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^{40}AR/^{39}AR MINERAL AGES OF METAMORPHIC CLASTS FROM THE KUMA GROUP (EOCENE), CENTRAL SHIKOKU, JAPAN: IMPLICATIONS FOR TECTONIC DEVELOPMENT OF THE SAMBAGAWA ACCRETIONARY GROUP

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The Sambagawa metamorphic belt exposed in central Shikoku records a high-P/T metamorphism, and consists of the Oboke nappe and structurally overlying internally imbricated Besshi nappe complex (Fig. 1). The Besshi nappe complex is unconformably overlain by the undeformed and nonmetamorphic Kuma Group of Eocene age. The Kuma Group consists mainly of conglomerates with subordinate sandstone and mudstones. Clasts within Kuma conglomerates in the Kamegamori area include:

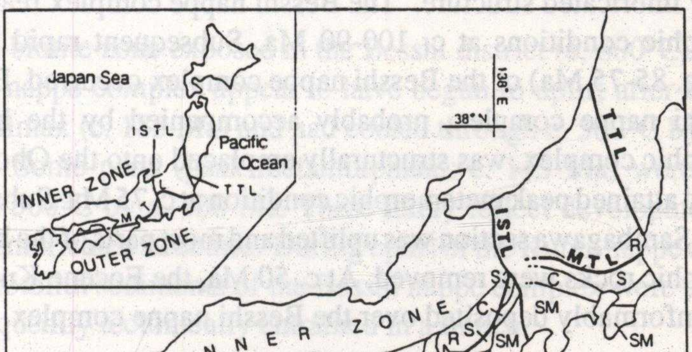

Figure 1: Principal tectonic division of Japan: MTL=Median Tectonic Line; ISTL=Itoigawa-Shizuoka Tectonic Line.

1) low-grade schists derived from the basement Sambagawa complex exposed unconformably below the conglomerates; and, 2) high-grade metamorphic rocks such as garnet amphibolites and oligoclase-bearing pelitic schists. The clasts of high-grade metamorphic rocks within the Kuma Group were derived from basement units exposed in the Eocene, but which have been completely removed by erosion. $^{40}Ar/^{39}Ar$ isotope correlation ages recorded by hornblende from clasts of garnet amphibolite and amphibolite within the Kuma Group are 131.1 ± 4.9 Ma and 156.8 ± 4.3 Ma. These are interpreted to date post-metamorphic cooling through temperature required for intracrystalline retention of argon. These ages are older than other cooling ages reported from the Sambagawa belt. Plateau ages of 108.8 ± 0.7 Ma and 115.7 ± 0.6 Ma are recorded by muscovite from the same clasts. Muscovite from the basement Sambagawa pelitic schist records a plateau age of 78.7 ± 0.5 Ma.

Combined with previously calibrated $^{40}Ar/^{39}Ar$ ages of the Sambagawa schists, a multi-phase tectonic evolution is suggested for the Sambagawa accretionary prism (Fig. 2). Metamorphic culmination within the source terrane for the high-grade clasts occurred at c. 185-145 Ma. Parts of this complex cooled through c. 500°C by c. 150 Ma. Some sectors were uplifted through c. 500°C by c. 130 Ma. These age differences likely reflect an internally imbricated structure. The Besshi nappe complex reached peak metamorphic conditions at c. 100-90 Ma. Subsequent rapid uplift and cooling (c. 85-75 Ma) of the Besshi nappe complex occurred. Eventually the Besshi nappe complex, probably accompanied by the high-grade metamorphic complex, was structurally emplaced onto the Oboke nappe, which had attained peak metamorphic condition at c. 75 Ma. Subsequently, the entire Sambagawa section was uplifted and most parts of the high-grade metamorphic rocks were removed. At c. 50 Ma, the Eocene Kuma Group was unconformably deposited over the Besshi nappe complex.

Radiolarian fossils suggest a late Jurassic depositional age for at least some protoliths of the Samagawa belt (Besshi nappe complex). However the 157 Ma $^{40}Ar/^{39}Ar$ hornblende age from the Kuma clast (constituent of the Kuma nappe complex) suggest that deposition and metamorphic of other Sambagawa tectonic elements must have occurred before the middle Jurassic.

The temperature of peak metamorphic conditions within the Kuma nappe complex is similar or slightly higher than that of sectors of the

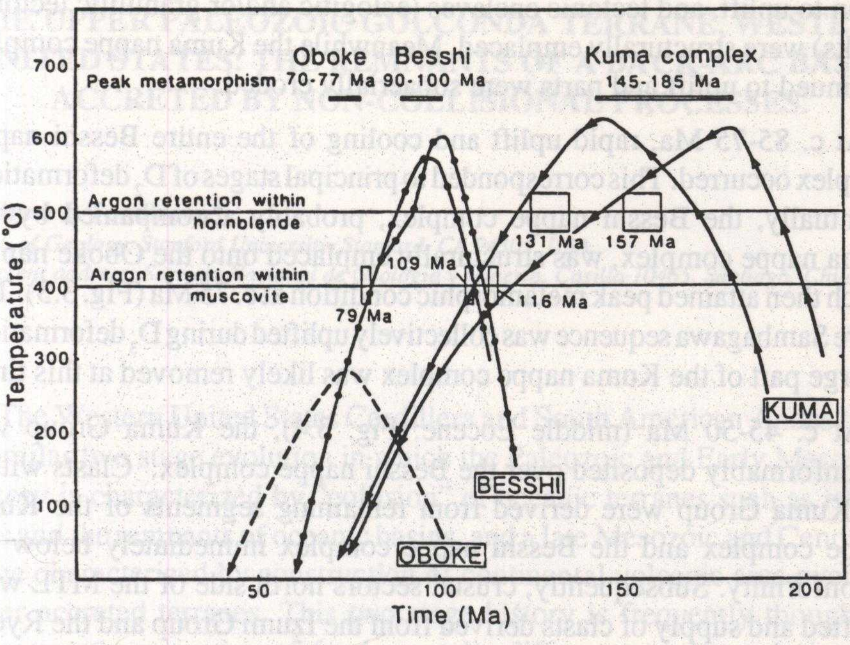

Figure 2: Generalized time-temperature evolution of the Kuma, Besshi and Oboke nappe complex in th Sambagawa accretionary prism.

oligoclase-biotite zone exposed in the Besshi district (c. 600°C). Parts of the Kuma nappe complex appear to have begun to uplift after the metamorphic climax (c. 185 Ma) and had cooled through c. 500°C by 150 Ma (Fig. 3.1). Some parts (peak metamorphism: c. 145 Ma) were uplifted through c. 500°C by c. 130 Ma. These likely reflect development of an internally imbricated structure. During uplift of the Kuma nappe complex, original protolith sediments of the Besshi nappe complex were deposited and subsequently tectonically entrained in a trench.

The Kuma nappe complex was further uplifted, and cooled through c. 400°C by c. 115-110 Ma. At that time, protolith sediments of the Besshi nappe complex were progressively subducted and experienced high P/T prograde metamorphism along the surface of the subducting plate. The Besshi nappe complex reached peak metamorphic conditions at c. 100-90 Ma (Fig. 3.2). The subducting plate appeared to have changed into a highly oblique direction, producing E-W ductile D_1 shearing. This caused local inversions of metamorphic temperature due to development of megascopic sheath folds. Subsequently, upper levels of the Besshi nappe complex began to uplift, and tectonic enclaves (eclogitic and/or granulitic tectonic blocks) were structurally emplaced. Meanwhile the Kuma nappe complex continued to uplift and parts were subaerially eroded.

At c. 85-75 Ma, rapid uplift and cooling of the entire Besshi nappe complex occurred. This corresponded to principal stages of D_2 deformation. Eventually, the Besshi nappe complex, probably accompanied by the Kuma nappe complex, was structurally emplaced onto the Oboke nappe, which then attained peak metamorphic condition at c. 75 Ma (Fig. 3.3). The entire Sambagawa sequence was collectively uplifted during D_3 deformation. A large part of the Kuma nappe complex was likely removed at this time.

At c. 45-50 Ma (middle Eocene: Fig. 3.4), the Kuma Group was unconformably deposited over the Besshi nappe complex. Clasts within the Kuma Group were derived from remaining segments of the Kuma nappe complex and the Besshi nappe complex immediately below the unconformity. Subsequently, crustal sectors north side of the MTL were uplifted and supply of clasts derived from the Izumi Group and the Ryoke belt gradually increased.

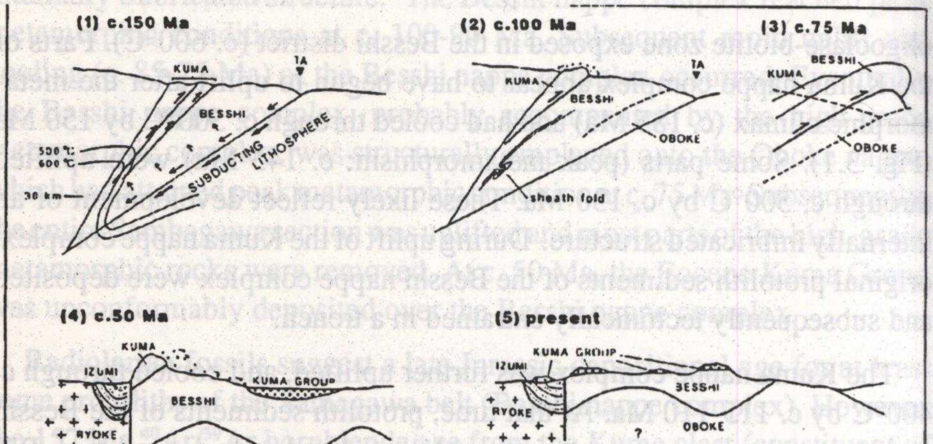

Figure 3: Generalized model for the tectono-metamorphic evolution of the Sambagawa accretionary prism: TA= trench axis; MTL= Median Tectonic Line.