

COPPER, BRONZE, AND BRASS

Although Nephi's tools were most likely made of iron or steel, bronze remains a possibility. Thus a review of the development of copper and its alloys may be in order and of special interest to readers of the Book of Mormon.

Most copper artifacts dated to before 5000 B.C. are of native metallic copper.³⁶ However, copper was the first metal to be smelted from its secondary ore minerals,³⁷ mostly malachite and azurite, and smelting slags from central Anatolia (Çatal Hüyük) have been dated to as early as 6000 B.C.³⁸ In the Near East native copper is found in a belt from northwest Anatolia to northern Iraq, with a second major source at the Talmessi Mine in Iran. The earliest copper mining appears near Ur before 4000 B.C., and copper was smelted at Ur by 3500 B.C.³⁹ Sea trade between Mesopotamia and Magan (northern Oman) brought impure copper ingots, via Dilmun (Bahrain), up the Euphrates River to Mari, in Sumeria, where the copper was refined.⁴⁰ This trade continued until about 1700 B.C., when copper mining on Cyprus began in earnest.⁴¹

Palestine had little or no native copper, and the metal was relatively rare there in the Bronze Age but became more abundant about the time of Abraham (Middle Bronze Age, about 2000 B.C.). Copper was seriously mined, as secondary carbonates and silicates, and smelted at Feinan in Wadi Arabah by the kings of Israel.⁴² These colorful, secondary minerals, largely malachite and chrysocolla, are sold to modern tourists as "Elat Stone."

In the Americas artifacts of hammered native copper in the Lake Superior region date from 3000 B.C.⁴³ Complex and sophisticated metallurgical technologies in the pre-Columbian New World, however, are presently recognized only in the Andes Mountains of Peru and Chile,⁴⁴ where copper was smelted from rare copper arsenides, sulfates, and chlorides.⁴⁵ Smelted copper is not presently recognized before the first century A.D.,⁴⁶ when arma-

ments of cast copper appear (e.g., mace heads, spear points, thrower hooks).⁴⁷

In the modern world, brass is an alloy of copper and zinc, and bronze is an alloy of copper and tin. Understanding the copper alloys of the ancient or medieval world, however, requires an explanation.

The first copper alloy (Early Bronze Age, about 3500 B.C.) was arsenic-copper, sometimes called "arsenic-bronze," and was probably produced by accident.⁴⁸ Copper minerals of the Talmessi Mine were closely associated with arsenic minerals, and smelting likely produced an unintentional alloy⁴⁹ that melted at lower temperatures than pure copper and was more fluid and easier to cast.⁵⁰ The new alloy, if recognized as such, was not distinguished with a new name, and the Hebrew word נְחֹשֶׁת and Greek word χαλκός were applied to both copper and the new arsenic-copper alloy.⁵¹ Arsenic was soon a deliberate addition to smelted copper, but before the Middle Bronze Age (2000–1600 B.C.) in the Near East, a tin-copper alloy had largely replaced the earlier arsenic-copper alloy.⁵² Tin-copper was far superior and was also absorbed by the Hebrew and Greek words noted above. No new word was created to distinguish this new copper alloy.

The zinc-copper alloy may also have been formed by accident, because the common secondary minerals of zinc (smithsonite and hemimorphite) may be closely associated with the common secondary minerals of copper (malachite, azurite, and chrysocolla) in weather-altered, near-surface deposits. Normal smelting of zinc ore does not yield metallic zinc, but smelting a mixture of secondary minerals of zinc and copper together may yield a zinc-copper alloy. Deliberate zinc-copper did not come into use before Roman times, and earlier accidental examples of this alloy are extremely rare.⁵³ This new alloy, too, was absorbed by the existing Hebrew and Greek words for copper, and the Latin word *aes* or *aeris* stood for copper and both of its major alloys.⁵⁴

In antiquity the words *bronze* and *brass* did not exist. *Brass* is an English word derived from *braes* (Old English) and *bres* or *bras* (Middle English) about 1200 A.D.⁵⁵ In the language of Tudor England, *brass* stood for any copper alloy, and the King James Bible uses the word in that context.⁵⁶ Joseph Smith, favoring the King James Bible, translated the Book of Mormon using *brass* in the same manner. In a few verses of the Old Testament the Hebrew word for copper is even translated “steel”⁵⁷ (2 Samuel 22:35; Job 20:24; Psalm 18:34; Jeremiah 15:12) and “amber” (Ezekiel 1:4, 27; 8:12).

The word *bronze* did not come into use before the 18th century and did not exist in Tudor England.⁵⁸ It does not appear in the King James Bible (it does appear in other versions of the Bible) or in the Book of Mormon, and the objects designated “brass” were most likely the tin-copper alloy.

The brass plates of Laban may have been copper, as bronze is harder and more difficult to engrave upon. The Liahona may well have been of supernatural origin and, hence, of any metal or alloy that Nephi chose to call “fine brass.”

Pure copper can be “work hardened” by hammering and annealed by heating and slow cooling to prevent cracking with repeated hammering.⁵⁹ The tin-copper alloy was far superior, however, and bronze was the metal of choice throughout long periods of human history. The Bronze Age in the Near East began well before 3000 B.C. and lasted through 1200 B.C., when bronze was largely replaced by iron.⁶⁰ Even in the Roman period, however, spearheads and arrowheads (socketed items) were still cast in bronze,⁶¹ as iron could not be melted and cast.

“Classical bronze” contained about 10 percent tin, but even 2 percent tin produced noticeable positive effects.⁶² Tin is rare in the Near East, and the sources of tin for the Bronze Age are still speculative. Tin was quite possibly the catalyst for international trade, bringing tin from Italy, Sardinia,

Greece, Crete, Portugal, Brittany, Spain, and faraway Cornwall (British Isles) in the west⁶³ and from Afghanistan, via the Indus Valley, in the east. By the mid-third millennium, native gold and cassiterite (SnO_2) were panned together from Himalayan riverbeds and transported to markets in the Near East.⁶⁴

In the New World some arsenic-rich copper minerals of Peru and Chile may also have been smelted to produce accidental arsenic-copper, but deliberate addition of arsenic is apparent by at least 1000–1700 A.D.⁶⁵ The placer cassiterite from Bolivia⁶⁶ provided tin for the tin-copper alloy, characteristic of a much earlier Bronze Age in the Old World; and among the Incas, bronze was a rather common metal available to people of many social classes.⁶⁷ From the Andes, metal technology appears to move north into Panama and Mexico.⁶⁸ Spanish conquerors, however, found the Aztecs of Mexico still in a pre-bronze age,⁶⁹ a considerable regression from an earlier civilization. The last mention in the Book of Mormon of working iron, copper, brass, and steel is Jarom 1:8, scarcely 200 years after Nephi arrived in the New World. About 250 years later, however, King Noah taxed all people who possessed these metals (see Mosiah 11:3). Roper notes only fire-hardened, wooden weapons, some lined with obsidian chips, in Mesoamerica at the time of the Spanish conquest.⁷⁰

Lechtman appears to say that the traditional sequence of Near East metallurgy from simple native metals to complex copper alloys to iron-steel does not seem to apply in the New World, where the sequence is related rather to the ideology, worldview, and values of its people.⁷¹ That conclusion will need to be verified by further research and discovery, which may also shed light on the extent to which the highs and lows of New World metallurgy were determined by the influx of foreign migrations bringing new technology and by subsequent social decay and loss of technology. ■