

Mesoproterozoic Tirathgarh lamproite within the Indravati Basin sediments of central India: Constraints on the timing and conditions of deposition and its relation to the breakup of the Columbia supercontinent

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This study presents the first comprehensive analysis of the mineralogy, whole-rock major and trace element geochemistry, and paleomagnetic dating of an ultrapotassic intrusion located at the base of the Indravati Basin in central India. The intrusion, emplaced as a sill, cuts through the lower section of the Tirathgarh Formation within the basin.

Mineralogical evidence, particularly the ilmenite trend showing increased Fe alongside decreased Mg and Mn, along with high Fe/(Fe+Mg) ratios in spinels resembling the Magnetite Trend-2, supports a lamproite affinity for this intrusion. Whole-rock geochemical data further confirm its lamproitic nature, characterized by low SiO₂, elevated alkali content, and enrichment in LREE. High-field-strength elements, which remain stable during hydrothermal alteration, exhibit strong geochemical similarities to lamproites from the Eastern Dharwar Craton in southern India, suggesting a primary magma origin from an enriched mantle source.

Paleomagnetic analysis places the Virtual Geomagnetic Pole (VGP) at 171.27°E, 75.46°S, with Dp/Dm values of 5.31/9.35. Based on the paleogeographic motion of the southern Indian block, the intrusion is estimated to have formed around 1380 Ma. This Mesoproterozoic age indicates widespread ultrapotassic magmatism across Peninsular Indian cratons, likely driven by the global tectonic processes associated with the breakup of the Columbia Supercontinent.

Furthermore, this new age constraint suggests that sedimentation in the Indravati Basin commenced during the Mesoproterozoic, around 1380 Ma. A notable positive cerium anomaly observed in the studied lamproite, relative to other rare earth elements (REEs), is attributed to the incorporation of Ce into Fe- and Mn-oxides and oxyhydroxides. This geochemical signature, resulting from the sequestration of cerium from an oxic water column, indicates an oxidizing environment during sediment deposition in the basin.

Keywords: Indravati Basin, Ultrapotassic rock, Cerium anomaly, Lamproite, Columbia break-up, Tirathgarh