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Exploring the petrographic record of distinct magma flow regimes created during dike ascent

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The physical, chemical and thermal properties of magma strongly impact how explosive a volcanic eruption will be and how long it will last. In a volcanic arc setting, a dominant mechanism of magma ascent that leads to eruption is diking. Two new flow regimes have recently been proposed for Newtonian flux-driven fractures that are analogues to dikes (Chalk and Kavanagh, 2024). Particle image velocimetry (PIV) was applied to analogue dike experiments involving an elastic crust analogue (transparent gelatine) injected by a magma analogues (water and silicon oil, which are Newtonian fluids). The fluids were seeded with passive-tracer particles that were fluoresced in a 2-D laser sheet. These experiments show that across five orders of magnitude in Reynolds number (Re) the flow patterns for the Newtonian fluid dikes all comprise a central fluid jet with fluid recirculation around the dike margin. The overall fracture tip propagation velocity is a simple linear function of the volumetric flux Q. Within the viscous-dominated regime ($Re < 0.1$) the jet length decreases with Q, whereas in the inertia-dominated regime ($Re > 30$) the jet length increases. In this presentation we discuss the petrological evidence of magma ascent and identify the conditions for different dike ascent flow regimes to be recorded in the development of a volcanic plumbing system.

Chalk, C. M., and J. L. Kavanagh. "Up, down, and round again: The circulating flow dynamics of flux-driven fractures." *Physics of Fluids* 36.3 (2024).