Petrological study of crystallization process of a composite dike in the Ryoke belt (Mie Prefecture, SW Japan)

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A composite dike with a width of about 3 m discordantly intrudes to the gneissose structure of pelitic and psammitic migmatites in Hakusan-cho, Mie Prefecture (Ryoke belt, SW Japan). This composite dike has silicic margin of about 15 cm in width and mafic rocks in its center in the form of discrete pillows of about 5-30 cm in width, representing coexistence of silicic and mafic magmas. This study aims to discuss how the composition of these magmas changed through magma mingling, magma mixing and chemical diffusion by observing microtextures indicative of magma mixing and spatial change of mineral compositions.

The silicic host rock more than 3 cm distant from the mafic pillow consists of plagioclase + biotite + quartz + K-feldspar + garnet. Silicic host rock in the vicinity of the mafic pillows shows the mineral assemblage of plagioclase + biotite + quartz ±K-feldspar with minor garnet. On the other hand, the mafic pillows mainly consist of two parts, hornblende-bearing and hornblende-free domains. The hornblende-bearing domain mainly consists of plagioclase + hornblende + biotite + quartz ±K-feldspar. The hornblende-free domain, commonly developed in between the hornblende-bearing domain and the silicic host, mainly consists of plagioclase + biotite + quartz ±K-feldspar.

Some microtextures indicative of magma mixing (e.g. acicular apatites, rapakivi feldspars, “anorthite spikes” in plagioclase) (Hibbard, 1991; Baxter and Feely, 2002) were found both from the mafic pillows and from the silicic host in the vicinity of them. Especially in felsic back veins developed in the mafic pillows, coarse-grained plagioclase shows a zonal inclusion arrangement of quartz and biotite. A number of acicular apatite crystals are included in and outside the inclusion arrangement, whereas no apatite inclusion is present inside the inclusion arrangement. This microtexture is considered as evidence of local magma mixing in felsic back veins.

When focusing on one pair of a discrete pillow and its silicic host, systematic change in mineral composition is observed in the silicic host and the mafic pillow as a distance from the mafic pillow: From the silicic host to the mafic pillow, anorthite value of fine-grained plagioclase, $Mg/(Mg+Fe_{total})$ ratio, Cl and TiO_2 concentrations of biotite gradually approach to the value observed in the mafic pillow. These chemical trends indicate that magma composition changed prior to the crystallization of these minerals. Observation of the sharp silicic host/mafic pillow boundary and rare occurrence of magma mixing textures both in silicic and mafic rocks suggests that chemical diffusion across the interface between the two magmas played an important role before mechanical mixing.

In a larger scale, 3 different mafic pillows in different positions of the vein (about 10 cm, 20 cm and 160 cm distant from the dike wall) show different $Mg/(Mg+Fe_{total})$ ratio of biotite and hornblende. The mafic pillow at 10 cm and that at 20 cm have similar $Mg/(Mg+Fe_{total})$ ratio of biotite and hornblende, whereas mafic pillow at 160 cm-distance has higher $Mg/(Mg+Fe_{total})$ ratio than them. This indicates the difference in the degree of chemical exchange between the silicic host and the mafic pillows as a distance from the vein wall.

