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Petrochronology and P-T estimation for the Paleoproterozoic gneiss and metagranitoid in the southwestern Yeongnam Massif (Gurye-Hadong area), South Korea: Defining Orosirian ultrahigh-temperature metamorphism

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Ultrahigh-temperature metamorphism has recently been confirmed in the basement rocks in the southwestern Yeongnam Massif (Gurye-Hadong area), South Korea, based on phase equilibria modeling and thermometric estimations. However, the precise timing and duration of ultrahigh-temperature metamorphism remain uncertain. This study presents zircon and monazite U-Pb dating combined with rare earth elements (REE) analyses of garnet, zircon and monazite to link geochronological data with the P–T conditions.

The Gurye-Hadong area is dominated by paragneisses and metagranitoids. Based on the detailed field and petrographic observations, the studied rocks are divided into spinel-bearing granitic gneiss and spinel-bearing metagranitoid. The spinel-bearing granitic gneiss is subdivided into leucocratic and melanocratic layers. The leucocratic layer consists of quartz, plagioclase, K-feldspar, garnet, biotite, sillimanite, cordierite, and minor ilmenite and spinel whereas melanocratic layer is dominated by garnet and cordierite. The spinel-bearing metagranitoid exhibits a blastoporphyritic texture with randomly oriented K-feldspar blastoporphyries that locally define foliation and comprises K-feldspar, plagioclase, melt, spinel, garnet, biotite, ilmenite and quartz.

Phase equilibria modeling indicates peak metamorphic conditions of 912-925 ℃/9.8-10.8 kbar for leucocratic layer of spinel-bearing granitic gneiss and 911-932 ℃/9.8-10.7 kbar for spinel-bearing metagranitoid. These estimates agree with Ti-in zircon (746-978 ℃), Ti-in quartz (807-955 ℃) and ternary feldspar thermometry (870-970 ℃) within error. Zircon and monazite U-Pb dating indicates metamorphic ages of ~1870 Ma for leucocratic layer of spinel-bearing granitic gneiss and 1866-1870 Ma for spinel-bearing metagranitoid. Garnet in both samples shows depleted heavy REE pattern that decreases from core to rim. Zircon cores display steep heavy REE, while rims are relatively flat to gently sloping. Monazites are enriched in light REE and depleted in heavy REE patterns. Lu distribution coefficients suggest equilibrium among garnet cores, zircon rims, and monazite at peak conditions, followed by progressive re-equilibration during retrograde metamorphism.

These results suggest that regional ultrahigh-temperature metamorphism in the southwestern Yeongnam Massif might have begun at least ~1870 Ma. Together with previous studies, the southwestern Yeongnam Massif may have experienced Andean-type orogenesis prior to ~1870 Ma, followed by ultrahigh-temperature metamorphism at ~1870 Ma that possibly associated extensive mafic magmatism associated with slab retreat and/or slab rollback.