FLOW AND HEAT TRANSFER PROPERTIES OF MONO CRATERS RHYOLITES: EFFECTS OF TEMPERATURE, WATER CONTENT, AND CRYSTALLINITY

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ABSTRACT

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 present measurements of the viscosity and thermal diffusivity of Quaternary rhyolitic lava flows from Mono Craters, California. We quantify the effects of temperature, dissolved water content, and crystallinity on viscosity and thermal diffusivity. We use the parallel plate and concentric cylinder methods to obtain viscosity measurements between 5 x 10^3 to 8 x 10^12 Pas, from superliquidus conditions to the glass transition; the laser flash (LFA) method to measure thermal diffusivity of samples between room and subliquidus 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 muffle furnace 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. We add to this by presenting our own models based on the empirical TVF equation and the theory-based Adam-Gibbs equation, finding that the Adam-Gibbs model fits our data slightly better. We also present a model relating the thermal diffusivity of the samples to their crystal contents and temperatures below the glass transition. Water has a negligible effect on thermal diffusivity at the low concentrations in the samples studied.