Fluids transport and magma-driven metamorphism related to Granitic Pegmatite Complex in Kinka-san Island, NE Japan

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Fluid transport plays the important role on various geological processes within the crust, including volcanism, earthquakes, formation of hydrothermal ore deposits, and the development of geothermal reservoirs. Recently, several geophysical observations (seismic velocity, electrical resistivity) suggest the existence of the deep-seated fluids or melts in the crusts [e.g., Wannamaker et al., 2009]. However, the detail mechanisms of generation and transport of aqueous fluid are poorly understood. Pegmatite commonly forms at the late stage of in the development of granitic systems, and is associated with metamorphism within the crust. In order to gain a better insight of the transition of magmatic and hydrothermal systems and the dynamic behaviors of aqueous fluids through the crusts, we investigated the petrology and mineralogy of pegmatitic dikes in the quartz diorite and the surrounding metamorphic rocks in the Kinka-san Island, Northeast Japan.

The Kinka-san Island is located in the southern Kitakami mountains, NE Japan. It consists of the Cretaceous granitoid bodies. At the north-western side of the island, a small amount of metamorphic sequences, pelitic schist and mafic schist, are exposed in contact with the quartz diorite body with abundant pegmatite dikes. The quartz diorite is composed of quartz (Qz)-plagioclase (Pl)-K-feldspar (Afs)-hornblende (Hbl)-biotite (Bt)-apatite (Ap)-titanite (Ttn)-ilmenite (Ilm)-magnetite (Mag). Based on the hornblende-plagioclase thermometer (Holland & Blundy, 1994) and Al-in-hornblende barometer (Anderson & Smith, 1995), the P-T condition of the quartz diorite is estimated to be 700-750˚C and 0.37-0.42 GPa, which is close to the P-T condition of the wet solidus of granitic rocks. The pegmatite dikes cut the quartz diorite and has typical graphic, aplitic, and blocky textures with assemblage of Qz-Pl-Afs-Bt-Grt-Ilm-Mag. Besides, thin quartz veins, whose walls are rimed by biotite and pyrite, rarely occur in quartz diorite. The metamorphic rocks have veins normal to the foliation with major mineral assemblage of Qz-Afs-Pl-Bt±Grt, showing the similar mineral assemblage of pegmatite. Assuming the similar pressure to the quartz diorite, the temperature of the amphibole-bearing mafic schist (Hbl-Pl±Qz±Afs±Ttn±Apt), and amphibole-bearing veins in mafic schist (Hbl-Qz-Afs) are estimated to be 610-660˚C and 600-630˚C, respectively, which are 100˚C lower than that of the quartz diorite. A quartz vein hosted by the mafic schists showed a mm-scale reaction zone, which was composed of Na-rich Pl-aluminosilicate (Als)-Hbl-Qz, showing the temperature of ˜520˚C. One of the important features is the ubiquitous occurrences of garnet either in pegmatite and pelitic schists, which have spessartine-rich compositions (X_{Mn}0.6, X_{Fe} 0.27, X_{Ca} 0.09, X_{Mg} 0.04) in the former, and almandine-rich (X_{Mn}0.24, X_{Fe} 0.65, X_{Ca} 0.04, X_{Mg} 0.07) in the latter. A slight zoning of garnet is observed in pegmatite from Mn-rich core to Alm-rich rim. We will analyze trace elements within garnet for characterizing the fluids related to pegmatite formation and metamorphism.

Based on the observation and analyses, the following scenario is considered on the generation and transportation of supercritical fluid from the melt to the crust. Quartz diorite intruded into the upper crust (700-750˚C in 0.37-0.42 GPa) and the country rock would have been suffered from contact metamorphism (610-660˚C). At the late stage of solidification, pegmatite was formed within the quartz diorite body, and some propagated into the metamorphic rocks (˜520˚C). These features suggest that pegmatites and later stage vein systems play important roles on transporting fluid in the high-T crusts.

References

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