Ziff, Magic Goggles, and Golden Plates

Etymology of Zyf and a Metallurgical Analysis of the Book of Mormon Plates

Jerry D. Grover, Jr. PE, PG

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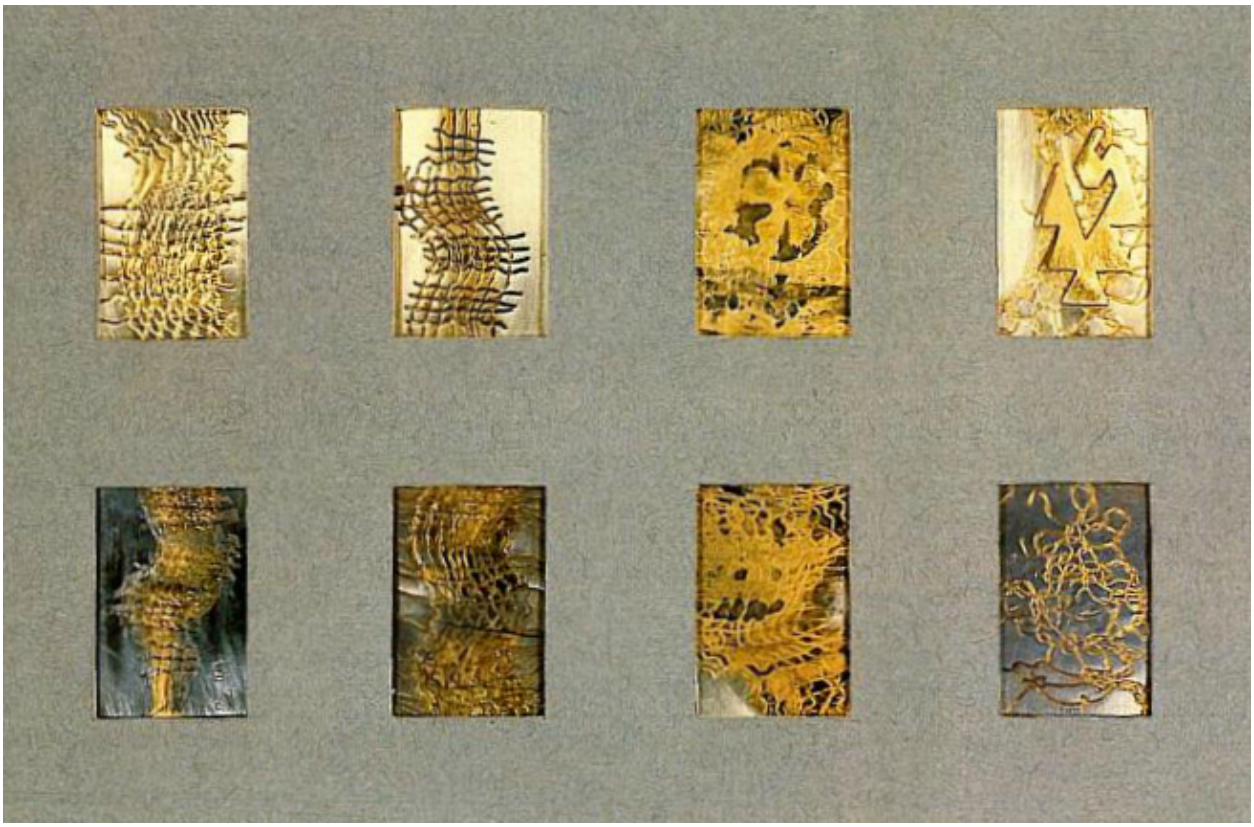

by

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On the front cover:
Experimental patina generation of depletion gilded gold plates using 9-carat silver-gold-copper alloy (Del Solar et al. 1982)

On the back cover:
Tairona bird pendant with cast and gilt tumbaga, from Minca, Santa Marta Magdalena, Museo del Oro, Bogata, Columbia (Del Solar et al. 1982)
Sitting tumbaga statuette of a Quimbaya cacique (chief) from Colombia, private collection, Madrid, Spain
Gold-copper-silver alloy ternary color diagram (Del Solar et al. 1982)

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Introduction

One day while viewing various Internet videos involving the Book of Mormon, I happened across a video of a joint presentation by Dr. John Clark, Matthew Roper, and Wade Ardern from the 2005 FAIR Conference on Archaeology and the Book of Mormon. As part of the presentation, Matthew Roper displayed slides indicating various Book of Mormon items as "unknowable" because they were "logically beyond proof or disproof" as it is not known "what they are in the real world." Chief among those listed by Mr. Roper was the "famous but mysterious metal ziff," with Mr. Roper citing from the nineteenth-century anti-Mormon, Origen Bacheler. Bacheler made the following challenge in his publication, *Mormonism Exposed Internally and Externally*:

> And what kind of metal is ziff! Come, Joseph, on with thy goggles, and translate thy translation, and tell us what *ziff* means. (Bacheler 1838, 14)

I had just completed a few years of research that resulted in the publication of the book *Geology of the Book of Mormon*, and I had been surprised by just how little real scientific research had been done with regards to geological references in the Book of Mormon. I wondered if Mr. Roper's comments on *ziff* were really based on the fact that a large amount of research had not proved fruitful, or whether no one had really tried very hard, similar to the lack of research I had seen on geology in the Book of Mormon. Since I have not been too involved with any Book of Mormon research groups, and because I had not dealt with metals and ore bodies in *Geology of the Book of Mormon*, *ziff* piqued my natural curiosity and seemed like an excellent intellectual challenge.

As a self-funded, self-publishing, free-lance scientist when it comes to the Book of Mormon research, I am able to operate without academic deadlines, budgets, or publishers who want a marketable product, and therefore I am able to wander in my research wherever it takes me. This particular research on *ziff* proved to be both engaging and expansive, as it took me into areas of interest that I had not suspected. As the reader will notice, I am not a Book of Mormon apologist; I am actually a bit tired of the research that is primarily directed at responding to critics of the Book of Mormon as it seems to miss many topics, essentially conceding the research prioritization to individuals who really don't care what actual ancient information exists in the Book of Mormon. On the other hand, much of the so-called research attacking the Book of Mormon is less than objective.

Having read the Book of Mormon many times, I have found that it supports itself sufficiently well and independently without my feeble attempts at analysis. My research interest is not to prove that Joseph Smith was or was not a prophet, nor to engage historic and present theocratic leaders of the LDS Church in all their various prior and current positions and statements. My approach is simply to objectively inquire and then provide whatever scientific information I can and lay it out for anyone to follow. I have no pre-conceived objective; most of the time I find the research path itself much more interesting than the final conclusions (if there end up being any).

I think my relationship to Book of Mormon research was best expressed by the character of Professor Henry Jones and his quest for the Holy Grail in the 1989 movie *Indiana Jones and the Last Crusade*:

> Professor Henry Jones: Elsa never really believed in the grail. She thought she'd found a prize.
>
> Indy: What did you find, Dad?
>
> Professor Henry Jones: Me? ... Illumination!

As this book is not written to be wildly entertaining or a bestseller, I'm hoping that the reader will be patient through the tedious sections and ultimately receive at least a small kernel of illumination about the Book of

Mormon. So, put on thy goggles that I have provided and join me in a wandering scientific journey into the Book of Mormon, starting with *ziff*.

Chapter 1
Ziff—Text and Translation

One of the more intriguing mysteries of the Book of Mormon involves the identification of an unknown material known as "ziff." The word *ziff* occurs in the Book of Mormon in the context of King Noah and his less than stellar governmental practices, and is mentioned in the following Book of Mormon verses:

> Mosiah 11:3
>
> And he laid a tax of one fifth part of all they possessed, a fifth part of their gold and of their silver, and a fifth part of their ziff, and of their copper, and of their brass and their iron; and a fifth part of their fatlings; and also a fifth part of all their grain.
>
> Mosiah 11:8-10
>
> 8 And it came to pass that king Noah built many elegant and spacious buildings; and he ornamented them with fine work of wood, and of all manner of precious things, of gold, and of silver, and of iron, and of brass, and of ziff, and of copper;
>
> 9 And he also built him a spacious palace, and a throne in the midst thereof, all of which was of fine wood and was ornamented with gold and silver and with precious things.
>
> 10 And he also caused that his workmen should work all manner of fine work within the walls of the temple, of fine wood, and of copper, and of brass.

Understanding *Ziff* Based on Book of Mormon Text and Translation

In trying to understand what *ziff* is, one must determine where the word could have come from in the context of the Book of Mormon "translation." It has become fairly well accepted that the Book of Mormon was not translated in the normal sense of the word. Joseph Smith read the text that was shown to him either by the interpreter stones provided to him or his own seer stone, at least in the case of proper names and non-English terms. For the bulk of the translation he did not look at any of the characters or words on the plates to determine the meaning of a particular character or sets of characters, there were just a few initially that he translated individually. Joseph dictated the words to a scribe, and it was dependent on the scribe to write the word correctly. For many person and place names and perhaps for a few other words that Joseph Smith or the scribe was unfamiliar with, the word was spelled out letter by letter (Skousen 2006).

The section of the Book of Mormon containing the word *ziff* is not contained in the Original Manuscript of the Book of Mormon (Skousen 2001), so it is not possible to see if there were any corrections made to the first spelling of the word as sometimes happened when a name was dictated letter by letter. It is fairly certain that the scribe for the verses using the word *ziff* was Oliver Cowdery. The word was not apparently a known word, and contained an "ff." Since the sound for "ff" is not distinguished from "f," it is speculated that the word *ziff* must have been spelled out letter by letter (personal communication, Royal Skousen 2014). However, because "iff" is a common spelling for similarly sounding English words (cliff, plaintiff, etc.), it is possible that it was not dictated letter by letter, but was written down in the most common and consistent English form.

The various possibilities of dictation for the word "ziff" are (1) that the scribe just heard the word, and the sound appeared to have a slightly different "f" sound, (2) that the scribe heard the word and used similar English words to construct the "ff" in *ziff* (i.e., cliff, stiff, etc.), or (3) that Joseph Smith dictated the word letter by letter to the scribe.

Curiously, the Printer's Manuscript of the Book of Mormon (Skousen 2001) does capitalize the word as "Ziff" in both verses where it is found, and does not capitalize the other metals or items listed. Royal Skousen (personal communication, 2014) indicated that because of the somewhat haphazard capitalization by the scribes (some worse than others) and also by comparison with other words starting with *z*, the capitalization of the word *ziff* in two places does not necessarily indicate the word is somehow different than other lower case words in the verses containing *ziff* (or other places in the Book of Mormon) but it might be. In order to determine if the capitalization was in fact intentional as part of the letter for letter dictation process, it was necessary to complete a further evaluation of the practice of capitalization in the Original Transcript of the Book of Mormon. All 200-plus proper personal and geographical names and non-English words were evaluated, the challenge being to identify an underlying capitalization pattern through the "noise" of scribal preference or nineteenth-century capitalization randomness.

It has been noted by Skousen that his general observation of errors in spellings of proper personal and place names did not occur on the first occurrence of non-Biblical words, only on subsequent spellings, which is one of the indicators that these words were spelled out letter by letter to the scribe. In order to determine whether specific capitalization was a part of the letter by letter spelling dictation process, the Original Manuscript was examined for the first occurrence of all of the non-Biblical proper personal and geographical names as well as the non-English words. Instead of an order of translation from the beginning of the Book of Mormon to the end, Skousen has indicated that the translation of the Book of Mormon began with the book of Mosiah and continued to the end of the Book of Mormon, after which the books from First Nephi to Mosiah were translated. For the capitalization analysis, both potential orders of translation were taken into account.

As much of the Original Manuscript no longer exists, many of the first instances could not be evaluated. Biblical terms were not examined, as their spellings may have been known to the scribe and it was not necessary to spell them out. Of the non-Biblical proper personal and geographic names examined, it was determined that all were consistently capitalized on the first instance. They are as follows:

Ammoron	Korihor	Pagag
Anti-Nephi-Lehies	Laman	Riplah
Antionum	Lehonti	Sam
Antipas	Lemuel	Sariah
Antipus	Midian	Shazer
Antiparah	Morianton	Teancum
Cumeni	Moroni	Tubaloth
Gid	Neum	Zenock
Irreantum	Paanchi	Zenos
Jershon	Pacumeni	

There are non-English words that are not person or place names: amnor, antion, cumoms, cureloms, deseret, ezrom, gazelem, leah, liahona, limnah, neas, onti, rameumptom, senine, senum, seon, sheum, shiblon, shiblum, shum, and ziff. Only two of these words, *Gazelem* and *antion*, were present in the Original Manuscript. Unlike proper personal and place names, *antion* was not capitalized, but *Gazelem* was. It should be noted that one textual interpretation of *Gazelem* denotes the word as the name of an individual, and another interpretation denotes it as an object.

In the Printer's Manuscript, these non-English words were not capitalized with a few exceptions. The word *deseret* was originally written in the Printer's Manuscript with a capital letter D, which was overwritten by a lower case d. The sixth instance of eight of *senine* is capitalized (Alma 30:33), the rest are not. The only instance of *Sheum* is capitalized in the Printer's Manuscript. The single instances of *Gazelem*, *Liahona*, and *Rameumptom*, all significant religious items, are capitalized in the Printer's Manuscript. As previously mentioned, the only two instances of *Ziff* are capitalized.

No absolutely definitive conclusion can be reached by the fact that *Ziff* is capitalized in both instances that it occurs in the Printer's Manuscript. As much as can be derived from the Original Manuscript, it is clear that the first spellings of proper person and place names have consistent capitalization. The non-English word in the Original Manuscript, *antion*, is consistent in that it is not capitalized. From patterns in the Printer's Manuscript, there is a distinct possibility that *Ziff* enjoyed some special religious designation or status, identical to Gazelem, Liahona, and Rameumptom (and perhaps Deseret). However, the fact that Sheum, apparently a type of grain, was also capitalized may provide the possibility that the capitalization is just scribal preference, although there are some grain deities that exist in Mesoamerica such as the Maize God. The capitalization of the sixth instance of *senine* appears to be a scribal preference and doesn't affect the first instance analysis.

Pronunciation of the Word *Ziff* in the Book of Mormon

In examining the various constructs of the word *ziff* at the point of translation, the differing scenarios can present different possibilities. If not spelled out by Joseph Smith, it is possible that the spelling that we have was not representative of the actual exact pronunciation of the original word because Joseph Smith may not have pronounced it correctly when dictating it, or the scribe had to interpret the word and construct it in English as he heard it.

What was clearly not provided during the dictation was a phonetic guide of the pronunciation of non-English terms (such as personal and place names) so one has to arrive at a pronunciation based on an English interpretation of the spelled-out word. In the case of *ziff*, which is what is called a transliterated word (a word from a different language written in English solely based on pronunciation in the original language), even if the spelling of the word is correct and was designated letter by letter, there is also a question of what the proper English pronunciation would be. Royal Skousen has asserted that the English in the Book of Mormon is from the 1500 and 1600s, not the 1800s (Skousen, 2005). Since the Book of Mormon translation contained English words and phrases from the 1500s to potentially the early 1800s, there may be variability in pronunciation, as the pronunciation of English, like every other language, changes over time. There are numerous documented pronunciation changes in English from the 1500s to the 1800s. It is also important to point out that while certain sections of the King James Bible are included essentially verbatim in the Book of Mormon, the target language for the translation was not limited to the vocabulary of the King James Bible, as there are numerous words that appear in the Book of Mormon that are not found in the King James Bible (i.e., abyss, incomprehensible, etc.).

This is not to say that a matching word for *ziff* in English (or transliterated from another language) is going to have a radically different pronunciation, but it would be expected that there is some limited range of pronunciation differences or similar sound substitutions present. For example, in modern English, the letters "r," "v," and "f" are close in the way the sounds are formed, as are "s" and "z," and sometimes native speakers have difficulty delineating the difference in some forms of these sounds when listening to a newly encountered word containing these letters. Linguists have a variety of terms to describe each type of sound of speech; this study will not delve into all of the linguistic classifications of sound, but will try to provide a framework on a more layman level.

With regards to the final “ff”, it is also possible that the utilization of the double “f” may not denote any original phonetic element, but may have been a preference of the translator in order to distinguish the word *ziff* from the word *Zif*, which is one of the ancient Hebrew months.

One needs to have some flexibility in searching for potential matches of words that “sound the same” as *ziff*, because of the potential uncertainty as to what the exact pronunciation of *ziff* was at the time of the Book of Mormon translation.

Because of its textual position amongst a list of metals in the Book of Mormon, and based on the stated use of ziff as part of the ornamentation of “spacious buildings,” the obvious place to commence an investigation of the meaning of the word *ziff* is that it is some type of precious or semi-precious metal, metal alloy, or a treated metal.

Chapter 2
Narrowing the Possibilities

Part of the scientific method is elimination of various possibilities, thus limiting the scope of detailed inquiry, and then what remains must contain the answer. We can assume that *ziff* is not one of the other base metals mentioned in the Book of Mormon that were translated into English. This would rule out the following metals:

- Gold
- Silver
- Copper
- Iron

It should be noted that there may be some form of the metal or combination of the metal that may be described by a different term (gilded, brazed, etc.) so care is needed not to exclude all forms of the base metal from consideration as a candidate for *ziff*. As with all ancient metallurgy, all ancient precious metals contained small amounts of other metals and impurities. Almost all ancient gold naturally contains considerable amounts of silver for example (Forbes 1950). The terms *brass* and *steel* mentioned in the Book of Mormon cannot be considered to be exclusive, as these terms in ancient metallurgy and medieval metallurgy were not uniform and could indicate a variety of alloys with copper (for brass) and iron (for steel).

For the word *ziff*, one must eliminate all metallic substances as a possibility that had an English term that was in use from the 1500s until sometime before the translation of the Book of Mormon was started. Modern exotic metals need not be considered (i.e., lanthanides, actinides, etc.). Metals (defined as Alkali, Alkali-Earth, Transition, Poor, and Semi metals on the periodic chart) that can be eliminated based on this criterion after examining the 1828 Webster's Dictionary, the Oxford English Dictionary, and medieval English texts are:

Base Metals

- Gold
- Silver
- Copper
- Iron
- Tin
- Mercury (Quicksilver)
- Lead
- Platinum
- Zinc
- Sulphur
- Titanium
- Sodium
- Potassium
- Magnesium
- Calcium
- Strontium
- Barium
- Yttrium
- Tantalum
- Chromium
- Molybdenum
- Tungsten
- Manganese
- Osmium
- Cobalt
- Iridium
- Nickel
- Palladium
- Platinum
- Cadmium
- Aluminum
- Boron
- Arsenic
- Antimony
- Bismuth
- Selenium
- Tellurium

Alloys

- Brass (copper and tin)
- Bronze (copper and zinc)
- Steel (iron and carbon)

Potential Remaining Metals not identified before early 1800s

- Vanadium
- Scandium
- Lithium
- Rubidium
- Cesium
- Beryllium
- Radium
- Zirconium
- Hafnium
- Niobium
- Technetium
- Rhenium
- Gallium
- Indium
- Ruthenium
- Rhodium
- Thallium
- Silicon
- Germanium
- Polonium

Of the remaining list of potential metals, there are none that ancient metallurgists would be expected to be able to produce. The only remaining possibilities for *ziff* as a metal are some form of alloy, a specialized form of a known alloy, or a known base metal that had some unique surface treatment or feature.

Chapter 3
Approach to Investigation of *Ziff* Possibilities

Having narrowed the list of possibilities for *ziff*, the following sequential steps will further narrow the possibilities for *ziff*:

1. Search English records from the 1500s to the 1800s for the word *ziff* or similar words or forms
2. Search for a transliterated word for *ziff* from more modern non-English sources with a history of metallurgy
3. Search for an ancient Semitic or Mesoamerican word or proto-word for *ziff* that matches or has evolved within the Nephite language to *ziff*.

Before commencing research into historical metals, it is necessary to understand that unlike our modern technological world of defined chemistry and exact international standards of metals and alloys and their definitions, the historical and ancient world was not so organized. Broad terms were used to include a variety of types of metals and alloys. Sometimes metallurgy was as much a religious and medicinal endeavor as it was a material science. Further confusion is created because, for the most part, the historians themselves are not metallurgists, and so are trying to describe something for which they may have no first-hand knowledge of process or terminology. Complicating things further is the translation of these ambiguous terms into another language which itself may have less than specific terminology. A good illustration of this is found in the writings of Pliny the Elder, Gaius Plinius Secundus (AD 23-79), a Roman of Equestrian rank who wrote a 37-volume set entitled *Natural History*.

Figure 1. Pliny the Elder

In attempting to describe a metal of his time, Pliny used the term *aes* in Latin (Pliny 77a). *Aes* in Latin can mean *bronze*, which modern scientists define as an alloy of copper and tin. The term can also mean *brass*, which modern scientists consider an alloy of copper and zinc. Some modern translators have translated the *aes* term of Pliny's to be brass, not bronze (Pliny 77b). Most ancient *aes* also contained lead. While that may seem vague enough, Pliny goes on to describe the three types of Corinthian bronze (*aes*), which he also defines by their relative content of

gold and silver, so *aes* can also be defined as an alloy with those metals. The term *bronze* or *brass* (even Book of Mormon *brass*) are terms that should be approached with caution when attempting to identify any historical or ancient alloy, as they often are catch-all terms for the various alloys of copper, and are often defined by the appearance and color, not by the metals contained in the alloy.

Ancient metallurgy involved proven techniques or recipes used by specific craftsmen or guilds, more so than any specific chemistry, since chemistry as we know it did not exist. The composition of the finished metal itself was often determined by the ore body utilized. Even today, since ore bodies vary widely in chemical composition, various tests and pilot plants are used to determine the best extractive process technique for a particular metal in a particular ore body. The same extractive challenge caused by differences in ore bodies existed for ancient metallurgists as well.

The vagaries of metallurgical definitions, especially of brass and bronze, extended well beyond Joseph Smith's time. The National Bureau of Standards' Letter Circular 487 (1937) stated:

> The first bronze was essentially an alloy of copper with tin, whereas brass was an alloy of copper with zinc, but it was soon found that the addition of other metals to the simple binary copper-tin alloy often resulted in a material with improved properties, such as strength and corrosion resistance or more pleasing appearance. Consequently, many of our nominal copper-tin alloys contain both tin and zinc and sometimes other metals. In such alloys it is often difficult to determine whether the zinc or the tin has a predominating effect; the decision cannot be based on the numerical percentages of the two since a given amount of tin usually has more effect than an equal percentage of zinc. With increasing complexity in the composition of the alloys, it becomes increasingly difficult to determine whether a given alloy should be called a brass or a bronze. In those cases where a distinction between brass and bronze could be made, there has been no great misuse of the term "brass" save that in railroad engineering parlance any kind of a bearing is often called a "brass" referring to the bearing rather than to the alloy of which it is made. On the other hand, misapplications of the term "bronze" are frequently encountered. Bronze has long been generally accepted as being superior in a number of ways to brass and advantages of this fact were taken in applying the term "bronze" to newly developed alloys. The term "bronze has been applied to so many copper alloys that the simple alloys of copper with tin are now often referred to as "tin bronze".
>
> Brass is an alloy consisting essentially of copper (50 to 95 per cent) and zinc (50 to 5 per cent). If the zinc content is greater than 30 per cent the alloy is a "high brass" or a "yellow brass", whereas if the zinc content is less than 20 percent the alloy is a "low brass." Brass containing an intentional admixture of lead for improving its machining characteristics is known as "leaded brass" or "lead brass." Alloys that contain more than 50 per cent zinc are usually designated as "zinc-base alloys."
>
> Brass of the general composition 60 per cent copper, 40 per cent zinc is widely known as "Muntz metal," but such names for specific compositions are less commonly applied to brasses than to bronzes. However some specific terms may be very misleading. For example, the name "German silver" or "nickel silver" refers to the white color of the alloys, not to their composition.
>
> Examples of the improper application of the term "bronze" are found in the alloys known as "architectural bronze," "manganese bronze," and "bronze" screen wire cloth.

As is apparent, the National Bureau of Standards was still somewhat confused even in 1937.

The twelfth-century Upper Mesopotamian writer, Ibn al-Razzāz al-Jazarī, who was a metalworker by profession, in his *The Book of Knowledge of Ingenious Mechanical Devices*, refers to the cast bronze doors of Āmid as being of brass, which in view of the surviving portions, is very unlikely (Rogers 1976).

> Muslim artists and artisans used basically the same metals and alloys as their Roman and Byzantine predecessors: gold, silver, and alloys of copper, tin, lead, and iron. Exact information about these metals is

> scanty. Our ignorance stems from a number of reasons. Most Islamic metal objects have not been properly analyzed, and as a result terms like 'bronze' or 'brass' are used indiscriminately in museum or exhibition catalogues and other scholarly publications. Moreover, the medieval Islamic terminology for metals and their alloys is often ambiguous and therefore difficult to evaluate. For instance, no clear distinction was made between bronze and brass, the term ṣufr being used for both. (Baer 1983, 1)

In addition, when dealing with ornamental metals (like *ziff*) the ancient metallurgists (often alchemists), for the most part, were trying to produce a particular color or finish. The alchemists in particular were attempting to produce gold or gold gild (or at least the look of gold) from lesser metals. As a result, the ancient name of the metal or alloy may only be a representation of surface color, not of composition.

Chapter 4
Ziff as an Existing English Word

The first pathway of inquiry will be to examine English words used from the 1500s to the 1800s to see if there are any close word matches to *ziff* with metallic meanings.

The 1828 Webster's Dictionary does not list *ziff*, but has many "iff" words (i.e., sherriff, plaintiff, difficult, whiff, midriff, skiff, griffen, stiff, pontiff, bailiff, cliff, etc.), so at least the basic word structure of *ziff* could be an original English word if the word proves to be a rare trade word that was not discovered in dictionaries examined. The King James Version of the Bible (using the Pure Cambridge Edition) does not contain the word *ziff*, but like the 1828 Webster's Dictionary, there are "iff" structure words (four of them: stiff, different, cliff, sheriff).

The 1828 Webster's Dictionary does include the word *zaffer*:

> ZAFFER, n. The residuum of cobalt, after the sulphur, arsenic and other volatile matters have been expelled by calcination; so that it is a gray or dark

Zaffer is also known as *zaffre*. Some elements of the word are similar to *ziff* ("z" and "ff" separated by a vowel), and might be considered as a candidate for *ziff* under the assumption that the exact spelling was not provided to the scribe and some pronunciation variation occurred in the dictation. However, it was a known English word in the 1600s so it cannot be completely ruled out.

Royal Skousen (2009) in *The Book of Mormon, The Earliest Text* has indicated that many of the translated words and phrases in the Book of Mormon are from 1500 to 1700 Early Modern English vocabulary, as well as 1611 King James Version Bible English. Early Modern English is the transition from Middle English in the late 1500s to Modern English during the mid to late 1600s. A search of Early Modern English dictionaries (Johnson 1768; Johnson 1792) and a search of the Middle English Dictionary (University of Michigan 2014) does not find the word *ziff*, but like the 1828 Dictionary, there are many words with the "iff" form in Middle English (bailiffs, cliff, swiff, meiff, chiff, etc.). One primary source used for the search of Middle English dictionaries was the electronic Middle English Dictionary: The print MED, completed in 2001, has been described as "the greatest achievement in medieval scholarship in America." Its 15,000 pages offer a comprehensive analysis of lexicon and usage for the period AD 1100-1500, based on the analysis of a collection of over three million citation slips, the largest collection of this kind available, so the search for *ziff* was considered extensive.

The online databases The Oxford English Dictionary (OED 2015), the Early English Books Online (EEBO 2015), and Literature Online (LION 2015) were also searched. *Zif* was found, but all instances were related to the pre-exile Hebrew month *Zif* (or its English equivalent, April). *Ziff* was also found in one AD 1540 reference, "The Byble in Englyshe," but it also was a reference in the Bible to the Hebrew month (1 Kings 6:1).

Although *zaffer* remains a remote possibility, there was no suitable English word found for *ziff*. As the term may be a trade or guild name of limited circulation and use, and not all writings have been indexed, there is still a small possibility that the word *ziff* may still be found. Metallurgical treatises written in English are sparse, so further research in this area is still warranted.

Chapter 5
Ziff as a Transliteration of an Existing Non-English Word

Transliteration is the taking of a spoken word or phrase from a different language and writing it in the alphabet and form of another language. Some might wonder if it is possible that the Book of Mormon could contain a non-English word. If the purpose of translation is to provide the term in English, and no English term is available, then the only options left are to provide a word that is in modern use that would accurately convey the intended meaning, even though it is not in the preferred language of translation, or to create a word in a transliterated form of the original language, with the probability that it's meaning may never be understood. Utilization of a non-English modern word would not be a typical approach for Book of Mormon linguists, however. At this stage, in order to gain a full understanding of this unknown word in the Book of Mormon, it would be wise to look at all potential options and see where the inquiry leads.

Transliteration has inherent inaccuracies, including:

1. In this case, the source of transliteration of an historic word must of necessity be from a written word. Knowing the exact pronunciation of a particular word in a native language at a particular point in time can be difficult, as pronunciation changes through time and the written word often does not change to reflect the changes in pronunciation.
2. There are always variations in pronunciation for a given word across a range of native speakers; large variations can occur if there are different dialects within a language.
3. A pronunciation sound in a source language may be non-existent or not quite the same in the target language. As a result, suitable approximations or substitutions are made for a transliteration into a target written language, introducing additional inaccuracies.
4. A word may be transliterated correctly at a specific point in time, but then the transliterated word in the target language may experience changes in pronunciation after that time.
5. Words that have undergone multiple transliterations through different languages will acquire additional inaccuracies with each transliteration.

A Systematic Approach to Transliteration

This case study for a transliterated *ziff* will involve looking for a word that has been transliterated to English from a word extant in some language from approximately AD 1500 to the early part of AD 1800. The pronunciation for *ziff* in the target language (English) would also need to have a pronunciation consistent with the spoken English of that time period. English spelling during much of that time period was not uniform and did not begin to regularize until printing presses increasingly used uniform spelling. Variant spellings can also produced variant pronunciations (Campbell 1999, 370).

Audio screening

Since listening to an electronic audio recording of a source language will provide a more accurate pronunciation of a word for transliteration into current English, this is a useful step to use in narrowing the scope for identification of the word *ziff*, recognizing that exceptions from this screening will be needed if historical linguistic research so dictates. It is recognized that not all languages have easily accessible audio of each word, and that pronunciations will only reflect the pronunciation of the individual who was recorded. For this aspect of the inquiry, an attempt was made to look at languages where metallurgy was anciently taking place, including languages spoken in Europe, Asia, Africa, South America, and the Middle East. It was not possible to look at all of the minor languages, but the attempt was to screen all of the larger language groups for a metallic term that approximated by sound the English transliteration of *ziff*. After reviewing and listening to an extensive list looking for an approximate transliterative match, two potential matches were found for the word *ziff* that appear to approximate the pronunciation criteria as well as being an ancient word related to metals.

Zyf

In Arabic, the word *zyf* (فيز), which is read from right to left, consists of the consonant letters zāy (ز), yā' (ي), and fā' (ف), which under modern transliterative rules of Arabic to English (www.en.wikipedia.org/wiki/Romanization_of_Arabic, 2014) could be rendered as zyf, zāf, zỳf, zīf, zef, ziif, and a few other configurations depending on the phonetic system used, but all systems are consistent in the transliteration of the zāy (ز) as "z" and the fā' (ف) as "f." The most common transliteration of yā' (ي) as a vowel would be the letter "i" as used in the English word "machine." Therefore the transliteration of this word to the English word *ziff* is acceptable by modern Arabic transliteration standards. A search of the Forvo.com audio file website (discussed below) does not have the word as a standalone word but does have the word contained in the word for "music" or "recital" (عَزيف). Listening to the audio of the word on Forvo, "ziff" is an accurate transliteration of "zyf" (www.forvo.com/word/%D8%B9%D9%8E%D8%B2%D9%8A%D9%81/#ar).

The modern definition of the Arabic word *zyf* in relation to its potential application to metal is "fraudulent or counterfeit coins."

Sfr

The word رفص (*sfr*) is an Arabic/Persian/Urdu word that is not found in modern dictionaries but is found in earlier dictionaries principally from the 1800s with meanings in Arabic of "brass," "yellow copper," or "gold", implying a possible gold-copper alloy, or copper with some surface treatment rendering it yellow. As previously mentioned, transliteration, by its nature, lends itself to inaccuracy because it is the attempt to take an audible word in a foreign language and represent it with letters that may not have the same sounds in the source language. In addition, the sounds of the word may not even exist in the English language, so they must be approximated. Since we don't have audible recordings of languages from the 1500s to the 1800s, the best approach is to attempt to use current audio files to find target words, and then work backwards using written phonetics (where they are available). The Arabic word رفص (normally read from right to left) consists of three Arabic letters:

Letter	Arabic Name	English phonetic transliteration
ص	sād	ṣ
ف	fā'	f
ر	rā	r

Written Arabic script is used for the written Persian and Urdu languages, although the spoken languages are not originally derived from Arabic. Forvo.com is an Internet site where native speakers add audio recordings of particular words or phrases including the words. For words using Arabic script, the basic Arabic alphabet is augmented by diacritics, which are marks that create or clarify additional pronunciations for short vowel sounds occurring between the letters and for some consonants. These would be similar to the diacritics used for ñ and é that most Americans are familiar with in the Spanish language. Forvo is only searchable for the base letters, not the diacritics, so further analysis of definitions of each word in each language is necessary. Following are the search results for رفص . A reasonable English transliteration is given after each sound:

http://www.forvo.com/search/%D8%B5%D9%81%D8%B1/fa/
Direct transliteration from the Persian sound files (3): ziff or ziffr or sefr

http://www.forvo.com/word/%D8%B5%D9%81%D8%B1/#ar
Direct transliteration from the Arabic sound file: ssufr

http://www.forvo.com/word/%D8%B5%D9%81%D8%B1/#ur
Direct transliteration from the Urdu sound file No. 1: ssufr
Direct transliteration from the Urdu sound file No. 2: ziffr

A recording on Forvo is an example of just one individual's pronunciation; naturally there will be some variation across a population. However, the examples in Forvo show that The Modern Standard Arabic form used for English of this word is ṣufr. For purposes of this inquiry, the word will be referred to in non-phonetic English as "sufr".

Review of written words and definitions

A review of written words from source languages was completed to further evaluate *sufr* for the transliterated word *ziff*. Once *sufr* was identified, an analysis of the steps and sequence of transliteration from the source language to *ziff* is necessary. The analysis involved various approaches, including the application of accepted historical linguistic techniques to evaluate the linguistic pathway from the source language to *ziff*. Unlike *zyf*, the transliteration was not direct and requires some linguistic steps.

Actual pronunciations of *sufr* differ, depending on the native variety of Arabic language of the speaker, as Modern Standard Arabic is a theoretical standard language, but is not actually anyone's native language. In many dialects in Arabic, the "u" sound in *sufr* is more or less interchangeable with "i." In Neo-Arabic and in Old Arabic, the opposition between i-u, is only weakly represented. It is observed that in many dialects there is no contrast whatsoever between i and u (Owens 2006, 51).

For example, in Nigerian Arabic there are no phonetic contrasts between i and u; there is lexical variation where either are used in words:

Himmirre -- humurre (donkeys)

Bitimm -- butumm (he finishes) (Owens 2006, 53)

Therefore, the words *sufr* and *sifr* can potentially be considered interchangeable from a pronunciation standpoint. An evaluation of all forms of the words that involve the three Arabic consonants (ṣ, f, and r) will be useful.

The Forvo database only had audio files for Persian, Urdu, and Arabic for *sufr*. *Sufr* is also present as written script in Pashto, Malay, Kurdish, and Ottoman Turkish. At this point, it appears that perhaps some reasonable transliterated words for *ziff* are found in Persian/Urdu/Arabic.

Any borrowing of a source word into a target language that has a different alphabet (such as Arabic to English) absolutely requires the use of transliteration. One useful tool to determine the feasibility of *sufr*/*sifr* deriving to *ziff* in the Book of Mormon translation is to compare similar pathways of other English words derived from *sufr*/*sifr*.

It is also useful to deconstruct each letter or sound of the word in evaluating the potential transition from *sufr*/*sifr* to the English form *ziff*.

1. The transition to the "i" in *ziff* from *sufr*/*sifr* is straightforward as previously discussed, as it already existed in one documented pronunciation of the word.

2. The transition from "f" to "ff" is also not considered to be a pronunciation transition as in most English words the "ff" sound is equivalent to "f." A common word structure in English for an "i" and an "f" sound together is "iff," so it may just reflect a common English word structure as opposed to a potential difference in pronunciation between "f" and "ff."

3. The letter "ṣ" in Arabic is not directly equivalent to forms of s in English, but is probably closest to the sound of "ss" in the word "massage". One comparative word that shows the linguistic pathway of "ṣ" to "z" is the English word "zaffer." Its linguistic pathway is from *sufr* to the French *zafre*, the Spanish *zafra*, the German *zaffer*, and then to the English *zaffer*. Other similar pathways in English to "z" from "ṣ" are (1) from *sifr* to *zero* occurring during the time period from AD 1200 to 1500, with *sifr* being Latinized into *zephirum* (Fibonacci AD 1202), and with the various dialects of Italian equivalents of this word being *zefiro*, *zefro*, and *zevero*; the latter was shortened to *zero* in English. And (2) in the Hebrew word for *Zion*, which when transliterated into Arabic utilizes "ṣ" as the equivalent "z." In addition, the interchangeability and migration from the "s" to the "z" sound is a well-documented pronunciation change that occurred within the English language during the period of AD 1500 to 1700 (Dobson 1957, 927).

4. The letter "r" of *sufr* is no longer present in the word *ziff*; the "fr" sound was substituted for an "ff" sound. This type of sound change is considered fairly common in historical linguistics. The deletion of a trailing consonant (like the "r" in *sufr*) or trailing vowel is called an apocope. Similar to an apocope, "final devoicing" sometimes occurs with the letters l, r, w, and j. Final devoicing is where a letter is present on the end of a word but no longer makes a sound. For example, *sifr* would then be pronounced "sif", so that a transliteration of the word would be *zif* or *ziff*, losing the r sound during transliteration. Another recognized sound change occurs when words are borrowed from a separate language. While some sounds are added to a word by language contact, other sounds may be eliminated (Campbell 1999). In addition, a search of English language dictionaries during the 1500s to 1800s does not show any English words that end in "fr," so any transliteration into English must of necessity either add a vowel between the "f" and the "r" (as happened with the word *zaffer* when it went to Latin-based words) or drop the "r." Since the word *zaffer* was already existent in English, it would have been appropriate during transliteration to drop the final "r" so as not to render a duplicative word while still maintaining the basic structure and intent of the

word. Finally, loss of a final "r" was a recognized pronunciation change that occurred in English during the period of AD 1500 to 1700 (Dobson 1957, 992).

Please note that the above analysis does not look at broader sound change shifts in other loan or derived words from the Semitic language into English; these sound shifts may in fact be the exception as opposed to the rule.

Conclusions

Inclusion of a more modern non-English transliterated word such as *ziff* would not be considered consistent with the general approach of linguistic origin of other non-English words in the Book of Mormon. However, it is a translation technique that is sometimes used, so must be considered in determining the possibilities for *ziff*. This approach yields *zyf* as a good candidate for *ziff*, with *sufr*/*sifr* also a secondary possibility.

Chapter 6
Modern Dictionary Definitions for صفر (*sifr/sufr*) and زيف (*zyf*)

In order to get a better sense of the more modern potential meanings of *sufr*/*sifr* and *zyf*, it is helpful to look at the medieval to modern definitions of the terms from Arabic, or from languages that borrowed and incorporated the Arabic script as part of the Islamic expansion that occurred from AD 600 to 800. Words that may have similar phonetics or similar spellings with related meanings are also useful to examine. The presence of these words in languages that derived from the early Arabic would be an indication that the word was extant prior to AD 600 in the Arabic language. These borrowed words might also provide some insight into the phonetic variance of the word, as well as additional meanings. It is also possible that borrowing by these other languages may have occurred prior to the Islamic expansion, or that the word may have been borrowed through pathways other than directly from Arabic. If similar words are not present, it does not necessarily indicate that the word was not present in AD 600 in Arabic, but it may mean it was a specialized term that was perhaps not in common usage in the Arabic of that time picked up by lexicographers of the time.

SIFR/SUFR – A Summary of Related Definitions and Sources

Persian

A Comprehensive Persian-English Dictionary (Steingass 1963)

Safār: Dry herbage

Sufār: A hissing, whistling chirping of a bird; a worm which gnaws the belly of a starving man; a collection of yellowish water in the belly

Saffār: A coppersmith

Shibh, shibah: like brass

Zar-nigár: Gilded, painted with gold

New Persian-English Dictionary (Beroukhim 1968)

A brazier (ṣaffar) or coppersmith

Kurdish

Kurdish-English Dictionary (Chyet 2003)

Sifar: copper

Sifir:

(1) copper

(2) brass

Zer: yellow metal

Zêŕ:

(1) gold

(2) gold pieces, gold coins, to shine, yellow metal

Urdu

Oordoo and English Dictionary (Thompson 1838)

Zufuránee: of saffron, a yellow color

Zur: Gold, riches, wealth, money

Zur-unḍóoḍa: gilt, plated with gold

Zur-i-soorkha: Gold: pure gold of a red colour, gold coin

Zur-gur: a goldsmith

Zur-i-gool: the yellow stamina of a rose

Zur-nigár: Gilt

Zur-nigáree: Gilding

Zurḍ: Yellow, pale, livid.

Sifr: A cipher

Sifṭ: Soft pitch

Suf-éer: Sound, whistling, a hissing noise, blowing, singing; a sapphire

Súfra: Bile, yellow

Súfur: The second month of the Mahomedan year

Arabic

A Dictionary of Modern Arabic (Newman 1871)

Söfr:

(1) U(s)fir: whistle, hiss also Söfar
Sâfir: whistling bird esp. a small bird so called
Suffarid: nightingale
Saffâra: a whistle (fife etc.)

(2) A(s)far: yellow
Söfr-- yellow copper, brass
Söfra: yellow colour, yellowness, yolk of egg
Safrâ: bile, gall
Söfâr: biliousness disease
Söffâr: worker in yellow copper
Söffârieya: yellowhammer? (a bird)
Saffir: make yellow paint
U(s)firr: become yellow
Söfâra: plant faded and yellow

(3) Safier: sapphire

A Dictionary, Persian, Arabic and English (Richardson et al. 1806)

Safar: House without furniture; a distemper in the belly which makes the face pale; second month of the Mahometan year

Sifr: A cipher; empty

Sufr: Copper

Safrā: Yellow, pale, vivid; the bile; empty, trifling, vain; more hissing, sonorous; gold; saffron

Safral: Hunger; yellowness; copper; the yolk of an egg; the rumbling noise of the belly

Sifrud: The nightingale
Suffrazi: Bilous, choleric

Arabic Dictionary [with etymologies] (Rajki 2005)

(Not necessarily based on Arabic word script)

ssifr: nought, zero [intra Semitic borrowing from ssafira], Azerbaijani cognate sifir, Hausa cognate sifiri, Hindi cognate sifr, Persian cognate ssefr, Swahili cognate sifuri, Turkish cognate sifir; borrowed from Aramaic

ssufr: brass (borrowing from Akkadian zabar); (borrowing from Sumarian zabar); Persian cognate ssofr; borrowed from Aramaic

ssufra: yellow color [intra Semitic borrowing from ssufr]; Persian cognate ssofrat; borrowed from Aramaic

Egyptian Arabic

A Vocabulary of Vernacular Egyptian Arabic, Containing the Most Useful Words Only (Tylor 1900)
yellow: aṣfar, ṣafrā, ṣufr

A Dictionary of Egyptian Arabic (Hinds et al. 1986)
Ṣafar: to whistle
Aṣfar: yellowness
Ṣaffar: to make yellow
Ṣafar: Safar, second month of the Muslim year

ZYF -- A Summary of Related Definitions and Sources

Kurdish

Kurdish-English Dictionary (Chyet 2003)

Şib: bronze, fake gold
Zîv: silver
Zîw: silver

Egyptian Arabic

A Dictionary of Egyptian Arabic (Hinds et al. 1986)

Zyf, zayyif: to counterfeit, forge (particularly money)

Urdu

Oordoo and English Dictionary (Thompson 1838)

Syf: A sword

Persian

A Comprehensive Persian-English Dictionary (Steingass 1963)

Zuyūf: Being clipped or base (coin); (plural of zaif) base coin
Zaif: Being bad or clipped (money)
Zīf: Clipt, base (coin)
Zīf: Pitch
Zar: Gold
Zā'if: False coin
Zar-koft: Plated with gold

Arabic

www.almaany.com/en/dict/ar-en/%D8%B2%D9%8A%D9%81/?PageSpeed=noscript, 2015
(various forms of *zyf*)

تَزْيِيف : (اسم) زَيْف

Counterfeiting
—act of copying, imitating (coins, handwritings, etc.)
—fraudulently alter or make false
—the act or instance of forging, counterfeiting, or falsifying a document etc.
—the act of forging; counterfeiting, etc.

زَوَّرَ : زَيَّف

Counterfeit; doctor ; fake ; falsify ; forge ; rig
—to copy, imitate (coins, handwriting, etc.)
—counterfeit, falsify, feign
—fraudulently alter or make false
—make (money etc.) in fraudulent imitation

زائِف : زَيْف

Spurious
—fabricated or illusory
—superficially, or on the surface favorable but really false
—not real or natural or part of a natural process; deliberately made; made by art; manufactured; fake; not sincere
—sham; counterfeit
—made or done in imitation of another thing in order to deceive
—look like real but not
—false; fabricated
—fraudulently alter or make false
—counterfeit, forged
—falsified; pirated; counterfeit
—mimic, imitative, forged
—forged, false, mimic

—not real, but intended to be very similar to a real situation, substance etc.
—false or not real
—to be false or forged
—false or pretended
—counterfeit; forged; falsified
—pretended; not genuine
—false; counterfeit; make-believe
—slanderer ; fabricator ; liar; counterfeit; not genuine

كَذِب : زَيْف

Falseness; falsity; unreality

زَيّف

Imitate

Hebrew

A Comprehensive Etymological Dictionary of the Hebrew Language for Readers of English (Klein 1987, 197, 201)

Zyph: to forge, falsify, counterfeit, adulteration
Zyw: brightness, radiance, splendor
Zphph: to coat with pitch

Chapter 7
Further Analysis of *Sifr*/*Sufr* (رفص)

More Recent Definitions and Usage from Historical Writings

The scope has been narrowed to two possibilities for *ziff*: *zyf* or *sifr*/*sufr*. The potential metallurgical make-up for *zyf* is fairly well defined as a gold gilded material, however the possibilities for *sifr*/*sufr* still remain somewhat broad. It is now necessary to look at the varying definitions of the English words and English terminology for metals from the 1500s to the 1800s to further narrow the scope as to the intended meaning of Book of Mormon *ziff*, as the *sifr*/*sufr* definition still encompasses some varying range of metals and alloys. As was the case for the previous analysis of narrowing and eliminating metals that were already identified in the English language during that time period, the same type of review is needed to identify any of the range of definitions for *sifr*/*sufr* that may have had an English equivalent; then that portion of the definition of *sifr*/*sufr* may be eliminated from further consideration as a transliterative candidate for *ziff*.

It is clear from the definitions from the potential source languages that if *ziff* is *sifr*/*sufr*, it is some sort of "yellow copper" or a distinct type of yellow brass/bronze that also involves gold. It may involve an alloy of copper that gives it a yellow color, or it may be a surface treatment or gilding that gives it that appearance. Historical naming of metals is not determined by a specific cutoff and classification of a percentage of alloy in a metal, it is more based on color, surface treatment, or use.

A compilation of historical writings for the source word was made to determine variations in the use of the potential source language word for *ziff* to better determine the actual meaning of the word. Application of principles of metallurgy were also useful to evaluate the exact definition of *ziff*.

Many medieval metallurgical reference books were consulted and any findings discussed, including:

The Book of Minerals by Albert Magnus, AD 1257

De Re Metallica by Georgius Agricola, AD 1556

Agricola makes no mention of any gold and copper alloy except as a test needle for purposes of touchstone assays.

The Pirotechnia of Vannoccio Biringuccio by Vannoccio Biringuccio, AD 1540

Biringuccio noted the existence of gold and copper alloys, but assigns them no particular name. (pg. 208)

Theophrastus on Stones by Theophrastus, 310 BC

Theophrastus notes that gold and silver together can be alloyed with copper, but no unique name is given to the alloy (Theophrastus 310, 54)

Pliny Natural History, Books 33-35 by Pliny, AD 77

Pliny discusses an apparent alloy of gold and copper (it could be interpreted as copper with a gold gild) called pyropus, however this term did not survive to the Middle Ages as an recognized name for the alloy, only as a name for a precious stone [pirope] (MED, 2014). Pliny also identifies Corinthian bronze, which is an alloy or gilding of both gold and silver with copper. Pliny indicates that it was a product that was no longer

made during his time, and there is an academic debate as to whether it existed at all as described by Pliny (Pliny 77a, 71, 95, 129, 133, 197).

Pliny, like Theophrastus, noted the mixture of gold and copper for use as a solder:

> The mixture is made with Cyprian copper verdigris and the urine of a boy who has not reached puberty with the addition of soda; this is ground with a pestle made of Cyprian copper in mortars of the same metal, and the Latin name for the mixture is santerna.

Theophilus on Divers Arts, The Foremost Medieval Treatise on Painting, Glassmaking and Metalwork by Theophilus, 1140 AD:

A form of counterfeit "Arabic gold" was described as a copper-gold alloy by Theophilus:

> Arabian Gold
> There is also Arabian gold, which is very precious and of an exceptional red color. The use of it is often found in very ancient vessels. Modern workmen counterfeit its appearance when they add a fifth part of red copper to pale gold and they deceive many unwary people. But this can be guarded against by putting it in the fire: if the gold is pure, it does not lose it lustre, but if it is an alloy, it completely changes color.

Presumably, in order to be considered a legitimate counterfeit, the alloy probably came from somewhere in the Middle East. No specific name for the copper-gold alloy was identified. Theophilus's only other mention of gold-copper alloys is small amounts that occur when copper is used as solder on gold items.

Other observations related to *sufr* provide some insight as to the early possibilities for *sufr*:

> Muslim artists and artisans used basically the same metals and alloys as their Roman and Byzantine predecessors: gold, silver, and alloys of copper, tin, lead, and iron. Exact information about these metals is scanty. Our ignorance stems from a number of reasons. Most Islamic metal objects have been properly analyzed, and as a result terms like 'bronze' or 'brass' are used indiscriminately in museum or exhibition catalogues and other scholarly publications. Moreover, the medieval Islamic terminology for metals and their alloys is often ambiguous and therefore difficult to evaluate. For instance, no clear distinction was made between bronze and brass, the term ṣufr being used for both. (Baer 1983, 1)

Possibilities for *sufr*/*sifr* Based on Color

Based on the dictionaries and historical information on *sufr*/*sifr*, the best possibility appears to be that it is an alloy or surface treatment of copper that renders it yellow. It is necessary to look at the varying alloys or surface treatments that could render that result. In modern metallurgy involving alloys and not surface treatment, there are two alloys that can render copper "yellow": gold (with or without silver) and zinc.

A) Copper with gold (with or without silver)

In modern commercial gold-copper alloys, the typical percentage is 75% gold (18-carat, pure gold is 24-carat), however it is common to have gold jewelry at 33% (8 carat). This would probably be considered the modern day cutoff between what would be considered gold and what one might consider "yellow copper." The gold-copper-

silver alloys are more commonly used than gold-copper alloys today. An 18-carat alloy of 75% gold with about equal parts of silver and copper has a yellow color; replacing more of the silver with copper produces a red gold. The 14-carat 58.35% gold, 2.5 to 5% copper with the balance being silver, creates a greenish alloy. Increasing the copper to 20 to 30% makes yellow golds and higher copper content produces a reddish color. The 10-carat golds are largely high copper alloys with various additions to control color. "White gold" is a series of gold-nickel-copper-zinc alloys; "pink gold" is a series of gold-silver-copper-nickel-zinc alloys containing the requisite amount of gold to make 10-, 12-, and 14-carat alloys. The copper varies from 51.5 to 31.0% (Hodge 1954, 573). Figure 2 shows what is known as a "ternary diagram" which can be used to determine the color of any copper-gold-silver alloy.

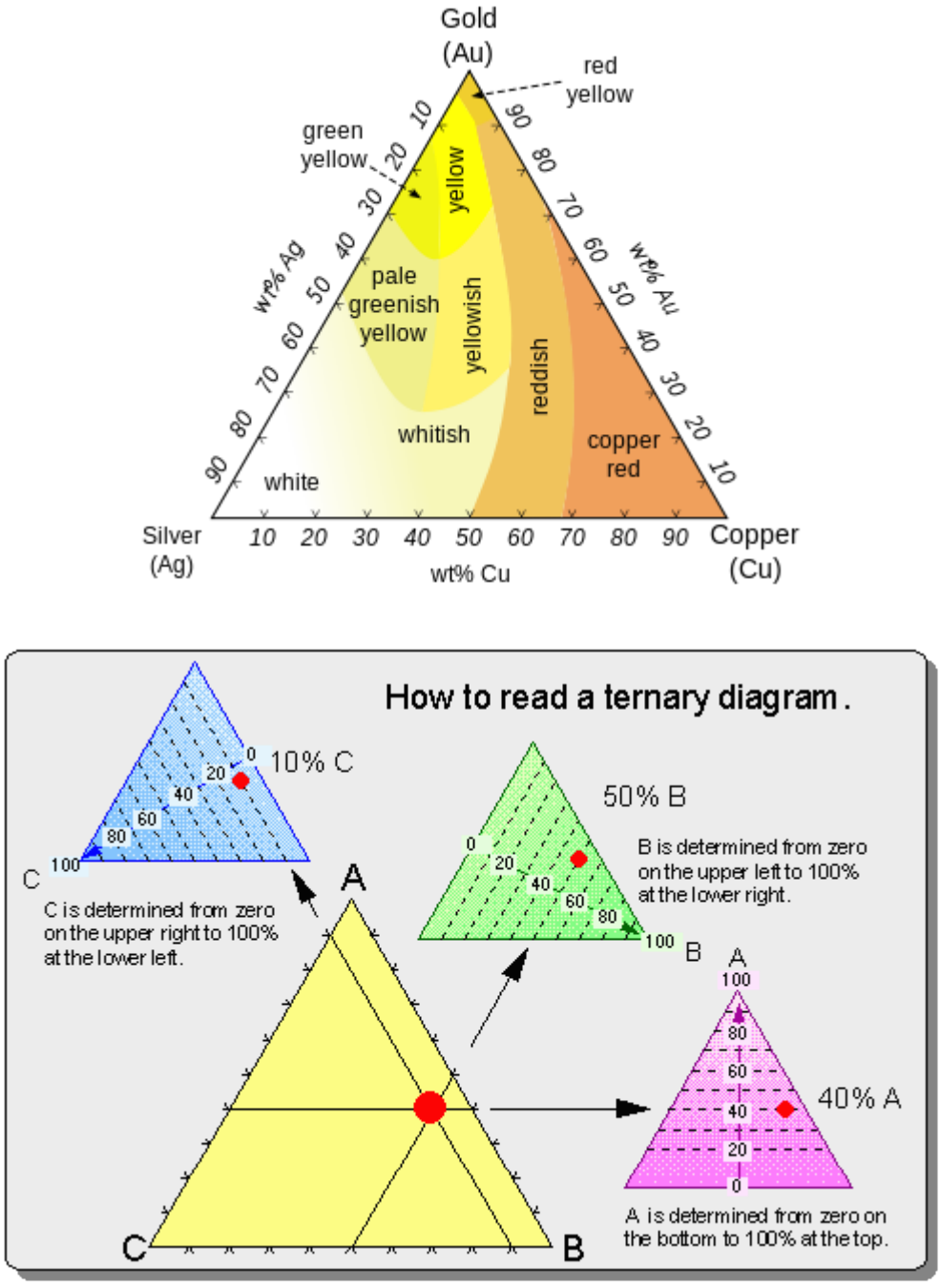

Figure 2. Gold-silver-copper color ternary diagram (Wikipedia Commons 2015)

In Egypt from the XVIII dynasty on is found the practice of debasing gold by alloying with copper; later in Egyptian history compounds containing up to 75% copper are found (Forbes 1950, 156).

As was previously noted, Theophilus in AD 1140 noted a counterfeit "Arabian gold" that was actually four parts gold and one part copper. Pliny (AD 77a) and Biringuccio (AD 1540) note the presence of gold and copper alloy but do not have names for them and do not use the terms "yellow copper." However Pliny does note that the color/quality changes with variations in gold and silver content.

Hufrat (in the Sudan) produced copper with a light yellowish color because the ore was laced with finely disseminated gold in the ore (Herbert 1984).

In some instances, "yellow copper" may in fact be actually just gold. In ancient African metallurgy, in general, gold seems to have come later than copper or other metals. Thus the Katanga people refer to gold as "yellow copper," calling it thus because they knew copper before gold (Cameron 1885).

B) Copper with zinc

Generally speaking, copper becomes yellower as the zinc content of the alloy increases. Modern copper and zinc alloys can contain up to 50% zinc. The following table indicates the relative colors of the various alloys of zinc and copper.

Table 1. Copper Alloy Table

Common Copper Alloys

Alloy	Common Term	Composition	Color	
			Natural	Weathered
C11000 / C12500	Copper	99.90% Copper	Salmon Red	Reddish-Brown to Gray-Green Patina
C12200	Copper	99.90% Copper 0.02% Phosphorous	Salmon Red	Reddish-Brown to Gray-Green Patina
C22000	Commercial Bronze	90% Copper 10% Zinc	Red Gold	Brown to Gray-Green Patina in Six Years
C23000	Red Brass	85% Copper 15% Zinc	Reddish Yellow	Chocolate Brown to Gray-Green Patina
C26000	Cartridge Brass	70% Copper 30% Zinc	Yellow	Yellowish, Gray-Green
C28000	Muntz Metal	60% Copper 40% Zinc	Reddish Yellow	Red-Brown to Gray-Brown
C38500	Architectural Bronze	57% Copper 3% Lead 40% Zinc	Reddish Yellow	Russet Brown to Dark Brown
C65500	Silicon Bronze	97% Copper 3% Silicon	Reddish Old Gold	Russet Brown to finely mottled Gray-Brown

Common Copper Alloys

Alloy	Common Term	Composition	Color	
			Natural	Weathered
C74500	Nickel Silver	65% Copper 25% Zinc 10% Nickel	Warm Silver	Gray-Brown to finely mottled Gray-Green
C79600	Leaded Nickel Silver	45% Copper 42% Zinc 10% Nickel 2% Manganese 1% Lead	Warm Silver	Gray-Brown to finely mottled Gray-Green

(Copper Association Development, Inc., 2015)

Examples of some trade metals currently sold as "Red Brass" and "Yellow Brass" are shown in figure 3. In this example, the "Red Brass" consists of 85% copper and 15% zinc; the "Yellow Brass" has 70% copper and 30% zinc.

Figure 3. Color difference of copper-zinc alloys (www.Monsterslayer.com 2015)

Probably to be considered "yellow," an alloy of copper and zinc would need to have copper in the range of 60 to 70%.

Chapter 8
Ziff as an Original Book of Mormon Civilization Word

The prior evaluation that the word *ziff* could possibly be a representation of a word (English or non-English) that existed from the 1500s to the very early 1800s required a linguistic analysis of transliteration and borrowing from one language to another during that period of time. A different explanation is that *ziff* is actually an original word used by Book of Mormon peoples, and that it presumably existed in a Semitic language used by one of the Book of Mormon immigrant groups prior to Lehi's departure from Jerusalem.

At this juncture, it appears that *zyf* is a better candidate than *sifr*/*sufr*, so most of the additional investigation will evaluate *zyf*. Some elements of variability of transliteration will still apply to consideration of *ziff* as an original Book of Mormon era term. The term still had to be transliterated to English through the translation process of the Book of Mormon, recognizing that the word *ziff* may only be an approximate pronunciation of the original Nephite term.

We do not know the spoken language of Mormon, or of any other New World peoples in the Book of Mormon for that matter. Statements regarding the original language are found in Mormon 9:32, which says that "the characters which are called among us the reformed Egyptian, [were] handed down and altered by us, according to our manner of speech" and that "none other people knoweth our language." The Book of Mormon also says that its first author, Nephi, was taught both the "learning of the Jews and the language of the Egyptians" (1 Nephi 1:2), and that the last portion of the book containing the word *ziff* was written in "reformed Egyptian" because that language took less space and was easier to engrave on gold plates than Hebrew, and that there was also an evolution of the Hebrew after the people left Jerusalem. A recent analysis of the Caractors document, which contains some of the original glyphs from the plates of the Book of Mormon, shows that the written language derives from Egyptian hieratic and demotic with some Mesoamerican elements (Grover 2015).

We do not know if the word *ziff* was part of the long-standing Nephite vocabulary or whether it was a borrowed word from some other ancient New World native language. The only real meaningful inquiry that can be attempted is to compare it with some of the Old World languages that we have some knowledge of. An analysis of various place and personal names in the Book of Mormon has shown links to Old World languages (Book of Mormon Onomasticon 2014). A look at the term *zyf* might provide some insight as to the possibilities of the word anciently originating from the Old World.

Potential Old World Language Sources

There were three migrations of groups of individuals from the Old World mentioned in the Book of Mormon. They are the family and associates of Lehi from Palestine and Arabia in approximately 587 BC, Mulek and associates from Palestine in approximately 580 BC, and a much earlier migration of the family of Jared and associates from somewhere in the Middle East at approximately 2500 BC (Sorenson 2013, 5).

Historical linguistics and Prior Attempts at *Ziff*

One principle of historic linguistics is the assumption that words that are represented by terms which have cognates widely spread across the languages in a language family are older in the associated cultures than terms

which do not have wide distribution. This also helps distinguish words that may have been borrowed from words that may actually be a proto word that preceded the languages that share the word (Campbell 1999).

In evaluating whether *ziff* is an original Nephite/Lamanite/Jaredite word, the only potentially original phonetic information in the Book of Mormon that we have are the original person and place names. There are various names that start with "z" (Zarahemla, Zeniff, Zoram, Zenos, Zenoch, Zebulun, Zechariah, Zedekiah, Zeezrom, Zemnarihah, Zenephi, Zerahemnah, Zeram, Zerin, Zion, and Zoramites) and there is one name that contains "iff" (Zeniff; see Mosiah 7:9, 13, 21; 8:2; 9:1; 10:19; 11:1). The etymology established from the Book of Mormon Caractors document indicates that the phonetic etymology from the Egyptian for Zeniff is the Egyptian word *snb* (Grover 2015, 130). If looking for an Egyptian phonetic source, the closest might be an abbreviated form of the Egyptian word for a metal that is used in a ritual, *sfdw*, with the first two letters providing a match for the phonetic elements of *ziff* (Dickson 2006, 154). It is possible that *ziff* is a transliteration of a Nephite/Lamanite/Jaredite word, as the letters and morpheme word form exist elsewhere in the Book of Mormon.

Prior attempts to use etymology to determine a meaning for the term *ziff* have all assumed that it is a Nephite term that was transliterated to English, and have looked for an ancient Hebrew meaning for the term. The Book of Mormon Onomasticon Project (wwi.lib.byu.edu/onoma/index.php/ZIFF, 2014) indicates that the Biblical name Ziph in Joshua 15:24 and the personal names in 1 Chronicles 4:16 and 2:42 (King James Bible has *Ziph* for both; the Masoretic text has *zîp* for both) would seem to offer the closest analog to Book of Mormon *ziff*. There is no etymology for these names in the Bible, so their connection to *ziff* could only be considered a phonetic one with the data available.

With the assumption that *ziff* is a metal, the Onomasticon Project opined that it would be "tempting" to equate *ziff* with the Hebrew vocable, *ziw*, meaning "glow, complexion." They also indicated that it might relate to the Hebrew month name *Zif* (King James Bible, 1 Kings 6:1, with the Hebrew *ziw*), meaning, the month of blooming. They also indicate it is probably related to Akkadian *zīmu*, "appearance, luster, glow." However, they indicate that this approach may have some problems because none of the Semitic cognates of Hebrew *ziw* end in a consonant, except possibly the Punic *zyb*. Furthermore, none of the translations of the 1 Kings 6:1 transliterate the Hebrew *ziv* with a final /f/ or a /p/, until the Matthew Bible, *Zif*, the Geneva Bible, *Zif*, and then the King James (the Septuagint does not contain this verse; the Vulgate and Wycliffe both have *Zio*).

While these prior approaches have yielded some clues, they have all taken the approach that the word *ziff* was the transliterated Nephite term, and then they have attempted to approach ancient Hebrew words to see if they can find correlations. As the Book of Mormon Onomasticon indicated, the word by its structure does not lend itself to a Hebrew origin.

The Semitic Language Family

The Semitic language family tree is found in figure 4 and shows the languages, their relative relationship to each other, and the languages each is derived from. These languages would be the most likely to show a cognate of *ziff*, evidence as *ziff* as a proto word, or a pool from which *ziff* may have been borrowed into pre-600 BC Biblical Hebrew. Also, since the Book of Mormon script is Egyptian or Egyptian based, it would be prudent to examine that language as well.

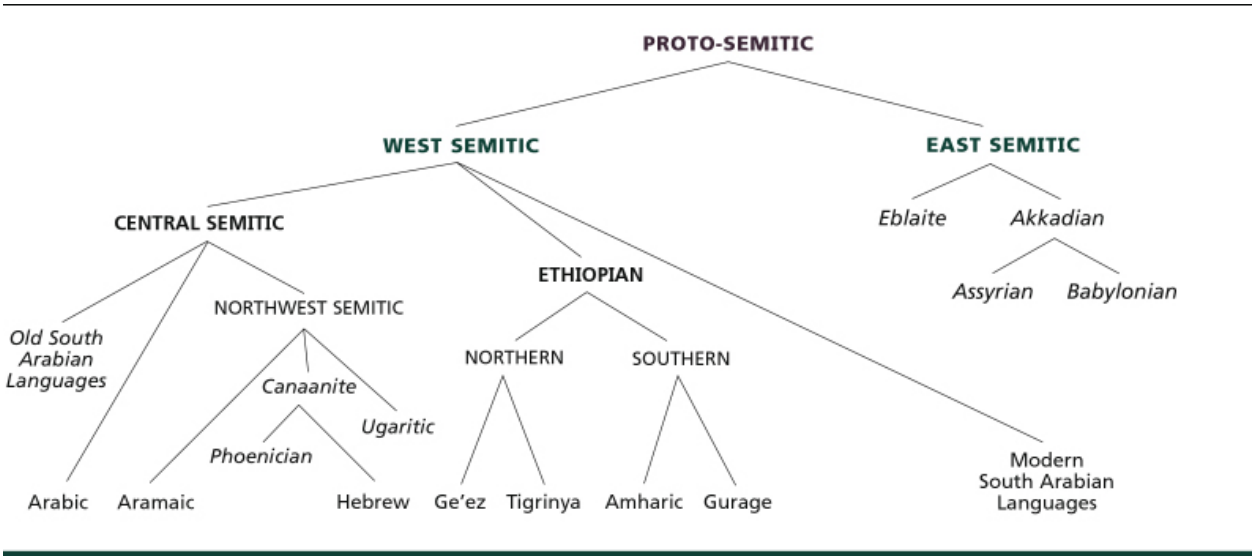

Figure 4. Semitic language family

As indicated in figure 4, the parent language is called "Proto-Semitic." Proto-Semitic is not an actual language, but is a hypothetical language derived by historic linguists approximating what an original word might have been before it was modified and became a daughter language.

Biblical Hebrew

It is first important to recognize that what we do not have the original text of the Bible as it existed in 587 BC when Lehi left the Old World. There are very few non-Biblical Hebrew scripts prior to 587 BC, so there are many original Hebrew words that we do not have. It is estimated that we only have one fifth of ancient Hebrew as reflected in the Biblical Hebrew in the Bible, so it would not be surprising to find a that a word like *ziff* existed in ancient Hebrew but is not actually found anywhere in the Bible (Albright 1962, 62), especially if it was borrowed. Many of the other Semitic languages have the same problem or worse. This is important to remember because there are many Hebrew words that could theoretically show up in the Book of Mormon and we have no ability to determine by relying on Biblical Hebrew texts if they existed in Biblical Hebrew. In addition, much of the ancient Hebrew that we have is essentially translation or transcription products of earlier Hebrew texts that no longer exist, and many of the translation products often translate the same original word differently. Figure 5 shows the translation sources and translation interrelationships of the Old Testament sources, figure 6 shows a simplified timeline for the Bible translations.

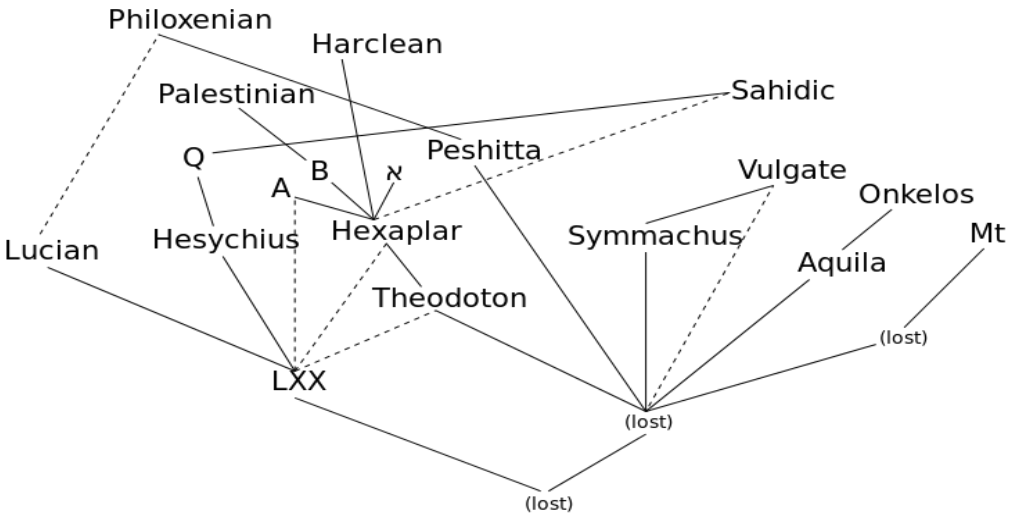

Figure 5. The interrelationship between various significant ancient manuscripts of the Old Testament (www.wikipedia.org 2014)

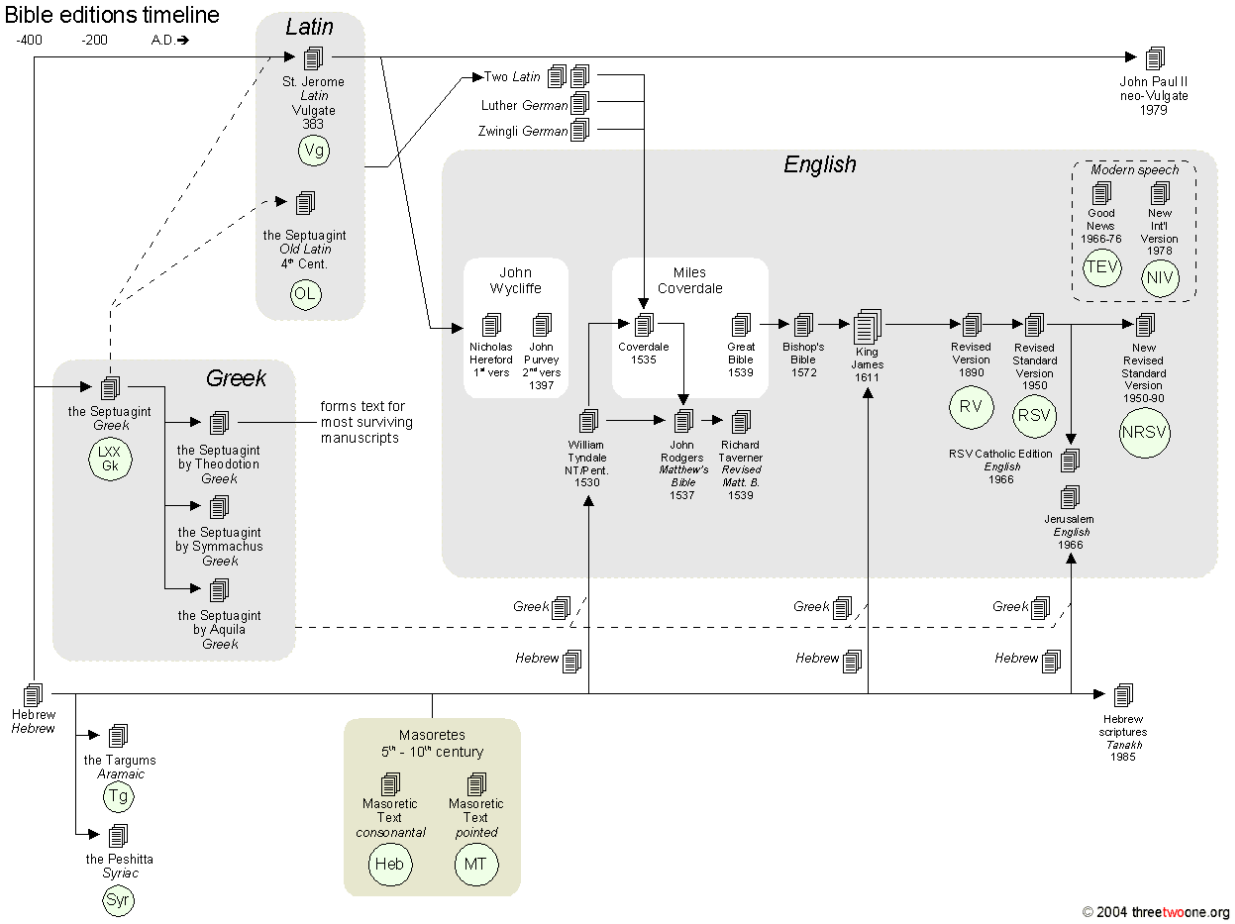

Figure 6. Bible editions timeline (www.threetwoone.org 2014)

Biblical Hebrew does not attest any verb or noun form from the root *zwp* or *zyp*. However, there is one geographical name, *zyp* (*Zif*), which could conceivably mean "(place of) casting metal" or something similar (Calabro

2015). It is also probable that a word *zayip* was part of Hebrew in the biblical period despite not being attested in the Bible, since Mishnaic Hebrew includes the noun *zayip* "bristles (of swine); eyebrows." This word is easily derived from an original sense of "coating." It is likely that this word, like the Arabic, is inherited from Common Semitic rather than being an Akkadian loanword.

Loan Word Possibility

In order to consider *ziff* as migrating with an immigrant population such as the family and friends of Lehi, then of a necessity the word would need to be found in a language spoken or written by the immigrant population. Many Semitic words involving metal or the working of earth materials are "loan words" either borrowed from a specific neighboring language or from a larger cultural group of adjacent languages. It is a well-accepted linguistic premise that, all things being equal, common technical vocabulary travels in the direction of the processes, instrumentation, and products to which it was applied (Mankowski 2000).

The following Biblical Hebrew words related to metals or earth products have been shown to be loan words from other Semitic languages (Mankowski 2000; Ellenbogen 1962):

1. Tin.

The Biblical Hebrew term for tin used in Amos 7:7-8 is (אֲנָךְ) *'anak*. As with many metallic terms in Biblical Hebrew, there has been some history of confusion involving this term among early Bible translators. It has been translated to mean:

Peshitta and the Targum (Aramaic) = "judgment, decision, sentence"

LXX (Greek) "steel, diamond"

Theodotion (Greek) = "molten"

Aquila (Greek) = "shining"

Vulgate (Latin) = "plaster, scoop, scoop shaped fire-pan or basin"

Linguistic equivalents in other Semitic languages are: Sumerian – *anag*; Akkadian – *annaku; '* Syriac – *'ankā* (tin); Arabic – *'anuk* (lead); Gə'əz – *nāək* (tin and lead); Armenian – *anag*; and Coptic – *anok*.

There has also been confusion regarding this term as most dictionaries list it as "tin or lead." It appears that the term is used primarily to refer to tin, but in some cases is referring to lead. It has been considered by some linguists that the source of this word is Akkadian (Ellenbogen 1962; Zimmern 1917), but more recent scholarship has classified it as a "culture word" with multiple potential sources, including non-Semitic languages (Mankowski 2000).

2. Iron. (בַּרְזֶל) *bar-zel'*

Linguistic equivalents in other Semitic languages are: Akkadian – *parzilla; Ugaritic – brŏl;* Phonecian/Punic – *brzl*; Aramaic – *przl';* Arabic – *firzil*; Old South Arabic -- *nāək*; Armenian – *anag*; and Coptic – *anok*.

This word has been identified as an introduced word from a Western source but has not been further delineated beyond that.

3. Glass. (זְכוֹכִית) *zekokith*

This term is found in Job 28:17 and derives from the Akkadian *zakakātu/zakukūtu*. Other Semitic equivalents are: Syriac – *zgūgītā*; and Mandaic – zgauita.

4. Clay, mire, mud. (טִיט) *teet*

This term is found in Leviticus 11:35 and is derived from the Akkadian terms *ṭīdu*, *ṭīṭu*, and *ṭīṭṭu*. Other Semitic equivalents are: Jewish Aramaic – *ṭyṭ'*; Syriac – *ṭinā*; and Aramaic – *ṭīn*.

5. Smelter, furnace. (כִּיֹּר) *koor*

This term is derived from the Akkadian and Sumerian terms *kīru* and *kir*. Other Semitic equivalents are: Common Aramaic – *kūr*; Aramiac – *kūr*; Gə'əz – *kawr*; Sabean – *kwr*, and Egyptian – *qu=ra.*

6. Pitch, bitumen. (חֵמָר) *khay-mawr'*

This term is found in Genesis 6:14 and derives from the Akkadian *kupru*. Other Semitic equivalents are: Syriac – *kūprā*; and Arabic – kufr.

7. Gold. (כֶּתֶם) *keh'-them*

The proposed loan pathway for this word for gold is Sumerian to Akkadian to Egyptian to Biblical Hebrew. The Semitic equivalents are: Sumerican – *kudim*; Akkadian – *kutimmu*; Egyptian -- *ku=t=m(t)*; and Imperial Aramaic – *kdm*.

8. (a qualification of gold) probably refined or purified. (סָגַר) *saw-gar'*

This term is derived from the Akkadian words sakru, sagru, or sag/kēru (Middle Assyrian, Neo-Assyrian, and Neo-Babylonian). Other Semitic equivalents are: Late Babylonian šagīru; and Ugaritic sgrt.

9. (some type of gemstone) perhaps agate. (שֹׁהַם) *šə·ḫōw*

The proposed loan pathway for this word is Sumerian to Akkadian to Biblical Hebrew. The Semitic equivalents are: Sumerian – *suba*, *šuba*; and Akkadian (Neo-Assyrian, Neo-Babylonian, Standard Babylonian) – *šubû*.

10. Red paste (possibly hematite). (בַּשָּׁשׁ) *šā·šar*

This term is derived from the Akkadian *šaršerru.*

11. Daric (gold coin). (אַדַּרְכֹנִים) *ad-ar-kone'*

This term was borrowed from the Old Persian daraniya. Other equivalents are Avestan – zaranya; Pahlavi – zarēn; and Sanskrit – hiranya.

12. Amethyst. (אַחְלָמָה) *akh-law'-maw*

This term was borrowed from the Egyptian ḫnm.t.

13. Sulphur. (גָּפְרִית) *gof-reeth'*

This term is borrowed from the Akkadian *kibrītu*. Also found in Arabic and Syriac – *kibrīt*; and In Armaic – *kbry*.

14. Jasper. (יָשְׁפֵה) *yaw-shef-ay'*

This term occurs in Akkadian in three forms – *ašpu*, *aspu*, and *iašpu*. Also found in Arabic and Persian.

15. Jacinth (לֶשֶׁם) *leh'-shem*

This is a loan word from Egyptian, nšm.t, and was one of the twelve precious stones mounted on the high priest breastplate (Ex. 28:19).

16. Natron (נֶתֶר) *neh'-ther*

This is a loan word that originated in Egyptian – nṯrj. Another equivalent is Akkadian – nitru, nitiru.

17. Chrysolite, topaz. (פִּטְדָה) *pit-daw'*

This is a loan word from the Sanskrit pĭta, and was the second jewel in the first row mounted on the high priest breastplate (Ex. 28:17)

It has also been noted that repeated references to the purification of metals and refining from dross in the Bible are probably of Persian origin (quoting Reitzenstein) (Forbes 1950, 344).

As is apparent, a metallic loan word (such as *ziff*) would not be unusual in Biblical Hebrew.

Ancient Arabic Investigation of *Zyf*

Based on the evidence developed so far in this inquiry, a good place to begin to search for *ziff* in the Semitic language family anciently is Arabic. An investigation of early Classical Arabic lexicons and original text sources has identified numerous references to *zyf*. These sources are early and have since been published in modern times with recent interpolation, addition, and insertion of vowels based on standardized criteria. Also there are differing forms of the word *zyf* (plural, adjective, etc.). This summary will not list or go into the details of the word with its more recent vowel insertion, as the purpose of this inquiry is to look at the original form of *zyf* as it would have existed in 600 BC, when it would have consisted of consonants only (*zyf*). If the original source lexicon or text actually identifies a specific original pronunciation of the vowel from an original source, that pronunciation will be noted.

Lexicons are one of the most useful tools in determining the source etymology and citations to texts using ancient words. Ancient lexicographers relied on native populations, early texts, and sometimes previous lexicons to compile their list of sources. In Arabic, one of the most reliable lexicons for early Arabic was created by Edward William Lane in 1863 and was titled the Arabic-English Lexicon (Lane 1863). Early sources identified in his work related to *zyf* were obtained by the author (some had to be ordered in Arabic from the Middle East) translated and examined under direction of the author, with the following attestations and meanings of the word *zyf*. Dates of the source are identified where known.

The Munajjad (Munjid) authored by Kuráa (circa AD 922)

1. Bad dirham
2. Raise up
3. Battlements
4. Upper part of a building (quoting ‘Adiyy ibn Zayd, sixth-century Arab Christian poet married to the granddaughter of Nu’uman ibn Mundhir, AD 580-595)

The Ṣiḥāḥ authored by Al-Jawhari (circa AD 1003). In addition to existing literary works, this lexicon was compiled by a variety of direct oral sources from the "desert."

1. Counterfeit or false dirhams

The Mughrib by Al-Muṭarrizī (born in AD 1142, died in AD 1213)

1. Fraud
2. Counterfeit money rejected by the public treasury

The 'Ubab authored by Aṣ-Ṣaǵānī (born in AD 1181, died in AD 1262)

1. Dirhams
2. Relates to walls, staircases, and other parts of walls, a battlement (quoting 'Adiyy ibn Zayd, sixth-century AD)
3. Fraudulent or bad dirhams (Ibn Durayd, 837-933 CE quoting the Lihyanites; Muzarrid, seventh-century AD poet, Hadith of 'Omar also known as `Umar ibn Al-Khattāb, 577- 644 CE)

The Lisān al-'Arab authored by Ibn Manẓūr (work completed in AD 1290)

1. Dirhams of no value – rejected because of fraud (quoting Ibn Sidah, Andalusian author of the lexicon Al-Muhkam, AD 1007 -1066)
2. Related to walls, building a wall, or jumping over a wall
3. Molding and top part of building, or battlements (quoting Adiyy Ibn Zayd, sixth-century AD)
4. "Clinking of zyf received as payment in Abqar"; "people like pieces of brass when they go down there and in the people is zyf like the zyf of dirhams" (quoting Imru' al-Qays, sixth-century AD poet)
5. "She did not give him zyf and they were not bad silver" (quoting Ibn Barri, Arab grammarian, AD 106-1187)
6. "You see the leaf of youth in her as it were dirhams, among which are both pure and zyf (impure)" (quoting the saying of Hubda, sixth century)
7. "coins that were hard and zyf (bad)" (quoting the saying of Muzarrid, seventh-century AD)
8. "he sold the discarded coins of the public treasury, and they were both zyf and hard – that is, bad" (quoting Hadith of Ibn Mas'ud, circa 644 CE)
9. "rejected dirhams" (recounted of 'Omar 577-644 CE)

The Miṣbāḥ authored by Al-Fayyūmī (work completed in AD 1334)

1. Bad dirhams, false coins
2. "some say that (dirhams that are) zyf are those that are coated with mercury/quicksilver compounded with sulfur and it was known before our time, and its value was like that of balance weights"

The Al-Qāmūs (Kamoos) authored by Al-Fīrūzābādī (born in AD 1329, died in AD 1414)

1. Dirhams "rejected on account of fraud"; "to make dirhams fraudulent"
2. "top that protects the wall"; "stairs of a staircase"; "the top part of the wall"

The Tāj al-ʻArūs authored by Al-Zabīdī (born in AD 1732, died in AD 1790)

1. Jump over a wall (referencing the Kuráa, AD 922)
2. A molding or top that shelters a wall
3. Battlements of a castle
4. Steps of a staircase
5. Describing buildings that are long and raised up
6. Related to dirhams (using source of Imrú al-Qays [sixth century] and Hubda ibn al-Khashram Arab poet, circa AD 670)
7. Various definitions involving bad or modified dirhams

"to be rejected on account of the fraud in them"

"to be bad dirham" (according to Muhkam, AD 1007 -1066)

"You see the people like pieces of brass when they do down together, and the people is zyf, like the zyf of dirhams" (quoting the poet)

"the coins were hard and zyf (bad)" (quoting Al-Muzarrid, seventh-century AD)

"bad dirham" with an indication that the the plural form has "i" as the first vowel, making zif (quoting Ibn Durayd, 837 – 933 CE, famous Arab poet, lexicographer, and philologist)

"Like the clink of flint flakes when you clutch them, so the clink of zyf received as payment in "Abqar" (citing Imru' al-Qays, sixth century)

"You see the youth in her as it were dirhams, among which are both pure and zyf (impure)" (citing Hubda ibn al-Khashram, sixth century)

"bad dirham"

"determination of rejection of bad dirham while in circulation" with the derivative coming from "covering, topping, or coating"

"adorn dirhams"

The Maqāmāt authored by Al-Harīrī (born in AD 1054, died in AD 1122)

"when as cast them as zyf"

"zyf is bad gold or silver"

Also of interest is an additional definition involving various strutting animals including pigeons (Munajjad, Lisān al-ʻArab, Al-Qāmūs, Tāj al-ʻArūs), camels (Ṣiḥāḥ, ʻUbab, Lisān al-ʻArab, Al-Qāmūs, Tāj al-ʻArūs), lions (ʻUbab, Tāj al-ʻArūs), doves (Tāj al-ʻArūs), other living creatures (ʻUbab, Lisān al-ʻArab), and even humans (Lisān al-ʻArab).

As is very apparent, *zyf* was a word with documentation to the earliest lexicon and Arabic sources available, circa late AD 500. Since the Arabic script known before AD 500 is found primarily in a few funerary inscriptions (Gruendler 1993), *zyf* is clearly an ancient Arabic word that could easily project back to the beginnings of the Arabic language and well into the times preceding Lehi.

To go beyond the earliest actual attestation (writing) of an ancient word, historical linguists use a variety of techniques to try to determine the source of a word. It is not an exact science, so most of these projections consist of plausible cases supported by various linguistic comparisons and analyses and naturally, not all historical linguists agree.

In projecting the ultimate source of the Arabic *zyf*, Fraenkel and Brockelmann agree that *zyf*, with the sense of the meaning as "false coin" or "forgery" (and those having to do with metal) is a loanword from Aramaic (*zyp'/z'p'*) (Fraenkel 1886; Brockelmann 1908). Zimmern, Brockelmann, Kaufman, and Sokoloff indicated that the Aramaic word is likely in turn a loan word from Akkadian as it appears to be limited to Eastern Aramaic dialects (Syriac, Mandaic, and Jewish Babylonian Aramaic) (Zimmern 1917, 27; Brockelmann 1908, 195; Kaufman 1974, 113; Sokoloff 2009, 361). However, Calabro indicates that there does not appear to be any evidence showing that the Arabic word is a loanword from Aramaic rather than a Proto-Semitic cognate given the fact that the attestations go back to pre-Islamic Arab poets (for which contact with Aramaic is less likely), there is a basic verbal root in Arabic, and the structure of the word compares well with some Akkadian forms (Calabro 2015).

The Akkadian source word is asserted to be *zi'pu* or *zīpu* meaning "mold, mint" (Brockelmann 1908, 195; Sokoloff 2009, 361).

Discussion of Arabic Definitions of *Zyf*

1. Bad or false coins, bad gold and silver

Examining the entirety of definitions of *zyf* from the Arabic lexicons and original sources, it is clear that *zyf* had one definition related to metal: counterfeit or bad money, bad gold, or bad silver. Some of the descriptions imply that the alloy itself was impure; there is also the specific definition that indicates that the money was coated or gilded using a process of mercury (quicksilver) and sulfur, which apparently used stamped weights as the base metal.

Islamic coin weights, called *sanaj* or *ṣanaj* in Arabic, are used as standards for the *mithqal* (a.k.a. *dinar*) (the gold coin) and its fractions or multiples, or for the *dirham* (silver coin) and its fractions or multiples. The weights were most often of bronze, but lead and iron weights are known. Inscriptions on metal weights are rare and mostly uninformative, being references to the reliability of the weight (*'adl*), pious phrases (*bism Allāh, al-mulk lillāh*), or common names (*'Ali, Muḥammād*). A very few weights, over-represented in museums, have the names of identifiable rulers. Some weights have meaningful ornamentation: punches or other marks to indicate the standard or the denomination of the weight (Bates 2007).

While by Islamic decree dirhams were to have been made of silver, the term *dirham* pre-existed Islam and was the Arabic term for the Greek term *drachma* or *didrachm* (2 *drachmae*). While the Greek drachma was typically a silver coin, gold drachma and electrum (gold-silver alloy) drachma are known anciently. In the King James Bible, Ezra 2:69 and Nehemiah 7:70 refer to gold "drams," and Bible scholars equate the word as the transliterated Hebrew word for drachma. This is consistent with some of the early definitions that referred to the bad coin as "hard" (seventh century and 644 CE), since hardness would be a test to determine whether in fact a coin is made of gold, as gold is a soft metal unlike the other metals used to make a counterfeit coin.

In attempting to make a false *zyf* coin, it appears, based on the description referred to in the Miṣbāḥ lexicon, that perhaps the actual coin weights were tooled as coins, and then coated gold (the color of native sulphur) by suspending golden sulfur powder in mercury and boiling off the mercury to leave a gold colored surface. The use of mercury in gold and silver gilding in this way is a common ancient technique. In this manner, the fake coins could

pass the test of weight and appearance. There would have been a volume issue with a lead-coated gold coin, as it would have needed 70% more volume (larger in size) to match the weight of a pure gold dirham or dinar.

Regardless of the intent of ancient governments in establishing standardized monetary systems, they were also subject to the supply and demand of precious metals, so often would debase the precious metal to lower concentrations in coinage, which, in the case of gold, would make a counterfeit gilded lead coin close to or equivalent in density, weight, and volume to a gold coin debased by a lighter metal such as copper or silver (lead is 25% denser than copper, 8% denser than silver). In the case of a counterfeit silver coin, since there is not a great difference between the density of silver and copper, this would have not been difficult to pull off.

Coins have been counterfeited since the invention of coinage. Before coinage, pre-coin precious metal ingots were counterfeited as well. In ancient times, forgers typically counterfeited coins by plating a base metal core with a precious metal exterior, since the value of coins was tied to the value of their metallic content. Such ancient counterfeit coins are called “fourrées” by numismatists (currency experts).

Fourrées are believed to have been made using a number of different techniques. With silver coins, the most common method is thought to have involved wrapping silver foil around a base-metal planchet (plain metal disc from which a coin is made), heating it, and striking the coin. In some or perhaps many cases, liquid or powdered solder may have been used to help fuse the foil to the planchet. In other cases, a thinner coating of silver is thought to have been produced by dipping a base-metal planchet in a silver solution. With gold coins, gold foil or thinner layers of gold leaf are thought to have been wrapped around the planchet and then burnished down before striking. The foil or leaf may have been affixed to the planchet by heating or with an adhesive such as gum arabic. In other cases, the planchet may have been coated with a liquid gold-mercury amalgam then heated to dissipate the mercury.

With both silver- and gold-plated coins, the plating was typically applied to the planchet before the coin was struck to prevent the softening or blurring of the design details, as happens today when current coins are electroplated.

Fourrées are usually lighter than official coins, with the interior of gold fourrées typically consisting of silver or copper, which are both lighter than gold, and with the interior of silver fourrées typically consisting of copper, which is lighter than silver. Counterfeiters used other metals too, including lead and iron, with some rare fourrées of bronze coins extant that were made from bronze-plated iron. With silver and gold fourrées the weight can be in the correct range if lead was used in the interior or if the flan (metal disk) was made larger than normal. Specific gravity testing can be helpful in the case of overlarge flans. It's likely that some percentage of fourrées with lead interiors have not yet been detected.

Fourrées are debased coins, but not all debased coins are fourrées. Some later official Greek silver coins and many official Roman silver coins were progressively debased, with increasing amounts of copper deliberately mixed into the silver-copper alloy. Severely debased, “surface-enriched” Roman coins were made by creating a planchet of copper alloyed with a small amount of silver, then pickling it with an acid before striking. This is the depletion-gilding process that is discussed at length in chapter 9; the acid leached copper from the surface and left a thin layer of nearly pure silvering. Later Roman coins may have been “silver washed,” with the planchets being covered with a very thin silver-mercury amalgam.

Just as not all debased coins are fourrées, not all ancient counterfeits are fourrées. Some no doubt were made with a homogeneously debased alloy, and it's likely that some percentage of these are as yet undiscovered. Some homogeneously debased ancient coins are official coins made by tribal peoples in imitation of the official Greek or Roman coins they came in contact with (Goldsborough 2014).

Though most fourrées are considered ancient counterfeits, not all are. The most notable exception is the Emergency Issue Greek Owl drachma fourrées, which were officially issued by Athens at the end of the Peloponnesian War when Athens was low on silver reserves and needed money to try to avoid the eventual defeat by the Spartans.

The existence of fourrées in ancient times is the reason that some ancient coins were test cut, which involved the slashing of the surface of a coin with a hammer and chisel to reveal the interior metal, or punchmarked, which involved punching a design or banker's mark into the surface (punchmarking was sometimes done instead to re-tariff a coin at its place of origin or to certify it as legal tender beyond its place of origin). To try to prevent detection, some counterfeiters made fourrées with test cuts engraved into their design, though these are seen rarely today. In ancient times some test-cut coins were consequently further test cut within the existing test cut. Naturally, counterfeiters then made some fourrées engraved with test cuts within test cuts, though these are even rarer today.

2. A Definition with Religious Context

Also of religious interest is the quotation by Imru' al-Qays that *zyf* was used for payment in "Abqar." Abqar is not a known geographical location. Some historians claim it to be in Saudi Arabia, others claim it's in Jordan, and some claim it's in Yemen. It is however a supernatural location, as Abqar is a city or a town in the invisible world of the Jinns. This mythology pre-dates Islam. In addition to being a location, Abqar is the highest rank given to demons, Satan being the lowest, Ifrit is one step higher, Marid is another step higher, and Abqar is the highest.

Jinn, (or singular, genie) are supernatural creatures in Islamic mythology as well as pre-Islamic Arabian mythology (see figure 7). They are mentioned frequently in the Quran (the 72nd sura is titled Sūrat al-Jinn) and other Islamic texts and they inhabit an unseen world called Djinnestan, another universe beyond the known universe. The Quran says that the jinn are made of a smokeless and "scorching fire," but are also physical in nature, being able to interact with people and objects and likewise be acted upon. The jinn, humans, and angels make up the three known sapient creations of God. Like human beings, the jinn can be good, evil, or neutrally benevolent and hence have free will like humans and unlike angels (Creative Commons 2015). Inscriptions found in Northwestern Arabia seem to indicate the worship of jinn, or at least their tributary status, hundreds of years before Islam.

The word or concept of jinn does not occur in the original Hebrew text of the Bible, but the Arabic word *jinn* is often used in several old Arabic translations. In Isaiah 6, the *seraphim* (lit. "burning/fiery ones") appear to Isaiah, with their six wings being used to cover, or hide, their body, face, and feet.

In several verses in Urdu Biblical translations, the word jinn or related words are mentioned as translations of "familiar spirit" or אוב (Job) for jann and "the devil" or δαιμόνιον (daimónion) for Iblīs.

Several passages from the New Testament refer to Jesus casting out evil spirits (or demons) from those that were demon-possessed. According to Islamic tradition, these evil spirits are strikingly similar to the jinn creatures mentioned in the Qur'an and Hadith literature. Among the similarities of these creatures is their ability to take possession of human beings.

In Van Dyck's Arabic translation of the Bible (Smith et al. 1865), these words are mentioned in Leviticus 19:31, Leviticus 20:6, 1 Samuel 28:3, 1 Samuel 28:9, 1 Samuel 28:7, 1 Chronicles 10:13, Matthew 4:1, Matthew 12:22, Luke 4:5, Luke 8:12, and John 8:44. Also, in the apocryphal book Testament of Solomon, Solomon describes particular demons whom he enslaved to help build the temple, the questions he put to them about their deeds and how they could be thwarted, and their answers, which provide a kind of self-help manual against demonic activity.

Figure 7. Depiction of demon Jinn Shaitan in Kitab al-Bulhan (the Book of Wonders), a fourteenth-century Arabic text (Al-Isfahani 1450)

3. Building or architectural references

The definition of *zyf* from the Arabic lexicons also consistently referred to building or architectural features specifically including or concerned with the upper portion or top of walls (battlements, upper part of walls, steps of a staircase, molding on the top of walls, jumping over a wall, and a top that protects a wall). The additional definition for *zyf* related to a variety of animals and animal positions/movements would also be consistent with the use of animal figures in the ancient Arabic world that were placed on various places on buildings (top of domes, walls, thresholds) in a religious or magical context as talismans or *apotropia*. One of the principal animals identified in the definition of *zyf* is a pigeon. It would seem a reasonable etymological inference that some form of the metal *zyf*, as has been documented for *sufr* (to be discussed in chapter 10), was used to manufacture some of these statues or figures.

Ancient Persian Investigation of *Zyf*

As has been noted in chapter 6, a Persian form of *zyf* appears as *zā'if*, also meaning "false coin." The source of the word in Persian was not borrowed from Arabic, but occurs in Lotera'i, an originally Jewish dialect in Persia. The earliest evidence for the dialect is in Persian texts of the tenth-century AD and the earliest occurrence of that word is in the twelfth century where the word *zyf* is found in a poem by Suzani that provides evidence for the language of Jews in Iran (Schwartz 2014, 39, 54). Schwartz derives the *zyf* word from Aramaic *zayif* "false."

Ehsan Yarshater, the first scholar to do a major study on Lotera'i, believes that the dialect originated among an enclave of Jews in Iran originating from the Babylonian Captivity, but not earlier (i.e., not from the Assyrian captivity). The word in Iran seems to have derived from eastern Aramaic (ultimately from Akkadian) (Yarshater 1977). This does place the source of the word *zyf* in the Aramaic that was present at the time of the Babylonian captivity.

"Ancient Aramaic" refers to the earliest known period of the language, from its origin until it becomes the lingua franca of the Fertile Crescent. It was the language of the Aramaean city-states of Damascus, Hamathand Arpad.

There are inscriptions that evidence the earliest use of the language, dating from the tenth-century BC. These inscriptions are mostly diplomatic documents between Aramaean city-states. The dominance of the Neo-Assyrian Empire under Tiglath-Pileser III over Aram in the middle of the eighth century led to the establishment of Aramaic as a lingua franca of the empire.

From 700 BC, the language began to spread in all directions, but lost much of its homogeneity. Different dialects emerged in Assyria, Babylonia, the Levant, and Egypt. However, the Akkadian-influenced Aramaic of Assyria, and then Babylon, started to come to the fore. As described in 2 Kings 18:26, diplomats of Hezekiah, king of Judah, desired to negotiate with Assyrian ambassadors in Aramaic, the author claiming this was so that the common people would not understand. Aramaic was a language that the Lehites likely would have known. Some Aramaic-derived words have been identified in the Uto-Aztecan language family in the Americas (Stubbs 2015).

Chapter 9
Ziff in the Americas

Having narrowed the range of possible meanings of *ziff* using information from more recent linguistic sources, it is now commensurate to look at what metals actually existed in the New World (where most of the Book of Mormon took place) and see if any could potentially fall into one of the remaining subgroups of *sifr*/*sufr* as well as *zyf*. The potential alloys remaining to be considered are bronze, brass, gold-copper, or gold-silver-copper for *sifr*/*sufr*. Also to be considered for *zyf* are any techniques that would involve adulterated gold. Gold, silver, a base metal such as copper that has been gilded with gold or silver, or an alloy with low gold or silver content will all qualify for *zyf*. The words for bronze and brass are found elsewhere in the Book of Mormon, but because we have little information as to what those terms might or might not mean, bronze and brass cannot be excluded for that reason. However, since the terms for bronze and brass are found in AD 1500 to 1800 English, the standard alloys for these terms (copper-tin and copper-zinc) will need to be excluded as candidates for *ziff*, although the door must be left open with regards to some specialty form of these alloys (surface treatment, high zinc brass alloy, etc.).

One point that needs to be examined at this juncture is whether there is any New World geographical limitation imposed by the Book of Mormon. The primary purpose of this inquiry is not to examine *ziff* in the context of any of the geographical models for the Book of Mormon, however, the best academically developed model involves Mesoamerica as the location for most events in the Book of Mormon. *Ziff* is never identified in the Book of Mormon as a material that was produced by any of the Book of Mormon peoples; it is only mentioned in one instance in the Book of Mormon, and was just a material that at least some of the people possessed in a very limited geographic area and in a limited time frame, the land of Nephi around 150 BC. Since its manufacture was not mentioned, whereas the Book of Mormon does indicate that other metals were found or worked by Book of Mormon peoples, *ziff* may in fact be an imported trade item. As such, a geographical limitation for the geographical source of *ziff* is not imposed, leaving open the possibility that it could have been an import from other New World locations.

With some form of the gold-copper and gold-silver-copper alloys left as the best candidates for *ziff*, we must now look to see whether these alloys existed in the New World. In the New World, both gold-copper and gold-silver-copper alloys are well known. These alloys were principally utilized for aesthetic and ornamental purposes rather than practical ends.

Natural copper was being worked in the Americas as early as 4000 BC. Hammered gold foil artifacts and a gold worker's toolkit have been found from as early as 1680 BC in the Andean highlands of Peru in Waywaka (Grossman 2013). Smelting of copper ores has been found on a large scale as early as 200 BC among the Mochica culture on the north coast of Peru. Mochica alloys also included gold-silver, copper-silver, copper-gold, and gold-silver-copper. The Mochica also discovered arsenical copper (Lambert 1997).

With regards to meeting the requirement of *zyf*, there are New World examples of gold and silver that have been alloyed with lesser metals and have also undergone gilding.

Tumbaga

Sorenson (2013) has suggested that *ziff* may be a New World gold-copper or gold-silver-copper alloy called tumbaga. In order for tumbaga to be a candidate, it is necessary to look at the word to see when it was accepted as

a linguistic term in usage in English at least in a limited way during the 1500s to the very early 1800s. If tumbaga was a word in usage to describe this New World alloy during this time period, than it may need to be excluded, since the word could have presumably been translated in the Book of Mormon as “tumbaga” instead of “ziff.”

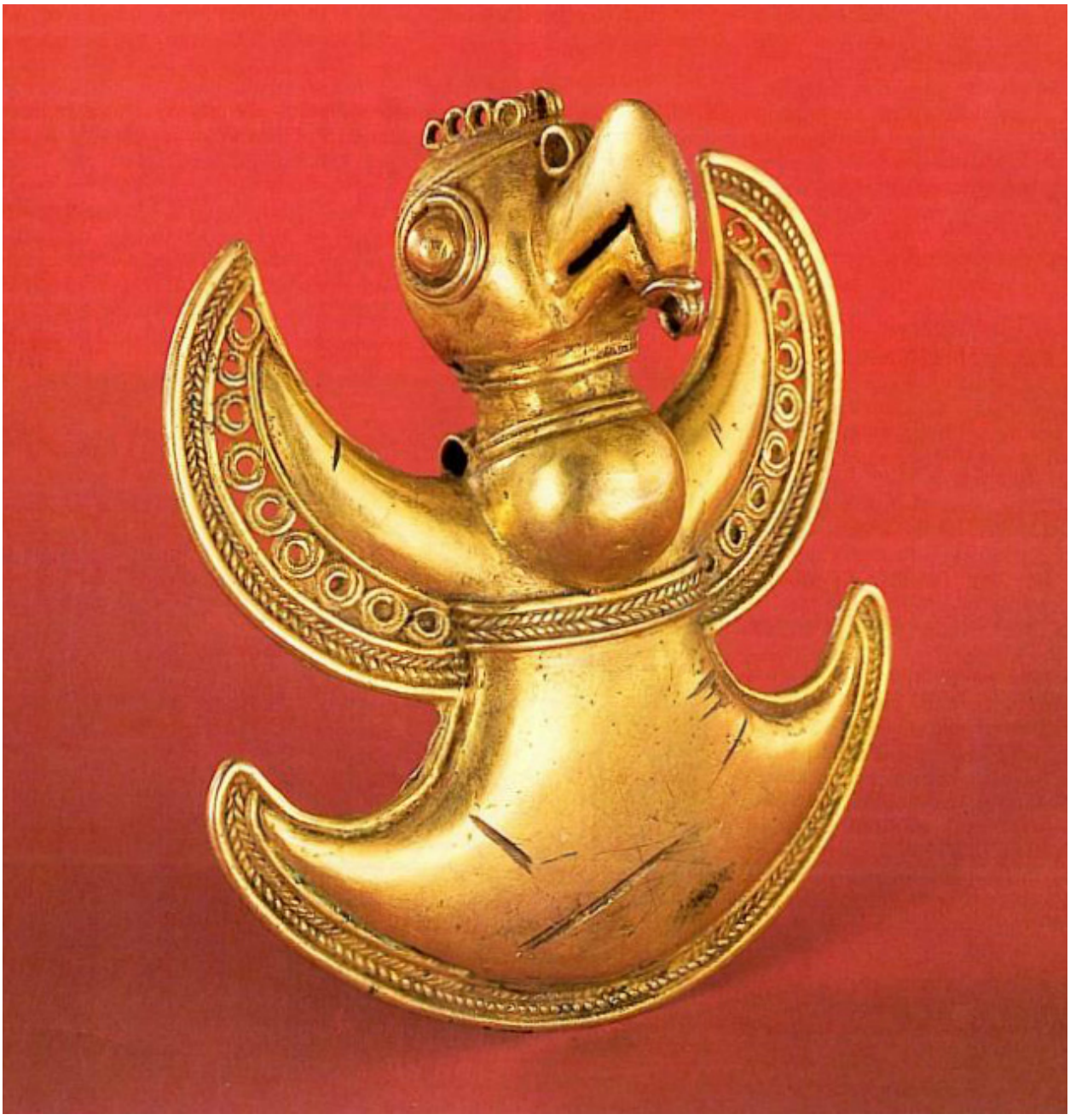

Figure 8. Tairona pendant, cast and gilt tumbaga from Minca, Santa Marta Magdalena, height 6.1 cm, Museo del Oro, Bogata, Columbia (Del Solar et al. 1982)

History of the Word Tumbaga

The Middle English Dictionary as well as the OED, EEBO, and LION indexes were consulted and the word tumbaga was not found there. Since tumbaga is a Spanish word, the following Spanish dictionaries were examined for the

presence of the word tumbaga (or any derivative of the word or alternate spelling of the word) on the website www.lexilogos.com. Tumbaga was not found in any of them.

> New Spanish and English dictionary: in two parts: I. Spanish and English - II. English and Spanish (1843)
>
> Dictionariumlatinohispanicum, et vice versa hispanicolatinum :dictionnairelatin-espagnol, by Antonio de Nebrija (1560)
>
> Dictionario de vocabloscastellanos, aplicados a la propriedadlatina, by Alonso Sánchez de la Ballesta (1587)
>
> Del origen y principio de la lenguacastellana o romance, queoi se usaenEspaña, by Bernardo Aldrete (1606)
>
> Tesoro de la lenguacastellana o española par Sebastián de Covarrubias Orozco (1611)
>
> Tesoro de la lenguacastellana o española par Sebastián de Covarrubias Orozco, augmenté by Benito Noydens (1674)

A careful analysis of the history of the term *tumbaga* has determined that its first use to describe the New World alloy did not occur until after 1817, and only on a limited basis in Spanish among Southeast Asia Spanish traders (Blust 1992). An indigenous term for the alloy was first noted by Columbus when encountering the alloy in the West Indies, where it was referred to as *guanin* in the Arawak language (Stone et al. 1967). In 1546 the explorer Juan Perez de Tolosa reports that the Motilones Indians in northwest Venezuela wore ornaments of a copper-gold alloy called *carcuri* (Rivet 1922). Tumbaga is clearly a recent loan word in the English language.

Depletion Gilding and Tumbaga

The pre-Columbian cultures of Central and South America were highly skilled at metal-working, and the depletion gilding method was described by the early recorders of the culture including Gonzalo Fernandez de Oviedo (AD 1535-1548) (Bray 1979), Tamalameque (1555) (Bray 1985), Martin Fernando de Enciso (1519), and Bernardino de Sahagun (Sahagun 1565).

Sahagun writes of the Aztecs:

> It was in addition treated with alum: the alum with which the gold was washed and rubbed was ground. A second time it entered the fire; it was heated over it. And when it came forth once more, for the second time it was once washed, rubbed with what was called 'gold medicine'. It was just like yellow earth mixed with a little salt; with this the gold was perfected; with this it became very yellow.

The ethno-historical accounts dating from the time of Spanish contact with the ancient Columbian Indians mention a rather different depletion gilding technique. Writing in 1519 of the Tairona Indians of the region of Santa Marta, Magdalena, Enciso states:

> … there is in possession of the Indians much gold and copper. There is also found much gilded copper. The Indians say that they gild the copper with a herb that is in that land, crushed, and with the top taken off; and they wash the copper with it; and placed in the fire it assumes the colour of very fine gold, and changes in colour more or less according to whether they give it more or less of the herb.

Tamalameque in 1555 describes the technique used in lowland Columbia as follows:

> … and in this way, placing it (a bracelet) in the fire, taking it out and putting it in water and hammering it on an anvil with the stones described they worked until they had increased its size many times until it was finished and then the herb they brought to give it colour was crushed on a stone and, once crushed in this

> way, they placed it in a small pot which they brought in and added water and ground white salt and stirred all together (then they polished, heated and quenched it in the solution several times) … and in this way it attained the colour and finish it should have … and they cleaned the said manylla (bracelet) with small quantities of fine sand that they brought in a maize husk, with their hands and water.

Similar to the Columbian technique, Ecuadorian Indians in the sixteenth century were using the juice of the plant *Oxalis pubescens* to gild tumbaga alloys (Rivet et al. 1946). Oxalis genus plants are widespread in Central and South America and are also found in Europe. It has been suggested that other species used by the Aztecs in the area of Oaxaca included Liana (Rivet 1921), Mansteras, and Anturiums (Stone et al. 1967).

Figure 9. Oxalis pubescens plant used by Ecuadorian Indians for depletion gilding (Flickr.com 2015)

Alloys utilized for depletion gilding by pre-Columbian Indians were one of two types. One type was known as tumbaga, consisting of reddish, bronze-colored copper-gold alloys produced with differing gold contents, and generally containing silver as an impurity. The other type consisted of pale greenish-white ternary silver-gold-copper alloys containing a high proportion of silver (similar to electrum in the Old World).

There were basically three methods of depletion gilding used in the New World. The first involved the alloy being rubbed with the juice of a plant (probably containing oxalic acid or another plant acid), perhaps also with ammonium carbonate soaked in urine. This technique was best suited to the tumbaga alloy of copper and gold, as it does not remove any silver that might be present in the alloy. The second and third methods were suited for the gold-copper-silver alloy as the methods also removed silver from the surface, but could also be used on the

tumbaga alloy. The second method used the application of special aqueous pastes or a solution of alum, iron sulphate, and salt at room temperature. After about ten days, the object was taken out and washed with a salt solution to remove the surface scale. It was then heated to convert the spongy, gold-enriched surface to a smooth, compact, richly colored surface. The third method used a cementation process where the object to be gilded was placed in a crucible and surrounded with a powdered mixture containing alum (potassium aluminum sulphate), common salt (sodium chloride), and brick dust (silica, clay, and alumina). The crucible and its contents were heated and the mixture reacted with the surface of the alloy to form chlorides of silver, copper and other impurity metals. The molten chlorides were then absorbed by the brick dust. Additional ingredients may have been ammonium chloride, potassium nitrate, copper and iron sulphates, vinegar, and urine. After cooling and washing to remove residues, the gold-enriched surface was improved by burnishing (polishing with pressure) (Lechtman 1971; Lechtman 1973).

It is important to note that the term *tumbaga* does not just imply a type of alloy, the term includes and encompasses the alloy that has undergone depletion gilding. Goldsmiths in pre-Columbian Peru and Columbia utilized a variety of techniques. Depletion gilded tumbaga discs have been found that were made during the early part of the classical Vicus period (400 BC – AD 100). The Vicús were followed by the Moche (100 BC – AD 800) who lived along the north coast of Peru and excelled in a variety of metalworking techniques, including depletion gilding. The Moche depletion gilding techniques were passed on to the Chimú (AD 1000-1470), the Sicán, Inca successors, and other cultures.

Tumbaga appears to have had religious and symbolic qualities for some peoples of the New World. It has been pointed out:

> What is the point of making objects from surface-enriched tumbaga? It cannot be to economize the gold, for the gold below the surface is 'wasted', and a golden appearance could be achieved more cheaply by applying gold foil. Perhaps … the 'essence' of the object required it to contain gold throughout, or it may have been the reddish color that was valued, or even the distinctive smell of tumbaga. (Bray 1985)

Bray further cites other direct sources from certain Columbian tribes who viewed the metals and their colors as related to reproductive creative forces and associated religious connotations.

Other gilded alloys in the Americas

South American goldsmiths occasionally used gilding techniques similar to those in the Old World involving dipping objects into molten gold or covering them with foil. In addition, they utilized a variety of novel methods. One involved chemical electroplating wherein the gold was dissolved in acid and then plated onto a copper-containing object immersed in the solution (Lambert 1997; Centeno et al. 2000).

Tumbaga and other yellow colored gold-silver-copper alloys all meet the general definitional requirements for *ziff* (*sufr*/*sifr*) because they would meet the "yellow copper" definition of *sufr*/*sifr*. The definition of *sufr*/*sifr* also includes both gold and copper, which may also be interpreted as including gold and copper alloys. Tumbaga and/or gold-silver-copper alloys that have undergone depletion gilding (or other forms of gilding) would all meet the definition of *zyf* as a gold gilded alloy. Gold gilded copper would also meet the definition of *zyf*.

Specific Technical Details of Depletion Gilding

Depletion gilding is a method for creating a layer of nearly pure gold on an object made of gold alloy by removing the other metals from its surface. It is sometimes referred to as a "surface enrichment" process. Alloys of silver can also be gilded by the depletion method; this is called depletion silvering.

Most gilding methods deposit gold that was not already part of the alloy onto the surface of an object. Instead; depletion gilding removes other metals in the alloy therefore increasing the concentration and purity of gold on the gold's surface, using gold that is already present on an object's surface as part of the alloy.

Depletion gilding produces a high-purity gold surface by removing silver and copper, leaving gold. Other metals are etched away from the surface of an object composed of a gold alloy by the use of acids or salts, often in combination with heat. Because no gold is actually added, only an object made of an alloy that already contains at least some gold can be depletion gilded.

Depletion gilding relies on the fact that gold is highly resistant to oxidation or corrosion by most common chemicals, whereas many other metals are not. Depletion gilding is most often used to treat alloys of gold with copper and/or silver. Unlike gold, both copper and silver readily react with a variety of chemicals.

The process of depletion gilding involves coating, immersing, or packing the object in a suitable acid or salt. These chemicals then attack the metallic copper and silver in the object's surface, transforming it to various copper and silver compounds. The object is usually heated to make the process more efficient. The resulting copper and silver compounds are then removed from the object's surface by washing, chemical leaching, heating, or physical absorption by porous materials. The inert gold remains behind, unaffected. The result is a thin layer of nearly pure gold on the surface of the original object. Figure 10 shows the depletion gilding process for a gold and copper alloy.

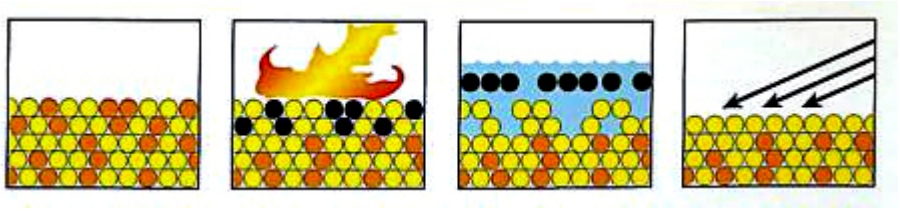

Figure 10. Simplified steps in the depletion gilding process, first the gold and copper alloy, second, heating which oxides copper, third, the application of the organic or mineral acid which removes the oxidized copper, and fourth, burnishing by the application of pressure and rubbing to eliminate voids in the surface gold (Henrichsen 2001)

There is no well-defined minimum gold content required to successfully depletion gild an object. However, the less gold that is present, the more other material must be etched away to produce the desired surface appearance. The removal of the other metals usually leaves the surface covered with microscopic voids and pits. This can make the surface soft and "spongy" with a dull or matte appearance. This effect becomes more pronounced as more of the non-gold metal is removed. For this reason, most depletion gilded objects are burnished (polished by rubbing) to make their surfaces more durable and give them a more attractive polished finish.

Depletion gilding is a decorative process; it does not increase the utility of the object. It is not widely used in modern times, having been superseded by processes more suited to mass production, such as electroplating.

However, depletion gilding was widely used in antiquity. While it requires skill to execute it well, the process itself is technologically simple, and uses materials that are readily available to most ancient civilizations.

In comparison to other forms of gilding, depletion gilding would not be considered an economical method of gilding, as it typically requires that the object contain some percentage of gold through the entire object, as opposed to just a surface application of gold that can be achieved through other gilding techniques that involve physical attachment of gold or gold foil, gluing of gold foil, heating of gold foil, or chemical attachment of gold to

the surface of a non-gold object. However, because the gold in depletion gilding is an inherent part of the metal, it is considered more durable, as the other forms of gilding are more susceptible to separation of the gold gilding from the surface of the object and subsequent corrosion.

Metallurgical analysis of New World depletion gilding on a very few ancient gold objects has yielded surface layers of gold ranging from 3 to 5 microns (Scott 2000; Scott 1983). Lab reproductions using the ancient New World depletion gildings techniques have produced surface gold layers ranging from 8 to 12 microns (Del Solar 1982).

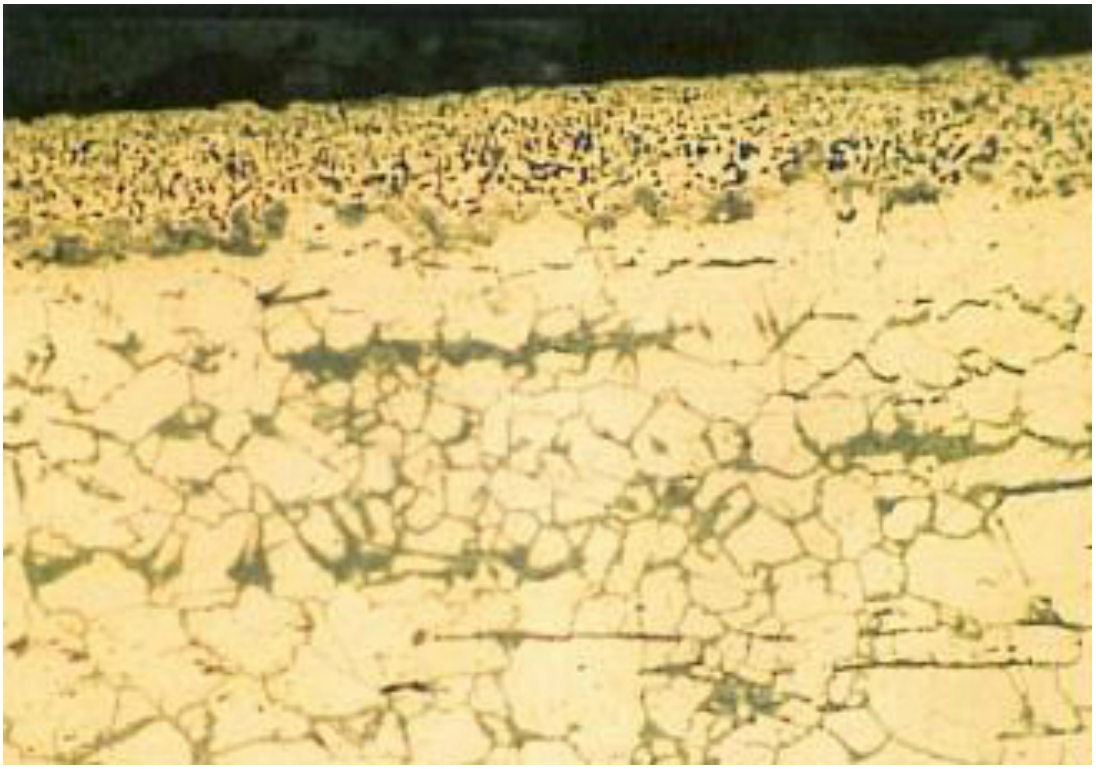

Figure 11. Photomicrograph showing depletion-gilded layer (top layer) on a Nariño sheet tumbaga (Scott 2000)

Old World Depletion Gilding

Outside of the Americas, depletion gilding was a known metallurgical technique for metal objects, but not a common one, and existing historical examples are rare.

The earliest example of depletion gilding was seen on three chisels excavated in the 1920s from a site known as the Queen's Grave in Ur, a city in the region of Sumer, southern Mesopotamia, in what is modern-day Iraq (La Niece 1995). These chisels date to 2600 BC.

Analysis of fifth- and fourth-century BC Greek "white gold" and electrum coins has shown the existence of a surface layer that is gold-enriched to concentrations of over 70% in places, while the base alloy contains 35% gold, indicating the presence of depletion gilding (Healy et al. 1971; Notton 1974).

Pliny, in the first century AD, described a cementation process for refining gold that has been interpreted as a depletion gilding process. It involved placing gold into a crucible in contact with a mixture of salt and brick dust and

then heating. Silver and base metals were gradually removed and absorbed into the brick dust leaving behind a residue of nearly pure gold that can be separated from the brick dust by washing (Pliny AD 77b).

The Egyptian document known as the Leyden Papyrus, which dates to the late third century AD, is the earliest direct literary evidence of depletion gilding. Sometime around 1828 a considerable number of papyri were recovered (presumably by grave robbers) from burial sites near Thebes in central Egypt. These were not in the form of rolls written in ancient hieroglyphics but rather in the form of separate numbered sheets or codices written in Greek, indicating that the documents and burials were from the Greco-Roman period and probably dated from sometime around the late third or early fourth century AD. The papyri in question were in remarkably good condition, due in part to their having been placed either in tightly sealed coffins or in sealed stone containers, and, in part, because they were, at the time of the original burials, brand new, having been specifically copied for that purpose as so-called "Totenbeigaben" or death offerings intended to accompany and serve the deceased in the afterlife. The following year twenty-four of these papyri were sold to the Museum of Antiquities at the University of Leyden in the Netherlands (Leyden and Stockholm Papyri 2008, 1).

The Leyden Papyrus contains 111 recipes for working with metals. Two of the recipes describe the process for depletion gilding. One of the recipes entitled "The colouration of Gold" (number 13) is a mixture of salt, vinegar, and *misy*. *Misy* is thought to be a sulphide or sulphate. A second recipe entitled "Gold Polish" consists of a mixture of *misy*, alum, and salt. Both of these recipes would produce strong acids, which would be consistent with the leaching that occurs in the depletion gilding process.

Figure 12. Leyden Papyrus at the University of Leyden, Netherlands

Depletion silvering was utilized on silver-copper alloy Roman coins dating from AD 63 to AD 260 (Cope, 1972). Another example of depletion gilding involving sixteenth century Japanese gold alloy coins has been documented (Gowland 1915; Gowland 1896). Two Celtic Central European gold rainbow stater coins (circa 100 BC) have been determined to exhibit depletion gilding (Stern 1993).

Depletion silvering has been identified by the Cleveland Museum of Art on a silver-copper alloy plate made in India during the Gupta Period (AD 300–500) (Gibbons et al. 1979).

In 1986 the Cleveland Museum of Art acquired three vessels thought to be from Tibet dating to the seventh century—a beaker, a rhyton, and a vase—that had a gold and silver alloy foil gild. Upon examination it was discovered that the gold and silver alloy foil had itself undergone depletion gilding to leave a gold gild on the outside of the foil (Christman 2000).

Figure 13. Seventh-century Tibetan rhyton with depletion gilding in the Cleveland Museum of Art (Christman 2000)

As previously mentioned, Theophilus describes a copper-gold alloy in AD 1140 that has all the hallmarks of depletion gilding:

> Arabian Gold
> There is also Arabian gold, which is very precious and of an exceptional red color. The use of it is often found in very ancient vessels. Modern workmen counterfeit its appearance when they add a fifth part of red copper to pale gold and they deceive many unwary people. But this can be guarded against by putting it in the fire: if the gold is pure, it does not lose it lustre, but if it is an alloy, it completely changes color.

As depicted in the gold-copper-silver color diagram in figure 14, any high quality gold with a reddish color would contain less than 10% copper and would be classified in the "red-yellow" color range. A gold-copper alloy that contained 20% copper would be redder in color and be classified in the "reddish" range. In order to create the effect of "red-yellow" some surface process would be needed. Theophilus noted that when heated the adulterated gold would change color, which is what would be expected for an object that has a depletion gilded surface, as once it was melted the true color of the underlying alloy (copper in this case) would be observed.

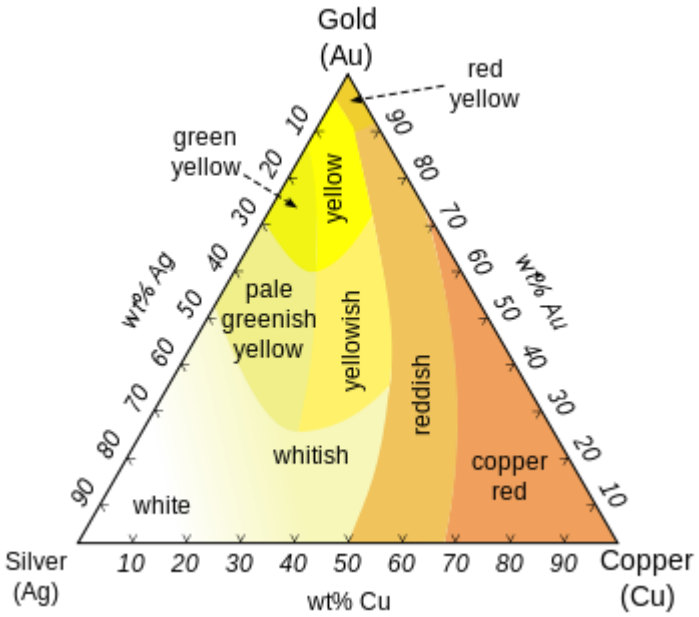

Figure 14. Gold-copper-silver diagram

Timeline Issues with *Ziff*

Ziff, like some other Book of Mormon metals, so far has not appeared in the archeological record in the appropriate Book of Mormon time frame (circa 150 BC) in the region of the Valley of Guatemala, which is the location where most Mesoamerican models place the Land of Nephi. As indicated in the Book of Mormon, the use of *ziff* was not utilitarian, but rather was strictly decorative, so no *ziff* in great amounts would be expected to be present. In fact, since the King Noah time frame is the only place where *ziff* is mentioned in the Book of Mormon, it is very likely that it was anomalous, and may have only been present because the Valley of Guatemala at that time was a major trade corridor.

Where precious metals are involved, there are plenty of archaeological instances where the archeological record lacks evidence of precious metals even when historical records clearly document their existence.

As was mentioned earlier, Corinthian Bronze is described in ancient Latin, Greek, Hebrew, and Syriac texts. Pliny indicated that Corinthian Bronze was valued “before silver and almost before gold” (Pliny, AD 77a). Cicero and Plutarch also commented on the uniqueness of Corinthian Bronze (Cicero 45 BC, Plutarch AD 100). Early Jewish authors of the Classical period, including Josephus, were impressed by the Corinthian Bronze doors of the Nicanor Gate in the Temple at Jerusalem (Josephus AD 79; Jacobsen et al. 1992). Syriac sources for Corinthian Bronze include the Syriac “Peshitta” version of Ezra 8:27 datable to around AD 200 (Weitzman 1999), a Syriac text attributed to the alchemist Zosimus composed between the seventh and tenth centuries AD (Jacobsen et al. 1992), and a lexicon composed in the tenth century AD by the Syriac scholar Bar Bahlul (Duval 1901).

Despite this historically well-documented and somewhat widespread precious metal, so far not a single example of Corinthian Bronze has ever been located in the archeological record or otherwise.

Another example of the absence of precious metals in the face of direct historical texts is the precious metals of the Fatamid Caliphate. The Fatimad Caliphate was a Shia Islamic caliphate that existed from 909 to 1171 AD, which covered a large area of North Africa, from the Red Sea in the east to the Atlantic Ocean in the west. The dynasty

ruled across the Mediterranean coast of Africa and ultimately made Egypt the center of the caliphate. At its height, the caliphate included, in addition to Egypt varying areas of the Maghreb, Sudan, Sicily, the Levant, and Hijaz.

> Without a doubt, the problem of the origin of the inlaid-bronze and brass industry in the Arab world is much more difficult than in Iran. The reason is simple: the virtual lack of precious-metal objects attributable to the Fatamids. Because of this, there is no question of comparing silver and base-metal products. Of course precious-metal objects existed, and existed in huge quantities, as the description by al-Maqrizi of the treasures looted from the Fatimid palace in Cairo makes abundantly clear. Included in his catalogue we find monumental sculpture in precious metal – a silver ship, a golden palm tree, a golden gazelle, a golden hen and a golden peacock – and literally thousands of vessels in silver or gold, enameled or gilded, encrusted with jewels, or inlaid with niello – dishes and inkwells, cups and jugs, lamps and trumpets, flower vases and boxes – and precious-metal fittings, for knives, for swords, for standards and parasol handles, for tent poles and the royal barges. Apart from odd items of gold jewelry, only one Fatimid object even partially of precious metal has so far been identified, and that is a bronze mirror with a silver back! (Allan 1982)
>
> Our knowledge of western Islamic metalwork prior to the rise of the Ayyubbids and the Mosul school is extremely scant. A few articles on the Fatimid treasury or on single items, odd entries in the occasional exhibition catalogue and some pieces in catalogues of private or public collections have left the subject obscure. (Allan 1986)

Beyond the example of the absence of a precious metal in archeology where historic texts are involved, in the case of pre-Columbian gold in Columbia, archeology failed to locate any workshop sites despite the fact that there were over 28,000 collected pieces in the Gold Museum in Bogatá and despite descriptions and direction to the locations in general terms from early explorers (Bray, 1978).

One reason cited for the inability to discover evidence of mining and smelting sites is that later European invaders, later miners, and eventually mining companies prospected for metallic ore sources in precisely the places where local people had been mining ore, smelting it, and probably working the metal. These later activities destroyed or changed the evidence of the earlier extractive metallurgy and processing technology (Hosler 2013).

There is no certain description of true smelting in Mesoamerica in the Book of Mormon, in fact, the use of all metals as merely ornamental is evidence in and of itself that there was probably not any smelting going on, but that the metallurgy was limited to cold working and perhaps some lower temperature hot-working of native metals. A full discussion of metallurgy in the Book of Mormon is a forthcoming publication I am working on, which will involve the discussion of brass and other metals mentioned in the Book of Mormon.

Gold in Ancient Palestine Previous to 600 BC

Since the original cultural source of the lineage groups (excepting the Jaredites) who make up the Book of Mormon originated from Palestine around 600 BC, it is certainly prudent to evaluate what archeologists there have experienced with regards to gold as a precious metal and the paucity of archeological evidence.

Canaanite Period

Despite extensive archeological excavations that have occurred along the coastal strip of Israel, only a very few Early Canaanite gold artifacts have been discovered. There is archeological evidence that gold was available for jewelry production in Canaan from 1800 BC to 1200 BC. At that time the main sources of gold were Egypt and Arabia. The Midianites, a nomadic Semitic people who lived along the Red Sea coast in the Gulf of Aqaba and in the northwest of the Arabian peninsula were the chief agents in gold trade with Arabia. They also mined and processed copper in Tymna (Altman 1979). Gold foil was used by the Canaanites for gilding bone and bronze objects.

Phoenicians, who would be differentiated from the general mass of Canaanites during the latter half of the second millennium BC, obtained gold from Ethiopia, Arabia, and Asia Minor. While there is no evidence that Phoenicians were smelting gold, they were experts in gold, silver, and gold gilding. Gilding was applied to metal, wood, and ivory, and the latter two were used to decorate walls and furniture. Wooden objects have not survived, but some examples of gilded ivory have been found.

Israeli Culture

In the Bible, gold is the most frequently mentioned of all metals but almost no gold objects have been found from the Israeli period of Palestine (1200 to 587 BC). Large quantities of gold were obtained by King Solomon and dedicated to the construction of the First Temple in 967 BC (1 Kings 6:20-35, 7:46-51). Only a few hoards have been found in Gezer, Akhsiv, and in Beth Shemesh, and they have consisted of relatively simple gold earrings, beads of various sizes and shapes, and discs with dots and holes apparently intended for sewing onto garments.

The Bible mentions Arabia, Sheba, South Arabia, and Ophir as sources of gold; Ophir is surmised to be situated between Mecca and Medina. The impression gained from the Bible and from modern research is that the use of gold for decoration was reserved for royalty and cultic purposes. Hebrew inscriptions on gravestones of the eighth and seventh centuries BC indicate that it was not the custom to put objects of value into the burial caves and there seems to have been very little gold in private hands (Paul et al. 1973). The main accumulation was in the Temple and an indication of the size of the collection is given in a description of some of the treasure returned by Cyrus 50 years after the destruction of the first temple in 586 BC (Ezra 1:9-11).

In Mesopotamia, where extensive archaeology has occurred, the same paucity and large gaps in metal discoveries have been noted:

> By the sixth millennium B.C. melted native copper, perhaps already producing “arsenical coppers,” and smelted copper were employed in northern Mesopotamia.
>
> Evidence for metallurgy in Mesopotamia between 5000 and 3500 BC is extremely poor, amounting to no more than a handful of copper ornaments and isolated pieces of lead… There is no evidence for the use of gold, electrum, or silver before 4000-3500 BC. In two cemeteries of that period in the south, at Eridu and at Ur, there is no metalwork in the graves. At present, we must assume, as the pattern of finds has now been consistent for over half a century, that this reflects a real situation in which even base metals served a minor, essentially decorative role in society.
>
> Stone and clay were the raw materials predominantly used by all prehistoric communities of farmers and craftsmen for their tool kits and for their weapons in war. Therefore copper tools were not needed to increase the efficiency of food production or of carpentry in the relatively small, self-contained villages of Iraq before 3500 BC. Indeed, at this stage stone tools were probably more efficient than copper and were easily made of accessible materials. There was no incentive to increase the potential supply of copper, even if there were the means, nor to improve the range and strength of copper tools. Metal was neither vital for subsistence nor yet valued as a prestige commodity. Brightly colored semiprecious stones, such as turquoise and lapis lazuli, or imitations of them in blue-glazed dark stones or faience served that purpose. Distance from the sources of such stones does not appear to have restricted their supply. (Moorey 1985)

In the case of Mesoamerica, where there is a high concentration of volcanos and associated volcanic deposits, obsidian was available and ubiquitously traded. The sharp edge of obsidian is much superior to any cold- or even hot-worked native metal.

Another reason for the lack of archeological evidence of precious metals in certain areas of Mesopotamia at certain times is that historical texts indicate that metals were often rigorously controlled by the bureaucracy and were regularly recycled (Moorey 1985). While we don’t have much in the way of early texts in the Valley of Guatemala,

the archeological record clearly shows that at the large archeological site of Kaminaljuyu there was wholesale recycling of carved monuments (Henderson 2013, 129-133). It would certainly be expected that whatever small amounts of precious metal there were would also be collected and recovered.

Plundering and tribute-taking also affected the metal supply in Mesopotamia. A famous Sumerian epic poem from the Early Dynastic Period describes how an expedition from Uruk into Iran seized not only precious metals but also the artisans skilled in working it with their tools, including molds for casting (Wilcke 1969). Probably the largest example of wholesale historical pillaging of metals (and everything else) was the Spanish conquest of Mesoamerica.

Importantly, since the Nephites are derived from a Palestinian culture, as mentioned previously the Bible itself contains a myriad of references to gold and describes specific gold objects, but relatively little has been found after extensive concentrated archeological excavations. It was not the practice to include gold in burial sites in Israel during the time period that Lehi and his family departed from Israel. As noted on the discussion regarding the Phoenicians, no metals used in the gilding and ornamentation of wood would have survived. The ornamentation referred to in the description of King Noah's activities appeared limited to wood inlay (Mosiah 11:8-9), which would not be expected to survive in the archeological record.

In addition, archeology focuses on the excavation of temples, graves, and habitation sites. Other than the one instance of King Noah, there are no other Book of Mormon examples of temple or building ornamentation by precious metals. There is no mention of burial practices that would include any or all of the precious metals mentioned in the Book of Mormon. There is also no real indication that the possession of precious metals was widespread; it was probably limited only to the elite, just as occurred in Israel.

Notably, in the South American production of gold, there is a gap of nearly 1000 years between the first discovery of worked gold together with gold-working tools (1500 BC) and the next most recent discovery (500 BC) (Scott 2000). No one doubts that there was gold being worked during this 1000-year time frame despite the complete lack of archeological evidence.

It is also important to remember that the Nephites were only one cultural subset of the entire Mesoamerican area, and for most of their history may have been a relatively small subset. Gold in their culture is only discussed right after the Lehi party first arrived in the early part of the sixth-century BC, then around 140 BC, 90 BC, 29 BC – AD 30, and AD 306. It cannot be extrapolated that all Mesoamerican cultures had precious metals (or even had an interest in them) from what is indicated in the Book of Mormon. On a few occasions in the Book of Mormon, an interest in precious metals is indicated by some portion of the Lamanites, but describes only those Lamanites who were adjacent to or sharing the same cultural area with the Nephites.

Chapter 10
Of Snakes and Serpents

Another approach to understanding the definition of *ziff* may lie in its actual use in its actual setting. Sometimes a material and its form are designated for a specific or unique use and its name or definition is based on that use. For example, the English word *cleanser* can consist of any number of mixtures and chemicals—it is the use of the material that defines the word, not the constituents of which it is made.

Anciently, particular materials were sometimes associated with a specific religious meaning or association. For example, several ancient civilizations practiced the sciences of alchemy and astrology and related various metals to specific planets. While Alchemy tries to understand the meaning of the metals and elements, Astrology is concerned with the interpretation of the zodiac and planets. The two were always considered related, and an understanding of one was thought to be helpful in understanding the other. As such, metallurgy and spiritual alchemy went hand in hand. The metals were believed to have a spiritual connection and every metal carried a special significance. The alchemists believed that each element had a physical representation and also a philosophical meaning.

The capitalization of the word *ziff* in both places where it is found in the Printer's Manuscript of the Book of Mormon leaves open the possibility that the word may have a specific religious connotation, similar to the words Rameumpton and Liahona.

Context of the Use of *Ziff* in the Book of Mormon

The Book of Mormon specifies that *ziff* was used, in conjunction with other precious metals and precious materials, to ornament "many elegant and spacious buildings" (Mosiah 11:8). It may have been used to ornament a palace and throne of King Noah although not specifically named (Mosiah 11:9). It apparently was not used within the walls of the temple (Mosiah 11:10) or for the seats set apart for the high priests (Mosiah 11:11). It appears from an overall look at the Book of Mormon that the use of these metals for ornamenting buildings was anomalous, and that may be why it is mentioned in this instance in that it constituted excessiveness by King Noah. There is no other mention of the use of ornamental metals on buildings, except for perhaps by inference over 400 years earlier in the building of a temple by Nephi (2 Nephi 5:16).

While not located in the Valley of Guatemala, a piece of copper sheathing was found on top of an altar at Cuicuilco in the Valley of Mexico, dating back to around the first century BC (Cummings 1933; Heizer et al. 1958). In some accounts of the Conquistadors of Peru in the fifteenth-century AD, they noted that entire walls of buildings were covered in gold foil (Scott 2000).

It is also useful to look at the events in the Book of Mosiah pertaining to the use of *ziff* to see what the existing cultural context of the use of *ziff* might have been. After becoming king, Noah had many wives and concubines, and did cause the people to commit whoredoms and all manner of wickedness (Mosiah 11:2). He laid a tax on the people taking a portion of their ownership of various items, including *ziff*, which was used to support himself, his wives, as well as his priests and their wives and concubines (Mosiah 11:4). He engaged in "riotous living" with his wives and concubines, and as did his priests with their harlots (Mosiah 11:14).

Notably, the prophet Abinadi, who reprimanded King Noah and was eventually put to death by him, specifically noted two areas of wickedness: worshiping graven images and sexual lasciviousness amongst the priest class, which

was then extended to the general population. In addition to general greed, Abinadi specifically identified these two main areas where they had deviated from the Law of Moses (Mosiah 12:29, 34-35, 13:12-13). Noah and his priests were apparently practicing a version of religion that they thought consistent with the Law of Moses (Mosiah 12:28). The religious practices were probably incorporating some elements of indigenous Mesoamerican religion including fertility rites. This type of incorporation of surrounding religious practices is called syncretization and is found in other situations of Nephite apostasy in the Book of Mormon (Wright et al. 2012). It seems apparent that the elements of the Mesoamerican religion being incorporated shared consistency with some corrupted elements of the Law of Moses.

Also notable is the fact that Abinadi emphasized that God would come down to earth and take upon himself the form of a man (Mosiah 13:34), which offended King Noah and his priests greatly and was one of the principal religious doctrines for which they condemned Abinadi to death (Mosiah 17:8). There are various possible reasons why this may have been an offense worthy of death.

1. The political position of king may also have been perceived as constituting a divine power, such that no intervention was needed by deity.

2. The form of worship that was being engaged in involved worshiping of graven images that were not in human form, so the description given by Abinadi would have been contrary to their belief in the form of God. Although not necessarily determinative, Abinadi specifically referred to “the devil” as “that old serpent” in Mosiah 16:3. The adopted religion also involved some sort of fertility type worship, or at least the promotion of sexual lasciviousness.

The incorporation of native religious beliefs by an enclave of a different religion is a common occurrence, even in the modern world. I have witnessed Chinese Catholic churches that allow the traditional worshipping of ancestors involving the burning of incense, where only saints were worshiped before. Statues of Christ often had Asian facial features.

The syncretization and modification of the enclave religion is easier when it involves slight modifications or incorporates parallel practices that don’t completely change the religious ceremony or practice. This makes it much easier for practitioners of the modified religion to claim that they are still essentially practicing the “old time” religion. Thus priests of Noah could still claim they were still practicing the Law of Moses without compunction.

The Southern Maya Region, which includes the Valley of Guatemala, has been classified by most archeologists during the Late Preclassic period (400 BC-AD 250, which includes the time of King Noah) as having a mix of cultures and ethnicities present, with the Maya culture being one of the dominant cultures (Love 2011). There is much disagreement among archeologists as to the cultural and geographical source of the Maya. The Book of Mormon itself reflects that at least two groups existed at that time, the Nephites and the Lamanites. Since political and religious affiliations are only two elements of a culture group, it would not necessarily be expected that the other basic ways of life and culture (diet, agricultural practices, dwelling type, etc.) were extremely different between these groups.

It would not be expected that any significant portion of the Maya culture in the Valley of Guatemala would have incorporated many cultural elements of the original Lehi group. The Maya as a culture group at the time of King Noah extended geographically far beyond the Southern Maya Region. In addition, it would not be expected that the culture of the original small group of Lehites arriving in the sixth-century BC would be existent in its exact original form 400 years later at the time of King Noah.

While the original culture of King Noah would be classified as Nephite, it seems clear from the religious practices (graven images, fertility practices, etc.) that there was a significant deviation on the level of the king and the priests to a different religious practice and they were incorporating the religious practices of adjacent cultural groups. It would be reasonable to assume that the group from which they were borrowing was the Maya. Since the adjacent group that the Book of Mormon refers to are the Lamanites, it would seem reasonable that the Lamanites belong to the Maya cultural group of the local area.

The Setting of the Land of Nephi at the Time of *Ziff*

According to the Sorenson and other geographic models of the Book of Mormon, the Land of Nephi was located in the Valley of Guatemala, with one of the principal archaeological sites being the ancient city of Kaminaljuyu. The known parts of Kaminaljuyu lie on a broad plain beneath roughly the western third of modern Guatemala City. Unfortunately, large portions of this archeological site were destroyed or covered by the urbanization of Guatemala City, so a complete archaeological representation of the city is now impossible.

The calendar system for year-counts up until 9 years after the Coming of Christ was the 12-lunar month year of 354.367 days/year (Grover 2015) and some additional dates are now known as found in the Caractors document. Using this calendar count, the basic timeline involving this area and the Book of Mormon calculated by using up until the time of King Noah is:

Circa 580 BC – Original small group of Nephites migrated from the Pacific coastal area up to the valley

Circa 548 BC–450 BC – Ongoing conflict with neighboring group(s), generally referred to as Lamanites; Lamanite groups practiced idolatry

Circa 393 BC–356 BC – Nephite conflict continues with Lamanites living in intermingled groups amongst the Nephites; kings are mentioned as leaders; Lamanites driven out from amongst the Nephites; Nephites "fortify" their cities; Lamanites purported to love murder and drink the blood of beasts

Circa 356 BC–290 BC – Alternating periods of peace and war between Lamanites and Nephites

Circa 290 BC–186 BC – Portion of the Nephites destroyed; Nephites left the land of Nephi for Zarahemla

Circa 179 BC – Zeniff departs Zarahemla; Zeniff negotiates settlement agreement with Lamanite king, Laman, to possess the land and cities of Lehi-Nephi and the land of Shilom; Lamanites vacate those portions of the valley of Guatemala

Circa 166 BC – Conflict between Lamanites and Nephites within the valley of Guatemala; Lamanites described as an idolatrous people; Lamanites described as a wild, ferocious, and blood-thirsty people

Circa 157 BC – King Laman dies

Circa 153 BC – King Noah comes to power (estimated)

Circa 143 BC – Abinadi put to death (estimated)

Circa 127 BC – Limhi sends out a group of men who recover the Jaredite plates

Religious Syncretization by King Noah from the Maya

Since the setting for the location of King Noah in the Land of Nephi has been identified as the area of the Valley of Guatemala, a look at aspects of what we know of the area in relation to the syncretization of the Nephite religion by King Noah might be of interest. Specifically the large archeological site of Kaminaljuyu in the valley can provide us some information.

King as a divine individual on earth

Among the Maya during the Classic period, the inherently human nature of kings contrasted against their ability to manifest the divine, a phenomenon described as “concurrence” by several authors (Houston and Stuart 1996, 297-300; Houston et al. 2006, 270, 275), meaning the king’s human body became simultaneously occupied by divine presence(s) during ritual performances (see also Schele and Freidel 1990, 70; Schele and Miller 1986, 302; Stone 1991).

Sculpture 11 at Kaminaljuyu has been interpreted in a similar fashion as the regalia of a king representing the god known as the Principal Bird Deity (“PBD”) (Henderson 2013, 335; see figure 15). Sculpture 11 is thought to be from roughly the same period as King Noah. The setting in this respect is consistent with the hostile reaction to Abinadi’s statement that God would come to the earth and walk among men, which would have been perceived as a direct challenge to King Noah’s position of being the manifestation of the divine on earth.

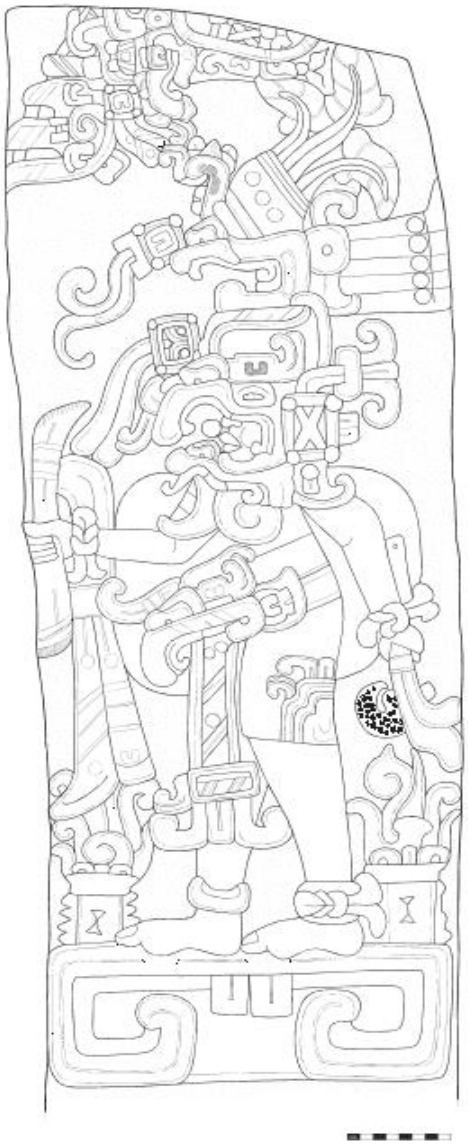

Figure 15. Sculpture 11 at Kaminaljuyu (Henderson 2013, 539)

Candidate Gods for King Noah graven images in Kaminaljuyu

The following Maya gods have been potentially identified based on iconography at Kaminaljuyu and all had what would qualify as "graven images" present at Kaminaljuyu. Most would be considered a local god or a local form of a regional Mayan god.

- Goddess O
- Trefoil eye god
- Antecedent God N
- Old God (Sculpture 17 at Kaminaljuyu)
- Kaminaljuyu Rain God
- Horned water deity
- Witz Eyed Earth
- Crocodile earth deity
- Bracket Beaked Deity
- Feathered serpent
- Principal Bird Deity
- Foliated Jester God

(Henderson 2013)

Since the priests of King Noah had to at least keep the delusion that they were somehow practicing the Law of Moses, one would expect that the graven images that they were worshiping would have some relationship to the practice of the Law of Moses. The most obvious choice would be the Feathered Serpent god, consistent with the serpent that that was raised by Moses in the wilderness (Numbers 21:8), although along these lines the Antecedent God N might be a possibility (depicted showing a serpent staff in one hand), the Kaminaljuyu Rain God (depicted with knotted snakes on his ankles and a twisting serpentine figure over his head), or the Bracket Beaked Deity (possessing a serpent body and considered a precursor to the Water Lily Serpent God).

The setting of Kaminaljuyu would be consistent with the Book of Mormon where graven images at least similar in appearance are present that could be considered a syncretization of the Law of Moses.

There is no specific archaeological evidence at Kaminaljuyu of the promiscuity attributed to the priests of Noah, but that would not be an unknown Maya practice.

Parallels to Corruption of the Law of Moses in Israel

As was described by Abinadi in the Book of Mormon, two principle deviations from the Law of Moses by Noah and his priests were graven images and sexual lasciviousness. A similar occurrence of syncretization happened to Jews practicing the Law of Moses, and ironically involved the element of *sufr*.

One ancient practice involving the use of bronze and gold-gilded bronze in religious figures was the Cult of the Bronze Serpents in ancient Canaan and Israel. The cult is fully represented in archaeological data, but the details of the worship are not completely clear.

The oldest bronze serpent excavated was found in Megiddo in Northern Israel, dated 1650-1550 BC, and was 18 centimeters in length. There were two terracotta figures of birds found in the same archaeological level and location. The room in which they were found was a sacral room associated with a temple. Another bronze serpent 10 centimeters in length was found in a strata dated to 1250-1150 BC associated with a palace that was about 10 meters away from the first serpent found (Loud 1948).

Another bronze serpent, found in Tel Mevorakh, is about 20 centimeters long and dates from 1500-1300 BC, was located on a platform on the west side of a sanctuary, and was found with other objects associated with cultic observances (Stern 1984).

Two bronze serpents were found in the Holy of Holies of Temple H at Hazor in Upper Galilee. The first one was 11 centimeters long and appeared to be a cobra and was dated to 1400-1300 BC. The second was dated to 1300-1200 BC, is approximately 7 centimeters long, and appears to be a pendant (Yadin 1961; Yadin 1989).

Two bronze serpents were also found in Shechem, which was a Canaanite city, and is mentioned in the Hebrew Bible as an Israelite city of the tribe of Manasseh and the first capital of the Kingdom of Israel. The serpents were probably found in the area of a Late Bronze temple, dated to 1450-1100 BC. However, archeological documentation of these is lacking (Joines 1974, 62-63).

A unique bronze serpent was discovered in Timna', located in the copper mining area of southern Israel. The serpent was bronze wrapped around with gold ribbon with a golden gilded head and is 12 centimeters long (see figure 16). It was excavated in the Hathor temple, and dated to 1300-1100 BC (Rothenberg 1988).

Figure 16. Bronze serpent with gilded gold head from the Temple of Hathor in Negeb

The Hathor Temple is found at the foot of the huge sandstone formation in the center of the Timna' Valley known as "King Solomon's Pillars." It was dedicated to Hathor, the Egyptian goddess of fertility and mining, and was founded during the reign of Pharaoh Seti I (1318-1304 BCE) and served the members of the Egyptian mining expeditions and also their local co-workers. The sanctuary consisted of an open courtyard with a cult chamber, where a niche had been cut into the rock, apparently to house a statue of Hathor. In the temple courtyard there was a workshop for casting copper figurines as votive offerings. There were also found numerous other Egyptian-made votive offerings, including many copper objects, alabaster vessels, cat and leopard figurines of faience, seals, beads, and scarabs as well as Hathor sculptures, figurines and plaques (www.nazarenemedia.net 2004)

With the decline of Egyptian control of the region in the middle of the twelfth-century BC, the mines at Timna' and the Hathor temple were abandoned. However, cultic activities in the temple were restored by the Midianites, who remained in Timna' for a short period after the Egyptians left. They cleared most traces of the Egyptian cult and effaced the images of Hathor and the Egyptian hieroglyphic inscriptions on the stelae. Other changes were made: a row of mazeboth (stelae), was erected and a 'bench of offerings' was built on both sides of the entrance. Remains

of woolen cloth found along the courtyard walls provide evidence that the Midianites turned the Egyptian temple into a tented desert shrine. Among the finds in this Midianite shrine was a large number of votive gifts brought especially from Midian, including beautifully decorated Midianite pottery metal jewelry. The bronze snake was found in the Midianite shrine as was a bronze phallic male figurine.

The evidence of a Midianite culture, as found in Timna', is important in light of the Biblical narrative of the meeting of Moses and Jethro, high priest of Midian (who was also Moses's father-in-law), and the latter's participation in the organization of the children of Israel in the desert (Exodus 18).

Finally, the most recent find was a bronze model of a serpent dating to 1100 to 900 BC, which was found in Gezer and is 18 centimeters in length. It was found in a circular structure of unknown use (Macalister 1912).

In understanding the Cult of Bronze Serpents in the context of Semitic beliefs, the snake has been interpreted as a phallic animal involved with fertility cults (Joines 1974, 62-63; Jaroš 1982). Fertility goddesses are depicted accompanied by snakes and sometimes in conjunction with depiction of birds (Münnich 2008). Elsewhere in the Ancient Near East the veneration of the snake or snake figures associate the snake with water, birds (specifically doves), as a symbol of life emanating from the earth (Joines 1968).

Mozeson (2000, 150) also notes a potential linguistic link in the Bible between the "fiery serpent" and *sufr*. Specifically, the Hebrew word for "fiery serpent" found in the Bible in Deuteronomy 8:15 and Isaiah 14:29 and 36 is שָׂרָף, or *säräp(h)*. The words *sufr* and *säräp(h)* are nearly linguistically identical with a transposition of the "f" and the "r," especially considering that both the ancient written Arabic and Hebrew did not contain vowels.

This type of linguistic sound change involving transposition of sounds is called *metathesis*. It has occurred in English with Old English *brid* becoming the Modern English *bird*, and Old English *hros* becoming the Modern English *horse* (Campbell 1999). In the instance of the three-letter words Arabic *sfr* and the Hebrew *srf*, since Arabic and Hebrew are of the same language family, it may be that one was borrowed from the other language, or there may be a proto-word that from which they both derived. A proto-word is a word that historical linguists postulate existed based on comparing similar words called cognates that exist in the different languages in a language family.

The seraph of Isaiah 6:2 and 6:6 is also the same Hebrew word as the "fiery serpents" (שָׂרָף). Seraph is a type of celestial or heavenly being in Judaism and Christianity. As a portion of the Book of Mormon contained the writings of Isaiah, seraphim (plural of seraph) were also known to the Nephites as they were mentioned in 2 Nephi 6:2, and 6-7. The seraphim are considered literally to be the "burning ones."

Numbers 21:9 refers to the curing serpent Moses raised up on a staff as also being made of brass-bronze and was yellowish. The story of Moses, the fiery serpents, and the brazen curing serpent are also referenced in the Book of Mormon (2 Nephi 25:20) and so would be known to the Nephites. The brazen serpent lifted up was considered by the Nephites to be a type or representation of Christ (Helaman 8:14-15, Alma 33:19-22).

Later in the Bible, just before the departure of Lehi's group from Jerusalem, King Hezekiah instituted a religious iconoclastic reform and destroys "the brazen serpent that Moses had made; for unto those days the children of Israel did offer to it; and it was called Nehushtan" (2 Kings 18:4). Modern exegesis holds two possibilities to the meaning of the word "Nehushtan," which is explained either as an image of bronze "nechash" (נְחָשׁ) or with the word serpent "naḥash" (נָחָשׁ), or as a lengthened form of "naḥash", and thus implying that the worship of serpents was of ancient date in Israel (www.JewishEncyclopedia.com 2014).

As noted in chapter 6, the definition of *sufr* includes yellow, brass, gold, and also a worm that gnaws the belly of a starving man. It is clear that the definition of the word itself encompasses many elements of the story of the

brazen serpent, so it would not seem just a serendipitous coincidence that there may be a religious importance placed on *sufr* and perhaps *ziff* in the Book of Mormon.

Context of the Ornamental Use of *Sufr* in the Middle/Near East

In early Middle and Near Eastern metalwork, the principal use of metal in conjunction with architecture was ornamental—for the plating of doors, casting of doorknockers, locks and keys, or the creation of window grills (Baer 1983, 303).

In addition to decorative metalwork, bronze and brass, and specifically *sufr*, were also used in religious or magical figures or images incorporated into architecture. One use of these images is to ward off evil or pests; this use is called *apotropaia*. In Byzantium, bronze images of animals were used to repel a wide range of pests including fleas, flies, mice, rats, snakes, turtles, and even unruly horses (Flood 2006). In the Islamic world the range of protection was limited more to snakes, scorpions, and birds. A typical example of this in the city of Ṣan'ā' in Yemen was recorded by the tenth-century Islamic historian al-Rāzī:

> Ṣan'ā' is surrounded with talismans against vipers and snakes, so that vipers and snakes can hardly harm anyone, and a person stung who has died from that has never been heard of. … One of these talismans is of iron and the other of brass (ṣufr) and they were hung on the gate of Ṣan'ā' town, the first, in the place known as al-Qaṣabah, was a thing made in the Jāhiliyyah (the pre-Islamic age), and one of them, it being of iron, is on the Bāb al-Misra'… (Serjeant et al. 1983, 487)

Apotropaia were also used at mosques and other public monuments. In Himṣ, Syria, a bronze scorpion was set on a dome near the central market to protect the entire city from scorpions, it was reported to be so effective that not only did snakes and scorpions not enter, but clothes washed in Himṣ water acquired the ability to repel snakes and scorpions (Ibn Hawqal 1873, 176, Le Strange 1890, 357). The Great Mosque of Damascus had talismans against reptiles, pigeons, spiders and other creatures placed on or suspended from its ceiling (Ibn Ṣaṣrā 1399, Arabic Text 120, English text 161).

Different from apotropaia, metal figures or images were also commonly used to ornament buildings in the form of the image of adoration itself, which can be seen even today on many religious buildings.

Chapter 11
Ziff and the Golden Plates

It has been suggested that the golden plates discovered by Joseph Smith consisted of the New World alloy tumbaga (Putnam 1966). Since tumbaga is one of the candidates for *ziff*, it is appropriate to evaluate the golden plates from a scientific metallurgical perspective to see what can be determined about the plates to explore this possibility. In carrying out this analysis, it will be necessary to evaluate each merited metallurgical technique, material, or method in both the Old and New World, since a portion of the Book of Mormon golden plates was made by Nephi, who originated in the Old World and traveled to the New World. In completing these comparisons, the comparison will mostly be limited to techniques known in the general area of the Middle East in the Old World, and in Central and South America in the New World. Issues of the metallurgy of Mesoamerica, where most of the credible geographic models place the Book of Mormon, will require a separate inquiry, which the author is hopeful to commence at some point in the future. That being said, there will be some general discussions included here to put the metallurgical inquiry into the golden plates in a geographic context.

Original Description of the Golden Plates

It is important to point out that no person who is known to have experience with metals examined the golden plates that were found by Joseph Smith. Those who handled or saw the plates would be considered metallurgical laymen, so statements made by them need to be considered from that perspective. No one who saw the plates made an assertion that they were made entirely of "pure gold" although there was a press recounting that did make that statement. In order to attempt a scientific determination of the metallurgical make-up of the plates, each parameter of the plates as described by persons who saw them must be evaluated. The following historical descriptions were made of the plates, these being comments of first-hand sources or recounting from first hand sources. The following list was compiled by FairMormon.org (FairMormon.org 2015) with a few other additions made:

1. Color of the plates

- "the appearance of gold"—Joseph Smith Jr., Eight Witnesses (J. Smith 1842, O. Pratt 1840, Book of Mormon 2015)
- "golden plates"—David Whitmer (Whitmer 1881)
- "in a good state of preservation, had the appearance of gold"— William Smith (W. Smith 1841)
- "pure gold"— citing Orson Pratt and Lyman Johnson (Catholic Telegraph 1832)
- "whitish yellow"— attributed to David Whitmer (Howe 1834, 16)
- "engraven on plates of gold"—Parley P. Pratt (P. Pratt 1840)
- "this pretended Revelation was written on golden plates, or something resembling golden plates"—citing Oliver Cowdery (Cowdery 1830)
- Josiah Stowell, under oath indicated he "saw a corner of it [plates]; it resembled a stone of a greenish caste" — (Morning Star 1832)

2. Color and type of engraving

- "[The plates] were filled with . . . Egyptian characters. . . . The characters on the unsealed part were small, and beautifully engraved. The whole book exhibited many marks of antiquity in its construction and much skill in the art of engraving."—Joseph Smith Jr. (J. Smith 1842)
- "There were fine engravings on both sides."—John Whitmer (Anderson 1981, 131)
- "We also saw the engravings thereon, all of which has the appearance of ancient work, and of curious workmanship."—Eight Witnesses (Book of Mormon 2015)
- "[T]he characters . . . were cut into the plates with some sharp instrument."—William Smith (W. Smith 1884)
- "On opening that part of the book which was not secured by seals, he discovered inscribed on the aforesaid plates, divers and wonderful characters, some large and some small"—citing David Whitmer (Howe 1834, 16)
- "These were filled with engravings on both sides"—Parley P. Pratt (P. Pratt 1840)
- "on each side beautifully engraved, and filled with black cement"—W. A. Appleby (Appleby 1844)
- "stained with a black, hard stain, so as to make the letters more legible and easier to be read."—Orson Pratt (O. Pratt 1859)

3. Metallurgical constituents of the plates

- "a mixture of gold and copper"—William Smith (W. Smith 1884)

4. Thickness and configuration of the plates

a) *Each plate was as thick as thick paper, parchment, or tin*

- "of the thickness of tin"—Oliver Cowdery (Cowdery 1830)
- "of the thickness of plates of tin"—Martin Harris (Harris 1859)
- "about as thick as parchment"—David Whitmer (Harris 1870)
- "[We] could raise the leaves this way (raising a few leaves of the Bible before him)."—William Smith (W. Smith 1844)
- "They seemed to be pliable like thick paper, and would rustle with a metalic [sic] sound when the edges were moved by the thumb, as one does sometimes thumb the edges of a book."—Emma Smith (E. Smith 1879)
- "each as thick as a pane of glass"—newspaper reporting on preaching by Orson Pratt (Fredonia 1832)
- "the plates themselves were about as thick as window glass, or common tin"—citing Orson Pratt (Catholic Telegraph 1832)
- "thickness of tin plates"—citing David Whitmer (Howe 1834, 16)
- "being about the thickness of common tin"—Parley P. Pratt (P. Pratt 1840)
- "as thick as common tin"—W. A. Appleby (Appleby 1844)

b) *The plates were fastened together by three D-shaped rings*

- "[T]hey were fastened with rings thus [a sketch shows a ring in the shape of a capital D with six lines drawn through the straight side of the letter to represent the leaves of the record]."—David Whitmer (Whitmer 1877)
- "bound together like the leaves of a book by massive rings passing through the back edges"—David Whitmer (Whitmer 1881)

- "They were bound together in the shape of a book by three gold rings."—David Whitmer (Whitmer 1888)
- "put together on the back by three silver rings, so that they would open like a book"—Martin Harris (Harris 1859)
- "bound together in a volume, as the leaves of a book with three rings running through the whole"—Joseph Smith (J. Smith 1842)
- "The plates were . . . connected with rings in the shape of the letter D, which facilitated the opening and shutting of the book"—William E. McLellan quoting Hyrum Smith (Huron Reflector 1831)
- "back was secured with three small rings of the same metal, passing through each leaf in succession"—citing David Whitmer (Howe 1834, 16)

c) *A portion of the plates were somehow bound together*

- "A large portion of the leaves were so securely bound together that it was impossible to separate them."—David Whitmer (Whitmer 1888)
- "What there was sealed appeared as solid to my view as wood. About the half of the book was sealed."—David Whitmer (Whitmer 1878b)
- "they thus translated about two thirds of what the plates contained, reserving the residue for a future day as the Lord might hereafter direct."—citing Orson Pratt (Catholic Telegraph 1838)
- "the leaves were divided equidistant between the back and the edge, by cutting the plates in two parts, and again united with solder, so that the front might be opened, while the back part remained stationary and immovable, and was consequently a sealed book, which would not be revealed for ages to come, and which Smith himself was not permitted to understand."—citing David Whitmer (Howe 1834, 16)
- "some of them are sealed together and are not to be opened, and some of them are loose"—Lucy Mack Smith (allegedly) (Caswall 1843, 27)

5. Weight of the plates

- "weighing altogether from forty to sixty lbs."—Martin Harris (Harris 1870)
- "I was permitted to lift them. . . . They weighed about sixty pounds according to the best of my judgement"; "I . . . judged them to have weighed about sixty pounds"; "They were much heavier than a stone, and very much heavier than wood. . . . As near as I could tell, about sixty pounds."—William Smith (W. Smith 1883, 12; W. Smith 1884; W. Smith 1894)

6. Dimension of the plates

a) *Breadth of the plates*

- "7 inches in length, 6 inches in breadth"— quoting Oliver Cowdery (Cowdery 1830)
- "six inches wide by eight inches long"—Joseph Smith Jr. (J. Smith 1842)
- "seven inches wide by eight inches in length"; "seven by eight inches"—Martin Harris (Harris 1859; Harris 1870)
- "about eight inches long, seven inches wide"; "about eight inches square"—David Whitmer; quoting David Whitmer (Whitmer 1888; Howe 1834, 16)
- "The plates were each about 7 by 8 inches in width and length."— Parley P. Pratt (Pratt 1840)
- "about eight inches long, and six wide"—Lucy Mack Smith (allegedly) (Caswall 1843, 27)

b) *Thickness of the plates*

- "a pile about 6 inches deep."—quoting Oliver Cowdery (Cowdery 1830)
- "[W]hen piled one above the other, they were altogether about four inches thick."—Martin Harris (Harris 1859)
- "The volume was something near six inches in thickness."—Parley P. Pratt (P. Pratt 1840)
- "The volume was something near six inches in thickness"—Joseph Smith (J. Smith 1842)

Preservation Box

Before initiating a discussion of the plates themselves, it is worth discussing the method of preservation of the plates. From a metallurgical standpoint, it is clear that the construction of the box in which the plates were placed anciently was not a haphazard burial; to the contrary, it is clear that the design and placement of the plates was performed by someone with a knowledge of corrosion processes. Oliver Cowdery indicated (as presumably recounted to him by Joseph Smith):

> First, a hole of sufficient depth, (how deep I know not,) was dug. At the bottom of this was laid a stone of suitable size, the upper surface being smooth. At each edge was placed a large quantity of cement, and into this cement, at the four edges of this stone, were placed, erect, four others, their bottom edges resting in the cement at the outer edges of the first stone. The four last named, when placed erect, formed a box, the corners, or where the edges of the four came in contact, were also cemented so firmly that the moisture from without was prevented from entering. It is to be observed, also, that the inner surface of the four erect, or side stones was smooth. This box was sufficiently large to admit a breast-plate, such as was used by the ancients to defend the chest, &c. from the arrows and weapons of their enemy. From the bottom of the box, or from the breast-plate, arose three small pillars composed of the same description of cement used on the edges; and upon these three pillars was placed the record of the children of Joseph, and of a people who left the tower far, far before the days of Joseph, or a sketch of each, which had it not been for this, and the never failing goodness of God, we might have perished in our sins, having been left to bow down before the altars of the Gentiles and to have paid homage to the priests of Baal! I must not forget to say that this box, containing the record was covered with another stone, the bottom surface being flat and the upper, crowning. But those three pillars were not so lengthy as to cause the plates and the crowning stone to come in contact. I have now given you, according to my promise, the manner in which this record was deposited; though when it was first visited by our brother, in 1823, a part of the crowning stone was visible above the surface while the edges were concealed by the soil and grass, from which circumstance you will see, that however deep this box might have been placed by Moroni at first, the time had been sufficient to wear the earth so that it was easily discovered, when once directed, and yet not enough to make a *perceivable* difference to the passer-by. (Cowdery 1835)

One of the principle agents in the corrosion of metals is contact with water and contact with soils bearing water and other chemicals that may promote corrosion. There are various design elements of the box specifically made for the purpose of metal preservation:

1. The box was sealed so as to prohibit water from entering the box
2. The stones were smooth to avoid retention of water on the surface of the stones
3. The plates were essentially suspended by the use of three pillars made of cement so that the plates would not touch any of the sides or top of the box that might be in contact with water or soil
4. The stone on the top of the box was of a crowning shape on top and flat on the bottom sitting on top of the box. This shape would cause any percolation from precipitation to be shed from off the top of the box so as to avoid any seepage into the box from above.

The location of the box was also placed "not far from the top" of the hill near Joseph's house (Smith 1902). A location at or near the top of a hill is an area that would not normally have a high water table and also would be an area that avoids groundwater accumulation.

Information regarding the plates from the Book of Mormon text

Another source of information regarding the makeup of the plates is the Book of Mormon itself. While there are numerous authors contributing to the Book of Mormon, the majority of the engraving of the plates was done by Mormon with some additions made after his death by his son Moroni. The first part of the Book of Mormon was engraved by various prophets starting with Nephi, and was characterized as the "small plates" by one of the prophets, Jacob, whose engravings were found there (Jacob 1:1).

Small plates

It is noteworthy that none of the persons who saw the plates commented that the "small plates" appeared different from the rest of the plates, or that there was any difference in any portion of any of the plates for that matter. A reasonable conclusion is that all of the unsealed plates were all substantially identical (at least in obvious outward appearance) with regard to color and thickness. Upon initial arrival in the promised land, the Lehite party pitched their tents and planted seed, which then grew "exceedingly." The Lehite party then journeyed in the promised land for an undefined period of time (1 Nephi 18:25) for an undefined distance. Some have surmised that this journey just included operation around a base camp (Sorenson 1992), however, nearly all of the references to "journey" in the books of Nephi are travels from point to point over significant distances. It does not specifically say whether the journey was all on land or which direction they went, but it does indicate that they found "all manner of ore." The large plates were manufactured by Nephi "with mine own hands" after this journeying in the promised land and were characterized as "plates of ore" (1 Nephi 19:1, 1 Nephi 1:17).

Sometime after that initial journey, the original Lehite group separated because Laman and Lemuel wanted to kill Nephi (2 Nephi 5). The location to which they relocated was then called Nephi (2 Nephi 5:8). There was no indication what direction they headed, only that they "journeyed in the wilderness for the space of many days" (2 Nephi 5:7). Nephi recorded that, the small plates had been manufactured by him in 557 BC or shortly thereafter (2 Nephi 5:28-31, 34). After making the small plates, he then retroactively engraved on them records of spiritual events that started in Jerusalem, which is all of the Book of Mormon up to that point in time (circa 600 BC to 557 BC). Nephi does not say whether the small plates were made before or after arriving in the area they called Nephi.

A textual analysis of 1 Nephi 19:1 and the preceding verse (1 Nephi 18:25) are important to evaluate at this juncture, mainly because the Original Text of the Book of Mormon as dictated differs from the present text in two significant ways. As has been previously mentioned, the dictation of the Book of Mormon did not include punctuation such as commas and periods, nor were there verses. There were what can be characterized as chapter breaks, however the current Book of Mormon does not always contain the original chapter breaks as dictated. The two verses of interest here in the Original Manuscript were not separated by a chapter break and should have read (still showing current punctuation and verses):

> And it came to pass that we did find upon the land of promise, as we journeyed in the wilderness, that there were beasts in the forests of every kind, both the cow and the ox, and the ass and the horse, and the goat and the wild goat, and all manner of wild animals, which were for the use of men. And we did find all manner of ore, both of gold, and of silver, and of copper.
>
> And it came to pass that the Lord commanded me, wherefore I did make plates of ore that I might engraven upon them the record of my people. And upon the plates which I made I did engraven the record of my

> father, and also our journeyings in the wilderness, and the prophecies of my father; and also many of mine own prophecies have I engraven upon them.

It is much more apparent under the original textual construction, which lacks the chapter break, that the "plates of ore" constituting the small plates were made from a combination of gold, silver, and copper.

The second difference involves the later punctuating of the Original Manuscript and the effect that the punctuation had the textual construction of this sentence:

> And we did find all manner of ore, both of gold, and of silver, and of copper.

The Original Manuscript did not contain the commas. The problem with the current textual construction is that it does not make perfect sense because of the word "both," which should be followed by two items, not three. At a minimum, the clause "gold and silver" is a linguistic couplet. It is clear that one of the ores must be a binary ore in order to have the word "both" make sense. The only possible textual constructions, because of the listed order, are gold and silver or silver and copper. Native gold and silver nearly always occur together as one "ore" in nature (Forbes 1950, 152). Technologies to separate gold and silver (called "parting") were not known to be practiced in the Old World before the fifth century BC, when the production of accurate and constant alloys became necessary with the introduction of coinage, as noted by the first pure gold coins with stamped images credited to king Croesus of Lydia (561-546 BC). A contemporary gold refinery has been excavated at the capital, Sardis (Gänsicke et al. 2000). The Lydians were able to refine their gold using salt and furnace temperatures of between 600 and 800°C. There has been no evidence discovered in the New World that any pre-Columbian culture possessed gold and silver separation technologies.

While potentially a linguistic couplet, the most consistent reading of the scriptural passage above is as a reference to a binary ore of gold and silver, with the additional separate ore being copper. One cannot tell from the description what percent of silver was found in the gold and silver ore, but the purity of gold of most ancient native gold ores is above 70% (Forbes 1950, 153). The metallurgically proper punctuation should be:

> And we did find all manner of ore, both of gold and of silver, and of copper.

This common textual pairing of silver with gold exists in virtually every instance for silver throughout the Book of Mormon (especially after leaving the Old World) indicating that one is dealing with the very common naturally occurring gold and silver alloy (1 Nephi 2:4, 2:11, 3:16, 3:22, 3:24, 13:7, 13:8, 18:25; 2 Nephi 5:15, 12:7, 12:20, 23:17; Jacob 1:16, 2:12; Jarom 1:8; Mosiah 2:12, 4:19, 11:3, 11:8; 11:9, 19:15, 22:12; Alma 1:29, 4:6, 15:16, 17:14, 31:24; Helaman 6:9, 6:11, 6:31, 7:21, 12:2, 13:28; 3 Nephi 6:2, 27:32; 4 Nephi 1:46; Ether 9:17, 10:12, 10:23). An exception is the discussion of the standardized exchange system (Alma 11:3-22), which used certain measures of silver as a standardized medium. Native silver is found rarely in its natural state without the presence of gold, so the single discussion of silver existing separately from gold should not be considered definitive proof that the metallurgical skills in the New World Book of Mormon included the ability to achieve gold/silver parting (separation).

It is also important to understand what is meant by the word *ore* in the Book of Mormon. As is apparent already, the terms for the actual metal and the ore of the metal are used interchangeably. Another example is illustrated when a set of 24 Jaredite plates were described as "plates which are filled with engravings, and they are of pure gold" (Mosiah 8:9), and "plates of gold." At another place in the Book of Mormon the very same plates are described as "plates of ore" (Mosiah 21:27). All indications of metallurgy in the Book of Mormon involving gold, silver, and copper do not necessitate the assumption that complex smelting or metallurgy is taking place, in fact, the references and textual construction indicate that one is dealing with simple ores (essentially native metal) not complex ores, which is why the terms for ore and the metals can be used interchangeably.

In the Mesoamerican areas adjacent to the proposed geographic models where the Book of Mormon took place (highland Guatemala and southern Mexico), gold working has been documented. It was present in Columbia by at least the fourth century BC, and by the early centuries AD was found in Panama and Costa Rica (Scott 2000). The only silver content identified in any objects found in Columbia is present in conjunction with and originally part of the native gold that was used (Scott 2000). Other areas of Central America do not show any gold and silver separation. This finding is consistent with the level of gold and silver metallurgy that the Book of Mormon is describing.

It is clear that Nephi had some skill at working metals, however it is a distinct possibility that the skill used in construction of the plates was not ultimately retained by all later generations of authors, as it appears that no additional plates beyond those made by Nephi were used. Nephi constructed the plates circa 567 BC, and after Nephi passed the plates on, his brother Jacob was still using extra plates made by Nephi (Jacob 3:14) for his engraving. Jacob also indicated that his people began to search "much gold and silver" (Jacob 1:16; 2:12). Around 400 BC, Jarom (Jacob's grandson) commented that he could not write much as the plates were small (Jarom 1:2) yet indicated his people were "rich in gold, and in silver" and in copper (Jarom 1:8). All subsequent engravers on the plates were extremely brief, evidence that there were no additional plates being made, and finally Amaleki declared circa 130 BC that "these plates are full" (Omni 1:30).

It seems apparent that at least until 400 BC the materials were available, but Jarom did not fashion additional plates even though it was limiting what he wanted to write. By 163 BC it is seems that the ability (seemingly because of lack of metallurgical skill) to fashion more of these types of plates may not have been present.

It is not clear what the metallurgical methods and metals were used for the separate record known as the large plates of Nephi (not included in the plates recovered by Joseph Smith) beyond what Nephi made from gold-silver and copper; there is no mention of anyone making any additional plates, yet there was no apparent comment that those plates were full. It is perhaps possible that Nephi constructed enough of those types of plates to last for the duration of the record, or that others were able to construct sufficient identical plates or plates of some other type.

Plates of Mormon and Moroni

Mormon and Moroni had the metallurgical skill and availability of materials to manufacture plates matching the small plates from circa AD 320 on, as Mormon made a record on plates which he made with his "own hands" (3 Nephi 5:11). Moroni appears to have had the ability to make plates as he indicated that he could not write further after his father Mormon was killed because there wasn't room on the plates and he didn't have any ore (Mormon 8:5), yet later he was able to fashion additional plates and write further. It is also possible that he was later able to retrieve plates that Mormon may have previously fashioned. The sealed portion of the plates was also prepared by Moroni using some type of soldering process. The description by David Whitmer of the sealed portion indicated that "(w)hat there was sealed appeared as solid to my view as wood" and were "united with solder," giving the impression that the solder was continuous around the plates such that the individual edges of the plates could not be seen.

Physical Attributes of the Plates

In determining the scope of investigation of the nature and underlying technology of the Book of Mormon plates, the small plates were most likely created utilizing pre 600 BC Old World metallurgical techniques given that Nephi originated from the Old World. It is possible, since the plates were actually made in the New World, that New World techniques may also have been acquired and utilized by Nephi. Mormon and Moroni would have used New

World techniques of AD 300 to 400, or alternatively, they may have used Old World techniques that were somehow passed down from 1000 years previously.

Recognizing the current lack of metallic archeological attestations in portions of the New World where most geographic models place the Book of Mormon, at this stage, technologies that will be discussed here will not, for the most part, be metallurgical techniques of local geographic areas, but will be those of the larger Near/Middle East in the Old World, and those from Central and South America in the New World.

Plate Surface

The surface of the plates was described as “gold,” “golden,” “having the appearance of gold,” “pure gold,” “whitish yellow,” and “in a good state of preservation.” No mention is made or implied of any tarnish or other signs of metal corrosion such as scaling, blistering, etc. Pure gold is the only ancient metal that does not experience corrosion under natural circumstances. Since there was no tarnish or corrosion present on the plate surface, it is apparent that the surface of the plates was, in fact, pure gold. It is hard to determine exactly what Josiah Stowell meant with relation to his description of the plates because he indicated he saw a corner of “it”, and that it “resembled a stone of greenish caste”. It would seem that perhaps he was seeing the solder type material that covered the exterior of the sealed portion of the plate stack, or perhaps the corner edges of the plates. In any event, his description only mentions a corner of “it”, so presumably he did not seen the plate surfaces where the engravings were located. As will be discussed later, a greenish caste could be indicative of a corrosion by-product of either copper or silver.

As previously discussed, all ancient native gold contains silver or other impurities. As a result, the metallurgical technology used for the surface of the plates must be able to produce a pure gold surface. The technology to separate gold from silver was not known in the Old World until after circa 550 BC and has not been documented in the pre-Columbian New World. The only known technology to concentrate pure gold during these ancient time periods onto the surface of an object is depletion gilding, therefor the pure gold surface of the plates must have been produced by depletion gilding of the final surface.

Black “Cement” and Black Staining of the Engraved Characters

The engravings were described as being “filled with black cement” and "stained with a black, hard stain, so as to make the letters more legible and easier to be read.” There are two possibilities to explain this material: (1) the material is a corrosion byproduct or (2) the material was purposefully placed in the engravings on the plates.

A) Corrosion byproduct

As the preservation box was designed and placed to avoid the presence of corrosive materials, it is apparent that corrosion was a potential concern for at least some of the items in the box. Nevertheless, the fact that the color of the plates indicated a gold surface with no mention of tarnish, would indicate that the gold surface was pure. The fact that the engraving furrows were filled with black material indicates that this part of the surface was not gold so either underwent corrosion or had to be protected from corrosion. This is definitive evidence that the underlying material contained copper and/or silver.

Gold has long been known for its amazing chemical stability in the natural environment. The chemical explanation for the remarkable corrosion resistance is based on its high value of standard reduction potential in the electrochemical series relative to other metals. Reduction potential is a measure of the tendency of a chemical species to acquire electrons and thereby be reduced. In more layman’s terms, the more positive the reduction potential is for a given metal, the greater is its resistance to corrosion. Corrosion consists of a metal reacting with

other chemicals to form various corrosion daughter products. Table 2 shows some reduction potentials for gold (Au), silver (Ag), and copper (Cu).

Table 2. Standard reduction potentials (E°) of metals (at standard conditions)

Reaction	E° (volts)
$Au^+ + 1e^- \leftrightarrow Au$	1.69
$Au^{3+} + 3e^- \leftrightarrow Au$	1.50
$Ag^+ + 1e^- \leftrightarrow Ag$	0.80
$Cu^+ + 1e^- \leftrightarrow Cu$	0.52

As is shown in the table, the ranking of the reduction potentials indicating resistivity to corrosion are gold, silver, and then copper. The reason why water and dissolved oxygen in water is not a factor in the corrosion of gold is that at any chemical environment where gold could react, water (H_2O) cannot exist as it would have completely reacted to break down into oxygen (O_2) gas and H^+ ions. Saying it another way, gold is in a very stable state in the chemical conditions where water can exist.

On the other hand, silver and copper are susceptible to corrosion. There are a variety of chemicals that can react with silver and copper, and the critical item involved in nearly all of these reactions is water. Potential corrosion byproducts of copper are copper oxides, copper hydroxides, copper carbonates, copper chlorides, copper sulfates, copper sulfides, copper phosphates, copper nitrates, copper silicates and organic salts (Scott 2002). As most copper corrosion products result in colors of green or blue, the possibilities for the "black cement" can be narrowed based on the black color alone. The byproducts that could qualify as black are:

Cuprite (in some situations)
Tenorite
Chalcocite
Digenite

Chalcocite and digenite are copper sulfides that only form as corrosion products in oxygen deficient underwater environments, so they can be ruled out as having any possibility of forming in the Hill Cumorah protective box. Tenorite forms when copper is slowly heated in the presence of air, and is an end product of a series of reactions involving corrosion products that are not black. Tenorite thus can be ruled out as forming in the Hill Cumorah protective box. Cuprite, while normally dark red to orange red, can exhibit other colors and has been observed as being black.

Cuprite has been identified as a corrosion product of the copper and silver substrate in tumbaga when it occurred and mixed with finely divided gold (Scott 1983). It was only observed in a powder form.

Potential silver corrosion byproducts in the New York Hill Cumorah type of environment that can exhibit a black color are silver sulphide (Ag_2S, acanthite) and silver chloride (AgCl, chlorargyrite) (Gal-Or 1992). In a dry environment, silver oxide (Ag_2O) may also be present (Lin et al 2013). Other colors of silver corrosion products are white and greenish.

Based on the representation that the material in the engravings was like cement, and that it appeared that it was placed there to enhance the legibility of the engravings, it does not appear that the black material was a corrosion product, especially considering that copper was an alloy. Corrosion would not be expected to be uniform within the plate stack and would typically appear as scale and metallic blisters, which were not observed on the plates.

While it is possible that black minerals could be some of the corrosion products, there are other expected corrosion products generated from copper and silver that are not black (green, blue, and white) and would also be expected to be present.

B) Purposeful patina blackening of the engraved characters

Orson Pratt's observation was that the engraved characters were purposefully colored black to make the engravings easier to read. Another secondary reason that the characters may have had "black cement" or "stain" placed in them would be for additional corrosion protection. Patinas can provide a protective covering to materials that would otherwise be damaged by corrosion or weathering. In the situation of gold gilded plates, the engraving of characters will cut through the outside gold layer into the underlying alloy containing copper and/or silver. Since both copper and silver are subject to corrosion, patination of the engravings would protect the entire piece from corrosion, stopping water, air, or any other corrosive agent from contacting the copper and gold in the engraving furrows, stopping corrosion from occurring underneath the protective gold gilding.

Black Patination in the Old World

Ancient copper alloys are known to have been deliberately patinated for various reasons (Craddock and Giumlia-Mair 1993). Specifically, black patination was applied anciently to Corinthian bronze and to ancient Egyptian bronzes known as *hsmn-km* (meaning "black bronze"). This term was proposed as a hieroglyph transcript by John Cooney in 1966 (Cooney 1966). He interpreted the hieroglyph as the name of a certain type of bronze object that is inlaid with gold or electrum (ancient gold-silver alloy), with the background bronze deliberately darkened to enhance the contrast with the inlay, or where an inlay was intentionally darkened by patina (as would be the case with the Book of Mormon gold plates). The transcription of the hieroglyph studied by Cooney was subsequently revised and is now interpreted as *hmty-km*, meaning "black copper" (Giumlia-Mair 1997).

Similar to Egyptian "black copper," ancient Japanese processes involving *shakudo* gold-copper alloys produced a black patina (among other coloration); analysis shows that the black patina produced originated with copper alloys consisting of 5-7% gold (Uno 1929; Oguchi 1983). This patina layer has been identified as a thin layer of cuprite (Cu_2O) (Murakami et al. 1988).

Black patinated copper alloy objects were produced in Egypt as early as the Middle Kingdom Period (2040 to 1782 BC) (Giumlia-Mair 1996) and continued until they disappeared after the fall of the Roman Empire (Giumlia-Mair 2005). Scientists have recently been working to uncover the secrets of the patina on these ancient Egyptian objects.

Following the research on *shakudo*, additional research on British Museum pieces identified 13 museum pieces as black bronzes, the oldest of which dated to the Middle Kingdom. A summary of the research concluded that the alloy used to make the patinated object or inlays was (1) copper-based and contained gold and (2) that it consisted primarily of cuprite (Mathis et al. 2009).

In the Mathis (2009) study, various ancient Egyptian items exhibiting black patina located in the Musée du Louvre in Paris were analyzed, with the majority being from pre-600 BC. The bronzes analyzed had a substrate metal with concentrations of gold (.2–7.5%); the analysis of the content of the overlying patinas showed that the patina was made of cuprite and contained gold and/or silver in amounts corresponding to the substrate metal (see figures 17, 18, and 19). Thickness of the patinas ranged somewhat, with some in excess of 20 micrometers (μm), with one inlay sample being only 1 micrometer. On all of the patinas the presence of sulphur was detected, probably indicating the use of copper sulphides or sulphates in the chemical reagent used in the patination recipe. The conclusion of the study was that there was not a "single recipe for a single alloy, but of a set of recipes for various

alloys." It also concluded that most of the underlying alloys contained more gold than silver. The single inlay item on a Karomama statue dating from approximately 800 BC was unique because the patina contained a very high amount of gold (38%), with some silver (2%) and the balance consisting of cuprite.

This study also determined the following with regards to the manufacturing technique:

> The only existing reference on the manufacturing technique for black bronze is the Japanese recipe for *shakudo* alloy. The patina of this alloy is made in aqueous phase in an acidic solution containing copper salts. For Egyptian black bronze, the concentration of sulphur in every patina undoubtably indicates that copper sulphide or copper sulphate is used in the chemical reagent. The chlorine content may also be a trace of the composition of the solution used for patination.
>
> The Egyptian patinas are thicker than Japanese *shakudo* patina, which are almost ten times thinner, and are homogenous. The homogeneity indicates the use of a single procedure for making patina; the large thickness indicates either a very long treatment or a relatively high temperature. If the treatment is made in aqueous phase the temperature should be lower than 100°C, but certain procedures may have been used, including successive cycles of heating and chemical oxidation. (Mathis 2009, 71)

Figure 17. Sphinx of Siamun with inlay gold and black patina from the Louvre Museum, Paris (Wikipedia.org 2007)

Figure 18. Sobek Aegis with gold and inlay black patina from the Louvre Museum, Paris (www.metmuseum.org 2007)

Figure 19. Sphinx of Thutmose III with inlay gold and black patina from the Louvre Museum, Paris (www.pbs.twimg.com 2015)

Additional metallurgical analysis has since been performed on a number of the ancient Egyptian patinas. A study in 2012 of 23 ancient Egyptian patinated objects from the Egyptian Museum in Cairo and the Faculty of Archeaology Museum in Cairo were analyzed by optical microscopy to determine the make-up of the patination (Mohamed et al. 2012). Only one object that could positively be identified as pre-600 BC was analyzed. It was not a gold alloy but was a copper and lead alloy. The black patina was found to contain cuprite, calcite, tenorite, calcium carbonate, animal glue, and ester of fatty acids. The study did show that black patination is not necessarily dependant on the underlying gold concentration of the copper alloy.

It is not apparent that the famous gold plates of King Darius of Persepolis, an example of anciently engraved gold plates from the Old World, have ever been studied to determine the gold content and surface analysis or to identify depletion gilding. The plates when unearthed were apparently very bright and lacked corrosion. In some photographs, the engravings do have a black/brown coloration to them; perhaps the Book of Mormon gold plates had a similar look (see figure 20). The Darius gold plate was underneath a silver plate that was very corroded and black, and perhaps the engravings collected some of the black corrosion product from the overlying plate. It is not known if they were cleaned after being recovered.

Figure 20. Gold plate of King Darius

In modern times, one metal conservation technique that has been utilized is patinization. This technique was employed for the protection of the bronze column of King Sigismund III in Warsaw (Socha 1980).

As far as the physical characteristics of patinas, an ideal naturally occurring patina on bronze or copper would be expected to consist principally of cuprite, with a density of 6.0 g/cm^3, however studies of atmospherically generated copper and bronze patinas show some variability with densities measured as low as .9 g/cm^3 (Singer et al. 2001).

Niello and Black Matte

Niello is another technique that was utilized anciently to fill recessed metal surfaces with a decorative black material (typically individual silver, copper, and lead sulfides, or a combination thereof) to produce an ornamental inlay effect (see figure 21). Neillo typically produces a lustrous, quasi-metallic finish, which does not square with the description of the black material as "cement" or "stain." Niello work was widely used on Bronze Age objects, including gold, and is represented in ancient European, Islamic and Indian metalwork (Scott 2002). Niello is not known in the New World. Niello does not appear to be a good candidate for the black material in the engravings on the plates, as it also requires the filing or scraping of the filled engravings, which would negatively affect the surrounding thin gold gilding.

Figure 21. Bronze dagger blades with niello, ca. sixteenth-century BC, from Grave Circle A (Shaft Graves IV and V), Mycenae, Greece. Inlaid with gold, silver, copper, and black niello. Top: a papyrus swamp, 9 2/5 in.; middle: a lion hunt, 8 2/5 in.; bottom: three lions running, 6 2/5 in. Athens Museum

Black matte is an Old World and New World technique of etching used to create a black color on gold and has been used in the ancient New World as well on tumbaga discs and items (Scott 2000). However, this process requires the

use of a strong acid to actually etch the gold surface. The Book of Mormon gold plates have characters that were engraved, not etched, so this metallurgical process would not be related to the Book of Mormon gold plates.

Patination in the New World

As part of a small research project that experimented with various New World depletion gilding techniques and parameters, one depletion gilding technique involved sequential washing and then heating with a torch. This technique was used on ternary alloy plates consisting of 37.5% gold, 57.5% silver, and 5% copper with various designs engraved on their surfaces (Del Solar et al. 1982). Areas where depletion gilding was not desired were covered with a resist, and to give variations in the color of the enriched surface the resist was applied in different stages of the heating and washing cycles. The surface was burnished and was finally heated in the presence of ammonium sulphide or sulfur to give a brown-black surface color or patina to the undepleted regions. The experimental plate second from the left on the top row of figure 22 would most approximate the description given for the Book of Mormon gold plates with black filled engravings, and was produced using known pre-Columbian New World depletion gilding techniques. It was thought that the color was caused by the formation of silver and copper sulfides.

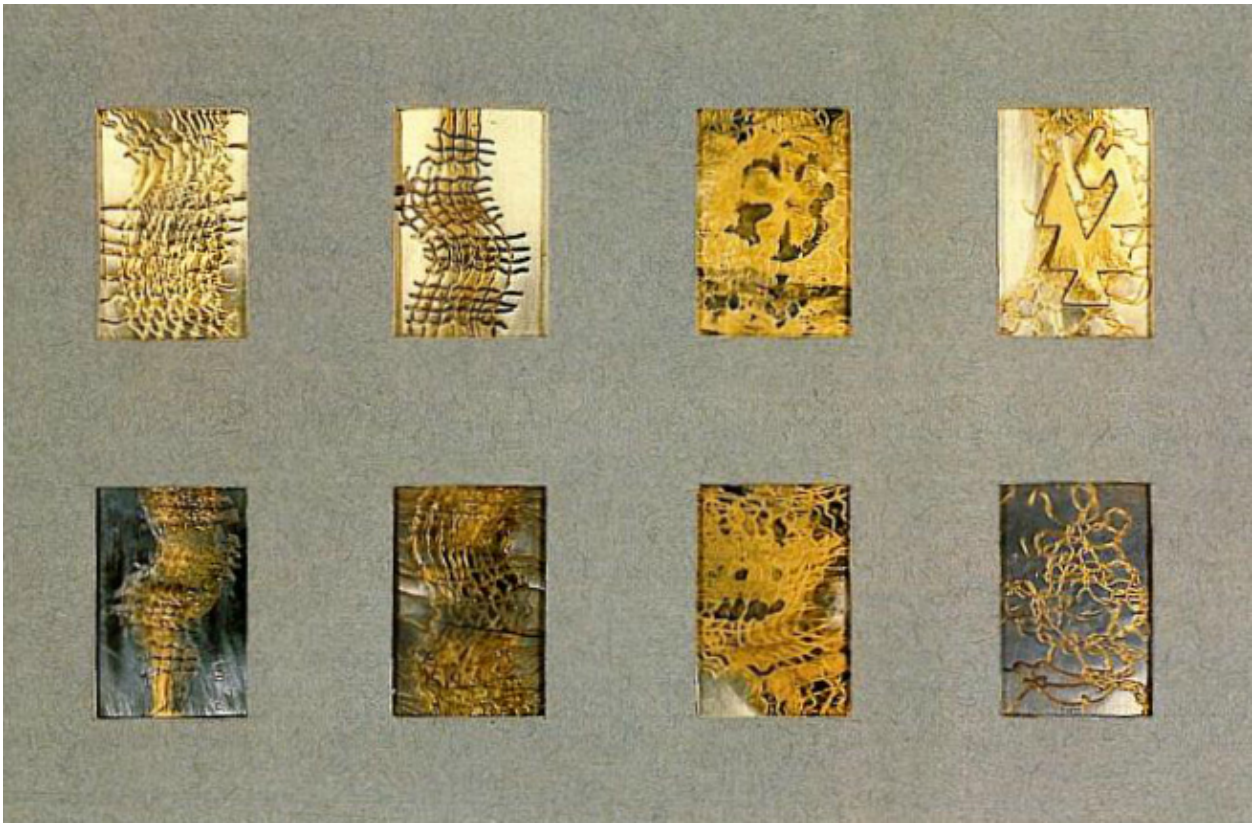

Figure 22. Experimental patina generation of depletion gilded gold plates using 9-carat silver-gold-copper alloy (Del Solar et al. 1982)

Similar to the Book of Mormon gold plates, if the surface was a depletion gilded surface, the engraved lettering would have exposed the underlying alloy. As the Del Solar experiment showed, the undepleted engraved area could have had a black coloration patina added through the use of heat together with sulphur or a sulphur compound that caused reactions only with the exposed copper and silver, but not the gold.

Various depletion-gilding techniques were used anciently in the New World to create varying color surfaces, so the creation of differential patina coloring would not be unexpected. A bicoloured (black and gold) flat tumbaga disk with an alloy containing 25% gold by weight was discovered in El Tambo, Nariño, Columbia, that exhibits proof of differential coloring techniques using depletion gilding (see figure 23).

Figure 23. Bicolored flat tumbaga disk from the Pieartal Period, AD 800–1200 (Museo del Oro: Bogotá, Columbia: 21,521)

Sealed portion and solder

David Whitmer indicated that half (or perhaps 2/3) of the plates were "sealed" by the method of connection by "solder." The exact appearance of the solder is not further described, but it appears to have been continuous along the edges of the sealed plates so as to render a somewhat continuous surface all around, an assumption consistent with the statements that the sealed portion was "stationary" and "immobile" and "solid as wood."

It would seem that the use of the term *solder* by David Whitmer would indicate a metallic material. No mention is made of a different coloration. Since the sealing was done by Mormon or Moroni, the technique need not have originated with Nephi it may have been an exclusive New World metallurgical technique. Since Josiah Stowell described a corner of the plates as looking like a stone with a greenish "caste" which would be interpreted as a small degree of color, there may have been copper and/or silver present in trace amounts in the solder, which would not be inconsistent with a surface that had a lower quality of the depletion gilding process applied.

The soldering of gold was a known goldsmithing technique in the ancient New World (Mendoza 2008). Figure 24 shows a gold monkey figurine from Peru made during the Moche Period in the Sipán style and probably dates to the early centuries AD. The monkey is made of a hammered gold alloy, and was carefully made of a number of pieces that are joined together with soldering. A join can just be seen in the head, passing across the top of the skull.

Figure 24. Gold monkey figurine from Peru from the early centuries AD (Scott 2000)

Gold Gilding techniques and corrosion

When it comes to the gilding of gold there are four classifications of bonding that occur as shown in figure 25. Mechanically attaching a gold foil to a substrate metal is done by crimping, riveting, or inserting it into grooves. Gold leaf is weakly secured to a substrate metal when gold is glued or caused to adhere by burnishing (polishing and applying pressure). Gold leaf is so fragile that it cannot even support its own weight (Oddy 1981). It seems apparent that neither of these methods was used with the gold plates, as neither would have held up to consistent use over a long period of time (as the small plates would have had), and both are very susceptible to corrosion (see figure 25).

The three more likely gilding techniques that could have been used to make the gold plates are diffusion bonding, mercury gilding (fire gilding), or depletion gilding. Diffusion bonding involves applying the gold leaf by burnishing and then by gently heating the metals, which causes interdiffusion of the gold with the underlying silver-copper substrate. Mercury gilding involves the use of an amalgam (an alloy of gold and mercury), which is spread onto the silver-copper substrate and then heated to drive off the mercury (which volatilizes into gas). The remaining gold forms a well bonded but porous layer (Oddy 1993). Because the surface is heated, a certain amount of diffusion bonding takes place. The depletion gilding technique has been discussed in chapter 9. Both mercury gilding and depletion gilding produce a porous gold surface that may be subject to potential corrosion as depicted in figure 25. However, further burnishing of the surface can collapse and eliminate the porous channels, eliminating the susceptibility of the underlying substrate.

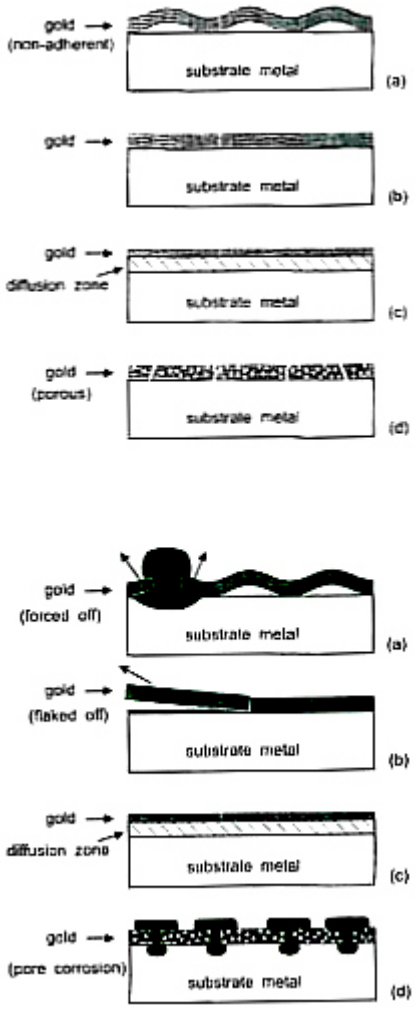

Figure 25. The top four schematic diagrams show variations in gilding layers that are (a) poorly secured, e.g., mechanically attached foil; (b) weakly secured, e.g., burnished or glued gold leaf; (c) strongly secured, e.g., diffusion bonded by heating burnished gold leaf; and (d) strongly secure but porous, e.g., fire-gilded or depletion gilded. The bottom four schematic diagrams show corrosion of the four types of gilding: (a) gold forced off by corrosion beneath it; (b) flaking of gilding after deterioration of glue or corrosion beneath gilding; (c) no corrosion as long as gold is continuous and well secured; and (d) corrosion through pores in the gold (Selwyn 2000)

Relative to the various gilding processes, lacking the ability to separate gold from silver, a pure gold gilded surface is not likely to be achieved when using an ore that contains both gold and silver, as there would always be some silver present in a diffusion bonded gilded surface or a mercury-gilded surface. Even small amounts of silver and copper in the gold leave the surface susceptible to tarnish. During accelerated tarnish testing, even 22 ct (92 wt%) gold alloy can tarnish in a short period (Tucillo and Nielsen 1971). Only the depletion gilded surface could provide a surface of pure gold. Since the metallurgical ability to "part" or separate gold from silver did not exist in the Old World prior to 600 BC, and since no corrosion was observed on the surface of the gold plates, depletion gilding is the only method that is consistent with the description of the surface of the plates and statements by Nephi. In the New World many gold objects actually have a fusion bonded gild, which gilded surface has undergone a separate treatment of depletion gilding in order to leave the very outer surface of the gilding as pure gold (Scott 2000).

There is one unique method of gold gilding that has been found to exist in the New World that warrants mentioning. Long before the invention of the European battery, Moche-Viscus masks and pectorals form the site of Loma Negra on the north coast of Peru were gilded by an electrochemical replacement process, which involved immersion of copper in a plating solution or by applying paste (Lechtman et al. 1982). This might be considered as an alternate to the other types of gilding; however, it would probably have to have been done before the plates were engraved or it would have coated the engravings. Depletion gilding on the outer surface was still necessary to ensure a pure gold outer surface. The process was not known in the Old World, so would not be considered a likely possibility for the creation of the small plates of Nephi.

Rings

There were three rings binding the plates, made of the "same metal" as the plates. Exact dimensions are not known; for purposes of this investigation the rings are estimated to be ¼ inch thick, round, and passing through three 3/8 inch holes in the plates. Because of the "D" configuration, the straight side of the rings is assumed to be 7 inches in height (1 inch greater than the 6 inch height of the plate stack). The curve is calculated to be 11 inches based on the sketch, making the total length of each ring 18 inches.

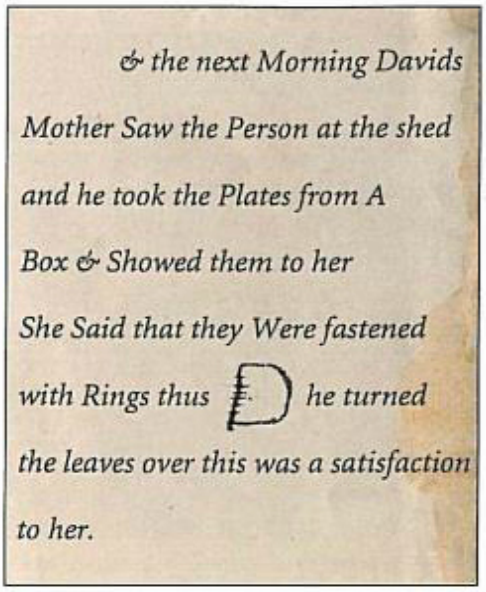
& the next Morning Davids
Mother Saw the Person at the shed
and he took the Plates from A
Box & Showed them to her
She Said that they Were fastened
with Rings thus he turned
the leaves over this was a satisfaction
to her.

Figure 26. A drawing of the "D" shape of the rings as recounted by David Whitmer to Edward Stevenson and recorded in his diary (Whitmer 1877)

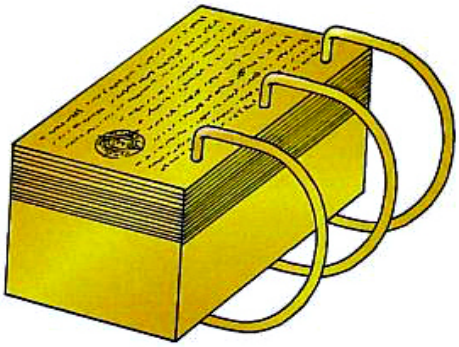

Figure 27. Artist rendering of the plates with rings (Henrichsen 2001)

Thickness of the Individual Plates

There are four descriptive parameters relating to the thickness of the individual plates:

1) They would rustle with a metallic sound when thumbed like the edge of pages in a book.

Emma Smith recounted in 1879 in an interview with her son, Joseph Smith, III, that she had felt the covered plates as they lay on the table, tracing their outline and shape. She indicated that "they seemed to be pliable like thick paper, and would rustle with a metallic sound when the edges were moved by the thumb, as one does sometimes thumb the edges of a book" (Vogel 2003a). Katherine Smith, Joseph Smith's sister who was 14 or 15 when she was allowed to handle the covered plates, told her grandson that she "rippled her fingers up the edge of the plates and felt that they were separate metal plates and heard the tinkle of sound that they made" (Vogel 2003b).

2) They were not quite as thick as common tin.

Joseph Smith indicated in March of 1842 that "each plate was six inches wide and eight inches long, and not quite so thick as common tin. They were filled with engravings, in Egyptian characters and bound together in a volume as the leaves of a book, with three rings running through the whole. The volume was something near six inches in thickness, a part of which was sealed" (J. Smith 1842). Oliver Cowdery, Martin Harris, and David Whitmer all corroborated that the plates were "as the thickness of tin," "of the thickness of plates of tin," or the "thickness of tin plates" (*Cowdery* 1830; *Tiffany's Monthly* 1859; Howe 1834, 16)

3) They were as thick as window glass.

It was reported in an 1832 newspaper report regarding a preaching discussion that was had with Arson (Orson) Pratt and Lyman Johnston that "the plates themselves were about as thick as window glass, or common tin" *(Catholic Telegraph* 1832). It was also reported that two Mormon missionaries (identified as Lyman E. Johnson and Orson Pratt by corroborating reports), in a visit to Venango County Pennsylvania, reported regarding the gold plates that they were "each as thick as a pane of glass" (*Fredonia Censor* 1832). While neither of these individuals actually saw the plates to our knowledge, they certainly were friends and associates with those who had.

4) They were as thick as thick paper or parchment.

Corroborating Emma's description that they were like thick paper, David Whitmer described the plates "about as thick as parchment" (*Iowa State Register* 1870).

Common tin and window glass

In trying to use these descriptions to determine the thickness of each individual plate, the reference to "common tin" or "plates of tin" is not extremely useful as tin plate was produced in variable thicknesses in the nineteenth century, some as thin as .001667 inches (Encyclopedia Britannica 1797, 12:118). Variable thicknesses of parchment were also made, so that parameter is also not extremely definitive.

On the other hand, surprisingly, the thickness of historic window glass in the 1800s can be determined. During the first part of the nineteenth century the process of window glass production called cylinder glass became the predominant method of window glass manufacture (Davis 1949). This method of window glass manufacture produced glass of highly uniform thickness. During the nineteenth century, Americans desired larger and larger window panes which required thicker glass (Roenke 1978), which thickening continued steadily although not completely uniformly into the first few decades of the twentieth century; after that time machine production commenced and the thickness of glass became standardized to between 0.11811 and 0.129921 inches.

Archeologists have extensively scientifically tested the nineteenth century thicknesses of window glass, as it is a parameter that assists them in dating historical structures from the 1800s. Those who described the plates as being as thick as window glass were recounting what they had heard from actual witnesses, which, for purposes of this determination, would be around 1830. Three of the most thorough and well-respected window glass methods are the Roenke, Moir, and Schoen methods.

Roenke's 1978 method sampled 21,965 pieces of glass at 15 different locations. Based on that method, the thickness of a standard pane of window glass in 1830 would be .055 inches.

Moir's method (Moir 1987) involved a large number of sites and formulated an equation for the calculation of thickness:

Date = 84.22 x (thickness of glass in .01 mm) + 1712.7

Utilizing a date of 1830 and solving for the equation, one also arrives at a thickness of.055 inches using the Moir method. The Schoen method (Schoen 1990) also involves an equation:

Date = 1725.7 + 1713.01 (thickness in .001 inches)

Utilizing a date of 1830 and solving for the equation one arrives at thickness of .061 inches using the Schoen method.

Metallic Rustling and Thick Parchment

From the outset, it is apparent that persons who saw the plates made no attempt to measure the thickness of each plate (they probably had no means to do so anyway), so the visual observations of thickness such as "thick parchment," "not quite so thick as common tin," and "as thick as window glass" are naturally going to be subjective within a certain range of accuracy. The description that can be the most reliably tested is the audible and stiffness phenomena that the plates exhibited, producing a rustling or tinkling sound by riffling the edges using the side of the thumb (similar to what one would do with a stack of playing cards after shuffling).

In order to test this parameter, a test plan was derived by the author to assess the potential range of thickness of the plates, also considering the economic cost of any testing that involved gold. The initial test would involve "soft" annealed copper, recognizing that the Book of Mormon gold plates probably were tempered and may have consisted of a copper-gold-silver alloy, which may be stiffer. The use of the soft copper would at least provide a maximum thickness below which additional tests and evaluations of alloys would be performed.

Soft Copper

The author acquired stacks of soft copper plates of varying thicknesses to determine what thicknesses (if any) produced sufficient bendability to create a rustling or tinkling of sound. Twenty-four gauge (.0216 in.) was too thick and stiff; 30 gauge (.010 in.) and 36 gauge (.005 in.) were in the suitable thickness range to be flipped through and "rustle." Thinner gauges were too soft and would bend prior to producing a rustling sound.

As one considers the possibility of the thinner range of thicknesses, the ability to engrave on both sides of the plate without deformation of the plate needs to be considered. In order to test the probable limits of thinness, hand engraving tools were used by the author to determine an approximate minimum thickness. Successful engraving on both sides of a the soft copper plate were carefully achieved down to a thickness of .005 inches without the push-through of impressions to the opposite side of the plate. Therefore alloys that are harder than soft copper at

this thickness can be satisfactorily engraved. The test did not involve chasing engraving techniques (use of a mallet) but only involved hand pushing.

It was obvious from the testing that the golden plates were definitely tempered or work-hardened, as soft copper metal at these thicknesses is so soft that it bends at the slightest bump, much too easily to qualify for material for a set of plates that would have been periodically handled.

Essentially, based on the audible sound production and physical bendability test of soft copper, the plates would not have been much thicker than .015 inches, as at greater thickness even the softest copper was too thick to elastically bend easily or at all.

Tempered Copper

A second level of evaluation was next completed by evaluating tempered copper sheets, since soft copper was not a possibility for the plates because it is so easily bent, even by a small impact. Since the plates were actually used and transported modernly and to some extent, at least a portion of them anciently, it is a fair estimation that some durability is required. A suitable level of temper had to be determined to match the golden plates as closely as possible.

To truly evaluate the stiffness of a metal plate, a scientific parameter used for stiffness called Young's Modulus of Elasticity must be considered. A stiffer material has a higher Modulus of Elasticity. Since test materials were limited to commercially available copper and alloy sheets, and because of the economic reality of testing multiple gold alloy concentrations, the appropriate test method was to test materials that did not contain gold but were identical in stiffness (elasticity) and "hardness" to that expected from the potential ancient metal candidates. The elastic modulus is an intrinsic material property and fundamentally related to atomic bonding.

Hardness

The parameter known as "hardness" has been measured for the surface of ancient metals and is also known and measured for modern commercial metal classifications. Anciently, pure copper that is cold worked has a Vicker's hardness of 100 to 120 H_v (Scott 1991, 82-83). For modern commercial gold-copper-silver alloys, although proprietary, other primary metals typically present in the balance of a 9-carat gold (35%) are copper and silver in that order. Nine-carat gold is typically cast with a hardness of 70 to 105 H_v, and can be annealed to a hardness of 160 to 170 H_v (www.18carat.co.uk, 2015), and by extrapolation, 4-carat gold could be cold worked to approximately 130 H_v.

The metallurgical term "cold working" (also known as "work hardening") involves changing the shape of the metal by doing "work" on the metal in its solid state. When metal hardens after being molten, it will have small crystalline "dislocations" or imperfections in the overall crystalline structure.

Because plastic deformation results from the movement of dislocations, metals can be strengthened by preventing this motion. When a metal is bent or shaped, dislocations are generated and move. As the number of dislocations in the crystal increases, they will get tangled or pinned and will not be able to move. This will strengthen the metal, making it harder to deform. This process is known as cold working. At higher temperatures the dislocations can rearrange, so little strengthening occurs (www.isptechnology.wikispaces.com 2015).

One can try this with a paper clip. Unbend the paper clip and bend one of the straight sections back and forth several times. Imagine what is occurring on the atomic level. Notice that it is more difficult to bend the metal at the

same place. Dislocations have formed and become tangled, increasing the strength. The paper clip will eventually break at the bend. Cold working obviously only works to a certain extent. Too much deformation results in a tangle of dislocations that are unable to move, so the metal breaks instead.

Heating removes the effects of cold working. When cold worked metals are heated, recrystallization occurs. New grains form and grow to consume the cold worked portion. The new grains have fewer dislocations and the original properties are restored.

The author's attempt was to try to approximate with the test materials, where possible and known, the measured or expected hardness of candidate ancient metals and alloys. Commercially produced metals are classified by temper or hardening using the commercial terms soft (annealed), quarter hard, half hard, full hard, and spring hard, and will conform to known ranges of hardness as these commercial terms have a specific standard that they must meet in order to have these classifications.

Elasticity

I have been unable to locate any data on the testing of ancient copper or gold or their alloys to determine the modulus of elasticity, however, it does not appear to be entirely necessary because modern testing shows that cold working of copper and gold or copper-low gold alloys only changes the modulus of elasticity by 5% and only during the first 20% of the degree of cold working (Umekama 1954). The cold working of hammered plates is going to be far above the 20% degree of cold working. The final metal samples for comparison in this analysis are all copper or alloys that are at least 50% cold worked (half hard), and are matches for ancient copper elasticity.

In addition, the modulus of elasticity for various gold and copper alloys remains the same when copper is above 80% (Umekama 1954), so this parameter for copper plate should match the golden plates. There is no specific research located on the effects involving a gold-copper-silver alloy. For low concentrations of silver (5%) in a gold alloy, the modulus of elasticity does go up by around 6%, however, the full cold working of the same alloy drops the modulus of elasticity by 10% (Umekama 1954). Therefore, a gold-silver-copper alloy with low silver concentrations that is cold worked should have much the same modulus of elasticity as the gold-copper alloy without the silver.

Testing

First, since a discreet range of acceptable thicknesses was established in testing the soft copper, evaluations of .004, .005, .006, .007, .008, .009, and .010 inch thick copper sheets with a classification of 110 H02 (half-hard) were made.

According to ASTM B152, the standard for cold rolled tempered copper, H02 half hard has a Rockwell Hardness Superficial 30T hardness of 43-57, which equates to a Vicker's hardness of 97 to 108 H_v, so would be equivalent to an ancient cold-worked pure copper. The analysis of the .004, .005, .006, .007, .008 inch thick copper demonstrated bendability that closely matched what one would experience with a thick parchment, and produced the rustling type sounds described by Emma Smith. The maximum thickness that could possibly exhibit this characteristic would be .010 inches thick.

Gold-Silver-Copper Alloy

A commercially purchased thin sheet of 9 carat annealed yellow gold (37.5%) with a thickness of .0078 was also tested. The composition of the rest of the alloy was considered proprietary by the commercial supplier. However a

standard formula for the alloy would be 45% copper and 17.5% silver. It is recognized that this may not be an exact match to the expected alloy, but was still evaluated. Based on the gold-silver alloy data, this alloy would be expected to be about 10% stiffer than a low silver alloy. Testing of this alloy indicated that it is too stiff and would not have been able to be flipped through and rustled at this thickness, so this result is consistent with the half hard tempered copper test.

A bench test was performed at the direction of the author by creating a gold-silver-copper alloy consisting of 85% copper, 12% gold, and 3% silver. The material was alloyed, cold worked, annealed with no quench, rolled, and then annealed and rolled again to a thickness of .007 inches, with no final annealing. The sheet was able to pass the flipping and rustling test, but would have to be considered on the high side of that test, meaning that this alloy would be too stiff much above .007 inches.

Separation of the Plates

In 1966, Putnam estimated that the air void space in the stack of gold plates (caused by the separation of the individual plates due to varying thickness caused by hammering etc.) was ½ the weight of the stack. However there was no real data presented as the basis for that supposition. Although it is obviously not possible to make any direct measurements, it is possible to approximate the separation distance and related void space by examination of ancient New World deflections of flat polished plates that have undergone depletion gilding to see what the surface deflections are as measured by variation in thickness of an individual plate. In addition to the difference in thickness, there might be an overall deformation or slight warping unrelated to the thickness variation of an individual plate, as the plates were obviously not created by machine rolling but by hand hammering, working, and polishing. It is assumed that the plates would not have been cast, as plates that are thin are difficult if not impossible to cast using ancient technologies. The warping or deflection would be minimized in a heavy stack of plates, so would not be expected to be great.

Some flat gold depletion gilded discs, fragments of discs and sheets, and flat sheets were recovered in the city of Pupiales in the Nariño area of Columbia dating from the period from AD 800–1250 (Scott 2000) and are similar to the one shown in figure 23. Discs are typical in the Nariño area and have a characteristic feature that their thicknesses do not vary over wide limits; the surfaces have had careful control being smoothed to show no evidence of hammer marks. The average thickness of the sheets and discs are from .33 mm (.013 in.) to .53 mm (.021 in.) so would be comparable to but slightly thicker than the Book of Mormon gold plates.

The measured variation of the highly polished disc and disc fragment thicknesses ranged from 5.13% to 12.9%. The flat sheets with a lower level of polish ranged from 6.3% to 39% with one outlier of 131.0%. The separation distances caused by the thickness variation can then be calculated to arrive at a percent void space for the stack caused by thickness variation. If the gold plates were similar to the highly polished discs, then the void space from thickness variation could range from 4.9% to 11.4%. If the gold plates are similar to the sheets, then the void space from thickness variation could range from 5.9% to 39%, with perhaps larger deflection in a stack or irregular variation of the measured thickness across individual plates causing additional void space up to a total of 50%.

As mentioned, there might be additional void space caused by larger areal scale deflection or warping of the Book of Mormon gold plates, but would probably not be extremely significant based on the weight flattening. The deflection in the bottom two-thirds of the stack would be expected to be minimal as the weight of the overlying plates would eliminate the effects of deflection or warping.

Dimensions of the Engraved Characters

Joseph Smith described the characters as "small and beautifully engraved." David Whitmer characterized the engravings as "divers and wonderful characters, some large and some small." In Putnam's 1966 article, he indicated that he had created a legible engraving in English with lower-case letters less than 1/16 inch in height. He gives us no information about the width, dimension, or depth of the engraving. Graver tools can be formed in many shapes and angles. Although small, the metal removed from the plates by the engraving process needs to be considered in later weight calculations, therefore a reasonable estimate of the metal removed from the plates by the engraving needs to be considered. A reasonable estimate of the metal removed would be 5% of the engraved surface area to a depth of .0015 inches. Based on observed New World thicknesses in the pure gold layer left by depletion gilding we can also assume a thickness of the surface gold layer to be approximate 10 microns, or .000394 inches.

Calculation of Alloy Mix of the Plates

Since it is clear that a depletion gilded gold surface was present on the Book of Mormon gold plates, and with a defined range of thickness for each individual plate, as well as other defined parameters, it is possible to determine the metallurgical makeup of the plates. A series of iterative scenarios will be evaluated to determine which metal or alloy mixes are possible and still meet the 60-pound weight requirement. The following parameters will be used in an initial calculation:

Scenario 1: Highly polished plates

Thickness of each plate: .005 inches
Size of the plates: 6 inches wide, 8 inches long, and 6 inches high
Height of soldered/sealed stack: 3 inches, completely encapsulating sides of bottom plates, solder assumed to be as thick as one plate with depletion gilding on outside only
D-Rings: 3 rings with a diameter of ¼ inch, holes in plates 3/8 inch, the length of each of the ring bars is 18 inches (7 inches straight side, 11 inch looped side—assumes a half circle with diameter of 7 inches)
Depth of depletion gilded gold layer on all items: 10 microns
Depth and percent of engravings: 5% of surface area of the plate, to a depth of .0015 inches
Assume plate separation at 12% of stack (maximum void for highly polished plate)
Black patina density is .217 lbs/in^3

Using a height of 6 inches, a 12% void space and .005 inch thick plates one arrives at the number of plates to be:

6 in - (6in x .12)/.005 = 1056 total plates.

Since the total surface area (x) = surface area of each side of the plates less the surface are of the holes plus the surface area of the D Rings plus the surface area of the solder, then:

$$x = \{[(6\text{ in} \times 8\text{ in}) - (3)(\pi(3/16\text{ in})^2](2)(1056)\} + 3(18\text{ in} \times \pi(\tfrac{1}{4}\text{ in})) + 3\text{ in}(8\text{ in} + 8\text{ in} + 6\text{ in} + 6\text{ in})$$

Utilizing this equation, the total surface area of the plates is 100676 in^2, the surface area of the rings is 42.4 in^2, and the surface area of the solder is 84 in^2, for a total surface area of 100802.4 in^2.

Knowing the total surface area, it is now possible to calculate the total volume and weight of gold for the gilded gold surface, which is the surface area of the plates less the engraving, plus the surface area of the rings and solder, all to a depth of 10 microns (.000394 in.):

$$(100802.4\text{ in}^2 - (100676\text{ in}^2)(.05))\ (.000394\text{ in}) = 37.73\text{ in}^3$$

The unit weight of gold for a cubic inch is .697 lbs/cubic inch so the total weight of the gild portion of the gold is 26.3 pounds. The black patina filling the engravings would weigh: (100676 in^2)(.05)(.0015 in)(.217 lbs/in^3) = 1.6

pounds. We can then calculate the remaining volume of the plates less the gilding and patina to see potential alloys.

In order to calculate the volume of an individual plate without the gilding, take the volume of the plate, less the holes, less the engraving. The thickness of the plate less the gilding would be (.005 in) – (2)(.000394 in)= .0042 in. The total volume (less the 3 holes and less the gilded layer) would be [(6 in x 8 in)(.0042 in) - (3)(π(3/16 in)^2](.0042 in) – ((.0015 in - (2)(.000394 in)) x 48 in^2(.05))x (.0042 in.) = .2 in^3/plate. Considering 1056 plates, the total volume of the plates themselves would be 211.4 in^3. The rings would be (3)(18 in)π(.249 in)^2 = 10.5 in^3. The solder plate would be .4 in^3. The total volume of the underlying alloy would be 222.3 in^3.

If the underlying metal was pure copper, which is lighter than gold and silver, at a weight of .321 pounds per cubic inch, the weight would be 71.4 pounds. Adding the weight of the gold gilding and the patina, the total weight of the plates would be 99.3 pounds. Since the weight of the plates was judged to be 60 pounds, this configuration of the plates is not a possibility. The primary variable that will affect the weight is the stack void; since a higher stack void percentage is necessary, we can conclude that the Book of Mormon plates were not "highly polished" like the highly polished Nariño discs.

Scenario 2

Same as Scenario 1 but using a void space of 30%

Solder and ring values would not change in this scenario

6 in - (6in x .30)/.005 = 840 total plates. Running through the same calculations as Scenario 1, the gilded gold would be 21.02 pounds, the patina 1.3 pounds, and assuming the underlying metal is the lightest possible (copper), the metal substrate would be 57.4 pounds, for a total of weight of 79.7 lbs. This is again higher than the 60-pound requirement for the Book of Mormon plates, and not a possible scenario.

Scenario 3

Same as Scenario 2 but using a void space of 50% (the higher range for the Nariño plates)

6 in – (6in x .50)/.005 = 600 total plates

Running through the same calculations as Scenario 1, the gilded gold would be 15.02 pounds, the patina .93 pounds, and assuming the underlying metal is copper it would be 42 pounds, for a total weight of 57.9 lbs. This is within the range of the 60-pound weight, but it also means that the plates were definitely a pure copper base metal with a gold gilded surface.

Scenario 4

One other scenario includes thicker plates; the upper limit of thickness would be .010 inches, as previous experiments determined. Assuming the maximum void space the calculation would be:

6 in – (6in x .50)/.01 = 300 total plates

The volume of the individual plate base metal less the gilding would change to 0.437 in^3/plate, or 131.1 in^3 for all plates. The total base metal volume considering the rings and solder would be 142 in^3.

Running through the same calculations, the gilded gold would be 7.53 pounds, the patina .47 pounds, and assuming the underlying metal is copper it would be 45.6 pounds, for a total weight of 53.6 lbs. This is within the range of the 60-pound weight.

In this scenario, a heavier base metal alloy including gold is possible, the base alloy could weigh 52 pounds and still meet the 60-pound requirement. Keeping in mind the unit weights of the alloy metals—gold at .697 pounds per cubic inch, silver at .379 pounds per cubic inch, and copper at .321 pounds per cubic inch—an equation for the base

alloy percentages would be:

$.697 lb/in^3 (g) + .379 lb/in^3 (s) + .321 lb/in^3 (c) = 52 lb/142 in^3$

Since silver was not added separately but occurs in the native gold ore, it could have ranged from 5 to 30%, so assuming a low end of 5%, the equation would be:

$.697 lb/in^3 (g) + .379 lb/in^3 (.05)(g) + .321 lb/in^3 (c) = .366 lb/in^3$ or

$.716 lb/in^3 (g) + .321 lb/in^3 (c) = .366 lb/in^3$

Since (g) and (c) are percentages then (g) + (c) must equal .95 (considering silver at 5%).

Solving for all of these multiple equations, the base alloy would end up as 87.6% copper, 11.8% gold, and .6% silver.

If one assumes the high end of the silver content as being 30% that of the gold, then the base alloy would end up as 85.2% copper, 11.4% gold, and 3.4% silver.

Therefore the highest gold content possible in the base metal alloy is 11.8% gold (3 carats). Other than the variables that describe the dimensions of the plates, the only other possible variable that would affect the gold content is the thickness of the gold gilding. The assumption we have used here—that the gilding thickness is in the upper end of observed ancient gilding (10 microns)—would seem to be the most likely, given that the base metal in the plates is copper or a high copper alloy. The thicker the gilding, the less likely the base metal is to be susceptible to corrosion. Corrosion begins when imperfections or openings in the gold surface allow water to attack the underlying metal. This attack is actually an electrical process where electrons move from one metal to the surface of another where they can participate in a cathodic reaction when water is present as present as a pathway (referred to as an electrolyte). The gold will act as an electrical conductor for the electrons, even though gold itself is not corroded (see figure 28).

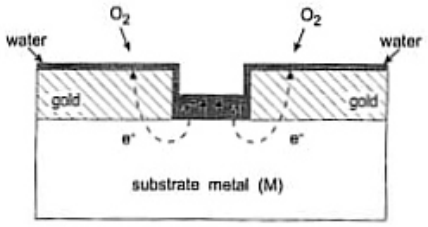

Figure 28. Schematic diagram of galvanic corrosion of substrate metal (Selwyn 2000)

Even assuming that the gold gilding was on the thinner end of ancient thicknesses (5 microns), using the conditions of Scenario 4, the resulting base metal alloy would still be a high copper-low gold alloy, on the order of 80.2% copper, 16.6% gold, and 3.2% silver.

From a metallurgical standpoint, due to some of the unique properties of "ordering" in gold-copper-silver alloys, the findings based on this testing are consistent with the workability of the metal for purposes of making plates. *Ordering* is the term used to describe how the differently sized crystals or unit structures of the alloyed metal form as the molten alloy solidifies from its "disordered" molten state. When this happens, there are different structures (phases) involving copper that can form, some of which are accompanied by volume changes that give rise to buckling and cracking. The yellowed area in the ternary concentration chart in figure 29 represents the different alloy mixes where this ordering problem occurs. These alloys are difficult to quench, harden noticeably during air cooling, and harden even further upon annealing (heating), making them the hardest and most difficult ones to

work. An experienced goldsmith would be aware of this metallurgical phenomenon. The range of the expected base metal substrate alloy for the Book of Mormon plates is shown as the red area in figure 29, which, as can be seen, lies outside of the alloy percentages that would create a problem for an ancient metal worker.

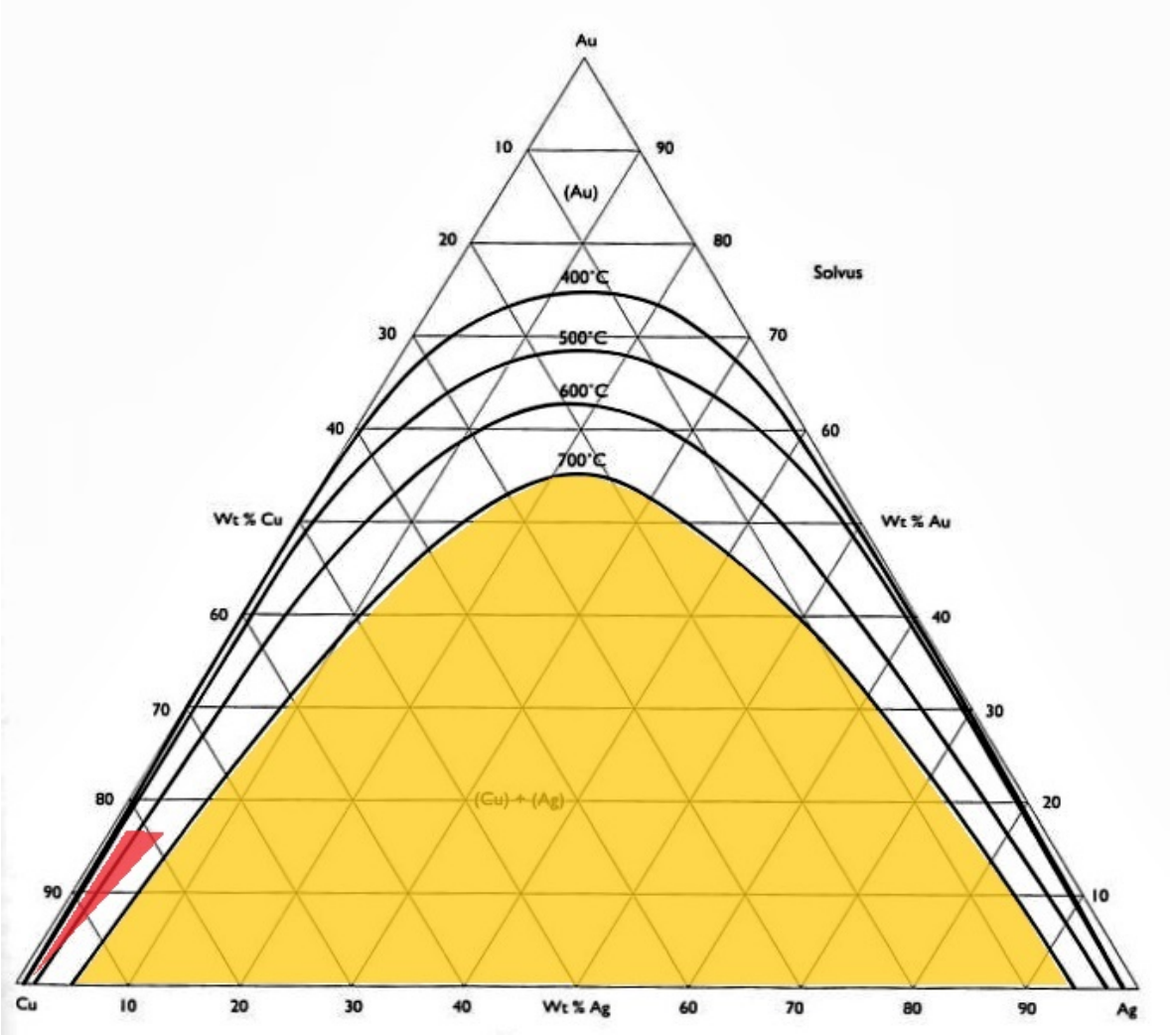

Figure 29. Ternary diagram showing areas where alloys are difficult to work with (yellow) and possible base metal alloys for the Book of Mormon plates (red)

It is interesting to note that William Smith did describe the plates as consisting of "a mixture of gold and copper," confirming precisely what the foregoing alloy analysis concluded. In addition, Josiah Stowell, who saw a corner of the plates indicated that the color was a "greenish caste" which would be indicative of the presence of copper. It has not been documented that William Smith actually saw the plates, but if not, he was intimately involved with persons that did see them. Since none of the persons involved with the plates was a metallurgist, the logical premise that would have to have been used to determine the presence of copper would have been by visual observation somehow of the underlying base metal, perhaps on a plate or ring edge subject to movement and wear, perhaps such as a hole in the plate where it contacts a ring or as Josiah Stowell indicated, perhaps William Smith saw the corners and knew enough about metal behavior to recognize that copper oxidized to a greenish color.

The base copper would have been easily distinguished by its red color, and if the base metal was in the ranges of copper, gold, and silver that this analysis has indicated, then the gold-silver-copper color would also fall into the range of "copper red" based on the ternary color chart shown in figure 29.

Summary

The Book of Mormon gold plates as described at the time of Joseph Smith are consistent with metallurgical properties and techniques known in the Old World prior to 600 BC and in the New World prior to AD 400, and are consistent with metal plates created to be both capable of supporting ancient engravings and to be preserved without corrosion. These ancient technologies included "black copper" patination and depletion gilding. In comparison with ancient pre-Columbian gold working, the Book of Mormon gold plates could not be in the classification of the highly polished Nariño discs, but would be more along the lines of the standard polish finish exhibited on the Nariño plate work with some underlying surface relief.

Because of the description given, it was possible to determine within a narrow range the metal and alloy mixture used to manufacture the plates. If the individual plate thickness is in the thinner range of .005 inches, then the base alloy must have been copper. If the plate thickness is in the upper thickness range of .01 inches, than the base alloy would consist approximately of a maximum concentration of 8% gold (2 carat), with a minimum concentration of copper of 90%, and silver not exceeding 2.5%, and would meet the classification of the pre-Columbian tumbaga alloy. Thinner gold gilding might cause the gold content in the base metal to be up to 16.6% gold (4 carat). Based on these endpoints, the total number of plates in the entire stack was from 300 to 600.

If the base metal was copper, the gilding would have been a diffusion gilded gold with silver impurities, with the surface of the gilding undergoing an additional depletion gilding process to eliminate the silver content in the gilding material to leave a pure gold surface. If the underlying base metal was a gold-copper-silver alloy, the surface would have undergone the depletion gilding process to leave a pure gold surface.

Chapter 12
Metallurgy of the Interpreters and Other Potential Metallic Items Present with the Book of Mormon Plates

Though they are not directly associated with *ziff*, a brief look at the other metal objects associated with the Book of Mormon plates would be in order.

The Interpreters (Urim and Thummim)

When Joseph Smith recounted Moroni's visit, he indicated that he was told that there would be two stones with silver bows present with the golden plates, and that the stones could be fastened to a breastplate that would also be present.

> Joseph Smith—History 1:35
>
> Also, that there were two stones in silver bows—and these stones, fastened to a breastplate, constituted what is called the Urim and Thummim—deposited with the plates; and the possession and use of these stones were what constituted "seers" in ancient or former times; and that God had prepared them for the purpose of translating the book.

When obtaining the plates Joseph Smith recounted:

> Joseph Smith—History 1:52
>
> Having removed the earth, I obtained a lever, which I got fixed under the edge of the stone, and with a little exertion raised it up. I looked in, and there indeed did I behold the plates, the Urim and Thummim, and the breastplate, as stated by the messenger. The box in which they lay was formed by laying stones together in some kind of cement. In the bottom of the box were laid two stones crossways of the box, and on these stones lay the plates and the other things with them.

In a revelation, Joseph Smith was told that the Urim and Thummim had an Old World origin. It is not clear from this recounting that the Urim and Thummim referred to here includes the silver bows or was limited to just the stones:

> Doctrine and Covenants 17:1
>
> Behold, I say unto you, that you must rely upon my word, which if you do with full purpose of heart, you shall have a view of the plates, and also of the breastplate, the sword of Laban, the Urim and Thummim, which were given to the brother of Jared upon the mount, when he talked with the Lord face to face, and the miraculous directors which were given to Lehi while in the wilderness, on the borders of the Red Sea.

In the Book of Mormon, the two stones are described as having been sealed up by Ether, later found, and provided to Mosiah$_2$.

> Ether 3:23, 24, 28
>
> 23 And behold, these two stones will I give unto thee, and ye shall seal them up also with the things which ye shall write.

> 24 For behold, the language which ye shall write I have confounded; wherefore I will cause in my own due time that these stones shall magnify to the eyes of men these things which ye shall write.
>
> 28 And it came to pass that the Lord commanded him that he should seal up the two stones which he had received, and show them not, until the Lord should show them unto the children of men.

Moroni does indicate that "the interpreters" were sealed up with the golden plates; no indication is made of the silver bow in which they sat or the breastplate:

> Ether 4:4-5
>
> 4 Behold, I have written upon these plates the very things which the brother of Jared saw; and there never were greater things made manifest than those which were made manifest unto the brother of Jared.
>
> 5 Wherefore the Lord hath commanded me to write them; and I have written them. And he commanded me that I should seal them up; and he also hath commanded that I should seal up the interpretation thereof; wherefore I have sealed up the interpreters, according to the commandment of the Lord.

Because we don't have a definitive source of where the "silver" bows were made, both the Old World and New World are possibilities. The description of the bows as "silver" may refer either to color or to the underlying composition.

There are essentially two metallic possibilities based on the silver color: silver or platinum. If the bows were made of a polished silver, which was known in both the Old World and the New World, than they may have required some anti-corrosion surface treatment techniques prior to placement in the sealed box. Treatment techniques from the Old World are discussed below. In addition, a second-hand source many years after the plates were discovered indicated that the silver bows (spectacles) appeared to have been in a recessed lid located on top of and connected to the plate stack. This source was Joseph Smith, Sr., who provided the following description of the plates (Lapham 1870, 307):

> In answer to our question, as to what it was that Joseph had thus obtained, he said it consisted of a set of gold plates, about six inches wide, and nine or ten inches long. They were in the form of a book, half an inch thick, but were not bound at the back, like our books, but were held together by several gold rings, in such a way that the plates could be opened similar to a book. Under the first plate, or lid, he found a pair of spectacles, about one and a half inches longer than those used at the present day, the eyes not of glass but of diamond. On the next page were representations of all the Masonic implements, as used by masons at the present day. The remaining pages were closely written over in characters of some unknown tongue, the last containing the alphabet of this unknown language.

This description is exactly consistent with Moroni stating that he had already sealed up the interpreters prior to completing and sealing up the actual plates. This fact was not part of the earlier analysis of the plate metallurgy; it was assumed that the spectacles were not in the plate stack when the witnesses approximated the weight of the plates.

As a result, if the silver bows were sealed in some fashion in a recessed box/lid, they would not be subject to much corrosion as only the oxygen trapped in the lid would be available for corrosive chemical reactions.

Platinum is a metal that does not oxidize in air at any temperature, but is corroded by halogens, cyanides, sulfur, and caustic alkalis, none of which would be expected in the sealed box.

Archaeologists have discovered traces of platinum in the gold used in ancient Egyptian tombs as early as 1200 BC. However, the extent of early Egyptians' knowledge of the metal is unclear (McDonald et al. 1982, 7–8).

The metal was manufactured and used by pre-Columbian Americans near modern-day Columbia and Ecuador to produce artifacts of a white gold-platinum alloy and other platinum items dated as early as 350 BC. They employed a relatively sophisticated system of powder metallurgy. The platinum used in such objects was not the pure element, but rather a naturally occurring mixture of the platinum group of metals, with small amounts of palladium, rhodium, and iridium (Scott et al. 1994). Either an Old World or New World source of platinum for the bows is a possibility.

In the various descriptions of the golden plates, no preservation of the metal by varnish or oils is mentioned, and since descriptions are from multiple sources and contain some detail, none was presumed. However, since we do not have much in the way of description of the other items potentially included in the stone box, these techniques remain possibilities.

Iron has been known as a very vulnerable material since antiquity. Corrosion and electrochemical phenomena were known in ancient Egypt and Mesopotamia. Evidence of this is seen in copper-coated pottery found in Egypt, which indicates that coating techniques for precious metals were in use some 2500 years ago (Aromaa 1995, 16; Häyhä u.d.).

As early as 1000 BC, the Egyptians developed varnishes, which were combinations of natural resins (sandarac or mastic) and oils. These varnishes were applied hot as protective coatings for iron (Bradley et al. 1955, 378) and could be used for other metals.

Although corrosion was not understood, some practical methods were in use to protect iron from corrosion. The Romans knew that iron, copper, and lead corroded and developed methods to prevent it. According to the literature Pliny the Elder (AD 23–79) recorded some recipes. He suggested a mixture of bitumen, pitch, white lead, and plaster for iron protection and a mixture of turpentine and pitch for bronzes (Aromaa 1995, 16). According to Bradley and Burns, Pliny's recipe for iron protection is as follows: "If you desire to protect iron from rust, give it a varnish of ceruse, plaster, and tar" (Bradley et al. 1955, 378).

Iron in need of protection was mainly that of warrior's weapons, and the following recipe for armor was given by a German author in 1616: "Pour olive oil in a heavy mortar, stir it well with a pestle until it warms itself, put white lead to it and rub it again until it becomes black. Pour a little oil of tartar in it and with Neat's foot oil or old fat make a salve. Smear the armor with the salve" (Bradley et al. 1955, 378). This was the level of prevention of corrosion in Europe for nearly 1800 years.

Lacquering as a form of metal protection was in use hundreds of years before the Christian era in the Far East. The binding medium was mainly *Rhus vernicifera*, which hardens to an insoluble film. Objects treated in this way have been very well preserved (Bradley et al. 1955, 379).

Other Potential Items in the Burial Box

Based on some historical documentation there is supposition that the sword of Laban, the Liahona, and the brass plates were also buried in the box with the golden plates, but there is no firsthand information from Joseph Smith that they were present. As previously recounted, Oliver Cowdery did not mention the presence of any of these items either.

Catherine Salisbury, the oldest surviving sister of Joseph Smith, recorded in 1886:

> I remember well the trials my brother had, before he obtained the records. After he had the vision, he went frequently to the hill, and upon returning he would tell us, "I have seen the records, also the brass plates and the sword of Laban with the breast plate and the interpreters." (Salisbury 1886)

An even earlier account was written by Mormon critic John Hyde in 1857, who wrote in passing,

> Joseph Smith says he found, with these [Moroni's] plates, ... the sword of Laban.

He also recorded that when Joseph finally got the plates on September 22, 1827, that

> besides the plates, he had, according to his third story, a breast-plate of brass, Laban's sword, the crystal interpreters, [and] the "brass ball with spindles" director of Lehi. (Hyde 1857, 215, 244)

The testimony of the Three Witnesses mentioned only that they saw the plates (Book of Mormon 1830), but other accounts reported that they also saw other items.

> The three witnesses were also to see the sword of Laban, the Liahona, the Urim and Thummim, and the breastplate as promised in DC 17:1.

In Martin Harris's dying testimony he said:

> Just as sure as you see the sun shining, just as sure am I that I stood in the presence of an angel of God with Joseph Smith, and saw him hold the gold plates in his hands. I also saw the Urim and Thummim, the breastplate, and the sword of Laban. (Pilkington 1930)

David Whitmer told George Q. Cannon that "he was plowing when Joseph and Oliver came to him to speak about his being one of the witnesses." He then related:

> They went out and sat upon a log, conversing upon the things to be revealed, when they were surrounded by a glorious light which overshadowed them. A glorious personage appeared unto them and exhibited to them the plates, the sword of Laban, the Directors which were given to Lehi (called Liahona), the Urim and Thummim, and other records. (Cannon 1884)

David Whitmer is also quoted as follows:

> We not only saw the plates of the Book of Mormon but also the brass plates, the plates of the Book of Ether, the plates containing the records of the wickedness and secret combinations of the people of the world down to the time of their being engraved, and many other plates ... there appeared as it were, a table with many records or plates upon it, besides the plates of the Book of Mormon, also the Sword of Laban, the Directors i.e., the ball which Lehi had-and the Interpreters [Urim and Thummim]. I saw them just as plain as I see this bed (striking the bed beside him with his hand), and I heard the voice of the Lord, as distinctly as I ever heard anything in my life declaring that the records of the plates of the Book of Mormon were translated by the gift and power of God." (Whitmer 1878b)

Sword of Laban

Laban, a Book of Mormon contemporary of $Nephi_1$ in Jerusalem (c. 600 BC), possessed a unique sword. "The hilt thereof was of pure gold, and the workmanship thereof was exceedingly fine, and the blade thereof was of the most precious steel" (1 Ne. 4:9). The sword was brought with Nephi to the Western Hemisphere.

Nephi used the sword in "defence" of his people (Jacob 1:10), as did King Benjamin (W of M 1:13). Benjamin later delivered the sword to his son $Mosiah_2$ (Mosiah 1:16). The sword of Laban seems to have been preserved as a sacred object among the Nephites, as was Goliath's sword in ancient Israel (1 Sam. 21:9).

In June 1829 the three witnesses to the Book of Mormon plates were promised a view of the sword (D&C 17:1). According to David Whitmer's report, that promise was fulfilled "in the latter part of the month" (Jenson 1882, 208).

The use of gold in the Old World (where the sword of Laban originated) has been thoroughly documented. The use of steel in the Old World prior to Lehi's departure is also well documented. The earliest known production of steel are pieces of ironware excavated from an archaeological site in Anatolia (Kaman-Kalehoyuk) and are nearly 4,000 years old, dating from 1800 BC (Akanuma 2005).

The Brass Plates

The brass plates originated in the Old World, and brass production was well known there prior to Lehi. Specifically, in West Asia and the Eastern Mediterranean early copper zinc alloys are now known from a number of third millennium BC sites in the Aegean, Iraq, the United Arab Emirates, Kalmykia, Turkmenistan, and Georgia, and from 2nd Millennium BC sites in West India, Uzbekistan, Iran, Syria, Iraq, and Israel (Thornton 2007).

The protection from corrosion of the brass plates in the Book of Mormon plates box could have been accomplished through oil and varnish techniques as discussed above.

The Liahona

The Liahona is described in the Book of Mormon as being made of "fine brass":

> 1 Nephi 16:10
>
> And it came to pass that as my father arose in the morning, and went forth to the tent door, to his great astonishment he beheld upon the ground a round ball of curious workmanship; and it was of fine brass. And within the ball were two spindles; and the one pointed the way whither we should go into the wilderness.

As with the brass plates, this item occurs in the Old World (its actual origin is divine, so is unknown) and could have been protected with oil and/or varnish techniques.

Breastplate

There is no description that identifies what the breastplate was made of, while one might suppose metal would be one possibility, there is nothing in the descriptions that require it to be metallic, so any assertion of the material would just be speculation.

Chapter 13
Conclusions

While some of the analysis of *ziff* was a bit scientific and tedious, it has definitely been productive. The following conclusions can be made with regards to ziff and the gold plates:

The Etymology and Meaning of *Ziff*

The best candidate for the word *Ziff* (either by transliteration or by historical linguistic etymology) is *zyf*, with a secondary possibility being *sifr*/*sufr*. The etymology of *zyf* is derived from either Paleo-Hebrew or Aramaic. It is likely that it existed as a word in Biblical Hebrew. The word would have been in existence and known by the Lehites prior to departure.

The summary definition of *zyf* is as an ancient gold gilded metal, often used to counterfeit real gold and sometimes with religious connotations. Other definitions include portions of walls or stairs of buildings, and a relationship to animal movements, primarily birds.

***Ziff* in the Book of Mormon and the Americas**

Ziff in the Book of Mormon New World was either a gold-gilded copper or tumbaga. The Old World meaning of *zyf* is consistent with its use in the Book of Mormon, namely as a decorative metal, involving usage on buildings with religious connotations. The use of *ziff* as described in the Book of Mormon is consistent with context of an apostate Nephite culture located in the Valley of Guatemala at the proposed time frame of 200–100 BC.

Metallurgy of the Golden Plates

The golden plates consisted of either (1) a copper base gilded with a native gold-silver alloy or (2) a low carat gold-silver-copper alloy. The outside surface under either scenario was gilded using the fairly complex depletion gilding process, which was known prior to Lehi's departure in the Old World and has been documented in the proper time frames in the Book of Mormon in the New World. The black patina applied to the golden plates has been documented in the Old World prior to Lehi's departure and is a known metallurgical technique in the ancient New World.

Book of Mormon Implications

One implication of this research is to better understand the nature of the various untranslated words found in the Book of Mormon. In the case of *ziff*, it is clear that the reason that it was left in its untranslated but transliterated state is because there was no suitable word in English, neither from Joseph Smith's time nor in the earlier English of the 1500–1600s, which is proposed to be the target language time frame of the Book of Mormon translation. In trying to determine the etymology of the other unknown words, this principle should prove useful in determining the source and meaning of the word.

It has been an interesting journey for me, I hope the reader has found portions (or impossibly all) of this research interesting. At this point I would invite the reader to take off their goggles. It may have taken 177 years for the anti-Mormon Origen Bacheler's challenge to be met, but we now know what *ziff* means, and have learned a little bit about the gold plates themselves in the process. I'm hoping Mr. Bacheler is finally satisfied.

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Index

The identification of the mysterious material *ziff* from the Book of Mormon was a mystery from the time of the initial publication of the Book of Mormon until now. Finally, the linguistic and metallurgical meaning of *ziff* has been determined. Jerry Grover, a professional civil engineer, geologist, and translator has been able to determine the ancient term for *ziff* and to define its meaning, both anciently in the Old World and in the New World setting of the Book of Mormon. In addition, a detailed metallurgical analysis of the material and techniques used to construct the Book of Mormon plates has also been completed. The author's approach is meticulous and scientific. This book is a significant event in Book of Mormon studies and is a book that must be read by every serious student of the Book of Mormon and of Mesoamerican studies. The author is dedicating all proceeds from the book to additional scientific studies to cast further light on the ancient setting of the Book of Mormon.