Various fluid-rock interaction and tourmalinization in the Sanbagawa high-P/T metamorphic rocks, central Shikoku, Japan

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Various metasomatic rocks, such as tourmaline-rich rocks and micaceous schists have been found from the high-P/T Sanbagawa metamorphic belt in the Niihama area, central Shikoku, SW Japan. The Sanbagawa schist in the study area is tectonostratigraphically represented by Besshi nappe and structurally overlying Ojyoin nappe. The nappe can traced over a distance of about boundary 30km. The Ojyoin nappe consists mainly of pelitic and psammitic schists, whereas the Besshi nappe is characterized by thick layers of siliceous and basic schists. The mineral zones of Besshi nappe is cut by fault of nappe boundary. Serpentinite bodies are widely distributed around the nappe boundary, and part of serpentinites and lithologic-boundary between pelitic schist and mafic rock received various metasomatism, such as tourmalinization, chloritization and alkali-metasomatism.

The mafic-ultramafic complex body in Uchiyoke area is one of the best examples of Sanbagawa metasomatic alteration, with several phases of developed metasomatism. Widespread high-pressure metasomatism ensued, involving tourmalinization in serpentinite-alteration zone, formation of chlorite, talc and actinolite rocks, and mica formation in the mafic rocks.

The chlorite schists roughly of intermediate composition between pelitic schist and serpentinite. However, there is some difficulty in fully quantifying mass balances for the chlorite schists because of the reaction of pelitic schist and serpentinite is not simple mechanical mixture. Especially the differences of K and Ca shows the mass retransfer action. Tourmaline-rich rocks in chlorite schist were altered to an usual boron-rich composition, reflecting infiltration of highly boron, chemically reactive externally derived fluid. REE (rare earth element) distribution pattern of the tourmalinite and chlorite schists are LREE-enriched (La/Yb=6.1-26.3) and similar to pelitic schist's pattern (La/Yb=9.3-20.1). Ratios of La/Yb of Serpentinite and amphibole-schist (La/Yb=0.4-2.8) are obviously lower than these of tourmalinite and chlorite schist.

Micaceous schists were also altered to an usual K-rich composition, reflecting infiltration of K-rich fluid. In order that mica may replaced an amphibole and chlorite preferentially, the increase of the amount of K+Al and decrease of these of Mg+Fe are accepted. The stage of B-rich fluid infiltration is earlier than these of K-rich fluid, judging from a mineral texture and inclusions. Although the thickness of tourmalinized-layer is only 1m, the influence of K-metasomatism reaches 70% of mafic-ultramafic complex body.

Tourmaline is widespread, but sporadically scattered in the Sanbagawa pelitic schists. However, thin tourmaline-rich layers are found along the lithologic boundary between mafic and pelitic schists. Tourmaline of the layers is extremely abundant (up to 15%) and coarse-grained than those of other pelitic schists. In serpentinite alteration zone, tourmaline megacrysts (max 5cm) rarely occur from chlorite schist. These tourmaline belongs to the schorl-dravite solid-solution series.

The tourmaline has the zonal structure which shows formation condition. The change of XMg in the common pelitic tourmaline increases from the core to rim. However, rich-layer's tourmaline has no XMg and/or XMg reverse zoning structure. These tourmaline shows that external fluid supply B to the formation of tourmaline rather than the tourmaline grew using ordinal B content from clay mineral.

Based on geologic, petrographic and geochemical data, the infiltration of large volumes of B-rich fluid may have been focused along lithological boundaries, shear zones and serpentinites around the Ojyoin and Besshi nappe boundary during the high-P/T Sanbagawa metamorphism. B-rich fluids must have been derived from external system. The character of these fluids is similar with that of the components added to arc volcanism.