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Cenozoic Tectono-Thermal Modeling of the Leiqiong Area, Beibuwan Basin, Southeast China: Insights into the Geodynamic Mechanism of Leiqiong Volcanism

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The Beibuwan Basin, a Cenozoic extensional basin at the intersection of the Eurasian, Indian, and Pacific plates, provides key insights into the debated geodynamics of Late Cenozoic Volcanism in Southeast Asia. The tectono-thermal evolution of this basin is essential for understanding regional volcanism and geothermal genesis, yet remains poorly constrained. Here we employ a multi-episodic finite extension model to quantify lithospheric stretching factors, strain rates, and thermal structure along three profiles and 19 wells in the Leiqiong area. Results show total stretching factors ranging from 1.04 to 1.76, with peak strain rates during the Paleocene, Middle Eocene, and Oligocene. Basement heat flow increased progressively from 60–62.5 mW/m^2 at 65 Ma to 67–85.5 mW/m^2 at 23.5 Ma, subsequently decreasing to 65–82 mW/m^2 at present, indicating incomplete lithospheric thermal equilibration. Present-day Moho temperatures vary between 534 and 735 °C, with average Curie interface depth and thermal lithospheric thickness of 22 km and 78 km, respectively. The mean present-day mantle heat flow is 45 mW/m^2, constituting 69% of the terrestrial heat flow. Model results indicate that Paleogene extension induced significantly elevated mantle heat flow and temperatures, promoting potential crustal melting at 25–35 km depth. Limited anomalous post-rift subsidence, accompanied by localized uplift during the Early Miocene and Quaternary, implies the presence of mantle upwelling, likely plume-related, providing an additional heat source. These findings offer geothermal evidence that the interplay between lithospheric extension and hot mantle upwelling drove the Late Cenozoic Volcanism in the Leiqiong area.