THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 1 – 2013, ISSN 1453 – 083X

THE PRE-BIBLICAL METALLURGICAL ART ON THE BIBLICAL TERRITORY

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ABSTRACT

The Old Testament describes in detail the metallurgical achievements, both in the period before the conquest and colonization of the promised land (mostly related to the manufacturing of the Tabernacle, in this sense, the gold chandelier with seven branches, also known as the menorah, is an exceptional example), and the period after the conquest and colonization of the promised land (the sea of bronze pillars Boaz and Jachin, the 10 golden candlesticks with seven arms, etc., famous artifacts of Solomon's Temple facilities, are good examples). Question: at that time, did the Jews have the technical and technological knowledge necessary to create things in order to reach the great achievements of the metallurgical processes described in the Old Testament? This article tries to answer this question.

KEYWORDS: Canaan, pre-biblical metallurgy, casting, lost wax casting, Nahal Mishmar`s Treasure

1. Introduction

Even before it was colonized by the Jews, The Promised Land – known as Canaan – was inhabited by other peoples (Canaanites, Amorites, Philistines, etc.). At that time, those peoples already had a certain degree of culture and civilization, including a high level of metallurgical creativity and development.

As a result of the contact with these peoples, the Israelites were able to absorb technology, in addition to technological knowledge that they already had from the previous period which also includes the Egyptian slavery period; exception is the iron manufacturing[1]. For requirements of the subject matter, the pre-biblical time is the chalcolithic period (or Copper Age, 4500-3300 BC). For the two reference coordinates – time (the pre-biblical period)/geographical area/(Canaan) - based on archaeological material, two things with connection to the metallurgical aspects will be presented: (1) casting as a widely used pre-biblical metallurgical process, and (2) the treasure from Nahal Mishmar.

2. Casting, a widely used pre-biblical metallurgical process

Before it was colonized by the Israelites, the land of Canaan was inhabited by other peoples.

These people had reached a high level of metallurgical development and creativity. For example, in Canaanite temples were discovered many statues cast in bronze, mostly of small size.

An example is the figurine in Figure 1, dated sec. 17 BC: in figure 1a[2], we can see the original casting mold, made of stone; Figure 1b is the statue of a worship idol, cast in modern conditions in the original stone mold. In pre-biblical times, casting was one of the most important technological processes, used for the fabrication of copper objects.

The general scheme of development of processes for manufacturing objects by casting is shown in Figure 2. The raw material used was copper ore which may contain impurities of arsenic[3].

[1] A good example is the conflict with the Philistines, described in Kings1.

[2] The mold was discovered following excavations near Naharya (northern Israel), in a place where a Canaanite temple existed.

[3] The Nahal Mishmar`s treasure – most copper-arsenic bronze artifacts constitutes an eloquent example.

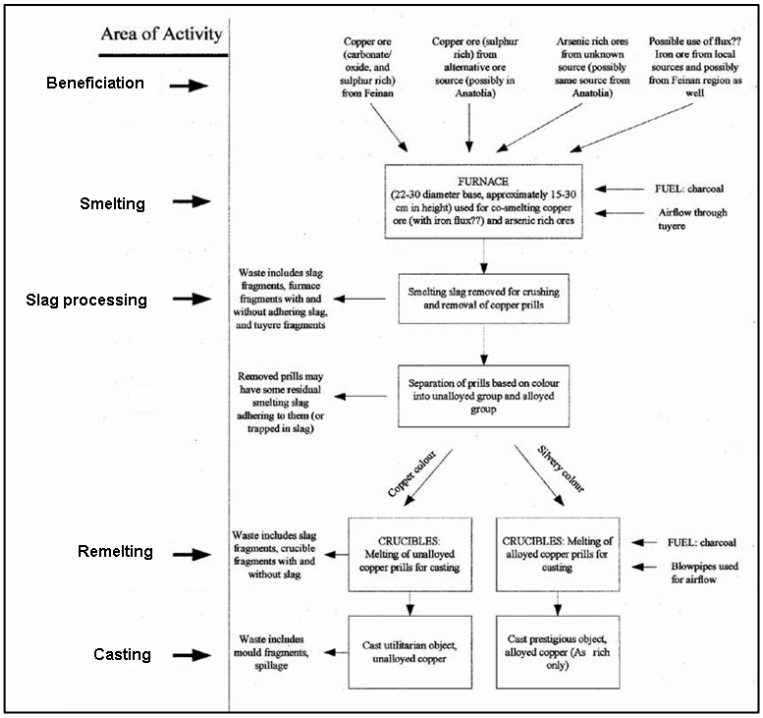

Fig. 1. *Canaanite religious idol* ***Fig. 2.*** *General scheme for manufactured artifacts by casting process*

As reference, the mineral exists in appreciable quantities as carbonate- malachite, $Cu_2CO_3(OH)_2$. The process used was pyro-metallurgical: thermal dissociation in a coal bed at temperatures of 700^0C.[4]

The first two activities in the scheme shown in Figure 1 are *de facto* extractive metallurgy.

The result, after melting, is a mass of clay which included copper grains[5]. The casting was done in disposable forms (sand, wax models, etc.) or forms with multiple uses (stone), etc., to a wide range of uses: cult and ornament objects, work tools (knives, chisels, axes, etc.), etc.

Lost Wax Casting process is one of the oldest techniques of casting metal - about 5000 years [2, 3, and 4]. Initially, the process was used for idols, ornaments, jewelry, etc.

But it seems that the Middle East has the first use of this process. In the Middle East, the Lost Wax Casting process has been used increasingly wider in Mesopotamia and Sumer (for statues made of copper and later bronze) since 3500 years BC; something later, the method is found in Anatolia.

The ancients quickly understood the advantages of the process: obtaining artifacts with complex configurations, versatility, repeatability, minimal finishing operations, the technique can be used for a large variety of metals and alloys (copper, gold, silver, bronze, etc.), etc.[6]

The majority of artifacts belonging to the Treasury from Nahal Mishmar were made by Lost Wax Casting process.

Made no later than 3700 years BC, this means that the first use of this process in the region was for the artifacts discovered in Nahal Mishmar.

3. The Treasure from Nahal Mishmar

We are in 1961. The team of archaeologists led by Pesach Bar Master was engaged in the search for possible additional scrolls in the Judean Desert, near the Dead Sea, where manuscripts from famous Oumran were discovered.

The geographical point at coordinates 31°38'0.93"N 35°36'4.34"E (located between Masada

[4] The melting process is carried out in two phases: (*)carbonate dissociation: $Cu_2CO_3(OH)_2 \rightarrow 2CuO + CO_2 \uparrow + H_2O \uparrow$ and (**)metal oxide dissociation: $2CuO \rightarrow 2Cu + O2 \uparrow$

[5] The slug will be eliminated later - totally or partially, and the copper granules obtained, following the melting procedure.

[6] In antiquity, the technique was known in India, China, Thailand, and was used by the Greeks, the Romans, the Aztecs and the Mayans, but also in Mexico and by the African population near the Benin bay. Many pieces found in Pharaoh Tutankhamen's tomb (1333-1324 BC) were also made through this process.

and Ein Gedi) is a cave accessible with difficulty, today called the Nahal Mishmar's Treasure.

In this cave were discovered 442 objects, wrapped in a mattress of straw, a real treasure (Fig.3).

Fig. 3. *Treasure of Nahal Mishmar: left: at finding time; right: after preservation*

This treasure is the largest group of ancient copper objects, found so far in the Middle East. Among these objects, 429 were made of copper-arsenic alloy (4-12% arsenic). This arsenic-bronze is the first alloy in the history of civilization [6]. 10 crowns, 256 mace heads, 118 scepters, 16 work tools chisel shaped were inventoried. Also, the thesaurus contains a set of objects of other materials: six of hematite, five of hippopotamus ivory and one of elephant ivory. Their esthetics is exceptional and they are so sophisticated that in many cases modern artisans are surprised. The shape and decoration of each artifact is unusual. Many are so strange that they it defy accurate definition. An additional aspect: each artifact is in itself unique, given that there are no two identical objects.

Fig. 4. *Examples of artifacts from the Nahal Mishmar's treasure*

Some additional examples are shown in Figure 4: a crown (center), a two-headed (left), a scepter with three-deer heads (right)[7].

The fact that 338 of objects represent deities,

• copper was associated with other minerals rich in arsenic [koutekit (Cu_5As_2) domeikite (Cu_3As)] and sulfur [Covelit (CuS)].

• Carbon-14 dating of the reed mat in which

[7] An explanation accepted by most researchers is that the objects found were objects of worship and belonged to Ein Gedi temple discovered. This temple is known in literature as the Chalcolithic Temple and the distance between Nahal Mishmar and Ein Gedi is about 12 km. Researchers believe that at the time of reference, for reasons of insecurity, the objects were transferred temporarily from Ein Gedi temple in a temporary place of refuge, the cave from Nahalal Mishmar. The reason for insecurity is not well defined, but depositors should have to return the treasure back to the Ein Gedi. The fact is that they did not returned it and the treasury had to wait for the team of archaeologists led by Pesach.

deity heads, scepters, supports the hypothesis that the antique warehouse complex was used for ceremonial and religious needs. The metal particles were studied for geo-chemistry-mineralogy. For this purpose, a variety of methods of investigation were used: SEM equipped with EDS (morphology and chemistry), ICP-AFS (chemical analysis), XRD (mineralogical composition).

A few results:

• chemical analysis of most minerals: 40.5% Cu, 10% As, 4% CaO, 2% P_20_5, 6.7% Al_20_3, 25.3% $Si0_2$, 1.5% Fe_20_3, 1.8% Na_20, 1 2% K_2O, 1.1% $Ti0_2$, 0.3% SO_3, 0.4% MgO, 2700 ppm Zn, 1600 ppm Mn, 400 ppm Ba, 360 ppm Pb, 100 ppm Ag, 55 ppm V, 25 ppm Sb.

• EDS analysis results of mineral elements: 71% Cu and 29% As.

the objects were wrapped suggests that it dates to at least 3700 BC.

Artefacts are particularly beautiful, with complex geometry, which explains the skill, professionalism and experience of the Canaan artisans[8]. Saas notes [7]: *The treasures from the Judean Desert represent the acme of the metallurgical skill of Chalcolithic artisans, working from 4500 to 3150 B.C.E., when copper and copper-arsenic alloys were first widely used in the Near East ...*

In parallel, it should be emphasized that the combination of primitive art, religion and metallurgy is striking in this case. Many of the artefacts were made by Lost Wax Casting process. Also, additional procedures were used: casting in open forms, casting in closed forms, etc. Several types of artefacts and their sections are shown in Figure 5.

Fig. 5. *Some examples of artifacts types from the Nahal Mishmar`s treasure*

As mentioned before, the material from which the Nahal Mishmar artefacts were made is arsenic bronze, the first alloy in the history of civilization, developed around 4000 BC.

Arsenic is a rare element in the earth's crust: its abundance is at about $5x10^{-4}$ % estimated. However, it often accompanies ores of gold, silver, lead and copper, thus becoming a by-product. Perhaps at first, this bronze was made by accident, likely caused by the similarity of colors both metalliferous ores and green-light the flame when heating in the furnace. One thing is sure: both "metallurgical" ancient and user - that could even be one and the same person - quickly realized that the pieces made of arsenic bronze have superior both technological properties (casting and forging capability) and use properties (toughness, hardness) compared to the similar parts made of copper.

Regarding the starting question: did the Jews of that time hold technical and technological knowledge necessary to create things of the great achievements of metallurgical order described in the Old Testament?

An affirmative answer can be given: the Jews came into contact with people who had a high level of metallurgical development and creativity, which allowed the technological knowledge assimilation.

[8] Today, the artifacts are exhibited at the Israel Museum in Jerusalem, Department of Antiquities.

4. Conclusions

• In pre-biblical times, casting was a widely used metallurgical process.

• Pre-biblical peoples held a high level of development and metallurgical creativity.

• In addition to technological knowledge already held in previous periods and by contact with these people, the Israelites could absorb metallurgical technology.

• Metallurgical achievements described in the Old Testament had the necessary technological knowledge support in order to be materialized.

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