Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SCG004-04 Room: 302 Time: May 25 09:45-10:00

Minor element composition and water quality of deep fluids trapped in LP /HP type metamorphic rocks

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Deep fluids derived from subducted terrestrial materials significantly affect various physicochemical processes in the subduction zone, e.g., earthquakes in the subducting plate, partial melting in the mantle wedge, which causes island arc volcanism and etc. (e.g., Schmidt and Poli, 1998). However, nature of deep fluids is still under the deep veil. To evaluate the effect of deep fluids which affect various subduction processes, following aspects of deep fluids should be evaluated, 1) depths and amounts of fluids release, 2) species and compositions of fluids, 3) fluid paths and scale of motion and etc. (e.g., Scambelluri and Philippot, 2001). In recent years, the depths and amounts of fluid release become to be evaluated by synthetic experiments and thermodynamic calculation in the basaltic system (e.g., Hacker et al., 2003), but other characters are not well understood.
Scambelluri et al. (2004) proposed an idea that B/Cl ratio in deep fluids derived from serpentinites can be used as an indicator of originated depth. Furthermore, Marschall et al. (2006) reported that total amounts of Li and B in metamorphic rocks decreased with the increase of metamorphic grade. Assuming that Li and B were concentrated in dehydrated fluids and were moved from the host rock, data presented by them predicted that the Li/B ration in dehydrated fluids increases with the metamorphic grade, such as from ca. 0.25 in the greenschist (GS) facies to ca. 0.55 in the eclogite (Ecl) facies, suggesting that the Li/B/Cl ratio in deep fluids can be used as an indicator of fluid generation depths.
To testify the hypothesis mentioned above, Sengen et al. (2009) carried out microthermometry and Raman spectroscopy for fluid inclusions in quartz veins developed parallel with the main foliation of the Sanbagawa belt and measured Li/B ratio of fluid inclusions extracted by crash-leaching technique. They revealed that Li/B ratio in leaching fluids increases from lower grade (0.02 in GS facies) to higher grade (from 0.09 to 0.27 in Ecl facies), although host rocks include multi stage origins of fluid inclusions characterized by higher melting temperature (>ca.-2oC, i.e., lower salinity) and lower melting temperatures between -16 oC and -5 oC (higher salinity).
The additional data of Li/B ratio were obtained from Ecl units both in Besshi and Kotsu area in the Sanbagawa belt and from lawsonite-blueschist (BS) unit in the Kamuikotan belt. The methods of extracting fluid inclusions and of the measurement of Li/B follow Sengen et al. (2009).
Li/B ratio obtained from 5 samples from Besshi area varies from 0.12-1.36, which are concordant well with the data of Sengen et al. (2009). However, Li/B ratio obtained from 4 samples from the Kotsu area varies from 0.03-0.06, and it from 2 samples of in the Kamuikotan belt are 0.02. These data are significantly lower than the expected values for BS (0.50) and Ecl (0.55). Data of ion-chromatography reveal that the hydrochemical facies of three leaching fluids in the Besshi area is NaCl type, i.e., the most predominant cation is Na among following five elements, Na, NH4, K, Mg, and Ca, and the most predominant anion is Cl among following three elements, F, Cl, SO4. NaCl type hydrochemical facies is common as hydrothermal fluids in deep crusts. On the other hand, HCO3 type hydrochemical facies, characterized by higher amount of Ca and K, is predominant in leaching fluids of Kotsu and Kamuikotan samples. Such hydrochemical facies is

common in hot spring or ground water. In our sample, there remains an ambiguity whether the higher amount of Ca and K can be an artifact in the laboratory through the reaction between CO2 dissolved in the extra pure water used for the crash-leaching and minor mineral phases included in crashed samples such as carbonate and other silicates. These data reveal that further comprehensive study is necessary to use Li/B ratio as the indicator of fluid generation depths.

Keywords: deep fluids, fluid inclusions, crush leaching technique, Li/B, eclogite, Sanbagawa metamorphic belt