB I. Homès-Fredericq 1986: 91.

[9] I would like to thank N. Lapp who kindly allowed me to reproduce this seal impression on jar no. 1303 of Numayra, EB III. Lapp 1989: 8, FIG. 7



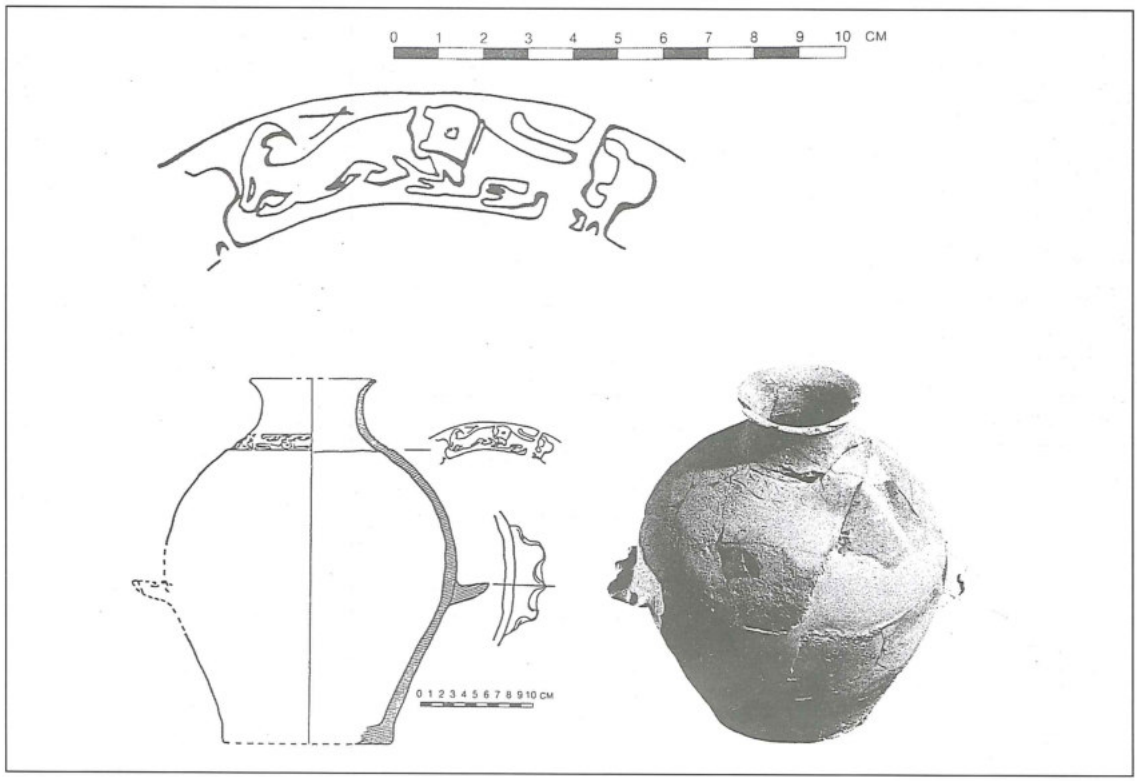


2. Juglet with stamp impression, al-Lāhūn, no. L.82/64. EB I. (Photo W. Delauwer, Belgian Committee of Excavations in Jordan).

the neighbouring countries. We know the Sumerian and Akkadian terms for seal cutter (*za-gindin, zadim, burgul, purkulullu*) as well as the term for his helper, called in Sumerian "*kab-sar*" (jeweller or stone mason) (Loding 1981: 6-14). Following an Achaemenid text, the apprentice had to be trained for four years before becoming an accomplished craftsman (Collon 1987: 102-103). Some Greek and Latin authors, such as Theophrastes and Pliny the Elder, mention the methods used in their time, probably inspired by more ancient techniques (Merrillees 1990: 23).

We will now try to follow the different steps for manufacturing cylinder and stamp seals. The logical process is first to find the raw material, examining the quality of the stones; then to give the general outline of the seal; and finally to engrave its lateral surface and its inner suspension hole. These last two operations can be interchangeable.

To understand how seals were made in antiquity, the modern lapidary techniques used for cutting agate beads in northern India warrant discussion. A thorough study of the Cambay beadmaking industry has been published by G. L. Possehl (1981), who observed that there was a striking similarity between this industry and ancient seal manufacturing at Lothal. In this region, southeast of Mohenjo Daro and Chanhudaro, the lapidary industry flourished between 2400 and 1700 BC. The seals were shipped from there to Mesopotamia; the intensity of this international trade during the Akkadian period is attested by the discoveries of H. Frankfort at Tall Asmar (1933: 47-53).



3. Seal impression on jar no. 1301, Numayra, Early Bronze Age. (Courtesy N. Lapp).

In the mines of northwest India, teams of three to five people nowadays extract lumps of precious or semi-precious stones. A man digs holes (around 3 feet in diameter) with picks or shovels to get the nodules out of the agate strata. Two or three women gather the lumps, clean the appropriate stones from the earth or from the waste materials, and sort them by size. Sometimes a small chip is made to see the quality of the selected stones. This first sorting and grading of the material is thus done in the mine, while a second, more careful selection, is done in the village. The stones are then transported to Cambay and brought to a specialized workshop in bags of 50 to 100 kg, where they are heated in small pots with smouldering sawdust (Possehl 1981: 41-42). A chemical reaction results that allows them to be transformed more easily. The first, rough outlines of the beads are cut and then smoothed by finer chipping with water buffalo horns, hammers, or spikes, while another worker does further chipping with a small iron hammer. The different stones are re-examined and sorted, then transported to a more specialized workshop, where the final touch is given.

In the Indian mines, the workers select agate, the material used for the Darius seal. Other stones can also be found in the region: jasper, rock-crystal, and similar minerals. In antiquity, seals were also made of different materials, mainly mineral (stone, faience, clay), vegetal (wood), or animal (ivory or bone). A great variety of minerals was used, ranging from river pebbles to chlorite and limestone. The stones could be opaque, translucent, or transparent. They sometimes have beautiful colours, such as cornelian, obsidian, turquoise, amethyst, agate, jadeite, hematite, and serpentine. Some are very hard to cut, such as rock-crystal, diorite, and amethyst. From the eighth century BC onward "quartz", chalcedony, and cornelians were mostly in favour. Lapis lazuli was probably chosen for its beautiful dark blue colour. In Jordan in the Iron Age, we find seals in limestone, agate, amethyst, chalcedony, jasper, quartzite, sardonyx, etc. Many stones were imported, attesting to international relations between far away regions and Jordan. It is often difficult to define the country of origin, but steatite could come from Egypt or Iran and serpentine, lapis lazuli, and alabaster from Mesopotamia, Iran, or Afghanistan (Homès-Fredericq 1970: 100-101).

When a wealthy person bought a seal in antiquity, he paid special attention to the magic value of the stone. Cuneiform texts reveal that a seal in lapis lazuli gives "power to its owner", while a seal in rock-crystal brings him more and more wealth and his name will be honoured. A seal in *ZA.TU.US.ASH* (an as yet unidentified material) presumably allows its owner to live with joy in his heart, while a seal in green marble will give favour upon favour before death (Williams Forte 1976: 1).

Next to the religious or magic power of the stone, its choice also depends on its technical characteristics. The material must be soft enough for shaping and carving the motives on the seal with the available tools (in the beginning flint scrapers, progressively replaced by copper, bronze, or iron chisels and engravers) and it must resist cracking while the general form, the design, and the suspension hole are being shaped. It must be hard enough to avoid breaking if it is dropped or bumped and must be solid enough not to wear down quickly. The hardness of the stones and the tools can also influence the design.

Stones vary in hardness, measured between 1 and 10 on the Mohs scale of hardness. The soft stones vary between 1 and 6, the hard ones between 7 and 10. Seals generally have a hardness between 3 and 7 (Berry 1969), the most adequate for preservation and conservation being between 4 and 6. The modern archaeologist also has a few simple chemical tests available to identify stones, such as the carbonate test, the dolomite test, and the specific gravity test.[10]

As we have no literary sources to know how ancient craftsmen decided if a material had the proper qualities of resistance, we may believe that they followed tradition and worked in an empirical fashion. We may imagine that they examined the texture and the structure as well as the colours of the minerals. They probably valued the homogeneity of the very fine-grained rocks and generally chose single mineral crystals. They surely had observed that a fingernail scratches soft materials (hardness 2.5 or lower), a copper tool harder ones (hardness 4), and an iron instrument even harder ones (hardness over 6). In the first periods soft stones (Mohs hardness 1 to 3) were used, such as calcite and limestone (Gwinnett and Gorelick 1991: 189). Later, when stronger instruments were in use, harder stones were selected, such as basalt, translucent, semi-opaque to opaque chalcedony, cornelian (Mohs 7), diorite, goethite, haematite, jasper, lapis lazuli, quartz and quartzite, and rock-crystal. Soft stones, such as chalk, chlorite, serpentine, and soapstone were still in use,[11] next to other materials, such as sintered quartz compositions (Egyptian faience, frit, or paste).[12]

Once the stones had been selected, the general outlines of the seal were shaped by a first faceting: unfinished or broken seals found in a workshop of Mallia give information about this technique in the Greek Late Bronze Age, but the observations can also be made for

[10] See Berry 1969: 67 for more details of the different tests which can be used in modern times.

[11] For a list of soft and hard stones, with their characteristics and hardness scale, see Merrillees 1990: 33-42.

[12] The faience factories in Palestine and Jordan are studied in McGovern 1985.

the Western Asiatic seals. Stamps could easily be shaped in soft stone: in the beginning, flint burins or engravers were probably used, as the chipping technique was known in the prehistoric period. When stronger implements (copper and iron) were invented, harder stones could be used. J. G. Younger (1981: 33-34) assumes that the "cylinders were shaped from cores made by the tubular drill", because their diameters were relatively standard. Saw and file traces are recognizable on some seals (Younger 1981: 34, FIGS. 12-13). These marks were later abraded with sand, mixed with olive oil or water.

The tools used for the design and the stringhole can be studied through modern experimentation. A few years ago two American orthodontists, L. Gorelick and A. J. Gwinnett, experimented with the techniques of seal manufacture.[13] As dentists, they were interested in the morphological aspects of dental bio-material and they used the Scanning Electron Microscope (SEM) for their examination of the surface of enamel after bonded braces are removed. As Dr. Gorelick had a large collection of cylinder seals, the two colleagues became interested in examining the irregular surfaces of ancient seals. They were confident that they could read the marks of the tools as easily as they could on teeth, if they examined them with their specialized microscope. They had to study tool traces on rough surfaces, where polishing had not removed them. They thought that if they experimented with filling the drill holes of seals and beads with silicone, the impressions left in this "highly accurate, flexible and inert material" which "literally turns the drill holes inside out, thereby disclosing their surface topography", could give valuable information, once examined with the SEM (Gwinnett and Gorelick 1991: 189).

Gwinnett and Gorelick (1979: 26, FIG. 21) looked carefully at the design of a Proto-Elamite stamp seal. Some marks were very regular, and must have been made by a bow-drill; other lines were made by a pointed instrument (engraver or chisel). Others were not intentional; the tools of the craftsmen skid sometimes. They also observed marks of abrasive (sand, mixed with olive oil or water) used to make the work of the seal cutter easier. All those marks were very faded and could not have been distinguished without the microscope.

The instruments used by the lapidaries in antiquity are known from tools found at Tall Asmar in Mesopotamia: different hoards packed and hidden in small pots were found under the floors of Akkadian houses (2450-2250 BC) (Frankfort 1933: 47-48 and FIG. 37). They belonged to jewellers or perhaps to craftsman, travelling from one town to another (Frankfort 1939: 5). Their equipment consisted of several engravers, small edged copper chisels, and a borer probably belonging to a bow-drill with a spatula-shaped cutting edge and square section. The pots also contained a small lapis lazuli seal with a silver cap (ready to be sold), finished and unfinished seals, beads, earrings and other ornaments, two pointed instruments in copper, a whetstone probably used for polishing the seals, a set of weights and a copper plate. Alalakh, Ugarit, and Karkemish in Syria and Uruk, Tepe Gawra, Chagar Bazar and other sites in Mesopotamia, have revealed comparable tools (Collon 1987: 102-104). Those of a Babylonian jeweller from c. 1750 BC were found in a jar from Larsa (Arnaud *et al.* 1979: 20-23, 54-64), containing beads, seals and sealing, weights, a whetstone, and a small anvil. For Iran, G. Contenau mentioned at Susa a small metal point moved by a bow-drill.[14] Perhaps other objects, described in excavation reports as needles, awls, or points could be interpreted as engravers, borers, and chisels for seals and jewelry in Jordan.

In prehistoric times, the tools to make scratches, lines, and grooves, were probably hafted flint micro-burins (Gorelick and Gwinnett 1981: 21), but they quickly became pointed bronze or copper stems, found in the Syrian and Mesopotamian lapidary treasures. The pink alabaster seal of Bāb adh-Dhrā' was carved with one of these pointed stems in the Early Bronze Age.[15] The seal cutter first made a human figure, but later on, he or another craftsman changed his mind and engraved a more traditional, geometric design with a similar pointed tool. These were in use for a long time.

On a sintered quartz (faience) scarab seal found at al-Lāhūn (FIG. 4),[16] the flat side was carved with various pointed tools of different dimensions, used in the Late Bronze/Iron transitional period. It shows the body of a ram and a well modelled, upraised *ureus* that could have been made by the tubular drill technique, while an *atef*-crown was deeply carved by a V-shaped instrument. The coat and the scales on the bodies of the animals were later criss-crossed with a pointed engraver, showing that the combination of different techniques allowed special details to be rendered. The design is a well known iconographic motif of Egyptian influence and shows once more that Moab had international relations far away to the south. The seal, however, was locally made by the artist who probably had a model in favour at this period. He seems to have not understood the hieroglyphic signs, which he reproduced in a wrong order, giving a defective spelling of the god's name, Amon-Re.[17]

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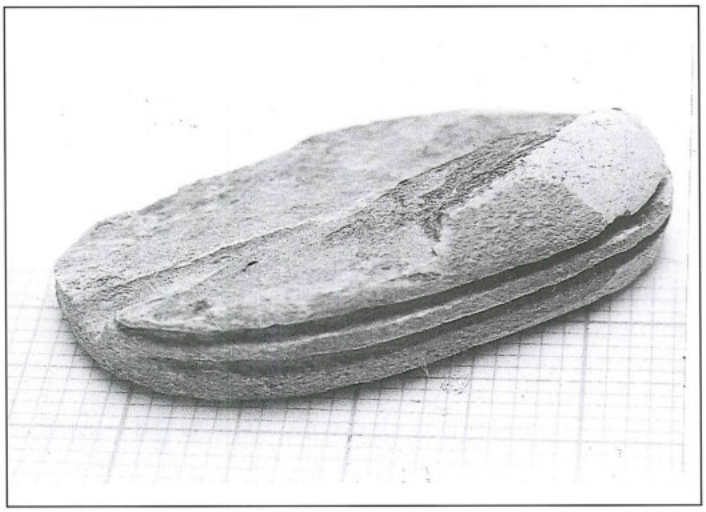
[13] For a list of their publications, see Gwinnett and Gorelick 1991: 196; see also Gorelick and Gwinnett 1991: 37-48.

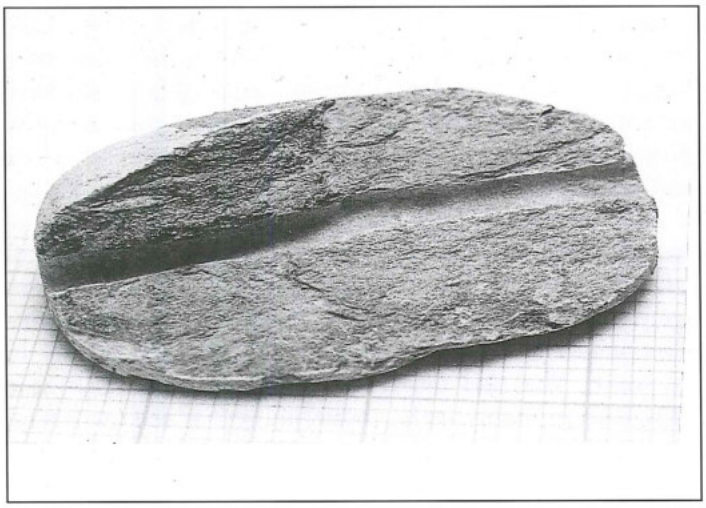
[14] Contenau 1931: 606: "une petite tige en métal, qu'il (l'artiste) anime d'un mouvement de rotation en avant et en arrière, grâce à la corde d'un archet".

[15] Cylinder seal, 40 mm H., 25.5 mm diam., Early Bronze. Lapp 1989: 5, FIG. 4.

[16] Stamp seal, 30 mm length, 19 mm width, upper part broken: 10.5 mm to 3 mm H. transitional period Late Bronze-Iron Age. Homès-Fredericq 1988: figure on p. 42.

[17] I thank our colleagues L. Limme and K. Kitchen who gave me this precious information.





4. Scarab seal, no. L.87/10, al-Lāhūn, transitional period Late Bronze-Iron Age. (Photo W. Delauwer, Belgian Committee of Excavations in Jordan).

If we observe the design on a cylinder seal from Dayr 'Allā, now in the Jordan Archaeological Museum in 'Ammān (FIG. 5),[18] we notice that the snake and the stem of the life tree were made with pointed instruments (chisels and engravers) whereas the flowers on the tree and the head and body of the two human figures were made of drilled rather than engraved holes.

The first drills were probably made of stone or wood and moved by hand (Bessac 1986: 124, FIG. 29), as the work of Gorelick and Gwinnett has shown. The stem is regularly turned and leaves circular marks in the stone, especially if some abrasive (sand, beach sand, or crushed stones, mixed with water or olive oil), is added (Gorelick and Gwinnett 1981: 44-45). An Egyptian fresco represents a carpenter and a lapidary with bow-drills of the Late Bronze Age.[19]

Artisans soon realized that it was possible to obtain regular holes in the stone by using a constant rotation speed and relatively constant pressure (Bessac 1986: 233, FIG. 54). The bow drill, such as the one described by Contenau, was originally made as a vertical drill, but later on as a horizontal lathe, with a string turned around the drill. The tip of the drill is placed on the object to be perforated. Some abrasive is added at the beginning of the work (Possehl 1981: 44-46).

In Egypt, as in Cambay, the drill rests on the workman's leg, to allow him to apply carefully controlled force on the bow with the alternating movements of the rope. The force of the pressure depends on the hardness of the stone. Different tests with drill bores were made by Gwinnett and Gorelick. They examined with their

5. Cylinder seal of Dayr 'Allā, Jordan Archaeological Museum, no. J.12677a. (Photo S. Da'ja, courtesy Department of Antiquities of Jordan and Joint Expedition at Deir 'Alla).

[18] Cylinder seal, Dayr 'Alla excavation 1961, Jordan Archaeological Museum, no. J.12677a; Late Bronze Age. Homès-Fredericq and Franken 1986: 145, no. 415.

[19] Fresco from a tomb at Thebes, Late Bronze Age. Gorelick and Gwinnett 1978: 40, FIG. 4.

scanning electron microscope the holes left in a slate pebble, drilled with bow drills of wood, hollow cane, and flint. The different tools left different holes. They experimented with changes in a wooden drill stick and the hole at different stages, using sand as an abrasive. The wear of the instrument is clearly visible (Gwinnett and Gorelick 1979: 19, FIGS. 4-7). Similar traces can be found in the sealing of stamp and cylinder seals (especially in the Sibitti representations).

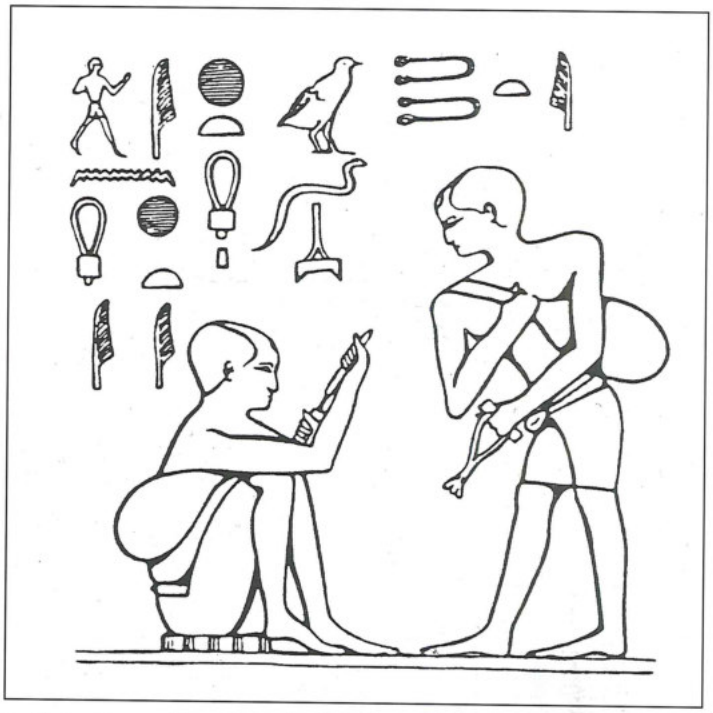
One of the last operations when preparing a seal is to make a vertical or horizontal suspension or string hole. This perforation is always made in the same way, and can be seen on various cylinder seals of the Royal Museum of Art (FIG. 6).[20] First a small cup was chipped on the upper side of the seal: it was used as a starting hole to fix the tool (chisel or drill) and could also serve as reservoir for the abrasive (sand or hard stone grit, mixed or suspended in a liquid such as water or oil). On the back of the scarab seal of al-Lāhūn (FIG. 4) a 0.2 cm wide hole is clearly visible, as this part of the object was broken in antiquity. The initial hole is generally drilled somewhat more than halfway, for reasons of resistance. The same operation is done on the other side of the object. A poorly trained lapidary will end up with a bad junction and misaligned drill holes. At al-Lāhūn, the first hole was done with a fairly new drill while the second one was continued with another tool. It is of course safer to drill small holes from both sides rather than a straight hole through the seal, because breakage, chipping, and shattering around the suspension hole during the oscillation of the tool are frequent.

Once again, Egyptian representations can help (FIG. 7) (Gorelick and Gwinnett 1981: 24; Homès-Fredericq *et al.* 1981: 11, FIG. 5). In a relief from the fifth dynasty (2500 BC) the seal maker holds a seal in one hand and in the other a vertical hand drill in a wooden shaft, to drill the hole. With a circular movement in the hole and the help of an abrasive (see the bag of the second seal cutter), the craftsman drilled the suspension hole.

This way of drilling the holes requires precision. The second hole must be placed to meet the first one exactly: this is often a matter of chance. In a marble cylinder (FIG. 8) from the Royal Museum of Art and History of Brussels,[21] the hole was bored from both sides, but the tool was broken when the drilling was nearly finished. This seems to happen often in the Jamdat Nasr period. The tools probably broke because the instruments were misused or were not strong enough (FIG. 9).[22]

Before a seal could be sold, it had to be polished, so that all unnecessary marks were wiped off. Today in Cambay, a modern commercial abrasive wheel is powered by an electric motor (Possehl 1981: 43, FIG. 7): the beads are turned continuously until the surface is smoothed and polished to the desired degree. Coarse abrasives are used at first, finer ones are used later. Thus tool marks are erased and the seals are beautifully brilliant. The carefully polished seals and beads from 'Ammān, Jericho, or Jarash(?) (Bienkowski 1991: 134, FIG. 150) were probably made in the same way, although in antiquity, seals were polished by hand. This was al-

6. Cylinder seal, Royal Museums of Art and History, Brussels, no. 0.1437.

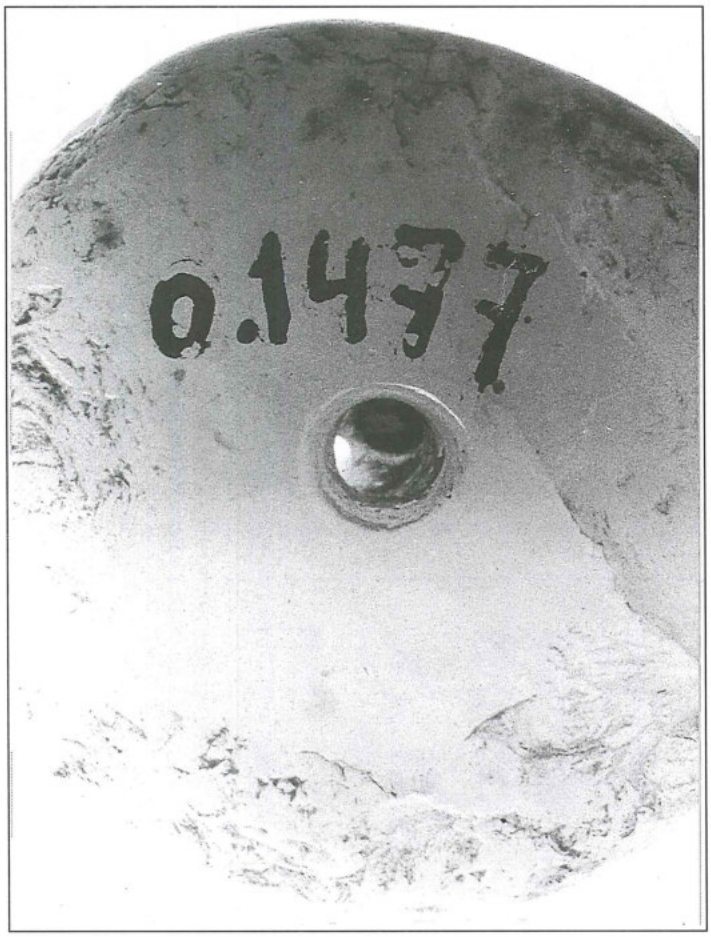


7. Seal cutter on Egyptian relief, Sakkara, fifth dynasty (Gorelick and Gwinnett 1981).

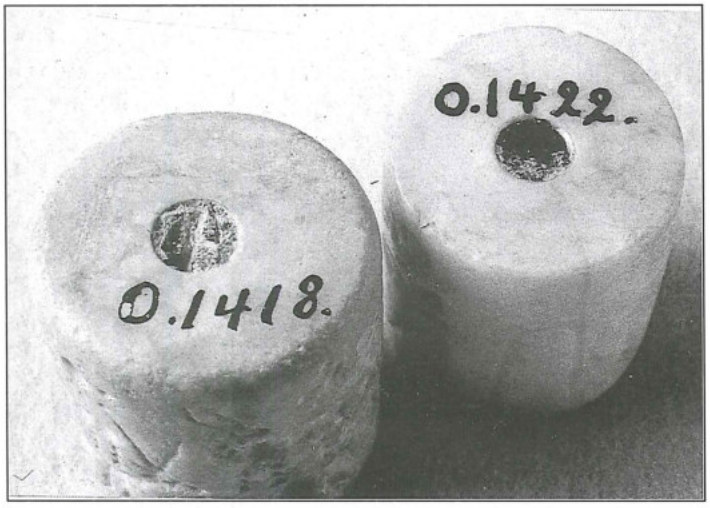
[20] Marble cylinder seal, Jamdat Nasr period, Royal Museums of Art and History, Brussels, no. 0.1437. Speleers 1943: 33.

[21] Marble cylinder seal, Jamdat Nasr period, Royal Museums of Art and History, Brussels, no. 0.1477. Speleers 1943: 21.

[22] Marble cylinder seal, Jamdat Nasr period; Royal Museums of Art and History, Brussels, nos. 0.1418, 0.1422. Speleers 1943: 43, 52.



8. Cylinder seal of the Royal Museums of Art and History, Brussels, no. 0.1477.



9. Cylinder seals of the Royal Museums of Art and History, Brussels, nos. 0.1418, 0.1422.

ways the case: in Cambay, some years ago, before the bead industry became mechanized, Possehl (1981: 46) observed that the "beads and slurry were swan into a skin bag and was 'rolled' across a floor between two men". The result was nearly the same as using a machine. Progressively finer abrasives must have been used to give the seal a smooth finishing touch, producing finer and finer grooves (Gwinnett and Gorelick 1991: 189).

Seals could be personalized by inscriptions, such as the beautiful agate with metal ring belonging to "Palti, son of Maish, the herald",[23] or the one attested by the clay bullae of "Qaus-Gabr, king of Edom" (Millard 1991: 143).

After these different steps, it was still possible to embellish the seal with bronze, silver, or gold metal caps. The decoration depends on the period, the wealth of the purchaser, and the craftsmen. The octagonal, white, chalcedony stamp seal, found in the tomb of al-Muqābilayn by Harding (1950: 46, no. 33 PLS. 13.2, 15.9), is mounted on a bronze swivel, which is part of a fibula. It matches a fashion of this period in western Asia and should be of Mediterranean origin (Yassine 1984: 99). In any case, this jewelry must have been precious enough to be buried in the tomb.

Conclusions

The numerous Near Eastern stamp and cylinder seals are usually studied from the iconographic, historical, or geographical points of view. Not much is known about ancient craftsmen: the Sumerian and Akkadian names for their function are mentioned in the Mesopotamian texts but little else. For Jordan their workshops or methods are not yet known. The study of the techniques used for seal manufacturing in different countries of the Near East gives important information about their work processes. Stamp and cylinder seals appear in the Early Bronze Age in Jordan; they were first impressed or rolled on pottery, in contrast with Mesopotamian tradition. Soft materials (stone, clay, bone, wood) were used in the beginning, replaced by harder stones when copper and iron implements were in use. The shapes and the designs depend on the tools used by the lapidary; the marks on the unpolished surfaces are also good indicators for the study of manufacturing.

The first tools seem to have been made of microburin or flint engravers and wooden drills; later, copper (end of the fourth millennium BC) and iron (first millennium BC) chisels and engravers were used. The hand drill developed into a bow drill (which was first held vertically and afterwards transformed into a horizontal bow lathe). The abrasives used at the time could have been beach sand, crushed stones, and other crushed hard materials, mixed with water and oil. To choose their design, the seal cutters looked at models or sketches.

The normal manufacturing of a seal followed the

[23] Agate seal with metal ring from Umm Udhayna tomb, Jordan Archaeological Museum. Millard 1991: 141, FIG. 162.

above mentioned process: hardness, colour, magic, and sometimes medical properties were taken in consideration when choosing the raw material to make a seal. The different steps in faceting and cutting a seal, in engraving the design, and polishing or embellishing it, can be reconstructed thanks to comparisons with the lapidary industry in modern India.

The technical development also depends upon the material used (hard or soft stones, bone, ivory, clay, etc.), their origin (local or foreign) and the tools (engraver, chisel, drill, etc.). The historical events (political expansion of each region) and international trade also left their influence. Looking at the modern analysis of the tool marks by Scanning Electron Microscope and making comparisons with the contemporary beadmakers of Cambay, it is possible to evoke the everyday life of the sealcutters in ancient Jordan.

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