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Properties of water in rocks and minerals

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Water is ubiquitously distributed in the interior of the earth, forming various species. In rocks, water is trapped at intergranular regions as the form of H2O fluid which are constructed by clustered H2O molecules and as the form of -OH in mineral crystal structures. Also, in open cavities which are constructed by crystal structures, H2O molecules are not clustered but isolated H2O molecules are incorporated. It is well known that these water species contribute to earth dynamics such as reactions and deformation of minerals (recent studies of these subjects are summarized in Dysthe & Wogelius, 2006, Chem Geol). Based on these backgrounds, determinations of contents, distributions, states, migration rates, etc. are one of the most important subjects in earth sciences.

Infrared (IR) spectroscopy has widely been used to determine the above properties of water in rocks and minerals (See Aines & Rossman, 1984, JGR; Keppler & Smith, 2006, RiMG for IR spectra of various rocks and minerals). In this study, for advanced IR spectroscopic measurements, I will introduce high temperature in situ measurements and 2-dimensional mapping measurements based on my previous studies. First, I use chalcedonic quartz, which is constructed by microcrystalline quartz. Chalcedonic quartz contains abundant H2O fluid at intergranular regions and mainly Si-OH in quartz crystal structures. Therefore, the properties of water are easily measured by IR spectroscopy. The sample is heated from room temperature up to 500 degree C, and changes of the states by temperature changes and dehydration will be discussed. Next, I use beryl, which contains isolated H2O molecules in its open spaces of the crystal structure. Polarized IR spectra are measured at room temperature and high temperatures. Then, changes of the states of water will be compared with those of chalcedonic quartz. Finally, IR mapping measurements are performed for plastically-deformed granitoid (mylonite), and 2-dimmensional distributions of water in polymineralic rocks are determined. Then, I will discuss relations of mineral phases, species and contents of water, in comparison with the results from the analyses of the states, diffusivity by dehydration as described above. I will also discuss possible microscale processes of water in relation to the deformation mechanism.

Keywords: H_2O, -OH, grain boundary, crystal structure, infrared spectroscopy