European Mineralogical Conference
Vol. 1, EMC2012-452-4, 2012
European Mineralogical Conference 2012

The influence of garnet Fe^{3+} content on Fe-Mg geothermobarometry

C.E. Höfer (1,2), G.M. Yaxley (2), G.P. Brey (1), and H.E. Höfer (1)

(1) Institut für Geowissenschaften, Johann Wolfgang Goethe-Universität, Altenhöferallee 1, D-60438 Frankfurt am Main, Germany, (2) Research School of Earth Sciences, Australian National University, Canberra ACT 0200, Australia

It has long been well established that the peridotitic phases garnet, clino- and orthopyroxene contain minor Fe^{3+} in addition to Fe^{2+} under upper mantle redox conditions (Canil and O'Neill, 1996). Fe-Mg geothermometry commonly applied to determination of pressure-temperature conditions of equilibration of upper mantle peridotite xenoliths does not consider the influence of this Fe^{3+} content in garnet or coexisting pyroxenes. Temperatures estimated with the well-known grt-ol- and grt-opx-thermometers (O'Neill and Wood, 1979 resp. Harley, 1984) will be significantly underestimated (possibly by more than 200°C) if the Fe^{3+} in the natural garnets is higher than in the experiments. This is very critical for cpx-free harzburgites and dunites since the control e.g. by the two-pyroxene thermometer is missing. In combination with the Al-in-opx barometer such samples are misplaced to more shallower depths (more than 40 km) with increasing oxidation state. Most of the previous experiments have been carried out in graphite lined Pt-capsules which were thought to ensure that all Fe is present in the divalent state. In order to quantify the possible effects of Fe^{3+}, high pressure and temperature experiments in piston-cylinder apparatus have been conducted. A double-capsule technique has been used to buffer oxygen fugacity (fO_2) at 3 different conditions, corresponding to the Iron-Wüstite (low fO_2), CCO (medium fO_2), MnO/Mn_3O_4 (high fO_2) buffers.
The sample materials were powders synthetised from high purity oxides, carbonates and hydroxides. $Mg(OH)_2$ was included in the mixes to provide about 5 wt% H_2O as a flux to aid in equilibration. Compositions reflect combination in various proportions of olivine, garnet and orthopyroxene from a garnet peridotite xenolith from Udachnaya kimberlite, Siberia (Uv45/03; Yaxley et al., 2012). Experiments were conducted at 3.5 and 6.0 GPa from 1100 to 1400°C. They crystallised garnet, orthopyroxene, olivine and some with clinopyroxene and spinel. Major element compositions were determined using a JEOL 6400 SEM fitted with a Link EDS Detector.
Fe^{3+} in the experimental garnets will be determined on a JEOL Superprobe JXA-8900 at the University of Frankfurt using the Flank Method (Höfer and Brey, 2007). These results enable us to assess the influence of garnet Fe^{3+} content on existing conventional geothermobarometers.

Canil & O'Neill (1996) Journal of Petrology 37, 609-635
Höfer & Brey (2007) Am. Mineral. 92, 873-885
O'Neill & Wood (1979) Contrib. Mineral. Petrol. 70, 59 70
Yaxley et al. (2012) Lithos 140–141, 142–151