

Chemical characteristics and formation P-T conditions of fluid inclusions in quartz veins from the Sanbagawa metamorphic belt

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Direct investigation of the chemical characteristics of metamorphic fluids is a key to understand fluid circulation in plate subduction zone. We report chemical characteristics and formation P-T conditions of the fluid inclusions trapped within foliation parallel quartz veins from the Sanbagawa metamorphic belt, SW Japan. Microthermometry experiments and chemical analyses were conducted by using Heating and Cooling stage, ICP-MS, and micro Raman spectrometer.

We have investigated the fluid inclusions trapped within syn-metamorphic quartz veins, Sanbagawa pelitic schists (chlorite zone), SW Japan. The quartz veins are abundant in fluid inclusions, but the main problem arises in identifying fluid inclusions that are truly representative of fluids present during progressive metamorphism. Many fluid inclusions observed in the quartz veins have generally undergone a long history of fracturing, accompanied by trapping of secondary fluid inclusions, during their return to the surface. The fracturing has arrayed the secondary inclusions in the quartz veins. For this study, we have carefully selected large fluid inclusions (more than 5 micrometer) that are isolated from alignment of the secondary fluid inclusions.

The host quartz was doubly polished and cooled and heated under optical microscope using Heating and Cooling Stages (LINKAM LK-600) at Department of Geology and Mineralogy, Kyoto University. The salinity of chloride-dominated aqueous fluid inclusions can be estimated from the melting temperature of ice during a cycle of freezing and heating. The determined freezing temperatures range from -9.2 to -14.5 degree C. This temperature range corresponds to the salinities from 13.07 to 18.13 wt% when using experimental results of Bodnar (1993). Homogenization temperatures range from 320 to 450 degree C.

Bubbles of the fluid inclusions were analyzed by micro Raman spectrometer. Clear CH₄ peaks were observed at about 2916 cm⁻¹. Internal pressures of the fluid inclusions can be determined as 85±20 bar (at 22 degree C), from the pressure dependence of CH₄ Raman shift (Chou et al, 2006).

Once the internal pressure of the fluid inclusion is determined, density of the H₂O-NaCl liquid is also determined (1.11g/cm³). Relationships between pressure, temperature and fluid density at the trapping condition can be estimated by using the equation of state (EOS) of H₂O-NaCl system (Bodnar 1994), because the methane concentrations are negligibly low (X_{CH₄} = 0.006). Calculated fluid pressure ranges from 3.7 to 6.5kb at the homogenization temperatures of the fluid inclusions (320-450 degree C). These values indicate the lower limits of fluid trapping P-T conditions. Estimated P-T range is consistent with the metamorphic condition of the Chlorite zone (250-360 degree C, 3-6.5kb) and suggests that the fluids were released by metamorphic dehydration.

Trace element composition was analyzed by ICP-MS after crush leaching. The relative Li-B-Cl compositions of the Sanbagawa fluid inclusions (trapped at about 20 km depth) are quite similar to those of the spring waters of the North Island (B-rich fluids) derived from about 20 km depth. These results suggest that fluid inclusions would be possible candidates of the source of the spring waters. We are currently investigating pressure effect on the dehydrated fluid composition by using fluid inclusions and spring waters from various depths.