THEME 1:
THE DYNAMIC SOLID

Session 1.1:

Hydrogen and its influence on mineral structure, properties and behaviour

CONVENED BY:
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Most minerals and oxides contain hydrogen, usually in the form of hydroxide. Hydrogen content in minerals varies widely, from a few wt-ppm H_2O to several percent. The presence of a small concentration of hydrogen may profoundly affect material properties such as elasticity, plastic properties, electrical conductivity, as well as the favourability of processes such as phase transitions, metamorphic reactions and melt generation. The aim of this symposia is to provide and opportunity for scientists from a number of disciplines to discuss and compare their approaches. We particularly encourage papers on topics such as: Crystal chemistry, hydrogen defects and diffusion properties of minerals; isotope geochemistry of hydrogen; solubility of hydrogen in minerals and the synthesis of hydrogen-rich phases; partition coefficients of hydrogen between minerals and minerals/melt; impact of hydrogen on mineral properties; development of analytical methods: FTIR, NMR, ion probe, nuclear reaction analyses, etc.; water percolation in mantle rocks. Results from experiment, observations from natural samples and numerical modelling by geoscientists as well as material scientists are welcome.

1.1.11

Detecting hydration in the Earth's interior

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Liquid water covers more than 70% of the Earth's surface, but constitutes only 0.025% of its mass. The nominally anhydrous polymorphs of $(Mg,Fe)_2SiO_4$, olivine, wadsleyite, and ringwoodite, which are likely the most abundant phases in the upper mantle, constitute one of the largest potential reservoirs of water (as hydroxyl) in the planet, and are capable of incorporating up to ten times the amount of water in the oceans. Ocean volume, therefore, need not be constant over Earth history but may represent a dynamic equilibrium between the interior and surface reservoirs.

The crystal structures and physical properties of these minerals are affected by hydration. Static compression measurements show that the bulk moduli of both ringwoodite and wadsleyite decrease markedly with hydration, incorporation of one weight percent H_2O has a effect similar to increasing the temperature by 600 K. Measurement of the complete elastic tensor of hydrous Fo_{90} ringwoodite to 10 GPa has been accomplished by ultrasonic methods. The effect of one percent hydration on ringwoodite has an effect on the P-wave velocity similar to increasing the temperature by 600 K and on shear velocity by 1000 K. These data also mean that observed velocities are consistent with a pyrolite composition model with significant hydration (0.5 to 2 percent H_2O by weight). Although increasing both hydration and temperature have similar effects on velocities, they have opposite effects on the displacement of the 410 and 660 km discontinuities so that it may be possible to detect significant hydration in the upper mantle. Further data on the effects of hydration on thermal expansion and the pressure derivatives of thermal expansion will be required to obtain an estimate of the hydration state of the interior.