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FLUID RELATED ORIGIN OF SILLIMANITE VEINS IN POLYMETAMORPHIC ROCKS FROM THE RYOKE BELT, JAPAN

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In the polymetamorphic area, it is important to distinguish the effect of each metamorphism in order to appreciate the evolution of thermal structure of the area. Some authors have successfully distinguished the regional metamorphism from the postdating contact metamorphism (e.g. Miyake et al., 1992), but studies dealing with a fluid activity during polymetamorphism is not sufficiently available. Veins consisting of fibrous sillimanite (Sil) in a contact metamorphic aureole have been previously interpreted as a result of fluid activity (e.g. Johnson et al., 2003).

In Kasagi area (Kyoto, Japan), Ryoke metamorphic rocks are widely exposed and main lithology is pelitic and psammitic schists and gneisses. Younger Ryoke granites discordantly intrude to the metamorphic rocks and, therefore, the regional metamorphic rocks are overprinted by the heat (Ozaki et al., 2000) and fluid flux from the granites. This area belongs to the Sil zone that is defined by the presence of Sil in the pelitic lithology (Ozaki et al., 2000) whose origin has not been discussed in detail.

However in this area, fibrolite bundles are often observed to cross-cut the gneissosity formed by the regional metamorphism and it seems difficult to explain their formation during the regional metamorphism. In this study, we report the mode of occurrence of Sil veins emanating from the granite into psammitic gneiss and discuss the fluid-related origin of them.

The studied psammitic gneiss containing Sil veins is collected from the Sil zone near the granite intrusion contact. Ryoke granite intrudes discordantly to the gneissosity of this sample, and the Sil vein subparallel to the gneissosity emanate from it. The Sil vein consists of fibrolite and retrograde muscovite (Ms) replacing it. Quartz (Qtz) in the matrix near the vein are coarser-grained and they include fibrolite grains. The amount of fibrolite included in the Qtz decreases as a distance from the Sil vein increases. Fibrolite is present in veins and Qtz grains. Fine, retrograde Ms after fibrolite is present along grain boundaries in the matrix. Although plagioclase (Pl) is a common constituent mineral in the matrix, it is almost completely absent near and in the Sil veins. K-feldspar is absent in the studied sample, but instead, retrograde Ms cutting the schistosity is abundant in the matrix.

Cathodoluminescence (CL) observation of the microstructures around the Sil veins revealed that the brightness of CL signal of Qtz grains increases as the distance from the Sil vein increases. That is, Qtz grains near the vein or including Sil are dark under CL observation. In particular, part of a single Qtz grain including more fibrolite grains appears dark under CL image.

From the observation of microstructural relationships described above, we consider that Sil veins were formed by the fluid released from the Ryoke granite. Formation of fibrous Sil by the action of mobile hydrogen ions on pre-existing minerals has been previously discussed (Vernon, 1979). Moreover, experimental work has shown that Al2SiO5 minerals and Ms can be produced by the action of acidic, aqueous solutions on various common silicate minerals (Burnham, 1967). In this study, fibrolite is present in veins and Qtz grains and the amount of fibrolite crystals included in the Qtz crystals decreases as a distance from the vein increases. Pl is absent in and at the vicinity of the veins. From these pieces of observation, a fluid from the granite would have reacted with the matrix to dissolve Pl and to form coarser-grained Qtz and fibrolite bundles simultaneously. Thermodynamic calculation using SUPCRT92 (Johnson et al. 1992) has revealed that infiltration of the aqueous fluid with low Na+/H+ and K+/H+ ratio can destabilize Pl and stabilize Sil under the presence of Qtz at 3 kbar, 600oC. Therefore, Sil in this study is not regional metamorphic in origin, but is probably a result of fluid infiltration during a contact metamorphism by the Ryoke granite.

Keywords: fibrous sillimanite, Ryoke belt, fluid-related origin, polymetamorphism