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# Non-Newtonian magma flow in volcanic conduits

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The dynamics of magma ascent along volcanic conduits towards the Earth's surface affects eruptive styles and contributes to determine the volcanic hazard. The rheology of ascending magmatic mixtures is known to play a major role on mass flow rate as well as on pressure and exit velocity at the vent, even determining effusive vs explosive eruptive behaviour. In this work we explore the effects of non-Newtonian rheology on the dynamics of magma flow in volcanic conduits. We develop a quasi-2D model of magma ascent that incorporates a rheological constitutive equation describing the strain-dependent effect of gas bubbles on the viscosity of the multiphase magma. Non-Newtonian magma flow is investigated through a parametric study where the viscosity of the melt and the water content are varied over natural ranges. Results show that non-Newtonian rheology determines higher ascent velocities and larger mass flow rates. The pressure distribution along the conduit remains very similar to the Newtonian case, deviating only at conduit exit. Plug-like velocity profiles develop approaching the conduit exit, when mixture velocity is high, and are favored by smaller liquid viscosity. Neglecting the non-Newtonian behavior of bubble-bearing magmas may thus result in misinterpretation of the dynamics of volcanic eruptions.