FOUNDATION FOR RESEARCH ON ANCIENT AMERICA

THELONA D. STEVENS, PRESIDENT / 202 SOUTH PENDLETON AVE. / INDEPENDENCE, MO. 64050

NEWSLETTER NO. 33 October 20, 1979

Dear Members and Friends,

Dr. Richard A. DeLong will be the speaker at the Foundation's fall meeting at 3:00 P.M., October 28, at the Stone Church, Partridge Hall. Our last newsletter carried accounts of a trip early this year to Cacaxtla, Mexico by Dr. DeLong accompanied by Frederick O. Weddle, photographer. Through the influence of Thoric Cederstrom, permission was obtained to take pictures of a mural at Cacaxtla not yet open to the public for photographing. Dr. DeLong will make a special trip from Colorado for the purpose of presenting these pictures and giving his explanation of them. This will be a very special event.

It is with gratitude that FRAA acknowledges your response to our invitation to participate in the projects planned to promote understanding and use of the Book of Mormon. That these projects have met with general approval has been shown by your letters and contributions. Even though these contributions represent only a srart on what is needed, it is a nice start, and already work has begun on the preparation of slides with accompanying cassettes designed for advancement of understanding and appreciation of the Book of Mormon by both individuals--members and nonmembers--and groups, to be offered for sale at minimum cost. It is our hope and determination to proceed with this work as quickly as possible. We shall keep you informed as to our progress.

Roy E. Weldon has done it again. He has just recently announced another book off the press, the first volume of a new series, Book of Mormon Claims and Evidences, $3.50. Order "Buckeye," 2705 Windsor, Independence, MO 64052.

We remind you once again that you must notify us of any change of address if you want to receive your newsletters. The Post Office does not forward bulk mail but discards it.

--T.D.S.

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Due to lack of space in our newsletters, it is only now possible to present the following article written by Thoric Cederstrom while he was still in the Institute of Archaeology, Hebrew University of Jerusalem, Israel, in 1978.

A NOTE ON THE MANUFACTURE, COMPOSITION AND OCCURRENCE OF BRASS IN THE ANCIENT NEAR EAST

Research conducted for the Foundation of Research on Ancient America

By

Thoric Nils Cederstrom

In response to the discussion of metallurgy by Robert Smith and Roy E. Weldon in a recent issue of the FRAA bulletin,* I would like to offer the following comments on the metal brass and its relationships in the Ancient Near East. The question of its antiquity is still open, the problem of its composition and manufacture still exists, and both archaeology and archaeometry are striving to answer and solve them.

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*See FRAA Newsletters 28:5; 27:4; 24:5,6

The understanding of the following discussion of necessity dictates the comprehension of basic chemistry. I have tried to keep it as simple as possible in hopes that the widest range of readers may benefit from it.

Composition: Brass is an alloy consisting of copper and zinc. Today, the commonest modern brasses contain about 30-40 percent zinc, producing a bright, shining, hard metal. To understand the historical development of brass one must analyze the geology of zinc.

Zinc: It does not occur in a native metallic state, but its components are widely distributed. Zinc ores are partially associated with ores of lead, silver, copper, antimony, and arsenic, often in the form of complex ores. Zinc, therefore, as a separate metal was unknown to the ancients, having only been recognized as such just recently. The most important zinc ores used today are as follows:

Sphalerite (ZnS) It is called zinc blende and has a reddish brown color to black, occurring only below the ground and never on the surface. It is assumed by many that it was not used in antiquity. However, this is probably wrong, as it occurs with copper sulphite (CuS) and lead sulphite and consequently would have been found while smelting these ores.

Zinc Carbonate ($ZnCO_3$) Its mineral name is smithsonite but it is more commonly referred to as calamine. It occurs in heavy crusts of crystals and can be blue, green, yellow, gray, and brown. Straight $ZnCO_3$ is pure white and the various colors are due to mineral incrustations.

Zinc Silicate ($ZnSiO_3$) In mineralogical terminology it is referred to as hemimorphite, while its common name is electric calamine. It is found in massive crystalline crysts in the form of glittering, very shiny, needle-shaped crystals.

Manufacture: Zinc could not have been produced in antiquity on a large commercial scale and if ever obtained, it must have been accidently. "In Europe zinc was certainly not known until the early sixteenth century, though the metal was produced earlier in the East" (Forbes 1950:272). The ignorance of this metallic component, however, did not prevent ancients from using this ore when manufacturing an alloy. It is well known that bronze preceded tin production by centuries. The following consideration briefly outlines some of the complex problems involved in zinc smelting and consequently in brass production.

Zinc melts at 420°C but boils at about 950°C., i.e. at a much lower temperature than any other common metal. In order to reduce it from ores, it needs to be heated in contact with charcoal at 1000°C. Unfortunately, this is above its boiling point so that it comes off as a vapor and is quickly converted back into zinc oxide and is therefore lost. The modern process uses zinc sulphide (zinc blende) as an ore, roasts it to zinc oxide, and then smelts it at 1000°C.-1300°C. in an almost closed vessel with code to reduce it to metal vapor. This is quickly condensed to metal at one end of the vessel which is kept just above the melting point of zinc. Lacking these advanced techniques and equipment and the necessary control, the ancient metallurgists were clearly at a disadvantage for recovering zinc from ores and therefore alloying brass.

During the times when ores were mentioned in writings in Greek Classical days, no distinction was made between the three ores ($ZnCO_3$, $ZnSiO_3$, ZnS). There is good evidence that they were talking about separate ores but were referring to them as the same thing. The Greeks used the term cadmeia to refer to zinc, which was ZnO (zinc oxide) found in the natural smelting process of various ores. As noted above, zinc melts at 420°C. and boils at around 950°C., temperatures not difficult to obtain for metallurgy even in most ancient times. The basic process in antiquity of obtaining zinc is briefly described below.

$CuCO_3$ (copper carbonate) and $ZnCO_3$ (zinc carbonate) were placed in a charcoal furnace and both would be reduced to the respective metals, copper and zinc. Above the charcoal bed with the ores was a reducing atmosphere of air, oxidizing atoms. Temperature for reduction needed was between 907° and 950°. During the furnacing, zinc would vaporize and combine with oxygen to form 2ZnO (zinc oxide). It then condensed on the cooler parts of the walls of the furnace. It had a fluffy texture and the Greeks referred to it with a special name, pompholix. Some ZnO also formed on the bottom of the furnace in a slag form and its special name, Spodos, distinguishes it in the literature. Figure 1 schematizes the smelting process. After there was an established brass industry in which calamine ($ZnCO_3$, zinc carbonate) was used deliberately, it was refined by this process. The smelters would purposely throw calamine ore into the furnace, separate and collect the fluffy stuff (pompholix-zinc oxide).

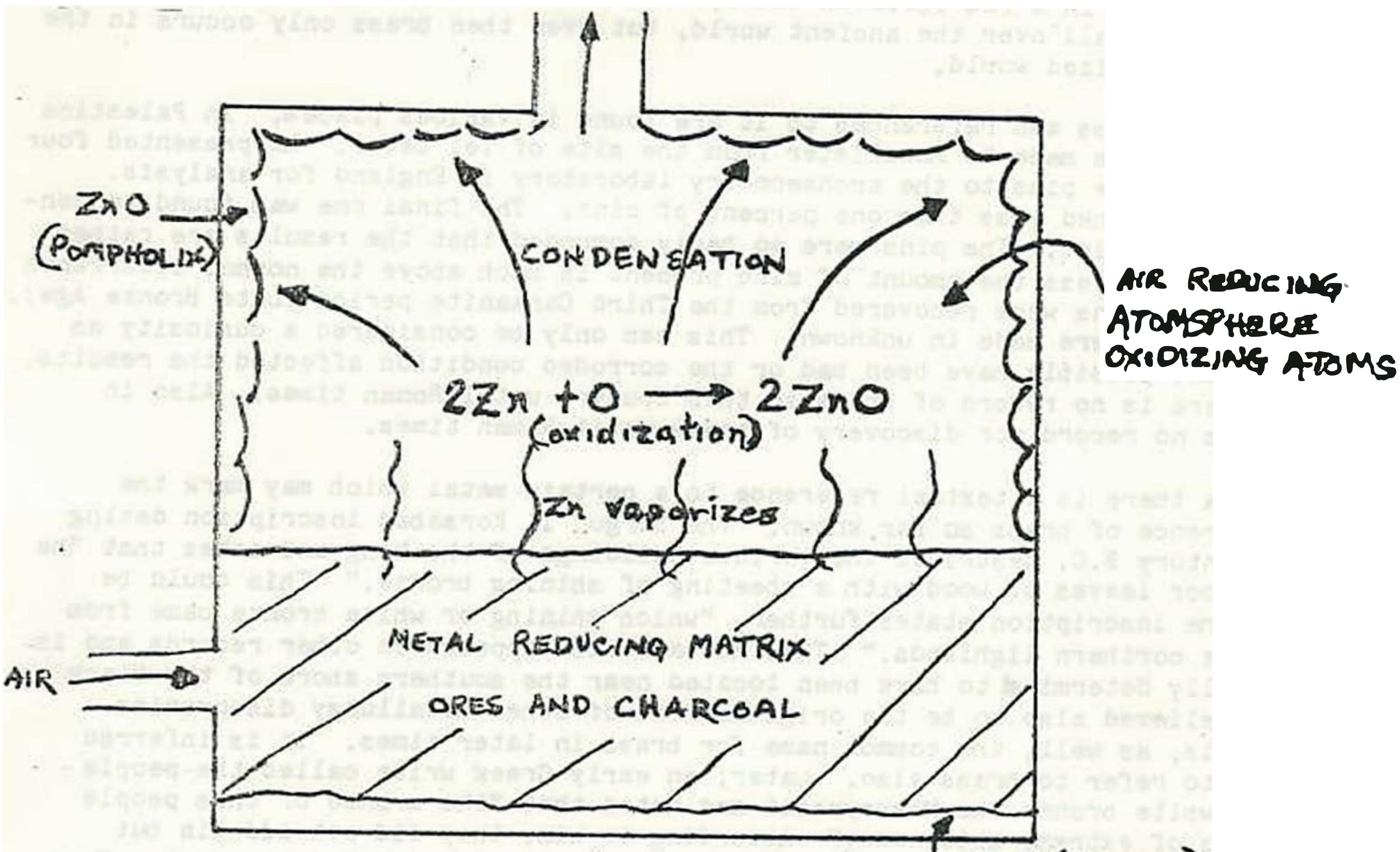

FIG. 1

If the ancients never saw zinc, how then was brass made? Most copper ores contain very little zinc naturally, but even if copper ore with zinc was reduced and the zinc stayed, it wouldn't be enough to make anything recognizable as brass. In some ancient bronzes there is found up to 2 percent zinc and this is a very high amount to occur naturally. However, as much as 15-40 percent is needed to change the color and the structural properties. Only with the start of the use of closed furnaces and the collection of zinc can brass be considered as a conscious effort.

According to written texts brass was first made by a process called cementation. Early texts make quite clear what exactly was done. Brass was made from copper, the metal, and calamine (meaning $ZnCO_3$ or ZnO). The metallurgists told how they did this. Calamine was ground with charcoal to a fine mixture and copper metal was imbedded in it. This was fired at 800°-900°C., still below the boiling point of zinc. Through this process there occurred some reduction of zinc metal and at this temperature the zinc metal which was molten diffused into the copper, thus forming brass.

History and Occurrence: Most scholars feel that it must have been discovered accidentally due to the nature of zinc. This smelting produced spectacular results; the copper color would come out as gold. One text even refers to the process as purifying the copper. Because of this, brass was very long considered to be a specific metal, not an allow but a "mock gold." The peculiar properties of zinc (discussed above) made it impossible for early metallurgists to prepare this metal on a large scale for many centuries even after its discovery. Lack of analytical methods also hindered the comprehension of the chemical processes involved in its smelting. Brass itself seems to have been discovered early in the first millennium B.C. There is, however, a difference of more than 2,500 years between the manufacture of the copper-zinc alloy, brass, and its metallic constituent (metal zinc).

Brass was certainly produced consciously from the classical period onwards. There is none, really, except in a few isolated cases, until the Graeco-Roman period, when it was found spreading all over the ancient world, but even then brass only occurs in the fringes of the civilized world.

In earlier times brass and references to it are found in various places. In Palestine the only reference is made to Macalister from the site of Tel Cezer. He presented four badly corroded bronze pins to the archaeometry laboratory in England for analysis. Three of them contained less than one percent of zinc. The final one was found to consist of 23 percent zinc. The pins were so badly corroded that the results are rather suspect but nevertheless the amount of zinc present is much above the normal occurrence in copper. These pins were recovered from the Third Canaanite period (Late Bronze Age). How and where they were made in unknown. This can only be considered a curiosity as the analysis may possibly have been bad or the corroded condition affected the results. After this there is no record of brass in this country until Roman times. Also in Egypt there is no record nor discovery of brass until Roman times.

In Mesopotamia there is a textual reference to a certain metal which may mark the earlist occurrence of brass so far known. The Sargon II Korsabad inscription dating to the 8th century B.C. describes the various buildings of the king and notes that "he covered the door leaves of wood with a sheeting of shining bronze." This could be bronze, but the inscription states further, "which shining or white bronze came from Mussair in the northern lighlands." This Mussair also appears on other records and is archaeologically determined to have been located near the southern shore of the Black Sea. It is believed also to be the original home of other metallurgy discoveries. White bronze is, as well, the common name for brass in later times. It is inferred in this case to refer to brass also. Later, an early Greek write called the people who invented white bronze the Mosscynocci and notes that "the bronze of this people excels, but is of extreme whiteness." According to him, they did not add tin but earth (oxidized zinc?) and kept their smelting process a secret from outsiders. This same area is the home for the first development of steel. Although no brass dating to this textual reference has been found in archaeological context in Anatolia and Mesopotamia, much has been found before Roman times. The basic problem in its recovery is its rapid corrosion rate which, depending on the climatic conditions, oxidizes quickly.

Zinc itself, as ore deposits, had a very wide distribution. Again, in the same place as the earlist occurrence of brass, the southside of the Black Sea. there are very extensive zinc deposits. In Cyprus zinc is present in association with copper ores. In southern Iran there are also very large deposits of various zinc ores. For the ancient world, however, metallurgists were not restricted to those areas as zinc is found almost everywhere in some amounts and since ancient man used little, it was feasible to exploit small deposits.

Book of Mormon: In this record there are several references to the use of brass. With our present situation of archaeological knowledge any definite statements must be tentatively asserted. While it may be reassuring and hopeful to believe that the "next dig" will produce favorable finds to support a particular theory, as scientific archaeologists we must work with the present body of factual data that we have at hand and not base assertions on as yet undiscovered evidence. True scientific hypothesis building and testing is grounded in established research results and actively seeks to test the full implications of its proposal. The "hypothesis" of the Book of Mormon are too complex and far-reaching, and to be able to judge whether the data "supports" them or not one must understand clearly the relationship between research, data, and theories, and more particularly, the nature of the Book of Mormon itself. In the case of brass (one "claim" of the Book of Mormon), we have one textual passage that may refer to it before the time mentioned in the Book of Mormon. Yet, there is no actual archaeological discovery to confirm that it was actually manufactured at that time. We should be open, too, to the possibility, as Robert Smith pointed out, that the translation "brass" perhaps refers to a special type of bronze (of which there is abundant evidence). In short, there is no data to support a conclusion either way that brass was or was not used. In closing, in hopes of stimulating further discussion and thought, not just on this particular problem, but also on others in the Book of Mormon, I ask, "What difference does it make?"

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(Report based on article "Native Americans were Continents' First Astronomers," by Ray Williams, in the October 1978 Smithsonian, pp. 78-85.)

EARLY AMERICAN ASTRONOMERS

by Frances M. Mills

In the Four Corners area of New Mexico are hundreds of towers built of carefully cut sandstone blocks fitted together without mortar. They were built by the Anasazi (Navaho for Ancient Ones), ancestors of the Pueblo Indians. The towers are round, square or D-shaped, and always perched on canyon edge or giant boulders.

A typical tower is Hovenweep Castle, originally built about 1200 A.D., and added to over succeeding generations, and, like the other towers of the area, it has specially built sighting holes in the walls; one hole aligns to the Summer Solstice, June 21, and another to the Winter Solstice, December 21.

In 1978 a team from St. John's College in Annapolis, Md., led by Ray Williamson, checked some of these Anasazi towers for astronomical accuracy, and concluded that the Ancient Ones had a precise calendar. Why should these people go to such effort for a calendar? They were agricultural people and needed to know the most favorable times of planting and harvesting, for one thing. Also, ceremonies accompanied all major activities of the people, and in order to be effective with the gods to whom the ceremonies were addressed they must be performed at precisely the correct time. The risings and settings of sun, moon and stars provided the accurate timing, and the towers with carefully situated sighting holes were astronomical observatories in the true sense.

In the same area in Casa Rinconada, a "great Kiva" or ceremonial chamber with its north entrance precisely aligned to the North Star, and wall niches aligned east and west. Across the canyon from Casa Rinconada lies Pueblo Bonito, placed to receive maximum sun in winter.

Hope Pueblos still watch sunrise and sunset on important dates in relation to notches in mountain skylines. In Chaco Canyon a sun symbol painted on a canyon wall is so placed that a person standing with his back to the symbol sees the sun at Summer Solstice rising behind a prominent rock pillar. Another such symbol was found on a mesa wall at the eastern end of Chaco Canyon.

Other paintings in Chaco Canyon have raised the questions of whether the Anasazi witnessed --and recorded--the brilliant supernova of July 4, 1054. Since many of the area's buildings date from the 11th to 13th centuries certainly there were people living there who were astronomically experienced enough to recognize the supernova as an unusual event. The pictographs include a sun, a crescent moon, a star and a hand. Computer research indicates that in the early morning skies at that date the crescent moon appeared above a 10-pointed star, with the sun beneath, as at sunrise. Or, is it only a Hopi painting of three major deities--sun, moon, and morning star?

On the eastern slopes of the Rocky Mountains are thousands of stone circles, known as Medicine Wheels. Some are as much as 82 feet across, with 28 stone spokes radiating from a central stone cairn, with other cairns situated at several spots around the rim. A person standing on a certain cairn and sighting across the central cairn at Summer Solstice would see the sunrise behind the central cairn; likewise from another cairn the Summer Solstice sunset. Still other positions are aligned to the rising times of Sirius, Rigel and Aldebaran. Aldebaran arises a few minutes before sunrise at the Summer Solstice; Rigel, one month later, and Sirius two months after the solstice. The Medicine Wheels have cairns oriented to these risings.

The purpose of these stone circles can only be guessed at. The risings of these three stars form a natural calendar. Perhaps important ceremonies took place at these times; perhaps the appearance of Sirius in late summer warned tribes summering in the high pastures that they should return to the lowlands before the snows came.

The desert and mountain Indians were not the only early American star-watchers. At Cahokia, near St. Louis, the remains of four circles of postholes have been studied. New posts were placed in the ancient holes by modern researchers, and the summer and winter solstice sunrises checked out perfectly as did also the spring and autumn equinoxes.

The people of Cahokia and the Anasazi were farmers, and the best times for planting and harvesting were important and accompanied with impressive ceremonies. The plains Indians were not farmers, but hunters; yet they constructed stone circles on mountain tops with the same alignments as the Casa Rinconada or Cahokia. The need for an accurate calendar was shared by all these widely separated peoples, whether for utility or ceremonial purposes.

Comments:
These Pueblo Indians did not develop the science of astronomy, but admit that the towers which they were using were built by their ancestors, their "Ancient Ones." This fact is supported by National Geographic, which has twice presented photographs of the astronomical observatory at Chichen Itza (Jan. 1925, p. 74; July 1931, p. 113).

Roy Weldon has a chapter, "Astronomy," in his new Book of Mormon Claims and Evidences, in which he quotes Professor Spinden (Scientific American, Dec. 1926, p. 413):

> At Copan, one of the oldest cities of the Maya Old Empite which flourished from 100 B.C. to 500 A.D., two stone stelae or monuments...have been discovered. These ...form a gigantic sun dial four and one-half miles across. Here, "the sun as viewed from the eastern stela, set behind the western stela every year upon a date which the Maya regarded as the beginning of their agricultural year... The most remarkable discovery was the fact that the base of the eastern stela is on the exact level with the base of the western."

Weldon says, "It should be noted that Mr. Spindon puts the flowering of Copan squarely within the Golden Age and "high water mark" of the ancient Nephite Empire. (pp. 78,79).

Both Alma 16:54,55 and Helaman 4:62 show that the Nephites had knowledge of astronomy.

--T.D.S.

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