Geophysical Research Abstracts, Vol. 7, 01563, 2005
SRef-ID: 1607-7962/gra/EGU05-A-01563

New insights on the water storage in the uppermost mantle: Evidence of dehydration in peridotites

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From experimental studies, it is known that a significant part of the water capacity of our planet might be hydrogen dissolved as point defects in the minerals of the Earth's mantle. These hydroxyl groups embedded in the mineral structures are easily detectable using Fourier–transform infrared spectrometry at trace element levels (few ppm by weight). We report water contents in upper mantle minerals from peridotites embedded in alkali basalt from Pali-Aike (southernmost South America). The water content obtained using FTIR analyses demonstrates that olivine, diopside and orthopyroxene contain a significant amount of water. The water concentration in the individual minerals and the ratios of the water concentrations for olivine to pyroxene, determined from our observations, decrease with decreasing depth from garnet-bearing to spinel-bearing peridotites. These ratios are about one order of magnitude smaller than experimental partition coefficients at equilibrium for similar temperature and pressure, reflecting partial loss of water from the minerals during ascent.

In addition, profiles using polarized infrared radiation across crystallographically oriented single-crystals of olivine reveal hydroxyl-depleted rims. These observations indicate that partial to complete dehydration occurs during the ascent of the xenolith-bearing magma to the Earth's surface. Using experimentally obtained diffusion coefficients for hydrogen, we estimate that the duration of the dehydration for the garnet-bearing xenoliths is a few (2-5) hours. Despite this rapid ascent rate for the host alkali

basalts, the water content of the minerals has been altered during ascent. Thus, the water content of the upper mantle based on measurements within mantle-derived peridotites is likely to underestimate the true water content of the uppermost mantle.