EXPERIMENTAL DETERMINATION OF Fe-Mg INTERDIFFUSION RATES IN CLINOPYROXENE AND IMPLICATIONS FOR GEOTHERMOMETRY INVOLVING FERROMAGNESIAN MINERALS

Müller, T., Dohmen, R. & Chakraborty, S.

Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, D-44801 Bochum
e-mail: thomas.mueller-1@rub.de

Clinopyroxene (cpx) is a common constituent of many igneous, metamorphic and mantle derived rocks. Spatial variation in the chemical composition of cpx can be interpreted as a record of the magmatic or metamorphic evolution and the partitioning of Fe and Mg between cpx and other ferromagnesian minerals is typically used as a geothermometer. Zoning in such minerals is often the result of diffusive exchange leading to partial disequilibrium profiles. Such profiles can be used to constrain thermal histories if the kinetic parameters are known.

We present experimental data for the chemical interdiffusion of Fe-Mg in natural diopside crystals at ambient pressure, at temperatures ranging from 800 1200 °C and oxygen fugacities of 10^{-11} to 10^{-17} bar. Diffusion couples were prepared by ablating an olivine (Fo_{30}) target to deposit a thin film (20 – 100 nm) onto a polished surface of a natural diopside crystal using the pulsed laser deposition (PLD) technique. After diffusion anneals, compositional depth profiles at the near surface region (~ 400 nm) were measured using Rutherford Back-scattering Spectroscopy (RBS).

Experimental results reveal that the data can be described by a single Arrhenius relation without strong dependence of $D^{Fe\text{-}Mg}$ on composition of cpx or oxygen fugacity. $D_{\alpha}^{Fe\text{-}Mg}$ in a ferromagnesian mineral, α, is arranged in the order spinel > olivine > grt ≈ opx > cpx. Diffusion in cpx may thus be the rate limiting process for the freezing of many geothermometers and compositional zoning in clinopyroxene may preserve records of a higher temperature segment of the thermal history of a rock than that recorded in other coexisting mafic minerals. Modelling results suggest that in the absence of pervasive recrystallization, cpx grains will retain compositions from peak temperatures at their cores in most geological settings where peak temperatures did not exceed ~ 1100 °C, but resetting may be expected in slowly cooled mantle rocks, plutonic mafic rocks, or some UHT metamorphic rocks.