

Mesoarchean metamorphic relics in metasedimentary Sukma Group, Bastar craton, central India: constraints from detrital zircon U-Pb and combined garnet Lu-Hf and Sm-Nd chronology

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Sparsely preserved Mesoarchean meta-supracrustal rocks are reliable markers of cryptic early Archean tectonic activity associated with craton assembly. The Bastar craton in central India hosts remnants of two Archean supracrustal groups, the metasedimentary Sukma Group, and the volcano-sedimentary Bengal Group, although the stratigraphic relations between the two remain unresolved. The Sukma Group supracrustal rocks are metamorphosed to the upper amphibolite-facies, but its deposition time and age of metamorphism are unknown. Here, we present detrital zircon U-Pb, and combined Lu-Hf and Sm-Nd garnet geochronological evidence to constrain their depositional history and timing of metamorphism.

Detrital zircon grains separated from two Sukma Group supracrustal samples yielded concordant $^{207}\text{Pb}/^{206}\text{Pb}$ ages between 3.6-3.1 Ga, whereas the youngest concordant $^{207}\text{Pb}/^{206}\text{Pb}$ age places its maximum depositional age at <3.10 Ga. Pure garnet multigrain fractions were separated from Sukma Group garnet-bearing quartzite samples and sequentially leached with concentrated sulphuric acid and aqua regia to remove any phosphate and oxide inclusions, respectively. The aqua regia leachates were collected and analyzed to yield higher $^{147}\text{Sm}/^{144}\text{Nd}$ ratios than the residual garnet fractions which greatly improves the precision of the isochron ages. Samarium-Nd whole-rock garnet isochrons from the three meta-psammite samples yielded ages of 2978 ± 41 Ma, 3005 ± 14 Ma, and 2972 ± 16 Ma, respectively. The same garnet grains were then analyzed by the Lu-Hf method which yielded a whole-rock garnet tie-line age of 2921 ± 43 Ma and a whole-rock-garnet isochron age of 2962 ± 46 Ma.

Therefore, we present the first quantitative report of a major phase of Mesoarchean sedimentation in the Sukma Group, and also direct evidence of a Mesoarchean tectono-thermal event. We speculate that the Sukma Group represents platformal sedimentary rocks involved in the Mesoarchean ‘Sukma orogeny’ which indicates some form of crustal stacking due to convergent tectonics likely as a result of amalgamation between Paleoproterozoic cratonic fragments.

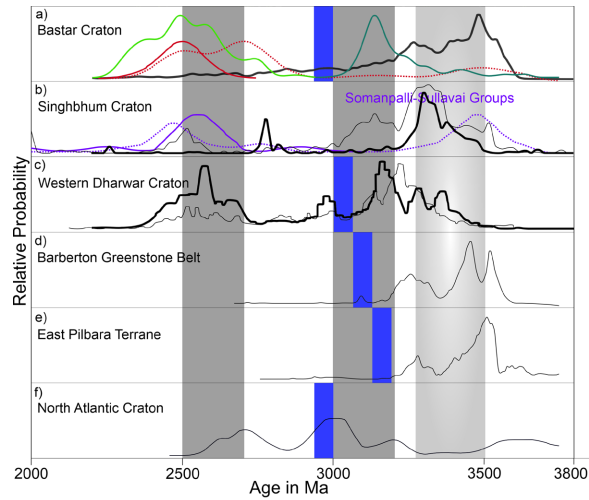


Figure 1. Probability density plots of detrital zircon age distributions between 3600 and 2000 Ma compiled across Archean terrains. Magmatic zircon age probability distribution plots (shown in bold) suggest that best match for the siliciclastic detritus to the Sukma Group (blue curve), Bastar craton, are the Mesoarchean (3.3-3.1 Ga) granitoids of the Singhbhum and Western Dharwar cratons. Detrital zircon age spectra of younger sedimentary rocks from Bengal Group (green curve) and Dongargarh-Kotri Supergroup (red curve) are also shown in panel (a). Vertical dark grey bands correspond to global detrital zircon age peaks and vertical blue bands correspond to reported occurrences of Mesoarchean metamorphism in Archean cratons.

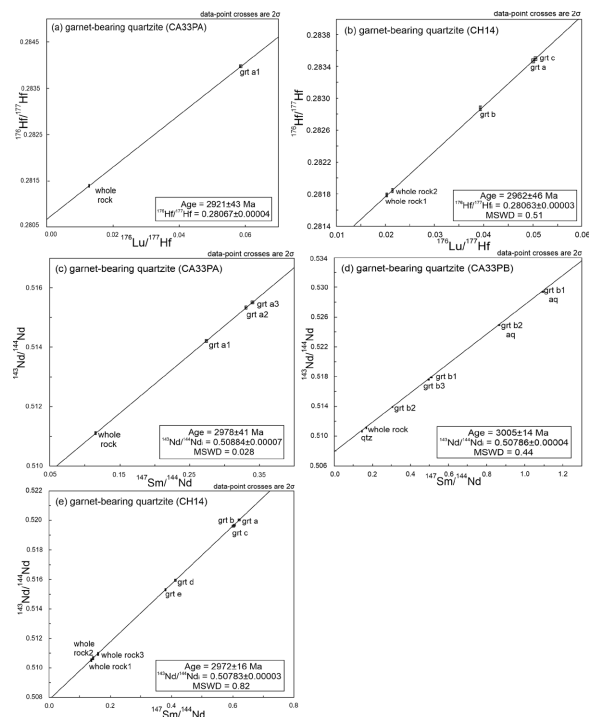


Figure 2. Lu-Hf and Sm-Nd whole rock-garnet isochrons from garnet-bearing metapsammite samples (CA33PA, CA33PB, and CH14) of Sukma Group, Bastar craton.