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In a recent *BYU Studies* article, Bart Kowallis describes how the events of destruction in the Americas at the time of Christ's death can be attributed to a single explosive volcanic eruption.[1] He lists the events that occurred during the destruction as recorded in 3 Nephi, and among those mentioned is the sinking of cities into the sea (3 Ne. 8:9, 14; 9:4, 7; 10:13). As a possible explanation for this phenomena, Kowallis offers accounts of *tsunami* (tidal waves) and *seiche* waves (waves generated in lakes), both of which can occur during an explosive volcanic eruption.[2] In conjunction with these two explanations, I would offer a third possible cause for the "many great and notable cities [being] sunk" (3 Ne. 8:14) that is not addressed in Kowallis's article.

At 11:40 A.M. on the morning of June 7, 1692, a large earthquake destroyed the famous pirate city Port Royal, Jamaica, causing the deaths of approximately four thousand people. In describing the event in his book *Buccaneer Harbor*, Peter Briggs told of the experience of Reverend Dr. Emmanuel Heath of Christchurch:

> On the morning of June 7 . . . Dr. Heath attended divine service as he did every morning, hoping to set an example for "a most ungodly, debauched people." Dr. Heath was due for lunch at the house of Captain Ruden, but he stopped first at an inn to have a glass of wormwood wine with a merchant friend. . . . Dr. Heath waited impatiently while his friend very slowly finished smoking his clay pipe. The reverend was a courteous man and did not want to be late for his engagement. Then, at twenty minutes before noon, while still at the inn, he felt the earth begin to heave and roll beneath him. "Lord, Sir," he shouted, "what is this?"
>
> His friend replied, "It is an earthquake. Be not afraid. It will soon be over."
>
> Dr. Heath ran into the street and, within moments, felt two much greater shocks. By the time he arrived at Captain Ruden's house, the building itself had vanished into the sea, along with three or four blocks behind Wharfside Street. In panic Dr. Heath raced toward Morgan's Fort, only to see it crumbling. Then before his eyes his church and its high tower fell. He saw the earth open up and swallow people.[3]

Another witness to this devastating event, Sir Hans Sloane, was in a small boat in the bay at the time of the earthquake. He wrote that, upon arriving on shore, he "found all houses even with the ground; not a place

to put one's head in" and that "the terrible earthquake shook down and drowned nine-tenths of the town of Port Royal in two minutes time, and all by the wharfside in less than one." Sloane also recorded that his own home "sunk right down and is now under thirty feet of water."[4]

The most intriguing fact about this destruction and the sinking of the city is that a tsunami was not involved. The city literally sank. It was not buried or washed away by a large wave.[5]

To understand the sinking of Port Royal, it is important to understand a phenomenon called "liquefaction." Liquefaction occurs in water-saturated soil or sand where grains are resting on each other with water filling the spaces between the grains. A large earthquake sets up vibrations that put those grains into motion so that they no longer rest on each other. The water becomes the support, and the sand becomes liquefied and behaves like a liquid. The grains can no longer bear weight, and effectively they become a form of quicksand. Anything resting on the sand or soil that is denser than the liquefied material will sink.[6]

Liquefaction occurred at Port Royal. The city was built on a large spit of sand extending off the coast of Jamaica. The sediment was saturated by the surrounding sea. Although the water may not have been visible on the surface, it was there. One witness recorded, "In the violent Shake the Sand cracking and opening in several places where People stood, they sinking into it; the Water boiled out of the Sand."[7]

One of the effects of liquefaction is the "fountaining" of water up out of the ground as it is displaced by sinking objects. If a brick is put into a bucket of water, the water will rise; if a person sinks into liquefied sand, the water in the sand is displaced and will rise. This effect occurs on a smaller scale as one walks along a wet beach. The pressure of feet on the sand squeezes the water up. Thus, water "boiling" out of the sand can be one of the signs of liquefaction.

When the earthquake subsides and the shaking stops, the sand re-solidifies, encasing anything that has sunk into it. One witness of this effect at Port Royal wrote, "Many People were swallowed up; some the Earth caught by the middle, and squeezed to Death; . . . others went down, and were never more seen."[8]

The Book of Mormon mentions that the city of Gilgal was "sunk, and the inhabitants thereof [were] buried up in the depths of the earth" (3 Ne. 9:6). Those victims that had sunk deep enough would have been literally "buried." Those that may have been "caught by the middle" would not really have been "squeezed to death" but rather prevented from expanding their lungs and thus suffocated by the sand as it resolidified. Port Royal was not the only part of Jamaica that sank due to the earthquake—more than a thousand acres of land were also submerged on the north side of Jamaica.[9]

Although this particular earthquake was not generated by a volcanic eruption—since there are no active volcanoes in Jamaica[10]—it is entirely conceivable that an earthquake of this magnitude could be generated by a volcanic eruption. The relatively small volcanic eruptions of Mount St. Helens in 1980 and Sakura-jima volcano in 1914 generated earthquakes with magnitudes of 5.1[11] and 6.7[12] respectively. Although it is not known what the magnitude of the Port Royal earthquake was, it is estimated to have been near 8.0.[13] A very large eruption, like that suggested by Kowallis, could generate much stronger earthquakes that last for a longer period of time.

Smaller magnitude earthquakes can also cause liquefaction, based on their duration. The earthquake at Port Royal, as well as having a large magnitude, is also thought to have lasted five to seven minutes—one of the major reasons liquefaction took place there.[14] The account of the destruction in 3 Nephi mentions that the earthquake lasted about three hours (3 Ne. 8:19), which would have been more than enough time to liquefy any water-saturated soil. Thus, if any Nephite or Lamanite cities were built in the same type of geologic and geographical setting as that of Port Royal, the earthquakes reported in 3 Nephi would have been of such duration and magnitude as to cause those cities to sink into the ground as well as the sea.

It is possible that the type of explosive volcanic eruption described by Kowallis could have generated earthquakes large enough to cause liquefaction. Water-saturated, sandy seacoasts could potentially be liquefiable in a large-magnitude, long-duration earthquake. Any Nephite or Lamanite cities built near the coast, on liquefiable soil, could have sunk by liquefaction.

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2. Kowallis, "In the Thirty and Fourth Year," 143, 162–66.

3. Peter Briggs, *Buccaneer Harbor: The Fabulous History of Port Royal, Jamaica* (New York: Simon Schuster, 1970), 111–13.

4. Briggs, *Buccaneer Harbor*, 111–13.

5. George R. Clark II, "Swallowed Up: The Quake That Swallowed a City," *Earth Magazine* 4 (April 1995): 34–41.

6. W. W. Hays, ed., *Facing Geologic and Hydrologic Hazards —Earth Science Considerations,* Geological Survey Professional Paper 1240-B (Washington, D.C.: United States Government Printing Office, 1981).

7. Clark, "Swallowed Up," 37.

8. Clark, "Swallowed Up," 37.

9. Briggs, *Buccaneer Harbor*, 111–13.

10. G. Wadge, "A Miocene Submarine Volcano at Low Layton, Jamaica," *Geology Magazine* 119 (1982): 193.

11. R. I. Tilling, Lyn Topinka, and Donald A. Swanson, *Eruptions of Mount St. Helens: Past, Present, and Future*, USGS Special Interest Publication (Washington, D.C.: United States Government Printing Office, 1990), text-fiche, p. 10.

12. R. P. Hoblitt, C. D. Miller, and W. E. Scott, *Volcanic Hazards with Regard to Siting Nuclear-Power Plants in the Pacific Northwest*, USGS Open File Report 87-297 (Washington, D.C.: United States Government Printing Office, 1987).

13. Clark, "Swallowed Up," 39–40.

14. Clark, "Swallowed Up," 38.