

Public Abstract

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Title: Flow and heat transfer properties of Mono Craters rhyolites: effects of temperature, water content, and crystallinity

The nature of volcanic processes, including rate of magma ascent, exsolution of volatiles, eruption style, and flow distance, is highly dependent on the viscosity of the associated magma and its ability to transfer heat. We quantify the effects of temperature, dissolved water content, and crystallinity on the viscosity and thermal diffusivity of rhyolitic glass. We use the parallel plate and concentric cylinder methods to obtain viscosity data between its liquid state (like melted cheese) and its squishy solid state (like solid cheese). We use the laser flash (LFA) method to measure the thermal diffusivity of samples between solid and squishy solid state temperatures. The investigated obsidian samples, collected from three different flow lobes, contain between 0.1 and 1.1 wt.% H₂O, and less than 2 vol.% crystals. We also remelted one sample from each lobe in a furnace at 1500 deg C to produce nearly anhydrous, crystal free glass. We fit our viscosity data to four literature models relevant to rhyolitic melts, two developed specifically for rhyolites and two global models developed for all types of magma. We add to this by presenting our own models for rhyolites based on the empirical TVF equation and the theory-based Adam-Gibbs equation, finding that the Adam-Gibbs model works slightly better in fitting the data. We also present a model relating thermal diffusivity of the samples to their crystal contents and temperatures below the squishy solid state. Water has a negligible effect on thermal diffusivity at the low concentrations in the samples studied. Our data and modeling increase our understanding of volcanic processes, particularly how magma and heat move within the volcano as well as the type of eruption we can expect. Data on rhyolitic melts can be applied to continental volcanoes such as Mt. St. Helens as well as calderas such as Long Valley and Yellowstone, which have produced some of the largest eruptions on Earth.