三波川変成岩の年代学 Geochronology of Sanbagawa schists, SW Japan

板谷徹丸 Tetsumaru ITAYA
岡山理科大学自然科学研究所
Research Institute of Natural Sciences, Okayama University of Science
受入教官名：基礎宇宙化学部門　中村栄三

Southwest Japan, a segment of the circum-Pacific orogenic chain, consists of several subduction-accretion complexes and high-pressure metamorphic belts of Phanerozoic age. The Sanbagawa high-pressure schist belt belongs to the Jurassic subduction complexes. The belt extends about 800km along the Pacific Ocean side of southwestern portion of the Japan arc. The Sanbagawa metamorphic sequence has long been studied extensively on its general geology, petrology and structural geology. Geochronology of the belt has also been well documented since Banno and Miller (1965), in particular, after the systematic K-Ar and Ar-Ar phengite analyses by Monie et al. (1987), Itaya and Takasugi (1988), Takasu and Dallmeyer (1990).

The timing of peak metamorphism has been estimated from the Rb-Sr whole-rock isochron ages (116±10Ma; Minamishin et al., 1979) of the high-pressure schists in central Shikoku area. Okamoto et al. (1999) gave SHRIMP U-Pb zircon ages (112-118Ma) from quartz eclogite, which are consistent with the Rb-Sr whole rock age. These suggest that the Sanbagawa metamorphic rocks exhumed after the age of 110Ma that should be older than the K-Ar and Ar-Ar ages of K-bearing minerals such as phengites, biotites and amphiboles. Most of K-Ar and Ar-Ar mineral ages are younger than the age but some rocks have given the ages siginificantly older than 110Ma, e.g., K-Ar biotite age (128Ma) from omphacite bearing amphibolite and K-Ar phengite ages (123 and 136Ma) from quartz eclogite both of which occur in the Iratsu mafic - ultramafic body. These are likely due to excess argon trapped in the minerals during the metamorphism. The Sanbagawa schist clasts in Eocene Kuma conglomerate have also extremely older ages for garnet amphibolites (Takasu and Dallmeyer, 1992; Itaya, unpubl. data). Takasu and and Dallmeyer (1992) considered that the older age rocks exhumed as the Kuma nappe predating the Sanbagawa main schists. This is unlikely because the Ar-Ar age spectra of amphibole are very irregular and have no plateau region and the total gas ages are also so heterogeneous among the grains from the same sample (Itaya, unpubl. data). This type of amphiboles probably formed in heterogenous excess argon environment during the metamorphism though the phengite associated with amphiboles has the age consistent with that of the main Sanbagawa schists.

Itaya and Takasugi (1988) carried out the conventional K-Ar study of phengites from the Sanbagawa schists in central Shikoku and gave ages that ranged from 88Ma to 64Ma. Monie et al. (1987) and Takasu & Dallmeyer (1990) have reported 40Ar/39Ar ages of phengite from the same metamorphic sequence, which are the same as the conventional K-Ar ages of Itaya and Takasugi (1988). This indicates that the conventional K-Ar phengite analyses are applicable to revealing the timing and kinetics of exhumation of the whole Sanbagawa metamorphic sequence as followed by Itaya and Fujino (1999) and Miyashita and Itaya (in review).

Phengites in the pelitic and psammitic schists generally occur forming aggregates consisting of fine-grained phengite crystals and are extremely fine-grained in domains close to relatively rigid garnet and albite porphyroblasts, indicating that deformation-induced grain-size reduction had taken place in phengite during the ductile deformation accompanying the exhumation of host schists. The matrix phengites in schists are chemically heterogeneous on the thin-section scale. The matrix phengites having low Si values are likely to have been formed during retrograde metamorphism in extremely restricted equilibrium domains.

The two or three different types of schists from the same outcrop, which have a similar grain size of phengite, have similar K-Ar ages, suggesting that the closure temperature does not depend on chemistry. However, the hematite-rich quartzose schist with strong grain-size reduction of both phengite and quartz has a significantly younger K-Ar phengite age than the pelitic and quartzose schists in the same outcrop that do not show grain-size reduction. We suggest that, the exhumation tectonics of the schists, which have experienced strong ductile deformation at temperatures less than ca. 350oC, played an important role resulting in the observed variation in age.

Although K-Ar phengite ages have discordant relation among the different types of schists from the same out crop, there are two contrasting age-temperature-structural relations for the Sanbagawa metaorphic sequence. Systematic K-Ar phengite analyses show a younging polarity from Southern Unit (82Ma) to Northern unit (58Ma) in the Kanto Mountains. The age range is similar to that in the central Shikoku. The older schists occur in the higher metamorphic grade zone in the central Shikoku while in the lower-grade zone in the Kanto Mountains. The thermal structures in the central Shikoku are inverted, so that the highest-grade zone occurs in the upper or middle parts of the apparent stratigraphic succession. In contrast, the Kanto Mountains have a normal thermal structure: the higher-grade zone is in the lower part of the apparent stratigraphic succession. The different tectonic features in exhumation offer the two contrasting age - temperature - structure relations at the western side of Sanbagawa belt in the central Shikoku and the eastern end of Sanbagawa belt in the Kanto Mountains that are 800km distant from each other.