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Ultrahigh-temperature metamorphism and near-isobaric cooling of garnet-orthopyroxene granulite xenoliths in the Sancheong anorthosite, Yeongnam Massif, Korea

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Elevated heat flow associated with mafic magmatism in an accretionary orogen has often been proposed as a driving mechanism for ultrahigh-temperature (UHT) metamorphism. The Sancheong–Hadong anorthosite complex, situated in the southern Yeongnam Massif, Korea, is renowned for the Paleoproterozoic (ca. 1.87–1.86 Ga) emplacement in association with a variety of granulite-facies gneisses. Here, we present new findings on the UHT metamorphism and near-isobaric cooling of garnet-orthopyroxene granulite xenoliths entrained in the Sancheong anorthosite. These xenoliths record evidence for in-situ melting typified by leucosomes containing peritectic garnet and orthopyroxene. The presence of garnet coronas at the interface between orthopyroxene and plagioclase in the granulite is attributed to near-isobaric cooling. Phase equilibria modelling of the granulite reveals peak metamorphic conditions reaching 930–950 °C and ~8 kbar, followed by near-isobaric cooling and subsequent melt crystallization at 770–790 °C and ~6.7 kbar. Such a UHT condition of granulite is corroborated by ~886–894 °C estimated from the Ti-in-zircon thermometry. SHRIMP U–Pb analyses of zircon from two granulites and one leucosome yielded consistent $^{207}Pb/^{206}Pb$ ages of ~1860 Ma. In addition, U(–Th)–Pb analyses of monazite in two granulites and one leucosome yielded $^{207}Pb/^{206}Pb$ ages of 1864 ± 9 Ma, 1862 ± 12 Ma, and 1860 ± 13 Ma, respectively. These results indicate a (near-)complete resetting of the U–Pb system at ~1860 Ma during the UHT event. The oxygen isotopic compositions of zircon in granulites have $\delta^{18}O$ value of 8.15 ‰, whereas those of zircon rim in the leucosome show a reduction to 7.67 ‰. The latter closely aligns with 7.52 ‰ estimated from monazite in the granulites; in contrast, the monazite in the leucosome records a slightly lower $\delta^{18}O$ value of 6.57 ‰. Such a trend imply that the $\delta^{18}O$ value is homogenized during the in-situ melting at the UHT condition and undergoes a decrease during melt crystallization. Our results suggest that lower crustal granulite in the southern Yeongnam Massif has most likely undergone ~1.86 Ga UHT metamorphism in association with the anorthosite magmatism. The near-isobaric cooling path of granulites is further accounted for by extensional tectonics prominent at the late stage of the Paleoproterozoic hot orogenesis.