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Inside the volcano: The how and why of Thrihnukagigur volcano, Iceland

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The Thrihnukagigur volcano, located in the Brennisteinsfjöll fissure swarm on the Reykjanes Peninsula, Iceland, offers a unique exposure of the upper magmatic plumbing system of a monogenetic volcano. The volcano formed during a dike-fed strombolian eruption ∼3500 BP with flow-back leaving an evacuated conduit, elongated parallel to the regional maximum horizontal stress. At least two vents were formed above the dike, as well as several small hornitos south-southwest of the main vent. In addition to the evacuated conduit, a cave exists 120 m below the vent. The cave exposes stacked lava flows and a buried cinder cone. The unconsolidated tephra of the cone is cross-cut by a NNE-trending dike, which runs across the ceiling of this cave to the vent that produced lava and tephra during the ∼3500 BP fissure eruption. We present geochemical, petrologic and geologic observations, including a high-resolution three-dimensional scan of the system that indicate the dike intersected, eroded and assimilated unconsolidated tephra from the buried cinder cone, thus excavating a region along the dike, allowing for future slumping and cave formation.

Two petrographically distinct populations of plagioclase phenocrysts are present in the system: a population of smaller (maximum length 1 mm) acicular phenocrysts and a population of larger (maximum length 10 mm) tabular phenocrysts that is commonly broken and displays disequilibrium sieve textures. The acicular plagioclase crystals are present in the dike and lavas while the tabular crystals are in these units and the buried tephra. An intrusion that appears not to have interacted with the tephra has only acicular plagioclase. This suggests that a magma crystallizing a single acicular population of plagioclase intruded the cinder cone and rapidly assimilated the tephra, incorporating the tabular population of phenocrysts from the cone. Petrographic thin-sections of lavas sampled near the vent show undigested fragments of tephra from the cone. This conceptual model for basaltic cannibalism is supported by field observations of large-scale erosion upward into the tephra, which is coated by magma flow-back indicating that magma was involved in the physical erosion of the tephra. Whole rock major and trace element geochemical data are consistent with this model of mixing between the intruded magma and the tephra. While the unique exposure at Thrihnukagigur makes it an exceptional place to investigate basaltic cannibalism, we suggest that it is not limited to this volcanic system. Rather it is a process that likely occurs throughout Iceland and may contribute to the evolution of the crust in other predominately basaltic settings.