K-Ar phengite geochronology of HP-UHP metamorphic rocks -Slow and Fast Schists-

*Tetsumaru Itaya[1,2,3]

1. Engineering Geology Center, Hiruzen Institute for Geology and Chronology, 2. Institute of Geohistory, Japan Geochronology Network, 3. Institute of Frontier Science and Technology, Okayama University of Science

The presence of discordant and anomalously old K-Ar ($^{40}Ar/^{39}Ar$) phengitic white mica ages in metamorphic rocks has been widely reported in collisional orogenic belts. These results are likely due to the presence of excess ^{40}Ar trapped in the metamorphic minerals during recrystallization. This type of inherited excess argon is due to the fact that white micas in continental lithologies derived from precursor older rocks were not reset completely during HP-UHP metamorphism because the closure temperature of white mica is much higher than that generally accepted, approximately 600 ˚C. On the other hand, HP-UHP metamorphic rocks commonly experienced severe ductile deformation during their exhumation. The phengite in the HP-UHP schists also experienced deformation-induced (dynamic) recrystallization and chemical change depending on the local bulk chemistry under the progressively changing P-T conditions during exhumation. Radiogenic argon is released from deformed phengite, as documented by a comparison of the in situ $^{40}Ar/^{39}Ar$ dating of phengite with equant shapes included in rigid garnet and stretched phengite in the matrix. The inconsistent ages observed among the rock samples with the same P-T-t history and in a single phengite crystal are due to the heterogeneous deformation among the samples and the crystal domains. The duration of deformation during exhumation spans a period from the peak metamorphism to the end of deformation in the crust, making it possible to calculate the exhumation rates of HP-UHP metamorphic belts consisting of metamorphosed oceanic lithology without excess argon. The Sanbagawa belt, SW Japan, experienced exhumation rates from the deepest level to the lower crust of 4.5 mm/y for the Iratsu quartz eclogite in the Besshi unit and 6 mm/y for the biotite zone in the Asemi-gawa unit, and the exhumation rates were less than 6 mm/y for the lower grade zones. In the Lago di Cignana of the Western Alps, Italy, the early stage of exhumation from the deepest level to the lower crust level had exhumation rates of 15-26, 8-16, and 1.3-2.5 mm/y for the UHP rock and the adjoining HP meta-ophiolitic and blue schist units, respectively. The slow exhumation rates of the Sanbagawa belt suggest a low strain rate during rock deformation, resulting in the “slow schist” sequence with recumbent fold structures. The high rates of exhumation in Lago di Cignana suggest a high strain rate during rock deformation, resulting in the “fast schist” sequence consisting of several units of which the boundaries are distinct faults. The high exhumation rates in Lago di Cignana HP-UHP units could be attributed to the continental collision event that is not observed in the Sanbagawa HP schist belt.

Keywords: Pacific type HP-UHP metamorphism, Phengite K-Ar (40Ar/39Ar) age, Argon release mechanism, Deformation-induced recrystallization, Effective diffusion length scale, Slow and Fast Schists

