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Alteration of magmatic monazite in granitoids from the Ryoke belt (SW Japan): Processes and consequences

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Abstract

The alteration of magmatic monazite and its consequences for monazite geochronology are explored in granitoids from the western part of the Ryoke belt (Iwakuni-Yanai area, SW Japan). Biotite-granite samples were collected in two plutons emplaced slightly before the main tectono-metamorphic event: the first one, a massive granite (Shimokuhara) adjoins schistose rocks affected by greenschist facies metamorphism; and the second, a gneissose granite (Namera) adjoins migmatitic gneiss that experienced upper-amphibolite facies conditions. Despite contrasting textures, the granite samples have similar mineral modes and compositions. Monazite in the massive granite is dominated by primary domains with limited secondary recrystallization along cracks and veinlets. It is variably replaced by allanite+apatite±xenotime±Th-U-rich phases. The outermost rims of primary domains yield a weighted average $^{206}Pb/^{238}U$ date of 102 ± 2 Ma while the Th-U phases show Th-U-Pb dates of 58 ± 5 and 15 to 14 ± 2–3 Ma. Monazite in the gneissose granite preserves sector- or oscillatory-zoned primary domains cross-cut by secondary domains enriched in Ca, Y, U, P, and containing numerous inclusions. The secondary domains preserve concordant $^{206}Pb/^{238}U$ dates spreading from 102 ± 3 to 91 ± 2 Ma while primary domain analyses are commonly discordant and range from 116 to 101 Ma.

Monazite alteration textures in the two granites chiefly reflect differences in their post-magmatic histories. In the massive granite, monazite replacement occurred via a nearly stoichiometrically balanced reaction reflecting interaction with an aqueous fluid enriched in Ca+Al+Si±F during hydrothermal alteration of the granitic assemblage, likely below 500 °C. In the gneissose granite, a small amount of anatectic melt, probably derived from the neighboring metasedimentary rocks, was responsible for pseudomorphic recrystallization of monazite by dissolution-reprecipitation above 600 °C. Regardless of whether monazite underwent replacement or recrystallization, primary monazite domains preserve the age of magmatic crystallization for both plutons (102 ± 2 and 106 ± 5 Ma). Conversely, the age of monazite alteration is not easily resolved. Monazite replacement in the massive granite might be constrained using the Th-U-rich alteration products; with due caution and despite probable radiogenic Pb loss, the oldest date of 58 ± 5 Ma could be ascribed to chloritization during final exhumation of the granite. The spread in apparently concordant $^{206}Pb/^{238}U$ dates for secondary domains in the gneissose granite is attributed to incomplete isotopic resetting during dissolution-reprecipitation, and the youngest date of 91 ± 2 Ma is considered as the age of monazite recrystallization during a suprasolidus metamorphic event. These results reveal a diachronous, ca. 10 Ma-long high-temperature (HT) history and an overall duration of about 15 Ma for the metamorphic evolution of the western part of the Ryoke belt.

Keywords: Monazite replacement, monazite recrystallization, dissolution-reprecipitation, partial melting, LA-ICP-MS geochronology, Ryoke plutono-metamorphic belt