Shallow subsurface controls on volcanic eruption fluid dynamics

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Volcanic fissure vents are difficult to quantify, and details of eruptive behavior are elusive even though it is the most common eruption mechanism on Earth. A fissure's surface expression is typically concealed, but when a fissure remains exposed, its subsurface conduit can be mapped post-eruptively with VolcanoBot. The robot uses a NIR structured light sensor that reproduces a 3D surface model to cm-scale accuracy, documenting the shallow conduit. VolcanoBot3 has probed >1000m3 of volcanic fissure vents at the Mauna Ulu fissure system on Kilauea. Here we present the new 3D model of a flared vent on the Mauna Ulu fissure system. We see a self-similar pattern of irregularities on the fissure walls throughout the entire shallow subsurface, implying a fracture mechanical origin similar to faults. These irregularities are typically 1 m across, protrude 30 cm horizontally into the drained fissure, and have a vertical spacing of 2-3 m. However, irregularity size is variable and distinct with depth, potentially reflecting stratigraphy in the wall rock. Where piercing points are present, we infer the dike broke the wall rock in order to propagate upwards; where they are not, we infer that syn-eruptive mechanical erosion has taken place. One mechanism for mechanical erosion is supersonic shocks, which may occur in Hawaiian fountains. We are calculating the speed of sound in 64% basaltic foam, which appears to be the same velocity (or slightly slower) than inferred eruption velocities. Irregularities are larger than the maximum 10% wall roughness used in engineering fluid dynamic studies, indicating that magma fluid dynamics during fissure eruptions are probably not as passive nor as simple as previously thought. We are currently using the mapped conduit geometries and derived speed of sound for basaltic foam in fluid dynamical modeling of fissure-fed lava fountains.