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Non-Newtonian rheology of back-arc volcano: application to magma ascent at Unzen

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Mt. Unzen (1990-1995), Japan, showed variable eruptive regimes ranging from Vulcanian explosions to lava dome emplacements and pyroclastic flow generations. This variation in eruptive style remains to be understood to mitigate volcanic hazards at Unzen as well as other explosive volcanoes. Here, we characterized the rheological behaviour Mt. Unzen dome samples and applied them to a conduit flow dynamics.We have studied the effects of applied stresses on the viscosity of Unzen's melts by using a high-load (0-200 MPa), high-temperature ($<$1050 °C) uniaxial press. A direct comparison of viscosities at similar temperatures and low stresses and strain rates (in the Newtonian regime) reveals that samples from Unzen have moderately higher viscosities than those with single-phase peraluminous synthetic compositions. The relationship could be rationalised using the Einstein-Roscoe equation. However our results show that Unzen's lavas behave as a pseudo-plastic fluid exhibiting important shear thinning, which is independent of the viscous heating effect. The viscosity of Unzen lavas decreases exponentially by approximately 1.5 log units between the differential stresses of 1 to 60 MPa; point at which viscous heating and micro-cracking begin to be detected. The obtained results are applied to conduit flow dynamics subject to no-slip conditions. We evaluate the observed strain rate effect against the profile of a conduit flow with typical effusion rates measured at Unzen. Results using Unzen's rheological data are comparable to other arc volcanoes (Lavallee et al., this session); it emphasises the localisation of strain near the conduit margin, leading to the self-lubrication of the conduit, and favouring the plug ascent model.