The rheological behaviour of porous magmas: Bubbles vs. Vesicles

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The presence of pores strongly controls the rheological behavior of magma and thus influences all volcanic processes (pre- syn- and post-eruptive). Nevertheless, the effects of porosity on magma rheology are still unresolved and subject to debate.

Here we present a new set of experiments designed to investigate the rheology of pore-bearing melts at high temperature (750-800 °C), low strain rates (10^{-6}-10^{-7} s^{-1}) and variable porosity (10-70% vol.). Experiments were performed at 1 atm using a Thermomechanical Analyzer (TMA) on 5 x 5 mm cores of natural rhyolitic obsidian from Krafla, Iceland (vesicle and crystal-free) initially containing 0.11 wt% dissolved H_2O.

Our experiments comprise two steps. First, cores are heated above the glass transition temperature interval (900 - 1050° C) and held for set times (10-24 h) to create bubble-bearing cores. Second, the cores are deformed at lower temperatures (750 or 800°C) under a constant load (150 g) for 5-20 hours. We have employed two different strategies for the second step: i) samples were deformed in situ directly after foaming (single-stage, SS); or ii) samples were deformed at temperature after 15 days repose at room T (double-stage, DS). Our experiments provide data on the effects of porosity on the viscosity of natural rhyolitic deposits (e.g., ignimbrite, lava). Discordant results from single-stage vs. double stage experiments suggest that the rheology of porous volcanic materials depends on whether pores are vapor-filled (e.g., lavas) or are empty and connected by cracks (e.g., pyroclastic deposits).