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Monazite EMP ages of the granitic and metamorphic rocks from Kontum Massif, central Vietnam

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The Kontum Massif is exposed on a mountain range of the central Vietnam. Recent chronological data revealed that the metamorphic rocks from the Kontum Massif were formed in the late Proterozoic to the early Paleozoic as a core complex of the Indochina craton, and were reworked during the Late Permian (Carter et al., 2001; Nagy et al., 2001; Tran Ngoc Nam et al., 2001; Osanai et al., 2001; Nakano et al., 2005). The lithology of study area consists of intrusive rocks and granulite facies metamorphic rocks with locally remaining ultrahigh-temperature (UHT) metamorphic rocks and diamond-bearing ultrahigh-pressure (UHP) metamorphic rocks as relicts (Osanai et al., 2004; Nakano et al., 2004). The UHT metamorphic rocks from the Kontum Massif have experienced the clockwise P-T-t path, starting from diamond stable UHP (over 2.5 GPa, 900 degree-C) to low-P and T (0.6 GPa, 700 degree-C) through UHT (1.2 GPa, 1050 degree-C) peak metamorphic conditions (Osanai et al., 2004; Nakano et al., 2004).

Garnet-bearing granite (Grt granite) occurs as a stock or a lens in the granulite facies metamorphic rocks. Grt granite forms migmatite structure accompanied by garnet - orthopyroxene gneiss (Grt-Opx gneiss). Grt-Opx gneiss contains euhedral to subhedral orthopyroxene including tiny anhedral biotite and biotite - quartz intergrowth replacing orthopyroxene, suggesting biotite break down incongruent melting has taken place in Grt-Opx gneiss. The initial Sr and Nd isotope ratios of Grt granite and Grt-Opx gneiss corrected by 250 m.y. range from 0.7321-0.7562 and 0.51163-0.51167 (equivalents to epsilon Nd values from -12.4 to -13.3), respectively. The results of petrological and geochemical investigations suggest that Grt granite has been derived from crustal materials with similar isotopic signature to Grt-Opx gneiss.

We performed Th-U-Pb monazite EMP dating of both Grt granite and Grt-Opx gneiss owing to determine the time and origin of granitic magma formation in the Kontum Massif. As a result, age distribution of monazite EMP dating shows a bimodal shape regardless of lithology. The older age group obtained from core of zoned monazite and homogeneous grains of monazite shows ca 270-250 Ma, whereas the rim of zoned monazite gives ages of 230-240 Ma. Back-scattered images of monazite grains indicate that the areas showing older and younger ages correspond to dark and bright color of the zoned monazite, respectively. Taking the age distribution and chemical composition of monazite into accounts, growth of monazite occurred at least two stages. As the rim of zoned monazite showing younger ages is very thin and the homogeneous older areas are dominant in the dated samples, the time of older age (270 - 250 Ma) would indicate a conspicuous growth stage of monazite grains. Blocking temperature of monazite in the U-Pb system is believed to be ca 700 degree-C. Taking monazite EMP dating both Grt granite and Grt-Opx gneiss with combination of above mentioned petrology and isotopic geochemistry into account, the time of formation of Grt granite magma is regarded as ca 270 - 250 Ma. The tiny rim of monazite grains may be crystallized by hydrothermal liquid liberated from successively cooling granite bodies.

Although U-Pb zircon SHRIMP dating of metamorphic rocks including the UHT metamorphic rocks from the Kontum Massif give ages of 300 - 250 Ma (Carter et al., 2001; Tran Ngoc Nam et al., 2001; Osanai et al., 2004), the peak metamorphic age is inferred as ca 270 - 250 Ma in terms of SHRIMP chronology of zircon with combination of zircon inclusion mineralogy (Nakano et al., 2005). The older monazite EMP ages both Grt granite and Grt-Opx gneiss obtained from this study are identical with the inferred peak metamorphic age. Therefore, the time of Grt granite formation would have occurred concurrently with the age of peak metamorphic stage.