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Early Cretaceous ultramafic lamprophyre magmatism in north-western India: Manifestation of Kabul block rifting

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Alkaline magmatism, particularly lamprophyres, serves as a crucial proxy for understanding lithospheric dynamics and mantle processes. The western Indian volcanic passive margin, shaped by lithospheric stretching and rift basin formation, experienced significant melt emplacement during continental break-up. The earlier discovery of ultramafic lamprophyres (UML) in the Palanpur region of Kutch, dated to ~120 Ma, represents one of the earliest known occurrences of alkaline magmatism associated with the western margin of India.

This study investigates two UML dykes (PD 1 and PD 2), which exhibit a porphyritic texture with prominent phenocrysts of olivine, clinopyroxene, and phlogopite. Mineral chemistry analyses reveal compositions akin to global ultramafic lamprophyres, characterized by silica undersaturation and low CaO content. Whole-rock geochemistry, including major and trace element data, further confirms their UML affinity. Trace element ratios, such as La/Yb (66–76) and Dy/Yb (~4), closely align with global damtjernite values, suggesting derivation from a garnet stability field and an enriched deep lithospheric mantle source rather than a depleted mantle.

Paleomagnetic investigations indicate an emplacement age of approximately 120 Ma, corroborating previous radiometric dating. This phase of UML magmatism is linked to the separation of the Kabul Block from Greater India, driven by slab pull-induced lithospheric thinning and rifting. The NNW-SSE dyke orientation, along with past kinematic studies, further supports their origin in relation to the Kabul Block rifting event. Paleomagnetic data also suggest a shift in paleolatitude from ~25°S (PD 2) to ~22°S (PD 1), possibly indicating a counter clockwise rotation of the Indian plate. We rule out the direct involvement of the Kerguelen mantle plume in the genesis of UML in Kutch. Instead, our findings highlight major plate tectonic events, particularly significant rifting episodes, providing a refined understanding of the tectonic evolution of the Indian plate around 120 Ma.