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Synthetic aqueous inclusions of dehydrated fluids from hydrated minerals

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Introduction

Deep aqueous fluids derived from subducted plate significantly affect volcanic activity in the subduction zone. Therefore, it is important to examine the chemical compositions of dehydrated fluids from hydrated minerals to grasp H2O behavior in the subduction zone. However, quantitative estimations from material sciences for deep aqueous fluids were not discussed enough, whereas thermodynamic models were sufficiently discussed. The observation and analysis of aqueous fluids is needed to grasp deep aqueous fluids behavior in the subduction zone.

In natural samples, fluids were trapped in minerals. Purpose in present study is to trap dehydrated fluids from hydrated minerals in quartz single crystals.

Previous studies

Sterner and Bodnar (1984) made synthetic fluid inclusions by using internally heated pressure vessels. They sealed quartz crystal with micro cracks and the desired fluid composition in noble metal capsules. Synthetic fluid inclusions were formed by healing fractures in natural quartz in their study. Since then, many researchers synthesized fluids inclusions. However, no one make synthetic aqueous inclusions of dehydrated fluids from hydrated minerals.

In the meanwhile, Kogiso et al. (1997) carried out dehydration experiments on a natural amphibolite under open system conditions. They estimated the chemical composition of aqueous fluid from the gap between starting amphibolite and dehydrated charge.

In present study, we trapped dehydrated fluid from hydrated minerals in quartz by using crack healing method.

Experimental methods

Starting materials were Brazilian quartz single crystals and H2O and Mg(OH)2. Quartz single crystals were cut into about 1-2mm size and inclusion-free crystals were selected as starting materials. Inclusion-free quartz crystals were heated to 350 C and then, immediately upon removal from the oven, quenching in cold distilled water. After drying in a vacuum oven at 150 C overnight, inclusion-free quartz crystals were sealed with an arc-welder in Pt capsules along with other starting materials.

In the first experiment, distilled water and a quartz crystal were sealed in a Pt capsule to check crack healing and trapping fluids. In the second experiment, Mg(OH)2 and a quartz crystal were sealed. In the third experiment, Mg(OH)2 was sealed with quartz rapped in a Pt foil (0.0025mm in thickness) with holes (30-50 un in diameter) to prevent the reaction between quartz and Mg(OH)2. Pt capsules were about the bottom portions of 5 mm long, 2mm in diameter (0.1mm in thickness). The capsules were placed into piston cylinder, solid media apparatus. Experimental conditions were 800 C, 1GPa and 3 hours. After quenching, thick thinsections (60-100 um in thickness) were prepared to examine with a optical microscope and a scanning electron microscope equipped with and energy dispersive X-ray spectrometer.

Results and discussions

In the observation of the first sample, fluid inclusions with 5 um size were in quartz crystal.

In second sample, fluid inclusions with 5-15 um size were observed in quartz crystal. Mg2SiO4 polycrystal band with 100-200 um thickness was observed between quartz and MgO (or Mg(OH)2). Moreover, a few MgSiO3 crystals were observed between quartz and Mg2SiO4. Therefore, the reaction between quartz and Mg(OH)2 were undoubtedly caused during the second experiments.

In third sample, fluid inclusions with 5-15 um size were observed. A little amount of Mg2SiO4 was observed on the points where quartz was not wrapped in Pt foil. However, the reaction between quartz and Mg(OH)2 were scarcely caused during the third experiments.

Conclusion

In present study, we trapped dehydrated fluid from hydrated minerals in quartz for the first time. However, 5-15 um was not enough size to estimate the chemical composition of fluid inclusions. Discovery of the experimental condition to synthesize large fluid inclusions will lead the interpretation about fluids behavior in the subduction zone.

Keywords: fluid inclusion, dehydrated fluid, synthetic experiment, piston cylinder