Non-equilibrium degassing and vapor fluxing recorded in obsidian pyroclasts

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The concentrations of CO_2 and H_2O in obsidian pyroclasts are used in reconstructions of volcanic degassing processes [1-3]. The degassing models that can reproduce the elevated CO_2/H_2O ratios in volcanic glass from Mono Craters, California, include degassing of a CO_2-rich parent melt [1], fluxing of a CO_2-rich vapor through shallow, previously degassed magma [2], and slow diffusion of CO_2 [3]. This study is motivated, in part, by the desire to find a geochemical measurement that can distinguish between these models.

We present area maps of CO_2 and H_2O profiles from eight pyroclastic obsidian clasts from Mono Craters using Fourier Transform Infrared Spectroscopy (FTIR). We document relatively large intraclast heterogeneities in dissolved H_2O and CO_2 at the sub-millimeter scale. The lifetime of these heterogeneities inferred from diffusion modeling is approximately tens of minutes to hours, and hence their preservation requires a mechanism for frequent re-introduction of dissolved volatiles into the melt at the sub-millimeter scale. We conclude that obsidian fragments are assembled from non-equilibrated melt parcels, rewelded ash and vapor pockets during shearing accompanied by repeated fracturing and healing. This process can self-consistently explain the observed heterogeneities, the existence of flow bands, the presence of both cuspate and sheared vesicles, hydrogen isotopic characteristics, and previously inferred cycles of bubble growth and resorption during magma ascent. Some of the clasts have bands or patches of elevated CO_2 associated with clusters of cuspate vesicles, which are interpreted to represent healed fractures or collapsed foams that were filled with a CO_2-rich vapor.

[1] Newman et al. (1988) *Journal of Volcanology and Geothermal Research,* **35**, 75-96. [2] Rust et al. (2004) *Geology* **32**, 349-352. [3] Gonnermann and Manga (2005) *Earth and Planetary Science Letters*, **238**, 1-16.