

## **Strain-testing diffusion modeling in the lab: zeroing in on the reactive crystal-melt interface**

THOMAS SHEA, HOPE A. ISHII, JOHN P. BRADLEY <sup>12</sup>

<sup>1</sup> Department of Geology & Geophysics, SOEST, University of Hawai'i at Mānoa, Honolulu, HI 96822  
(tshea@hawaii.edu)

<sup>2</sup> Hawai'i Institute of Geophysics and Planetology, SOEST, University of Hawai'i at Mānoa, Honolulu, HI 96822

The use of geospeedometers to extract timescale information from concentration gradients in minerals has soared over the past two decades. The technique holds remarkable potential: mineral-forming elements diffuse at different rates, therefore, multiple elements and multiple minerals within a single hand-specimen can be analyzed to reconstruct both the petrological history and the duration of key perturbations to a magmatic system (crystallization, magma mixing, assimilation, ascent...). Combined with in-situ isotopic dating of these minerals, age and duration can be integrated to establish powerful models of magma transport and storage through the crust.

So far, diffusion coefficients for any given element have all been obtained in laboratory settings using ideal solid-solid (or solid-thin film) couples. In the case of natural magmas, however, petrologists have to worry about the reactive interface; during magma mixing, for instance, crystals may react with the surrounding melt by either dissolving or growing, producing a non-ideal, defect-rich interface. To examine the influence of a reactive interface on timescales retrieved from diffusion modeling, 1-atm melt-bearing olivine re-equilibration experiments were performed using a natural basalt from Kilauea. Experimental charges contained olivine seeds that partially resorbed during a 24h superliquidus treatment, and subsequently grew rims during cooling. The charges were then left to re-equilibrate for different periods. Concentration gradients measured yield diffusivities for Fe-Mg, Ca, Ni, Cr that are overall much faster (2-30x) than those predicted by expressions based on solid-solid experiments. These differences are interpreted to reflect enhanced defect formation during the initial stages of crystal melt reaction. Transmission Electron Microscopy (TEM) work is underway to resolve the abundance of defects in olivine showing only dissolution and dissolution + growth. By examining the interface of experimental and natural olivine at the nanoscale we can evaluate whether fast-path, enhanced diffusion poses a dilemma for geospeedometric applications. In other words, is the experimental reactive interface comparable to the interface of natural zoned crystals?