An Experiment in Ancient Egyptian Silver Vessel Manufacture*

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As a result of recent technical investigations into ancient metallurgy, the various ancient technologies of metal-working in the Old World have become better understood. Alongside the technical studies of other metals worked in antiquity—most notably gold, copper, bronze, and iron—studies of silver metallurgy have been comparatively few. In the light of this fact, the purpose of this archaeological note is to provide certain technical insights into some of the methods and techniques used in ancient Egyptian silver vessel-manufacture. This has been attempted by producing a silver bowl utilizing the same kinds of equipment and tools which are depicted in a silver vessel-manufacture scene in the New Kingdom tomb painting of Rekhmire at Thebes (Fig.1).[1]

The reproduction of the Rekhmire scene shows a workshop where metalsmiths are engaged in making several different silver vessels, depicted in white, in the upper and lower registers, and one tall gold vessel (grey in Figure 1 but yellow in the colored reproduction) in the lower register. The inscription in the upper register at the right explains, "Making all the vases for the divine limbs and . . . *uz*-vases in gold and silver in all the works of eternity."[2] From the reproduction, the major stages involved in gold and silver vessel-manufacture are represented

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1 The Rekhmire scene in Fig. 1 is from the colored reproduction by Prisse d'Avennes, *Histoire de l'Art Égyptien, d'Après les Monuments, Atlas 2* (Paris, 1878), Pl. 56. A photograph of the original tomb scene in black and white is reproduced in W. Wreszinski, *Atlas zur altaegyptischen Kulturgeschichte* (Leipzig, 1923), Tfn. 317, 318. Rekhmire served as the vizier to two pharoahs of the Eighteenth Dynasty: Thutmosis III (1490–1436 B.C.) and Amunhotpe II (1438–1412 B.C.), to which time the Rekhmire tomb has been dated by P. Newberry, *The Life of Rekhmara* (Westminister, 1960), 13f.; the dates for Thutmosis III and Amunhotpe II are after the chronology by W. K. Simpson, *The Ancient Near East, A History* (New York, 1971), 300.

2 Newberry, *Rekhmara*, 37.

as essentially the same and include forming, finishing, and decorating the vessel. These three stages are clearly, if only cursorily, represented in the Rekhmire scene, although they are not ordered in the proper chronological sequence.

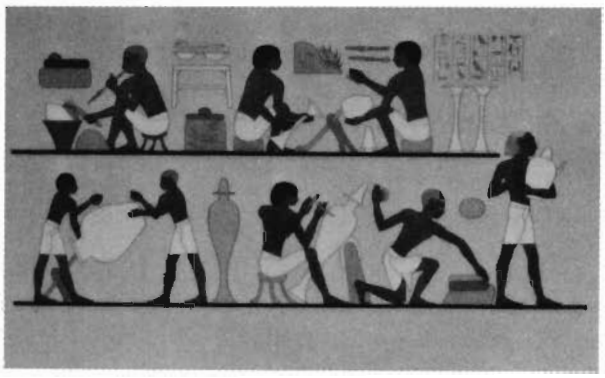

Figure 1

Sources of silver

Technical investigations into the geological origins of silver in ancient Egypt have suggested that the major source was the naturally alloyed silver-gold ores indigenous to the Eastern Desert of Egypt. Numerous deposits of these silver-gold ores have been reported in recent times throughout the Eastern Desert, those deposits in the north generally being more argentiferous than those in the south.[3] Some of these deposits show signs of ancient workings, although the dating of the workings usually remains problematic. It has been reported that recent assays of some of these Egyptian silver-gold alloys contain about 23 to 50 percent gold,[4] while a number of ancient Egyptian silver artifacts analyzed for their chemical compositions have been found to contain high concentrations of gold, ranging from 2.7 to 38.1 percent.[5] This correlation thus suggests that these artifacts had been produced from the indigenous silver-gold ores.

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3 A comprehensive survey of gold ore and silver-gold ore deposits in the Eastern Desert has been provided by R. H. Greaves and W. F. Hume, "Gold Mining in Egypt in Recent Times," in Hume, *Geology of Egypt,* (Cairo, 1937), II/3: 723–70, and 778.

4 The topic of silver sources in ancient Egypt is treated in detail by A. Lucas and J. R. Harris, *Ancient Egyptian Materials and Industries* [4], (London, 1962), 245–49.

5 The most recent program of chemical analyses of ancient Egyptian silver artifacts, undertaken to determine the geological sources of silver, has been made by J. Mishara and P. Meyers, "Ancient Egyptian Silver: A Review," *Recent Advances in Science and Technology of Materials,* ed. A. Bishay (New York and London, 1974), 3: 29–45, especially 38, Table (I), Group 2.

Production of the silver bowl

To obtain the silver required for silversmithing, the Egyptians only needed to melt the silver-gold, which occurs in the metallic, or native, state, in a furnace or a small brazier. While the melting temperature of pure silver metal is 960.5° C., this temperature is increased somewhat by the presence of gold or copper,[6] which melt at 1063° C., and 1083° C., respectively, the two most frequent and most significant impurities detected in analyses of Egyptian silver artifacts. The method of melting native metals is demonstrated by the metalsmith at the far left in the upper registers of the Rekhmire scene. There he appears to take gold nuggets from a pile at his feet, and utilizing forceps and a blowpipe he melts the gold in the small brazier before him. The method he would have followed for melting gold, and silver as well, was probably like that which has been recorded for a present-day Afghan silversmith. This silversmith placed particles of silver directly on a bed of glowing charcoals in a small, open hearth. With the one hand he blew through a short blowpipe to raise the heat of the charcoals, and with the second hand he manipulated the forceps to fuse the particles of silver.[7]

The Rekhmire metalsmith then could have scraped the molten silver off the charcoals and poured it onto a flat stone surface, or the like, to cool into a circular puddle. This puddle could have been used as a raw sheet of silver to make any of the vessel forms represented in the Rekhmire scene.

In my experiment in vessel-making, a sheet of commercial sterling silver was used, the chemical composition of sterling silver being set by law at 92.5 percent silver to 7.5 percent copper. This sheet of silver was relatively thin, 18 gauge, or about 1.0 mm. in thickness, and had been pre-cut into a circle 15 cm. in diameter. It was presumed that the methods of making a vessel from a piece of modern, 18 gauge sterling silver would closely approximate those methods the ancient Egyptians would have used in making their silver vessels.

The materials of all the tools and other equipment utilized in my experiment were known and used in other contexts by the ancient Egyptians.[8] There is as yet no direct archaeological evidence, however, that the Egyptians used any of these materials specifically in conjunction with silver vessel-making.

Forming the vessel

The initial stage of vessel-making is that of forming. Forming is, basically, the hammering of sheet-metal to stretch it into the desired vessel form. This can be done by a variety of methods. One of the simplest is called sinking, and this is shown by the kneeling metalsmith at the far

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6 Lucas, *Materials and Industries*, 253.

7 A photograph of the Afghan silversmith melting the silver is illustrated by P. Knauth and the editors of Time-Life Books, *The Metalsmiths* (New York, 1974), 23.

8 For each material referred to in my experiment in silver vessel-manufacture, its use in other contexts in ancient Egypt is discussed by Lucas, *Materials and Industries*.

right in the bottom register of the Rekhmire tomb scene. In sinking, the sheet-metal is hammered into the depression of a yielding material like wood or a layer of pitch. In the case of the metalsmith in the Rekhmire scene, he appears to use a round rock as a hammer to sink a sheet of gold into the dark layer of pitch overlaying an anvil of wood or stone.

For my experiment, sinking the sheet of sterling silver in this manner was quite satisfactory in initiating the vessel form (Fig. 2). The silver was placed on a layer of pitch—consisting of wood pitch, plaster, and tallow—on a large tree stump anvil. With a round, smooth limestone rock, weighing about 495 grams, the silver was sunk into a small depression in the pitch, hammering first in the center and working in close, concentric courses to the outer edge of the silver circle. Each hammer blow imparted a small concave mark in the silver, and at the same time each blow helped to distort the flat sheet of silver into a slightly concave form. After a complete round of hammering to the outer edge of the silver, the silver was very hard and springy and needed to be annealed, or softened again by heat. This was done by heating the silver over an oven to a dull red color, around 600° to 700° C., and then allowing it to cool before hammering again. It was convenient to do only a limited amount of sinking into the pitch, having produced a shallow, saucer-like silver form.

Figure 2

Figure 3

Figure 4

A more suitable material to receive the major amount of sinking was the tree stump anvil itself (Fig. 3). Its surface was worked to produce a small, shallow hollow, measuring about 7 cm. in diameter and 2 cm. in depth; it appears as a small dark patch below the rim of the silver in Fig. 3. The silver was placed over this hollow and hammer blows were directed into it, again beginning in the center and working in concentric courses to the outer edge of the silver. Each full round of hammering was followed by an annealing. The hammering was easily accomplished with the stone hammer, for it was the weight of the stone, and not human force, that did most of the work. By continually hammering the sheet of silver at a slightly steeper angle to the hollow, the vessel form gradually became thinner, more concave, and taller. It was necessary occasionally to hammer directly on the top of the rim of the bowl to thicken, and thereby strengthen it. The hammering of the bowl continued until the final form was reached at 5 cm. in height and 14 cm. in diameter across the top (cf. Fig. 12). The thickness of the bowl is variable: at the bottom center point it is 0.8 mm., at the greatest curvature near the bottom it is 0.6 mm., and at the thickened rim it is 1.2 mm. These particular variations in thickness are also characteristic of many ancient metal bowls and plates.

Another method by which to form a vessel is the complementary method of raising, oftentimes performed in conjunction with sinking. In raising, the sheet of metal is hammered over a securely anchored stake, or a similar object, to form the vessel. The raising of silver vessels is represented twice in the Rekhmire scene. One metalsmith at the extreme right in the upper register raises a medium-size cannister form, and two metalsmiths at the far left in the bottom register together raise a very tall silver vase form. Raising has the advantage over sinking in that more complicated vessel forms can be hammered over a stake, such as vessel forms with restricted necks and small mouths, examples of which are the silver vessel forms being raised in the Rekhmire scene.

In my experiment, a limited amount of raising of the silver bowl was performed over a stake reconstructed after those depicted in the Rekhmire painting (Fig. 4). The Rekhmire stakes may have been made either of wood or metal, such as bronze. I used a cylindrical wooden stake secured at one end beneath the tree stump anvil, and secured at the other end between two vertical wooden supports mounted on a horizontal wooden base. The end of the wooden stake was slightly rounded for raising. Since the form of the silver bowl had already been established by the sinking method, raising on the stake was only used to hammer out some uneven areas of the bowl, rather than to alter the form.

The forming stage in making the silver bowl was a relatively simple one. The time required to form the bowl was about 15 hours. To form some of the much larger and more elaborate silver vessels in the Rekhmire scene, however, even skilled Egyptian metalsmiths probably invested several days.

Finishing the vessel

The second stage in vessel-making is finishing. This stage comprises several steps based on successive applications of abrasion, smoothing, and polishing, aimed to bring the surface of the silver to a bright, mirror-reflecting finish. The various finishing steps are represented collectively by the action of the center metalsmith in the upper register of the Rekhmire scene. There he appears to rub a stone, or a similar abrasive, over the surface of the silver vessel to finish it.

In actuality, the finishing stage involves more work than this single Rekhmire representation would suggest. In my experiment, the silver bowl was in a somewhat crude condition after the forming stage. The surface of the silver was bumpy, marred, and scratched from hammering. It also showed an overall fire-scale, mat-grey in color, that had resulted from the oxidation of the copper in the sterling silver when the bowl was annealed.

The first step in finishing the silver bowl was to use a coarse, flat granite rock to rub down all of the bumps and to scrape the rim of the bowl to an even level (Fig. 5).

Figure 5

The next step was to file away the deep scratches and nicks by rubbing the entire surface of the silver with a small piece of pumice stone (Fig. 6). The result of the filing step was a smooth satin finish.

The bowl was then vigorously burnished with the limestone hammer that had been used in the forming stage (Fig. 7). The burnishing action consolidated the surface of the silver to produce an overall, but incomplete, mirror-reflecting finish. Burnishing with the limestone hammer was the most time-consuming and most strenuous step in the entire vessel-making experiment, requiring about 20 hours of work. The surface of the silver was not completely burnished because the broad surface of the hammer could not reach into the many shallow,

Figure 6

Figure 7

scratched depressions that remained from the previous filing step with the piece of pumice.

These scratched depressions, however, were easily burnished to the same mirror-reflecting finish by rubbing them with a small, pointed agate stone (Fig. 8). It was important that both materials used in the burnishing steps—the limestone hammer and the small agate stone—had slightly roughened working surfaces. When I tried burnishing the silver with an agate of coarser texture, I found it too rough to produce the mirror-reflecting finish. On the other hand, when I tried a highly-polished agate stone, it was too smooth and lacked the power to burnish the silver.

The final step in the finishing stage was polishing the bowl with a clean, white linen cloth to remove the dust and finger prints (Fig. 9).

Figure 8

Figure 9

Each step of the finishing stage had to be performed carefully and without hurrying in order to achieve the proper final mirror-reflecting finish. The entire finish stage was completed in about 25 hours. If similar finishing techniques had been followed by the ancient Egyptians, the time required to finish the larger silver vessels in the bottom register of the Rekhmire scene must have been appreciable. Considering the number of steps involved in the finishing stage, and the amount of time needed to perform them, it is ironic that only one representation of the finishing stage was illustrated in the Rekhmire painting.

Decorating the vessel

The final stage in vessel-making is decorating. There are many techniques that can be used in mechanically decorating a vessel with a hammer and a chisel-like tool; the two most common are chasing and repoussé work. In chasing a vessel, the chisel-like tool is hammered on the exterior of the vessel, whereas in repoussé work the tool is applied to the interior of the vessel. Frequently the two techniques are combined to achieve different decorative effects. Depending on the size and the shape of the chisel-end making contact with the metal, and also depending on the force with which the chisel is struck with the hammer, the techniques of chasing and repoussé can produce decorative effects ranging from large, high relief forms to fine, shallow lines. The particular technique of chasing in which lines are made with a sharp bevel-ended chisel is termed tracing. Traced lines are a typical kind of decoration seen on ancient Egyptian silver vessels. It is likely, although not certain, that the seated metalsmith in the center of the bottom register of the Rekhmire scene uses his flat hammer and a bronze chisel to trace lines into the large silver vase.

Figure 10

Figure 11

I found tracing a single, shallow line in the silver bowl was a quick and simple decorative technique. To prepare the bowl for tracing, it was necessary first to oil the interior of the bowl, fill it with liquid pitch, and allow the pitch to cool (Fig. 10). The pitch served to reinforce the interior of the bowl against the force of hammering the chisel on the exterior. Undoubtedly the metalsmith decorating the large silver vase in the Rekhmire painting had, similarly, filled his vessel with pitch to prevent crushing its wall when hammering at his chisel.

In my experiment, the silver bowl was then inverted, placed on a protective piece of linen, and propped up at one end on the flat granite stone that had been used in the finishing stage (Fig. 11). The chisel used for tracing was a cast, high-tin bronze, each side of the working-end having been scraped on the granite stone to a sharp bevel. With the limestone hammer, the chisel was rapped gently at about a 45° angle to the surface of the silver in order to allow the chisel to glide across the silver. Care had to be exercised so that the chisel was directed to

glide in a straight line. After every few centimeters of tracing, the chisel needed to be re-sharpened on the granite stone and the bowl needed to be rotated to continue the tracing. The completed traced line was a fine, shallow one (compare Fig. 12). On close examination, it was seen to be a narrow groove with a ridge on each side, resulting from the metal displaced by the chisel.

Figure 12

Once the line had been traced, the silver bowl was finished. The removal of the pitch was easily accomplished first by warming the bowl just enough to soften the pitch. Facilitated by the oil in the interior of the bowl, the soft lump of pitch was then pushed out of the bowl. A clean, linen cloth was used to wipe out the interior of the bowl. The exterior of the bowl showed the subtle, traced line against the bright, mirror-reflecting surface (Fig. 12). The minute scratches on the surface which could not be entirely burnished or polished away betrayed the hand-craftsmanship of my silversmithing with primitive tools and equipment.

The decorating stage of the experiment was a very simple one, requiring only a few hours of time. Depending on the amount of chasing, repoussé work, and tracing an ancient Egyptian metalsmith would have performed, the decorating stage may have lasted much longer.

Summary

In this archaeological experiment, I have tried to explain in detail the methods and techniques of silvervessel-manufacture that are represented in the Rekhmire tomb painting. While the Rekhmire scene accurately represents the essential stages of silver vessel-making, those stages are neither ordered sequentially nor explained in adequate detail for the tomb scene to serve today as an illustrated guide to silver vessel-manufacture. The Rekhmire scene does, however, serve as a valuable source of information in reconstructing the methods and techniques of ancient Egyptian silver vessel-making. As a source, it represents certain tools and equipment—such as the shaftless hammers, the braziers, the pitch blocks, and the raising stakes—which otherwise would have been lost or gone unrecognized in the archaeological record. By utilizing such tools and equipment in my experiment, in materials known to the ancient Egyptians, it is hoped that new insights into the methods and techniques of Egyptian silver vessel-manufacture have been offered.