Multi-component diffusion between felsic and more silicic melts from tektites and experiments

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Multi-component diffusion in silicate melts or across melt-solid boundaries is the rate-limiting process in many natural situations, including magma mixing, crustal melting, assimilation, and impact metamorphism and melting[1]. Past studies of these processes mostly focused on melts with less SiO_2 than typical rhyolites (i.e. ≤75 wt.% SiO_2). This study examines compositions between rhyolite and pure SiO_2. In particular, we investigate chemical diffusion between pure silica inclusions (lechatelierite) and surrounding felsic glass in natural tektites and experimental analogues.

Concentration profiles across lechatelierite-host glass contacts in a natural tektite indicate diffusion between the two melts at high temperatures prior to quenching. Measured profiles of all oxide components are asymmetric in shape (indicating composition-dependent diffusion), and parts of these profiles indicate uphill diffusion of K_2O. We used the MELTS liquid activity-composition model[2] to convert composition to chemical potential, revealing that apparent uphill diffusion is primarily driven by non-ideal mixing in the melt. However, these models are hindered by uncertainty in the thermal history of the sample. We undertook a series of melting experiments using an aerodynamic levitation laser furnace with a starting mixture of powdered natural tektite + 60-100 μm quartz grains at 1800-2200°C from 1-120s. Comparison of the textures of these experimental products suggest minimum times and temperatures for the formation of lechatelierite of ~ 50 s at 2000 °C. Continued analysis of these experimental products will examine compositional gradients across silica-rhyolite contacts.

[1] Liang (2010), *Rev. Mineral. Geochem.* **72**, 409-446 [2] Ghiorso & Sack (1995) *Contrib. Mineral. Petrol.* **119**, 197-212