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Investigating New World Volcanism at the Time of Christ's Death

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analyses of thousands of passages throughout the standard works, enabling anyone proposing a new chiasm to see what might already be written on it. With adequate time and resources, all of this could be made available with the click of a mouse.

When completed, the online chiasmus database will be a unique resource. Its sheer size will make it an important center for further chiasmus research and exploration for interested people all around the world.

"Interest in chiasmus has not waned," says Welch. "In fact, at the annual meeting of the Society of Biblical Literature in Atlanta this past November, several new books, papers, or chapters appeared utilizing chiasmus in analyzing various biblical texts. I am grateful to many people who have contributed over the years to building the makings of this chiasmus archive. J. D. Payne and several others are to be thanked especially."

To submit materials or to volunteer services in furthering the Chiasmus Archive, please contact M. Gerald Bradford, codirector of research at the Institute.

Investigating New World Volcanism at the Time of Christ's Death

A recent article in the *Journal of Book of Mormon Studies* reported that ice cores taken from Greenland and Antarctica yield evidence broadly consistent with the 3 Nephi 8 account of cataclysmic New World events—presumably including a violent volcanic eruption—at the time of Christ's death (Benjamin R. Jordan, "Volcanic Destruction in the Book of Mormon: Possible Evidence from Ice Cores," *JBMS* 12/1 [2003]: 78–87). What other methods might yield corroborating evidence of such an eruption? Two possibilities are the analysis of tree rings and sea and lake sediments.

Tree-ring records are abundant and easy to date. By merely counting tree rings, very accurate dates can be determined. A tree ring that shows damage or is very thin relative to adjacent rings indicates environmental stress, such as drought or frost. Evidence of frost damage in tree rings may indicate volcanic events because the environmental cooling following volcanic eruptions often results in very severe winters and extended periods of frost. However, the great difficulty in trying to use tree rings to identify volcanic events is that frost-damaged tree rings "vary considerably from one event to another in the severity of cell damage, in their frequency of occurrence at a particular site, and in their range of distribution."[1]

Many environmental factors influence the growth of tree rings, yet there are no direct measurements taken from tree rings that can indicate volcanism, such as the detection of ash or the measurement of sulfate ions. Thus, tree rings are really only useful in the study of volcanic eruptions if a known, dated eruption is compared to the tree-ring record to see if the eruption coincides with tree-ring damage or thinning.

It might be worthwhile to examine tree rings from trees in Mesoamerica for the time period around AD 30–40. However, I am not aware of any living trees in Mesoamerica that are 2,000 years old; and even if there are, I doubt if approval would be given to cut one down or even to take a core sample for examination. A frost ring at AD 119 preserved in trees from the White Mountains of California is attributed to the Ilopango eruption,[2] so maybe other examples can be found that would cover the required time period. Wood found at archaeological sites might yield a useful record, but wood does not preserve well in Mesoamerica. Even if such well-preserved wood were found with evidence of damage or thinning for the time period in question, that would not independently confirm an eruption.

The second method uses the actual physical evidence of an eruption. It might be possible to identify an ash layer from sediment cores obtained from the seafloor around Mesoamerica. Unfortunately, analyzing core samples collected near the coasts of Mesoamerica and Central America would

be a difficult and expensive endeavor for a number of reasons.

Through the International Deep Sea Drilling Project and the Ocean Drilling Program, 33 cores have been drilled off the coasts of Mesoamerica.[3] Each of these cores contains ash layers that record volcanism over the last several million years up to the present. In fact, almost all of the cores furnish evidence for volcanism in the region over the recent past in the form of distinct ash layers—obvious evidence that the area has been volcanically active through geologic time and up to the present. The problem is that these layers have not been accurately dated to within the time period of the last 2,000 years. These layers need to be radiometrically dated, but this has not been successfully done for any layers younger than a few tens of thousands of years.

Even if these cores were dated, the error factor would be at least as large as, and most likely larger than, that of the ice cores. In addition, because burrowing creatures disturb the seafloor sediment, any layer from an eruption would need to be fairly thick in order to be preserved. A thin ash layer would be completely obliterated. My own work indicates that it is possible to geochemically correlate ash layers off the coasts of Mesoamerica with volcanic deposits on land, but only if there is good preservation of the layers and the source on land is already known, sampled, and geochemically characterized.[4]

Two studies have attempted to correlate geologically recent tephra layers (those deposited less than a few hundred thousand years ago) from the seafloors on either side of Mesoamerica with land deposits, but strong correlation has not been successful except in the case of one layer. That layer deals with an eruption that occurred at least 62,000 years ago and was large enough to produce a substantial ash layer in the ocean sediments. There are only three identified layers younger than this correlated layer, but all appear to be much older than the time of Christ's death.[5]

Another possibility for obtaining direct evidence of a volcanic eruption is taking sediment cores from lakes. These cost much less to acquire than deep-sea cores; and unlike deep-sea cores, they often show, due to seasonal changes, annual layers that can be counted like the layers in ice cores and tree rings. This makes it possible to more precisely date any ash layers within the lake sediments. Although Mesoamerica is in the tropics, it still has a wet season and a dry season each year. However, even if annual layers cannot be determined, lake sediments usually contain biotic material that can be radiometrically dated.

The next step in researching whether or not the destruction in 3 Nephi 8 was caused by a volcanic eruption could be to collect core samples from lakes within Mesoamerica, such as Lake Managua in Nicaragua, in order to identify an ash layer that dates to the same time period. Geochemically, these could also be compared to the Tacaná volcanic eruption, which is discussed in the *Journal of Book of Mormon Studies* article. Lakes with high sedimentation rates or low-oxygen conditions (which would reduce or prevent disturbance by animals) would be the best choice. Research of this kind would contribute information to other fields as well, such as climate study. *—reported by Benjamin R. Jordan*

Notes

1. Valmore C. LaMarche Jr. and Katherine K. Hirschboeck, "Frost Rings in Trees as Records of Major Volcanic Eruptions," *Nature* 307 (1984): 124.
2. Ibid., 125.
3. Space does not allow a complete listing of reports that discuss cores taken from areas near Mesoamerica and Central America. For a recent report, see Haraldur Sigurdsson et al., "History of Circum-Caribbean Explosive Volcanism: $^{40}Ar/^{39}Ar$ Dating of Tephra Layers," *Proceedings of the Ocean Drilling Program, Scientific Results* 165 (2000): 299–314.
4. See Benjamin R. Jordan et al., "Geochemical Correlation of Volcanic Ash Layers in the Caribbean Sea with Ignimbrites of Nicaragua and Honduras," *GSA Abstracts with Programs* 33 (2001): A-85.
5. See Frederick A. Bowles, Robert N. Jack, and I. S. E. Carmichael, "Investigation of Deep-Sea Volcanic Ash Layers from Equatorial Pacific Cores," *Geological Society of America Bulletin* 84 (1973): 2371–88; and John W. Drexler et al., "The Los Chocoyos Ash, Guatemala: A Major Stratigraphic Marker in Middle America and in Three Ocean Basins," *Quaternary Research* 13 (1980): 327–45.