Chemical system dealing with phase equilibrium of pelitic and siliceous gneisses in the high-grade Ryoke metamorphic complex in the Yanai-Hikari area

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High-grade area of the Ryoke metamorphic complex in the Yanai-Hikari area is divided into three zones based on pelitic mineral assemblages, i.e., K-feldspar-cordierite (KC) zone, sillimanite-K-feldspar (SK) zone and garnet-cordierite (GC) zone. The highest grade zone (GC zone) is distinguished from other zones by the reaction,

sillimanite + biotite + quartz = garnet + cordierite + melt (or Vapour) (1)

Re-definition of KC and SK zones, such that aluminosilicates occur either in cordierite-bearing rocks or garnet-bearing rocks, enabled the regional mapping of the study area (Ikeda et al., 2019). Thermobarometry using garnet, biotite and plagioclase shows that SK zone represents higher pressure than KC zone at lower temperatures of reaction (1). It is, however, still unclear which chemical system accounts for differences in mineral assemblage and in pressure-(*P*)-temperature(*T*) condition between the zones. This study evaluated whether the traditional AFM approximation (K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O system with excess quartz, K-feldspar and aqueous fluid) is still valid for describing phase equilibrium of Ryoke metamorphism or additional components are necessary.

We examined all the samples that were used in thermobarometry, i.e., including garnet, biotite and plagioclase with or without aluminosilicates. Mg/(Fe+Mg) values of biotite in SK zone are lower than those in KC zone. Mg/(Fe+Mg) values of garnet in SK zone are also lower that or same as those in KC zone. These features are clearly inconsistent with the predictions based on the AFM approximation with the estimated *P*-*T* conditions. Garnet in KC zone contains spessartine component higher than garnet in SK zone. Addition of MnO into the system enlarges garnet stability toward higher Mg/(Fe+Mg) and causes biotite that coexists with garnet to be higher in Mg/(Fe+Mg), which can bring the internal consistency among the observed chemical composition, *P*-*T* condition and mineral assemblage. We conclude that the AFMMn system can describe the phase equilibrium of pelitic and siliceous gneisses of the study area.

Reference: Ikeda T, Miyazaki K, Sugawara Y (2019) Abstract of Annual meeting of Geological Society of Japan

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