Linking high-temperature metamorphism, charnockite formation, and fluid-rock interaction during the waning stage of Paleoproterozoic hot orogeny in the Yeongnam Massif, Korea

Yuyoung Lee¹, Moonsup Cho², and Taehoon Kim³
¹Korea Basic Science Institute, Research Center for Geochronology and Isotope Analysis, Republic of Korea (yuyoung2@kbsi.re.kr)
²Department of Earth and Environmental Sciences, Chungbuk National University, Cheongju 28644, Republic of Korea
³Geoanalysis Center, Korea Institute of Geoscience and Mineral Resources, Daejeon, Republic of Korea

Incipient charnockites are orthopyroxene-bearing granitic gneisses that are commonly considered to be a product of infiltration of CO₂-rich fluids during high temperature dehydration in the granulite terrane. Greenish patches of incipient charnockite are locally present and hosted by granitic gneiss in the Sancheong-Hadong anorthosite complex, southern Yeongnam Massif. Both lithologies are foliated and show a variety of field evidence for partial melting and melt crystallization. Granitic leucosomes and biotite or garnet-rich residua are ubiquitous along ductile shear bands and/or penetrative foliations in the gneiss. These melt-related features are consistent with mineral assemblages and reaction textures, characterized by biotite-breakdown melting. Based on phase equilibria modeling, P-T conditions of peak metamorphism are constrained at 3.5–8.5 kbar and 770–840 °C. Sensitive high-resolution ion microprobe U-Pb analyses of inherited cores and overgrowth rims of zircon from a charnockite yielded the weighted mean ²⁰⁷Pb/²⁰⁶Pb ages of 1880 ± 5 Ma and 1861 ± 4 Ma, which are interpreted as the times for magmatic crystallization and subsequent anatexis of granitic protolith, respectively. This timeline is consistent with that determined from the host granitic gneiss. In contrast, monazite grains from the charnockite and granitic gneiss yielded the weighted mean ²⁰⁷Pb/²⁰⁶Pb ages of 1842 ± 8 Ma and 1838 ± 18 Ma, respectively, suggesting that an influx of aqueous fluid took place ~20 m.y. after the crystallization of granitic melt. Both charnockitic and granitic gneisses underwent high-temperature metamorphism and partial melting at ~1.86 Ga, and were followed by fluid influx at ~1.84 Ga, apparently characterized by monazite recrystallization in association with the retrogression of orthopyroxene to ferromagnesian amphibole-rich aggregates in the former. Thus, the timing and conditions of high-temperature metamorphism, charnockite formation, and fluid flow suggest that the granulite-facies metamorphism and fluid-rock interaction is linked to the waning stage of Paleoproterozoic hot orogenesis in the Yeongnam Massif.