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Observational Constraints on Dynamic Topography Associated with Large Igneous Provinces

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Large Igneous Provinces (LIPs) – primarily oceanic plateaus, highly magmatic divergent continental margins, and continental flood basalts – are surface manifestations of underlying dynamic mantle processes. In the marine realm, volatiles in basaltic glasses yield eruption depths of LIP lavas, and microfossils in surmounting sediment on LIPs and adjacent seafloor record the dynamic topography of LIPs through space and time. Scientific ocean drilling is typically required to obtain basaltic glasses and overlying sediment, and the two LIPs most thoroughly sampled to date are the Kerguelen Plateau/Broken Ridge (Indian Ocean) and the Ontong Java Plateau (Pacific Ocean), both Early Cretaceous in age. Dynamic topography through time of these two LIPs contrasts markedly. Much of the uppermost igneous crust of Kerguelen Plateau/Broken Ridge erupted subaerially, whereas that of the Ontong Java Plateau erupted in a submarine environment. Following emplacement, Kerguelen Plateau/Broken Ridge subsided similarly to oceanic lithosphere of normal thickness, despite the presence of buoyant continental crust in the LIP, for several tens of millions of years, until portions of the feature were uplifted in association with rifting and breakup between the Kerguelen Plateau and Broken Ridge between 40 and 50 Ma. Subsidence of most of the Kerguelen Plateau and Broken Ridge, similar to that of normal oceanic lithosphere, resumed after breakup and persists to the present day, with the exception of portions of the Kerguelen Plateau affected by Cenozoic hotspot magmatism that created the Kerguelen Isles, Heard Island, McDonald Islands, and adjacent submarine volcanoes. Since formation, the Ontong Java Plateau, in contrast, has subsided considerably less than normal oceanic lithosphere. Some portions have experienced uplift associated with magmatism post-dating formation of the LIP that has created atolls and submarine volcanoes, and uplift/subsidence associated with subduction/obduction of the LIP along the North Solomon Trench. Considerably more observational data are needed to characterize the uplift and subsidence histories of LIPs globally, and combined observation, experimentation, and modeling are required to illuminate causal dynamic mantle processes.