

# Incorporation of OH in olivine at high pressure: new experimental results

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**Authors** [Mosenfelder, J L\\*](#), [Deligne, N I](#), [Asimow, P D](#), [Rossman, G R](#),  
Department of Geological and Planetary Sciences, California Institute of Technology,  
M/C 170-25, Pasadena, CA 91125 United States

## Abstract

Numerous studies of natural and experimentally hydrated samples show that olivine can incorporate substantial amounts of hydrogen at high pressures, which has important implications for the rheology, melting behavior and transport properties of the mantle. We have conducted new experiments to further investigate the incorporation of hydroxide in olivine at high pressures (2-10 GPa) and temperatures (1100-1300°C) and varying oxygen fugacity and silica activity. In contrast to previous experiments, we calculate the concentration of OH in olivine by integrating the total absorbance from three FTIR spectra polarized in orthogonal directions and applying the new calibration of Bell et al. (in press). This procedure is inherently more accurate than the use of nominally unpolarized spectra and the generic calibration of Paterson (1982). We have used both fine-grained natural Fo90 olivine powders and oriented single crystals (500 x 600 x 700 μm) as starting materials. Water in the experiments is provided by dehydration of talc and/or brucite, the ratio of which is chosen in order to establish equilibrium with either orthopyroxene or (Mg,Fe)O. In some experiments, Ni-NiO or Re-ReO is also added to the charge in order to influence the oxygen fugacity of the experiment. In experiments using fine-grained powders at 1150-1300°C, significant grain growth takes place, resulting in grain diameters up to ~300 μm; suitably oriented grains for polarized spectroscopy are then identified using a variety of techniques. Our preliminary results include the following: 1) The spectra in all samples are dominated by sharp peaks in the range of ~3650-3400 cm<sup>-1</sup>, regardless of estimated silica activity. This is consistent with most previous experimental studies and, broadly speaking, with the spectra of most natural olivines. 2) The shapes of the spectra in all our samples are similar regardless of whether grain growth occurred under hydrous conditions or diffusion of H into existing large crystals took place. This strongly suggests that the mechanism of incorporation is identical in both cases. However, in experiments at 1100°C, large single crystals exhibit strongly zoned concentration profiles, consistent with the most recent diffusion data for OH in olivine (Kohlstedt and Mackwell, 1998). This complicates interpretation of these experiments and casts uncertainty on interpretation of previous experiments that used the same technique. 3) Comparison of experiments using Ni-NiO or Re-ReO as buffers shows little effect of oxygen fugacity (in this range, ~2 log units in fO<sub>2</sub>) on either concentration or incorporation

mechanism. 4) Concentrations measured in the samples that used fine-grained starting materials are 2.5-3 times higher than the previous estimates for OH solubility measured by Kohlstedt et al. (1996). This difference is primarily attributed to use of the new calibration and measurement of polarized spectra. We are conducting further experiments to understand more quantitatively the roles of silica activity, oxygen fugacity, and starting point defect structure on incorporation of OH in olivine.

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