Calibration of the Absolute OH Content of Olivine.

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Abstract

Paterson (1982) developed a method to determine the absolute OH concentration in minerals from the intensity of OH absorptions in the IR spectrum that has been widely applied to geophysically important earth materials in nature and in laboratory experiments. Subsequent studies have shown the desirability of mineral-specific calibrations of the IR spectrum. Here we report a new calibration of the IR spectrum of OH in olivine that implies greater absolute concentrations. Polarized infrared spectra, covering all three optic orientations were collected on three gem-quality olivines of high-pressure natural origin. Absolute H concentrations were determined by ^{15}N nuclear reaction analysis at the Institut für Kernphysik, U. Frankfurt on the same samples, or pieces of the same sample demonstrated by FTIR to be homogeneous. The experimental setup involves a custom constructed shielded high vacuum sample chamber and a pre-analysis surface sputtering technique that yield background levels for H (blanks) equivalent to 2 ± 2 ppm H_2O by weight. H contents of the three samples were measured as 16 ± 5, 140 ± 20 and 220 ± 20 ppmw H_2O, with uncertainty derived from counting statistics and the variable concentrations measured in depth profiles. A linear correlation between integrated IR intensity and absolute H content was obtained, giving the calibration H_2O (ppmw) = 0.188 ± 0.012 times the total integrated absorbance of the OH bands between 3650 and 3100 cm^{-1}, per cm sample thickness. The molar absorptivity I = 29500 ± 1900 is similar to polarization-corrected values for garnet, but lower than values for pyroxenes (Bell et al 1995). This calibration yields OH concentrations higher by a factor of 2.3 than the method of Paterson (1982) applied to our polarized spectra. Greater deviations result if unpolarized spectra are used. Using the new calibration, the most hydrous mantle olivine measured to date contains 240 ppm H_2O, while the experimentally determined solubility of OH in olivine at its high pressure limit (Kohlstedt et al., 1996) is approximately 0.62 wt.%.

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