Other Earthquake and Volcanic Events

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Chapter 13
Other Earthquake and Volcanic Events

Land of Nephi Volcano Event

An apparent volcanic event takes place in the Book of Mormon around 30 BC when two individuals, Nephi and Lehi, are imprisoned because their religious teachings were not well received by the local religious and political powers. The geographical location of the prison is determined by a reference at Helaman 5:21 that identifies the prison as the same one where Ammon and his brethren were imprisoned by the servants of Limhi (Mosiah 7:5–8). By this reference we are able to determine that the prison was located in the land of Nephi, which is adjacent to the land of Shilom. The relevant scriptures relating the incident as well as the earlier Mosiah incident are cited here:

Helaman 5:20–49

> 20. And it came to pass that Nephi and Lehi did proceed from thence to go to the land of Nephi.
>
> 21. And it came to pass that they were taken by an army of the Lamanites and cast into prison; yea, even in that same prison in which Ammon and his brethren were cast by the servants of Limhi.
>
> 22. And after they had been cast into prison many days without food, behold, they went forth into the prison to take them that they might slay them.
>
> 23. And it came to pass that Nephi and Lehi were encircled about as if by fire, even insomuch that they durst not lay their hands upon them for fear lest they should be burned. Nevertheless, Nephi and Lehi were not burned; and they were as standing in the midst of fire and were not burned.
>
> 24. And when they saw that they were encircled about with a pillar of fire, and that it burned them not, their hearts did take courage.
>
> 25. For they saw that the Lamanites durst not lay their hands upon them; neither durst they come near unto them, but stood as if they were struck dumb with amazement.
>
> 26. And it came to pass that Nephi and Lehi did stand forth and began to speak unto them, saying: Fear not, for behold, it is God that has shown unto you this marvelous thing, in the which is ~~shown~~ [shewn] unto you that ye cannot lay your hands on us to slay us.
>
> 27. And behold, when they had said these words, the earth shook exceedingly, and the walls of the prison did shake as if they were about to tumble to the earth; but behold, they did not fall. And behold, they that were in the prison were Lamanites and Nephites ~~who~~ [which] were dissenters.
>
> 28. And it came to pass that they were overshadowed with a cloud of darkness, and an awful solemn fear came upon them.

29. And it came to pass that there came a voice as if it were above the cloud of darkness, saying: Repent ye, repent ye, and seek no more to destroy my servants whom I have sent unto you to declare good tidings.

30. And it came to pass when they heard this voice, and beheld that it was not a voice of thunder, neither was it a voice of a great tumultuous noise, but behold, it was a still voice of perfect mildness, as if it had been a whisper, and it did pierce even to the very soul--

31. And notwithstanding the mildness of the voice, behold the earth shook exceedingly, and the walls of the prison trembled again, as if it were about to tumble to the earth; and behold the cloud of darkness, which had overshadowed them, did not disperse--

32. And behold the voice came again, saying: Repent ye, repent ye, for the kingdom of heaven is at hand; and seek no more to destroy my servants. And it came to pass that the earth shook again, and the walls trembled.

33. And also again the third time the voice came, and did speak unto them marvelous words which cannot be uttered by man; and the walls did tremble again, and the earth shook as if it were about to divide asunder.

34. And it came to pass that the Lamanites could not flee because of the cloud of darkness which did overshadow them; yea, and also they were immovable because of the fear which did come upon them.

35. Now there was one among them who was a Nephite by birth, who had once belonged to the church of God but had dissented from them.

36. And it came to pass that he turned him about, and behold, he saw through the cloud of darkness the faces of Nephi and Lehi; and behold, they did shine exceedingly, even as the faces of angels. And he beheld that they did lift their eyes to heaven; and they were in the attitude as if talking or lifting their voices to some being whom they beheld.

37. And it came to pass that this man did cry unto the multitude, that they might turn and look. And behold, there was power given unto them that they did turn and look; and they did behold the faces of Nephi and Lehi.

38. And they said unto the man: Behold, what do all these things mean, and who is it with whom these men do converse?

39. Now the man's name was Aminadab. And Aminadab ~~said~~ [saith] unto them: They do converse with the angels of God.

40. And it came to pass that the Lamanites said unto him: What shall we do, that this cloud of darkness may be removed from overshadowing us?

41. And Aminadab said unto them: You must repent, and cry unto the voice, even until ye shall have faith in Christ, ~~who~~ [which] was taught unto you by Alma, and Amulek, and Zeezrom; and when ye shall do this, the cloud of darkness shall be removed from overshadowing you.

42. And it came to pass that they all did begin to cry unto the voice of him ~~who~~ [which] had ~~shaken~~ [shook] the earth; yea, they did cry even until the cloud of darkness was dispersed.

43. And it came to pass that when they cast their eyes about, and saw that the cloud of darkness was dispersed from overshadowing them, behold, they saw that they were encircled about, yea every soul, by a pillar of fire.

44. And Nephi and Lehi ~~were~~ [was] in the midst of them; yea, they were encircled about; yea, they were as if in the midst of a flaming fire, yet it did harm them not, neither did it take hold upon the walls of the prison; and they were filled with that joy which is unspeakable and full of glory.

45. And behold, the Holy Spirit of God did come down from heaven, and did enter into their hearts, and they were filled as if with fire, and they could speak forth marvelous words.

46. And it came to pass that there came a voice unto them, yea, a pleasant voice, as if it were a whisper, saying:

47. Peace, peace be unto you, because of your faith in my Well Beloved, ~~who~~ [which] was from the foundation of the world.

48. And now, when they heard this they cast up their eyes as if to behold from whence the voice came; and behold, they saw the heavens open; and angels came down out of heaven and ministered unto them.

49. And there were about three hundred souls who saw and heard these things; and they were ~~bidden~~ [bid] to go forth and marvel not, neither should they doubt.

Mosiah 7:5–8

5. And when they had wandered forty days they came to a hill, which is north of the land of Shilom, and there they pitched their tents.

6. And Ammon took three of his brethren, and their names were Amaleki, Helem, and Hem, and they went down into the land of Nephi.

7. And behold, they met the king of the people ~~who were~~ [which was] in the land of Nephi, and in the land of Shilom; and they were surrounded by the king's guard, and ~~were~~ [was] taken, and ~~were~~ [was] bound, and ~~were~~ [was] committed to prison.

8. And it came to pass when they had been in prison two days they were again brought before the king, and their bands were loosed; and they stood before the king, and ~~were~~ [was] permitted, or rather commanded, that they should answer the questions which he should ask them.

Natural Event Analysis

It does not appear possible to explain all of the phenomena of this event with natural causes. Specifically, the “flaming fire” that did not burn anything has no known natural explanation that I am

aware of. The description of the fire did at least indicate that the walls of the prison were constructed of wood or other flammable material, noting the witnesses' surprise that the fire "did not take hold on the walls of the prison" as was expected.

The other events that occurred considered together have all the hallmarks of a mild volcanic eruption, which would typically include an earthquake corresponding with the start of the eruption, and then a series of mild earthquakes of similar size spaced over the period of the eruption. The possibility that a volcanic eruption is an explanation for this event has been noted in a general way by Brant Gardner (2007, 93–94), but no attempt was made to identify the specific mechanisms or location. Specifically, after the fire appeared, the sequence of events was:

1. First earthquake
2. Overshadowing cloud of darkness appeared
3. Second earthquake
4. Third earthquake
5. Cloud of darkness dissipated

No time periods are provided for each of these events, but based on what was going on, it appeared to be more than an hour. Each of the earthquakes appeared to be of similar intensity, each earthquake was strong enough to cause the walls to "tremble" but not sufficient to cause the walls to "tumble to the earth" even though the witnesses thought they might.

An earthquake with an intensity of Level IV on the Modified Mercalli scale is described as:

> Felt indoors by many to all people, and outdoors by few people. Some awakened. Dishes, windows, and doors disturbed, and walls make cracking sounds. Chandeliers and indoor objects shake noticeably. The sensation is more like a heavy truck striking building. Standing automobiles rock noticeably. Dishes and windows rattle alarmingly. Damage none.

An earthquake with an intensity of Level V on the Mercalli scale is described as:

> Felt inside by most or all, and outside. Dishes and windows may break and bells will ring. Vibrations are more like a large train passing close to a house. Possible slight damage to buildings. Liquids may spill out of glasses or open containers. None to a few people are frightened and run outdoors.

An earthquake with an intensity of Level VI on the Mercalli scale is described as:

> Felt by everyone, outside or inside; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight to moderate to poorly designed buildings, all others receive none to slight damage.

The Mercalli scale was developed assuming modern construction techniques; most ancient structures would probably fall into the modern day classification as "poorly designed buildings."

Based on the Mercalli scale, it appears that the earthquakes were probably between a IV and V, based on the fact that the prison was not actually damaged, but appeared to be close to the level where damage might have begun. A number of 4.5 would seem reasonable.

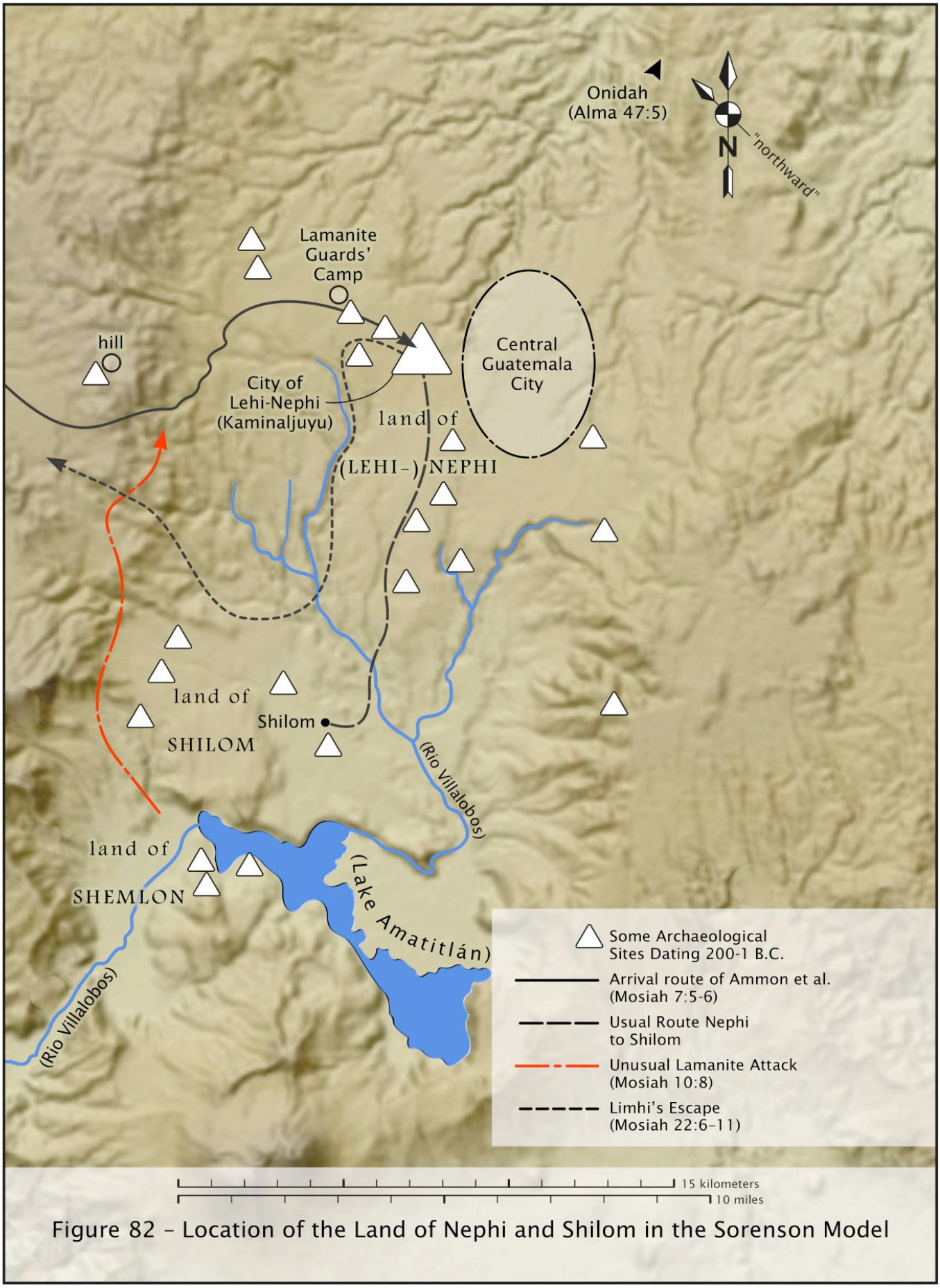

Figure 82 – Location of the Land of Nephi and Shilom in the Sorenson Model

Comparison with Sorenson Model

Sorenson has identified the Land of Nephi to be located in the area of the current Guatemala City, north of Lake Amatitlan (see figure 82). Just south of Lake Amatitlan is the volcano Pacaya. Also to the west is the volcano Aqua, which has not been historically active. Pacaya (figure 83) is a volcanic complex that is currently active, and has been so quite frequently historically. It is an excellent candidate for the source and cause of the incident at the prison in the Land of Nephi. Pacaya has produced both large scale and mild volcanic eruptions in modern times. Pacaya has exhibited eruptions from the cone as well as eruptions on its flanks.

A mild eruptive event in May of 1998 produced an ash cloud that traveled north to Guatemala City that mirrors the "cloud of darkness" event that occurred in 30 AD. Figure 84 is an 'isopach' map that shows the depositional thickness of the ash cloud.

Figure 83. Pacaya Volcano November 1988 (Smithsonian, 2014)

With regards to the series of earthquakes that occurred in 30 BC, it would be useful to calculate their approximate magnitude to see if they are consistent with a volcanic earthquake generated by either Pacaya or Aqua.

Using an intensity of 4.5 on the Mercalli scale, we can back-calculate the magnitude of the earthquake using the Zobin formula previously discussed.

$$I = 0.66M_w - 1.13\text{Log}R - 0.0072R + 3.73$$

I : Intensity in Modified Mercalli

R : the distance away from the hypocentral point of the earthquake (the point on the surface immediately above the earthquake epicenter).

M_w: Intensity in Moment Magnitude Scale at the volcano

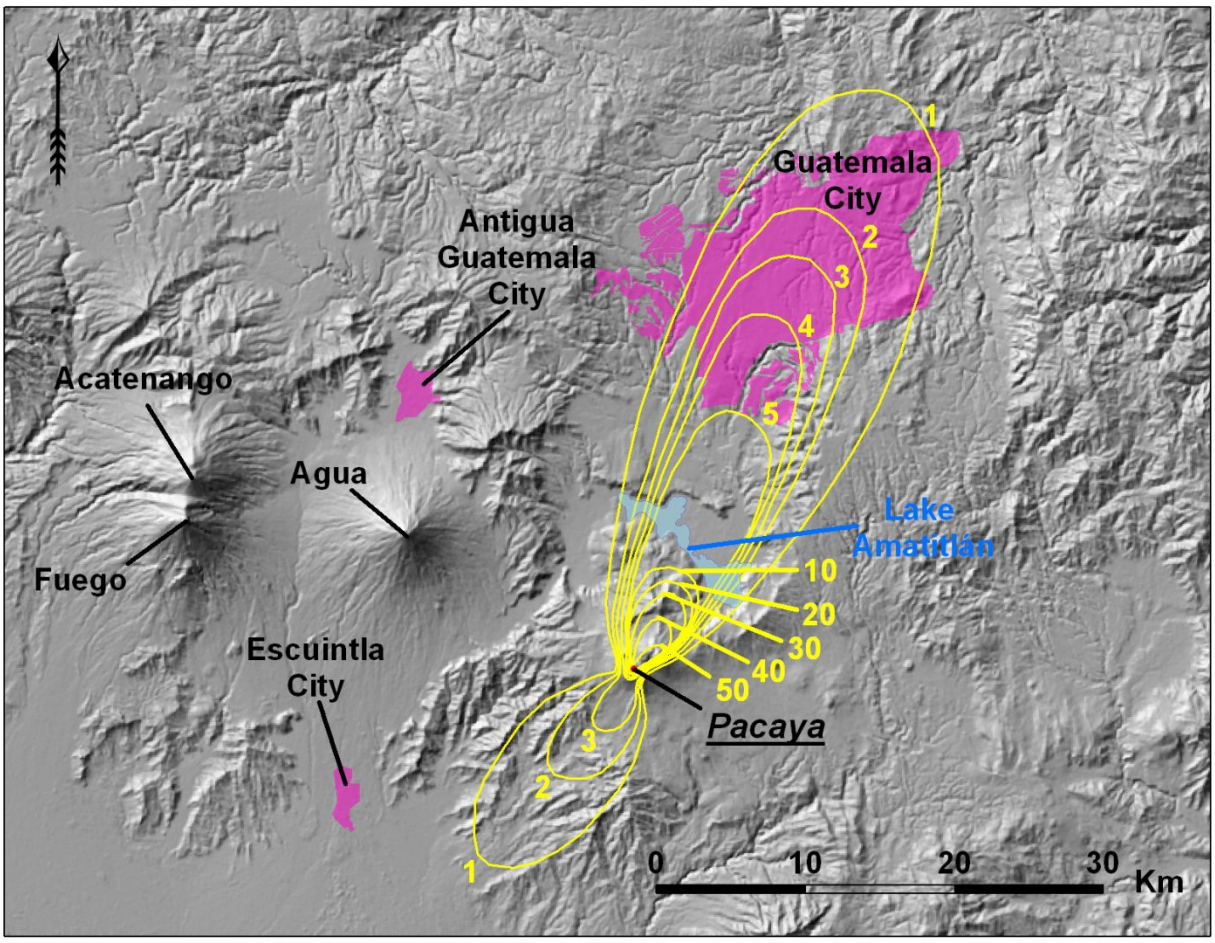

Figure 84. Isopach map associated to the volcanic event of May 20, 1998. The values of the isopachs (in yellow) are given in millimeters. The names of other volcanoes and populated centers (in pink), as well as the lakes (in blue) are also given. (Gomez, 2009, 31)

The distance from the summit cone of either the Pacaya or the Agua volcano to some of the southern archealogical sites in land of Nephi is approximately 17 kilometers, the distance from a potential flank eruption is 15 kilometers. The distance to the central archeological sites is approximately 24 kilometers. As the exact location of the prison is not known, there will be some potential variability, but not much. Using these parameters, the magnitudes of the volcanic earthquakes that occurred in 30 BC are between 3.3 M_w and 3.8 M_w, which is precisely in the common magnitude range of volcanic eruption earthquakes.

With regards to the land of Nephi as placed in Sorenson's model, the surrounding geology is highly corroborative.

Ammonihah Earthquake Event

About 81 BC, another event involving an earthquake and a prison took place in the city of Ammonihah. This event involves one very strong earthquake event, appearing to be a Level VIII on the Modified Mercalli scale. The recounting of the event in the Book of Mormon is as follows:

Alma 14:25–29

> 25. And it came to pass that they all went forth and smote them, saying the same words, even until the last; and when the last had spoken unto them the power of God was upon Alma and Amulek, and they ~~rose~~ [arose] and stood upon their feet.
>
> 26. And Alma cried, saying: How long shall we suffer these great afflictions, O Lord? O Lord, give us strength according to our faith which is in Christ, even unto deliverance. And they ~~broke~~ [break] the cords with which they were bound; and when the people saw this, they began to flee, for the fear of destruction had come upon them.
>
> 27. And it came to pass that so great was their fear that they fell to the earth, and did not obtain the outer door of the prison; and the earth shook mightily, and the walls of the prison were rent in twain, so that they fell to the earth; and the chief judge, and the lawyers, and priests, and teachers, ~~who~~ [which] smote upon Alma and Amulek, were slain by the fall thereof.
>
> 28. And Alma and Amulek came forth out of the prison, and they were not hurt; for the Lord had granted unto them power, according to their faith which was in Christ. And they straightway came forth out of the prison; and they were loosed from their bands; and the prison had fallen to the earth, and every soul [which was] within the walls thereof, save it were Alma and Amulek, ~~was~~ [were] slain; and they straightway came forth into the city.
>
> 29. Now the people having heard a great noise came running together by multitudes to know the cause of it; and when they saw Alma and Amulek coming forth out of the prison, and the walls thereof had fallen to the earth, they were struck with great fear, and fled from the presence of Alma and Amulek even as a goat fleeth with her young from two lions; and thus they did flee from the presence of Alma and Amulek.

Sorenson's model identifies the location of Ammonihah as the ruins at Mirador, Chiapas, Mexico. Mirador is located at approximately latitude 16° 39' 50" longitude 93° 34' 37" north of the town of Colonia Vicente Guerrero (see figure 86). The ruins at Mirador sit at the northwestern boundary of the strike-slip Fault province of the Sierra de Chiapas. The El Brillante-Uzpanapa strike-slip fault lies 3 km north of Mirador, the Quintana Roo strike-slip fault sits 7 km to the southwest (El Servicio Geológico Mexicano, 2005). The area is currently an active earthquake zone. Very recent activity includes an earthquake of magnitude 5.0_w occurred on January 20, 2011 4.0 kilometers to the northwest of the site at a depth of 154 kilometers on the El Brillante-Uzpanapa fault. Another earthquake at depth along the fault 7.0 kilometers to the southeast was recorded April 02, 2008, with a magnitude of 4.1_w at a depth of 180 kilometers on an unidentified fault (ANSS, 2014).

Figure 85 – Ammonihah Location in the Sorenson Model

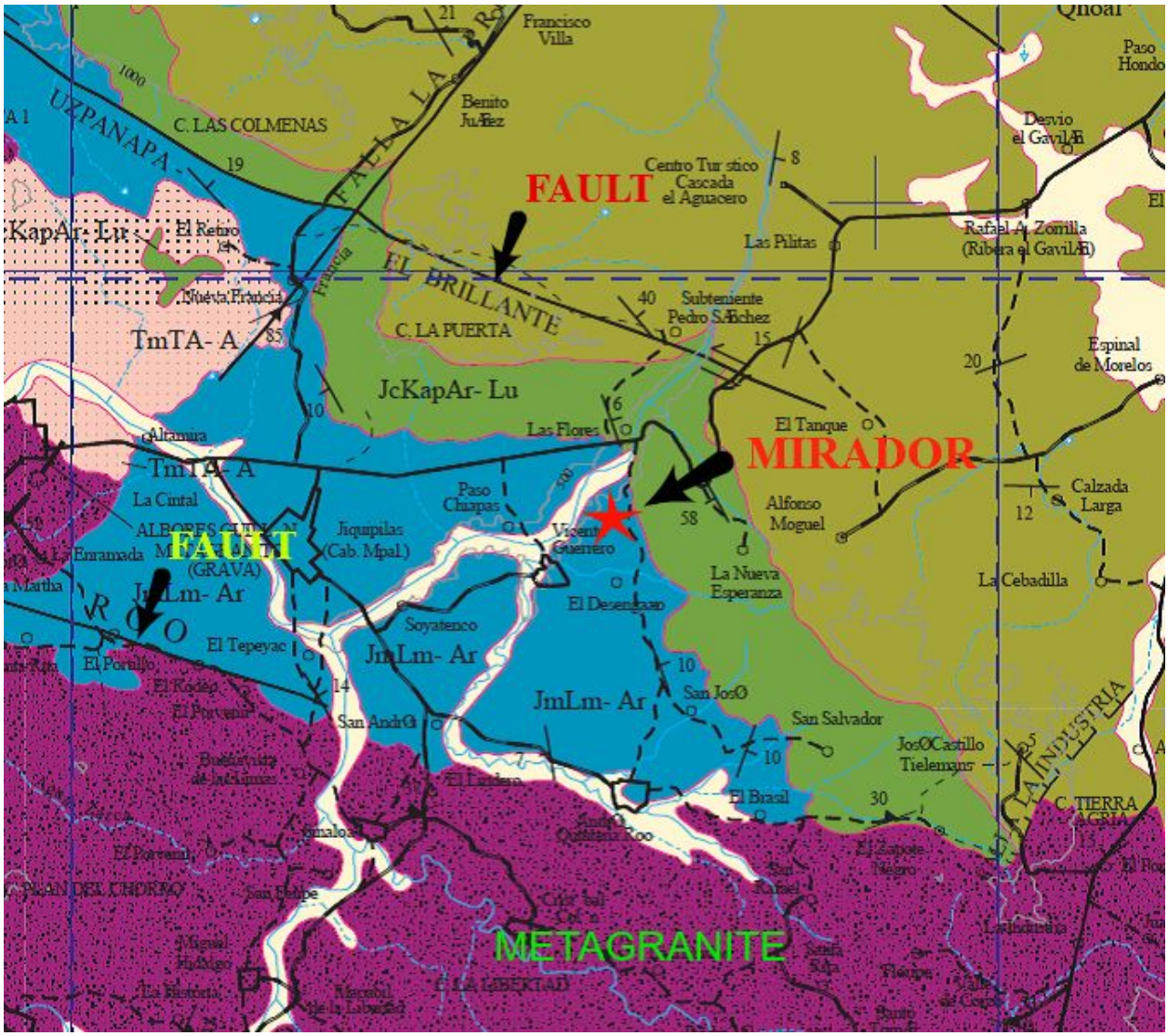

Figure 86. Geologic map of Mirador area; pink stipple formation is metagranite, which underlies layered sedimentary formations (blue, green, olive) (El Servicio Geológico Mexicano, 2005)

Also of interest is the indication that the people heard a “great noise” and came running together. A phenomenon that has been historically identified as an “earthquake boom” is indicated here. The inner workings of earthquakes that cause earthquake booms, called supershear earthquakes, which break the seismic sound barrier creating a sonic boom, have been confirmed in laboratory experiments using granite under controlled upper-crustal stress conditions (Passelègue et al., 2013). Supershear earthquakes are events in which the rupturing fault breaks faster than certain seismic waves can travel, creating a seismic mach cone that fires out the end of a fault's rupture zone. That cone and the waves that follow can cause inordinately severe shaking, out of proportion to the earthquake's magnitude. These earthquakes have been observed almost exclusively in strike-slip faults because of higher rupture speeds that occur with strike-slip faulting (Wang et al., 2013). Incidentally, the geologic formation at depth beneath Ammonihah is a Paleozoic metagranite, which

seems to correlate nearly exactly to the laboratory experiments recently performed using granite to generate supershear "sonic boom" earthquakes (see figure 86).

The description of the event at Ammonihah in the location proposed by Sorenson is entirely plausible, in terms of both the earthquake magnitude standpoint and the sonic boom ("great noise") that was heard at the time of the earthquake, probably emanating from the underlying metagranite formation and the fault. The site sits in an active earthquake zone sufficient to generate earthquakes of intensities greater than Level VIII on the Mercalli scale, which is the level indicated for collapse of the prison. The site has proximity to some major faults, a subduction zone at depth, and recent recorded earthquakes. The fact that the earthquake involved a sonic boom may have set this particular quake apart from others common to the area, coupled with the collapse of the prison and death of their political and religious leaders with only Alma and Amulek emerging, would have been ample cause to be "struck with great fear."

Jaredite Geologic Events

The record of the Jaredites as contained in the book of Ether does not indicate direct geologic events. However, there are two natural disasters described that might lend themselves, at least in part, to geologic events.

In Ether chapter 9 when Heth was the ruler, a description of a dearth on the land involving a significant ecosystem disruption is given:

Ether 9:29–35

> 29. But the people believed not the words of the prophets, but they cast them out; and some of them they cast into pits and left them to perish. And it came to pass that they ~~did~~ [done] all these things according to the commandment of the king, Heth.
>
> 30. And it came to pass that there began to be a great dearth upon the land, and the inhabitants began to be destroyed exceedingly fast because of the dearth, for there was no rain upon the face of the earth.
>
> 31. And there came forth poisonous serpents also upon the face of the land, and did poison many people. And it came to pass that their flocks began to flee before the poisonous serpents, towards the land southward, which was called by the Nephites Zarahemla.
>
> 32. And it came to pass that there were many of them which did perish by the way; nevertheless, there were some which fled into the land southward.
>
> 33. And it came to pass that the Lord did cause the serpents that they should pursue them no more, but that they should hedge up the way that the people could not pass, that whoso should attempt to pass might fall by the poisonous serpents.
>
> 34. And it came to pass that the people did follow the course of the beasts, and did devour the carcasses of them which fell by the way, until they had devoured them all. Now when the people saw that they must perish they began to repent of their iniquities and cry unto the Lord.

> 35. And it came to pass that when they had humbled themselves sufficiently before the Lord ~~he~~ [the Lord] did send rain upon the face of the earth; and the people began to revive again, and there began to be fruit in the north countries, and in all the countries round about. And the Lord did show forth his power unto them in preserving them from famine.

Ether 10:18–19

> 18. And it came to pass that Kish passed away also, and Lib reigned in his stead.
>
> 19. And it came to pass that Lib also did that which was good in the sight of the Lord. And in the days of Lib the poisonous serpents were destroyed. Wherefore they did go into the land southward, to hunt food for the people of the land, for the land was covered with animals of the forest. And Lib also himself became a great hunter.

Ether 11 describes references "famines and pestilences" and "a great destruction," "such an one as never had been upon the face of the earth":

Ether 11:5–7

> 5. And it came to pass that the brother of ~~Shiblom~~ [Shiblon] ~~caused~~ [did cause] that all the prophets who prophesied of the destruction of the people should be put to death;
>
> 6. And there was great calamity in all the land, for they had testified that a great curse should come upon the land, and also upon the people, and that there should be a great destruction among them, such an one as never had been upon the face of the earth, and their bones should become as heaps of earth upon the face of the land except they should repent of their wickedness.
>
> 7. And they hearkened not unto the voice of the Lord, because of their wicked combinations; wherefore, there began to be wars and contentions in all the land, and also many famines and pestilences, insomuch that there was a great destruction, such an one as never had been known upon the face of the earth; and all this came to pass in the days of ~~Shiblom~~ [Shiblon].

Unlike the rest of the Book of Mormon, the Jaredite record does not contain calendar markers to show precisely when these natural disasters took place. Based on generational counts, and using a generic lifespan with some assumptions, Sorenson (1985) and Palmer (1982, 128) place the approximate dates of these events as:

> Sorenson
>
> Severe drought 2300 BC to 2200 BC
>
> War, famine, destruction 1050 BC to 900 BC
>
> Palmer
>
> Potential rule of Heth 2230 BC to 2090 BC
>
> Potential rule of Shiblon 1070 BC to 940 BC

Location of Jaredite Lands

Virtually all Mesoamerica Book of Mormon geographical models identify the Jaredites as part of the Olmec culture. The geographical lands of the Jaredites are illustrated in figure 87 (Sorenson's map 11 from *Mormon's Codex*).

Volcanic Events during Jaredite Natural Disaster Time Frames

Volcanic eruptions have been implicated in serious disruptions to local ecology and civilizations. In determining whether volcanic activity may have had a role in the Jaredite natural disasters it is necessary to evaluate the volcanic history of volcanoes in or adjacent to Jaredite lands to see if there are any correlations. The potential volcanoes in or adjacent to Jaredite lands are San Martín, Pico de Orizaba, Las Cumbres, El Chichón, and the Naolinco Volcanic Field.

Radiocarbon dating has shown the activity of these volcanoes during or close to the proposed natural disaster time frames to be:

Disaster during Heth rule

Las Cumbres
1970 BC ± 50 years**

El Chichón
2030 BC ± 100 years** (Tephra Unit K)

Pico de Orizaba
2110 BC ± 50 years**
2300 BC ± 75 years**

San Martín
2130 BC ± 50 years**
2308 BC to 2198 BC*

Disaster during Shiblon rule

Naolinco Volcanic Field
1200 BC ± 50 years**

San Martín
1320 BC ± 300 years**
1470 BC to 1160 BC***

*Sieron et al., (2014)
**Smithsonian (2014)
***Riveron et al., (2009), Santley (2007)

The volcanic eruption data does show multiple volcanic eruptions from multiple volcanoes occurring in and immediately adjacent to Jaredite lands.

Figure 87 – Jaredite Lands in the Sorenson Model

Book of Mormon/Jaredite Climate Compared with Scientific Determinations of Paleoclimate

The climatic history of a region can be determined by a variety of methods, including pollen studies that reveal changing plant assemblages related to climatic changes, and investigations of the relative abundance and fossil assemblages of diatoms, phytoliths, and foraminifera. More direct indicators of specific climatic parameters such as precipitation and temperature can be derived from isotopic examinations, particularly the $\delta\ ^{18}O$ ratio of marine cores and ostracod/gastropod shells extracted from closed basin lakes. Stratigraphic geochemical and lake level analyses can also be utilized to understand larger scale climatic patterns.

Studies in the Caribbean region utilizing these methods include Lake Miragoane, Haiti (Hodell et al., 1991; Higuera-Gundy et al., 1999), and Lake Valencia, Venezuela (Bradbury et al., 1981, Leyden, 1985, Curtis et al., 1999) with other correlations coming from studies in Floridian sinkholes (Watts and Hansen, 1994), Peten in northeast Guatemala (Leyden, 1984), and Lake La Yeguada, Panama (Piperno et al., 1989).

The Caribbean regional data indicates a dry period correlating to the late Pleistocene (approximately 9750 BC), followed by increased precipitation and temperature levels, with the period of maximum precipitation occurring from the early to mid Holocene (approximately 3900 BC), followed by a return to significantly dryer conditions after 1250 BC, with the level of aridity increasing again at 450 BC. The Heth event time frame (2300–2090 BC) is not inconsistent with the climatological data in that it did not occur at a period of high precipitation, however it does appear that the drought during this time period was caused or exacerbated by local climatological conditions as there is no indication of a regional increase in aridity. The Shiblon event time frame (1070–900 BC) does correspond with the dry conditions that were initiated after 1250 BC, so does not necessarily indicate a drought caused by local environmental conditions.

Local Climatological Effects of a Volcanic Eruption

It has long been recognized that volcanic eruptions affect worldwide climate by the injection of aerosols into the stratosphere (Franklin, 1974, Fong-Chiau et al., 2003) and can cause droughts or significant cooling on a regional scale far from the volcanic eruption. Sorenson (2013), citing other sources, noted the local effects of volcanic eruptions in Mesoamerica. This included the work of Gill and Keating (2002) that found a highly statistical correlation in Mesoamerica between large volcanic eruptions anywhere in the world with drought and subsequent famine. In addition, it has recently been recognized that the local ground level emissions from volcanic eruptions can cause localized droughts because the reactions of local emissions, SO_2, and other volcanic gases in the local atmosphere can suppress rainfall by inhibiting raindrop formation (USGS, 2001).

On a local level, Sorenson (2013) also noted that the 1902 eruption of the Santa Maria volcano in Guatamala killed all of the birds for hundreds of miles around, with the result that “flies, mosquitos, and rats [multiplied] to such an extent that life for human beings became nearly unbearable” because of illnesses (Dull, 2001). Moziño (1870) reported a similar effect on wild birds as a result one

of the smaller eruptive events during the 1793 eruption of the San Martín volcano, in that they were stunned and immobilized such that they could be collected by hand.

Dull also noted that:

> Although post- eruption starvation and disease have caused only 4 percent of the volcano-related deaths worldwide since 1900, this percentage swells dramatically to 49 percent for the pre-industrial period from 1600 to 1899. . . .
>
> Thus, malnutrition, starvation, and pestilence following the TBJ (260 AD Tierra Blanca Joven eruption of the Ilopango caldera in central El Salvador) eruption might have been partly responsible for progressive demographic collapse throughout the abandonment zone.

Sorenson (2013), citing other authors, recounts the noxious effects on human health from the eruption's volcanic ash and gases, and notes the contamination of water supplies by ashfall, essentially stopping agricultural production. Moziño also reported with regards to the 1793 San Martín eruption, that there was fish kill and clogging of the Tuxtla River with mud and sand, with the drinking of the murky water the cause of "many grave cases of dysentery and persistent coughing."

Analysis of 2300 to 2090 BC Jaredite Natural Disaster Event ("Heth Event")

The Heth Event in the book of Ether can be summarized chronologically as follows:

1. Great dearth upon the land
2. Inhabitants destroyed exceedingly fast because of the dearth; there was no rain on the face of the earth
3. Poisonous serpents came forth and poisoned many people
4. Flocks flee 'before' the poisonous serpents towards the land southward
5. Some of the animals perished along the way; some made it into the land southward
6. Serpents stopped pursuit, hedged up a way so people could not pass without falling to the poisonous serpents
7. People followed the path of the animals, eating all of the ones that had fallen
8. Rain came back to the earth
9. Sometime later the serpents were destroyed so people could pass to the land southward

In the Jaredite/Olmec homeland area there are 5 types of poisonous snakes; coral snakes, fer-de-lances (pit vipers), cantils, eyelash vipers, and regionally located pit vipers. There are two varieties of coral snakes, the variable coral snake and the elegant coral snake. The 5 types of regional pit vipers are the jumping pit viper, the Olmecan pit viper, the hog nosed pit viper, Dunn's hog-nosed pit viper, and Rowley's palm pit viper.

Coral snakes prefer wooded areas, marshes, or places with loose soil. Coral snakes remain in their dens for the majority of the day and are rarely spotted by humans during the day. Unlike many other snakes, the coral snake is not bold and will try to flee a situation rather than stand its ground. If the animal feels harassed, however, it may strike without warning.

The Mexican cantil occurs in a vast range of habitats, including seasonally dry forest, tropical deciduous forest, tropical scrub forest, and savanna. Habitat bordering rivers or streams is preferred, but it may also occur in grasslands and cultivated lands. They are generally shy by nature, and if threatened their first instinct is to rely on camouflage. If unable to do so they will use a threat display to ward off potential predators. The tightly coiled animal will raise the last several inches of its tail, this portion often being bright yellow or green in juveniles and a faded yellow or green in adults, the animal will then quickly flick its tail creating a loud whipping sound against its coils or surroundings. They generally will only display these behaviors when given no other choice.

The eyelash viper prefers lower altitude, humid, tropical areas with dense foliage, generally not far from a permanent water source. It lives in trees and is not known to be an aggressive snake, but will not hesitate to strike if harassed.

The fer-de-lance (aka terciopelo) likes moist environments, and occurs in most life zones located at low or middle elevations (up to 600 meters), excluding those with strong seasonal dry periods. These snakes have been described as excitable and unpredictable when disturbed. They can, and often will, move very quickly, usually opting to flee from danger, but are capable of suddenly reversing direction to vigorously defend themselves. In a review of bites from this species suffered by field biologists, Hardy (1994) referred to it as the "ultimate pit viper."

The jumping pit viper lives in moist forests, including tropical moist and wet rainforest, deciduous forest and lower cloud forest, as well as secondary forest. The common name alludes to the supposed ability these snakes have to launch themselves at an attacker during a strike, thereby bridging a distance that is equal to or greater than the length of the body. They are slow-moving and non-aggressive. However, when provoked all species will put on a rather dramatic open-mouthed threat display. These snakes may be active both during the day and at night.

The Olmecan pit viper lives principally in the Tuxtla Mountains. Its preferred habitat includes upper rainforest and cloud forest, including degraded forest and associated pastureland. It is not known to be quick-moving or aggressive.

The hog-nosed pit viper and Dunn’s hog-nosed pit viper occupy lowland rainforest and lower mountain wet forest. They have also been found in secondary forest. They are not known to be quick-moving or aggressive.

Rowley’s palm pit viper inhabits intermediate elevations cloud forest and moist ravines in pine-oak forest. It is found in primary forests and coffee plantations. They are not known to be quick moving or aggressive.

In trying to identify the most likely specie(s) of the poisonous serpents referred to in this event it must be noted that the Jaredite lands were not in the mountains but were in the low-lying flat lands, thus probably ruling out the pit vipers. The description given in Ether of the snakes indicate that they were fast moving and were apparently somewhat aggressive. That would indicate that the most likely candidate species is the fer-de-lance (aka terciopelo) (see figure 88). As the fer-de-lance is principally adapted to moist habitat, it would also be likely to migrate en masse looking for suitable habitat in the case of a drought.

Figure 88. Fer-de-lance (courtesy pariasprings.typepad.com, 2014)

The episode of snake migration described in Ether is not in the least far-fetched. Snakes often migrate en masse on a seasonal basis, and are known to migrate in search of water in the midst of drought. In 2007, a large migration of venomous brown snakes invaded the city and suburbs of Sydney, Darwin, and other areas of Australia that had been hit by the worst drought in 100 years, biting many people. The snakes were seeking water, and were much more aggressive than normal, although brown snakes are known to be an aggressive snake.

It has been suggested that the migration of snakes discussed in Ether was to follow a food source, namely the flocks (Tvedtnes, 1997); however, this does not appear to be consistent with the description that the fleeing animals that died were not eaten by the snakes, but were instead left for the inhabitants to collect and eat. It appears that the snakes were looking for water, and perhaps when water and moist habitat were located (perhaps a river?) they stopped.

The description in Ether about the snakes maintaining high population densities blocking or "hedging" passage of a particular area for a period of time might be explained by the lack or reduction of snake predators in conjunction with ample food supply, which may have occurred because of a significant removal of local bird predators as has been documented to occur as a result of volcanic eruption. There would be no competition from birds for the rodent or lizard food supply, and there would be no cap on the venomous snake population from direct predation by snake-eating birds.

This situation of ample food supply and lack of predation currently exists off the shore of Brazil, almost 93 miles away from downtown São Paulo, on an island called Ilha de Queimada Grande. The island is untouched by human developments because of snakes. Researchers estimate that on the island live between one and five snakes per square meter. The snakes live on the many migratory birds (enough to keep the snake density remarkably high) that use the island as a resting point. There are also no natural predators of the snakes on the island.

The snakes on Queimada Grande are a unique species of pit viper, the golden lancehead. The golden lanceheads that occupy the island grow to well over half a meter in length, and they possess a powerful fast-acting poison that melts the flesh around their bites. Golden lanceheads are so dangerous that, with the exception of some scientific outfits, the Brazilian Navy has expressly forbidden anyone from landing on the island.

Locals in the coastal towns near Queimada Grande recount grisly tales of death on the island. In one, a fisherman unwittingly wanders onto the island to pick bananas. Naturally, he is bitten. He manages to return to his boat, where he promptly succumbs to the snake's venom. He is found some time later on the boat deck in a great pool of blood. The other story is of the final lighthouse operator and his family. One night, a handful of snakes enter through a window and attack the man, his wife, and their three children. In a desperate attempt to escape, they flee towards their boat, but they are bitten by snakes on overhead branches.

There are many species of birds in the Jaredite/Olmec homeland area that prey on snakes and rodents including:

Gray-headed kite
Plumbeous kite
Crane Hawk
White Hawk
Great Black Hawk
Roadside Hawk
Barred Forest Falcon
Collared Forest Falcon
Laughing Falcon
Ornate Hawk Eagle
Black-and-White Hawk Eagle
Sharp-shinned Hawk
Bicolored Hawk
Common Black-Hawk
Broad-winged Hawk
Swallow-tailed Hawk
Great Horned Owl
Northern Pygmy Owl
Central American Pygmy Owl
Mottled Owl
Striped Owl
Northern Harrier

Great Blue Heron
Little Blue Heron
Black-Crown Night-Heron
Osprey
Wood Stork
Cattle Egret
Limpkin
Least Bittern
Yellow Crowned Night Heron

Elimination or decimation of these species would eliminate serious predators on snakes as well as removing competition for snake prey. There are also perhaps a hundred other species of birds in the Jaredite region, which, although not preying on snakes, prey on rodents or lizards, similar to the fer-de-lance. Elimination or depletion of these species would also allow population explosions of snakes utilizing rodents and lizards as a food source.

Notably, it is indicated in Ether that sometime later (approximately 400 years) the serpents were "destroyed," but does not say whether the methodology of the destruction was human or natural; perhaps it occurred naturally by the re-establishment of competing predator populations.

While any occurrence directly caused by volcanic activity is not enumerated in Ether for the Heth Event, the volcanic activity that occurred concurrent with the "dearth" may have been one of the causalities, and may also help to explain the poisonous serpent phenomenon.

Analysis of 1070 to 900 BC Jaredite Natural Disaster Event ("Shiblon Event")

The Shiblon Event does not mention any specific causality for this natural disaster, such as a drought, but states that there were "many famines and pestilences, insomuch that there was a great destruction, such an one as never had been known upon the face of the earth." Since there were volcanic eruptions occurring during this time period, it is plausible that these volcanic eruptions might be a primary cause of the Shiblon Event, as they are capable of precipitating drought, famine, and pestilence, and can cause great destruction.