Genesis of Pyroducts of the Galápagos Islands, Ecuador

by

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Abstract

Little has been published on the development of lava tubes, or "pyroducts" of the Galápagos. Here we report on fieldwork conducted during the 16th International Symposium on Vulcanospeleology which was held in the islands in March 2014. During the week the major volcanic caves were visited and studied in context. Santa Cruz is the most central island of the Galápagos. It is a large shield volcano with a high abundance of parasitic cones, large lava caves and enormous pit craters (e.g. Los Gemelos). Santa Cruz is subdivided into an older, uplifted Platform Unit with an age of 1.3-1.1 Ma, while the younger unit is represented by lavas (mainly exhibiting olivine tholeiites and transitional alkalibasalts besides some hawaiites) of the Shield Series with ages as young as 30-20 ka.

A total of eleven pyroducts were investigated prior to and during the symposium: Cueva del Cascajo, Cueva de Gilda and Gallardo, Mirador de los Túneles (Cueva de Kübler), Cueva de Chato 1, Cueva de Royal Palm, Tortoise Junction tourist cave, Cueva La Llegada, and Cueva de Premisias on Santa Cruz Island and Triple Volcán (a vent), Cueva de Sucre and Túnel del Estero on Isabella Island. In addition, detailed surveys were conducted in Cueva del Cascajo and Mirador de los Túneles/Cueva de Kübler. These caves fall into two groups, those with one pāhoehoe sheet as primary roof (5) and those with a much thicker roof (6) composed of a primary pāhoehoe roof, reinforced by successive ʻaʻā flows of the same eruption. In the latter group the primary pāhoehoe

sheet often collapsed during activity, being transported away so that the cores of the ʻaʻā flows are now giving stability to the roofs. All caves show very low braiding (i.e. they are mono-trunked).

The longest cave, Cueva del Cascajo, estimated to be about 3 km long, was investigated by the participants. The uphill, 150 m long section was surveyed in great detail to understand its genesis. This section has four collapse holes (the fifth downhill serves as the normal entrance to the cave). The section is divided by a septum (a secondary ceiling) throughout, separating the passage into an upper and a lower level. In places up to five septa are present. This suggests a gradual downcutting of the flowing lava during activity. The space below the lowest septum amounted to about 5 m^2, a measure of the cross-section of the lava river. Another indicator of downcutting is the presence of a prominent lava-fall. Where the lining had fallen away, we noticed ʻaʻā rubble- and core-layers along the walls, showing that the lava flow has in fact down-cut into older rock. The survey showed that the downcutting amounted to 10 m in this section, decreasing to 5 m at the entrance collapse. Thus, the present cave represents a canyon down-cut by a stepped river of lava, originally flowing at its bottom.

We found evidence of downcutting in most of the caves (exception Túnel del Estero), confirming the observations from Hawaiʻi that show that lava caves are not created at the end of the eruption "when the tube runs empty", as popular views suggest. Rather prolonged activity creates a gas-space above the down-cutting lava river. We were able to divide the caves into three states according to the importance of the observed erosion. Overall the caves of Galápagos appear to best fit the "inflation" model whereby the primary roof consists of one or a stack of pāhoehoe sheets with the conduit developing below. Evidence for roof formation by "crusting over of a channel" was not observed.