Rising of a high-temperature metamorphic belt due to buoyancy

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Cretaceous Ryoke (plutono-metamorphic) complex (hereafter Ryoke complex) is distributed as the Ryoke metamorphic belt (Ryoke belt) with more than 1,000 km length in Japanese Island. Recently, we found a possible western extension of the Ryoke complex, that is high-temperature metamorphic rocks in the Omuta district, northern Kyushu, Japan. Protolith of the high-T metamorphic rocks in the Omuta district is Triassic high-pressure Suo (metamorphic) complex (Miyazaki, et al., submitted). The lower-grade part of the metamorphic rocks partly preserves schistosity of the Suo complex, although high-grade part consists of migmatite and gneiss. Pressure differences between low-grade and high-grade parts cannot be explained by geologically estimating thickness between both parts, and it is suggested that thinning should be taken place between the low-grade and high-grade parts (Ikeda et al., accepted).
Pervasive occurrence of migmatite implies that melt existed at the peak high-T metamorphism. Because density of melt is lower than solid rock, melt has a buoyance. However, viscosity of felsic melt is very high, and the melt is difficult to easily separate from the solid rock. Therefor, we consider a rising of the high-grade part as that of the mixture of melt and solid rock.
To evaluate the rising of the mixture, we performed numerical simulation, in which the crust and mixture are assumed as host and buoyant viscous fluids, respectively. Without thermal diffusion between host and buoyant viscous fluids, the buoyant viscous fluid rises as a diapir. In the case with thermal diffusion, density of the buoyant viscous fluid increases with decreasing temperature. The buoyant viscous fluid transforms to the host viscous fluid during the rising. After the transformation, the transformed viscous fluid stops to rise. We also simulate the case with continuous production of buoyant viscous fluid. In this case, the buoyant viscous fluid also transforms to the host viscous fluid, and the transformed viscous fluid still rise to shallower depths than the case without the continuous production. The transformed viscous fluid suffers a vertical compression and horizontal extension after the transformation. This implies thinning of the transformed viscous fluid.
The results of numerical simulation suggest that high-T metamorphic rocks with pervasive occurrence of migmatite can rise to a shallow depth when melt production continues. Zircon U-Pb ages of plutonic and volcanic rocks in the northern Kyushu shows that melt generation continued from 112 to 98 Ma. Zircon U-Pb ages of the high-T metamorphic rocks in the Omuta district also suggest that high-T metamorphism and partial melting occurred at 105.1 ±5.3 Ma (Miyazaki et al. submitted). The thinning of high-grade part of the metamorphic rocks in the Omuta district and the above-mentioned age constrains suggest that the high-T metamorphic rocks rose due to buoyancy.

Keywords: high temperature metamorphic belt, rising, Ryoke