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Earliest Paleoarchean terranes in the Bastar craton formed as distinct crustal fragments and support dual-mode early Archean geodynamics

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Early Archean tectonic models to explain generation of voluminous tonalite-trondhjemite-granodiorite (TTG) magmas, being mostly non-unique [1, 2] based on granitoid trace element geochemistry, support the relative importance of intra-crustal melting over subduction episodes or to their formation by dual-mode geodynamics [2, 3]. Based on the dual-mode tectonic model of crust formation [3], however, it is more likely that distinct TTG dominated crustal fragments would have formed during Paleoarchean by partial melting of mafic and felsic lithologies at different depths and emplaced with or without fractional crystallization. Based on trace element geochemistry, we support this process from the three distinct Paleoarchean terranes identified constituting the Bastar craton.

The Sukma terrane Paleoarchean migmatite dioritic gneiss domains are metaluminous and exhibit a general trondhjemitic trend, whereas both the augen gneiss and leucocratic gneiss migmatitic components are mostly metaluminous and show a calc-alkaline trend; dioritic and augen gneiss are classified as medium-pressure TTGs, whereas the leucocratic gneiss samples are classified as high-pressure TTGs (Fig.1, after [2]). The Sukma terrane migmatitic TTGs are primarily slab failure plutons derived from garnet peridotite sources (Fig.2). The Kapsi terrane Paleoarchean TTGs, however, are moderately trondhjemitic and show strong calc-alkaline trends. They are metaluminous, low- to medium-pressure TTGs inferred to originate from melts of mafic lithologies and are divided between arc and slab failure plutons derived mainly from spinel-peridotite sources and dominated by amphibole fractionation. In contrast, the Kondagaon terrane Paleoarchean low-pressure TTG and transitional-TTG rocks are metaluminous and were primarily derived from the melts of pre-existing felsic crust and metasediments with lesser mafic input. They are mainly slab failure plutons derived from spinel- and garnet peridotite sources. This coeval Paleoarchean extraction of TTG magmas from variable depths with variable precursor mafic and pre-existing felsic crust, most likely Eoarchean in age, would then support the numerical models of dual-mode model of early Archean mobile lid geodynamics [3]; the slab failure would indicate transient episodes of subduction or recycling.

[1] Moyen, J-F., 2011. Lithos 123, 21-36.

[2] Laurent, O., Guitreau, M., Bruand, E., Moyen, J-F., 2024. Elements 20, 174-179.

[3] Rey, P.F., Coltice, N., Flament, N., 2024. Elements 20, 180-186.