

Ni diffusion in small angle grain boundaries of forsterite

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Defects such as grain boundaries and interfaces are potent pathways for the transport of elements in rocks [1]; therefore they strongly affect large-scale physical properties of rocks, e.g. viscosity, electrical conductivity and bulk diffusivity. Yet data for geo-relevant materials are rare. The dependence of diffusion on the grain boundary structure e.g. defined by the lattice misfit, in silicates is unknown [p.954, 2]. Limited experimental studies in material sciences indicate major effects of grain boundary orientation on diffusion. Lately, synthetic georelevant bicrystals became available. Thus only now, first diffusion data on single grain boundaries have been produced [e.g. 3].

The effect of grain boundary orientation on diffusion in forsterite tilt grain boundaries (misorientations of 17° and 11°) was characterized by transmission electron microscopy (TEM). The site specific TEM-foils were cut using the focused ion beam technique (FIB). To study diffusion we prepared amorphous thin-films of Ni₂SiO₄ composition perpendicular to the grain boundary using pulsed laser deposition. Annealing (800-1000°C) leads to crystallization of the thin-film and Ni-Mg inter-diffuse into the crystal volume and along the grain boundary. The interdiffusion profiles were measured using the TEMs energy dispersive x-ray spectrometer standardized using the Cliff-Lorimer equa. and EMPA measurements.

We obtain volume diffusion coefficients that are consistent with earlier studies of Ni-Mg interdiffusion in forsterite at comparable temperatures. Contrasting to [4] our volume diffusion data are about an order of magnitude slower, while having similar activation energies. Grain boundary diffusion perpendicular to the dislocation lines of the small angle grain boundaries proved to be max. an order of magnitude faster than volume diffusion. The difference decreases markedly at temperatures above 1000°C.

[1] Hartmann, Wirth & Markl (2008) *Contributions to Mineralogy and Petrology* 156, 359-375. [2] Dohmen & Milke (2010), *Reviews in Mineralogy and Geochemistry* 72, 921-970. [3] Marquardt, Petrishcheva *et al.* (2011), *Contributions to Mineralogy and Petrology*. 162, 739-749. [4] Ito, Yurimoto, *et al.* (1999). *Physics and Chemistry of Minerals* 26, 425-431.

Magma Signatures in the Terceira Rift Azores: a melt inclusion study

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The Terceira Rift (TR) is a 550km long ESE trending line of volcanic reliefs (Graciosa Island, Terceira Island, D. João de Castro Bank, S. Miguel Island) alternating with deep basins (e.g. E of Terceira, Hirondelle) that define the plate boundary between the European and African plates on the Azores plateau [1]. Seismic tomography suggests that the Azores plume is centered NE of Terceira supplying upwelling plume material SW of Terceira (e.g. Faial) [2].

Melt inclusions (MI) are small portions of melt trapped during crystal growth. Their study allows the characterization of the composition of primary melts, mantle heterogeneity, magma sources and timescales. This study presents the first geochemical dataset of olivine-hosted unexposed MI sampled from submarine and subaerial lavas along the TR. Plots of incompatible trace element ratios (Fig.1) confirm the presence of distinct mantle signatures showing a mixing trend between two end-members that represent extreme topographic domains: Terceira and Hirondelle Basin. These findings will be discussed considering recent geophysical and geochemical data obtained in the area.

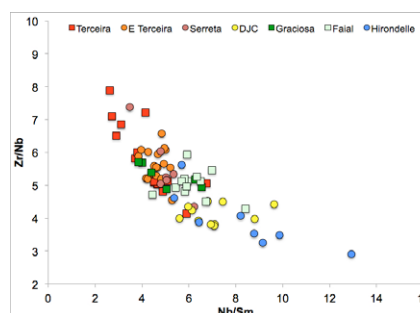


Fig. 1 Incompatible trace element plots of olivine-hosted MI from the TR. (square symbols: aereal lavas; circles: submarine lavas)

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