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TALL 'HORNITO-STYLE' LAVA STALAGMITES AND LAVA COLUMN IN LAVA COLUMN CAVE, EL MALPAIS NATIONAL MONUMENT

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Abstract—New Mexico hosts spectacular lava tube caves that exhibit remarkable lava features. Most of these caves are in El Malpais National Monument. Two types of lava features, lava columns and lava stalagmites, are named for their resemblance to columns and stalagmites common to limestone caves. Lava Column Cave, in El Malpais National Monument, exhibits rare large examples of a lava column and two lava stalagmites. We measured one of the lava stalagmites and the lava column heights to be 3.17 meters (10.4 feet) and 4.45 meters (14.6 feet), respectively, making them among the largest thus far reported in El Malpais National Monument. We also observed that these lava features have central conduits. We suggest they formed the same way that hornitos and squeeze-ups form on lava flow surfaces, by lava extruding from the floor of the cave, rather than from accumulation of dribbles and blobs of lava falling from the ceiling. Our interpretation for the origin of these lava features differs from the origin of the more typical lava stalagmites and columns.

INTRODUCTION

Many lava features within lava tube caves resemble speleothems, and accordingly speleothem types have been borrowed to describe lava tube cave features, especially for lava stalagmites, stalactites, and helictites (Hill and Forti, 1997; Palmer, 2007). Wentworth and Macdonald (1953) described the origin of lava stalagmites and two types of lava stalactites in Hawaii caves. Lava stalagmites were noted by Waters et al. (1990) in California caves. A detailed description of features such as lava stalagmites and columns in lava tube caves is provided by (Larson, 1991, 1993). These features are well-represented in caves of El Malpais National Monument, New Mexico.

Lava stalagmites are defined as mounds of agglutinated droplets of lava (Wentworth and Macdonald, 1953), which describes the more typical occurrence of lava stalagmites, or as vertically oriented accumulation and accretion of droplets and dribbles of semi-solid and solid lava (Larson, 1991, 1993). Lava stalagmites and columns that could form from extrusion of lava from the floor do not quite fit these definitions, even though a vertical accumulation occurs. This type of lava stalagmite or column having the source of lava from the floor, we suggest, would fit the description of a squeeze-up or a hornito, which usually forms on the lava flow surface above lava tubes, and not in the caves. Hornitos are also known as driplet spires or cones that retain a central conduit (Larson, 1991, 1993; Wentworth and Macdonald, 1953) and sometimes occur on a lava tube floor (Larson, 1991, 1993). Squeeze-ups and hornitos on lava flow surfaces (not in the caves) can have the appearance of lava stalagmites (Fig. 1). Three very wide and tall lava features in Lava Column Cave, El Malpais National Monument, form as a lava column and two lava stalagmites, but exhibit central conduits, like hornitos. Here, we describe these features in Lava Column Cave as lava stalagmites and a lava column and include the physical description of the two lava features. The smaller lava stalagmite, while large, had fallen over and was not included in this study.

LAVA FEATURES OF INTEREST

There are important lava tube caves in New Mexico (Goar and Mosch, 1992), and specifically in El Malpais National Monument, where lava features typical of lava tube caves are well-exhibited. Most common are lava stalagmites, lava soda-straw stalactites, and lava helictites. These features are spectacular but are usually very small and hard to see, particularly the lava features on cave floors. As such, they are especially vulnerable to damage by visitation (Polyak and Provencio, 2006). With the exception of the Lava Column Cave lava column and stalagmites, the vast majority of lava stalactites, columns, and stalagmites in El Malpais National Monument caves are interpreted to have formed by accretion of dripping lava during lava tube system activity. The lava column and lava stalagmites described herein are much larger than other lava features noted in El Malpais National Monument, which makes them extraordinary.

Lava Column Cave is located in the Bandera flow, and therefore the cave and its lava features formed about 11,000 years ago (Dunbar and Phillips, 2004; Laughlin et al., 1994). The cave is relatively small with only ~50 meters of passage that is 8 to 10 meters wide and 3 to 6 meters high (Fig. 2A). Overall, the cave is nearly devoid of distinct lava features, and the only ones of interest are located at the back of the cave. The intact lava stalagmite is adjacent to the lava column (Fig. 2B). The overall appearance of the lava column gives the impression that lava was injected from the ceiling rather than the floor of the cave. Closer examination shows the presence of central conduits in both the lava column and nearby upright

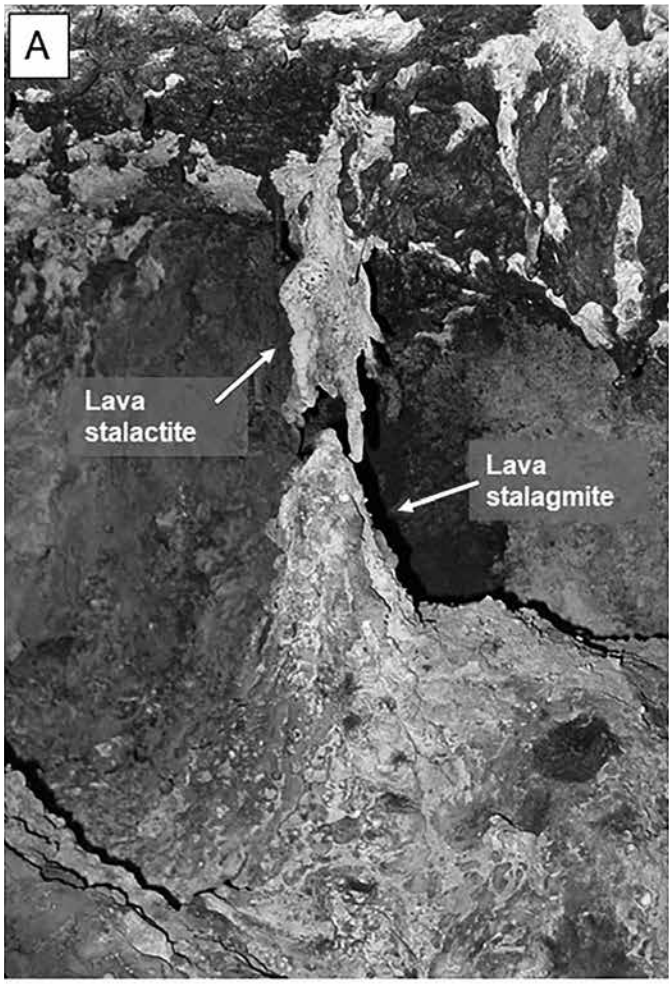
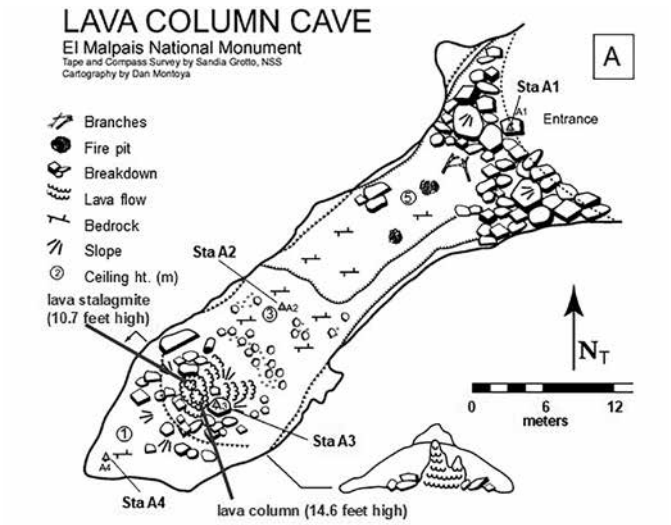


FIGURE 1. **A**) Photograph of a typical lava stalagmite. Note the presence of a lava stalactite immediately above the lava stalagmite. If these had connected, then they would have formed a lava column. **B**) Photograph showing a stalagmite-shaped squeeze-up on a tumulus on the surface of the 1919 Kilauea lava flow (courtesy of Dr. William R. Halliday). Squeeze-ups and hornitos on lava flow surfaces can resemble cave stalagmites.



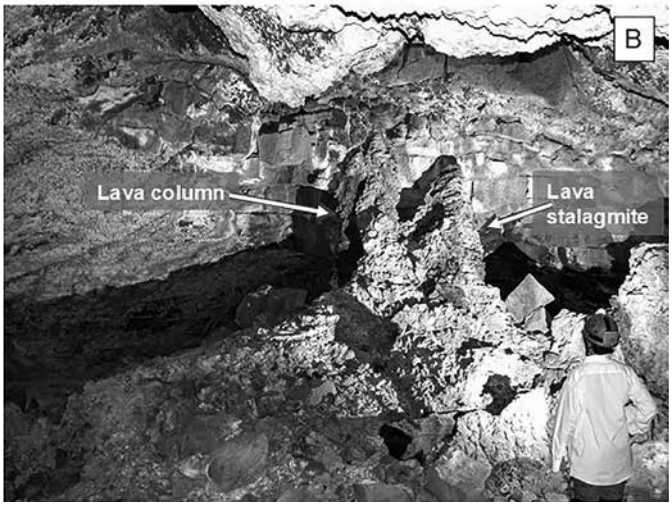


FIGURE 2. **A**) Map of Lava Column Cave indicating the location of a large lava stalagmite and lava column. The map was generated by the Sandia Grotto of the National Speleological Society for El Malpais National Monument. **B**) Photograph showing the lava column and lava stalagmite.

lava stalagmite, which indicates an origin like that described for hornitos or spatter cones, features that form on the surface of lava flows.

Examination of the central conduits of the lava stalagmite and column indicate that the conduit diameter is ~0.15 meters and the depth of the conduit descends to near the same level as the cave floor (Fig. 3). There was no distinct indication of a point of injection of lava at the base of the conduits. The heights of the hornito-style lava stalagmite and column above the cave floor are 3.17 meters (10.4 feet) and 4.45 meters (14.6 feet), respectively, making these exceptionally large lava features. The interior of the conduits (at the top) are lined with lava coralloids that slightly point downward. The exterior of the stalagmite and column are stacked lobes of lava, and a lava toe extrudes from the lava column.

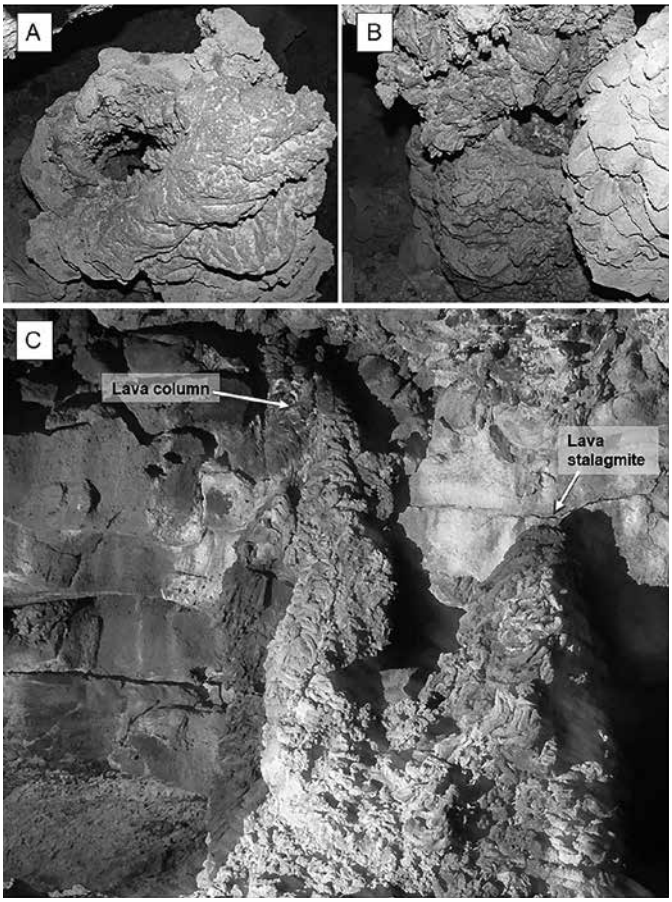


FIGURE 3. This figure shows the central conduit of the lava stalagmite (**A**) and the lava column (**B**). Note that the bottom photograph (**C**) shows the top half of the lava stalagmite and lava column, and that the source of lava to form the column (and the stalagmite) is from the floor, not from the ceiling as it appears.

DISCUSSION

We suggest that these squeeze-up hornito-type lava features that formed in a lava tube cave should be formally described as a lava column and two lava stalagmites even though we interpret them to have different origins than typical lava columns and stalagmites. Given that the Lava Column Cave lava stalagmite and column formed like a hornito, then the material that accreted to form these features was injected into the cave from the floor, not from the ceiling. There are no distinct lava features above the stalagmite or column that would indicate spattering, which suggests that the squeezing up of lava was relatively slow and steady, and not violent. The lava column accreted high enough to connect with the ceiling, and issue lava up into a depression in the ceiling, making it look as though the lava that formed the lava column was sourced from the ceiling (Fig. 3C). Final subsidence of lava in the central conduits must have been fluid enough to spread out evenly with the floor of the cave. Considering that hornitos are commonly formed over lava tubes, the presence of these features suggests that there was another lava tube level below the tube that formed Lava Column Cave. While somewhat rare, multi-level tubes are observed in some of the caves in these lava flows.

Other than the lava features in Lava Column Cave, the tallest lava stalagmites and lava columns in El Malpais National Monument caves are less than one meter in length. To our knowledge the world's tallest lava column measured is 7.8 meters from Majanggul (Manjang) Cave, Korea (Dell'Amore, 2012; Jeon and Woo, 2018; Okada et al., 1991). Lava stalagmites that exceed 3 meters in height in Mathaioni Cave (Kenya) are reported as possibly the largest lava stalagmites in the world (Forti et al., 2003). These heights are similar to but slightly higher than those of Lava Column Cave lava stalagmite and column. However, there appears to be a lack of information regarding descriptions, including heights of these types of lava features. Lava Column Cave has what might be considered among the highest and largest lava stalagmites and lava column in the world.

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