3D-tectonothermal structure of deeply subducted materials revealed in the Akaishi Mountains, Nagano, Japan: Implications for Izanagi–Pacific ridge subduction and exhumation tectonics

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To understand the impact of ridge subduction in the Oshika area, Nagano, Japan, we have assessed in detail the tectono-thermal structure of deeply subducted materials based on the Raman spectra of carbonaceous material (RSCM) thermometry, U–Pb detrital zircon ages, and white mica K–Ar ages. The three-dimensional thermal structure constructed from 155 samples demonstrated a few thermal anomalies ranging between 235 and 400 ˚C, roughly corresponding to the distribution of each tectonostratigraphic unit. The maximum depositional ages and white mica K–Ar ages in most units become older toward the structurally upper unit. This trend suggests that the lower Cretaceous accretionary complex (AC) and the upper Jurassic AC are in contact along a low-angle fault, which is a similar tectonic architecture to that of the Kii Peninsula and Shikoku in SW Japan. Our detailed field observations and petrological studies revealed that the weakly metamorphosed Kamasawa unit that formed at 3.0–5.0 kbar (depths of 11–19 km) and 313 ±32 ˚C (n = 22) is widely exposed as a “tectonic window” along rivers. The deeply subducted materials in the Kamasawa and Akaishi units reveal higher peak temperatures than those in the lower Sanbagawa Metamorphic Complex (MC) and the upper Chichibu AC. The timing of low-grade metamorphism inferred from the white mica K–Ar ages was estimated as ~58 Ma, which is younger than the high-P/T type metamorphism in the structurally lower Sanbagawa MC. These data suggest two distinct thermal events, the earlier high-P/T type metamorphism taking place during subduction and the later thermal metamorphism that occurred during exhumation. In particular, the timing of the later thermal metamorphism is highly consistent with that of the drastic change in plate reorganization owing to Izanagi–Pacific ridge subduction along the east Asian continental margin. Our geological interpretation implies that thermal metamorphism of deeply subducted materials (depth > ~10 km) occurred in response to the underplating of the Izanagi–Pacific ridge during the Paleogene. The geological event we recognized may have led to the extensional exhumation of deeply subducted materials containing high-P/T type metamorphic rocks in order to maintain a critical taper of accretionary wedge during the same period.

Keywords: Low-grade metamorphism, Sanbagawa Metamorphic Complex, RSCM thermometry, U–Pb age detrital zircon

