Mechanism of Formation and Age of the Ayyarmalai A-type Charnockite – Granite association from the South-Eastern Palghat- Cauvery Shear System, Southern India

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ABSTRACT

The Ayyarmalai A-type charnockite and A-type alkali granite lies on the south-eastern margin of the Palghat-Cauvery Shear System and provides an example of co-magmatism that was later overprinted with granulite facies metamorphism at ~2.45-2.5Ga. The Palghat-Cauvery Shear System represents an intriguing zone with Neoproterozoic aged granulites (~800-500 Ma) to the south and Archaean granulites (~3000-2500 Ma) to the north; the origins of which are still often disputed. This study presents whole rock major and trace element compositions, mineral chemistry, pressure-temperature estimates and whole rock Sm-Nd, Rb-Sr, Pb-Pb and $\delta^{18}O$ isotopic compositions of this A-type charnockite-granite association found at Ayyarmalai, Tamil Nadu, Southern India. The subsequent data from this study suggests that: (1) the Ayyarmalai charnockites from the Palghat-Cauvery Shear System have zircon ages that are synchronous with events in the Northern Granulite Terrain; (2) The Dharwar Craton is a strong candidate for the protolith of these rocks; (3) Evidence of a Neoproterozoic-Cambrian granulite metamorphic event (~520 Ma) appears to be absent in these rocks questioning the existence or location of a Neoproterozoic - Cambrian suture zone proposed for the Palghat-Cauvery Shear System recently.

U-Pb zircon ages show zoned igneous cores ~2.65-2.68 Ga ages in both rock types defining the crystallisation age, while the large metamorphic rim overgrowths date the Archaean granulite metamorphic event at ~2.45 - 2.5 Ga. Geochemical data of the Ayyarmalai charnockites reveal a very primitive, unfractionated REE pattern with no Eu-anomaly, ferroan, high K-calc-alkaline, with moderate enrichment of LREE with respect to HREE and fall within the field of high Ba-Sr type granitoids. Extraction of Pyroxene- Hornblende rich cumulates resulted in an intermediate charnockite driving the crystallisation towards the final A-type alkali granite. The A-type alkali granite show a more fractionated REE pattern with a significant Eu-anomaly, ferroan, high-K- calc-alkaline, with enrichment of LREE and depletion in the low Ba-Sr type granitoids. εNd and Nd model ages indicate

a highly evolved protolith ($\varepsilon_{Nd}(0)$ =-25.15 to -33.14) that encountered a crustal Archaean source (2.89-3.09 Ga) causing contamination as the magmas ascended. Harker diagrams, Nd data (isochron age, ~2519 Ma) and U-Pb zircon crystallisation ages suggest a co-magmatic relationship between the charnockite and alkali granite. Conventional geothermometry/barometry suggest minimum pressure-temperature conditions existed at 740 – 750°C and P=5.61 – 5.84 kbar.

The data presented from this study is consistent with a magmatic origin of these charnockites favouring the early crystallisation of orthopyroxene. The correlation with the data from the Dharwar Craton suggest that the study region may have encountered Dharwar Craton on magmatic ascent causing crustal contamination.

Keywords: A-type Charnockites, A-Type alkali Granite, Southern Granulite Terrain, Palghat- Cauvery Shear System, co-magmatism, Archaean – Palaeoproterozoic Boundary.