

Fluid inclusions from the Ryoke metamorphic belt - A possible existence of the bright layer

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Recent geophysical explorations have revealed an existence of bright layer (low-density layer) at around 350C, possibly a trigger of earthquakes. Since the layer is conceived as a fluid reservoir, it is quite possible that fluids derived from the reservoir can be found as fluid inclusions in veins from the Ryoke metamorphic belt.

Fluid inclusions in quartz veins from the Ryoke metamorphic belt in Kasado-Jima, Yamaguchi Prefecture have been analyzed in this study. The area is hosted by the metamorphic rocks of the Cretaceous Ryoke metamorphic belt. The rocks are derived mainly from pelites, psammities, cherts and carbonates of a Jurassic accretionary complex (Kuga group). The central part of the area is occupied by Hiroshima granite. Based on their mineral assemblages, the metapilites can be divided into two metamorphic zones, from north to south: biotite zone and cordierite zone, which correspond to the zones in the Iwakuni-Yanai district proposed by Okudaira, et al (1993). The contact aureole caused by Hiroshima granite is up to 300m in width from the granite.

Quartz veins for fluid inclusion studies were collected from two localities, area-1: in the biotite zone free from contact metamorphism and area-2: in the biotite zone of the contact aureole. A contemporary R-shear, T-shear and X-shear vein system are recognized in the area-1, while two directions of the veins (B cut by A) are found in the area-2.

According to microthermometric and Raman analyses, the inclusions are classified into 6 types: type 1 to 5 including vapor +/- liquid of the H₂O-CO₂-CH₄ system and type 6 with nahcolite (NaHCO₃) solid. Characteristics of the type 1 to 5 inclusions depend mainly on CO₂ and/or CH₄ concentrations. Inclusions from the area-1 show high-CO₂ and low-CH₄ types and the type 6. Those from the vein-A in the area-2 are the type 1 to 5, while low-CO₂ types and H₂O-NaCl fluids are found in the vein-B. Salinities (NaCl eq.) of H₂O-NaCl fluids are low as 5wt. %. Homogenization temperatures of the inclusions show their trapped temperatures at around 330C.

Thermodynamic analyses of the fluid system based on equations of state (EOS) have revealed that the fluids could not boil in situ (i.e., the vein forming area). The fluids trapped in inclusions might have been CO₂-rich fluids separated from [source fluid(s)] in deeper conditions below quartz veins. Various types of the inclusions may show an evolution (a degree of degassing) of the [source fluid(s)].

Inclusions of H₂O-NaCl-CO₂-CH₄ fluids are also found during a preliminary study in the Yanai Ryoke metamorphic area, Yamaguchi prefecture. Morikiyo (1992) reported CO₂-rich inclusions from the Ryoke metamorphic rocks in the Narai-Komagane area, Nagano prefecture. A line of those evidences may suggest a wide and/or ubiquitous existence of the [source fluid] within or below the Ryoke metamorphic belt. Hence, we may say that the [source fluid] was possibly in the bright layer and released CO₂-rich fluids during boiling in the layer.