Crustal-scale pattern of rising buoyancy of viscous fluids and mid Cretaceous geology related to high-temperature metamorphic belt in northern Kyushu, Japan

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We compare crustal-scale pattern of rising buoyancy of viscous fluids with mid Cretaceous geology related to high-temperature metamorphic belt in northern Kyushu. The results of numerical simulation of crustal-scale rising of viscous fluids show that the pattern of rising viscous fluids transform from diaper-like to branching dike-like patterns with increasing viscosity and density contrasts. Blob-like and dike-like patterns appear at the transient conditions between the diaper-like and dike-like patterns. The patterns are similar to stock or batholith of plutonic rocks. Because a slow horizontal velocity is adopted at the bottom of the system, horizontal-elongated patterns, which are resembled to metamorphic belt, are formed in the diapir regime when viscosity and density contrasts are small. Consequently, the patterns of rising viscous fluids change as follows with increasing viscosity and density contrasts; metamorphic belt-like pattern, diaper-like pattern, blob-like and dike-like pattern, and dike-like pattern.
We also reviewed the mid Cretaceous geology of the northern Kyushu, Japan as follows; 1) the Suo metamorphic rocks (including Chizu metamorphic rocks) have occupied shallow (near surface) to middle curst (up to 25 km depth), 2) large amounts of felsic plutonic rocks (batholith) intruded into the Suo metamorphic rocks at around 10 km depths, 3) high-temperature metamorphic rocks, which have been formed at 20-25 km depths, are exposed in the southern area of the northern Kyushu, 4) felsic volcanic tuffs are intercalated in the Kanmon Groups in the northern area of the northern Kyushu. Zircon U-Pb ages for 2) and 3) are 107-97 Ma (felsic plutonic rocks) and 105.1±5.1 Ma (high-T metamorphic rocks) (Miyazaki et al., 2014). We obtained zircon U-Pb ages from the felsic tuffs in the Kanmon Group as follows; 111.6±0.8 Ma (Wakino Subgroup) and 106.3±0.7 Ma (Shimonoseki Subgroup). These ages imply that high-*T* metamorphic belt, batholith of felsic-plutonic rocks and volcanic rocks in sedimentary rocks were formed simultaneously in mid Cretaceous.
The high-*T* metamorphic belt, batholith of felsic plutonic rocks and volcanic rocks were formed by rising viscous fluids, such as mixtures of melt and solids, magma, or melt. The results of the simulation suggest that when a degree of separation of melt from solids is small, such as slowly rising partial melted metamorphic rocks, the rising pattern should be large metamorphic belt-like pattern elongated toward trench side from arc side due to drag of horizontal mantle flow. On the other hand, intrusion of plutonic rocks as batholith or eruption of volcanic rock through dike will be formed when a degree of separation of melt from solids is large. Although the simulations of viscous crust predict to form dike-like patterns, deformation rate of the viscous crust becomes so large. The realistic crust cannot deform as viscous fluids at such high deformation rate. It is suggested that ascent of magma through dike is progressed by brittle failure. It is also expected that surface of marginal area of the intrusion of large amounts of magma as batholith or rising of large metamorphic belt should be relatively descending. The sedimentary basin of the Kanmon Group is possibly formed in such a relative descending area.

Keywords: Crust, Metamorphic belt, Viscous fulids, Northern Kyushu, Hgih-temperature metamorphic rocks

