Raman spectroscopy analyses to determine the H content of nominally anhydrous minerals wadsleyite and ringwoodite

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H_2O is present in the deep mantle as H atoms bonded to the structure of nominally anhydrous minerals (NAMs) balanced by the formation of cation vacancies. Considerable amounts of H (hundreds of ppm wt H_2O) have in fact been measured in xenocrysts found in kimberlites and minerals in xenoliths that are brought to surface by magmatic events. As even low amounts of H affect mantle mineral properties, and as a consequence whole mantle dynamics, addressing the H_2O content of NAMs is very important.

In this study we synthesized high-quality single crystals of NAMs wadsleyite and ringwoodite with different amounts of H, by means of a multianvil apparatus. These minerals are of particular interest because they are the most abundant phases in the mantle transition zone and they can contain large amounts of H_2O (wt%) as shown by experimental and natural samples. The H_2O content of the synthesized minerals were investigated by elastic recoil detection analyses (ERDA), which is a nuclear and absolute technique, as weel as Fourier transform infra-red (FTIR) and Raman spectroscopy.

The results provide a calibration to determine the H_2O content of wadsleyite and ringwoodite, in the chemical systems $MgO-SiO_2-H_2O$ and $MgO-SiO_2-FeO-H_2O$, by Raman spectroscopy. The advantages of this technique are its high accessibility and the straightforward preparation of the samples, which is not at all the case for ERDA and FTIR measurements. The calibration of the Raman technique is therefore a valid alternative to determine H content of wadsleyite and ringwoodite crystals with very small size (< 50 µm across) that are typical of natural and experimental samples. Further, our results are used to provide constrains on the absorption coefficients of wadsleyite and ringwoodite that are employed in FTIR quantitative analyses.