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Magmatic and metamorphic P-T evolution of Udayagiri anorthosite complex, Eastern Ghats Belt, Eastern India

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The polycyclic granulite facies terrane of the Eastern Ghats Belt (EGB) in eastern India is intruded by Proterozoic massif-type anorthosite complexes near its western and northern tectonic contacts with the Archaean Bastar and Singhbhum cratons respectively. Following their emplacement, these meso- to Neoproterozoic complexes (anorthosite and comagmatic members) are themselves metamorphosed under high-grade conditions. Studies on anorthosite complexes of the EGB focused mainly on their petro-mineralogical characterization, structural setting, petrogenetic evolution and relative timing of emplacement in relation to regional deformation events. This contribution evaluates the pressure-temperature history of the Udayagiri anorthosite complex (UAC) from the northern part of the EGB based on paragenetic, textural and mineral chemistry characteristics of the meta-igneous rock suite. This also reports unequivocal textural evidence of collision related tectonic exhumation for first time.

The massif-type UAC mainly comprises of anorthosite, leuconorite-olivine leuconorite and norite diapir in the decreasing order of areal extent. The basic data on petro-mineralogical aspects to characterize the rock types of the UAC is provided in Mahapatro et al. [1]. The UAC is significant because of its unique petrological characters amongst similar complexes in the belt. These rocks exhibit both relict magmatic mineralogy and textures with a metamorphic overprint. The primary plagioclase laths in anorthosite are moderately calcic (~An50-60) and exhibit bent lamellae, kinking and moderate strain-induced recrystallization formed during emplacement and solidification of the plutons. The intercumulus minerals are dominated by orthopyroxene (XMg = 0.55-0.58) with subordinate inverted pigeonite, clinopyroxene, olivine (XMg = 0.6) and ilmenite, occurring either independently or as aggregates. Olivine grains invariably have reaction/kelyphytic rim of orthopyroxene (XMg = 0.68 to 0.70) around them in leuconorite, formed as a magmatic peritectic product above the solidus by reaction with the melt.

Reaction textures of garnet formation can be seen in leuconorite and olivine leuconorite, in which small garnet grains form necklaces along the borders of orthopyroxene and opaque minerals at the interface with plagioclase according to the simplified reactions: Opx + Pl = Grt ± Cpx ± Qtz indicating cooling from crystallization stage. Furthermore, vermicular and radial rod-, bleb- and drop-shaped clinopyroxene-anorthitic plagioclase symplectite is observed growing from garnet borders indicating subsequent breaking down of garnet during an event of near-isothermal decompression (ITD).

Based on phase constraints on composition of igneous plagioclase and associated mafic phases [2], in combination with ternary feldspar solvus and exsolution in inverted pigeonite, the leuconorite-anorthosite suite is estimated to have crystallized at ca. 1000-1100 °C and 10-8 kbar. Field relations and microtextural observations indicate that the UAC was emplaced after the fabric-defining late-Mesoproterozoic deformation and high-grade metamorphism of the country rocks. Recently published age data suggest that anorthosite magmatism in the EGB occurred in a narrow time interval during the early Neoproterozoic. The post-intrusion metamorphic evolution of the complex is characterized by high-grade largely static recrystallization of magmatic parageneses and textures during an initial episode of cooling along a near-isobaric cooling path, from the magmatic crystallization stage to the ambient regional geotherm (ca. 750 °C, 8.0-7.5kbar). This was followed by decompression (ca. 2 kbar) as a consequence of thrusting and uplift of the frontal part of the granulite facies terrane and its juxtaposition with the Singhbhum craton during the late Neoproterozoic to early Palaeozoic Pan-African tectonothermal event.

[1] Mahapatro S N et al. (2013) Jour Geol Soc India 82: 319–329
[2] Fram M S and Longhi J (1992) Am. Miner. 77: 605-616