MITT.ÖSTERR.MINER.GES. 151 (2005)

HYDROUS COMPONENTS IN NOMINALLY ANHYDROUS MINERALS

Rossman, G. R.[1]

[1]Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, 91125-2500, U.S.A.
email: grr@gps.caltech.edu

Hydrous components in the nominally anhydrous minerals occur in a large number of phases and influence many chemical and physical properties of the host mineral. They are recognized as an important contribution to the Earth's water cycle. While the detection and determination of concentration is most conveniently achieved by infrared spectroscopy, it requires independent calibration for accurate analyses. IR spectra can determine the individual species in which the hydrogen is associated and can identify fluid inclusions and alteration products. A variety of analytical methods has been used to determine absolute concentrations of the hydrous components, but hydrogen manometry and nuclear profile analysis with N-15 ions have proven to be the most useful absolute analytical methods in the past. Raman spectroscopy can detect OH, but, in our experience, has not proven reliable for absolute concentration determinations.

Minor amounts of OH are found in most common mantle phases and numerous crustal phases including many common silicates and oxides. Concentrations range from <10 ppm in pyrope garnets to percents in grossular garnets. Analytical calibrations of the IR spectra now exist for olivine, certain garnets, pyroxenes, kyanite, zircon, and some oxides. Generic calibrations have been refined, but have not eliminated the need for mineral-specific calibrations. H_2O is typically found at concentrations reaching 2% in ring silicates and minerals with large channels. In feldspars and feldspathoids concentrations range from near zero to nearly 0.2%.

Minerals synthesized under high PT conditions contain much larger concentrations than found in their natural counterparts and have led to much current discussion about the importance of OH in the deep mantle and the question of how much water exists at depth. Recent work has also shown that water resides in some crustal and mantle phases as nano-inclusions that range in size from 10's to 100's of nanometers in size. In olivine, they may be an exsolution product that indicates that the phase formerly contained higher concentrations of bound OH in the deep earth.