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Similarities in basalt and rhyolite lava flow emplacement processes

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Here we use field observations of rhyolite and basalt lava flows to show similarities in flow processes that span compositionally diverse lava flows. The eruption, and subsequent emplacement, of rhyolite lava flows is currently poorly understood due to the infrequency with which rhyolite eruptions occur. In contrast, the emplacement of basaltic lava flows are much better understood due to very frequent eruptions at locations such as Mt Etna and Hawaii.

The 2011-2012 eruption of Cordón Caulle in Chile enabled the first scientific observations of the emplacement of an extensive rhyolite lava flow. The 30 to 100 m thick flow infilled a topographic depression with a negligible slope angle (0 - 7˚). The flow split into two main channels; the southern flow advanced 4 km while the northern flow advanced 3 km before stalling. Once the flow stalled the channels inflated and secondary flows or breakouts formed from the flow front and margins. This cooling rather than volume-limited flow behaviour is common in basaltic lava flows but had never been observed in rhyolite lava flows.

We draw on fieldwork conducted at Cordón Caulle and at Mt Etna to compare the emplacement of rhyolite and basaltic flows. The fieldwork identified emplacement features that are present in both lavas, such as inflation, breakouts from the flow font and margins, and squeeze-ups on the flow surfaces. In the case of Cordón Caulle, upon extrusion of a breakout it inflates due to a combination of continued lava supply and vesicle growth. This growth leads to fracturing and breakup of the breakout surface, and in some cases a large central fracture tens of metres deep forms. In contrast, breakouts from basaltic lava flows have a greater range of morphologies depending on the properties of the material in the flows core. In the case of Mt Etna, a range of breakout morphologies are observed including: toothpaste breakouts, flows topped with bladed lava as well as breakouts of pahoehoe or a'a lava. This range in breakout morphologies is in stark contrast to breakouts observed at Cordón Caulle.

We also compare the cooled crusts that form on the surface of the flows; in basalts this is of order tens of centimetres thick, in rhyolite flows the crust is of order several metres thick (based on field observations and theoretical values). This surface crust may control the flow advance in the latter phases of the flow evolution, causing stalling of the flow front and subsequent breakout formation. The similarities in flow features between compositional end members hints at a more universal model for lava flow emplacement.