Geophysical Research Abstracts
Vol. 18, EGU2016-2821-1, 2016
EGU General Assembly 2016

Shallow hydrothermal alteration and permeability changes in pyroclastic deposits: a case study at La Fossa cone (Vulcano island, Italy):

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La Fossa cone at Vulcano, the southernmost island of the Aeolian volcanic archipelago (Italy), has been characterized by an intense fumarolic activity since its last eruption dated 1888-90.
Mineralogical alteration induced by shallow hydrothermal circulation has significantly reduced the permeability of the volcanic products, causing important feedbacks on the circulation of fluids in the shallowest portion of the volcanic edifice.

The summit area of the cone is sealed by a quite continuous coating surface, fostering the condensation of hydrothermal fluids inside the volcanic edifice. The combination of fractures and volcano-stratigraphic discontinuities, conveying hydrothermal fluids, makes significant rock volumes prone to slide seaward, as occurred in 1988 during the main unrest experienced by Vulcano island since its last eruption. Similar instability conditions are found over the Forgia Vecchia crater rim area, formed by phreatic activity on the NE flank of the cone, where tensile fracturing and hydrothermal circulation interacts with mutual negative feedbacks.

In the behalf of the DPC-INGV V3 Project 2012-15 we investigated the mineralogical composition and the hydraulic conductivity (under saturated conditions) of volcanic deposits potentially prone to hydrothermal fluid circulation, for evaluating their ability in retaining water, creating favourable conditions for gravitational instability. We also measured rainfall rate and volumetric soil moisture content in two automated stations located in different areas, with and without active hydrothermal circulation.

We found that hydrothermal alteration transforms volcanic products into clay minerals, significantly reducing permeability of volcanic deposits. Argillified volcanic materials show background water contents, modulated by impulsive increments following rainfalls, higher than unaltered pyroclastic deposits, due to the combination of lower permeability and direct condensation of hydrothermal vapour.

The abovementioned considerations allowed us to conclude that large sectors of the NE area of La Fossa cone are prone to potential instability conditions, due to permeability changes induced by the shallow circulation of hydrothermal fluids.