

The Kerguelen Plume: What We Have Learned From ~120 Myr of Volcanism

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The Kerguelen Plume has had a major role in creating major volcanic features in the Eastern Indian Ocean over the last ~120 myr. In order to understand this role, igneous basement has been drilled and cored at 9 sites on the Kerguelen Plateau, 2 sites on Broken Ridge and 7 sites on the Ninetyeast Ridge^(1,2,3,4). In addition, stratigraphic volcanic sections on the two relatively young islands (Kerguelen and Heard) constructed on the Kerguelen Plateau have been studied^(5,6), as well as dredged samples from seamounts defining a linear trend between these islands⁽⁷⁾. Major results are:

(a) The Kerguelen Plateau began forming at ~120 Ma, after Gondwana breakup. Eruption ages decrease from ~120 Ma in the southern plateau to ~95 Ma in the central plateau. This age range is not consistent with a pulse of volcanism associated with melting of a single, large plume head.

(b) The sampled volcanic portion of the plateau is dominantly tholeiitic basalt that formed islands, but the waning stage of volcanism included alkalic basalt and highly evolved, explosively erupted trachytes and rhyolites.

(c) At several geographically dispersed locations on the plateau, the Cretaceous tholeiitic basalt has been contaminated by a component derived from continental crust. Geophysical data are consistent with continental crust in the oceanic lithosphere and clasts of ancient garnet-biotite gneiss occur in a conglomerate intercalated with basalt on Elan Bank.

(d) The Ninetyeast Ridge is a 5000 km volcanic feature composed of tholeiitic basalt whose eruption age increases from south to north (~38 to 82 Ma), as expected for a hotspot track.

Although these lavas have diverse geochemical characteristics there is no evidence for a continental component.

(e) The oldest lavas (~30 Ma) on the Kerguelen Archipelago are tholeiitic to transitional basalt but younger archipelago lavas (<25 Ma) and Heard Island lavas are alkalic. This change to alkaline volcanism reflects a decreasing magma flux from the plume accentuated by the thick Cretaceous plateau lithosphere underlying the islands.

(f) Seamounts between the Kerguelen Archipelago and Heard Island are formed of 18-21 Ma alkalic basalt that may reflect the Tertiary track of the Kerguelen plume.

(g) Isotopic ratios (Sr, Nd, Hf and Pb) range widely in lavas from the Kerguelen Plateau, Ninetyeast Ridge, Kerguelen Archipelago and Heard Island. A significant role for continental crust is obvious at several locations on the Kerguelen Plateau and in a single trachyte from Heard Island. In contrast, there is no evidence for continental crust contamination in lavas from the Ninetyeast Ridge and Kerguelen Archipelago. The isotopic diversity of these lavas reflects plume heterogeneity and mixing of plume and MORB-related asthenosphere and lithosphere.

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