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Metals and Metallurgy Relating to the Book of Mormon Text

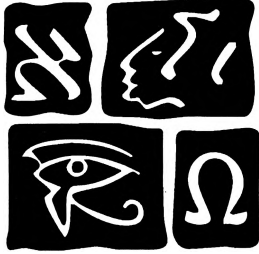
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Abstract: The text of the Book of Mormon refers many times to metals, ores, and metal processing. John Sorenson provides an annotated bibliography of sources on archaeological finds of Old World and Mesoamerican metallurgy and metal specimens. He includes a summary of statements in the Book of Mormon text about metals, ores, and metal processing, with notes on Hebrew usage of metal-related terms.



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FOUNDATION FOR ANCIENT RESEARCH AND MORMON STUDIES

John L. Sorenson

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Summary

The text of the Book of Mormon refers many times to metals, ores, and metal processing. John Sorenson provides an annotated bibliography of sources on archaeological finds of Old World and Mesoamerican metallurgy and metal specimens. He includes a summary of statements in the Book of Mormon text about metals, ores, and metal processing, with notes on Hebrew usage of metal-related terms.

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Metals and Metallurgy relating to the Book of Mormon Text

John L. Sorenson

Introduction

The text of the Book of Mormon refers many times to metals, ores, and metal processing. There are three kinds of problems for interpreting those statements: (1) Internal textual problems. What do the words mean? How are they to be translated in terms of modern languages? (2) Problems with archaeological correlations specific to the New World. Conventional scholars say that no metals were used in Mesoamerica during the period of Book of Mormon history and, furthermore, that certain kinds of metals apparently indicated by the text are never evidenced in the archaeological remains in that area. (3) Archaeological and historical problems concerning the Near East. The metallurgical background of the migrating peoples (Jared and his party, Lehi and his group, and Mulek and his) as described by scholarly sources is sometimes said not to square with statements or implications in the Book of Mormon text about that background.

The material presented in this study is intended as an aid to addressing these three problems in Book of Mormon studies. I plan to produce an explication of the textual and scholarly materials according to my understanding at some time in the future. Meanwhile, others may find my materials useful for their own interpretations. At the least, the contents below will serve as a diverting antidote to overconfident assertions about what is "known." In the words of educator Ross Stagner, "We know too many things that just are not so."

Contents

Part 1. Annotated bibliography of sources on the Old World metallurgical background of peoples who may have migrated to America from Southwest Asia and some related methodological issues.

Part 2. Annotated bibliography on aspects of the history of pre-Columbian metalworking in the New World, with emphasis on Mesoamerica.

Part 3. Index to Parts 1 and 2.

Part 4. Table and commentary regarding probable and possible pre-A.D. 900 Mesoamerican metal specimens.

Part 5. A summary of statements in the Book of Mormon text about metals, ores, and metal processing, with notes on Hebrew usage of metal-related terms.

Part 1

Annotated Bibliography of Sources on the Old World Metallurgical Background of Peoples Who May Have Migrated to America from Southwest Asia, and Some Related Methodological Issues

Alieva, L. G., and A. M. Gasanova. "Problem of the unknown metal *kharsini* in medieval written sources." *Doklady Akademii Nauk Azerbaidzhanskoi SSR* 37/4 (1981?). (In Russian.) English abstract in *Art and Archaeology Technical Abstracts* 19/1 (1982): 111.

Relevant to the problem of fixing the technical meaning of an ancient textual term. Evidence is presented that *kharsini* is a native metal which contains both arsenic and antimony. The documents had been unclear; modern chemists had surmised the substance named might be brass or antimony. [For more on the general problem, see Balmuth 1971.]

Balmuth, Miriam S. "Epigraphical intimations of early coinage in the Near East." *American Journal of Archaeology* 67 (1963): 208.

Inscriptions at Alalakh in the 18th-15th centuries A.D., Ugarit in the 14th, and Assyria in the 7th can be interpreted to refer to pre-weighted, recognizable money. Lydia produced the "first consecutive coinage" toward the end of the 7th century, but possibly there were independent, guaranteed coinages earlier.

Balmuth, Miriam S. "Remarks on the appearance of the earliest coins." In *Studies Presented to George M. A. Hanfmann*, edited by David Gordon Mitten et al., 1-7. Harvard University Fogg Art Museum Monographs in Art and Archaeology II. Mainz: Philipp Von Zabern, 1971.

Page 1: "The reconciliation of archaeological evidence with ancient written sources is one of the more frustrating and, at the same time, tantalizing exercises both for the historian and the classical archaeologist." She speaks of the development, not the invention, of coins. In light of this insight, a Lydian coin emerges as a piece of metal being made identifiable rather than a piece of metal to be decorated while identifiable, as it became in Greece. As far back as the third millennium B.C. documents comment on metal as an expression of price. Examples are given. Sennacherib before 681 B.C. wrote of making molds of clay and pouring bronze in them to fashion half-shekel pieces. Herodotus and Aristotle furnish the earliest Greek references to coins, crediting the Lydians, but theirs was the first bimetallic coinage, not necessarily the first coinage *per se*.

Caley, Earle R. *Orichalcum and Related Ancient Alloys. Origin, Composition and Manufacture with Special Reference to the Coinage of the Roman Empire*. Numismatic Notes and Monographs No. 151. New York: American Numismatic Society, 1964.

Page 1: The Latin word *orichalcum* and its Greek predecessor designated different metals or alloys at different times. Today it is used to designate a copper alloy containing zinc. At no time were the proportions of copper and zinc held exactly constant, hence the term refers to a class of alloys, not just one. Though Roman alloys of this class may be called brass, they contain lower proportions of zinc than most varieties of modern brass. Pages 3-5: Analyses and discussion of metal objects from Central Europe containing zinc as a principal component of the alloy. At least one is

“pre-Roman”; four others “are probably all much earlier than the beginning of the Christian Era.” Page 6-7: In the Mediterranean region the earliest use of a zinc alloy is at Gezer in Palestine, belonging to the period known as Semitic III (1400-1000 B.C.) and “which may be termed a zinc bronze.”

Congdon, Lenore O. Keene. “Steel in antiquity: a problem in terminology.” In *Studies Presented to George M. A. Hanfmann*, edited by David Gordon Mitten et al., 17-27. Harvard University Fogg Art Museum Monographs in Art and Archaeology II. Mainz: Philipp Von Zabern, 1971.

Page 17: The problem of whether an ancient people “had steel” is often terminological. Few people who are not trained in metallurgy attempt to learn what steel really is. Pages 18-19: A superlative brief discussion of iron/steel processing is given. “Steel is iron that has been combined with carbon atoms through a controlled treatment of heating and cooling. Through this, it changes its physical properties to become an alloy . . . of iron atoms and carbon.” Pages 24-25: In the third millennium B.C. smiths in the mountains of Armenia learned to take iron ore from bogs and lakes and using hearths and bellows-fed furnaces, turn this into a plastic lump or sponge. Hammering then forced out impurities resulting in “wrought iron,” which was softer and more malleable than bronze. This quenching produced a pearlite substance. A similar process was independently discovered in Egypt and Nubia as part of the refining of gold. By 1400 B.C. the Armenians had discovered and could reproduce, with varying success, the method of carburizing iron by prolonged heating in contact with carbon, probably the charcoal of their forges. This produced martensite, a thin layer of steel on the exterior of the object. It is best considered “semi-steel.” By 1000 B.C. this process had spread to the Mediterranean. But smiths did not know why this process produced the results it did. (“Steel was easy to discover, but the recognition that it was an alloy was long delayed.” Before the chemical discovery of carbon in steel in A.D. 1774, steel was considered just a purer form of iron.) Page 26: “Possibly as early as the ninth century B.C., certain tools and possibly weapons were composed of a case-hardened or carburized iron or semi-steel.”

Craddock, P. T. “Europe’s earliest brasses.” *MASCA Journal* 1 (Dec. 1978): 4-5.

While it is supposed that zinc metal was first produced in Europe only since 1738, it has been acknowledged that brass, an alloy of copper and zinc, was made directly from copper and zinc ore by the Romans. Recent work has shown that certainly brass, and perhaps metallic zinc, were known to Hellenistic civilization. In addition to the old Greek word for copper or bronze, *chalkos*, *orechalkos* (“golden,” or more likely, “mountain,” “copper”) was used from at least the 7th century. New analyses of Greek and Etruscan metalwork reveal “lost” brasses. Also, actual Hellenistic zinc has been found in the Athenian Agora. While that was questioned because of its uniqueness, now the discovery of contemporary Etruscan brass strengthens the case.

Crawford, Harriet. *Sumer and the Sumerians*. Cambridge: Cambridge University Press, 1991.

Pages 131-39: Metal working. Page 131: Texts from Ur of Early Dynastic I date already distinguish copper and bronze. Copper and lead were most widely used metals in pre-dynastic times, but electrum is also evidenced. Page 132: Lost wax casting shows up in the Eanna III hoard and lumps of ore from the Anu ziggurat at Uruk (period IV). By E. D. III, Mesopotamian craftsmen had mastered all major techniques in copper, lead, silver, gold and tin and had begun to experiment with iron on a small scale. The Royal Cemetery at Ur shows both tin bronze and arsenical bronze, as well

as silver, gold and electrum. Also all types of casting, granulation, cloisonné, and gold wire. Metal working was no doubt earlier outside the Mesopotamian flood plain. The Iranian plateau was one of the source areas from which knowledge and objects reached Mesopotamia; excavations at Tell-i-Iblis and Gabristan show copper working in the early 5th millennium and use of copper-arsenic alloys from the first half of the 4th millennium. Page 133: Third millennium levels show mass produced weapons of metal.

Forbes, Robert James. *Metallurgy in Antiquity: A Notebook for Archaeologists and Technologists*. Leiden: E. J. Brill, 1950.

Page 402: Less than 300 tons of meteoric iron are known at present, most of it in the New World. [Contrast Lapaz, and Nininger.] Perhaps people in the Old World used up an equal amount. "The ancients possessed in the natural (meteoric) nickel-iron alloy a type of steel that was not manufactured by mankind before 1890." "Nearly all the people of Antiquity use such words for iron as 'heaven metal' or 'something hard (stone) from heaven.'" Eskimos detached pieces from meteorites by hammering, the same way Indians used to separate fragments from copper masses near Lake Superior. Eskimo metallurgy was very different from that of the Norse nearby. There seems to have been no technological contact between the two.

"Steel" in the Authorized Version (KJV) of the Bible should often be read "bronze" or "copper". Page 435: The "northern iron" of Jer. 15:12 is probably Chalybian steel, and the "bright iron" taken from the merchants of Dan and Javan (Jer. 27:19) may refer to Ionian steel, "though others say that the Phoenicians got these materials from Uzal (S. Arabia) and that it might be Indian steel!" The "bedstead of iron" of Og, king of Bashan (Deut. 3:11) east of the Jordan, was probably a basalt sarcophagus, for the peasants there still call basalt "iron"; this makes it probable too that the "iron" teeth of the threshing sledge mentioned in Amos 1:3 were really pieces of basalt, which are still used for these instruments in that area.

He has difficulty accepting independent invention in America of bronze-making in view of the inherent unlikelihood of invention of such a complex process even a single time.

Heskel, Dennis L. "A model for the adoption of metallurgy in the ancient Middle East." *Current Anthropology* 24 (June 1983): 362-66.

Page 362: Heat-treated metal objects were present at Çatal Hüyük in the late 7th and early 6th millennia B.C. then were virtually absent for the next 2000 years. He maintains that this sequence relates directly to specific economic, political and social factors affecting the need for metal in those societies, not to technical lacks. The earliest piece of metal known archaeologically is a copper pendant from Zawi Chemi dated 8500 B.C. which may be hammered native copper. Page 363: During late 5th and 4th millennia, production and use of metal changes dramatically with the emergence of complex society. Lead smelting and possible annealing from Ç. Hüyük probably date to this later time. Page 365: "The apparent failure of ancient Middle Eastern societies to exploit the knowledge of metallurgy evidenced at Çatal Hüyük possibly 2,000 years . . . (before) must be associated with an absence of a sufficient surplus of food or trade items."

Heskel, Dennis, and Carl Clifford Lamberg-Karlovsky. "An alternative sequence for the development of metallurgy: Tepe Yahya, Iran." In *The Coming of the Age of Iron*, edited by Theodore A. Wertime and James D. Muhly, 229-65. New Haven: Yale University Press, 1980.

Page 257: At Yahya, where metallurgy begins in the range 4500-4000 B.C., "None of the evolutionary schemes (of metallurgical development) presented either accounts for the actual technological progression for a single site/region or, more importantly, provides the necessary cultural correlations with the technological developments to be of use archaeologically." 262: "Our conclusion (also) indicates that the introduction of technological changes in metallurgical production does not lead to immediate observable changes in the social system at Tepe Yahya throughout the 4th millennium." "The implications of this situation clearly differ from the common assumption, namely, that technological innovations lead to rapid and major changes in social institutions." Page 263: "Such a study tends to weaken the materialist [economic determinist] reconstruction of historical processes."

Mallowan, M. E. L. *The Early Dynastic Period in Mesopotamia*. Vol. I. Revised edition. Cambridge: Cambridge University Press, 1968.

Page 60: A dagger handle of non-meteoritic, terrestrial iron was found at Chagar Bazar in level 5, in a grave. Thus iron-working was already established in north Syria at least as early as Early Dynastic IIIb. This discovery coincides with one at Tell Asmar where were found traces of a blade of terrestrial iron in a bronze knife handle.

Moorey, P. R. S. "The archaeological evidence for metallurgy and related technologies in Mesopotamia, ca. 5500-2100 B.C." *Iraq* 44/1 (1982): 13-38.

Pages 13-14: By the middle of the third millennium B.C. at Ur, the grave material "reveals knowledge of virtually every type of metallurgical phenomenon except the hardening of steel that was exploited by technologists in the entire period up to the end of the 19th century A.D." (quotation from C. S. Smith). Page 14: "Metal finds are very rare, at the best of times, in temple or settlement excavations." When an archaeological period is poorly represented in the mortuary record, its metalworking is likely to be more than ever obscure. Pages 16-17: Evidence for metalworking installations in Mesopotamia in the period considered here is negligible. Page 21: By the end of the Protoliterate, the range of techniques is considerable: gold, silver, lead, lost wax, etc. (some development of wax casting even in Ubaid is indicated). Page 22: Fragments of iron in the Anu ziggurat in the 4th millennium and at Tepe Gawra (cf. page 30). The earliest tin bronze is at Tepe Gawra at the outset of the 3rd millennium.

Page 29: The precocious appearance of iron in Mesopotamia has not yet been fully considered. Fragments in early contexts have been too easily dismissed in the past as intruders from later levels. This need not be so. Small pieces of terrestrial iron might result from copper smelting where iron fluxes have been used, leaving ductile iron in the bottom of the furnace. Worked, meteoric iron has always been accepted in early contexts when identified by metallurgists. Page 30: Terrestrial iron has been identified by metallurgists in 3rd millennium samples from Chagar Bazar and as the blade of a knife or dagger with a bronze hilt from Kish and from Tell Asmar in mid- to later 3rd millennium. Other reported finds are listed also.

Moorey, P. R. S. "Early metallurgy in Mesopotamia." In *The Beginning of the Use of Metals and Alloys. Papers from the Second International Conference on the Beginning of the Use of Metals and Alloys, Zhengzhou, China, 21-26 October 1986*, edited by Robert Maddin, 28-33. Cambridge: Massachusetts Institute of Technology, 1988.

Summarizes evidence for the development of metalworking in Mesopotamia before 2000 B.C. in its social and economic context. Page 28: "In historic times texts indicate that metals were rigorously controlled by the bureaucracy and were regularly recycled. Consequently the actual amount of metal recovered through excavation at any period is no guide to the scale of contemporary use. Metal finds are rare in all periods on settlement sites. It is also exceptional . . . for metal artifacts to be found in quantity in graves." Page 30: About the middle of the fourth millennium B.C. remarkable changes in the status of metallurgy become evident. "The range of metals and techniques was already wide, and the level of skill was high." Page 31: Archaeology reveals the first systematic exploitation of native gold and electrum; silver is now extracted from lead ores and is widely used; both texts and objects reveal the presence of iron. We cannot be certain whether this is both meteoric iron and iron smelted as a by-product of copper smelting, which was steadily increasing (including bronze use).

Muhly, J. D. "Copper and tin: the distribution of mineral resources and the nature of the metals trade in the Bronze Age." *Transactions of the Connecticut Academy of Arts and Sciences* 43 (March 1973): 155-535.

Pages 171-79: Words for copper. Detailed comparison of terms in most relevant languages. Pages 240-47: Words for tin. Page 245: Harris notes that spellings in Egyptian texts frequently make it difficult to distinguish between the terms for tin and lead. Muhly explains why.

Muhly, James D. "The beginnings of metallurgy in the Old World." In *The Beginning of the Use of Metals and Alloys. Papers from the Second International Conference on the Beginning of the Use of Metals and Alloys, Zhengzhou, China, 21-26 October 1986*, edited by Robert Maddin, 1-20. Cambridge: Massachusetts Institute of Technology, 1988.

Important discussion of diffusion, stimulus diffusion, and migration as explanations for the spread of metallurgy in the Old World. It is a current penchant to deny these a significant role but that is a fashion not justified by the facts. Proper understanding of the development of metallurgical technology must not dodge, as it has been doing, "a study of origins." Possible relations between Chinese metallurgy and that of the Near East are discussed at length in this light. Cites C. S. Smith and Wertime on the unlikelihood of independent development of metalworking in China, or anywhere else, and reprises the latest findings about the origin and development of metallurgy in early China, contra Renfrew and some other archaeologists.

Muhly, J. D., and T. A. Wertime. "Evidence for the sources and use of tin during the Bronze Age of the Near East: A reply to J. E. Dayton." *World Archaeology* 5 (1973): 116.

Failure to recover by excavation metals or other elements of technology attested by historical documents should not be taken to assume their absence.

Sillitoe, Paul. "Stone versus steel." *Mankind* 12 (Dec. 1979): 151-61.

New Guinea peoples using stone tools did not wish to give them up when offered steel tools. He discusses various tests on the comparative utility of stone versus steel and concludes that steel is not decisively superior to stone.

Sjodahl, J. M. *An Introduction to the Study of the Book of Mormon*. Salt Lake City: Deseret News Press, 1927.

Pages 74-75: The same term, *nechushah* or *nechushet*, in the Old Testament (KJV) has been rendered "steel" in four places (2 Sam. 32:35, Job 20:24, Ps. 18:34, and Jer. 15:12) and "brass" twice (one, Gen. 4:22). Yet Gesenius renders it as "copper," "mostly as hardened and tempered in the manner of steel."

Tylecote, Ronald F. "Furnaces, crucibles, and slags." In *The Coming of the Age of Iron*, edited by Theodore A. Wertime and James D. Muhly, 183-228. New Haven: Yale University Press, 1980.

Table 7.2 gives "Some Examples of Early Smelted Copper Artifacts," the earliest being at Tepe Yahya, Iran, and Beersheba, Israel, 3800 B.C. Page 210: As regards "The Earliest Iron-Making Furnaces," "The most primitive type of furnace for making iron is the bowl furnace, which is no more than a hole in the ground or rock . . . and a short, probably dome-shaped superstructure of clay." Implies that this was not superseded until Roman times [and would be very difficult to discover and identify]. Pages 211-12: Aside from a glance at a couple of examples of what he terms "hardly any remains of early furnaces" in the Near East and Europe, he notes that "most of our evidence dates from the classical and Hellenistic periods (after 500 B.C.)."

van der Merwe, Nikolaas J., and Donald H. Avery. "Pathways to steel." *American Scientist* 70 (1972): 146-55.

The idea that iron technology spread outward from the Mediterranean across the Old World is too simple. China and Africa followed markedly different pathways to steel from the solution developed in the Mediterranean. It is also possible that iron technology was independently developed in Southeast Asia. The first smelting of iron may have taken place as early as 5000 B.C. (Samarra, Mesopotamia), but more commonly early iron was of meteoric origin, with a characteristic nickel content of above 4%. Nonetheless, an iron with the characteristics of wrought iron was produced sporadically throughout the Bronze Age, but it was easily bent, could not keep a sharp edge and was difficult to weld together to form large objects. Actually "any efficient copper smelting operation requires a co-smelting of copper and iron oxides" (chemical formulae given). If iron oxide is not naturally present, it must be added to increase copper yield. Pure copper cannot compete with flaked stone for cutting edges, but it can be hardened by alloying.

Page 147: Development of copper-bronze metallurgy between 4000 and 1000 B.C. resulted in inadvertent production of iron even though the early metallurgists were mainly unaware of how the iron came about. Page 149: In the Mediterranean area, industrial development of bloomery iron began around 1200 B.C., but its properties were generally inferior to good tin-bronze, though production was difficult. Steel could be produced only on the surface of an object; some smiths did master this process of (steel) carburization during the next several centuries. An Egyptian knife, ca. 800-900 B.C., shows a clear laminated structure of fagoted carburized sheets.

Page 152: Legend to Fig. 6: “The technological level of a smelting process may be underestimated if the only evidence is archaeological.” Photo and discussion makes clear that “there were many furnace designs and smelting procedures in Africa, none involving more than a handful of persons yet yielding excellent carbonized iron.”

Waldbaum, Jane C. “The first archaeological appearance of iron and the transition to the Iron Age.” In *The Coming of the Age of Iron*, edited by Theodore A. Werhane and James D. Muhly, 69-98. New Haven: Yale University Press, 1980.

Pages 69-72: Summing up, “iron was used sporadically and treated as a precious material in almost every instance,” as attested by their contexts—graves, treasure hoards, temples, and the nature of the objects themselves. Pages 72-73: According to analyses of the earliest materials, both meteoritic and smelted iron were in use simultaneously during this time. In Mesopotamia three analyzed specimens, in Anatolia one, in Egypt three, were smelted. “From present evidence one cannot determine whether smelted or meteoritic iron deserves precedence. The earliest piece of all, the Samarra implement, is smelted.” Page 74ff: Similar data are given on later periods. Page 79: A number of ancient Near Eastern texts deal with meteors and meteorites; some seem to show both observation of meteorite falls and understanding of the relationship between iron derived from meteorites and its cosmic origin. Hittites used the term “black iron of heaven,” but the Egyptian term “iron of heaven” (*bia' n pet*) did not come into use until the Nineteenth dynasty and was then used to refer to all iron, without distinction as to origin. Page 80: Through the Late Bronze Age no archaeological remains are known as evidence for deliberate smelting of iron and only one possible text implies smelting. Page 81-82: The Hittites have been attributed with control over the production of smelted iron through some “secret” for the process, but this is highly doubtful. In any case virtually no iron implements have ever been found at Hittite sites (some have supposed the artifacts had been “plundered”) despite the finding of many bronze objects. Page 83: Further, even in the two or three century transition to “the Iron Age” after 1200 B.C., bronze continued to be preferred for utilitarian purposes with iron only an acceptable substitute. Page 84: The growth in iron weapons is discussed. Page 90: “Given the uncertain technical capabilities of the early smiths and the unreliable nature of many of their products, we can begin to understand the reasons for the rather halting adoption of iron, and the continued production of bronze utilitarian implements begins to fall into place.”

Wheeler, Tamara S., and Robert Maddin. “Metallurgy and ancient man.” In *The Coming of the Age of Iron*, edited by Theodore A. Werhane and James D. Muhly, 99-126. New Haven: Yale University Press, 1980.

Page 116ff: On the carburizing of iron (i.e., “steel”-making). Page 121: “Smiths were carburizing intentionally on a fairly large scale by at least 1000 B.C. in the Eastern Mediterranean area.”

Part 2

Annotated Bibliography of Sources on Aspects of the History of Pre-Columbian Metals in the New World with Emphasis on Mesoamerica

Acosta, Jorge R. "Los Toltecas." In *Los Señoríos y Estados Militaristas*, Román Piña Chan, coördinador, 137-58. México: Instituto Nacional de Antropología e Historia, 1976.

Page 158: The total absence of metals during the (Tula) Toltec period is inexplicable since this was already in the full epoch of use of gold, silver, and copper. This presents a mystery which up to now has not been explained: was the use of metal later or have archaeologists not had the luck to find it? The only two objects of copper which have been found (at Tula) belong unquestionably to the Aztec horizon.

Agrinier, Pierre. "Un complejo cerámico, tipo Olmeca, del preclásico temprano en El Mirador, Chiapas." In *Sociedad Mexicana de Antropología*, XIII Mesa Redonda, Xalapa, 1973, *Arqueología* II. México, 1975. Pages 21-34.

Page 24: Enormous quantities of iron ore fragments, lightly magnetic (perhaps ilmenite), in more or less cubical form, have been found at El Mirador and nearby. Some had holes drilled in four sides. Flannery found similar mineral objects at San Lorenzo associated with the San Lorenzo phase, one with a hole. Page 25: Various deposits of iron are known to be situated near El Mirador. Agrinier thinks they may have been *atlatl* weights, as they closely resemble such weights from the U.S. Northwest made of lead.

Aguilar P., Carlos H. "La orfebrería en el México precortesiano." *Acta Anthropologica* 2/2 (Dic. 1946).

Page 21: According to Sahagún, metal tubes were used by lapidaries as instruments to perforate precious stones. Holes in stone masks were possibly made the same way. But when we see them in Teotihuacan masks, we suppose that they just used reeds in place of metal tubes, since metals were not then known. [Classic age metals now being demonstrated, the use of such tubes may be more logical than the supposed but awkward reeds. Cf. Arreola.]

Aguirre, Oscar, et al. [17 others]. "Primer informe sobre los trabajos arqueológicos de rescate efectuados en el vaso de la presa de El Infiernillo, Guerrero y Michoacán." *Boletín INAH* 17 (Sept. 1964): 24-31. [México]

Page 29: Preliminary analysis shows that *tierra caliente* in this part of Michoacán and Guerrero was occupied toward the end of the local Classic, about 700 of our era. Page 31: "In this region metallurgy could have been somewhat earlier than the date of A.D. 900 which is usually considered when it appeared in Mesoamerica." Curiously, among the materials found, a considerable amount of the most ancient show clear correspondences with the Southwest of the United States. [Note: In a personal communication to J. L. Sorenson dated April 30, 1972, Gareth W. Lowe wrote: "In a personal conversation, Jorge Angulo swears they found 'Peruvian pots and Southwest copper bells' together in the Balsas salvage."]

Alcina Franch, José. "La producción y el uso de metales en la América pre-colombina." In *La Minería Hispana e Iberoamericana: Contribución a su Investigación Histórica: Estudios - Fuentes - Bibliografía*, vol. 1, 307-31. (VI Congreso Internacional de Minería. Ponencias del 1 Coloquio Internacional sobre Historia de la Minería.) León, Spain: Catedra de San Isidoro, 1970.

Pages 307-12: Mining is described in early Spanish sources on the Andes, consisting of horizontal or vertical one-person holes, up to 40 fathoms deep horizontally, without any bracing. Thousands of people might be involved in such mining operations. Work was very difficult, holes small, lighting nil. Tools included deer horn ends, wood sticks tipped with copper, hammers of an alloy of copper and gold that was extraordinarily hard, and, most commonly, stone hammers. The mines might be considered holy places, receiving prayers and fiestas in their honor. For the Incas copper was the most common metal; gold was state property. Page 313: Most pre-Columbian gold came from placering in mountain streams. Of course we have no archaeological documentation of such. Page 314: Silver artifacts are known in Peru from the beginning of the Christian era and Ecuador from the 6th century. In Mexico Clavijero said that Aztec silver came from mines of Tlaxco, Tzompanco, and other regions. Page 315: Reproduces data from Rivet and Arsandaux (1946) on proportion of bronze among all cuprous artifacts, ranging from nearly 90% in highland Peru and Bolivia to a small fraction in Ecuador and especially on the coast. Prehispanic copper mines mentioned include mines in Guerrero and Guatemala (Altos Cuchumatanes). Page 316: Bronze was invented in Bolivia. It did not reach Ecuador or Colombia but was a minor feature in Panama. Page 317: Tumbaga was on the coasts of Ecuador and Peru before the Christian era. Excavations in the Antilles and northern South America have failed to reveal tumbaga-like alloys reported by the Spaniards. Pages 317-18: Only on the coasts of Ecuador and Colombia was platinum isolated and used to make decorative objects. Page 318: Lead use goes back to around A.D. 1000 in the Maya area. Page 319: Among the Incas there was a word for iron, *quellay* (citing Rowe in *Handbook*, 246). Pages 323-31 present hemispheric distribution maps and regional sequences for the use of each metal. Page 323: Gold: non-Mayan Mexico, A.D. 750, Maya area, A.D. 900. Page 324: Silver, A.D. 900 in Mesoamerica. Page 325: Copper, A.D. 900 (A.D. 1000 for Maya area). Page 326: Bronze, A.D. 900 with a question mark. Page 328: Platinum in Ecuador from 300 or perhaps 500 B.C. Page 329: Same for lead in Ecuador. For Mesoamerica, perhaps A.D. 900 in Maya area for lead, later to the west. Page 331: Meteoric iron: map shows Alaska, Greenland, Mississippi and Ohio valleys, and Bolivia. Among the Eskimo from 300 B.C. No other dates given.

Arreola, J. M. "Sellos, indumentaria, utensilios domésticos, utensilios industriales, objetos rituales, caracteres alfabéticos o numéricos." In *La Población del Valle de Teotihuacan*, edited by M. Gamio, 3 vols. México: Secretaría de Agricultura y Fomento, Dirección de Antropología, 1922. Vol. 1, pp. 212-20.

Page 218: Meteoric iron was used by the Teotihuacanos for ritual purposes. There exist in the Museum at the site various mirrors worked from fragments of meteorites, while some masks have eyes of the same material. Some masks had eyes with iron discs, only the remnants of oxidation remaining on certain ones. Considers that probably copper tools were used to work stone, including drills up to 3 cm. in diameter. [Cf. Aguilar.]

Balser, Carlos. "Los objetos de oro de los estilos extranjeros de Costa Rica." *Actas y Memorias, 36a Congreso Internacional de Americanistas, España, 1964* 1 (1966): 391-98.

Page 396: In Panama, gold was used locally from A.D. 250 based on a radiocarbon date at Venado Beach. Page 395: Lothrop supposed that a pendant from the Cenote at Chichén Itzá was imported from Coclé, but many of that type come from Costa Rica where they were locally manufactured. Balser seems to suppose a pre-Quimbayan date for some of these ("classic" Quimbayan—Colombian—metallurgy is set at A.D. 400-700).

Balser, Carlos. "Metal and jade in lower Central America." *Actas y Memorias, 37a Congreso Internacional de Americanistas, Mar del Plata, Argentina, 1966* 4 (Buenos Aires, 1968): 57-64.

Goldworking was introduced in Panama from Colombia around A.D. 250. The Coclé style objects were the first to penetrate Panama and Costa Rica in quantity and very soon were manufactured in both those areas. Trade pieces reached Yucatan during the Mayapan period, citing Lothrop. Page 58: Gold artifacts were chiefly from nuggets, found even today in rivers and creeks of Costa Rica, some weighing several pounds. Page 61: Feels that artistic developments in gold work in Lower Central America were local inventions, "but the techniques of metal working were probably influenced by trans-Pacific contacts" (makes comparisons of jade and metal working with China).

Bancroft, Hubert Howe. *Native Races of the Pacific States*, vol. 2. London: Longmans, Green, 1875.

Page 407: Armor was made for the elite in the form of a cuirass of gold and silver plates. On their heads they wore helmets of gold, silver, and skins. Tezozomoc said the Tarascans had "steel helmets" (citing Kingsborough, vol. 9, p. 83), even though Bancroft says that iron was not used in any shape. Page 408: A Tabascan cacique presented armor to Grijalva consisting of wood covered with gold plates for legs and a head-piece covered with gold plates, with cuirasses of solid gold, along with a quantity of armor plates sufficient to cover the whole body (citing Torquemada, Herrera, Gomara, Oviedo, Cogolludo). Page 409: Clubs were nailed with (i.e., finished with protruding nails of) iron, copper, and gold, according to Ixtlilxochitl, citing Kingsborough.

Barlow, Robert H. "Straw hats." *Tlalocan* 2/1 (1945): 94.

According to an early west Mexican (Spanish) *relación*, tradition held that culture heroes Cuanamoat ("ancestor of the Huaynamotecs?") and Ceutarit ("ancestor of the Náyeres or Cora") taught their people to make fire and "gave them also machetes or cutlasses of iron."

Bastow, J. W. "Commerce, money and currency of the ancient peoples of Mexico," *Memorias, 11a Congreso Internacional de Americanistas, México, 1895*. México, 1897. Pages 47-64. [No title was given this item in the proceedings; that used here is taken from the opening statement to the effect that the Secretary of the congress read Bastow's "Memoria . . . sobre el comercio, moneda y cambio de los antiguos pueblos de México."]

Cites statements of chroniclers concerning money or the equivalent. Page 50: "Money, in its broad sense, was known in Mexico in the pre-Colombino period, it passed

current in commerce and was accepted at fixed values. Nearly all authors who wrote of that period, mention the existence and use of five different classes of money.” (1) Gold in grains or dust enclosed in transparent duck quills. (2) Small pieces of cotton cloth, colored and stamped, called *patolquachtli*, used in making basic purchases. (3) Pieces of tin; Cortez is the only authority on this in his letter to the King: “among the natives of Tachco (Taxco), certain small pieces of it, a kind of money, very thin.” (4) Pieces of copper, cast or hammered, cut into the form of a chopping knife in the form of the letter T. Page 51: [Citing Bancroft, 276 of these were found in a jar dug up in the vicinity of Monte Alban. Bastow says that Bancroft wrote: “These supposed hatchets, were, according to some authorities, coins.” Bastow then adds: “(NOTE. Mr. Bancroft uses here the word coin inadvertently, instead of money; these pieces of copper were certainly not stamped as coins are.)”] (5) Cacao. Page 53. “Clavijero was of the opinion that, there was a bona-fide coined money, insomuch as, that the pieces of tin and copper in use as money, bore some sign or seal authorized by the king or some feudal lord; yet, as no other author supports this claim . . . it may be affirmed that they were not stamped authoritatively or otherwise.” Chavero believes that “small pieces of bronze called *tlachco* were used as money.” Sahagun says that the Aztec king gave to his merchant soldiers sent on trading expeditions 1600 *quauhltli*, or eagles, to trade with. Bustamante supposes them to have been copper pieces mentioned; but Brousseau believes . . . that they were of gold.” The latter also believes that the “golden quoits” with which Montezuma paid his gambling debts (page 54) also served as money. Among the Nahuas gold and copper were used as a medium in trade, or money. Clavijero says, “Silver was dug out of the mines of Tlachco and Tzompanco. Of copper they had two sorts, one hard which they used instead of iron, the other flexible They dug tin from the mines of Tlachco and lead from the mines of Izmiquilpan . . . in the country of the Otumies. Of tin they made money and they sold lead in the market.” In Nicaragua, according to Cogolludo, copper bells and rattles, red shells on strings, precious stones and copper hatchets served as money. Page 55ff: Possible examples of shell money are discussed. Page 63-64: While weights and scales are not supposed to have been known to the Mexicans, Bastow here cites certain evidence to the contrary.

Baudez, Claude F., and Pierre Becquelin. “Archéologie de Los Naranjos, Honduras.” *Etudes Mesoaméricaines* Vol. 2. México: Mission Archeologique et Ethnologique Française au Mexique, 1973.

Page 401 (cf. p. 5): A metal fragment was found in feature T.57, dating to the Yojoa phase. Strong Maya influence on the ceramics of this phase is from Tepeu 1 and 2 plus a few Tzakol features. Page 406: Radiocarbon dates on T.57 material: A.D. 690 +/- 90, A.D. 450 +/- 100, and A.D. 420 +/- 100.

Bent, Thomas W. *The Tucson Artifacts*. Tucson, Arizona: The author, 1964.

Over two dozen artifacts—crosses, swords, spearheads—nearly all made of lead, were found between 1924 and 1928. Most had on them jumbled Latin inscriptions. At least four of the objects were excavated by the University of Arizona in 1928 from beneath many feet of overburden of unknown age.

Bierne, Daniel Randall. "Cultural patterning as revealed by a study of pre-Columbian ax and adz hafting in the Old and New Worlds." In *Man across the Sea: Problems of Pre-Columbian Contacts*, edited by C. L. Riley et al., 139-77. Austin: University of Texas Press, 1971.

Page 173: Certain large axes of Ecuador of stone "appear to be close copies of some metal forms known only in Egypt and the Near East." Also he refers to "the striking similarity between the polished stone axes of the Antilles and the Bronze Age metal axes of England." [Compare Ibarra Grasso 1969.]

Blackiston, A. Hooton. "Recent discoveries in Honduras." *American Anthropologist* 12/4 (1910): 536-41.

"Bell Cave" lies at the headwaters of a stream that flows into the Chamelecon in the Naco area. Page 537: His guide, an old Indian, had found a few bells on the surface inside the uninhabited chamber, "and later excavations revealed hundreds of specimens," highly varied. Page 539: Over 800 bells in total in addition to pieces of native copper from three to seven inches long from which bells were fashioned. The mine from which the ore had been taken is a comparatively short distance away. There were also a number of copper spear points, one ten inches long attached to a portion of a shaft now "petrified." Page 540: The majority of the artifacts "shows a decided Mayan influence in feature and treatment." [The presence of jades carved in Maya style makes this horde of potential interest as a Classic-age occurrence, although the date of this site is usually taken as Postclassic.]

Blanton, Richard E., and Stephen A. Kowalewski. "Monte Alban and after in the Valley of Oaxaca." In *Supplement to the Handbook of Middle American Indians*, Vol. 1, 94-116. *Archaeology*, edited by J. A. Sabloff. Austin: University of Texas Press, 1981.

Pages 106, 108: Monte Alban IV remains relate to the artifact complex from the Lambityeco site and as such "are securely dated by an unusually tight cluster of radiocarbon dates to within a few decades of A.D. 700." [See Rabin. Thus the Zapotec metal objects assigned to IV by Caso, below, date about the same.]

Boggs, Stanley H. "Informe sobre la tercera temporada de excavaciones en las ruinas de 'Tatzumal.'" *Tzunpame*, Año 5/4 (1945): 33-45. [San Salvador]

Page 33: Work in 1944 in Mound 1 in the Tatzumal Group in the Chalchuapa Archaeological Zone is reported. Pages 42-43: Tomb I, which corresponds with when the structure was built, contains ceramic vessels identified by R. E. Smith as pertaining to the Tepeu I phase of Uaxactun. This is confirmed by similarities to pottery at Copan directly associated with Stelas I (9.12.5.0.0=GMT A.D. 677) and M (9.16.5.0.0=GMT A.D. 757) as well as pre-plumbate pottery in the Motagua Valley found by Smith and Kidder (Magdalena phase). He estimates the date of Tomb I at around A.D. 750. Three pieces of metal were found in this tomb. To Boggs's knowledge, these are the oldest metal objects found so far in Central America.

Boos, Frank H. *The Ceramic Sculptures of Ancient Oaxaca*. New York: A. S. Barnes, 1966.

Figure 435 on page 466: A figure of an acrobat or juggler of Monte Alban II date is clearly represented wearing bells (in a form known later in metal) attached to his ankles.

Borhegyi, Stephan F. de. "Un raro cascabel de barro del período primitivo pre-clásico en Guatemala." *Antropología e Historia de Guatemala* 9 (1957): 9-11.

Two unusual clay objects from the Las Charcas site in highland Guatemala date to either the phase of that name or to Providencia [i.e., 500-200 B.C.]. [See Borhegyi 1970.]

Borhegyi, Stephan F. de. "Shell offerings and the use of shell motifs at Lake Amatitlan, Guatemala, and Teotihuacan, Mexico." In *Actas y Memorias, 36a Congreso Internacional de Americanistas, España, 1965* 1 (Sevilla, 1966): 355-71.

Page 364: "Most of the Mesoamerican shell ornaments and especially the *oyoualli* or the so-called horse-collar shaped shell pendants or pectorals [and their gold replica at Chichen Itza; see Tozzer, 1957, fig. 180, and Coggins and Shane, 58] are probably of Early and Mid Classic date and not Post Classic as suggested by Ekholm (1961)."

Borhegyi, Stephan F. de. "Depósitos subterráneos en forma de botella y sonajas de barro del preclásico de Guatemala." *Estudios de Cultura Maya* 8 (1970): 25-34.

Rivard had commented on Borhegyi's (1957) discovery of two clay objects dating to the first millennium B.C. Rivard insisted that they must be clay "bells," copies or prototypes of Post-Classic metal bells of the same form shown on codex representations of Maya God A. Borhegyi here clarifies, asserting that functionally these items could not have been "bells" but must have been rhythm instruments or rattles.

Bosch-Gimpera, Pedro. "Paralelos transpacíficos de las altas culturas americanas y su cronología." *Anales de Antropología* 7 (1970): 43-89. [México]

Armenoid physical traits intruded in Peru about 500 B.C., arriving with the first gold and copper work, carried by Dongson culture bearers from southeast Asia (ultimately from the Pontic steppes).

Bray, Warwick. "Ancient American metal-smiths." (The Curl Lecture 1971) *Royal Anthropological Institute, Proceedings for 1971*, pages 25-42. 1972.

A superior treatise intended to put metalworking into broad historical and anthropological perspective. All the important processes are discussed. Smelting techniques and archaeological evidence for them (not uncommon in Peru, especially the *huayra* or wind smelter) are also treated. Page 28: "There is a remarkable similarity between these [described] Peruvian tools and the sets of 'cusion stones' found in Bell Beaker graves and associated with the earliest copper metallurgy in northern Europe." Page 30: The rudimentary nature of the equipment and methods is emphasized at the same time credit is given for real results. Page 32: The archaeological discoveries reflect inadequately the actual situation. Estimates are given for the Spanish "take" of metals at the Conquest: nearly 61,000 kg. of silver and 8,000 of gold from Peru and 350 kg. of silver and 4,000 of gold from Mexico. Annual production in Peru was estimated by Cieza de León at 190 tons of gold and 635 tons of silver per year, and more copper than that, all by part-time miners "using the simplest possible technology." Page 36: In Mexico metallurgy appears quite suddenly between A.D. 700 and 900, citing Aguirre and Wilkerson. Page 38: Metal occurs with Uluá Polychrome wares at two sites in Honduras, while a Colombian or Isthmian gold ornament was in a burial with Uluá marble vases at Finca Santana. Objects of comparable date are from San

Agustín Acasaguastlan (citing Smith and Kidder), Zacualpa and Los Limones. Page 39: In quoting Landa, he glosses “soft brass” as “i.e. copper alloy.”

Bray, Warwick. “Maya metalwork and its external connections.” In *Social Process in Maya Prehistory*, edited by Norman Hammond, 365-403. New York: Academic, 1977.

Maya territory was at the frontier of two distinct metalworking provinces: Mexico proper and isthmian Central America. By the end of the Late Classic, local schools of metalwork had developed in Maya territory itself. This article is an extensive catalog, including hitherto unpublished or unillustrated items, with a list of sites or areas from which they came and discussion of each type of artifact with list of objects under each type. “Metal objects appeared sporadically throughout the Maya zone during the Late Classic.” Under his category “Bells,” in a paragraph labeled “w. Anthropomorphic wirework bell,” he discusses the one reported by Joyce “reputedly from Palenque.” He considers it “unique, but probably Maya.” Under “Discs,” he treats “b. Soconusco discs.” This is a little group of gold discs, restricted in time to the Late Classic (citing three: the one Lothrop pictured from Zacualpa, the one from Los Limones, and the Nottebohm disc from “near Ayutla”). They seem to come from a single workshop. [Cf. Coe and Flannery.]

Bray, Warwick. “Gold-working in ancient America.” *Gold Bulletin* 11/4 (1978): 136-43. Reprinted in *Katunob* 10/4 (Dec. 1977[sic]): 1-8.

Page 136: Most of the gold the conquering Spaniards obtained was melted down on the spot. Quotes the artist Dürer about the “amazing objects” and “subtle ingenuity” of the American artisans on the basis of specimens he saw in Brussels in 1502. He mentioned a gold sun “a whole fathom [six feet] broad” and a moon of silver just as large. Combining these accounts with laboratory analyses nowadays allows presenting a fairly detailed picture of aboriginal gold technology at the time of the Conquest.

Page 137: Tumbaga: the silver—up to 25%—was not intentional but was a natural impurity in the gold in Mexico through the Northern Andes. Farther south silver was more abundant and alloys often contained only a small percentage of gold. Tumbaga is harder than pure gold yet easier to cast than its constituent metals alone, while its melting point is lower than those of gold or copper. With appropriate surface treatment, tumbaga jewelry can be made to look like pure gold. Tools such as awls, axes, chisels, and hooks of this alloy were normally finished by cold hammering and gave a working edge nearly as hard as cold-worked bronze. Pages 137-38: In Peru at least, the first stage in making a sheet metal item using gold was to make an ingot of cast metal which was then alloyed. The resultant metal was worked by alternate hammering and annealing into sheet 0.2 mm. thick, the perfect evenness of which compares well with today’s machine-made product. Hammering alone of gold makes it hard; annealing is essential to restore its malleability by reheating it to red then quenching it in water, followed by more hammering. By chemical processes (described) the copper and silver can be largely removed from the surface leaving a surface appearance of almost pure gold. Page 139: Welding, soldering, or brazing was also used to join previously-shaped pieces.

Page 139: Simple and lost-wax methods of casting are described. Page 140: Some single pieces so done weighed over a kilogram. They could also cast in two (fused) metals. Page 141: Granulation: “The method used in Ecuador and Colombia seems to be the one employed by the ancient civilisations of the Old World and which was rediscovered in Europe less than fifty years ago.” This consisted of mixing copper

hydroxide with glue which was used to bond fine globules of gold in place. When heated, the metals bonded as the glue was burnt away. Gilding: occasionally gold foil was used to cover an object. More often "depletion gilding" was employed in which the surface is depleted of copper with the aid of an acid plant juice. Page 142: No "pre-European workshop" has ever been excavated by trained archaeologists in America. At La Tolita, Ecuador, smiths worked with copper, gold, tumbaga, lead, and platinum, which had so high a melting point that they sidestepped the problem by sintering it with gold (described).

Page 143: Of Montezuma's treasure, Peter Martyr said: "If ever the wits and inventions of men have deserved honour or commendation in such arts, these seem most worthy to be held in admiration. . . . And, in my judgment, I never saw anything whose beauty might so allure the eyes of men."

Brinton, Daniel G. *The Annals of the Cakchiquels*. Philadelphia, 1885.

Page 19: Gold and silver were classed under the term *puvak* and called either white or yellow *puvak*. Iron and copper were both known as *ghigh*, again with color distinguished. These two materials were constantly referred to as part of the tribute collected in late prehispanic times.

Brown, Kenneth L. "The Valley of Guatemala: a highland port of trade." In *Teotihuacan and Kaminaljuyu: A Study in Prehistoric Culture Contact*, edited by William T. Sanders and Joseph W. Michels, 205-395. The Pennsylvania State University Press Monograph Series on Kaminaljuyu, 1977.

Page 278-79: A vessel recovered from an offering site on the south shore of Lake Amatitlán by Borhegyi contained liquid mercury and cinnabar. The cinnabar was probably recovered from around geothermal vents found near the lake, particularly on the south shore. "It is quite probable that the liquid mercury was derived from volatilizing the cinnabar and condensing the fumes. [On the contrary, Pendergast 1982 prefers the view that natural-occurring mercury was collected to account for the handful of cultural uses of it in the Maya area.]

Brush, Charles F. "Pre-Columbian alloy objects from Guerrero, Mexico." *Science* 138 (1962): 1336-38.

A site near Zihuatanejo has yielded to a private collection a large number of metal artifacts. Most of those examined were of intentional bronze and indicate use of that alloy for everyday objects. Fragments of slag indicate that some smelting operation took place in the vicinity. No date is offered.

Caley, Earle R., and Dudley T. Easby, Jr. "New evidence of tin smelting and the use of metallic tin in pre-Conquest Mexico." *Actas y Memorias, 35a Congreso Internacional de Americanistas, México, 1962*. Vol. 1. México, 1964. Pages 507-17.

Page 507: As of 1946 not a single tin object was known in Mexico from pre-Spanish times nor any direct evidence of tin smelting such as furnaces, crucibles, or slag. Page 508: "Direct archaeological evidence of smelting operations [for any metal] is rare in pre-Conquest Peru and unknown in Mexico for all practical purposes." [Then cites three uncertain but minor exceptions.] Furthermore, few objects of metallic tin survive from antiquity in the Old World (citations). Page 508-9: This paper reports on objects found in Guerrero and Oaxaca by Rubín de la Borbolla and which now prove to be metallic tin. Page 512: They summarize statements by Cortés and other early Spaniards

stating that tin objects were in use and even that thin pieces of the metal were used as a medium of exchange in Taxco (which is near Rubín de la Borbolla's site in Guerrero). Page 513: Tin was obtained in part at least by placering, confirmed by the meaning of the Nahuatl word for tin, *amochitl*, which means, by poetic allusion, "it was made by water." They then show that there was no technological problem for native craftsmen in obtaining sufficiently high temperature to treat cassiterite ore from Guerrero. Fig. 4 shows a false filigree bead from Oaxaca, one of Rubín's objects, which is a "white copper-tin alloy of approximately 50% Cu and 50% Sn." Page 515: "More than one person suspected that we were dealing with silver before the pieces were analyzed. The results also show that it is not prudent always to discount or ignore historical accounts as possible sources of technical information; some of the 16th century chroniclers apparently were wiser and more observant in such matters than many of their critics."

Carr, C., and D. W. G. Sears. "Toward an analysis of exchange of meteoritic iron in the Middle Woodland." *Southeastern Archaeologist* 4/2 (1985): 79-92.

Page 79: They summarize chemical data on the only Eastern Woodland iron specimens so far analyzed and (Table 1) give distributional data on all other (over 50) known iron objects. Those tested were meteoritic and had been worked by cold hammering. The use of iron is restricted almost entirely to the Middle Woodland period, ca. 200 B.C. to A.D. 450. Decorative or ceremonial objects were made as well as tools. Page 84-86: Conjectures are offered [but questions left unanswered] as to why some areas had so many more specimens than others, in light of the presumed uniform natural fall of meteorites.

Caso, Alfonso. "Lapidary work, goldwork, and copperwork from Oaxaca." In *Handbook of Middle American Indians*, Vol. 3, edited by Gordon R. Willey, 896-930. Austin: University of Texas Press, 1965.

Pages 928-30: Under the heading "Zapotec Goldwork" he treats the following six objects: Four pieces of gold jewelry (Fig. 59), published by Saville in 1920, were found in Tehuantepec but are Zapotec in style, he agrees with Saville. Another object published by Saville (Fig. 60) is not exactly in Mixtec style [despite including it under this heading, he fails to assert positively that he considers this Zapotec but seems to go along with Saville's judgement that it is]. A ring (Fig. 61) "is much more Zapotec in style" than the previous item. Of it he says, contradictorily, "it is doubtful if we can attribute it to the Zapotecs" yet it "possibly could be credited to this people." Fig. 62 shows a set of copper rattles in process of being uncovered in the patio of Tomb 105 at Monte Alban; at least eighteen standard-shaped bells are visible in the photograph and the total number must be at least twenty five. It, together with a cache of five money-axes, from the mound containing Tomb 21, he assigns to Monte Alban IV. [At the time Caso wrote, he considered this period "contemporaneous with Tula." Subsequent work, especially at Lambityeco, has established a date near A.D. 700 for M.A. IV and thus for these objects. See Rabin, and Blanton and Kowalewski.]

Caso, Alfonso. "Lapidaria y orfebrería en Oaxaca." In *Los Señorios y Estados Militaristas*, Román Piña Chan volume coordinator, 326-55. Instituto Nacional de Antropología e Historia. México, 1976.

Page 344: Some Monte Alban Tomb 7 pieces were gold-silver alloys; one called "oroche" [=electrum; see Caso 1965] was 62% gold and 38% silver.

Caso, Alfonso, and D. F. Rubín de la Borbolla. *Exploraciones en Mitla, 1934-1935*. Instituto Panamericano de Geografía e Historia Publicación Num. 21. 1936.

Page 10: Tomb No. 5 contained a disc-shaped object of metal, composed principally of iron and sulfur according to the analysis done by the Instituto de Geología. A ceramic vessel in the tomb was of Mixtec type. Page 34: A non-quantitative analysis of this disc is given. It contained "considerable" iron, but no nickel, which it would have had were it of meteoric origin.

Chadwick, Robert E. L., Jr. "Archaeological synthesis of Michoacan and adjacent regions." In *Handbook of Middle American Indians*, Vol. 11, edited by Gordon F. Ekholm and Ignacio Bernal, 657-93. Austin: University of Texas Press, 1971.

Page 680: According to preliminary analysis of materials from the Middle Balsas River basin salvage project, Lorenzo sees a late occupation in the area, beginning about A.D. 700, at which time metallurgy seems to have been introduced. Metallurgy is estimated to have been introduced somewhat earlier than is usually conceived. Published artifacts include silver earplugs and copper fishhooks [date not clarified] similar in form to Peruvian ones.

Chadwick, Robert E. L., Jr. "Toward a Theory of Trans-Atlantic Diffusion." Typescript in Lee Library, BYU (based on the author's 1974 Ph.D. dissertation at Tulane), n.d.

Presents evidence that probably there were several trans-atlantic incursions of "prospector culture(s)" to the New World prior to the 15th century. Specific ceramic forms, physical anthropological features, and statements from the early Spanish chronicles are used as evidence. These features are found in areas where the appearance of metallurgy coincides with belief in a Quetzalcoatl deity. A coherent cultural complex is indicated, he holds, in which a people (physical type) shares a long-lasting symbolic identity structure in areas as diverse as Tlatilco and Monte Negro in Mexico, Kotosh, Peru, and the Bell-Beaker area of Iberia and North Africa.

Charency, Hyacinthe de. "Les noms des métaux chez différents peuples de la Nouvelle Espagne." *Compte-Rendu, 8e Congrès Internationale des Américanistes, Paris 1890*. Paris: Ernest Leroux, 1892. Pages 536-47.

Page 537: Certain tribes of the Rio de la Plata (Argentina) used meteoric iron. According to Motolinia, tradition says Quetzalcoatl introduced metallurgy in Mexico in A.D. 68.

Chavero, Alfredo, ed. *Obras Históricas de Don Fernando de Alva Ixtlilxochitl*. 2 vols. México: Editora Nacional, 1952.

Vol. 2, page 56: The "Toltecs" used clubs studded with iron.

Clavijero, Francisco Javier. *Historia Antigua de México*. México, 1964. [1780].

Page 223: On the Aztec royal insignia: "When the king went out on campaign he wore . . . on his feet certain half boots of thin gold plates and other thin platelets of the same metal on his arms . . . (and) on his neck a chain of gold." The boots were called *cozehuatl*, the chain *cozcapetlatl*. [Note chains shown on Cotzumalhuapa sculptures; see Thompson 1943.]

Clement, André. "L'emploi des minerais ferreux dans l'Amérique précolombienne." *Reseña y Trabajos, 26a Congreso Internacional de Americanistas, Sevilla, 1935*, Tomo I. Madrid, 1948. Pages 136-42.

Hematite was used to manufacture a North American axe head which was analyzed to show 68% ferrous oxide. Solid hematite as well as pyrites, both forms of iron, were so used in various parts of the New World.

Coe, Michael D., and Kent V. Flannery. "Early cultures and human ecology in south coastal Guatemala." *Smithsonian Institution Contributions to Knowledge*, Vol. 3. 1967.

Page 93: A gold plaque was found inside a San Juan Plumbate bowl in a cache at Los Limones, near Ocos. 95. This cache dates to the Marcos Phase (A.D. 750-900). Another plaque comes from the border region, probably from the vicinity of Ayutla. The Los Limones plaque falls into a group with the Zacualpa and Nottebohm plaques known from the literature (the latter was probably from near Ayutla). The Zacualpa find was associated with nine vessels, described. On the basis of their styles, "The Zacualpa disk . . . would also date to the Late Classic, probably to its later part." A second Zacualpa disk existed but looters had taken it. "All five" of these plaques are Late Classic. The authors compare them to the metal associated with San Juan Plumbate in the Motagua Valley tomb reported in Smith and Kidder.

Coggins, Clemency Chase, and Orrin C. Shane III, eds. *Cenote of Sacrifice: Maya Treasures from the Sacred Well at Chichén Itzá*. Austin: University of Texas Press, 1984.

The exhibit catalogue constituting most of this volume is by Coggins. Page 27: The Early Phase of Cenote ritual probably began late in the eighth century A.D., at the same time that dates written in the Maya Long Count were being carved on the stone lintels of Chichén Itzá. The first portion of this Early Phase lasted until about A.D. 900 "and marked the beginning of a kind of Cenote ritual that included objects resembling others found cached contemporaneously at the Puuc site of Uxmal."

Page 43: Gold Disc F. Shows a prisoner scene that is "Maya in world view and execution." One of the figures shown "wears a single large bell on his left calf." [Cf. Lothrop 1952, fig. 34.] Terminal Classic, A.D. 800-900.

Page 45: Tumbaga bell, "jar shaped," characteristic of the Coclé region and Costa Rica, the likely source for this one. [Cf. Lothrop 1952, figs. 108, 109.] Terminal Classic, A.D. 800-900.

Page 48: Thirteen effigy projectile points in sheet gold. [Cf. Lothrop 1952, fig. 51c.] Terminal Classic–Early Postclassic, A.D. 800-1100.

Page 50: Gold Disc H. [Cf. Lothrop 1952, fig. 1.] Terminal Classic, A.D. 800-900. A figure depicted in this scene "wears four bells at his calf, like numerous gold and copper bells actually thrown into the Cenote."

Page 55: Three face ornaments of sheet gold. [Cf. Lothrop 1952, figs. 54, 55.] Terminal Classic, A.D. 800-900.

Page 56: Plain disc, sheet gold. [Four gold discs from the Cenote are mentioned but Coggins leaves it unclear if this is one of those. Cf. Lothrop 1952, fig. 9b.] Terminal

Classic–Early Postclassic, A.D. 800-1100. “The lowland Maya were never goldsmiths, although they did emboss and cut imported sheet gold.”

Page 57: Hat/bowl, sheet gold. [Cf. Lothrop 1952, fig. 54.] Terminal Classic–Early Postclassic, A.D. 800-1000.

Page 58: Effigy shell pendant (“horse collar,” or *oyoualli*). All others in this form are from shell; they are known archaeologically from Early to Terminal Classic. [Cf. Lothrop 1952, fig. 56.] Terminal Classic, A.D. 800-900. [Cf. Borhegyi who dates this to the Middle Classic.]

Page 58: Flat gold rings. At least 60 of these have been taken from the Cenote. [Cf. Lothrop 1952, fig. 51.] Terminal Classic–Early Postclassic, A.D. 800-1100.

Page 62: Two tumbaga figurine pendants. From Central America. [Cf. Lothrop 1952, fig. 92. Perhaps his reference on p. 110 to tumbaga figurines of early date refers to these?] Terminal Classic, A.D. 800-900.

Page 63: Two tumbaga figurine pendants. From Central America. [Cf. Lothrop 1952, fig. 89 d, h.] Terminal Classic, A.D. 800-900.

Page 64: Tumbaga figurine pendant. From Central America. [Cf. Lothrop 1952, fig. 89c.] Terminal Classic, A.D. 800-900.

Page 64: Tumbaga figurine pendant with bell cast onto the figure. From Central America. [Cf. Lothrop 1952, fig. 89b.] Terminal Classic, A.D. 800-900.

Page 65: Tumbaga figurine pendant. From Central America. [Cf. Lothrop 1952, fig. 88.] Terminal Classic, A.D. 800-900.

Page 65: Tumbaga figurine pendant. From Central America. [Cf. Lothrop 1952, table 36.] Terminal Classic, A.D. 800-900.

Page 66: Tumbaga monkey pendant. From Central America. [Cf. Lothrop 1952, figs. 93c, 108.] Terminal Classic, A.D. 800-900.

Page 84: Gold frog pendant. Terminal Classic–Early Postclassic, A.D. 800-1100.

Page 85: Gold turtle pendant. Terminal Classic–Early Postclassic, A.D. 800-1150 (sic).

Page 85: Gold turtle bell. [Cf. Lothrop 1952, fig. 104h.] Terminal Classic, A.D. 800-1000.

Pages 86-87: Six monkey-bells-with-tail are mentioned in the collection, four are illustrated here, one of which is tumbaga, the others gold. [Cf. Lothrop 1952, fig. 105.] Terminal Classic–Early Postclassic, A.D. 800-1150.

Page 88: Two plain bells are illustrated. Twenty-two more are in the collection, while Thompson found a total of 80 gold or tumbaga bells in the Cenote. “These imported bells were an important part of the regalia of the Mexican warriors who dominated Chichén Itzá from about A.D. 800 until 1150.” [cf. Lothrop 1952, fig. 103b.] Terminal Classic–Early Postclassic, A.D. 800-1150.

Page 88: Seven gold head bells are in the collection, three are here illustrated. [Cf. Lothrop 1952, fig. 104.] Terminal Classic–Early Postclassic, A.D. 800-1150.

Page 91: Two gold crab bells. [Cf. Lothrop 1952, figs. 106, 107.] Terminal Classic–Early Postclassic, A.D. 800-1150.

Page 93: Gold bell surmounted by “eagle.” [Cf. Lothrop 1952, fig. 99.] Terminal Classic–Early Postclassic, A.D. 800-1150.

Covarrubias, Miguel. *The Eagle, the Jaguar, and the Serpent; Indian Art of the Americas: North America, Alaska, Canada, the United States*. New York: Knopf, 1954.

Pages 26-27, 123, 246, 269-72: Metal weapons from the Old Copper culture of the Great Lakes area bear strong, specific resemblances to Old World forms.

Cummings, Byron. “Cuicuilco and the Archaic of Mexico.” *University of Arizona Bulletin* 4/8 (*Social Science Bulletin* No. 4) (1933).

His 1925 work revealed a piece of hammered copper fastened by copper nails around wooden remains of what he called a “wand.” The object rested on a peculiar stone altar. Pages 38-39: The description of the stratigraphy leaves the exact placement uncertain, but Sorenson reads it to say that deposits of some six feet of intentionally deposited material plus two feet of surface soil and volcanic ash covered the altar. [Compare Haury, Sorenson 1954a, and Urban, synthesized in the commentary at the end of this paper.]

Davis, Leslie B. *The Prehistoric Use of Obsidian in the Northwestern Plains*. 2 vols. Ph.D. dissertation. University of Calgary, 1972.

Vol. 1, pages 148-58: A supply of many pounds of obsidian from Obsidian Cliff, Yellowstone Park, was carried to Ohio, where it was worked by Hopewellian craftsmen between 500 B.C. and A.D. 200. [Showing the extreme distance across which prized minerals might be moved in ancient times.]

Diehl, Richard A. *Tula: The Toltec Capital of Ancient Mexico*. London: Thames and Hudson, 1983.

Page 116: No metal objects have been located at Tula, but some painted figures in friezes “display yellow bracelets and necklaces which I believe were made of copper or gold.” He doubts there were any metal workers on site despite “Sahagun’s passing references to Toltec metallurgy.” [Sahagun’s statements are more than “passing references.”]

Drucker, Philip, and Eduardo Contreras. “Site patterns in the eastern part of Olmec territory.” *Journal of the Washington Academy of Sciences* 43 (Dec. 1953): 389-96.

The site of Pueblo Viejo in remote, mountainous, southern Veracruz, where Stirling found an iron artifact [see Stirling, below], is characterized by Drucker and Contreras on the basis of their 1953 visit as similar in construction to other, clearly pre-Columbian, sites in the area.

Easby, Dudley T., Jr. "Two 'South American' metal techniques found recently in western Mexico." *American Antiquity* 28/1 (1962):19-24.

A rich burial site dating to the last (pre-hispanic) period of Tzintzuntzan, the Tarascan capital, yielded offerings of gold, silver, copper, and other minerals. Ecuadorean contacts are strongly suggested by particular details of working the sheet gold as well as in production of true metal wire drawn through a narrow orifice drilled in hard stone. A high degree of sophistication of the metal craftsmen is shown. True drawn wire has not been convincingly demonstrated anywhere in America before.

Easby, Dudley T., Jr. "Pre-Hispanic metallurgy and metalworking in the New World." *American Philosophical Society Proceedings*, 109/2 (1965): 89-98.

A very conservative general description of basic processes.

Easby, Dudley T., Jr. "Aspectos técnicos de la orfebrería de la Tumba 7 de Monte Albán." In Alfonso Caso, "El tesoro de Monte Albán." *Memorias del Instituto Nacional de Antropología e Historia* 3, 343-94. México: Instituto Nacional de Antropología e Historia, 1969.

Page 393: Given the lack of gold objects which show a gradual development of the techniques and long tradition implicit in the variety and perfection of the fine casting, it is appropriate to ask, from where and when did this knowledge of the working of metals come to Mexico? It is generally believed that it arrived in Mexico from the south, and we have made note of certain Panamanian influences in the sketch of some of the pectorals, but one looks in vain in the metallurgical materials to the south for the prototypes of the Universe Pectoral or of the belt fastener. Did the Mexicans receive no influences from the outside? And how does one explain the incredible skill and perfection in the use of "false filigree" technique exclusively in Mexico? These questions are pertinent to the antiquity of this art and occupation in Mexico. Page 394: "The majority of scholars, relying on circumstantial evidence, believe that fine metallurgy in ancient Mexico was limited to a few centuries before the arrival of the Spaniards. Perhaps they are right, but it seems to me that their theory leaves much to be explained. I daresay this historical aspect of the problem merits more investigation."

Easby, Dudley T., Jr., Earle R. Caley, and Khosrow Moazed. "Axe-money: facts and speculation." *Revista Mexicana de Estudios Antropológicos* 21 (1967): 107-48.

Page 107: Most of the examples known are from Oaxaca but others have been found in Chiapas, Guerrero, and Michoacan. Page 108: They have usually been found in large hoards or caches. Lengthy discussion settles all question that these objects indeed served as money, not as functional cutting instruments. Page 132: Since examples are found in Ecuador and Peru, but never between there and Mesoamerica, this seems clear proof of maritime commerce between the two areas. Page 133: Fr. Pedro Simon, whose reputation for accuracy is notable, wrote in 1625 that metallic money was in use among the Chibchas around Bogota, consisting of plain cast circular counters, like blank coins. None have been found.

Eliade, Mircea. *The Forge and the Crucible: The Origins and Structures of Alchemy*. 2d ed. Chicago: University of Chicago Press, 1978.

Page 22: "Metallurgy as such, in Central and South America, is probably Asiatic in origin. Most recent researches tend to relate it to the south Chinese culture of the Chou epoch."

Epstein, Jeremiah F. "Pre-Columbian Old World coins in America: an examination of the evidence." *Current Anthropology* 21 (February 1980): 1-20.

Discusses critically 40 coins claimed to have been found within the U.S., following his substantial search for documentation on each. The most plausible interpretation, he concludes, is that the coins were lost only recently. Most appear to have been lost since World War II. For none is there sufficient evidence to accept them as genuinely ancient coins from pre-Columbian contexts in America. Appended commentaries by interested scholars both support and damn the author's finding.

Escalante, Roberto. "El vocabulario cultural de las lenguas de Mesoamérica." In *La Validez Teórica del Concepto Mesoamérica. XIX Mesa Redonda de la Sociedad Mexicana de Antropología*, 155-65. México: Sociedad Mexicana de Antropología y Instituto Nacional de Antropología e Historia (Serie Antropológica), 1990.

Using a dozen reconstructions of protolanguages from the literature, he identifies lexical items shared under ten lexical domains. Under "economy" he finds the following sharings: Protomaya and Otomanguean protolanguages: "metal" (pages 156, 158). Protomaya, Protohuave and Otomanguean protolanguages: "metal" (*hierro*, *hacha*) (pages 156, 161). [Compare Longacre and Millon.]

Franco Carrasco, José Luis. "Material recuperado." In *Minería Prehispánica en la Sierra de Querétaro*. México: Secretaría del Patrimonio Nacional, 1970. Pages 27-36.

Pottery from surface collections and inside native mines in the area is described. Among the materials: a version of Thin Orange like that from Teotihuacan dating from the 6th to 8th centuries, a Black Olmecoid type dated securely to the end of the Middle Preclassic, and a Black Veracruzian type of the second half of the Preclassic (i.e., the Late Preclassic). Abundant human bones and skulls were found evidencing frequent decapitation (presumably of slaves). The basic digging tool was a stone hammer of diorite or andesite grooved for mounting in a wooden handle. Also found were some wooden wedges, one of which "shows symptoms of being ancient, but we are suspicious, for the cuts which shaped it seem to have been made with a steel blade." A C-14 date on the wedge, however, gives A.D. 465. Veracruz objects (e.g., figurines and a palma) were also found, and circular stone constructions would be considered temples of Quetzalcoatl if found in the Huasteca. [Compare Langenscheidt.]

Furst, Peter. "West Mexico, the Caribbean and Northern South America: some problems in New World interrelationships." *Antropológica* 14 (June. 1965): 1-37. [Caracas]

Pages 18-20: In the context of a discussion of the shaft-tomb complex, which was obviously diffused between Peru and west Mexico, two sheet-gold ornaments reportedly from a burial in Jalisco are compared with a piece from the Nazca culture of Peru. Similarities are so marked that the Jalisco pieces might be imports from Peru. The Nazca features could date stylistically as early as proto-Nazca or, preferably, Nazca A (ca. A.D. 300). [The shaft-tomb complex in west Mexico dates between 200 B.C. and A.D. 400; see S. V. Long and R. E. Taylor, "Suggested revision for West Mexican archeological sequences," *Science* 154 (1966): 1456-59; and C. W. Meighan, "Cultural similarities between western Mexico and Andean regions," in *Precolumbian Contact within Nuclear America*, edited by J. C. Kelley and C. L. Riley, 15-18. Southern Illinois University Museum Mesoamerican Studies No. 4, 1969.]

Gann, T. W. F. "Maya jades." *Proceedings, 21st International Congress of Americanists, Part 2, Göteborg, 1924*. Göteborg, 1925. Pages 274-82.

Page 279: At Copan he found mercury in a cruciform vault, apparently the foundation at one time for a stela.

García Payón, José. "Archaeology of Central Veracruz." *Handbook of Middle American Indians*, vol. 11, edited by Gordon F. Ekholm and Ignacio Bernal, 505-42. Austin: University of Texas Press, 1971.

Page 542: "They had so little copper that they imitated metal bells in pottery."
[Compare Vaillant and Vaillant 1935.]

Gay, José Antonio. *Historia de Oaxaca*, Tomo 1. México: Imprenta del Comercio, 1881.

Page 60: In the heart of the mountains of this state there exist inexhaustible silver deposits as shown in the stream sands. Page 61: Describes methods for placering gold, done by individual families. Page 62: Sheets of gold were formed using stone hammers, citing Sahagún. In Oaxaca they did the same, as shown by the fact that "recently the Mixtecs have sold to some European antiquarians very thin sheets of gold, evidently worked by hammering, that their ancestors had been able to preserve and on which were engraved ancient hieroglyphs."

Goodman, Claire Garber. *Copper Artifacts in Late Woodlands Prehistory*, edited by Anne-Marie Cantwell. Evanston, Illinois: Center for American Archaeology at Northwestern University, 1984.

The editor argues that knowledge involved in making Middle Woodland copper panpipes may have been limited to certain individuals or lineages, for, following collapse of the Hopewell Interaction Sphere (c. A.D. 400), not only panpipes but all copper luxury items disappeared in the midwest, not to reappear for 500 years.

Goodyear, W. "Distritos mineros de El Salvador." *Sociedad de Geografía e Historia de Guatemala, Anales* 31 (1958): 130-49.

An 1880 assessment of commercial mining possibilities. There are three significant mining areas in the country, exclusively in the north (in addition to smaller ones farther south): San Miguel (northeast of Usulután), Metapán (north of Lago de Guija), and the Sensuntepeque district (in the curve of the Rio Lempa). Page 131: The principal minerals involve gold and silver as well as iron, copper, and zinc.

Griffin, James B. "A non-Neolithic copper industry in North America." *Actas y Memorias, 36a Congreso Internacional de Americanistas, Sevilla, 1964*, vol. 1, pages 281-85. Sevilla, 1966.

The almost pure copper deposits of the Lake Superior basin were first exploited not before 3000 B.C. and most of the implements were made between 2000 and 1000 B.C. Rather than one "culture" being credited for this work, he supposes a series. Some copper pits are 15-20 feet deep, and there were thousands of pits. Implements were shaped by cold hammering and annealing. None was ever melted or cast. There is no known cultural connection to any other area of the world. The products were all utilitarian until around 1000 B.C. when some copper and tubular beads began to be made. They were distributed from Saskatchewan to Ontario and New England to Illinois with eastern Wisconsin having the most. Most of the 20,000+ artifacts have

been surface finds. In the Ottawa Valley burials and village occupations have revealed over 250 copper artifacts including unworked copper. [Compare Covarrubias, Neiburger.]

Grossman, Joel W. "An ancient gold workers tool kit." *Archaeology* 25 (Oct. 1972): 270-75.

Page 270: "Until this year, the earliest recorded metal artifacts in Peru—and for that matter in all of South and Mesoamerica—were some gold ornaments of Chavín style . . . dating to about 800 years B.C." He here reports finds at Waywaka, southeast of Lima, where the pottery is almost indistinguishable from some on the coast dated 1900 B.C. Page 272: A radiocarbon date comes out at 1490 plus or minus 100 B.C. [When MASCA corrections are applied, this date becomes 1890 B.C.] Page 275: Hammered gold foil was put in burials and a gold bead was placed in the mouth of the deceased. Annealing is a possible technique here.

Grove, David C. "The Formative of Morelos: problems and comments." *Sociedad Mexicana de Antropología, XIII Mesa Redonda, Xalapa, 1973*. Arqueología II. México, 1975. Pages 267-74.

Page 272: Solid iron ore (hematite, magnetite) fragments occur in archaeological contexts at highland sites, including Chalcatzingo.

Haury, Emil. "Cuicuilco in retrospect." *Kiva* 41/2 (1975): 195-200.

He participated in the dig at Cuicuilco with Cummings. Page 199: Cummings's notes were stolen in 1925 on his way home from Mexico, so no details of stratigraphy can be checked. Cummings inferred that the copper sheet specimen recovered dated before the time of the lava, but, Haury asserts, there are specific reasons to doubt the reliability of the association; implied most important of these is that metal is not otherwise known until A.D. 900. The mound tops not covered by lava yielded Aztec pottery mingled with Preclassic pottery, so he is convinced that the copper came from Aztec reuse of the mound. Also the form (sheeting and nails) suggest late metallurgical achievements. Haury did not see the specimen removed from the ground.

Hawley, F. G. Personal communication to J. L. Sorenson, 1954.

Shown the Vaillants' drawing of a clay "ornament" of Gualupita II date from Morelos [without knowing its provenance or attributed date], Hawley and his colleague E. B. Sayles, experts on Southwest bells, agree that the maker of the clay object had seen a copper bell and had intended to copy it even though he had failed to make a very accurate copy.

Hedges, R. E. M., R. A. Housley, I. A. Law, and C. R. Bronk. "Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 9." *Archaeometry* 31 (1989): 207-34.

Page 230: Radiocarbon accelerator dates are reported on metal specimens submitted by W. Bray including two from the cenote at Chichén Itza. Dates are respectively A.D. 230 and 1070 B.C. Bray observes that the two should have been close to each other, and "any age older than 2000 B(e)fore P(resent) is archaeologically unacceptable. The lab comments that older carbon may have become incorporated in the Chichen Itza casting cores during deposition in the waterlogged environment, which may be responsible for older than predicted ages.

Heine-Geldern, Robert von. "Die asiatische Herkunft der südamerikanischen Metalltechnik." *Paideuma* 5 (1954): 347-423.

A monograph presenting the case for an early first millennium B.C. movement of metalworkers from the Caucasus (with links to the Hallstatt culture) through interior Asia to Southeast Asia, where the Dongson culture resulted. From there metalworking knowledge was transmitted across the Pacific to both the middle and northern Andean areas. Many very specific parallels in forms and decoration of metal artifacts are pictured and discussed which link the Caucasus, Indo-China, and the Andes.

Heine-Geldern, Robert von. "American metallurgy and the Old World." In *Early Chinese Art and Its Possible Influence in the Pacific Basin; a Symposium Arranged by the Department of Art History and Archaeology, Columbia University, New York City, August 21-25, 1967*, edited by Noel Barnard, 3 vols., vol. 3, 787-822. New York: Intercultural Arts, 1972.

Discusses the spread of metallurgy from the Southeast Asia Dongson culture to South America with reference to methods, forms and decoration. It cannot reasonably be doubted that knowledge of granulation came to America from the Old World, and the lost-wax method is also likely to have come by diffusion. Page 810: "The discovery of the qualities inherent to metal ores and the invention of smelting constitute one of the greatest miracles within the whole history of culture. Yet, scholars have lightheartedly credited South American Indians with the duplication of this miracle. In addition, the independent re-invention of bronze has been ascribed to them." To him this view is unbelievable.

Hendrichs, P. R. "Datos sobre la técnica minera prehispánica." *El México Antiguo* 5 (Num. 3-5): 148-60.

Investigating "caves" in the northeastern Balsas basin, he found that many were actually pre-Columbian mines with large numbers of stone implements inside and outside them. By experimentation he found that they were thoroughly capable of doing the digging and that they produced marks identical to what he found in the walls of the "caves." Mines occur in both non-metalliferous and copper- and mercury-bearing materials. On the basis of the small working space demonstrated in many of the portions dug, he suggests that children were employed for mining, as they were in China.

Hensoldt, H. "Meteorites and what they teach us, I." *American Geologist* 4 (1889): 28-38.

Page 37: The Aztecs possessed certain implements, such as knives and daggers, made of iron, but only the most elite possessed such; iron was prized higher than gold. Page 38: Their iron was of meteoric origin like that of the Mayas and Incas, of which many weapons are still preserved in collections.

Hodge, F. W., ed. *Handbook of American Indians North of Mexico*, Part 2. Smithsonian Institution, Bureau of American Ethnology, Bulletin 30. Washington, 1910.

Page 833: A Creek Indian group, the "Tukabatchi," in Alabama "had in their possession certain metal records which they had preserved from time immemorial. Adair . . . says that in his time [1778], they consisted of five copper and two brass plates." [Compare Samuel Williams.]

Hosler, Dorothy. "Ancient West Mexican metallurgy: South and Central American origins and West Mexican transformations." *American Anthropologist* 90 (1988): 832-55.

Pages 832-833: A maritime exchange system, based in Ecuador, transmitted technical know-how and sometimes artifacts to West Mexico from Ecuador, Colombia, and lower Central America between approximately A.D. 800 and 1200. Thereafter new elements from those same regional metallurgies were also introduced in West Mexico along with elements from southern Peru. Not all facets of Andean and Central American metallurgies were developed in Mexico, however, despite the availability there of the ores and metals required to reproduce those technologies. In West Mexico metal came to be used principally for objects demarcating sacred and elite domains of culture. They employed copper, silver and gold and binary alloys of copper-silver, copper-arsenic, and copper-tin, among others. Ethnohistoric sources say that metal bells were thought worn by deities as well as rulers and elites; in each of three indigenous Mesoamerican languages the word for "metal" and "bell" and a "good sound" is the same word. Practical tools crafted comprised only a small proportion of the total. Sound and color were two primary considerations in preparing metals in Mexico. Pages 834-35: In the Andean area two bronzes were used: copper-tin and copper-arsenic, for both tools and objects for status display. The earliest metals in the Andean area were copper and gold, evident from about 1500 to 200 B.C. The bronzes initially appeared in northern Peru between about A.D. 200 and 800. Lost-wax casting was known in Colombia by the beginning of the Christian era and became widespread between the 3rd and 10th centuries. Lost-wax was equally important in central Panama as early as A.D. 200. The earliest evidence for metallurgy in lower Central America and Colombia dates to about 100 B.C. In southern Peru and the adjacent Bolivian highlands metalworking had taken root by about 800 B.C. Page 839: Bells appear in West Mexico between A.D. 800-1200. In Colombia lost-wax cast bells first appear between A.D. 200 and 500 and in Panama and Costa Rica by A.D. 500.

Hosler, Dorothy, Heather Lechtman, and Olaf Holm. "Axe-monies and their relatives." *Dumbarton Oaks Research Library and Collection, Studies in Pre-Columbian Art and Archaeology* 38, 1990. [Washington]

Page 51: A Spanish-looted tomb in Ecuador in 1563 yielded between 600 and 1000 *hachuelas* (hatchets) of copper, that is, axe-monies. Salomon argues from this that these were a symbolic form of wealth among Cañari elite. These authors say (page 53): "It is clear that *hachuelas* constituted a form of wealth and that they were often hoarded in great quantity." Page 50: Saville reported a cache of 120 axe-monies that had been placed in pairs in a chamber excavated in a mound near Xaaga, Oaxaca. Page 82: The merchants of Chinchipe, Ecuador, were the only ones in the Inka domain to use money (*moneda*). They used copper, each copper token or item of currency having a fixed value. These have not been found archaeologically.

Ibarra Grasso, Dick Edgar. "Las hachas de metal y de piedra en América, con referencia a las formas líticas que imitan modelos metálicos y paralelos transpacíficos." *Actas y Memorias, 35a Congreso Internacional de Americanistas, México, 1962*, vol. 1, pages 21-30. México, 1964.

Demonstrates that while metal *hachas* or axe-heads are widely recognized as present in America since A.D. 1200, identical forms in stone, including clearly metallic details, are much older. The stone forms are imitations of metal objects among people who did not possess much or any metal.

Ibarra Grasso, Dick Edgar. "La imitación de objetos metálicos en otros materiales por pueblos precolombinos que no trabajaban los metales." *Verhandlungen des 38. Internationalen Amerikanistenkongresses, Stuttgart-München, 1968*. Band 1, pages 79-84. München: Klaus Renner, 1969.

Page 79: Already in the Uruk period in Mesopotamia we find ceramic objects whose form clearly models earlier metal objects. In a majority of cases the metal objects have not appeared in the archaeology, but nobody doubts their existence. Other instances: Egypt, China, Greece, Anatolia (page 80), and Polynesia. In the New World we have instances for the Olmec and Chavin cultures. For the latter these consist of stone axe-heads provided with small wings that imitate bronze axes such as are found in Egypt toward the end of the Bronze Age. For the Olmec there are ceramic vessels which are imitations of metal vessels. Page 81: Many ceramic vessels in the Chavin culture also show derivation from metal forms. Also, tribes of interior Brazil use wooden swords that imitate forms of bronze swords of prehistoric Europe. Page 82: These facts are to be explained by supposing maritime diffusion from the Red Sea via south India and Indonesia across the Pacific. Heine-Geldern's picture of an origin in south China or Indonesia for metal bearers who reached South America will not do since, for example, metal depilatory tweezers, so abundant in the Andean zone, are typical of the European Bronze Age but never in ancient China or India. Page 83: Probably it was the failure of artisans who could work iron to arrive by ship that led to the resort to stone imitations.

Ibarra Grasso, Dick Edgar. *América en la Prehistoria Mundial: Difusión Greco-fenicia*. Buenos Aires: Editora Argentina, 1982.

A little before 3000 B.C. influence from Indonesia is manifest in Ecuador and perhaps western Mexico, including cultural traits originating in Bronze Age Sumeria. Around 500 B.C. intense new influences, including migrations, reached Mesoamerica, yielding the Late Preclassic. Metallurgy was not then received but many copies of metal objects in other materials exist, while in Ecuador and Peru full metallurgy was received, perhaps from Phoenicians and Greeks.

Joyce, T. A. "An example of cast gold-work, discovered at Palenque by de Waldeck, now in the British Museum." *Proceedings, 21st International Congress of Americanists, First Part, The Hague, 1924*, pages 46-47. The Hague, 1924.

Illustrates and discusses a gold, lost-wax cast bell in the form of a human head wearing a turban-like headdress, nose ornament, and "ear studs." The British Museum acquired it from a member of the de Waldeck family; they say it was obtained by Frederick de Waldeck at the ruins of Palenque in 1832-1834. Other antiquities were held by the family, none of which Joyce found to be incorrectly labelled. He sees no reason not to accept the attribution and to consider it proof that casting gold "had attained a considerable development under the Old Empire of the Maya." [Bray 1977 accepts this as "probably" a Maya piece.]

Joyce, T. A. "Report on the investigations at Lubaantun, British Honduras, in 1926." *Journal of the Royal Anthropological Institute* 56 (1926): 207-30.

Page 229: A flat, hammered copper axe-blade was found on the surface in the immediate neighborhood of the ruined city. [It is impossible to know whether the copper is associated with the main (Classic) period of inhabitation.]

Kelly, Isabel. "Excavations at Culiacán, Sinaloa." *Ibero-Americana* No. 25, 1945. [University of California]

Pages 149-50: A piece of iron was found in the form of a small circlet. A technical analysis calls it "relatively pure iron which has been forged or hot-worked in some way. It may initially have been derived from meteoric iron, but it certainly is not now in that condition; the fine grain which is shown in the structure indicates that it has been worked." Kelly then assumes that it is "post-white iron" (i.e., European) but "worked according to the local native shape-patterns of copper artifacts." Pages 150-51: Discusses the occurrence of "large quantities of burned stone" on the naturally stoneless delta of the Culiacán. "This may or may not prove to be slag from prehistoric smelting operations." These burned rocks are all found in association with evidences of prehistoric occupation.

Kelly, Isabel. "The archaeology of the Autlan-Tuxcacuesco area of Jalisco, 2: the Tuxcacuesco-Zapotitlan zone." *Ibero-Americana* 27 (1949). [University of California]

Page 153: Briefly summarizes work by Rubín de la Borbolla at Tzintzuntzan. He had not published on it [and apparently never did]; the only report is this note by Kelly, based on a personal communication from the excavator dated Jan. 15, 1943. "Copper . . . appears in what promises to be the earliest horizon of the trio [of 'horizons' at Tzintzuntzan]. This last[-mentioned, i.e., earliest] phase is as yet only partially defined. It is represented by a partly destroyed tomb which produced copper wires in company with jades of Teotihuacán type, of Monte Albán III type, and of 'Tarascan' type. Ceramically, nothing is known of this early Tzintzuntzan phase. . . . If the dating suggested by the jades is substantiated by further evidence, this may be the earliest occurrence of copper on record for Mexico." [R. Chadwick, *Handbook of Middle American Indians*, 11: 673, notes this Teotihuacan-influenced period at Tzintzuntzan.]

Kelly, Isabel, and Angel Palerm. *The Tajín Totonac. Part 1. History, subsistence, shelter and technology*. Smithsonian Institution Institute of Social Anthropology Publication 13, 1952.

Pages 244-45: The conquering Spaniards found non-trivial amounts of gold on this part of the Gulf Coast and reported it worked by the natives, yet no metal artifacts have ever been recovered from archaeological sites definitely identified as Totonac.

Kidder, Alfred V., and Edwin M. Shook. "A unique ancient Maya sweathouse, Guatemala." In *Amerikanistische Miscellen (Mitteilungen aus dem Museum für Völkerkunde in Hamburg 25; Festband Franz Termer)*, 1959. Pages 70-74.

North of Colomba a Late Classic mound contained a tomb and a mortuary offering including nine "pottery bells."

Kidder, Alfred V., Jesse D. Jennings, and Edwin M. Shook. *Excavations at Kaminaljuyu, Guatemala*. Carnegie Institution of Washington Publ. 561, 1946.

Page 144-45: Mercury found in a tomb of Esperanza (Middle Classic) date points to an interest in minerals. Natural occurrences of liquid mercury are extremely rare and usually only in minute quantities. The specimen here constituted about 25 cc. of mercury in a small container supposed to have been a (decayed) gourd. Mercury was used in some metallurgical operations; see, for example, Linné 1938.

Two occurrences of metal artifacts from Kaminaljuyu are also noted on these pages. One was a pair of small gold figurines (illustrated) from Finca Las Charcas, reported by the finca owner to have been found in a small plain red pottery jar at a depth of 50-75 m. in a low mound. Since the authors are unaware of any similar gold ornaments, their authenticity is assumed doubtful. They had been presented by the owner to ex-president Ubico.

[Note: In the Gates Collection, Brigham Young University Lee Library, correspondence is found from T. T. Waterman to William E. Gates (at the time expatriate Director General de la Dirección General de Arqueología, Etnología e Historia y Museo Nacional Anexo de la República de Guatemala; Waterman was his employee in Guatemala City). Under date of 31 Aug. 1923, Waterman says: "I have today seen gold figurines (believe it or not) dug up within two miles and a half of our museum." The site, "on the Mixco road," was being dug, unofficially, by Batres Jaurequé and perhaps others and was obviously Kaminaljuyu, for on 20 Sept. 1923 he wrote again: "Now listen to this. There is a city right out of this town, not two miles and a half. The ruins occupy a site more than a mile square. . . . The following things are there, or have recently been taken away. (1) Small gold figures (seen by myself)."]

"The other purported find of metal was made before 1800: two identical copper discs, engraved. . . . As reproduced [cf. Bancroft 1875], the style of these designs is obviously European, but because eighteenth-century drawings of such objects were often very faulty, and because it is unlikely that in those days antiquities were being forged, we think it quite possible that the discs were authentic." "If the above specimens are pre-Columbian, we doubt that they can date from Esperanza times." [Such "discs" fit most logically as part of the Late Classic family of disc specimens discussed by Lothrop, and Coe and Flannery.]

[King, Edward] Lord Kingsborough. *Antiquities of Mexico*. 8 vols. London: James Moyes, 1831-1848.

Vol. 6, page 470: English translation of "Viages de Guillermo Dupaix sobre las antigüedades Mejicanas" (also in Spanish at volume 5, pp. 290-291). A disc of unspecified metal two inches in diameter shaped and engraved by hand shows scenes on either side of "purely historical and very mysterious hieroglyphical" nature. The object is displayed at volume 4, Plate 8, Figure 12, is reproduced in Bancroft 1875, and is discussed by Kidder, Jennings, and Shook.

Vol. 8, pages 357-58: According to William Bolsover who dealt with the Ispogogee Indians at Tuckabatchee, Alabama, their priests had many brass and copper plates on which were sacred writings of their forefathers which they said were given to them by the same deity the whitemen call God.

Langenscheidt, Adolphus. "Antecedentes históricos." In *Minería Prehispánica en la Sierra de Querétaro*, unnumbered pages, twenty-first page in sequence. México: Secretaría del Patrimonio Nacional, 1970a.

Mina is used here to refer to subterranean digging, versus *yacimiento* for worked surface deposits. Some of the former involved galleries and ventilation holes. There were pre-Columbian minas in the states of Jalisco, Nayarit, México, Guerrero, Michoacán, Zacatecas, Guanajuato, Chihuahua, Hidalgo, and Querétaro. For example, Larrainzar in 1873 discovered a prehispanic copper mine in Cerro del Aguila in Guerrero.

Langenscheidt, Adolphus. "Las minas y la minería prehispánicas." In *Minería Prehispánica en la Sierra de Querétaro*, 45-50. México: Secretaría del Patrimonio Nacional, 1970b.

The main aim of mines in this sierra was to obtain cinnabar, but apparently also green calcite, fluorite, and silver and lead ores. Earliest evidence of exploitation goes back to the fourth century B.C. [sic] and continued more or less until the eighth century A.D. Extremely difficult conditions are indicated for workers, including vestiges of food and burials inside the mines which lead him to think that miners lived and died underground, probably under a regime of slavery. In this range some 2000 mine openings have been located. Five radiocarbon dates are given ranging from A.D. 15 to A.D. 540, however it is likely that the Olmecs, great consumers of cinnabar, had much to do with earlier workings. Artifacts found come from Teotihuacan, central Veracruz, and the Huasteca, as well as Querétaro, Michoacán, and Colima. [Compare Franco.]

LaPaz, Lincoln. "Topics in meteoritics. Hunting meteorites: their recovery, use, and abuse from Paleolithic to present." *University of New Mexico Publications in Meteoritics* 6 (1969): 55-67.

Page 78: A catalog of meteoritic iron used by "more or less primitive man" shows widespread ability to work it practically. Pages 80-83: Locations of meteorites in Mexico are given, where they have been converted into axes, knives, anvils, plowshares. One was as large as 269 lbs. Page 84: The Sumerian, Hittite, Assyrian, and Hebrew names for iron meant something like "fire or metal from heaven." The Hebrew word is *parzil*.

Larsen, Helge. "The Ipiutak culture: its origin and relationships." In *Indian Tribes of Aboriginal America. Selected Papers of the XXIXth International Congress of Americanists [1949]*, edited by Sol Tax, 22-34. Chicago: University of Chicago Press, 1952.

Page 26: Chain and swivel elements in carved ivory are taken as imitations of metal objects supposing that the Ipiutak people, lacking sufficient quantities of iron, used ivory as the material for various symbolic objects which were of iron in Asia. [The logic is that a chain makes no utilitarian sense in material other than metal and would not have arisen in the absence of knowledge of metal chains. Compare art representations of chains in Mesoamerica.]

Lechtman, Heather. "The Central Andes." In *The Coming of the Age of Iron*, edited by Theodore A. Wertime and James D. Muhly, 267-334. New Haven: Yale University Press, 1980.

Page 275: "Our picture of the earliest metallurgy in the Andes is changing as the data trickle in, but we are far from any clear interpretation of those data." Page 276: The earliest documented metal finds comprise a group of tiny pieces of hammered gold foil dating (uncorrected C-14) at 1500 B.C. Other small pieces of worked gold are at about 1000 B.C. Until 1975 no metal finds of any kind were reported by excavators at the type site of Chavín de Huántar itself, but in 1975 a single tiny piece of sheet gold was found there. Page 285: "It would be foolish to attempt any generalizations or careful evaluations of these beginnings in Andean metallurgy when we see that within the last thirteen years . . . bits and pieces of information have slowly collected to alter our previous notions of the nature of Early Horizon metallurgy."

Leemans, C. "Description de quelques antiquités américaines conservées dans le Musée Royal Néerlandais d'antiquités, à Leide." *Compte-rendu, 2e Congrès International des Américanistes, Luxembourg, 1877, Tome 2, pages 283-302. Paris, 1878.*

Page 299: He describes objects found by a Dutch engineer in eastern Guatemala while engaged in constructing a canal (date not given). This is the first published notice of the Leyden Plate or Plaque. The location was near San Filippo on the Graciosa River near the frontier between British Honduras and Guatemala, "at great depth under the surface." Page 301: Included with three nephrite carvings and one in quartz was a small round bell of "bronze" in the form of some fruit, with a clapper.

Linares de Sapir, Olga. "Ceramic phases for Chiriqui, Panama, and their relationship to neighboring sequences." *American Antiquity* 33 (1968): 216-25.

Page 224: Chiriqui was participating in a wide sphere of cultural connections extending as far as Mesoamerica during the period 300 B.C. to A.D. 300. [Metallurgy was now established in Panama and presumably could have affected Mesoamerica. A personal communication from Gareth W. Lowe to Dale McElrath dated June 15, 1972, copy in J. L. Sorenson's possession, notes striking similarity between the Zoned Bichrome pottery of Costa Rica, ca. 300 B.C. to A.D. 300, and that at the large Perseverancia site in coastal Chiapas. It looks to Lowe "like we had a very important and probably seaborne interchange between Costa Rica and Nicaragua and the northwestern coast of Chiapas" at this time.]

Linné, Sigvald. *Zapotecan Antiquities and the Paulson Collection in the Ethnographical Museum of Sweden*. Ethnographical Museum of Sweden (n.s.) Publication No. 4. Stockholm, 1938.

Page 53: Discusses Caso's 1935 finds in a Mitla tomb including part of an iron plate (see Caso and Rubín de la Borbolla 1936). "The iron plate is no doubt to be counted among the most remarkable objects that have at any time been discovered in Mexico seeing there is nothing to indicate that it is of post-Columbian origin." Page 75: Linné also discusses the amalgam method of gold plating clay beads, known from Mitla, the Rio Ulua, and the Tarascan area. Page 74: It uses gold mixed with mercury coated on the clay, the mercury being volatilized when fired. The process was known in the Old World.

Linné, Sigvald. *Mexican highland cultures*. Ethnographical Museum of Sweden Publication 7. Stockholm, 1942.

Page 132: Burial 1 included a "metal-resembling substance, small, irregular-shaped pieces. Analysis has shown them to contain copper and iron." [Personal communication from Robert Chadwick to J. L. Sorenson says that R. Millon dates this burial to the Tlamimilolpa phase, that is, before A.D. 400.] The same burial contained an iron pyrite mirror.

Litke, James. "Advanced Indian civilization destroyed around 600 B.C." *Salt Lake Tribune* (Associated Press), June 14, 1984, pages 1 and 2.

According to Dr. Donald Lathrap of the University of Illinois new finds date civilization in the Cauca valley of Ecuador to 1500-600 B.C., rather than the 400-800 hitherto assigned. The remains were buried beneath massive volcanic activity and the area rendered uninhabitable for a period of between 500 and 1000 years. The pre-600 B.C. civilization produced "a host of spectacular gold pieces."

Longacre, Robert E., and René Millon. "Proto-Mixtecan and Proto-Amuzgo-Mixtecan vocabularies: A preliminary cultural analysis." *Anthropological Linguistics* 3/4 (April 1961): 1-44.

Pages 1-4: They comprehensively review studies on groupings of the languages under consideration and their possible (glotto)chronological positions. In summary, a date of about 3000 years ago for the Proto-Mixtecan (PM) horizon is both plausible and conservative. A date 500 to 1000 years earlier is probable for Proto-Amuzgo-Mixtecan (PAM).

Page 22: In any given set (of terms used in the reconstruction) the possibility always exists that separate but parallel semantic shifts may have taken place in all the languages under consideration in the set. "While this possibility is remote, it seems to have occurred in several of the sets which reconstruct" in these proto-languages. "For example, one set, linguistically evaluated as solid [on a scale from strong through solid and plausible to weak], reconstructs in Proto-Mixtecan with the meaning *bell* or perhaps *metal*. The existence of metal or metal bells at this early date is highly improbable on the basis of existing archeological evidence. Examination of the set suggests that the original meaning may have been *rattle* but it is impossible to be certain of this." Page 29: The meaning bell/metal is excluded for reasons discussed. [Compare Escalante.]

Longyear John M., III. *Archaeological investigation in El Salvador*. Harvard University Peabody Museum of Archaeology and Ethnology Memoir 9, no. 2. 1944.

Plate VII, page 30: The Usulután type vessel shown, particularly the handles, looks like a ceramic imitation of a metal vessel with rivets. [The Usulután is probably pre-Classic in date, but surely no later than Classic.] Also note the striking similarity between Pl. VIII, 8, 9, and Peruvian vessels, both metal and ceramic, of Late Chimú date illustrated in Jorge C. Muelle, "Concerning the Middle Chimú style," *University of California Publications in American Archaeology and Ethnology* 36/3 (1934): 203-22.

Longyear, John M., III. *Copan ceramics. A study of southeastern Maya pottery*. Carnegie Institution of Washington Publication No. 597, 1952.

Page 112: Two fragmentary legs broken from a hollow gold-copper figurine were found in the vault under Stela H. (Dated: 9.17.12.0=GMT correlation A.D. 782.) "I suggest that these small fragmentary objects were gathered together and inserted into the vault sometime during the post-Classic period, perhaps by a band of pilgrims visiting the deserted ceremonial center." [This speculation is not only groundless but contrary to the excavator's judgment. See Stromsvik.]

Samuel K. Lothrop. *Zacualpa. A study of ancient Quiche artifacts*. Carnegie Institution of Washington Publication 472, 1936.

Page 70: Discusses a tomb (apparently looted; he is reporting on the resulting collection) which contained ceramics of Middle and Late "Old Empire" (Classic) types (compared with Holmul and Chamá). Page 75: Three copper pieces were in this tomb, one of them a disc, and another disc had been taken by the looters. Page 71-72: "Isolated finds of questionable authenticity . . . have been made at Palenque and Tikal, while, apart from Zacualpa, definite discoveries have recently been recorded at Yaxhá and Copán. We therefore are justified in believing that at the fall of the Old Empire the Maya did not manufacture but occasionally imported metal artifacts." To account for

the anomalous metal at Zacualpa, he considers that the tomb was re-used. Page 76: Fig. 73 shows a massive copper ax. Celts of this type supposedly were made in Oaxaca and traded south as far as the Peten and Salvador (nonspecific citations). "Some years ago we found in Tonicapan a steel blade of this kind set in a slot running through a massive wooden handle." [No further information nor citation is supplied on this point.]

Lothrop, Samuel K. *Metals from the Cenote of Sacrifice, Chichen Itzá, Yucatan*. Harvard University Peabody Museum of Archaeology and Ethnology, Memoir 10, no. 2. Cambridge, 1952.

Page 4: He thinks that during the so-called period of abandonment of the site (the few centuries before A.D. 987) offerings were thrown into the Cenote of Sacrifice, as shown by discovery of large numbers of jades carved in definite "Great period" (Late Classic) style. [Thus some metal pieces discovered in the Cenote logically could also date to that period.] Page 22: Isolated metal specimens of questionable provenience have been reported at Palenque, Yaxha, and Tikal. Two gold disks from Zacualpa in the Guatemalan highlands may be of considerable age as they were found in a stone, vaulted tomb. Page 23: The contents of the tombs "have been mixed" and it is possible that the tombs were used on more than one occasion. Page 25: (Citing Strong 1935) in the Bay Islands metal was found in a jar of Polychrome I style "which does not seem to be of great antiquity." [Now see Stone 1968 and Joyce 1991; the pot proves to be Terminal Classic.] Page 28: In the Sacred Cenote, in addition to a number of undecorated metal disks, 17 decorated ones were found, plus fragments. Page 29: Fig. 29 shows three artists' renderings of one of these; the obvious differences illustrate the difficulty of settling decorative details, but all of them show Tula-Toltec vs. Maya battle scenes thus dating to near A.D. 1000, by presently accepted chronology.

Page 42: Fig. 26 shows a number of "leg bands" redrawn; six show bells on them. No two of the bell representations is the same shape. "It is clear . . . that copper bells such as we illustrate . . . often were attached to the bands." [Compare Thompson 1948.] Page 67: Metal sheets shown had been nailed. Metal nails were used on the coast of Peru. Page 72: "Horse collars." One of gold from the Cenote is illustrated. Shell examples are from Kaminaljuyu (Esperanza), two from Uaxactun (Tzakol period), Holmul (III), and Teotihuacan. Is the gold specimen approximately contemporaneous with those in shell? "We see no reason to believe otherwise, and, if so, it may date from the middle of the Maya Great period. It therefore may be the oldest metal object recovered from the Cenote and the oldest known metal object of the Maya area." However it may also be later. Page 112: The "horse-collar" ellipses, judged on the basis of Proskouriakoff's art canons, would date between 9.18 and 10.2 (GMT=800-869). [Compare Borhegyi's earlier dating.] Page 82: Two pieces of gilded sheet copper (Figs 69, a, b) are of unknown meaning. They vaguely recall eccentric flints found in cities of the Great period. They also may be compared with unexplained shell objects found at Holmul [which shell objects are of Classic date]. [Compare Coggins and Shane.]

Page 98: An Aztec land route from the Valley of Mexico to Panama existed for the purpose of getting gold. Also, traffic by sea between Panama and Yucatan is clear, and Aztec traders had an outpost near the present Nicaragua-Costa Rica border. [Shows the degree of effort made to obtain metals at a distance.] Page 110: Regarding the figurine fragments of tumbaga beneath Stela H at Copan, it has been suggested by some that these might have been placed in the vault long after erection of the stelae. "We do not see how this is possible" Those Copan figurine legs show that figurines in the same style from the Cenote may be of comparatively early date, but this cannot be confirmed.

The only metal specimen from the Cenote which he believes possibly pre-Toltec is the gold "horse collar."

Lowe, Gareth W., Thomas A. Lee, Jr., and Eduardo Martinez Espinosa. *Izapa: an introduction to the ruins and monuments*. Brigham Young University New World Archaeological Foundation, Papers No. 31. Provo, Utah, 1982.

Page 153: One urn burial included "a unique, delicate oval thin gold pendant decorated with two embossed intertwined feathered-serpent heads." [Compare New World Archaeological Foundation, n.d., on the same piece.]

Lundell, C. L. *Ruins of Polol and other archaeological discoveries in the Department of Petén, Guatemala*. Carnegie Institution of Washington, Publication 436, Contributions 2, No. 8, 1934. Pages 175-86.

Page 185: In the village of Yaxhá he saw a hand-forged, copper ax that had been found by a milpero near the ruins of the Maya city of that name. "If this tool dates from the time of the Old Empire period, it is a find of greatest importance." [Lothrop 1936 accepted it as such.]

Mallery, Arlington H. *Lost America: The Story of Iron-Age Civilization Prior to Columbus*. Washington: Overlook Co., and Toronto: Clarke, Irwin, 1951.

Foreword by Matthew W. Stirling. Iron-smelting furnaces found by this engineer in two Ohio mounds demonstrate, he says, that Europeans with knowledge of iron technology lived here anciently. [J. H. McCulloch arranged for a radiocarbon date of such a furnace, which yielded an 18th-century date. Personal communication, 1992.]

Mallery, Arlington H., and Mary Roberts Harrison. *The Rediscovery of Lost America*. New York: Dutton, and Toronto: Clarke, Irwin, 1979.

Claims existence of a pre-European "iron industry," based on his excavations in Ohio and Virginia and other discoveries of Viking and Celtic remains in eastern North America.

Malone, Michael D. "An ancient Mayan cave." *Pacific Discovery* 24 (1971):1-8.

A student with an anthropology degree and archaeology experience examined a large dry cave in Belize 30 miles west of Altun Ha. Without removing any objects, he observed that the pottery belonged to the Tiger Run Complex of Barton Ramie dating to A.D. 600-700. Page 5: One of the pots in the cave contained a "flat freeform piece of badly oxidized copper."

Marcos, Jorge G. "De ida y vuelta a Acapulco con mercaderes de Mullu." In *Arqueología de la Costa Ecuatoriana: Nuevos Enfoques*, edited by Jorge G. Marcos, 163-96. Guayaquil, Ecuador: Escuela Politécnica del Litoral, Centro de Estudios Arqueológicos y Antropológicos y Corporación Editora Nacional, 1986

A highly detailed study of the Spondylus shell trade demonstrates that long-distance voyaging from Ecuador to Mesoamerica is highly likely to have occurred from at least 1500 B.C. to the Spanish Conquest. [Much further bibliography on sea travel between Andean South America and Mesoamerica can be found in Sorenson and Raish, *Pre-Columbian Contact with the Americas across the Oceans*, 2 vols. (Provo, UT: Research Press, 1990).]

Marx, Robert F., with Jenifer G. Marx. *In Quest of the Great White Gods: Contact Between the Old and New World from the Dawn of History*. New York: Crown, 1992.

Page 49: He found in the Royal Academy of History in Madrid a document by a Spanish bishop who visited Yucatan around 1550. At Mani he saw unique buildings which looked to him like some he had seen during a visit to the Holy Land. They bore stone roofs "held in place by iron rods." Local elders reported a legend that a band of white men had once come there "from a place called Carthage." [W. J. Folan, In *Estudios de Cultura Maya* 8 (1972): 67-76, shows and discusses odd monopod vessels, probably water containers, found at Mani cenote which date to the Middle Preclassic and are in form largely the same as eastern Mediterranean vessels of similar function.]

Maudslay, A. P. *Archaeology. Biologia Centrali-Americana*. London, 1889-1902.

Page 20: At Copan in Mound 4, he found a pottery vessel containing an offering of shell, jade, and pearls; in the bottom of the jar was a little cinnabar and "several ounces" of mercury.

McCartney, A. P., and D. J. Mack. "Iron utilization by Thule Eskimos of central Canada." *American Antiquity* 38 (1973): 328-39.

Specimens of meteoric and terrestrial iron are surveyed. Terrestrial iron was used for over two millennia in the western Arctic, suggesting that it was more significant in the Eskimo tool kit than has been thought and implying a very long-distance trade network, presumably involving northern Asia. In the eastern Arctic as far west as the western coast of Hudson Bay, iron supposedly of Norse Greenlandic origin was in use at least 400 years before any non-Norse European contact; it appears to have travelled by a route as long as 1400 miles.

McCulloch, J. Huston. "The Bat Creek inscription: Cherokee or Hebrew?" *Tennessee Anthropologist* 13 (1988): 79-123.

Reviews in detail the circumstances attending discovery of this inscription in Tennessee in 1889 by a Smithsonian Institution archaeologist. On the basis of the evidence from the excavation and critical analysis of the inscription itself, he concludes that the material is indisputably pre-Columbian rather than historic Cherokee as claimed by some. The "copper" bracelets excavated with the stone are now analyzed and found to be real brass; the only parallels he knows of are in the Mediterranean in the first and second centuries A.D. [but see *Craddock], supporting his reading of the inscription as Hebrew of that period. A radiocarbon date on wood preserved through contact with the bracelets is of the second century A.D.

Meighan, Clement W. "Prehistoric copper objects from Western Mexico." *Science* 131 (1960): 1534.

Over 100 copper objects have been found in controlled excavations at or near the settlement of Amapa, Nayarit. Chemical, X-ray fluorescence, and mass spectrometry analyses were made of eight of these (see table). Many were found in domestic refuse, showing that copper artifacts were in common use. "The dating also appears to indicate that the use of copper is more ancient on the west coast than in central Mexico, suggesting that knowledge of metallurgy may have originated in the west coast area."

Yet “the chronology is uncertain,” although copper is found associated with pottery that is presumably Late Classic and Early Post-Classic in date—something to be equated with the Mazapan horizon in central Mexico [sic]. Copper objects in Arizona–New Mexico are now generally considered trade pieces from Mexico; these reached southern Arizona by A.D. 900, and it would not be surprising if they originated in western Mexico earlier. “We do not have firm dates for the first appearance of copper in any of the regions mentioned.”

Meighan, Clement W. “Cultural similarities between western Mexico and Andean regions.” In *Pre-Columbian contact within nuclear America*, edited by J. Charles Kelley and Carroll L. Riley, 11-25. Southern Illinois University Museum, Mesoamerican Studies No. 4. Carbondale, 1969.

Page 14: “It is not likely that the limited archaeology done in west Mexico has identified the earliest metal objects, but at present there is no metal object from a dated context older than A. D. 800-900. Several workers in west Mexico believe they may have found metal objects slightly older than this, perhaps as early as A. D. 700, but evidence for such a dating has not yet been published. Among the metals occurring is bronze, which is known elsewhere in America only in the Andean region. He knows of 15 such artifacts of (true or intentional) bronze from west Mexico but many additional bronze items are found from Tehuantepec and Chiapas. [In a personal communication to J. L. Sorenson in the 1970s, Meighan was of the opinion that no evidence places any west Mexican metal much before A.D. 900.]

Meighan, Clement W., ed. *The Archaeology of Amapa, Nayarit*. Vol. 2 of *Monumenta Archaeologica*. Los Angeles: University of California, Institute of Archaeology, 1976.

Page 62: The ceramic sequence initially used by Grosscup to date metals in the Cerritos phase to after A.D. 900 has been revised on the basis of obsidian dating. Now, “if metal was present from the very beginning of the Cerritos phase, it suggests a date as early as A.D. 600 for metal on the West Coast.” This cannot be settled until finer divisions within Cerritos have been worked out.

Metropolitan Museum of Art. *Before Cortés: Sculpture of Middle America*. Catalogue by Elizabeth K. Easby and John F. Scott. New York, 1970.

Page 120: Regarding the “Chinesca” type figurines in and around southern Nayarit and Colima, they note the evidence that shows these were probably linked directly with South America, noting: “The numerous ear rings and nose ornaments on the Western [Mexican] clay figures . . . look like South American metal rings; however, no metal has been found in Protoclassic Western tombs.” “Helmets” of the same shape are shown on warrior effigies from northern Peru and Jalisco. They date to the shaft-tomb period which falls between 200 B.C. and A.D. 400. The note accompanying plate 99, which shows a seated Chinesca girl, dated by them 100 B.C.–A.D. 250, says: “Carelessly rendered openwork ear ornaments curiously suggest multiple metal rings, but no metal from the Protoclassic period has been found.”

Miller, Donald E. “La Libertad, a major Middle and Late Preclassic ceremonial center in Chiapas, Mexico: a preliminary report.” In *New World Archaeological Foundation, The Upper Grijalva Basin Maya Project. Reports on Field Work of 1975-1976*. Gareth W. Lowe, Director. Volume ms. dated Feb. 1977. Pages 8-24.

Page 22: Occupation is roughly 600-100 B.C. Page 15: Mound 2 had two burials near the surface containing Classic vessels. Page 19: Atop Mound 5 was another burial

where the skeleton bore six metal finger rings. From the metal alone the burial is assumed due to a "Postclassic visit." [There is no other evidence at the site for a Postclassic presence.]

Morley, Sylvanus G. "The earliest Mayan dates." *Compte-Rendu, 21e Congrès International des Américanistes, Göteborg, 1924*. Part 2. Göteborg, Sweden, 1925. Pages 655-67.

Page 655: The Leyden Plate (Plaque) was found in digging a canal in eastern Guatemala not far from Puerto Barrios (citing Leemans). It was found at considerable depth beneath a low mound. [Leemans said nothing about a mound but did say "at great depth."] A copper bell and objects of jade accompanied it. The date on it, 8.14.3.1.12, in the GMT correlation, is A.D. 320. Page 664: Supposes the copper bell dated from as much as a thousand years later than the Plate because "no metal objects have been found at any Old Empire site save this copper bell in this mound . . . and a gold object said to have been purchased by Waldeck at Palenque" (citing Joyce). But the latter "is so decidedly un-Mayan in character" that it may almost certainly be dismissed from further consideration as being of Old Empire manufacture. [Contrast positive views in Joyce 1924 and Bray 1977.]

Mountjoy, Joseph B. "On the origin of west Mexican metallurgy." In *Precolumbian Contact within Nuclear America*, edited by J. Charles Kelley and Carroll L. Riley, 26-42. Southern Illinois University Museum Research Records, Mesoamerican Studies No. 4. Carbondale [1969].

Examines the evidence for sudden intrusion of copper working into west Mexico from South America. Page 28: The complex in west Mexico is dated at A.D. 900 "(but perhaps as early as A.D. 700)." Page 39: "The comparison of the west Mexican and South American artifacts seems to support the hypothesis that metallurgy was introduced to west Mexico from South America and probably by direct contact" (page 40), presumably involving balsa rafts.

Mountjoy, Joseph B., and Luis Torres M. "The production and use of prehispanic metal artifacts in the central coastal area of Jalisco, Mexico." In *The Archaeology of West and Northwest Mesoamerica*, edited by Michael S. Foster and Phil C. Weigand, 133-52. Boulder: Westview, 1985.

Pages 136, 138: From the Tomatlán area, site Tom-28 yielded a metal strip from a trench in a natural mound with cultural materials. The piece came from just above a burial, and possibly part of it, in context with pottery quite like early Cerritos phase material from Amapa, Nayarit, that is, early in the range A.D. 600-1000. [Preliminary announcement of this find in *Current Research, American Antiquity* 45 (1980): 624, said that it pushes "back the date at which the first metal artifacts appeared along the coast of West Mexico" to the range 500-700.] Among artifacts from another (later) site in the area were individual links and whole sections of metal chain.

Mozziño, José Mariano. *Noticias de Nootka; an Account of Nootka Sound in 1792*. Seattle: University of Washington Press, 1970.

Page 64: The Northwest Coast had iron when discovered by Captain Cook. Philip Drucker suggests that it came around the northern rim of the Pacific. [Compare Quimby and also Rainey.]

Neiburger, E. J. "Did Midwest pre-Columbian Indians cast metal? . . . A new look." *Central States Archaeological Journal* 34 (1987): 60-74.

Early archaeologists believed that many Old Copper Complex artifacts were cast metal. Current thought denies the presence of technology to melt and cast copper in that area and time period. Most of the known 20,000+ artifacts appear to be hammered from float copper, yet new studies reveal that some show signs of being cast. A random xeroradiographic study of Wisconsin artifacts demonstrated casting characteristics for many specimens. Additional bibliography in support is cited. [Compare Griffin.]

Neiburger, E. J. "Melted copper from the Archaic Midwest (1000 BC)." *North American Archaeologist* 12 (1991): 351-60.

Although some Archaic site artifacts show signs of high-heat metalworking, there is little substantiated evidence that natives in the area had the furnace technology capable of reaching the required temperature for casting. However a large lump of hammered copper from a site in Michigan, discussed technically here, provides firm evidence of casting. It is unlikely that melting could have occurred without deliberate planning; copper dropped in a campfire would not reach a temperature high enough to melt. It is also unlikely that this particular specimen is a fake or product of "later" manufacture. Lack of other evidence of metallurgy at the site could be due to a pattern known in the Old World cultures where special metal manufacturing processes were reserved (secret) thus keeping the supply of a particular product to a minimum. More specimens should be examined.

New World Archaeological Foundation. Ms. of information submitted to "Current Research" in *American Antiquity* for January 1966 (from NWAFF files).

In Cache 107, Mound 114, Group F, Izapa, was a gold "medallion" showing twin intertwined repousse serpents. Abundant San Juan Plumbate pottery indicates a Late Classic date, or perhaps transition to Post-Classic. [Lowe, Lee and Martinez E. in the final site report eliminate the suggestion of possible Post-Classic dating.]

Nininger, H. H. *Our Stone-Pelted Planet*. Boston: Houghton Mifflin, 1933.

Chap. 13, "Mexico's Greatest Meteorites." Page 72: The two Chupaderos meteorites (in northern Mexico) weigh respectively over 15 and 7 tons. Page 74: Others: 3.5, 0.8, and 11 tons. Page 75: The Bacubirito iron of Sinaloa is 13 feet long and its weight is estimated at 27 tons. Artifacts were made from chunks hammered off these.

Nininger, H. H. *Find a Falling Star*. New York: Paul S. Eriksson, 1972.

Page 238: He estimates that the meteoritic increment is 50,000 tons per day over the earth (much of it too tiny to be useful, however).

Northrop, Stuart A. "Turquoise." *El Palacio* 79/1 (1973): 3-22.

Page 8: Deposits are found in Arizona, California, Colorado, Nevada, and New Mexico, all of which show evidence of pre-European mining. At Mt. Chalchihuitl, near Santa Fe, New Mexico, tens of thousands of tons of rock have been moved to get this mineral from an area of at least 20 acres [showing the scale of concern with mining].

Nottebohm, Karl-Heinz. *A second Tlaloc gold plaque from Guatemala*. Carnegie Institution of Washington, Notes on Middle American Archaeology and Ethnology No. 51, 1945. Pages 170-72.

This gold object is believed to have come from the western part of Guatemala near the Mexican border, probably from a burial. The subject of the representation seems the same as on the Zacualpa disc, i.e., Tlaloc the rain god. On that stylistic ground he assigns a date of "around Baktun 11" for both discs. [Contrary to the tomb associations reported by Lothrop at Zacualpa which are Classic.]

Patterson, Clair C. "Native copper, silver, and gold accessible to early metallurgists." *American Antiquity* 36 (1971): 286-321.

Ores in early times were easier to find than in late pre-Columbian times; the easily accessible deposits were used up progressively. Page 298: He dates Lake Superior copper at from 4200 B.C. (based on C-14 dating, corrected) to 1200 A.D. The area probably yielded a ton of copper a year. Page 313: If there were any transoceanic contacts (by metal-using peoples), the technological information they might have possessed would likely have been fruitless given the differing problems associated with getting out ore in the two hemispheres. In South America, metallurgy developed from working gold for ornamentation, not for utilitarian purposes as was the case in southwestern Asia. Throughout America the use of all metals seems to have been chiefly ceremonial or decorative.

Pedersen, Asbjorn. "Aspectos de la metalurgia indígena americana prehispánica: la huayra y su empleo en el proceso de fundición." *Etnia* 14 (Jul./Dic., 1971): 5-10. [Buenos Aires]

A brief review of descriptions of metalworking in prehispanic America on the basis of the earliest Spanish accounts. (The *huayra* is a wind furnace.) Page 5: Now that we have C-14 dating, it is seen that American metallurgy is a continuation of the late metallurgy of the Asiatic continent. Page 9: Regarding the origin of the *huayra*, it could have come from Asia where a similar version dates to great antiquity (citation).

Pendergast, David M. "Metal artifacts in prehispanic Mesoamerica." *American Antiquity* 27 (1962): 520-44.

A comprehensive survey of published metal artifacts and museum specimens, most from western Mexico, assigning each one a probable date based on stylistics and provenance. His earliest date is around A.D. 900. [This chronology requires extremely rapid technological evolution in the tenth century.]

Pendergast, David M. "Tumbaga object from the Early Classic Period, found at Altun Ha, British Honduras (Belize)." *Science* 168 (3 Apr. 1970): 116-18.

Page 117: From a trench in a temple in the ceremonial precinct; comparative stratigraphy shows the first major reconstruction of the temple took place between 125 and 200 A.D., while the final addition was no later than 550. Shell from the associated tomb was C-14 dated, corrected for upwelling, at A.D. 260. He settles, conservatively, on a date for a metal bead found in this trench: "somewhat before A.D. 500 is perhaps most probable" [taken here as A.D. 400-500.] The bead represented an animal claw and was constructed from thin sheeting, probably hammered and annealed, although casting cannot be ruled out. [A jaguar claw was a "sign of lordship" among the Quiché. See M. S. Edmonson, *The Book of Counsel: The Popol Vuh* (Tulane

University Middle American Research Institute Publication 35, 1971), page 216.]
Page 118: Two artifacts identical to this are in a collection from Coclé, Panama, dating for which is between A.D. 500 and 1300. A recent geological survey showed small quantities of easily recoverable placer gold, both fine powder and very small nuggets, in streams of the upland zone of western Belize.

Pendergast, David M. "Ancient Maya mercury." *Science* 217 (1982): 533-35.

Mercury in an offering at Lamanai, Belize, ca. A.D. 900, joins with other mercury offerings from Copan and nearby, Quiriguá, Kaminaljuyu, and Lake Amatitlán, dating overall from about A.D. 500-950. Discussion of possible geological sources concludes that likely it was obtained via slow collection from natural deposits and the offerings were then of high value. [Compare Brown.]

Perez de Barradas, José. *Viejas y Nuevas Teorías sobre el Origen de la Orfebrería Prehispánica en Colombia*. Bogotá, Colombia: Banco de la República, 1956.

Reviews theories for the origin of Colombian goldworking. Favors Heine-Geldern's view of its arrival via migrations from across the Pacific, particularly because New World metallurgy fails to show early stages in its development.

Phillips, George B. "The composition of some ancient bronze in the dawn of the art of metallurgy." *American Anthropologist* 24 (1922): 129-43.

Pages 140-41: Reports a "small globular-shaped bell . . . found with a number of others in a jar with inscribed characters buried in a mound near the village of Humebchin, Yucatan." Analysis shows this is not true bronze: "Central America, in spite of the advanced civilization of the Maya race, does not seem to have reached the Bronze Age." Page 130: The specimens considered were all "collected by the writer in the various countries visited." [Bray 1977, page 74, lists this as Late Classic, presumably because of the "inscribed characters," but with a query.]

Pickersgill, Barbara, and Charles B. Heiser, Jr. "Origins and distribution of plants domesticated in the New World tropics." In *Origins of Agriculture*, edited by Charles A. Reed, 803-35. The Hague: Mouton, 1978.

Page 826: "It is surprising that contacts which may have spread new types of maize, peanuts, etc. (between Peru and Mesoamerica) about 1450 B.P. did not also spread metal artifacts as curiosities or trade pieces."

Piña Chan, Román. "Commerce in the Yucatan Peninsula: the Conquest and Colonial Period." In *Mesoamerican Communication Routes and Cultural Contacts*, edited by Thomas A. Lee, Jr., and Carlos Navarrete, 37-48. Brigham Young University New World Archaeological Foundation Papers, No. 40, 1978.

Page 42: Brass was taken from Tabasco to Yucatan. Landa mentions "they had a certain soft brass, some with a little gold mixed in it." [Tumbaga? Bronze?] In Tabasco they had "medallions, thin as gold paper."

Pires-Ferreira, Jane W. "Shell and iron-ore mirror exchange in Formative Middle America, with comments on other commodities." In *The Early Mesoamerican Village*, edited by Kent V. Flannery, 255-72. New York: Academic Press, 1976.

Maps 36 locations where hematite, magnetite and ilmenite ferrous minerals are found near or in the Valley of Oaxaca and discusses the value attached to these minerals even in Early Formative times as evidenced by widespread trade in them.

Priest, Josiah. *American Antiquities and Discoveries in the West*. Third edition revised. Albany: Hoffman and White, 1833.

Page 134. Brass rings and an ivory image perhaps of medieval Catholic origin came from a mound near Cincinnati. Pages 176-77: At Marietta, Ohio, a mound yielded remains of a copper helmet and "half a steel bow." On following pages he also reports an iron blade from Ohio, a copper cross, and brass weapons from several places east of the Mississippi.

Proskouriakoff, Tatiana. "Sculpture and major arts of the Maya lowlands." In *Handbook of Middle American Indians*, Vol. 2, *Archaeology of Southern Mesoamerica*, Part 1, edited by Gordon R. Willey, 469-97. Austin: University of Texas Press, 1965.

Page 473: Characteristic of stela art in the "second half of Cycle 8" (actually from about GMT-based A.D. 275-435), all examples being confined to the Petén, are human figures in which "a heavy chain usually suspends from the belt, a grotesque ornament that hangs behind the legs of the figure." [See notes to Thompson 1943 regarding chains.]

Putnam, F. W. "Iron from the Ohio mounds; a review of the statements and misconceptions of two writers of over sixty years ago." *Proceedings, American Antiquarian Society* (n.s.) 2 (1882-1883): 349-63.

Page 349: "It has been generally accepted as facts that an iron or steel sword was found by Dr. Hildreth in a mound at Marietta, and that an iron blade and a plate of cast iron were found by Mr. Atwater in a mound at Circleville." Actually, the evidence does not show that either steel or wrought or cast iron were found. After discussing several copper ornaments found, (page 359) he notes an object of hammered meteoric iron. Page 360-61: Hildreth found only pieces of copper tubing "filled with iron rust," the only trace of the supposed sword. Putnam finds no trace of iron oxide on it. [Thomas 1884 refers to this matter.]

Putnam, Read H. "Were the plates of Mormon of tumbaga?" *Improvement Era* 69 (Sept. 1966): 788-89, 828-31.

Considers the reported dimensions of the plates possessed by Joseph Smith and estimates that their weight would have been around 100 lbs if the material had been pure gold. However, if copper-gold alloy (tumbaga) was used, the weight would have been of the order of 53 lbs while still having "the appearance of gold." This is closer to witnesses' reports of "about 60" lbs.

Quimby, George I. "Japanese wrecks, iron tools, and prehistoric Indians of the Northwest Coast." *Arctic Anthropology* 22/2 (1985): 7-15.

These Indians possessed iron blades for adzes and chisels. He presents evidence that the metal reached there on Japanese drift boats, estimating that thousands of such vessels probably reached American shores during the first 17 centuries of the Christian era.

Rabin, Emily. "The Lambityeco friezes, notes on their content with an appendix on C14 dates." *Boletín de Estudios Oaxaqueños* 33 (Abr. 1970): 11-15.

[In reference to Caso 1965, Saville, and Blanton and Kowalewski] C-14 dates are given for Lambityeco material, which is equivalent to Monte Alban IV. For eight samples, the range is A.D. 620-755. [With MASCA corrections, the range is 670-820; the period is reasonably put at 650-850.]

Rainey, Froelich. "The Ipiutak culture: excavations at Point Hope, Alaska." Addison-Wesley Module in Anthropology 8. In *Current Topics in Anthropology. Theory, Methods, and Content*, vol. 2. Reading, Mass., 1971.

Pages 24-27: These hunters of extremely valuable walrus who lived at Pt. Hope on the Bering Strait around the time of Christ had at least one wrought iron engraving tool. Their many ivory carvings, ivory chain links, and ivory swivels showed stylistically that they had been in touch with metal-working people. He speculates on the basis of a strong stylistic link that the connection was with distant northwest Siberia, by way of the (summer) Arctic coast, and that they probably traded their uniquely-prized walrus-skin cords for iron over that route covering thousands of miles.

Rebetez, René. *Objetos Prehispánicos de Hierro y Piedra*. México: Librería Anticuaria, n. d.

Pages 6-8. He illustrates prehispanic artifacts (mirrors, a necklace, and a pendant) found in tombs in the Tarascan area, on the boundary between Guerrero and Michoacán. They consist of iron adhering to slate stone, (page 14) the artificial bonding having been done with a procedure not understood. Page 15: Some 19 other artifacts of similar nature are in private collections.

Rivard, Jean-Jacques. "Cascabeles y ojos del diós Maya de la muerte, Ah Puch." *Estudios de Cultura Maya* 5 (1965): 75-92.

Notes the presence of metal bells from the Southwest to Chile. Metal and baked clay bells have been found at various places in the U. S. Southeast in mounds. Page 76: The oldest in South America are from the Gallinazo Period in Peru, painted on a vase scene. Page 86: Borhegyi reports two clay cascabels were found at the Las Charcas site near Guatemala City (shown, Fig. 23), but he considered them either utensils or phallic symbols. But identical ones are shown in the Dresden Codex on God A where they are clearly bells. [Compare Borhegyi 1970.]

Rondón Salas, Jorge. "Morfología de la cerámica en relación a las normas prestadas del metal." *Revista del Museo Nacional (de Historia)*, 1965-1966: 82-84. [Lima]

Illustrates that Lambayeque style, spouted-pottery vessels are imitations of metal prototypes, with copper evidently preceding silver and gold. This is shown by details which are structurally absurd in ceramic but obvious in metal. [Cf. Longyear 1944 and Ibarra Grasso.]

Root, W. C. "Report on metal objects from Mayapan." In *Mayapan, Yucatan, Mexico*, edited by H. E. D. Pollock, et al, 391-99. Carnegie Institution of Washington Publication 619. 1962.

Page 399: [Presumably] as a result of looting, Mayapan proved so poor in objects of metal that "it is difficult to say that the few that remain really give an adequate picture of what was once to be found there."

Rubín de la Borbolla, Daniel F. "Orfebrería tarasca." *Cuadernos Americanos* 3/15 (Mayo-Jun. 1944): 127-38.

Page 127: While the early Spanish documents talk of how much gold and silver the Tarascans had, the museum in Michoacán has only copper objects. Page 129: No doubt in large part the lack of existing gold artifacts is owed to Spanish looting. [Unmentioned is the possibility of modern "looting" by leakage from the museum inventory.] Page 133: But he observes that many copper objects were just gilded or surface-treated with silver or gold, which fooled the Spaniards. Page 134: Most of the chronicles show no understanding of gilding. The conquistadors did get gold and silver of great value, representing in many cases treasures accumulated from generation to generation. [See also Kelly 1949.]

[Sahagun, Bernardino de]. *The War of Conquest: How It Was Waged here in Mexico. The Aztecs' Own Story as Given to Fr. Bernardino de Sahagun, Rendered into Modern English by Arthur J. O. Anderson and Charles E. Dibble*. Salt Lake City: University of Utah Press, 1978.

Page 17: The Aztecs saw little distinction between copper and iron. Iron was sometimes called "black copper."

Sanchez, Jesús. "El Congreso Internacional de Americanistas en Europa y el cobre entre los Aztecas." *Museo Nacional de México Anales*, época 1, vol. 1 (1877): 387-95.

Page 388: Raw copper occurs in chunks in Chihuahua. Page 392: Bronze artifacts have been found at Teotihuacan.

Santley, Robert S., Ponciano Ortiz Ceballos, Thomas W. Killion, Philip J. Arnold, and Janet M. Kerley. *Final Field Report of the Matcapan Archaeological Project: The 1982 Season*. University of New Mexico Latin American Institute, Research Paper Series No. 15, 1984.

Pages 16-19: The site was occupied almost entirely in Early, Middle, and Late Classic. Pages 29-30: Operation I-C in Mound 22, an area not tested by Valenzuela, found a burial which bore six copper rings on the right hand. Lack of grave goods makes period assignment difficult. The copper rings imply a Postclassic date; however, the style of dental mutilation is distinctly Classic. Other features revealed in this pit lead them to conclude "the burial probably dates to the Middle Classic." [Compare Valenzuela.]

Saville, Marshall H. *The goldsmith's art in ancient Mexico*. Museum of the American Indian, Heye Foundation, Indian Notes and Monographs No. 7. New York, 1920.

Pages 147-49: In 1875 at the village of San Sebastian near the town of Tehuantepec house repairs uncovered a tomb which contained "gold jewels to the value of two thousand pesos, plus copper objects, stone beads, etc. All the gold objects except four

pieces were sold and melted down. Saville illustrates and discusses the four. "There can be no doubt that these jewels . . . belong to the Zapotecan culture." [Caso 1965 agreed and assigned them to Monte Alban IV. Currently that dates to 650-850; see Rabin.] Pages 149-50: Another gold ornament is shown and described. While Batres stated that this was of Toltec origin, Saville believes "from its general style it would seem to be of Zapotecan derivation." Another piece of similar form is next presented, and while Saville does not clearly state that it is Zapotec he implies so, referring to it as "the last piece of this class" that he would discuss. It came from a tomb in the valley of Oaxaca. Page 144-47: Two gold finger rings were found in 1831 near Huajuapán in northwestern Oaxaca in a tomb along with gold beads. The author considers them also Zapotecan in style. Still another ring known from the literature is described and illustrated; he considers it "distinctly Zapotecan in character."

Schoenberg, Paul Schmidt, and Jaime Litvak King. "Problemas y perspectivas de la arqueología en Guerrero." In *Primer Coloquio de Arqueología y Etnohistoria del Estado de Guerrero*. Instituto Nacional de Antropología e Historia y Gobierno del Estado de Guerrero: México, 1986. Pages 38-51.

Page 42: For Guerrero, reports, some of them old so that dating cannot be sure, suggest that metals were present. But the metal reported from El Infiernillo (citing Lorenzo 1964, in this bibliography as Aguirre et al.) and from Xochipala, in Epiclassic [700-900] period sites, suggests that this line of investigation is promising.

Shook, Edwin M. "Archaeological survey of the Pacific coast of Guatemala." *Handbook of Middle American Indians*, vol. 2, edited by Gordon R. Willey, 180-94. Austin: University of Texas Press, 1965.

Page 193: A recent find of gold discs, purportedly with San Juan Plumbate pottery, was made at Santa Clara below Ayutla. It represents the only occurrence on the south coast of metal in the Late Classic. [Bray 1977 accepts this as Late Classic on the basis of this article plus a personal communication from Shook. These discs seem distinct from the five known to Coe and Flannery when they published in 1967.]

Shook, Edwin M., and Alfred V. Kidder. *Mound E-III-3, Kaminaljuyu, Guatemala*. Carnegie Institution of Washington Publication 596, Contributions XI, No. 53, 1952.

Page 33: From a tomb of Miraflores age [ca. 100-200 B.C.], they report three lumps of iron oxide, "moulded to conical form." Page 118: A companion tomb in the same structure contained two or three other "cones" of the same. [The idea of molding iron oxide to a particular form rather than, say, scattering it over the tomb's contents is very unlikely; the lumps were probably oxidized iron objects.]

Smith, A. L., and Alfred V. Kidder. *Explorations in the Motagua Valley, Guatemala*. Carnegie Institution of Washington Publication 546, Contribution 8, pages 103-82. Washington, 1943.

Pages 170, 173: At Guaytan (San Agustín Acasaguastlán) they found a "small ragged bit of sheet metal," flat-hammered copper, in Tomb III, Structure 24. There was no possibility that it was intrusive. It contains 87% copper, a trace of silver and 13% gold. "It may well be a trade piece from the south." A single sherd of "non-effigy plumbate" pottery was with it. Page 173: On the grounds of other ceramic pieces in the tombs which appear contemporary with Tepeu phase, they would so date this feature "were it not for the fact that in Tomb III . . . there was found plumbate pottery, and . . . a bit of copper." [The discussion of chronology suffered from lack of

comparative material on “plumbate” in those days; here they date it to the very end of the Classic. Subsequently it became apparent that this was non-effigy, i.e., San Juan, plumbate; they note on page 174 that comparable simple plumbate is known from Amate phase at Kaminaljuyu and Tiquisate at El Baul. San Juan Plumbate is today dated A.D. 600-900.]

Smith, Robert E. “Archaeological specimens from Guatemala.” *Carnegie Institution of Washington, Notes on Middle American Archaeology and Ethnology*, 2/37 (1944).

He examined a group of privately-owned, amateur-dug artifacts from a single mound in San Miguel Ixtahuacan, Depto. de San Marcos, Guatemala. Included was a piece of sheet copper, reported to have been found inside one of the vessels. The eleven pots he sees dating to the Proto-Classic. He concludes, “In view of the above [the definite Proto-Classic features in the ceramics] and of the absence of any piece of known late type, I am inclined to doubt that the scrap of copper was found in association with these vessels. If such was actually the case, they would have to be assigned to a relatively recent period.”

Smith, Robert E. “A correction on ‘Preclassic metal?’” *American Antiquity* 20 (1955):379-80.

Since Smith 1944 was published he has learned that the pottery most probably did not come from where he was told it had. As the place was misrepresented to him, he thinks his informant “may also have been in error as to copper being found” in one of the Pre-Classic vessels. [Compare Sorenson 1954a.]

Smith, Robert F. “*Sawi-Zaa word comparisons.” Ms., Sept. 1977 (copy in possession of J. L. Sorenson).

*Zapotec. *bichi-chi gache*, “gold,” “money/yellow”; *guibaxñaa*, “copper.” Proto-Central Otomí. **bes-na*, “metal.” Proto-Mije-Zoque. **pusan*, “metal.” Cf. Hebrew. *paz*, “gold.”

Sorenson, John L. “Preclassic metal?” *American Antiquity* 20 (1954a): 64.

Notes artifacts from Cuicuilco and Guatemala (see R. E. Smith 1944, 1955) which appear to date from before the Classic but have been ignored in discussions of Mesoamerican metallurgy.

Sorenson, John L. “Indications of early metal in Mesoamerica.” (*Brigham Young University Archaeological Society Bulletin* 5 (1954b): 1-15. [Provo, Utah])

Surveys the evidence “that metal-working was known in Mesoamerica before the accepted 900 A.D. date.” A score or more objects had been published that support this position, possibly dating as early as the first century B.C.

Sorenson, John L. “A reconsideration of early metal in Mesoamerica.” *Katunob* 9/1 (March 1976): 1-8.

An update of Sorenson 1954b giving additional evidence and expanded argument.

Spear, Nathaniel, Jr. *A Treasury of Archaeological Bells*. New York: Hastings House, 1978.

Page 252: Illustrates a spherical, burnished ceramic bell (no indication is given whether this was a solid, soundless model or actually made a noise): "Mexico. Pre-Classic Period, circa 2000 B.C.-Christian Era." Page 205: Illustrates a nearly identical black ceramic bell said to have been "unearthed at Wickliffe, Kentucky, by Colonel and Mrs. King." "It may be dated about 900 A.D." "In a letter written in 1947, referring to clay bells, Colonel King said, 'We find them about the legs and above the feet, also often around the neck.'" Pages 219, 224-25: Concerning page 37 of Codex Vindobonensis Mexicanus I (Vienna Codex) from Mexico, the author comments that the largest figures, standing on either side of the tree, are black-painted minor gods who wear "spherical bells attached to bands above their wrists and just below their knees."

Stirling, Matthew W. Letter report to Arq. Ignacio Marquina, Director de Monumentos Prehispánicos, dated April 13, 1944, written at Paraíso, Tabasco. [Copy in possession of J. L. Sorenson.]

Of the remote mountain site of Pueblo Viejo, near the border of Chiapas and Veracruz: "One foot below the surface we found a large square hand-wrought iron spike. Since in this remote spot, it seems highly improbable that it could have been intrusive," he concludes that the site must have a post-Conquest date. [A later visit, reported in Drucker and Contreras 1953, found the constructions there similar to other, clearly pre-Columbian, sites in Tabasco and Chiapas which may date to the first millennium A.D.]

Stone, Doris. "The archaeology of central and southern Honduras." *Harvard University Peabody Museum of Archaeology and Ethnology, Papers* 49/3 (1957).

Pages 63-64: At the site of Los Naranjos on Lake Yojoa a number of copper fishhooks were found (by Strong, Kidder, and Paul); Fig. 64c illustrates four of them. Barbless gold fishhooks with similar eyes are found in Costa Rica and eastern central America. [R. Joyce, personal communication, May 1992, on the basis of her reanalysis of the Strong, Kidder, and Paul collection "suggest(s) the burial with the copper fish hook belongs to the late Terminal Classic or Early Postclassic." See her "Terminal Classic interaction on the southeastern Maya periphery," *American Antiquity* 51 (1986): 325. The Stone source is abstracted here for information, however the specimens are not listed in the table following because their date is beyond the limits of concern of this paper.]

Stone, Doris. "Introducción: El problema y las bases históricas y arqueológicas." *Actas y Memorias del XXXVII Congreso Internacional de Americanistas, Argentina, 196*, vol. 4, pages 3-17. Buenos Aires, 1968.

Page 11: In northern Central America, closely related with jade and metal artifacts are marble or alabaster vessels produced on the Sula plain in Honduras. Examples are cited from (Classic phase) Uaxactun and San Jose. These are cylinders with annular base and three low feet. Thirty of these appear in the Sula plain area, as well as copies in clay. Generally similar ones are found on the Isla de Sacrificios, Veracruz; inside some of them copper bells were found. This was also true of one from Los Tuxtlas found by Valenzuela. Axes and copper bells have also been found with clay prototypes on the Bay Islands. She has published two exemplars of marble vases from a burial at Finca Santana, east of Naco on the Sula plain. The first of these contained the only gold figurine that we know in Honduras, other than the fragment from Copan. The style is Quimbayan. It was found together with a piece of carved green jade, and the

figurine bears what could represent a bracelet of jade. Two other marble vases from the Sula area were with jades in Classic Maya style plus Uluá Polychrome ceramics of Mayoid type. At Finca Santana a tumbaga figurine in Costa Rican style was found in a grave together with two Uluá Marble vases. [Bray 1977 adds "pers. comm." from Stone as documentation of this final find. However, R. Joyce, personal communication, May 1992, documents that Uluá marble vessels, including those used by Stone to date the Finca Santana burial, are Terminal Classic, ca. A.D. 800-1000, so that date is assigned here to the gold.]

Stone, Doris. *Pre-Columbian Man Finds Central America. The Archaeological Bridge*. Cambridge: Peabody Museum Press, 1972.

Page 142: Uluá Polychrome Ware reflected the style of Tepeu ceramics and the ware is found in the Nahuatized Late Classic era in parts of western Honduras and El Salvador as well as Guatemala. Page 150-51: San Juan Plumbate is diagnostic of the period A.D. 650-925 (in Honduras). The earliest-dated ornaments of gold or gold alloy which we have from Upper Central America are approximately A.D. 751, according to radiocarbon tests made in connection with three figures from Tazumal (see Boggs). Their composition suggests Costa Rica as their place of origin. Gold and copper pieces were generally scarce during the Late Classic Period in Upper Central America. [R. Joyce, personal communication, May 1992, reports that current work establishes that "the Uluá Polychrome tradition and the parallel and distinct Bold Geometric polychrome tradition (including 'Bay Islands Polychrome II') develop between ca. 400 and 1000 AD." Thus a post-900 date is possible for the materials Stone is discussing.]

Stone, Doris, and Carlos Balser. *Aboriginal Metalwork in Lower Central America*. San José, Costa Rica: The authors (?), 1967.

Page 6: Goldworking reached Panama (Venado Beach, the Canal Zone) around A.D. 250. Root has proposed that it did not reach Costa Rica until A.D. 700. Boggs excavated from Tazumal, El Salvador, tumbaga objects consisting of a flying bird and a bell with a bird face, "dating approximately from 751 A.D." (citing Boggs, and Longyear [1952], p. 8). Root's analysis of the Salvadorean figures suggest Costa Rica as the point of origin. Page 35: A list of 35 types of utilitarian and ornamental gold artifacts (including helmets, chisels and bottles for Panama). Pages 43-44: Nine features connected with the art of casting are listed, all of which appeared in Asia much earlier than in America. They also list ten "decorative elements and artifacts (types) of metal which are found in both Asia and America" (citing Heine-Geldern 1954). Taken together and "associated as they are with the complex of metalwork, the likelihood of their being historically related is greatly increased. They appear late, and if they do indicate connections, a long continuance of transpacific contacts would be implied."

Stresser-Pean, Guy. "Ancient sources on the Huasteca." *Handbook of Middle American Indians*, Volume 11, 582-602. Austin: University of Texas Press, 1971.

Page 590: Archaeological sites in the Huasteca have revealed a good number of "bronze axes, adzes, and small bells." Gold was rare and silver not mentioned in the sources.

Stromsvik, Gustav. *Substela caches and stela foundations at Copan and Quirigua*. Carnegie Institution of Washington, Contributions to American Anthropology and History No. 37. 1941. Pages 67-96.

Abstract, page 71: Stela H. Contents of chamber: Upper part of fill contained bits of plaster of Paris from Maudslay's casting operations, which had worked down through

cracks. Also a bit of brass wire and a flake of copper, probably part of a bullet jacket. Plus two gold figurine legs, both broken, similar to specimens from Coclé, Panama (confirmed by metal analysis by Dr. Root). But “the legs seem too large to have entered through cracks in the chamber roof” (as he supposes the plaster, brass wire, and copper flake did), hence “they seem to have been part of the original substela deposit.” Sacrificial destruction of the figurines is the most likely explanation of their condition. [Cf. Morley.]

Strong, William Duncan. *Archaeological investigations in the Bay Islands, Spanish Honduras*. Smithsonian Institution Miscellaneous Collections, 92/14 (1935).

Abstract, pages 52-53, 60: At the Dixon site on Roatán Island, he found a considerable number of copper artifacts, most found inside a polychrome vase (“central votive offering”). In it were 30 copper bells, two copper rings or ear spools, and a hammered disk of copper. Also “about half a dozen” small copper bells were found in the soil nearby. Page 61: Two use the pseudo-wire decorative technique. Seven have animal faces in relief. The original source is unknown but they “closely resemble certain of the copper bells found in a large cave deposit on the Uloa River” described by Blackiston. Plate 6, 2 shows the “Polychrome I” offertory vase in which the metal was found (along with other objects to a total of 487 items).

Pages 86-87: At Indian Hill Site 1 on Barburata Island vessels of Polychrome I type, green stone carvings, and a simplified version of (Gordon’s) Uloa marble vases. Pages 106-107: Here a very thick piece of hammered-out copper was found, probably a pendant. Pages 116-17: The Mitchell-Hedges collection in the Museum of the American Indian came from this island and, he argues here, quite surely from Site 1. The material includes two copper bells. Pages 136, 139: The same collection has from Bonacca Island two small copper celts. The site is uncertain but logically it could be of Polychrome I date. [R. Joyce, personal communication, May 1992, explains that current ceramic chronology establishes the probable date for these materials as Terminal Classic, A.D. 800-1000, which is the date used here.]

Strong, William Duncan, A. V. Kidder II, and A. J. D. Paul, Jr. *Preliminary report on the Smithsonian Institution-Harvard University archaeological expedition to northwestern Honduras*. Smithsonian Institution Miscellaneous Collections 97/1 (1938). [Washington]

Page 41: At the site of Las Flores Bolsa, on the east bank of the Ulua (where it is nearest the Chamelecon River) they excavated thirteen skeletons. Grave goods included one copper fish hook, (page 121) the only metal object found. Types and sequence of the potsherds were to be discussed in the final report (never published). Page 120: However, both Mayoid and Bold Geometric styles of Polychrome were found at Las Flores, “both of the upper and later or conventionalized type” (Late Classic). [Compare the information from R. Joyce appended to the annotation on Stone 1968 above. Her reanalysis of this material establishes an Early Postclassic date as most probable.]

Thomas, Cyrus. “Iron from North Carolina mounds.” *Science* 3 (1884): 308-10.

Responds to a piece by F. Putnam (1883) which reviewed statements of old writers respecting metal found in U.S. mounds. Putnam concluded that “Mr. Atwater’s iron-bladed sword or steel-bladed dagger” was a figment of his imagination. But, says Thomas, a discovery made in North Carolina by an assistant of his in the Bureau of Ethnology during the past season in fact confirms Atwater and makes his artifact “at

least probable." The large triangular burial pit excavated, which contained 15 skeletons, also contained implements of iron. Under one's head was a large seashell with "hieroglyphics," and pieces of copper were at each ear and a piece of copper under his breast. Bracelets on each wrist mixed copper and shell beads. "At his right hand were found the implements of iron." Under his left hand was a(nother) sea-shell with hieroglyphics inscribed on the concave surface. Under the heads of two adjoining skeletons were also inscribed shells. Scattered among the ten or more accompanying skeletons were copper arrow-points, mica, black lead, etc. There were four iron specimens (now in the National Museum), much corroded, two flat, another "without doubt, part of the blade of a long, slender, cutting or thrusting weapon of some kind." The other is part of an awl-shaped implement fixed in a bone handle. The Bureau also possesses another "rudely hammered, small iron chisel or celt, found under somewhat similar conditions in a mound in the same section." These could not have been intrusive. The shell engravings are of "the mystic serpent, so strongly reminding us of Central-American figures." [Etowan? Compare McCulloch.]

Thompson, J. Eric S. *Excavations at San Jose, British Honduras*. Carnegie Institution of Washington Publication 506. 1939.

Page 176: Two small pebbles of lead ore were in Cache C1. Page 178: At the Mountain Cow site, iron pyrite mirrors date to Holmul III equivalent [=Early Classic]. Deposits are not far away. Oxidized copper remains in Cache C1 at San Jose suggested by their shapes copper bells or perhaps a knife, and date either to period V or the close of IV [=Late or Middle Tepeu]. Page 188: The same cache included remains of two copper bells and iron pyrite mirror fragments. "So far as the writer knows, this is the only discovery under archaeological conditions of copper in a supposedly Old Empire site." The cache is probably of the same date as the structure (C5), which was almost certainly built at the beginning of San Jose V.

Thompson, J. Eric S. "Some sculptures from South-Eastern Quetzaltenango, Guatemala." Carnegie Institution of Washington, *Notes on Middle American Archaeology and Ethnology* 1/17 (1943): 100-12. (Reprinted 1969 by AMS Press, New York.)

Regarding sculptures on adjacent fincas of Santa Margarita and San Isidro Piedra Parada. Pages 103-04: Stelas 1 and 2 each show a chain hanging diagonally to the rear from the belt of the human figure. This feature is also on the Leyden Plate and on Maya sculptures dating from the middle of Cycle 9. [Could a chain be made of anything but metal, or in imitation of metal? This seems so unlikely that the possibility vanishes that "chains" in art do not connote knowledge of metal.] Page 104: The style on the stelas is definitely "in the Izapa tradition." About a km. from the main group is a large boulder on which a human figure is shown grasping in his left hand what appears to be a curved blade. Similar curved blades occur on Stela 1 at Comitán (date: 10.2.5.0.0, GMT=874 A.D.), on a fresco showing a human sacrifice from the Temple of Warriors at Chichén Itza, and in slightly modified form at Izapa. [The curved blade might be obsidian, but if the chain is of metal, the blade could be too.]

Thompson, J. Eric S. *An archaeological reconnaissance in the Cotzumalhuapa region, Escuintla, Guatemala*. Carnegie Institution of Washington, Publication 574, Contributions to American Anthropology and History 9/44, pages 1-56. Washington, 1948.

Page 41: "No metal was encountered, but the elements which compose the necklace worn by the god on Monument 3, Santa Lucia, and the anklet of the principal personage on Monument 19, Santa Lucia, might be reproductions of copper bells. This

is not very probable, since the latest date of Cotzumalhuapan art falls at the very start of the copper horizon." [By 1967, however, Thompson, with others, was assigning an A.D. 600 date to Mon. 3.] [He here illustrates Monument 19, where the bells are obvious, but Monument 3 is not shown. He did not notice, but examination of figures on Monuments 5, 2, 4, 6 and 8 show them obviously to have a single bell on the right knee, while Monuments 18 and 21 show multiple bell sets on a total of four figures. The bells shown are of several forms, examples of which are inventoried in Bray 1977. Actual chains have been excavated in Jalisco by Mountjoy and Torres.]

Thompson, J. Eric S., ed. *Thomas Gage's Travels in the New World*. Norman: University of Oklahoma Press, 1958.

Pages 196-97: Gage: Among the mountains between Acasaguastlan (Motagua Valley) and Guatemala City, the Spaniards "discovered some mines of metal [meaning they were pre-hispanic?], which (they) have begun to dig," including copper and iron. Gold was taken from rivers by the Indians.

Thompson, J. Eric S. "A copper ornament and a stone mask from Middle America." *American Antiquity* 30/3 (Jan. 1965): 343-45.

Page 343: "A small mask (lost-wax) cast in copper with the features of a Maya merchant god supplies the first incontrovertible evidence that the Maya cast copper." This is from a collection once bought from Brasseur de Bourbourg. Page 345: Stylistics ("unquestionably Maya in style") makes it virtually certain that the piece was cast in the lowlands or perhaps Alta Verapaz. [He never states, but implies, that it would be of Classic date, as Pendergast infers, citing this source.]

[Times]. "New Finds in Sacred Well." *The Times of the Americas*, June 5, 1968.

A dispatch from Mexico City cites Román Piña Chan regarding excavations conducted since September 1967 in the bottom of the cenote of Chichén Itzá: "He said that in addition to gold and jade jewelry dating from the year 100 B.C., his group recovered some 200 skulls." [The published archaeological report on the work says nothing about metal at such a date.]

Tozzer, Alfred M. "Maya research." *Maya Research* 1/1 (1937): 3-19.

Page 12: "Early and vague reports tell of a gold bell found at Palenque and another at Tikal."

Urban, Sharon. "A copper wand from Cuicuilco." *Archaeological Survey Association of Southern California Newsletter* 16 (Summer/Fall 1969): 1-10.

Discussion of the thin copper plate attached with copper nails to a wooden core which B. Cummings found in 1924-25. Recaps at length what Cummings reported. A metallographic analysis now shows only that the object is 92% copper, but function cannot be guessed. At first she reads Cummings (as Sorenson 1954 did) to indicate that the object must belong to the construction phase of the site, i.e., not later than A.D. 300. But then she introduces Haury's caveat that the altar may have been used by the Aztec. She goes along on the basis of his authority.

Vaillant, George C. *The Aztecs of Mexico*. Harmondsworth: Penguin, 1950.

Page 149: "Some hollow clay bells from the late Toltec [i.e., Teotihuacan IV] occupation of Azcapotzalco tantalizingly suggest metal prototypes."

Vaillant, Susannah B., and George C. Vaillant. *Excavations at Gualupita*. American Museum of Natural History Anthropological Papers, vol. 35, part 1. New York, 1935.

Pages 22-23 and Fig. 29: Show and discuss a clay pendant described as carefully grooved and perforated at the neck "in the manner of a metal bell." The assigned date is Gualupita II [nowadays ca. 400-100 B.C.; see Hawley, personal communication, and García Payón 1971].

Valentini, Philipp J. J. *Mexican Copper Tools: The Use of Copper by the Mexicans before the Conquest*. Worcester, Mass.: Charles Hamilton, 1880.

Pages 8-10: Cortez and Bernal Diaz reported bronze although no such objects have been found. Still, as they were eyewitnesses, he respects them as the "highest authority" and allows that objects may yet be found to confirm their statements [they have been]. Cortez's second letter to the king is quoted: the marketplace in Tenochtitlan sold jewels of gold, silver, lead, brass, copper, tin, and stone and bone. Bernal says he saw axes of copper, bronze, and tin. When Cortez wanted to arm his people, he ordered the goldsmiths of Tezcuco to cast 8000 arrow-heads of copper, and these weapons were delivered within a week. Page 15: Quotes Antonio de Herrera (*Historia General de los Hechos de los Castellanos*, 1729) in his introductory "Descripción de las Indias" to the effect that in Zacatula and Colima copper mines were worked by indigenous people. The Indians make marvelous vessels (*vasos*) of this copper, besides having another kind of copper [bronze?], very hard, to make tilling tools. But Valentini considers this an anachronism. Page 16: Lead was called *temeztli* (=moon stone). Tin was used as money not only at Taxco, where Cortez discovered it in use, but in other provinces as well. Page 22: Metalworkers formed guilds into which apprentices were sworn to secrecy about their methods or they would suffer death. (These artisans quickly learned to counterfeit Spanish coins perfectly.) Page 30: A cacique who came to see Cortez on his march was "covered with gold plates" (armor). Some axes were apparently an alloy of gold. Page 31-32: Sahagun: Aztec workers made serving plates of silver and gold. Torquemada says they used gold nails to repair an idol. Page 39: Torquemada's language is interesting: "They also used certain copper coins, almost in the shape of a Greek Tau, T." Clavigero: "Their fourth species of money, which most resembled coined money, was made of pieces of copper, in the form of a T, and was employed in purchases of little value."

Valenzuela, Juan. "Las exploraciones efectuadas en Los Tuxtlas, Veracruz." *Anales, Museo Nacional de México*, época V, vol. 3, 1943. Pages 83-107.

The ruins at Matacapan are decisively like Teotihuacan, with specific architecture, figurines, ceramics and candeleros establishing the link between the two sites. [Compare the Early, Middle, and Late Classic dating for the site established by R. S. Santley et al. 1984.] Page 99: Beneath a stucco floor in Mound 4 they found a marble jar containing jade and red shell beads and a copper bell. As these were found with ashes and charcoal, it appears that this mound was used for religious ceremonies and these were offerings.

Page 102: In the Laguna de Catemaco small islands contain cultural remains. Tiny Agaltepec isle is almost completely built over with mounds surrounding a sunken patio. Page 103: In an excavation in the principal mound surrounding the plaza, he found a hollow copper lip plug (*bezote*) (see fig. 30), the only copper one found so far from the ancient cultures of Mexico. Pages 104, 107: The ceramics (see fig. 62) are earlier than those of Teotihuacan age at Maticapan. [A basal-flanged bowl and unbridged spouted vessel are shown, probably of Protoclassic to Early Classic age. In the general area artifacts of Monte Alban II age were found—see page 91. An Early Classic date is assumed here based on Santley et al.]

Verrill, A. Hyatt. "The Pompeii of ancient America. A vast settlement destroyed centuries before Christ." *The World's Work* 53/3 (Jan. 1927): 279-88.

Page 286-87: His excavation at Coclé, Panama, "in the interests of the Museum of the American Indian, Heye Foundation," revealed "at a depth of five and one-half feet below the surface at the temple site, among broken pottery and imbedded in charcoal, I found a steel or hardened iron implement. The greater portion is almost completely destroyed by corrosion, but the chisel-shaped end is in good condition. It is so hard that it is scarcely touched by a file and will scratch glass." "No doubt many will discredit this, or will claim that the implement is modern and found its way beneath the surface via some hole or crevice. But how can they explain the evidence of tool marks on much of the stone work? Not the irregular indentations which might, and very likely were, made by pecking with a stone hammer, but clearly cut delicate lines and chisel marks."

Weigand, Phil C. "The mines and mining techniques of the Chalchihuites culture." *American Antiquity* 33 (1968): 45-61.

Page 45: About A.D. 350 Teotihuacan influence (p. 54: probably Tlamimilolpa phase, and extending through Early Xolalpan) moved into Zacatecas where the large center of Alta Vista was constructed and mines were opened or radically expanded in the area. Page 54: By about 850 the area was abandoned. Page 49: Four minerals were exploited for sure: hematite, flint, weathered chert/flint, and rhyolite. Turquoise and jadeite may have been the real aims. [Compare Langenscheidt and Franco.]

Wilkerson, S. Jeffrey K. "Un yugo 'in situ' de la región del Tajín." *Boletín INAH* 41 (Sept. 1970): 41-45. [México]

Page 41: The site, Santa Luisa, lies 30 kms. from Tajín. Page 42: Among the offerings in a burial were a stone yugo and a copper tube. Page 44: Stylistically the building under which the burial was placed was erected during the last phase of construction but not at the end of the occupation. Most of this phase can be dated to the Late Classic. Basing only on dates from Pendergast 1962, he uses the presence of the copper tube to date the burial between 950 and 1450. He argues from this that the Tajín Late Classic may overlap into the Early Postclassic. [García Payón in *Handbook of Middle American Indians*, 11:527, is confident that the Classic at El Tajín ends no later than A.D. 800, which calls into question the late date for the metal.]

Williams, J. J. *The Isthmus of Tehuantepec, Being the Results of a Survey for a Railroad to Connect the Atlantic and Pacific Oceans*. New York, 1852.

Page 242: Rich iron ore veins are in the immediate vicinity of San Juan Guichicovi in the isthmus. Tin occurs in the Cerro de los Mijes (west portion of the isthmus).

Williams, Samuel Cole. *Adair's History of the American Indians*. Johnson City, Tennessee: Watauga Press, 1930.

Pages 187-88: A long footnote (written by the editor, Williams) on both these pages reports that, according to one Will. Bolsover in an account from 27 July 1759, at "Tuccabatchey-square," "on the Tallapoose river, thirty miles above the Alabamah garrison," Indians possessed five copper plates and two brass ones. These were carefully sequestered, only to be shown during an annual ceremony. As described by one Indian informant one of the five copper plates was a foot and a half long and seven inches wide while the other four were shorter and narrower. A sketch shows them in a long T-shape with a flared "blade" form at one end. The two brass plates were "stamped" with an off-center character shown as a combined A and E with a pair of dots or holes like eyes symmetrically in the upper portion. These were said to have been given "by the man we call God." There had been other shapes of plates, some "as long as he could stretch with both his arms, and some had writing upon them which were buried with particular men." No such plates were had by any but this town's people ("they were a different people from the Creeks"). [Cf. Hodge, and King.]

Zevallos Menéndez, Carlos. "Estudio regional de la orfebrería precolombina de Ecuador y su posible relación con las áreas vecinas." *Revista del Museo Nacional del Historia* 34 (1965-1966): 68-81. [Lima]

Page 69: He found in Guayas province, Ecuador, a piece of sheet copper in a Chorrera period burial (C-14, 860 B.C.). Also he found a copper mask in the Bahía phase (400 B.C.) together with ceramic ear ornaments of a form known only here and in Japan (see Fig. 12). Page 70: The metal is from Peru, so specimens even older may be expected closer to the ore sources. Page 78: He doubts that there was any "original center" of metalworking in America. It is even possible that many of the fundamental techniques came from Asia by transpacific contacts. In this view he concurs with Heine-Geldern and Ekholm, Pérez de Barradas, and Stone and Balser. Points out characteristics of Bahía figurines which point to a Japanese source, as Estrada concludes.

Part 3

Index to Parts 1 and 2

- Absence of metal where expected in archaeological record:** Acosta, 158; Alcina F., 317; *Balmuth; Rubín de la Borbolla; Bray 1978, 142; Caley and Easby, 507, 515; Diehl; Easby 1969; *Heskel; Ibarra Grasso 1969; Kelly and Palerm; Lechtman 1980, 276; *Moorey, 14; *Muhly and Wertime; Root; Valentini, 8-10; *van der Merwe and Avery.
- Alloys, unusual sorts:** *Alieva and Gasanova; Caley and Easby, 514-515; Caso 1976; Caso and Rubín de la Borbolla.
- Alloys varied by natural ore composition:** Bray 1978, 137.
- Amalgam,** see Metallurgical processes.
- Annealing,** see Metallurgical processes.
- Armor, metal:** Bancroft; Valentini, 30.
- Art representations of metal artifacts:** Boos; Coggins and Shane; Diehl; Furst; Metropolitan Museum; Thompson 1943, 1948.
- Bells, ceramic, imitating metal:** Borhegyi 1957, 1970; García Payón; Hawley; Longyear 1944; Rivard; Spear; Thompson and Shook; Vaillant; Vaillant and Vaillant.
- Bells as money:** Bastow, 54.
- Bells, earliest:** Hosler; Longacre and Millon; Rivard.
- Bells, sacredness:** Hosler.
- Book of Mormon "gold" plates:** R. Putnam.
- Brass:** Bray 1972, 39; *Caley; *Craddock; McCulloch; Piña Chán; Priest; Valentini, 8-10.
- Brazing,** see Metallurgical processes.
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- Bronze, intentional:** Brush; Meighan 1969.
- Casting, lost-wax:** Bray 1978, 139; *Crawford; Heine-Geldern 1972; Hosler; Thompson 1965.
- Central America:** Balser 1966; Linares; Stone and Balser.
- Ceramic imitations of metal objects,** see: Bells, ceramic, and Rondón Salas.
- Chains:** Clavijero; Larsen; Rainey; Thompson 1943, 103.
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- Coins, American, functional equivalents:** Bastow; Epstein; Hosler, Lechtman and Holm; Valentini, 39.
- Coins, Old World history and concept of:** *Balmuth.
- Coins, purported Old World coins found in U.S.:** Epstein.
- Earliest metals, New World:** Alcina F., 314, 317, 318, 323-331; Balser 1966; Balser 1968; Grossman; Hosler; Lechtman; Litke; Longacre and Millon; Pendergast 1962.
- Gilding,** see Metallurgical processes.
- Gold, amounts produced:** Bray 1978.
- Gold dust in quills as money:** Bastow, 50
- Gold, placering:** Alcina F., 313; Balser 1968, 58; Pendergast 1970.
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- Granulation, same process as in Old World:** Bray 1978, 141; Heine-Geldern 1972.

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Old Copper culture: Covarrubias; Griffin; Patterson.
Old World: Moorey 1988; Muhly 1988.
Platinum, in Ecuador and Colombia only: Alcina F., 317-318, 328.
Pre-Classic metal (possible): Boos; Cummings; Furst; Haury; Hedges et al 1989; Longacre and Millon; Metropolitan Museum; Neiburger 1987; Neiburger 1991; Pendergast 1970; Rivard; Shook and Kidder; R. E. Smith 1944; R. E. Smith 1955; Sorenson 1954a; Sorenson 1954b; Sorenson 1976; Spear; Thompson 1943; Times of the Americas; Vaillant and Vaillant; Urban.
Pre-Classic mining: Franco; Langenscheidt 1970b.
Problem, identification of metals mentioned in documents: *Alieva and Gasanova; Caley and Easby, 515; Forbes; *Sjodahl.

"Prospector culture": Chadwick n.d.
Quetzalcoatl, associated with introduction of metalworking: Chadwick n.d.; Charencey.
Silver, amounts produced: Bray 1978.
Sintering, see Metallurgical processes.
Smelting: Brush; Caley and Easby, 507-508; *Congdon; Linne 1942; Pedersen.
Social structure in relation to metal production: *Heskel; *van der Merwe and Avery.
Soldering, see Metallurgical processes.
Sophistication of Mesoamerican metal crafts: Bray 1978, 136, 143; Easby 1969.
South American influence on West Mexico: Aguirre; Chadwick 1971; Easby 1962; Easby 1969; Furst; Hosler; Marcos; Meighan 1969; Metropolitan Museum; Mountjoy 1969; Pickersgill and Heiser.
South American influence on southern Mesoamerica: Longyear 1944; Pickersgill and Heiser.
Steel, artifacts: Lothrop, 1936; Priest; Thomas.
Steel blade cuts on wood dated to Classic: Franco.
Steel, definition, types and processes: *Congdon; *Sjodahl.
Steel, technological history of: *Congdon; *Forbes; *Sillitoe; *van der Merwe and Avery; *Wheeler and Maddin.
Steel, helmets: Bancroft.
Steel, meteoric iron as: *Forbes, 402.
Stone, copies of metal in: Bierne; Covarrubias; Ibarra Grasso 1969.
Tin axes: Valentini, 8-10.
Tin, sources: Caley and Easby, 513; Williams.
Tin usage, Mexico: Bastow, 50; Caley and Easby; Valentini, 8-10, 16.
Trade, long-distance, in metals/minerals: Davis; Larsen; Lothrop 1952, 98; McCartney and Mack; Moziño; Rainey.
Transatlantic influences on metalworking: Bierne; Chadwick n.d.; Covarrubias; Horne; Mallery; Mallery and Harrison; Marx; McCulloch; R. F. Smith.
Transpacific influences on metalworking: Balser 1968; Bierne; Bosch-Gimpera; Bray 1978, 141; Eliade; Heine-Geldern 1954; Heine-Geldern 1972; Ibarra G. 1982; Linne 1938; Pedersen; Pérez de Barradas; Quimby; Stone and Balser; Zevallos M.
Tumbaga, artifacts: Coggins and Shane; Pendergast 1978; R. Putnam.
Tumbaga, characteristics: Bray 1978, 137.
Welding, see Metallurgical processes.
Wire manufacture, Tarascan: Easby 1962; Kelly.

* In Old World bibliography, Part 1.

Part 4

Probable and Possible Pre-A.D. 900 Mesoamerican Metal Specimens

Ref. No.***	Evidence Rating*	Date	Metal (No. of Specimens)							
			Cpr	Gld	Tbg	Irn	Brz	"Metal"	Other*	
6.12	A	600-900	1							
4.1	A	700-900		1						
5.1	A	550-800							1	
3.1	A	650-800	30+							
6.13	A	780			1					
5.2	A	750			?				3	
1.1	A	600-800	1							
6.11	A	350-450			1					
2.1	A	300-400	M**				M			
9			34+	1	2	2	0		4	0
6.2311	B	500-900	1							
6.30	B	600-900	1							
4.21	B	700-900	3							
4.22	B	700-900		1						
4.23	B	700-900		1						
6.2312	B	800-900		1						
6.2317	B	800-900		1						
6.2318	B	800-900			1					
6.2319	B	800-900		3						
6.2320	B	800-900			9					
6.21	B	750-850	3							
3.2	B	650-800	M	4+						
2.2	B	400-600					M			
2.80	B	400-600	6							
2.81	B	400-600	1							
1.2	B	200 B.C.-A.D. 400		2						
(For 6.2321-6.2333, 5.3, 5.4, 5.51, 5.52, 5.6, 5.8—see following 6.2320 in the commentary below.)										
16			17	13+	10	2	0		0	0

6.2313	C	800-900								1
6.2315	C	800-900								4
4.24	C	700-900			1					
4.25	C	600-900			2					
6.33	C	600-900	1							
4.6	C	600-900								M
2.84	C	700-800	1							
3.3	C	650-800			4					
6.22	C	400-800			1					
6.31	C	600-700	1							
2.6	C	550-750								1
4.73	C	550-700								25
1.3	C	400-700	M							
6.32	C	275-435								M
3.4	C	50 B.C.-A.D. 250								1
4.71	C	200 B.C.-A.D.100?								M
2.5	C	400-100 B.C.								1
4.41	C	200-1 B.C.					5			
<hr/>										
18			5	8	0	5	0	0		39
4.43	D	600-900			2					
6.41	D	600-900	1							
5.7	D	550-800	M							
6.43	D	320-900?	1							
6.42	D	320								1
2.82	D	100-300	1							
2.7	D	50 B.C.-A.D. 150	1							
1.4	D	200 B.C.-A.D. 400	M							
(For 5.51, 5.52, 5.6 and 5.8 see following 6.2320 in the commentary below)										
<hr/>										
8			8	2	0	0	0	0		1

6.2332	I	800-900?	2						
6.2333	I	800-900?		M					
4.42	I	600-900	2						
4.5	I	600-900					6		
6.51	I	600-900?		1					
6.52	I	600-900?	1						
3.51	I	700-900					1		
3.52	I	700-900					1		
5.51	I	700-900					1		
5.52	I	700-900					1		
2.83	I	550-800		M					
1.5	I	400 B.C.-A.D.800						&	
2.4	I	400-700				M			
2.3	I	400-600						1	
4.3	I	200-400	1						
4.72	I	200 B.C.-A.D. 100?						1	
2.9	I	B.C.						1	
6.24	I	100 B.C.		1					
(For 2.83 see following 6.2320 in the commentary below)									
18			8	2	2	0	2	10	3
69			72+	26+	14	9	2	14	43
Grand total: 137+ actual specimens, plus 38+ in "other" forms									

Evidence rating: The total evidence represented in available literature by which one may judge the certainty with which specimens have been identified, analyzed, and dated is summarized as though a teacher were grading a student, semi-objectively, on a scale A through D. A is reserved for cases where an experienced archaeologist excavated the item(s) from a datable context. Rating I signifies that the facts are too incomplete to permit a firm judgement about the value of the item for the purpose of this paper, yet it remains interesting enough to deserve some consideration.

* Representations of metal in ceramic and on stone.

** *M* represents that the number of specimens is more than two although the exact number is unknown. In totalling, these "multiples" are counted as only "two."

*** A reference number distinguishes each instance for which the quality rating is the same. More than one instance may occur at a site. Following the table, specific information about each specimen and site is appended.

& Mines in operation; at least silver and lead ores have been recognized as extracted from these.

Commentary on Table

See notes at the bottom of the preceding table regarding data quality rating. The listing below is by geographical sub-area, beginning with western Mexico. Dating takes advantage of current information, which may not agree with the original researcher's information or judgement.

1.1

A.D. 600-800. Site Tom-28, Tomatlán area. Jalisco.

•Copper (appears to be). Strip. One. From a trench in a natural mound with cultural debris.

Rating: A.

Notes: Mountjoy and Torres M., 136-138. Just below the metal strip (at the bottom of a one-meter deep trench) was an extended burial with a pot on the skeleton's chest. They could not determine if the metal was part of the burial (but imply the likelihood).

1.2

200 B.C.-A.D. 400. Jalisco?

•Gold. Ornaments of sheet gold. Two. In a collection, reported to be from a burial at an unspecified location in coastal Jalisco.

Rating: B.

Notes: Furst. Dates here follow Furst who supposes these items were part of the shaft-tomb complex shared between the two areas during the period indicated.

1.3

A.D. 400-700. Tzintzuntzan. Michoacán.

•Copper. Wire. Multiple. A tomb.

Rating: C.

Notes: Kelly 1949, 153.

1.4

200 B.C.-A.D. 400. Nayarit and Colima.

Ceramic figurines. Metal ornaments represented on Chinesca type figurines. Multiple. In various collections.

Rating: D.

Notes: Metropolitan Museum of Art, 120. Compare Furst.

1.5

400 B.C.-A.D. 800. Sierra de Querétaro.

Ores. Not found as such but assumed dug from ancient mine workings.

Rating: I.

Notes: Langenscheidt. Compare Franco C.

2.1

A.D. 300-400. Teotihuacan. D.F.

•Copper and iron. "Irregular pieces." Multiple. Linné's Burial 1, Tlamimilolpa area.

Rating: A.

Notes: Linné 1942. Evidently from a refining operation done in a pot.

2.2

A.D. 400-600. Teotihuacan. D.F.

•Iron. Mirror mosaic fragments. Multiple. In collections.

•Iron. Discs are inset in eyeholes of masks. Multiple. In collections.

Rating: B.

Notes: Arreola, 218. Masks are assumed here to date to Xolalpan Phase. They could be a century earlier, are somewhat less likely to be later.

2.3

A.D. 400-600. Teotihuacan. D.F.

•Copper? Drills. Multiple? Supposition from holes on masks. Museum collections.

Rating: I.

Notes: Aguilar, 21. Arreola, 218, thinks copper drills “up to 3 inches in diameter,” were used to drill stone at Teotihuacan, including masks, though no drills have been found.]

2.4

A.D. 400-700. Teotihuacan. D.F.

•Bronze. “Artifacts.” Multiple. “Have been found” at the site.

Rating: I.

Notes: Sanchez simply reports this as fact. Assumed Xolalpan, or just possibly Metepec.

2.5

400-100 B.C. Gualupita. Morelos.

Ceramic. “Pendant.” One.

Rating: C.

Notes: Vaillant and Vaillant, and Hawley.

2.6

A.D. 550-750. Azcapotzalco. D.F.

Ceramic. “(Imitation) bell.” Multiple.

Rating: C.

Notes: Vaillant. What he calls “the late Toltec occupation of Azcapotzalco” came to be called Teotihuacan IV phase and now translates to Metepec.

2.7

50 B.C.-A.D. 150. Cuicuilco. D.F. México.

•Copper. Sheath, flat-hammered, nailed around a wooden “wand.” One. Found lying atop an altar on the circular “pyramid.”

Rating: D.

Notes: Cummings, Haury, Sorenson 1954a, 1954b, 1976, and Urban. Sorenson reads Cummings’ unclear statement of the stratigraphy as saying that the specimen lay beneath six feet of intentionally placed material, above which were two feet of surface soil and volcanic ash. Haury, with Urban following, supposed that the metal should be explained as an offering by Aztec pilgrims. Hasso von Winning (Origins of Religious Art and Iconography in Preclassic Mesoamerica, ed. H. B. Nicholson. Los Angeles: UCLA Latin American Center, 1976, p. 150) interprets the 1957 work at the site by Heizer and Bennyhoff as establishing that the major eruption and lava flow that covered the site took place about A.D. 400, which is then probably the latest date for this artifact. For Haury to be correct, the top of the mound must have been free of any debris 500 years ago, leaving eight feet of burden to be accounted for. But the idea of pilgrims leaving such a unique item at a non-functioning site has little or no precedent to recommend it. A C-14 date on the wand would settle the matter.

2.80

A.D. 400-600. Matapan. Los Tuxtlas. Veracruz.

•Copper. Ring. Six. On skeleton in a burial in Mound 22.

Rating: B.

Notes: Santley et al.

2.81

A.D. 400-600. Matacapan. Los Tuxtlas. Veracruz.

•Copper. Bell. One. Part of an offering under a stucco floor in Mound 4.

Rating: B.

Notes: Valenzuela, 99. Valenzuela found evidence only of a Teotihuacan occupation plus something earlier which would be Early Classic in today's terms. Although Santley's group (1984) found a heavy Late Classic occupation, there is no reason to challenge Valenzuela's earlier attribution for this specimen. Stone 1968 cited the marble vessel and copper found by Valenzuela in relation to Late Classic occurrences of such vessels in Honduras. Joyce, personal communication, May 1992, says such vessels are Terminal Classic in Honduras.

2.82

A.D. 200-400. Agaltepec Island. In the Laguna de Catemaco. Los Tuxtlas. Veracruz.

•Copper. Lip plug. One. From a test excavation in the principal mound.

Rating: D.

Notes: Valenzuela, 102-103. Brief excavation and survey indicate a single occupation earlier than the Teotihuacan phase at Matacapan. Two vessels illustrated appear Protoclassic, and Monte Albán II materials were found in the vicinity.

2.83

A.D. 800-1000. Isla de Sacrificios. Veracruz.

•Copper. Bell. Multiple. Mortuary offerings in marble vessels.

Rating: I.

Notes: Stone 1957, 11. She connects marble vessels on the Sula plain and at this site with the Late Classic, but R. Joyce, personal communication, May 1992, maintains that those in Honduras are Terminal Classic, A.D. 800-1000, a date range which I accept for this instance unless new information should come forward to indicate otherwise.

2.84

A.D. 700-800. Santa Luisa. Veracruz.

•Copper. Tube. One. Burial offering, North Zone, Mound A, Structure A- sub 2.

Rating: C.

Notes: Wilkerson. García Payón, HMAI 11:527, ends the El Tajín Classic before 800. I accept this terminus. Wilkerson's reasoning on later periodization seems strained to accommodate Pendergast's chronology which is now evidently too late.

2.9

Pre-1 B.C. "Mexico."

•Ceramic. "(Imitation) bell." One. Evidently in a collection.

Rating: I.

Notes: Spear, 252.

3.1

A.D. 650-800. Monte Albán. Oaxaca.

•Copper. "Rattles" (bells). A set of at least 25 pieces (estimated from photograph). Cache. Patio of Tomb 105.

•Copper. Money axes. Five. Cache. In the mound over Tomb 21.

Rating: A.

Notes: Caso 1965. Fig. 62 illustrates the bells partially excavated.

3.2

A.D. 650-800. San Sebastian, near Tehuantepec. Oaxaca.

•Gold. "Jewelry." Four pieces were seen by Saville; other "gold jewels," seemingly many, from the same find and presumably of the same age were sold and then melted down. The resulting gold was valued at 2000 pesos at the time so it must have involved dozens of pieces. From a tomb encountered in 1875 during house repairs.

•Copper. Multiple "objects." From the same tomb as the gold.

Rating: B.

Notes: Saville; Caso 1965; Rabin.

3.3

A.D. 650-800. Sites, as described below. Oaxaca.

•Gold. "Ornaments." Two. From the literature, dated stylistically; the former of unknown provenience, the second from a tomb in the valley of Oaxaca.

•Gold. "Finger rings." Two. From a tomb near Huajuapán, northwestern Oaxaca; found in 1831.

Rating: C.

Notes: Saville; Caso 1965; Rabin.

3.4

50 B.C.-A.D. 250. Miahuatlán. Oaxaca.

•Ceramic figure with bells represented on ankles of a form later characteristic of metal bells. In Museo Frissell, Oaxaca.

Rating: C.

Notes: Boos.

3.51

A.D. 700-900. ElInfiernillo dam salvage (site not specified). Guerrero.

•"Metal."

Rating: I.

Notes: Schmidt S. and Litvak King, 42; Aguirre et al. 1964.

3.52

A.D. 700-900. Xochipala area (site not specified). Guerrero.

•"Metal."

Rating: I.

Notes: Schmidt S. and Litvak King, 42; Aguirre et al. 1964.

4.1

A.D. 700-900. Izapa. Chiapas.

•Gold. Pendant. One. Urn burial, Cache 107, Mound 114, Group F.

Rating: A.

Notes: Lee, Lowe and Martinez E., 153; N.W.A.F. "A unique, delicate oval thin gold pendant decorated with two embossed (repoussé) intertwined feathered-serpent heads."

This Peistal Phase is characterized by San Juan Plumbate. The 1965 N.W.A.F. statement (which calls the artifact a "medallion") identifies the locus; the published report does not.

4.21

A.D. 700-900. Zacualpa. El Quiché. Guatemala.

•Copper. Disc. Two. In a partial collection from a looted tomb.

•Copper. Ornament. One. In the same collection.

Rating: B.

Notes: Lothrop 1936, 70-75. Coe and Flannery, 93. Ceramics from the tomb are clearly of Middle or Late Classic types. One disc had disappeared but was reportedly like the remaining one. Coe and Flannery see the ceramics belonging to the "later part" of the Late

Classic. Bray 1977 thinks these discs may have been made in the same workshop as those from Los Limones and the one in the Nottebohm collection.

4.22

A.D. 700-900. Los Limones, near Ocos. Guatemala.

•Gold. Plaque or disc. One. Inside a San Juan Plumbate bowl in a cache.

Rating: B.

Notes: Coe and Flannery, 93, 95. The cache dates to the Marcos phase, which they put at A.D. 750-900, but now a rounder 700 beginning seems safer. The rating comes from the authors' implication that they had examined the cache's contents, presumably in the hands of a collector.

4.23

A.D. 700-900. "Probably from near Ayutla," on the border with Chiapas. Guatemala.

•Gold. Plaque or disc. One. In the Nottebohm collection.

Rating: B.

Notes: Nottebohm; Coe and Flannery; Bray 1977. Nottebohm says this is believed to have come "from the western part of Guatemala near the Mexican border." Coe and Flannery considered it from "near Ayutla." Bray 1977 thinks it may have been made in the same workshop as the discs from Los Limones and Zacualpa. For dating, see the discussion of the Los Limones disc.

4.24

A.D. 700-900. Near Ayutla, on the coastal border with Chiapas. Guatemala.

•Gold. Plaque or disc. One. Apparently in the hands of a collector.

Rating: C.

Notes: Coe and Flannery, 95. Bray 1977 considers this probably from the same workshop as plaques or discs from Los Limones and Zacualpa. For dating see 4.22.

4.25

A.D. 600-900. Santa Clara, "below Ayutla," on the coastal border with Chiapas. Guatemala.

•Gold. Plaque or disc. Multiple (two?) Apparently in the hands of a collector.

Rating: C.

Notes: Shook 1965. Mentions these as a "recent find." Bray 1977 accepts it as of Late Classic date, citing a personal communication from Shook, but does not make a specific connection of this item to other discs. This discovery (multiple pieces, at a specified site) seems different from the single disc from vaguely "near Ayutla" reported by Coe and Flannery in 1967; whether these are separate pieces needs to be clarified.

4.3

A.D. 200-400. San Miguel Ixtahuacán. San Marcos. Guatemala.

•Copper. "Piece of sheet copper." One. Reported to be have been in a pot in a mound.

Rating: I.

Notes: R. E. Smith 1944; Sorenson 1954a; R. E. Smith 1955. Smith first reported on these eleven looted pots with the copper said to have been inside one. As all pots were of Aurora Phase age, he was "inclined to doubt" that the copper actually had occurred with them. Sorenson 1954a raised a question about the find, Smith 1955 reported learning that the pottery probably did not come from where he had been told. Since the place was misrepresented to him, he supposed now that his informant "may also have been in error as to copper being found" with the vessels. Sorenson believes a looter/"collector" would be unlikely to connect the copper with odd pots when no sale was sought. It remains possible that the specimen may have been of the indicated age.]

4.41

200-1 B.C. Kaminaljuyu. Guatemala.

•Iron. "Lumps," "moulded to conical form." Five or six. Two tombs in Md. E-III-3.

Rating: C.

Notes: Shook and Kidder. Other iron oxide finds ("pieces") were found in Uaxactun burials by A. L. Smith, they say. The Uaxactun report does not make "pieces" clear, however Smith's close ties with Kidder and Shook allows presuming that their information came orally. But the Uaxactun pieces are not listed here because of lack of primary reference.

4.42

A.D. 600-900. Kaminaljuyu. Guatemala.

•Copper. Disc. Two. Reportedly from the site.

Rating: I.

Notes: Kidder, Jennings and Shook, 144-145. Dating here assumes that the pair of discs they mention most logically belonged in the same artifact family as the Zacualpa and Los Limones discs, though smaller. A Postclassic date is doubtful because Kaminaljuyu was largely unoccupied then.

4.43

A.D. 600-900. Kaminaljuyu. Guatemala.

•Gold. Figurine. Two. From the site.

Rating: D.

Notes: Kidder, Jennings and Shook, 144-145. A date after the Late Classic is doubtful for such a mound find.

4.5

A.D. 600-900. La Libertad. Chiapas.

•"Metal" (assumed copper). Finger ring. Six. Intrusive burial in the top of Md. 5.

Rating: I.

Notes: Miller. Absence of any specific evidence of a Postclassic presence elsewhere at the site, which was abandoned ca. 100 B.C., makes the burial more likely Classic, matching the other two Classic burials.

4.6

A.D. 600-900. Near Colomba in the piedmont. Guatemala.

Ceramic. "(Imitation) bells." Multiple. In a sweat house site.

Rating: C.

Notes: Kidder and Shook. Late Classic.

4.71

200 B.C.-A.D. 100? Abaj Takalik. Quetzaltenango piedmont. Guatemala.

•Metal? Chain. Represented on stela sculptures. Multiple.

Rating: C.

Notes: Thompson 1943, 103-104. The adjacent fincas of Santa Margarita and San Isidro Piedra Parada were later jointly rechristened Abaj Takalik; see Miles, HMAI 2:246. Cf. Proskouriakoff. Aztec rulers used chains as a symbol of rulership; see Clavigero. Mountjoy and Torres have found chains archaeologically.

4.72

200 B.C.-A.D. 100? Abaj Takalik. Quetzaltenango piedmont. Guatemala.

•Metal? Knife. Represented on boulder sculpture. One. "About a km. from the main group."

Rating: I.

Notes: Thompson 1943, 103-104. The dating applies generally to boulder sculptures of the piedmont.

4.73

A.D. 550-700. Santa Lucia Cotzumalhuapa. Escuintla. Guatemala.

•Copper? Bell. At least 25. Represented on human figures on Monuments 2, 3, 4, 5, 6, 8, 18, 19 and 21.

Rating: C.

Notes: Thompson 1948, 41. The dates indicated here are now fairly standard for this art.

5.1

A.D. 550-800. Los Naranjos, on Lake Yojoa. Honduras.

•"Metal." "A fragment." One. Excavated from feature T.57.

Rating: A.

Notes: Baudez and Becquelin, 5, 401. R. Joyce, personal communication, May 1992, reports that their Yojoa Phase in general appears to continue into the Terminal Classic (after 800), however she does not provide information that would justify modifying the dating of this particular feature.

5.2

A.D. 750. Tazumal. Chalchuapa zone, El Salvador.

•"Metal." "Pieces." Three. Excavated from Tomb I.

Rating: A.

Notes: Boggs. Stone 1972 mentions without citation radiocarbon tests done in connection with this find which confirm a date of A.D. 750.

5.3

A.D. 800-1000. Finca Santana, Sula plain, Honduras.

•Gold. Figurine. One. Inside an Ulua marble vase in a burial.

Rating: B.

Notes: Stone 1968, 11. On the basis of R. Joyce's personal communication, May 1992, this find is dated to the Terminal Classic, rather than the "Late Classic" indicated by Stone.

5.4

A.D. 800-1000. Finca Santana, Sula plain, Honduras.

•Tumbaga. Figurine. One. In a grave with two Ulua marble vases.

Rating: B.

Notes: Stone 1968, 11. Bray 1977 adds "pers. comm." from Stone as documentation for this find, which he too dates to the Late Classic. See notes to 5.3 re. Joyce's revision of date for this material.

5.51

A.D. 800-1000. Dixon site, Roatan Island, Bay Islands, Honduras.

•Copper. Bells. Thirty, plus "about half a dozen" smaller bells in the soil nearby. All were inside a "Polychrome I" vase which constituted a "central votive offering."

•Copper. Rings or ear spools. Two. Same offering.

•Copper. Hammered disk. One. Same offering.

Rating: D.

Notes: Strong, 52-53, 60-61. R. Joyce, personal communication, May 1992, re-examines the ceramic chronology to conclude that the Terminal Classic date here indicated applies to this material, despite Stone 1968, 11, which attempts to relate Honduran jade and marble or alabaster vessels with a broader, earlier "Late Classic" of the Peten.

5.52

A.D. 800-1000. Indian Hill Site 1. Barburata Island, Bay Islands. Honduras.
•Copper. Piece of hammered-out copper, probably a pendant. One. Excavated feature.
Rating: D.
Notes: Strong 1935, 86-87, 106-107. See the notes to 5.51.

5.6

A.D. 800-1000. Las Flores Bolsa. Ulua River valley. Honduras.
•Copper. Fish hook. One. Grave.
Rating: D.
Notes: Strong, Kidder, and Paul, 41, 120-121. See the notes to 5.3

5.7

A.D. 550-800. Los Naranjos, on Lake Yojoa. Honduras.
•Copper. Fishhooks. "A number." "At the site."
Rating: D.
Notes: Stone 1957, 63-64. She says these were found by Strong, Kidder and Paul, and illustrates four, but I cannot find reference to them in the report by the trio; I assume Stone knew there was a find. Compare Joyce's comments on chronology in connection with the annotation of Stone 1968, but in this case on the basis of Stone's statements, I retain Baudez and Becquelin's dating for the Yojoa Phase.

5.8

A.D. 800-1000. "Bell Cave." Honduras.
•Copper. Bells, copper pieces from which bells were being made, and spear points. Over 800 bells; several blanks; "a number" of points. Excavated inside a remote cave.
Rating: D.
Notes: Blackiston. See notes to 5.51. It is presumed here that this site dates to the Terminal Classic.

6.11

A.D. 350-450. Altun Há. British Honduras (Belize).
•Tumbaga. Bead representing an animal (jaguar?) claw, from thin sheet metal, hammered or perhaps cast. One. In a trench in the temple forming part of the south boundary of the ceremonial precinct.
Rating: A.
Notes: Pendergast 1970. His dating (merely, "somewhat before A.D. 500") seems excessively conservative considering the evidence presented.

6.12

A.D. 600-900. Guaytan, near San Agustín Acasaguastlán. Motagua Valley. Guatemala.
•Copper. "A small ragged bit of sheet metal," flat-hammered. In Tomb III, Str. 24.
Rating: A.
Notes: Smith and Kidder, 170, 173-174.

6.13

A.D. 780. Copán. Honduras.
•Gold-copper (i.e., tumbaga). Figurine legs (presumably broken off a single figurine). One (two legs). Substela cache in a chamber beneath Stela H.
Rating: A.
Notes: Stromsvik. Longyear, who was followed by Woodbury (HMAI 2:175) and Thompson (HMAI 3:347), was without any empirical basis in speculating a Postclassic date for this material. Stromsvik refers to "gold," but Longyear calls it "gold-copper."

6.21

A.D. 750-850. San José. British Honduras (Belize).

•Copper. Bells. Two. Cache C1.

•Copper. Knife. One. Cache C1.

Rating: B.

Notes: Thompson 1939. Oxidized copper remains suggested by their shapes two copper bells. Late Period IV or beginning of V. About the knife he is more equivocal, "perhaps a knife," but in any case there was an object of oxidized copper.

6.22

A.D. 400-800. Palenque. Chiapas.

•Gold. Bell. One. Collected at the site.

Rating: C.

Notes: Joyce 1924. The dates here are reasonable ones for Palenque's florescence.

Joyce considered this piece proof of knowledge of gold casting "under the Old Empire of the Maya." Bray 1977 accepted it as "probably" Classic Maya.

6.2311

A.D. 500-900. Chichén Itzá. Yucatán.

•Gold. "Horse-collar" ellipse. One. From the Sacred Cenote.

Rating: B.

Notes: Lothrop 1952, 72; Coggins and Shane, 58; Borhegyi 1966, 364. Borhegyi puts all examples of this form in the Middle Classic (A.D. 400-700). Coggins and Shane assign it to the Terminal Classic, A.D. 800-900 without specific basis.

6.2312

A.D. 800-900. Chichén Itzá. Yucatán.

•Gold. Gold Disc F. One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 43; Lothrop 1952.

6.2313

A.D. 800-900. Chichén Itzá. Yucatán.

•Copper?. Bell, represented worn in scene on Gold Disc F. One. From the Sacred Cenote.

Rating: C.

Notes: Coggins and Shane, 43; Lothrop 1952. Copper assumed.

6.2315

A.D. 800-900. Chichén Itzá. Yucatán.

•Copper?. Bells, represented worn in scene on Gold Disc H. Four. From Sacred Cenote.

Rating: C.

Notes: Coggins and Shane, 50; Lothrop 1952. Copper assumed although gold bells of the same shape were found in the Cenote.

6.2317

A.D. 800-900. Chichén Itzá. Yucatán.

•Gold. Gold Disc H. One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 50; Lothrop 1952.

6.2318

A.D. 800-900. Chichén Itzá. Yucatán.

•Tumbaga. Bell, "jar-shaped." One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 45; Lothrop 1952.

6.2319

A.D. 800-900. Chichén Itzá. Yucatán.

•Gold. Face ornaments of sheet gold. Three. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 55; Lothrop 1952.

6.2320

A.D. 800-900. Chichén Itzá. Yucatán.

•Tumbaga. Figurine pendant. Nine. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 62-66; Lothrop 1952, 110?

[Numbers 6.2321-6.2331, 5.51, 5.52, 5.6, 5.8, and 2.83 date within the broad Terminal Classic or Terminal Classic-Early Postclassic periods. The specimens might date as early as A.D. 800 (actually, Coggins says on p. 27, the Early Phase “began late in the eighth century”) or they might date afterward. In any case the commonly-held “metal curtain,” A.D. 900, date is demonstrated in principle by all these cases to be invalid. These instances are not tallied in the table.]

6.2321

A.D. 800-1000. Chichén Itzá. Yucatán.

•Gold. Hat/bowl of sheet gold. One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 57; Lothrop 1952.

6.2322

A.D. 800-1000. Chichén Itzá. Yucatán.

•Gold. Bell, turtle effigy. One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 85; Lothrop 1952.

6.2323

A.D. 800-1100. Chichén Itzá. Yucatán.

•Gold. Points, effigy, in sheet gold. Thirteen. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 48; Lothrop 1952.

6.2324

A.D. 800-1100. Chichén Itzá. Yucatán.

•Gold. Disc, plain sheet gold. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 56; Lothrop 1952. Coggins mentions four such discs from the Cenote but leave unclear whether this is one of those. The other three are not tabulated for lack of specification.

6.2325

A.D. 800-1100. Chichén Itzá. Yucatán.

•Gold. Pendant, frog. One. From the Sacred Cenote.

Rating: B.

Notes: Coggins and Shane, 84; Lothrop 1952.

6.2326

A.D. 800-1100. Chichén Itzá. Yucatán.

•Gold. Rings, flat. "At least 60." From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 58; Lothrop 1952.

6.2327

A.D. 800-1150. Chichén Itzá. Yucatán.
•Gold. Pendant, turtle. One. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 85; Lothrop 1952.

6.2328

A.D. 800-1150. Chichén Itzá. Yucatán.
•Tumbaga. Bell, "monkey-bell-with-tail." One. From the Sacred Cenote.
•Gold. Bell, "monkey-bell-with-tail." Five. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 86-87; Lothrop 1952.

6.2328

A.D. 800-1150. Chichén Itzá. Yucatán.
•Gold or tumbaga. Bells. Thompson found a total of 80. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 88; Lothrop 1952.

6.2329

A.D. 800-1150. Chichén Itzá. Yucatán.
•Gold. Bell, human head effigy. Seven. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 88; Lothrop 1952.

6.2330

A.D. 800-1150. Chichén Itzá. Yucatán.
•Gold. Bell, crab effigy. Two. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 91; Lothrop 1952.

6.2331

A.D. 800-1150. Chichén Itzá. Yucatán.
•Gold. Bell, surmounted by "eagle." One. From the Sacred Cenote.
Rating: B.
Notes: Coggins and Shane, 93; Lothrop 1952.

6.2332

A.D. 800-900? Chichén Itzá. Yucatan.
•Copper. "Pieces of gilded sheet copper." Two. Sacred Cenote.
Rating: I.
Notes: Lothrop 1952, 82. These undated pieces "vaguely recall eccentric flints" found in cities of "the Great Period." They also may compare with unexplained shell objects found at Holmul.

6.2333

A.D. 800-900? Chichén Itzá. Yucatan.
•Tumbaga? Figurines. Multiple. Sacred Cenote.
Rating: I.

Notes: Lothrop 1952, 110. Figurines from the Cenote “in the same style” as those beneath Stela H at Copan may be of comparatively early date, but this cannot be confirmed, he says. (May be the same as 6.2320.)

6.24

100 B.C. Chichén Itzá. Yucatan.

•Gold. Jewelry. One item, or perhaps more. Sacred Cenote.

Rating: I.

Notes: Times of the Americas.

6.30

A.D. 600-900. Lowland Maya area. Guatemala.

•Copper. Human effigy mask. One. Collection.

Rating: B.

Notes: Thompson 1965; Pendergast 1970, 117.

6.31

A.D. 600-700. Cave, 30 miles west of Altun Há. Belize.

•Copper. “Flat freeform piece of badly oxidized copper.” One. Inside a pot.

Rating: C.

Notes: Malone.

6.32

A.D. 275-435 (GMT-based). Various sites. Petén. Guatemala.

Chains. Represented on stela sculptures. Multiple.

Rating: C.

Notes: Proskouriakoff. Feature is characteristic on Peten sculptures of the “second half of the 8th Cycle.” The earliest Peten stela so far known is dated A.D. 292. On representations of chains as evidence for metals, see Thompson 1943, where he states that chains are represented on lowland Maya stelae dating to “the middle of Cycle 9.”

6.33

A.D. 600-900. Site near the village of Humebchin. Yucatán.

•Copper? Bell, small, globular shaped. Multiple. “In a jar with inscribed characters buried in a mound.”

Rating: C.

Notes: Phillips. The bell he had collected had been found “with a number of others.” Bray 1977, 74, counts this as Late Classic, apparently on the basis of the “inscribed characters” on the vessel, while adding a question mark to the date.

6.41

A.D. 600-900. Lubaantun. British Honduras (Belize).

•Copper. Axe blade, flat, hammered. One. Found on the surface in “the immediate neighborhood of the ruined city.”

Rating: D.

Notes: Joyce 1926. A Classic date for this artifact deserves consideration unless or until investigation shows significant Postclassic inhabitation in the vicinity.

6.42

A.D. 320. Tikal? Guatemala.

Chain. Represented on the Leyden Plate. One.

Rating: D.

Notes: Thompson 1943, 103-104. The Plate shows a chain hanging from the belt of the human figure. The plaque was thought carved at or near Tikal, although found near Puerto Barrios (see Rands, HMAI 3:577). Compare 6.32.

6.43

A.D. 320-900? San Filippo, near the frontier with British Honduras. Guatemala.

•Copper. Bell. One. "At considerable depth beneath a low mound."

Rating: D.

Notes: Morley. Leemans. Found with the Leyden Plate (GMT, A.D. 320) and objects of jade. Morley makes the statement "beneath a low mound," but Leemans, whom Morley cites, said only "at great depth," while digging a canal. Morley assumes a Post-Classic date for deposition of the lot (solely) because "no metal objects have been found at any Old Empire site," except this bell and the (to him questionable) from Palenque. Apparent association of the bell with three carved jades of Classic style plus reference to the depth of the find calls for the dating given here, now that other Classic metal pieces are known.

6.51

A.D. 600-900? Tikal. Guatemala.

•Gold? Copper? One.

Rating: I.

Notes: Lothrop 1936, 71-72. "Isolated finds of questionable authenticity . . . have been made at Palenque and Tikal." I have found no primary reference to such. Tozzer 1937 refers either to this find mentioned by Lothrop or to another: "Early and vague reports tell of a gold bell found . . . at Tikal."

6.52

A.D. 600-900? Yaxhá. Guatemala.

•Copper. One.

Rating: I.

Notes: Lundell, 185. Lothrop 1936, 71-72, spoke of this as one of a pair of "definite discoveries (that) have recently been recorded at Yaxha and Copan." Subsequently, Lothrop 1952, 22, classed it with finds at Palenque and Tikal as "isolated metal specimens of questionable provenience," though it is doubtful he could have had any new information to cause him to revise his earlier opinion.

Part 5

A Summary of Statements in the Book of Mormon Text about Metals, Ores, and Metal Processing, with Notes on Hebrew Usages of Metal-related Terms

Nephite/Lamanite Metals

brass (Old World)

1 Nephi 3:3

ca. 597 B.C. First mention of “plates of brass.”

1 Nephi 16:10

ca. 596 B.C. Liahona was “of fine brass.”

brass (New World:)

2 Nephi 5:15

ca. 580 B.C. Nephi taught his people to work “in all manner of . . . brass.”

Jarom 1:8

ca. 400 B.C. Became “rich in . . . brass (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war.”

Mosiah 11:3, 8, 10

ca. 160 B.C. Noah taxes brass (and other metals); also uses brass (and all other metals mentioned) to ornament “elegant and spacious buildings.”

Mosiah 8:10

ca. 121 B.C. Limhi recognizes Jaredite breastplates as of brass.

Helaman 8:14

ca. 24 B.C. Mention of “brazen serpent” of Moses.

brass, plates of

1 and 2 Nephi

Seventeen more times after the first mention in 1 Nephi 3:3.

Omni 1:14

ca. 210 B.C.

Mosiah 1:3, 16; 10:16

ca. 130 B.C.

Mosiah 28:11, 20

ca. 90 B.C.

Alma 37:3

ca. 70 B.C.

3 Nephi 1:2

ca. 5 B.C.

3 Nephi 10:17

ca. A.D. 30

(Figurative mentions of brass, in quotations from Isaiah, are omitted.)

copper

1 Nephi 18:25

ca. 585 B.C. Copper ore found in pioneering the new land

2 Nephi 5:15

ca. 580 B.C. Nephi taught his people to work “in all manner . . . of copper.”

Jarom 1:8

ca. 400 B.C. Became “rich in . . . copper (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war.”

Mosiah 11:3, 8, 10
ca. 160 B.C. Noah taxes copper (and other metals); also uses copper (and all other metals mentioned) to ornament “elegant and spacious buildings.”

Mosiah 8:10
ca. 121 B.C. Limhi recognizes Jaredite breastplates as of copper.

gold (Old World)

1 Nephi 2:4, 11; 3:16, 22, 24
ca. 597 B.C. Lehi possessed riches in gold.

1 Nephi 4:9
ca. 597 B.C. Hilt of the sword of Laban was “of pure gold.”

gold (New World)

1 Nephi 18:25
ca. 585 B.C. Gold ore found in pioneering the new land.

2 Nephi 5:15
ca. 580 B.C. Nephi taught his people to work “in all manner . . . of gold.”

Jacob 1:16, 2:12
ca. 540 B.C. Many Nephites “began to search much gold.”

Jarom 1:8
ca. 400 B.C. Became “rich in . . . gold (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war.”

Mosiah 11:3, 8, 10, 11
ca. 160 B.C. Noah taxes gold (and other metals); also uses gold (and other metals) to ornament “elegant and spacious buildings.”

Mosiah 19:15
ca. 130 B.C. Lamanites take tribute of gold from Zeniffites.

Mosiah 2:12
ca. 125 B.C. Mosiah is proud not to have enriched himself in gold from his subjects. Cf. Mosiah 4:19, implies gold is among riches widely held.

Mosiah 22:12
ca. 125 B.C. Limhi’s group takes their gold with them when they flee to Zarahemla.

Alma 1:29
ca. 90 B.C. Nephites have abundant gold.

Alma 17:14
ca. 90 B.C. Lamanites’ hearts were set on riches, including gold.

Alma 4:6
ca. 85 B.C. Nephites’ “exceeding riches” include gold.

Alma 11:4-19
ca. 80 B.C. Nephite units of gold and silver “money” detailed.

Alma 15:16
ca. 80 B.C. Amulek had forsaken his gold in fleeing.

Alma 31:24, 28
ca. 75 B.C. Zoramites’ hearts were set on riches, including gold.

Helaman 6:9, 11, 31
ca. 30 B.C. Lamanites and Nephites both had “exceeding . . . plenty of gold,” in both the land south and the land north. Both lands had “all manner of gold;” workmen worked “all kinds of ore and did refine it.” Built up gold idols.

Helaman 7:21
ca. 20 B.C. Nephites strove to get gold.

Helaman 12:2
ca. 10 B.C. Mormon’s commentary on history at this point mentions gold as one of the Lord’s blessings anytime.

Helaman 13:28
ca. 10 B.C. Samuel condemns giving gold to false prophets.
3 Nephi 6:2
ca. A.D. 25 Nephites' gold (implied common).
4 Nephi 1:46
ca. A.D. 300 Gold they (Nephites, Lamanites and robbers) "did. . . lay up in store in abundance."
(Figurative mentions omitted.)

iron

2 Nephi 5:15
ca. 580 B.C. Nephi taught his people to work "in all manner . . . of iron."
Jarom 1:8
ca. 400 B.C. Became "rich in . . . iron (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war . . ."
Mosiah 11:3, 8
ca. 160 B.C. Noah taxes iron (and other metals); also uses iron (and all other metals) to ornament "elegant and spacious buildings."
(Figurative expressions, including "rod of iron," omitted.)

silver (Old World)

1 Nephi 2:4, 11; 3:16, 22, 24
ca. 597 B.C. Lehi possessed riches of silver.

silver (New World)

1 Nephi 18:25
ca. 585 B.C. Silver ore found in pioneering the new land.
2 Nephi 5:15
ca. 580 B.C. Nephi taught his people to work "in all manner . . . of silver."
Jacob 1:16; 2:12
ca. 540 B.C. Many Nephites "began to search much . . . silver."
Jarom 1:8
ca. 400 B.C. Became "rich in . . . silver (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war."
Mosiah 11:3, 8, 9
ca. 160 B.C. Noah taxes silver (and other metals); also uses silver (and other metals) to ornament "elegant and spacious buildings."
Mosiah 19:15
ca. 130 B.C. Lamanites take tribute of silver from Zeniffites.
Mosiah 2:12
ca. 125 B.C. Mosiah is proud not to have enriched himself in silver from his subjects. Cf. Mos. 4:19, silver implied to be among riches widely held.
Mosiah 22:12
ca. 125 B.C. Limhi's group take their silver with them when they flee to Zarahemla.
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ca. 80 B.C. Amulek had forsaken his silver in fleeing.

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ca. 75 B.C. Zoramites' hearts were set on riches, including silver.

Helaman 6:9,11, 31

ca. 30 B.C. Lamanites and Nephites both had "exceeding plenty of . . . silver," in both the land south and the land north. Both lands had "all manner of silver;" workmen worked "all kinds of ore and did refine it." Built up silver idols.

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ca. 10 B.C. Samuel condemns giving silver to false prophets.

3 Nephi 6:2

ca. A.D. 25 Nephites' silver (implied common).

4 Nephi. 1:46

ca. A.D. 300 Silver Nephites, Lamanites and robbers "did. . . lay up in store in abundance."

(Figurative mentions omitted.)

steel (Old World)

1 Nephi 4:9

ca. 597 B.C. Laban's sword had a blade "of the most precious steel."

1 Nephi 16:18

ca. 595 B.C. Nephi's bow "was made of fine steel."

steel (New World:)

2 Nephi 5:15

ca. 580 B.C. Nephi taught his people to work "in all manner of. . . steel."

Jarom 1:8

ca. 400 B.C. Became "rich in . . . iron (and other metals) . . . making all manner of tools of every kind to till the ground, and weapons of war . . ."

ziff

Mosiah 11:3, 8

ca. 160 B.C. Noah taxes "ziff" (and other metals); also uses "ziff" (and all other metals) to ornament "elegant and spacious buildings."

Nephite Metallurgical Processes and Products

ax

Mormon 6:9

ca. A.D. 385 "Ax" among weapons used; no indication if metal.

bellows

1 Nephi 17:11

ca. 587 B.C. Nephi (in Arabia) knew how to make and use a bellows of animal skin "to blow the fire" for smelting ore.

breast-plates

Mosiah 8:9

ca. 125 B.C. Term “breastplate” is used in reference to brass and copper armor of the Jaredites.

Alma 43:19, 21,38,44

ca. 75 B.C. Nephite soldiers wear “breastplates” of unspecified form and material.

ore (Old World)

1 Nephi 17:9, 10, 16

ca. 587 B.C. Nephi knows about “ore” and how to refine and cast it.

ore (New World:)

1 Nephi 18:25

ca. 585 B.C. “All manner of ore” found in pioneering the new land; they recognize distinctions among gold, silver and copper ores.

Helaman 6:11

ca. 30 B.C. Both in the land north and the land south “there was all manner . . . of precious ore of every kind; and there were also curious workmen, who did work all kinds of ore and did refine it.”

Mormon 8:5

ca. A.D. 400 Moroni cannot make more plates to write on for “ore I have none, for I am alone.”

engrave (Old World)

1 Nephi 9:3; 19:1-2

ca. 596 B.C. On Nephi’s first (large) plates.

engrave (New World:)

2 Nephi 5:30-32

ca. 567 B.C. On Nephi’s second (small) plates.

(Additional engraving done on the same plates: Jac. 1:1, 3-4; 4:3; Jar. 1:14; Omni 1:11.)

molten

1 Nephi 17:9, 16

ca. 587 B.C. Nephi did “molten” (smelt) ore for metal for tools.

Jaredite Metals/Metallurgy*

brass

Ether 10:23

ca. 1500 B.C. Presumably bronze, as per the KJV. “Did work in all manner of ore, and they did make . . . brass, and all manner of metals”; but in the list of ores worked no mention is made of brass, only, correctly, of copper. (Typically, Mesoamerican bronze had the necessary mixture of tin in the ore without admixture being required.)

Mosiah 8:10

ca. 550 B.C. Brass breastplates from the final Jaredite battle(s) were brought to Limhi by his explorers.

* Incorporating data from charts prepared in 1980 by Robert F. Smith. Dates are approximated from J. L. Sorenson, “The Years of the Jaredites,” F.A.R.M.S. Paper, 1969.

copper

Ether 10:23

ca. 1500 B.C. "Did work in all manner or ore, and they did make . . . copper . . ."
Got copper ore for this purpose.

Mosiah 8:10

ca. 550 B.C. Copper breastplates from the final Jaredite battle(s) were brought to Limhi by his explorers.

gold

Ether 9:17

ca. 2500 B.C.? Jaredites had "all manner of . . . gold."

Ether 10:7

ca. 2000 B.C.? Riplakish, the king, "even his fine gold he did cause to be refined in prison."

Ether 10:12

ca. 1800 B.C.? Jaredites became rich in gold.

Ether 10:23

ca. 1500 B.C. Made gold from gold ore.

Mosiah 8:9

ca. 600 B.C. Explorers brought 24 plates "of pure gold" from the final Jaredite battle scene, which were those on which Ether had written his account.

plates

Mosiah 8:9

ca. 600 B.C. Explorers brought 24 plates "of pure gold" from the final Jaredite battle scene. [Does this imply that they recognized a distinction between these plates and those in use by Nephite scribes which were not of "pure gold"?]

iron

Ether 10:23

ca. 1500 B.C. Made iron from iron ore.

silver

Ether 9:17

ca. 2500 B.C.? Jaredites had "all manner of . . . silver."

Ether 10:12

ca. 1800 B.C.? Jaredites became rich in silver.

Ether 10:23

ca. 1500 B.C. Made silver from silver ore.

steel

Ether 7:9

ca. 2700 B.C.? Made swords of steel.

breast-plates

Ether 15:15

ca. 550 B.C. Jaredites had breast-plates at their final conflict.

Mosiah 8:10

ca. 550 B.C. Copper and brass breastplates from the final Jaredite battle(s) were brought to Limhi by his explorers.

head-plates

Ether 15:15

ca. 550 B.C. Jaredites had head-plates at their final conflict; not certain whether of metal. (See Notes below.)

money

Ether 9:11

ca 2500 B.C.? "Money." No characteristics indicated; not necessarily metal, though could have been.

ore

Ether 7:9

ca. 2700 B.C.? "He came to the hill Ephraim, and he did molten out of the hill, and made swords out of steel."

Ether 10:23

ca. 1500 B.C. "And they did work in all manner of ore, and they did make gold, and silver, and iron, and brass, and all manner of metals; and they did dig it out of the earth; wherefore they did cast up mighty heaps of earth to get ore, of gold, and of silver, and of iron, and of copper."

plow

Ether 10:25

ca. 1500 B.C. Made tools to . . . plow." Not necessarily of metal.

sword(s)

Ether 15:29

ca. 550 B.C. Last Jaredites fought with the sword. Not necessarily metal, though could have been.

tool(s)

Ether 10:25-26

ca. 1500 B.C. Made tools to till, plow, sow, reap, hoe and thrash, and "to work their beasts." Not necessarily metal (this verse is separated from v. 23 about metals by intervening v. 24, which concern textiles, suggesting that the writer did not mean to link the tools and weapons directly to metals).

weapons

Ether 10:27

ca. 1500 B.C. Made "all manner of weapons of war," whether of metal being left unclear.

Comments on Hebrew Usage of Metal-related Terms
by Robert F. Smith

Old Test. usages in B. of M.

brass 1 Ne. 20:4, cf. Isa. 48:4

3 Ne. 20:19, cf. Mic. 4:13

(KJV) Old Testament term**

"bronze," Heb. *neḥuša*
(Rev. Eng. Bib.: "brass")

"bronze," Heb. *neḥuša*

** Orthography approximate

gold	2 Ne. 12:7, 20, cf. Isa. 2: 7, 20 2 Ne. 23:12, 17, cf. Isa. 13:12, 17 3 Ne. 24:3, cf. Mal. 3:3	“gold,” Heb. <i>zahab</i>
iron	1 Ne. 20:4, cf. Isa. 48:4 2 Ne. 20:34, cf. Isa. 10:34 3 Ne. 20:19, cf. Mic. 4:13	“iron,” Heb. <i>barzel</i> “iron,” Heb. <i>barzel</i> (Rev. Eng. Bib.: “axe”) “iron,” Heb. <i>barzel</i>
silver	2 Ne. 12:7, 20, cf. Isa. 2:7, 20 2 Ne. 23:17, cf. Isa. 13:17 3 Ne. 24:3, cf. Mal. 3:3	“silver,” Heb. <i>keseḥ</i>
money	2 Ne. 9:50-51, cf. Isa. 55:1-2 2 Ne. 26:25, cf. Isa. 55:1 3 Ne. 20:38, cf. Isa. 52:3	“silver; money,” Heb. <i>keseḥ</i> (lit. “wages”) Heb. <i>keseḥ</i> Heb. <i>keseḥ</i>
ax	2 Ne. 20:15, cf. Isa. 10:15	“ax,” Heb. <i>garzen</i> (not necessarily metal)
bracelets	2 Ne. 13:19, cf. Isa. 3:19	“bracelets,” Heb. <i>šerot</i> (not necessarily metal)
chains	2 Ne. 13:19, cf. Isa. 3:19	“pendants,” “earrings,” Heb. <i>neṭifot</i> (not necessarily metal)
molten	1 Ne. 20:5, cf. Isa. 48:5	“graven (image);” “molten (image),” Heb. <i>nesek</i> (REB: “idol,” “image”)
plowshares	2 Ne. 12:4, cf. Isa. 2:4	“plowshares,” Heb. <i>ittim</i> (metal)
sword	1 Ne. 21:2, c. Isa. 49:2 2 Ne. 8:19, cf. Isa. 51:19; 2 Ne. 12:4, cf. Isa. 12:4	“sword,” Heb. <i>hereb</i> (lit. “short-sword”; “dagger”) “sword,” Heb. <i>hereb</i> “swords,” Heb. <i>ḥarabot</i> (cf. Jos. 5:2-3, “sharp knives,” i.e. of flint or obsidian, Heb. <i>ḥarabot surim</i>)

Notes:

ax(e) in the KJV is a translation of five separate Hebrew terms: (1) *garzen*, “ax”; “quarrying-ax” (Deut. 19:5; 20:19; 1 Ki. 6:7; Isa. 10:15, cf. 2 Ne. 20:15); (2) *qardom*, “adze”; “ax” (Judges 9:48; 1 Sam. 13:20); (3) *barzel*, “iron tool” (lit. “iron”) (2 Ki. 6:5); (4) *ma’asad*, “curved bill-hook” (for pruning); “adze” (Jer. 10:3); (5) *mapes*, “war-club,” “battle ax” (Jer. 51:20). Other usages are solely agricultural. Metal may be assumed only when specified.

sword in KJV translates five Hebrew terms: (1) *baraq*, “lightning” (metaphoric, Deut. 32:41); (2) *šelah*, “javelin”; “dart”; (3) *p^ʿtiḥa*, “drawn-sword,” “dagger”; (4) *reṣaḥ*, “murder” (metaphoric); (5) *ḥereb*, “short-sword”; “dagger,” “knife,” the most common of the five.

steel bow in KJV translates Hebrew for “bronze bow” in 2 Sam. 22:35; Job 20:24; and Ps. 18:34.

chains in the Book of Mormon is always figurative--2 Ne. 1:13, 23; 9:45; 13:19; 28:19, 22; Alma 5:7, 9, 10; 12:6, 11, 17; 13:30; 26:14; 36:18.

head-plate is surely equivalent to Hebrew *koba* and *qoba*, “helmet” (1 Sam. 17:5, 38, bronze; Isa. 59:17= *perikephalaía* in Eph. 6:17 and 1 Thess. 5:8).

breast-plate is apparently either a priestly pectoral vestment, Heb. *ḥošen* (Ex. 25:7), or the bronze scale-armor or corselet or coat of mail of 1 Sam. 17:5, 38; Isa. 59:17, *širion*, *širiona*, *sirion* (= *thóraka* in Eph. 6:14 and 1 Thess. 5:8).

piece(s) of gold, silver, money, as in Alma 11:4, are mentioned in Ex. 37:7; Gen. 33:19; Josh. 24:32; 1 Sam. 2:36; Job 42:11; none are coins.