Fast and Slow Schists: Constraints from phengite geochronology

*Tetsumaru Itaya[1]

1. Engineering Geology Center, Hiruzen Institute for Geology and Chronology

A systematic K-Ar age mapping along transects perpendicular to metamorphic thermal gradients have been carried out in the Sanbagawa *HP* schist belt in central Shikoku where the highest grade rocks occur in the middle part of the apparent stratigraphy. This reveals a positive correlation in age–*T* relationship that the ages are progressively older with increasing metamorphic temperature. It is impossible to explain the relationship based on the closure temperatures (CT) by the thermally activated diffusion model because CT would be much higher (ca. 600℃) than is currently generally accepted as revealed by the argon geochronology of the polymetamorphic terrains and because the metamorhic sequences formed in the temperatures lower than the CT. The *HP-UHP* schists have been deformed severely during the exhumation of their host rocks and the phengites have experienced the argon release from the phengite crystals by their dynamic recrystallization. The K-Ar ages are related directly to the ductile deformation history of the matrix phengite during exhumation and cooling of the schists. This suggests that the argon release cease when the ductile deformation of phengites stopped and the K-Ar ages are related to the timing of cease of ductile deformation. The coherent schist unit having an inverted thermal structure with large-scale recumbent folds may have undergone ductile deformation for a longer time at lower temperature, suggesting a relatively low strain rate for deformation of metamorphic pile. The duration of deformation during the exhumation after the peak metamorphism shows the average values from the peak metamorphism to the deformation ceasing level. It is 31 Myr in the biotite zone schists in the Sanbagawa *HP* schist belt in central Shikoku and much longer in the garnet and chlorite zone schists.
Multi-stage exhumation models have been proposed for *HP-UHP* metamorphic sequences. The models are that the exhumation rates were high from the deepest level to the lower crust and the rates decrease to the shallow crustal levels. In the Sanbagawa *HP* schist belt in central Shikoku, the eclogite facies metamorphic rocks exhumed faster than the lower grade rocks. The early stage of exhumation from the eclogite facies to the overprinting amphibolite facies gives 9 mm/y. The rates are much lower in the later stage of exhumation. Lago di Cignana *HP-UHP* units in the western Alps have very short duration of deformation, in particular, less than 5 Myr in Lago di Cignana *UHP* unit, suggesting the exhumation rate is higher than 18 mm/y in the early stage of exhumation from the deepest level (ca. 120 km) to the lower crust (ca. 30 km), being two times higher than that of the Sanbagawa *HP* schist belt. Lago di Cignana *HP-UHP* units and Sanbagawa *HP* schist belt both are Pacific-type *HP-UHP* metamorphic belts consisting of the metamorphosed oceanic lithology that usually record only a single metamorphic cycle though the former has been considered to be part of collisional orogeny. Lago di Cignana *HP-UHP* units having the higher exhumation rate are likely due to the subsequent continental collision event because Sanbagawa *HP* schist belt with the lower exhumation rate did not experience the subsequent continental collision event. Thus, the former with the high exhumation (strain) rate makes “Fast schist” sequence that the several unit boundaries are distinct fault and the later with the low exhumation (strain) rate, “Slow schist” sequence having the large scale recumbent fold.

Keywords: Pacific-type HP-UHP metamorphic belts, Exhumation rate, strain rate, phengite geochronology, Fast and Slow Schists

