American Mineralogist, Volume 87, pages 1432–1436, 2002

Hydrogen, lithium, and boron in mantle-derived olivine: The role of coupled substitutions

ADAM J.R. KENT* AND GEORGE R. ROSSMAN

Division of Geological and Planetary Sciences, Mail Code 170-25, California Institute of Technology, Pasadena, California 91125, U.S.A.

ABSTRACT

We report major element, boron, lithium, and water (present as structurally bound hydroxyl) contents for a suite of ten mantle-derived olivine crystals, measured by electron microprobe, secondary ion mass spectrometry, and Fourier-transform infrared spectroscopy. Water measurements are based on re-analysis and/or re-processing of data previously reported in the literature.

Analyzed olivines have lithium, boron, and water concentrations of 0.9–7.8 and 0.01–67, and 0.8–61 ppm (by weight), respectively. One olivine from Kingiti, Tanzania (possibly derived from metasomatized peridotite) is anomalous, with boron and lithium contents of 67 and 7.8 ppm, respectively. The remaining olivine samples have lithium and boron contents below 3 and 1 ppm, respectively. Although lithium, boron, and water contents vary substantially, their cation proportions are not strongly correlated, arguing against simple coupled substitutions involving these elements. Importantly, the incorporation of boron and water in olivine by the $B(F,OH)Si_{-1}O_{-1}$ substitution does not appear to be a universal feature of mantle olivine, although it may be significant in those with the highest boron contents.

Our data also support suggestions that olivine may be an important reservoir for hydrogen, lithium, and boron in the lithospheric and upper asthenospheric mantle, and may thus play a key role in the geochemical cycling of these elements within the mantle, and between the mantle and crust.