Small-scale heterogeneities in the enriched component of the Kerguelen mantle plume: Pb-Hf-Sr-Nd isotopic constraints from the Kerguelen Baie Charrier section

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The Kerguelen Archipelago, located in the southern Indian Ocean, represents the emergent part of the Northern Kerguelen Plateau and is the world's third largest oceanic island with the longest history. The Baie Charrier basaltic section, on the northern Courbet Peninsula, is composed of mildly alkalic and olivine-phyric basalts, with MgO contents (3.1-16.7 wt.%) reaching much higher values than most of the archipelago flood basalts. The Baie Charrier basalts display a limited range of initial isotopic compositions at 24.5 Ma ($^{176}Hf/^{177}Hf$ = 0.282813-0.282872; $^{87}Sr/^{86}Sr$ = 0.70482-0.70517; $^{143}Nd/^{144}Nd$ = 0.51257-0.51266) except for Pb, where $^{206}Pb/^{204}Pb$ ranges from 18.19-18.64. These compositions are consistent with that of the estimate for the enriched component of the Kerguelen mantle plume, which dominates the ~24.5 Ma 1000 m Mont Crozier basaltic section located 16 km to the southwest. The isotopic systematics of Baie Charrier and Mont Crozier basalts are very similar, suggesting that both sections are derived from the same enriched mantle source region. All of the alkalic basalts, including Baie Charrier, form linear arrays in Pb-Pb diagrams, in contrast to the older (29-26 Ma) tholeiitic-transitional basalts on the archipelago. In Pb-Pb and Pb-Sr diagrams, the trends for the alkalic basalts do not point towards the SEIR MORB field. This reflects the disappearance of the depleted component in these younger basalts (<25 Ma) as the archipelago evolved from a ridge-centered position at ~40 Ma to its current intraplate setting. The linear trends in Pb-Pb diagrams, revealed only by high-precision MC-ICP-MS analyses of the younger mildly alkalic basalts on the Kerguelen Archipelago, reflect the presence of small-scale heterogeneities within the enriched Kerguelen plume.

Principal Component Analysis of Cenozoic Kerguelen plume basalts

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We report the first results of Principal Component Analysis (PCA) of Pb, Sr and Nd isotopic compositions (TIMS and Nu Plasma MC-ICP-MS) from a set of 147 basalt samples from the Kerguelen Archipelago and Northern Kerguelen Plateau (NKP). These include 34 Ma ODP site 1140, Leg 183, on the NKP (n=20) and three distinct subaerial groups on the archipelago: (1) 29-28 Ma tholeiitic-transitional basalts (n=27), (2) 26-25 Ma transitional basalts (n=51), and (3) 25-24 Ma mildly alkalic basalts (n=49). With decreasing age, the 1st eigenvectors (v_1) account for 91%, 63%, 56% and 66% of the variance of each group, while the 2nd eigenvector (v_2) accounts for 6%, 32%, 33% and 20%. For all archipelago basalts, v_1 and v_2 show a variance of 67% and 26%, respectively. Using high-precision Pb isotopes only (n=110), the results are more skewed, with v_1 explaining 87% of the variance and v_2 8%. The temporal evolution of the studied basalts is associated with the northeast migration of the SEIR, increasing the distance between the depleted mantle source (ridge axis) and the Kerguelen plume. At 34 Ma this distance was 50 km, increasing to 250 km at 26 Ma, and finally to 400 km, at 24 Ma. Our study indicates that the Kerguelen plume is the dominant magma source throughout formation of the flood basalts. Pb-Pb isotope linear trends for the alkali basalts reflect the presence of heterogeneities among the plume source, which are represented by v_1. V_2 accounts for the presence of a depleted mantle component, which decreases during formation of the flood basalts. New high-precision Pb and Hf isotopic compositions will constrain the 3rd eigenvector.