H diffusion in olivine and pyroxene from peridotite xenoliths and a Hawaiian magma speedometer

A. H. PESLIER[1] AND M. BIZIMIS[2]

[1]Jacobs, NASA Johnson Space Center, MC JE23, 2101 NASA Pkwy, Houston, TX 77058, USA
anne.h.peslier@nasa.gov
[2]Earth and Ocean Sciences, U. of South Carolina, Columbia, SC 29208, USA
mbizimis@geol.sc.edu

Hydrogen is present as a trace element in olivine and pyroxene and its content distribution in the mantle results from melting and metasomatic processes. Here we examine how these H contents can be disturbed during decompression. Hydrogen was analyzed by FTIR in olivine and pyroxene of spinel peridotite xenoliths from Salt Lake Crater (SLC) nephelinites which are part of the rejuvenated volcanism at Oahu (Hawaii) [1,2].

H mobility in pyroxene resulting from spinel exsolution during mantle upwelling

Most pyroxenes in SLC peridotites exhibit exsolutions, characterized by spinel inclusions. Pyroxene edges where no exsolution are present have less H then their core near the spinel. Given that H does not enter spinel [3], subsolidus requilibration may have concentrated H in the pyroxene adjacent to the spinel exsolution during mantle upwelling.

H diffusion in olivine during xenolith transport by its host magma and host magma ascent rates

Olivines have lower water contents at the edge and near fractures compared to at their core, while the concentrations of all other chemical elements appear homogeneous. This suggests that some of the initial water has diffused out of the olivine. Water loss from the olivine is thought to occur during host-magma ascent and xenolith transport to the surface [4-6]. Diffusion modeling matches best the data when the initial water content used is that measured at the core of the olivines, implying that mantle water contents are preserved at the core of the olivines. The 3225 cm^{-1} OH band at times varies independantly of other OH bands, suggesting uneven H distribution in olivine defects likely acquired during mantle metasomatism just prior to eruption and unequilibrated. Diffusion times (1-48 hrs) combined with depths of peridotite equilibration or of magma start of degassing allow to calculate ascent rates for the host nephelinite of 0.1 to 27 m/s.

[1] Bizimis *et al* (2003) *EPSL* **217**, 43-58. [2] Bizimis *et al* (2007) *EPSL* **257**, 259-273. [3] Bromiley *et al* (2010) *GCA* **74**, 705-718. [4] Demouchy *et al* (2006) *Geology* **34**, 429-432. [5] Peslier & Luhr (2006) *EPSL* **242**, 302-319. [6] Peslier *et al* (2008) *GCA* **72**, 2711-2722.