

Pre-Collisional Extension and Potential Kimberlite Formation on the Ontong Java Plateau

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The Ontong Java Plateau (OJP), Earth's largest oceanic plateau, formed through plume ridge interaction between 120-90 Ma and later migrated toward the Australian Plate. Despite its approach toward subduction, the OJP exhibits extensive post-emplacement extension, including horst-graben systems and Alnöitic intrusions dated to 34-45 Ma. Seismic data further suggest vertical pipe-like bodies resembling kimberlites, while the plateau's unusually thick lithosphere (up to ~280 km) and MARID-like xenoliths, typically associated with continental cratons, raise the possibility of kimberlite-like magmatism within oceanic lithosphere. This study asks whether pre-collisional extension beneath the OJP could generate the pressure-temperature conditions necessary for diamond stability and kimberlite genesis.

We investigate this through thermomechanical numerical experiments using SOPALE, an Arbitrary Lagrangian-Eulerian viscoplastic modeling framework. Models incorporate a 700-km-wide plateau underlain by 120-280 km of lithosphere, realistic crustal thicknesses, and plate-motion boundary conditions derived from reconstructions of Pacific slab rollback. The simulations track the evolution of strain, strain rate, surface deformation, and thermal structure over 11 Myr-coinciding with the timing of Alnöitic magmatism. Extracted geothermal profiles are compared with diamond stability fields and thresholds for kimberlite melt generation. Model outputs are further evaluated against seismic constraints on lithospheric thickness, MARID xenolith geochemistry, and mapped extensional fault systems.

Preliminary results suggest that slab-pull forces acting on the trailing edge of the plateau may induce focused extension and localized asthenospheric upwelling, producing elevated temperature-pressure regimes potentially suitable for kimberlite formation within oceanic lithosphere.

This work addresses two key gaps in global geodynamics: (1) the mechanism driving extension adjacent to an advancing subduction system, and (2) the plausibility of kimberlite generation in oceanic lithosphere. By integrating modeling with geological and geophysical constraints, this project proposes the first mechanistic framework linking OJP extension to deep mantle melting processes, with implications for both tectonic evolution and economically significant magmatism in oceanic domains.