

含水鉱物・炭酸塩鉱物起源の脱水・脱炭酸流体を石英中に包有する実験 SYNTHETIC EXPERIMENTS OF AQUEOUS AND CARBONATE FLUID INCLUSIONS

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Deep aqueous fluids from subducted slab affect volcanic activity and seismicity in the subduction zone. (e.g., Schmidt and Poli, 1998) To reveal the chemistry of slab-derived fluids is crucial for understanding the material circulation in subduction zones, but as yet it is very difficult to experimentally constrain the chemical composition of these fluids. Diamond-trap experiments in combination with LA-ICP-MS analyses of frozen samples have been used to analyze chemical compositions of aqueous fluids in equilibrium with complex mineral assemblages (e.g., Kessel et al., 2004). However, in order to accurately determine fluid compositions experiments also need to be designed to account for modification of the fluid during quenching. Synthetic fluid inclusions trapped during high-pressure experiments can keep the composition of the fluids produced at run conditions. We have developed a method to trap fluids liberated during decomposition of hydrous and carbonate minerals as fluid inclusions in a quartz crystal.

The synthetic fluid inclusion technique (Stern and Bodnar, 1984) was employed in this study. Synthetic fluid inclusions were formed in synthetic quartz provided by Nihon Dempa Kogyo Co., LTD. Quartz single crystals were cut into about 1-2mm size, heated to 450 C, and then quenched in cold distilled water to make cracks within it. After drying in a vacuum oven at 150 C overnight, the quartz crystals with cracks were rapped in a piece of Pt foil (2.5um-thick) and sealed in Au or Pt capsules with various mineral assemblages, such as Mg(OH)₂, CaCO₃+SiO₂, CaCO₃+SiO₂+H₂O and mMgCO₃Mg(OH)₂nH₂O+SiO₂+Mg(OH)₂. The capsule was placed in a solid-media piston-cylinder apparatus and kept at the pressure range 0.5-1 GPa and at the temperature range 800-1100 C for 3-192 hours.

After quenching, thin sections (200-500um-thick) were prepared to examine with an optical microscope, Raman spectroscopy and microthermometry. The analyses for microthermometry were performed by referring Diamond (2001) and using the computer program Loner AP (e.g., Bakker, 2009).

Fluids liberated from Mg(OH)₂ were successfully trapped as fluid inclusions in all experiments. Microthermometry for a fluid inclusion in the sample synthesized at 800 C and 1 GPa for 3 hours showed the homogenization temperature of 251 C, molar volume of 22.8 cm³/mol. However, the calculated isochores shows that the temperature calculated for 1 GPa was 961 C, which was different from the run condition.

Fluid inclusions were not observed in experiments with CaCO₃+SiO₂, whereas were successfully synthesized in experiments with CaCO₃+SiO₂+H₂O. The size and amount of fluid inclusions in these samples were smaller than those in the experiments with Mg(OH)₂. Raman spectra showed the peaks of CO₂ but the broad peaks of H₂O were not observed clearly.

Fluids liberated from mMgCO₃Mg(OH)₂nH₂O+SiO₂+ Mg(OH)₂ were successfully trapped as fluid inclusions in all experiments. Raman spectra showed that the fluid inclusions in these samples were composed of H₂O and CO₂. Microthermometry for the three fluid inclusions in the sample synthesized at 850 C and 1GPa for 18 hours showed that the homogenization temperatures from vapor-liquid carbon phase to liquid carbon phase were 24-29.5 C and total homogenization temperatures were 255-269 C, yielding molar volumes of 24.2-26.3 cm³/mol and total mole fractions CO₂ of 12-18 mol%. The calculated isochores give 910-1033 C at 1GPa, which had wide distribution.

In the experiments of anhydrous systems, liberated fluid could not be trapped during crack healing or perhaps crack healing did not occur in the experimental conditions in present study. The temperatures estimated from microthermometry were different from run conditions.

To interpret the condition that fluid inclusions are produced, it is needed to figure out the reason of this discrepancy by more analyses with precise observations of occurrence.

Keywords: synthetic fluid inclusion, hydrous mineral, carbonate mineral, piston-cylinder