Post-peak incipient charnockite formation in the Neoproterozoic Trivandrum Block, southern India: new insights from monazite Th-U-total Pb geochronology

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Incipient charnockite (Pichamuthu, 1960) has been reported from many Neoproterozoic granulite terranes (e.g., Tsunogae et al., 2023) including some classic localities such as Kabbal, Ponmudi, and Kottavattom in southern India (e.g., Newton and Tsunogae, 2014; Raith and Srikantappa, 1993), Kurunegala in Sri Lanka (e.g., Hansen et al., 1987; Endo et al., 2017a), East Antarctica, and Madagascar (Endo et al., 2017b; Tsunogae et al., 2023) mostly along the Kuunga orogen. There has been an argument whether the incipient-charnockite formation is related to prograde or retrograde dehydration processes. As incipient charnockite patches clearly crosscuts the foliation of host orthopyroxene-free gneisses, it has been regarded that the incipient charnockite might have formed during a retrograde stage. However, the exact timing of the incipient-charnockite formation relative to the peak metamorphism is not known in many localities. This study thus performed in-situ monazite Th-U-total Pb geochronology of charnockite (quartz + plagioclase + K-feldspar + garnet + orthopyroxene + biotite) and host orthopyroxene-free garnet-biotite gneiss (quartz + plagioclase + K-feldspar + garnet + biotite) from Nanguneri in the Trivandrum Block, southern India, and evaluated the timing of incipient-charnockite formation. A monazite grain associated with orthopyroxene yielded a charnockite-forming age of 528 ± 7 Ma (weighted-mean age), which is obviously younger than the peak metamorphic age recorded in monazites from the garnet-biotite gneiss (574 ± 9 Ma). Therefore, the incipient charnockite probably formed during a post-peak retrograde stage, about 50 million years later than the peak event. The coarse-grained nature of the charnockite might be related to biotite dehydration and localized partial melting within the charnockite patches. Although the mechanism of dehydration processes during the retrograde stage is still not known, abundant secondary CO_2-rich fluid inclusions trapped in quartz and feldspar grains within the charnockite suggest a classic model of local infiltration of carbonic fluids derived from external sources (e.g., Newton, 1980; Newton and Tsunogae, 2014).

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