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## **“The Great and Terrible Judgments of the Lord”: Destruction and Disaster in 3 Nephi and the Geology of Mesoamerica**

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# “THE GREAT AND TERRIBLE JUDGMENTS OF THE LORD”: DESTRUCTION AND DISASTER IN 3 NEPHI AND THE GEOLOGY OF MESOAMERICA

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Neal Rappleye

*Review of Jerry D. Grover, Jr., Geology of the Book of Mormon. Vineyard, UT: Self-Published, 2014. 233 pp. +xi, including index and references. \$39.99.*

*Abstract: Over recent decades, several Latter-day Saint scholars and scientists have offered analysis and comparison to geologic events and the destruction recorded in 3 Nephi 8-9. Jerry Grover makes an important contribution to this literature as he provides background on geologic processes and phenomena, details the geologic features of the Tehuantepec region (Mesoamerica), and applies this information to not only the description of 3 Nephi 8-9, but other incidents in the Book of Mormon likely connected to geologic events. In doing so, Grover yields new insights into the narratives he examines, and adds clarity to geographic details that have been subject to varying interpretations.*

The destruction of Nephite and Lamanite lands and cities described in 3 Nephi has been repeatedly subjected to geologic analysis in an effort to better understand the natural disaster(s) described in the text. This type of effort can be seen in literature stretching back several decades. Though earlier examples exist, it seems sufficient here to start with the father of virtually all types of commentary and investigation of the Book of Mormon today — Hugh Nibley. In *Since Cumorah*, first published serially between 1964 and 1966, Nibley compared the descriptions mentioned in 3 Nephi with various descriptions of earthquakes and accompanying phenomena, including volcanic eruptions.<sup>1</sup>

Twenty years later, John L. Sorenson and James L. Baer, an anthropologist and a geologist respectively, would each expand on this type of analysis. Sorenson’s landmark volume *An Ancient American Setting for the Book of Mormon* not only includes discussion of the

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1 Hugh Nibley, *Since Cumorah*, 2nd ed. (Salt Lake City, Utah: Deseret Book/FARMS, 1988), 231–238.

kind of natural disasters which cause the sorts of destructions 3 Nephi describes, focusing mainly on volcanic eruptions, but also draws on geologic and archaeological evidence to argue that in fact such an event occurred in the right area during or near the right time.<sup>2</sup> Baer, the first actual geologist (whom I could find) to take a look at this aspect of the Book of Mormon, offered a short note in *Dialogue* in 1986, answering five specific questions about the geology of the catastrophe.<sup>3</sup>

The 1990s saw a proliferation of geologic studies of the 3 Nephi events. Russell H. Ball offered the formal hypothesis that the destruction was caused by seismic activity and that the three days of darkness were the result a volcanic ash cloud engulfing the land. Ball cited Pliny's description of the eruption of Mt. Vesuvius as a comparison to the Book of Mormon account.<sup>4</sup> John A. Tvedtnes collected and summarized the reports of several earthquakes and volcanic eruptions which allow for comparison to the 3 Nephi account.<sup>5</sup> John Gee compared the Book of Mormon description to that of the Karnak stele, linked by scholars to the volcanic eruption of Thera ca. 1530 BC.<sup>6</sup> The most thorough of these studies at this time was that of Bart J. Kowallis, a professor of geology at Brigham Young University. Kowallis provided an in-depth analysis of the text and accounts of volcanic eruptions to argue, fairly persuasively, that a single, explosive volcanic eruption could account for all of the destruction mentioned in 3 Nephi.<sup>7</sup> Geologist and oceanographer Benjamin R. Jordan wrote a short note adding "liquefaction" to the various phenomena described by Kowallis.<sup>8</sup>

While the idea continued to be repeated in various writings into the 2000s, little was done to push this theory further. A handful of short

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2 John L. Sorenson, *An Ancient American Setting for the Book of Mormon* (Salt Lake City, Utah: Deseret Book/FARMS, 1985), 129, 318–323.

3 James L. Baer, "The Third Nephi Disaster: A Geological View," *Dialogue: A Journal of Mormon Thought* 19/1 (Spring 1986): 129–132.

4 Russell H. Ball, "An Hypothesis concerning the Three Days of Darkness Among the Nephites," *Journal of Book of Mormon Studies* 2/1 (1993): 107–123.

5 John A. Tvedtnes, "Historical Parallels to the Destruction at the Time of the Crucifixion," *Journal of Book of Mormon Studies* 3/1 (1994): 170–186.

6 John Gee, "Notes and Communications: Another Note on the Three Days of Darkness," *Journal of Book of Mormon Studies* 6/2 (1997): 235–244.

7 Bart J. Kowallis, "In the Thirty and Fourth Year: A Geologist's View of the Great Destruction in 3 Nephi," *BYU Studies* 37/3 (1997–98): 136–190.

8 Benjamin R. Jordan, "Many Great and Notable Cities Were Sunk?: Liquefaction in the Book of Mormon," *BYU Studies* 38/3 (1999): 119–122.

notes were published on potential avenues of further research,<sup>9</sup> and Benjamin Jordan added an important article on the potential of ice-cores as evidence for such an eruption, identifying a few possible indications of a major eruption between AD 30–40 within various ice-core samples.<sup>10</sup> For the most part, however, most publications merely repeated or echoed previous publications.

In some cases, these geologic examinations have been used to link the Book of Mormon text to a particular geographical region. Nibley noted, “As is well known, ‘Central America lies in the heavy earthquake belt,’ as well as being both a coastal and a volcanic area — a perfect setup for all the disasters which the Book of Mormon describes so succinctly and so well.”<sup>11</sup> Hence Nibley concluded, “[The 3 Nephi account] furnishes convincing evidence that the person who wrote it must have had personal experience of a major Meso-American quake or else have had access to authentic accounts of such.”<sup>12</sup> Sorenson, of course, agreed with this assessment. Baer, too, made this connection, generically: “The west coasts of South and Central America have the geologic features that one would expect to find at the site of such a disaster [as described in 3 Nephi].”<sup>13</sup> Ball pointed out, “This general area in Mesoamerica is quite active seismically, and large areas are covered by lava flows and volcanic ash.”<sup>14</sup> In a lengthy footnote, Kowallis took it one step further, and speculated as to where in Mesoamerica the eruption took place.

For our purposes in understanding this Book of Mormon event, and using Sorenson’s geography as a guide, I would suspect the eruptive center to have been north of the Isthmus of Tehuantepec (in the land northward where destruction was greatest) and probably along the coast where the eruption could generate a tidal wave. However, more geologic and

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9 See “Volcanic and Ice Dating in the New World,” *Journal of Book of Mormon Studies* 10/1 (2001): 75; “When Day Turned to Night,” *Journal of Book of Mormon Studies* 10/2 (2001): 66–67; Benjamin R. Jordan, “Investigating New World Volcanism at the Time of Christ’s Death,” *Insights* 23/6 (2003): 3–4; Matthew Roper, “A Note on Volcanism and the Book of Mormon,” *Insights* 29/4 (2009): 4.

10 Benjamin R. Jordan, “Volcanic Destruction in the Book of Mormon: Possible Evidence from Ice Cores,” *Journal of Book of Mormon Studies* 12/1 (2003): 78–87.

11 Nibley, *Since Cumorah*, 236–237.

12 Nibley, *Since Cumorah*, 238.

13 Baer, “The Third Nephi Disaster,” 131.

14. Ball, “An Hypothesis,” 112.

geochronologic information is needed before any further speculations can be made.<sup>15</sup>

In his 2013 magnum opus, Sorenson reviewed several archaeological and geological reports that indicated volcanic activity and its effects throughout Mesoamerica around the first century AD.<sup>16</sup>

Despite all the ground already covered, Jerry D. Grover Jr., a professional engineer and geologist, provides important new insights as he takes his level of analysis a step further. In his recently published volume *Geology of the Book of Mormon*, Grover does not merely document how geologic and volcanic phenomena compare with the text, nor does he just point to eclectic reports of such phenomena in the archaeological record or simply note that Mesoamerica is an ideal region for these sorts of phenomena. He actually uses what is known geologically about the region to identify the best-fit scenario and flesh out geographical relationships and locations. As such, Grover's book is a must read for anyone interested in either the geology or geography of the Book of Mormon.

### Overview

Grover starts off by collecting and printing all the relevant textual descriptions of the 3 Nephi destruction, including prophetic descriptions from the likes of Nephi<sub>1</sub>, Zenos, and Samuel the Lamanite (pp. 1–6). Grover then reviews the Sorenson model, which he takes as a starting point for his geologic investigation (pp. 7–17). Grover then provides a simple but useful explanation of the basic geologic principles related to various types of natural disasters. This explanation is done in such a way that someone like me, who understands little of geology, can grasp these important fundamentals. This includes a discussion of the different types of fault lines and the different kinds of earthquakes they cause, the various kinds of volcanoes and volcanic eruptions, and different tools for measuring the magnitude of these geologic events. Grover also details each of the major faults and volcanoes (and eruption data for some) in the region around the Isthmus of Tehuantepec in Mesoamerica (pp. 19–49). Next, Grover reviews the different types of hazards caused by volcanic eruptions, including pyroclastic and surge flows, volcanic debris

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15 Kowallis, "In the Thirty and Fourth Year," 188, n. 80.

16 John L. Sorenson, *Mormon's Codex: An Ancient American Book* (Salt Lake City, Utah: Deseret Book and the Neal A. Maxwell Institute for Religious Scholarship, 2013), 641–649.

slides, Lahars, ash and tephra falls, volcanic earthquakes, tsunamis, and lava flows. If some of those terms seem foreign to you, don't worry; Grover explains each of these phenomena. He also explains earthquake and hurricane hazards and provides a table of the hazards described in 3 Nephi (pp. 51-72). Grover also reviews the timeline of events in 3 Nephi, proceeds to explore various scenarios, and offers a textual analysis of the geography of 3 Nephi (pp. 73-153). From there, Grover provides more specific analysis that I will discuss momentarily.

Throughout the book, Grover generously provides full-color graphs, tables, diagrams, illustrations, and photographs. Overall, the book collects a lot of important and useful information for looking at the geologic events described in the Book of Mormon and thus serves as a sort of source book for the subject that is essential for anyone interested in doing further research in this area.

### **A Rock-Solid Geographic Model**

After Grover provides an overview of the textual descriptions, basic geology, volcanoes and fault lines, and the hazards associated with eruptions and earthquakes, his next task is to determine if the destruction was caused by (1) only a volcano, (2) a volcano and an earthquake, or (3) a volcano, an earthquake, and a hurricane/storm. As pointed out above, Kowallis argued that a volcano alone could account for everything mentioned within the 3 Nephi account. While Kowallis's argument is persuasive, it lacks the important dimension that a geographical context can provide. His use of Sorenson's model to speculate on the location of the volcano does not take the next logical step: what does that model, and the distances of cities affected by the natural disaster reported, tell us about the type of event it must have been?

Grover adds this dimension to his analysis as he considers whether a volcano alone could account for everything in 3 Nephi. Grover's research indicates that "most volcanic-related earthquakes are less than magnitude 2 or 3 and occur less than 10 km beneath a volcano" (p. 77). To that, Grover adds, "Volcanic earthquakes of any tectonic significance are extremely rare. There have been only three volcanic earthquakes with a magnitude of 7 ( $M_w$ ) measured anywhere on earth in the past century" (p. 78).<sup>17</sup> Based on the modified Mercalli scale, a measure of earthquake intensity, Grover notes that the damage reported in the Book

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<sup>17</sup>  $M_w$  represents the intensity of an earthquake in "Moment Magnitude Scale" (p. 79).

of Mormon indicates at least a level VIII earthquake. Using a formula designed to convert  $M_w$  magnitudes into the Mercalli scale, Grover observes, “When applying the equation to a 7.1  $M_w$  earthquake, which is the biggest observed in a century, Level VIII earthquake damage occurs from the center of the volcano to a distance of 2.3 kilometers. ... It is clear that volcanic earthquake damage is very much limited to the proximity of the volcano itself” (p. 81). Simply by applying the dimension that distances add to the problem, Grover determines that a volcanic earthquake would be insufficient to account for the earthquake damage reported in the text. “In order to account for the destruction described in 3<sup>rd</sup> Nephi,” Grover concludes, “it is clear that a volcano *and* a regional earthquake are indicated” (p. 119). Since earthquakes can commonly trigger volcanic eruptions, it is not surprising that both would have occurred simultaneously (p. 137).

Understanding that both a volcanic eruption and a regional earthquake are required, Grover is able to look at the fault systems and the volcanoes in Mesoamerica to determine the best-fit scenario. Grover determines that, based on the kind of damage described in the Book of Mormon, the loci of seismic activity were probably in a strike-slip fault zone with an active volcano nearby (pp. 139–141) and that it should be located in the land northward, since 3 Nephi 8:12 indicates there was greater damage in the land northward. It just so happens that in Mesoamerica, only one fault system matches these criteria, and it is in Sorenson’s (and most other models’) land northward, crossing the Isthmus of Tehuantepec partially into the land southward.

The Veracruz fault segment satisfies all the necessary conditions given in the Book of Mormon as the primary earthquake fault system. It is a strike-slip fault, which typically generates surface ruptures, fractures, and subsidence. It is located in the land northward where the worst damage occurred. Part of the fault segment is in the land southward and could cause damage in the land southward. It is located on and adjacent to the coastal plains. It occurs in areas that had significant population at the time. ... It has a major volcano sitting directly on the fault system, the volcano San Martín. (p. 148)

While the dating of volcanic eruptions is difficult and imprecise, the San Martín volcano has several documented eruptive events with date ranges that include the first century AD (p. 39).

From here, Grover begins to analyze the specifics of Sorenson’s geography and the events described in the Book of Mormon with the



assumption that a level 8 (at the epicenter) earthquake along the Veracruz fault line and an eruption of the San Martín are the primary causes of the hazards reported in the text. The following points summarize the outcome of Grover's analysis:

- If Zarahemla is at Santa Rosa, in Chiapas, Mexico, then based on its distance from the Veracruz fault line, the earthquake would have been between a level 4 or 5 there, powerful enough to overturn torches, etc., causing the city to burn (pp. 159–160)
- If the city of Moroni was located near the Mecoacon Lagoon, the soil in that region amplifies the intensity of an earthquake; thus it would have been a level 8.6 and highly susceptible to liquefaction (the soil basically becomes liquefied and sinks into the ocean), especially if an earthquake- or volcano-induced tsunami hit the coast at that location (pp. 160–164).
- The city of Moronihah was probably located in the Grijalva (Sidon) River valley, near the level 8 intensity zone, where an earthquake-induced landslide could occur and cover it with a mountain of dirt and debris (see 3 Nephi 8:10). This differs from Sorenson's positioning of Moronihah, but that location was purely speculative and was not based on any textual clues, because none are available (pp. 164–169).
- The cities of Gadiandi, Gadiomnah, Jacob, and Gimgimno are not mentioned anywhere else in the text, so placing them within a geographic context is virtually impossible. Sorenson does little more than suggest that they are in the land northward.<sup>18</sup> Using the description “made hills and valleys in the places thereof” (3 Nephi 9:8), Grover suggests that this “is a perfect description of the uniquely hummocky deposits of many volcanic debris avalanches and some volcanic pyroclastic flows” (p. 178). Such a phenomenon would have occurred within a 26 km radius of the volcano, thus confirming a location in the land northward as the best-fit scenario, and further narrowing the range of possible locations to the area surrounding the San Martín volcano (pp. 178–181).
- If the city of Bountiful was near the modern city of Tonalá, Mexico, on the west side of the Tonalá River, then it would

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<sup>18</sup> John L. Sorenson, *Mormon's Map* (Provo, Utah: FARMS, 2000), 118, 119 (map).

have been within the level 8 intensity zone, but it “is located on stable bedrock” (p. 183), which would have reduced the effects of the earthquake. In fact, “this location for Bountiful would have received the lowest intensities of the earthquake anywhere north of the Veracruz fault, as it was the farthest away from the fault before encountering soils and sediments that significantly amplify the earthquake shaking. It would have been the area of least damage in the region where people might logically gather after a large earthquake” (p. 183).

This quick summary does not do justice to Grover’s analysis here, and other cities are included in his analysis. In the case of each city/land mentioned as having been destroyed in 3 Nephi 8–9, Grover carefully analyzes the description of how it was destroyed and its position to the earthquake/volcano (when possible, based on Sorenson’s model, but not all cities mentioned are situated in his overall geography, since they are mentioned only in this one place in the text), then he suggests a best-fit explanation. Throughout this analysis, it is striking how well Sorenson’s model holds up to this thorough geologic test. In only one instance — that of Moronihah, mentioned above — is it necessary to adjust Sorenson’s suggested location to accommodate the best-fit geologic explanation for destruction, and that single case is an instance in which there was little textual data for Sorenson to go on. In multiple instances, Sorenson’s previously identified location also happens to be an ideal location, geologically.

### **Additional Book of Mormon Events**

In addition to providing the most thorough look at the natural disaster recorded and described in 3 Nephi 8–9, Grover extends his analysis to other events recorded in the Book of Mormon that seem, based on the textual description, to involve either earthquakes or volcanic eruptions. These include an apparent volcanic event in the land of Nephi during the mission trip of Nephi and Lehi (see Helaman 5:20–49), an earthquake in Ammonihah (see Alma 14:25–29), and a few Jaredite events that might be linked to geologic activities (see Ether 9:29–35; 10:18–19; 11:5–7). The coverage for these events is less thorough, but much of the groundwork had already been laid in the background provided for the 3 Nephi disasters (pp. 191–210).

Once again, in terms of geologic tests for the geography, the Sorenson model does impressively well. His land of Nephi is located near the

volcano Pacaya, which is “an excellent candidate for the source and cause of the incident at the prison in the Land of Nephi” (p. 196). Overall, “the surrounding geology is highly corroborative” (p. 197). Ammonihah, in Sorenson’s model, is located in “an active earthquake zone” (p. 198), and the underlying geologic formations create the necessary conditions to cause a sonic boom, the likely event behind the “great noise” (Alma 14:29) reported in the text (pp. 200–201).

Grover offers some new insights into the potential cause of the famine, and the dearth and snake infestation that resulted from it (see Ether 9:28-35). For this, Grover points to the climatological effects of volcanic eruptions (p. 205–206): “It has long been recognized that volcanic eruptions affect worldwide climate ... and can cause droughts or significant cooling on a regional scale far from the volcanic eruption” (p. 205). It can also kill off “all the birds for hundreds of miles around” (p. 205). If a distant volcanic event, unobserved by the Jaredite record keepers, were the cause of the dearth, then it just might provide the perfect recipe for a snake infestation. Grover explains:

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. (p. 208)

This sounds a lot like the event in Ether 9:31. Odds are, the snakes were “looking for water, and perhaps when water and moist habitat were located (perhaps a river?) they stopped” (p. 208). Since rivers stretch across the northern part of the Isthmus of Tehuantepec (see the map on p. 204),<sup>19</sup> the dividing line between Sorenson’s land northward and land southward, this once again fits well with Sorenson’s model.

Such droughts need not be caused by volcanic eruptions, but other specifics of the Jaredite snake infestation dovetail nicely with such an explanation.

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

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19 This map was originally included as map 11 in Sorenson, *Mormon’s Codex*.

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. (p. 208).

A number of bird species in the region once occupied by the Olmec (Jaredite lands, in virtually all Mesoamerican models) prey on snakes (pp. 209–210), and the temporary “decimation of these species would eliminate serious predators on snakes as well as removing competition for snake prey” (p. 210). Later, as these birds of prey reestablished their populations, they would have begun to regulate the snake population, reducing it back down to normal levels, which would seem to fit the narrative in Ether where, eventually, the snakes no longer posed a barrier between the land northward and southward (see Ether 10:19).

The effects of a volcanic eruption on an environment, therefore, carries rather potent explanatory power for an event often mocked as ridiculous or fanciful by modern critics of the text. It is hard to imagine a more perfect geologic, geographic, and ecologic setup for the events described in Ether 9.

### **Implications for Book of Mormon Geography**

Grover’s investigations into the *geology* of the Book of Mormon have implications for the *geography* of the Book of Mormon. This should come as no surprise, since volcanoes and fault lines are inherently part of the landscape. While other writers, as pointed out earlier, have noted some vague geographic implications or requirements created by the geologic analysis, Grover’s in-depth “best-fit” analysis on a city-by-city, disaster-by-disaster basis generates rock-hard criteria that need to be factored into any geographic model of Book of Mormon lands. Grover helpfully outlines the minimum criteria his study yields:

- A volcano in the land northward, active, and with eruptions during the 3 Nephi time frame
- A regional fault system in the land northward with a presence or effect in the land southward capable of generating minimum intensities of Level VIII on the Mercalli intensity scale
- The requirement that the city of Ammonihah be in an area capable of producing an earthquake with a minimum intensity of Level VIII on the Mercalli intensity scale.

- The location of land of Nephi adjacent to a volcano active during the first century BC. (p. 211)

Grover then explains, “Once the basic screening criteria are met, the actual locations of cities and geological occurrences would then need to be evaluated” (p. 211). As discussed above, Sorenson’s model not only meets the minimum criteria but does remarkably well in the fine details. What about other geographic models?

According to Grover, “The active volcano requirement essentially eliminates all Book of Mormon geologic models located in the central and eastern United States, Baja California, and any area in Central America south of Costa Rica from being viable models as a location for the Book of Mormon” (p. 211). While Grover’s analysis points to several hazards best accounted for by the effects of a volcanic eruption rather than an earthquake, the most obvious reason for this is the three days of lingering darkness. Since some have pointed to the eyewitness reports of an 1811 earthquake in the eastern United States, which describe an “awful darkness of the atmosphere”<sup>20</sup> in an attempt to explain this feature without a volcano, Grover’s comments on this kind of phenomenon are important:

The mists or vapors of darkness are described as being widespread. The only realistic explanation for this phenomenon is a volcanic ash/tephra cloud disseminated as a result of a volcanic eruption. Occasionally during the initial moments of earthquakes, dust can be generated from shaken buildings or by brief release of sometimes pungent soil gases, but these have never been observed in modern earthquakes to last more than a few hours, and the same is indicated for pre-modern earthquakes by historic anecdote. Earthquake dust has not been observed to inhibit ignition. Volcanic ash distribution has been historically documented to inhibit combustion and last for days at a time. (p. 156)

In addition, the vast distribution of darkness required to cover all or most of the lands northward and southward is not a result of earthquakes but is a result of volcanic eruptions. In fact, it has been documented in an eruption of the very volcano hypothesized by Grover to be the source of the darkness in 3 Nephi: “The 1793 San Martín volcanic eruption is a

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<sup>20</sup> Letter of Eliza Bryan, March 22, 1816, online at <http://www.hsv.com/genlintr/newmadr/acnt1.htm> (accessed April 1, 2015).

recent example that shows that with an extensive dispersion of ash most if not all of the Book of Mormon lands could have been subject to the effects of volcanic ash” (p. 157; see the map of its ash cloud dispersion on p. 39).

Since the volcano requirement essentially eliminates all models outside of Mesoamerica, Grover spends no time looking at these models. He does, however, spend some time exploring V. Garth Norman’s (and Kirk Maglby’s, which largely overlaps with Norman’s) model insofar as it differs from Sorenson’s.<sup>21</sup> The most significant differences are that Norman prefers the Usumancinta River as the Sidon River, thus moving Zarahemla into that basin; and the east sea coast and its cities are moved from the Gulf of Mexico to the eastern coast of the Yucatan Peninsula. Since Joseph L. Allen also moves the east seashore to the eastern Yucatan coast, and F. Richard Hauck similarly prefers the Usumancinta River,<sup>22</sup> the outcome of this comparison applies broadly to their models as well, at least in terms of general observations though not necessarily in specifics. A short summary of the more salient points of this analysis are as follows:

- Norman’s city of Bountiful “is directly in the center of the Veracruz fault system,” and “would be expected to have maintained a maximum level of destruction” (p. 214). It therefore would not be expected to be a regional gathering place in the months after the destruction, as appears to be the case in 3 Nephi 11.
- Norman’s Ammonihah is “not seismically active,” and no earthquake has ever been measured “within 100 miles of this location” (p. 214). The nearby fault line “show[s] no evidence of any earthquake activity during Book of Mormon times”; “earthquake booms exclusively occur in strike-slip fault regimes and the faults in this location are not strike-slip faults” (p. 215).

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21 See V. Garth Norman, *Book of Mormon—Mesoamerican Geography: History Study Map* (American Fork, Utah: ARCON/Ancient America Foundation, 2008); Capitan Kirk (Kirk Magleby), “Book of Mormon Model,” at *Book of Mormon Resources*, July 28, 2012 (updated October 2, 2013), online at <http://bookofmormonresources.blogspot.com/2012/07/book-of-mormon-model.html> (accessed April 1, 2015).

22 See Joseph L. Allen and Blake J. Allen, *Exploring the Lands of the Book of Mormon*, rev. ed. (American Fork, Utah: Covenant Communications, 2011); F. Richard Hauck, *Deciphering the Geography of the Book of Mormon* (Salt Lake City, Utah: Deseret Book, 1988).

So even if there had been an earthquake, there would be no explanation for the “great noise” (Alma 14:29) reported as having occurred at the time of the earthquake. Magleby’s Ammonihah, to the west of Norman’s, is in an area more seismically active, but it is not intense enough (usually only Level IV on the Mercalli scale) to cause a prison to collapse, and there are still no strike-slip faults (pp. 215–216).

- The location of Moroni on the Yucatan coast is suitable, but only if we hypothesize a second earthquake in the land southward along a different fault line (p. 217). While, when taken in isolation, this still qualifies as a “best-fit” scenario, I think Occam’s Razor applies here. In the bigger picture, adding a second earthquake multiplies hypotheses unnecessarily, since we have in Sorenson’s model a suitable candidate for Moroni without it.
- Norman’s Zarahemla is not “best-fit” but “is reasonably consistent with the geologic conditions,” although Sorenson’s is in a better position geologically (p. 217).
- The location of Moronihah is “near a large group of volcanoes” (p. 217) and hence is “a geological possibility”; however “it would require a second volcano eruption,” which is even less likely than a secondary earthquake. Hence it “provides less probability for the location under the best-fit analysis” (p. 218). Again, Occam’s Razor seems applicable here.
- Stretching the land southward out to the Caribbean coast of the Yucatan also makes it harder for the darkness to be comprehensive in the land southward. Grover admits that “not necessarily ... every square mile” of Book of Mormon lands needs to be covered by darkness (if we grant some hyperbole on the part of the writers); nonetheless, “the description does imply that it is widespread over most of the face of the land” (p. 218). In order that this be the case in Norman’s (and, I would note, also Allen’s) model “necessitates the eruption of volcanoes in the land southward.” This is not only less likely, as mentioned above, but it is also not as consistent with the text, since according to Grover, “no specific and unique volcanic damage of any sort (unlike specific cities in the land northward) is indicated in the land southward” (p. 218).<sup>23</sup>

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23 I would only briefly add that Hauck’s model compresses the land southward into a small region that is usually the southernmost region in most other models. This sort of setup raises the question whether *any* of his land southward would have

- Large portions of Norman's land southward are not positioned in seismically active areas and thus are unlikely to be susceptible to any of the kinds of damage reported in the text (p. 219). This would also be true of Allen's model.

While some of these issues are more serious than others, generally speaking it is clear that models that shift the east seashore over to the Caribbean coast and position large parts of the population in the Yucatan are less geologically suitable than Sorenson's model.

While geology is only one of many factors to take into consideration when constructing a geography of Book of Mormon lands, it is a fairly important one. Volcanoes and fault lines don't disappear. Having them in the right places and active at the right times (though the data on timing may not always be available or as precise as we would like) is essential to any geography. And being able to account for the most damage reported in 3 Nephi 8–9 without having to multiply disasters is certainly a strength. It is a testament to the suitability and durability of Sorenson's model that 30 years after it was published, it would be found not only geologically viable but exceptionally so, whereas competing models are found to be geologically deficient in important respects.

### Conclusion

Regardless of one's preferences on geographic models, Grover's book on geology should be of interest to all students of the Book of Mormon. Grover substantially advances the discussion on geology in the Book of Mormon, its interaction with the geography of the text, and the aid it can be in fleshing out the geography (Grover determined likely regions for 10 cities entirely unplaced by Sorenson). The background information on geology and the geologic features of the Mesoamerican region alone make it an exceptionally useful tool for anyone who wants to study the Book of Mormon in its most likely New World environment. All the richly colored visuals, mentioned earlier, serve to greatly enhance the reading experience. I highly recommend *Geology of the Book of Mormon*.

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been covered by an ash cloud generated from a volcanic eruption way up north in the Tuxtla Mountains. It also places all his cities much farther away from the seismic activity of the Veracruz fault, and may require both a second volcano and second earthquake to account for all the hazards mentioned in the text. Once again, Occam's Razor seems applicable here, although more serious analysis of Hauck's model from someone more qualified than I would probably be necessary to come to firmer conclusions.



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