Water in the oceanic lithosphere: Salt Lake Crater xenoliths, Oahu, Hawaii

Anne H. Michael Bizimis

Jacobs Technology, ESCG, Houston, TX 77058, USA
Astromaterials Research and Exploration Science, NASA Johnson Space Center, Houston, TX 77058, USA
Earth and Ocean Sciences, University of South Carolina, Columbia, SC 29208, USA
Anne.h.peslier@nasa.gov
mbizimis@geol.sc.edu

Water can be present in nominally anhydrous minerals of peridotites in the form of hydrogen bonded to structural oxygen. Such water in the oceanic upper mantle could have a significant effect on its physical and chemical properties. However, the water content of the MORB source has been inferred indirectly from the compositions of basalts. Direct determinations on abyssal peridotites are scarce because they have been heavily hydrothermally altered. Here we present the first water analyses of minerals from spinel peridotite xenoliths of Salt Lake Crater, Oahu, Hawaii, which are exceptionally fresh. These peridotites are thought to represent fragments of the Pacific oceanic lithosphere that was refertilized by alkalic Hawaiian melts. A few have unradiogenic Os and radiogenic Hf isotopes and may be fragments of an ancient (~2 Ga) depleted and recycled lithosphere. Water contents in olivine (Ol), orthopyroxene (Opx), and clinopyroxene (Cpx) were determined by FTIR spectrometry. Preliminary H_{2}O contents show ranges of 8-10 ppm for Ol, 151-277 ppm for Opx, and 337-603 ppm for Cpx. Reconstructed bulk rock H_{2}O contents range from 88-131 ppm overlapping estimates for the MORB source. Water contents between Ol minerals of the same xenolith are heterogeneous and individual OH infrared bands vary within a mineral with lower 3230 cm^{-1} and higher 3650-3400 cm^{-1} band heights from core to edge. This observation suggests disturbance of the hydrogen in Ol likely occurring during xenolith entrainment to the surface. Pyroxene water contents are higher than most water contents in pyroxenes from continental peridotite xenoliths and higher than those of abyssal peridotites. Cpx water contents decrease with increasing degree of depletion (e.g. increasing Fo in Ol and Cr# in spinel) consistent with an incompatible behavior of water. However Cpx water contents also show a positive correlation with LREE/HREE ratios and LREE concentrations consistent with refertilization. Opx water contents increase with increasing degree of depletion and decrease with LREE/HREE ratios which is inconsistent with the incompatible behavior of H. Calculated water contents of melts in equilibrium with Cpx or Opx range from 1.4 to 3.8 wt % which is higher than that of all Hawaiian lavas. Calculated melts in equilibrium with Cpx and Opx have variable but mostly high H_{2}O/Ce ratios (194 to 1146) consistent with those of rejuvenated stage lavas from Niihau and the South Arch volcanic field, but unlike the drier shield building stage tholeiites. Whether the high water contents recorded in Salt Lake Crater xenoliths were acquired before and/or during interaction of the oceanic lithosphere with the Hawaiian plume will be discussed.