Geophysical Research Abstracts
Vol. 17, EGU2015-11083, 2015
EGU General Assembly 2015

Causes and consequences of conduit wall permeability changes during explosive eruptions

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Magmatic volatiles, and in some cases external water, drive explosive volcanic eruptions and so the permeability of magma and conduit wall rocks can modulate the style and intensity of eruptions. Both modelling of eruption dynamics and field studies of lithic clasts indicate that fragmentation levels during explosive silicic eruptions commonly reach depths of kilometres. An important consequence is that substantial deviations from lithostatic pressure are sustained in the conduit during eruption, which, according to finite element modelling, are sufficient to damage a substantial volume of rock around the conduit. Underpressured regions will be susceptible to conduit erosion, widening the conduit; field data provide constraints on erosion rates and erosion depths where subsurface stratigraphy is known. Damage to wall rocks will also increase the rock permeability adjacent to the conduit, which could significantly affect magmatic degassing during and between eruptions. The degree to which external water can interact with magma in the conduit will also depend on wall rock permeability and spatial and temporal variations in pressure. When a major magmatic eruption ceases, deep magma is likely to ascend to fill the lower conduit, and the upper conduit may partially collapse forming vertically extensive breccia. Subvolcanic rocks exposed by exploration and mining of porphyry copper deposits (PCDs) and associated alteration and breccias may provide further field constraints on these models. Although syn- and post-mineralization explosive eruptions likely ruin potential PCDs, earlier eruptions might make space for vertical shallow intrusions and help establish permeable regions conducive to focussing of magmatic fluids required for PCD generation.