Geophysical Research Abstracts
Vol. 15, EGU2013-10291, 2013
EGU General Assembly 2013
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Crystal-chemistry of amphiboles: implications for oxygen fugacity and water activity in lithospheric mantle beneath Victoria Land, Antarctica.

Costanza Bonadiman (1), Sabrina Nazzareni (2), Massimo Coltorti (1), Paola Comodi (2), Gabriele Giuli (3), and Barbara Faccini (1)

(1) Department of Physics and Earth Sciences, University of Ferrara, Italy (bdc@unife.it), (2) Department of Earth Sciences, University of Perugia, Italy, (3) Department of Earth Sciences, University of Camerino, Italy

Amphibole is the hydrous metasomatic phase in spinel-bearing peridotites from Baker Rocks (Northern Victoria Land, Antartica). It occurs both as disseminated or veins in the spinel lherzolites. Both types derive from a continuous reaction between metasomatic melts and the pristine paragenesis of the continental lithospheric mantle beneath the Northern Victoria Land. In order to determine the effective role of water circulation during the metasomatic process and amphibole formation, six amphiboles were fully characterised. The accurate determination of the site population and dehydrogenation of these amphiboles was carried out through Single-Crystal X-ray diffraction, electron micropoble analyses (EMPA) and secondary ion mass spectroscopy (SIMS) on the same single crystal. The Fe3+/(Fe3+ + Fe2+)ratio was determined by X-ray Absorption Near Edge Spectrocopy (XANES) on amphibole powder. The measured (from SIMS) degree of dehydrogenation (O(3)O_2-) is in the range 0.79-1.07 and in agreement with the calculated (from the M(1)-M(3) distance) values. The dehydrogenation is primary and ascribed to the Ti-oxy component of the amphibole, as suggested by the site populations; the post-crystallisation H loss is negligible. The aH2O of the Baker Rocks mantle lithosphere was calculated from the dehydration equilibrium among end-member components assuming that amphiboles are in equilibrium with the anhydrous peridotitic phases. The aH2O ranges from 0.0126 to 0.0545; a difference up to 60The oxygen fugacity of the Baker Rocks mantle xenoliths calculated on the anhydrous equilibria olivine-clinopyroxene-orthopyroxene-spinel is between -1.98 and -0.30 log units, below the fayalite-magnetite-quartz (FMQ) buffer. These results compare well with those obtained from the dissociation constant of water, which reflects the oxygen fugacity of the amphibole formation (Dlog fO_2 between -2.5 and -0.6 log units). The metasomatic process is able to stabilize amphibole in an environment of low water activity and low redox conditions. Amphibole acts as the main H acceptor among the peridotite minerals and it may prevent fluid circulation and contribute to buffer the oxygen fugacity.The important issue of this study is that amphibole within the lithospheric mantle not always means high water activity and oxidizing conditions.