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3D Geophysical Characterization of the 85°E Ridge Using Gravity Data and Seismic Profiles

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The 85°E Ridge is a prominent aseismic linear structure in the Bay of Bengal, extending from the Mahanadi Basin off India's northeast coast to the Afanasy Nikitin seamount. Despite numerous origin models ranging from hotspot volcanic chains and abandoned spreading centers to leaky transform faults and intra-plate deformation zones induced by the India–Eurasia collision the ridge's, formative mechanism remains unresolved. A critical limitation of previous studies is that their exclusive reliance on two-dimensional interpretations, without a dedicated three-dimensional model. This study presents the three-dimensional gravity-based crustal model of the 85°E Ridge, constructed by integrating satellite-derived gravity data with regional seismic constraints. After removing the gravitational contributions of bathymetry, oceanic crust, and upper mantle via isostatic equilibrium corrections, the residual gravity field attributable to sedimentary and ridge masses was isolated. The sedimentary layer was parameterized with a quadratic varying thickness function. Forward and inverse modeling techniques were then applied to this residual field to generate a three-dimensional sediment thickness model. Model performance was assessed by extracting control data points from existing seismic profiles across the ridge corridor. Comparison of observed versus modeled gravity anomalies yielded a root-mean-square (RMS) misfit of 0.74, indicating a satisfactory agreement. An independent seismic line excluded from the inversion was subsequently used for validation. The final model successfully reproduced the key structural and sedimentary features observed in this dataset, confirming both its robustness and predictive capability. Building on these results, a new hypothesis of compression-induced buckling and thrusting is proposed to explain the origin of the 85°E Ridge. In this scenario, compressive stresses associated with regional plate interactions deformed pre-existing crust, initiating magmatic intrusion and ridge uplift along a reactivated fault fabric. This hypothesis offers a unifying mechanism consistent with the ridge's aseismic character, multilayered magmatic composition, and regional tectonic setting.

Keywords: 85°E Ridge, Gravity Anomaly, Satellite Gravity Data, Forward Modelling, Inverse Modelling