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Synchrotron FTIR analysis of water concentration variations in skeletal sanidine crystals hosted by spherulites in the Hell's Gate rhyolitic lava flow, southern Arizona, USA

S. Seaman (1), E. Helfrich (1), M.D. Dyar (2), R. Smith (3)

(1) University of Massachsuetts Amherst, Massachusetts, USA, (2) Mt. Holyoke College, Massachusetts, USA, (3) National Synchrotron Light Source, New York, USA

Spherulites in rhyolitic lava flows typically consist of radiating skeletal crystals of feldspar +/- quartz that nucleated on a crystal or a vapor bubble. Variations in water concentration in and around spherulites provide information about the behavior of incompatible compounds at the melt/crystal interface. Spherulites from the Hell's Gate lava flow ($\sim$ 24 Ma) of the Atascosa Mountains of southern Arizona consist of two or more generations of skeletal radiating crystals, with each successive generation nucleating on the end of crystals of the previous generation. Spherulites generally nucleated on phenocrysts, or have at their center a fine-grained quartz/feldspar mixture. Imaging of water concentration analyzed by Fourier transform infrared spectrometry using synchrotron-generated radiation indicates that water concentration in skeletal sanidine in spherulites either oscillates or increases along the length of each generation of sanidine needles. Each successive generation of skeletal crystals in a single spherulite has a higher range of water concentration than the previous generation. Overall, water concentration increases from approximately 600 ppm in the cores of spherlites to approximately 7000 ppm in the rims of spherulites. Coexisting quartz phenocrysts are deeply embayed, possibly reflecting resorption due to increased concentration of water in the melt when sanidine crystallization in spherulites caused partitioning of water into the surrounding melt. Abundant melt inclusions in quartz phenocrysts record varying concentrations of water. However, the morphology of some melt inclusions indicates that they formed as deep embayments rather than as syn-crystallization inclusions. This suggests that melt inclusions even deep in quartz crystals may have formed relatively

late in the magmatic stage of the history of the lava flow. Fourier transform infrared analysis, with microscopy and mapping of water concentration, provides a local monitor of evolving water concentration during the quenching and crystallization sequence of the lava flow.