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The Kerguelen Plume Source Characterized by Hf Isotopes

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Sr, Nd, Pb and Hf isotopic data for the Kerguelen Archipelago basalts provide important constraints on source components for the Kerguelen Plume, one of the most isotopically extreme plumes (i.e. low $^{87}Sr/^{86}Sr$, high $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$).

We focussed on the Kerguelen Archipelago because many recent studies describing its time- and space-dependent compositional evolution are available. There is no evidence of a continental component in the archipelago lavas. In contrast, some Kerguelen Plateau lavas erupted within the embryonic Indian Ocean after Gondwanaland breakup, show geochemical evidence for continental contamination (Ingle et al., 2000).

We analysed the Hf isotopic compositions of 42 archipelago lavas, dominantly from basaltic stratigraphic sections. The samples encompass the entire range of chemical (transitional-alkali flood basalts and evolved lavas (trachyandesite, trachyte, phonolite)) and Sr-Nd-Pb isotopic compositions, as well as the entire age range of the archipelago lavas (29-0.1 Ma; Nicolaysen et al., 2000).

Sr-Nd-Pb-Hf isotopic data show that the main source of the archipelago lavas is the Kerguelen Plume. A dominant, relatively homogeneous, isotopic signature shown by more than 100 samples reflects the Kerguelen Plume composition. In detail, isotopic characteristics of the Crozier basaltic section (1000 m thick) suggest that it has the most representative composition of the Kerguelen Plume. It shows the highest $^{206}Pb/^{204}Pb$ (18.47-18.66) of the archipelago, and its Hf (0.28281-0.28290), Nd (0.51254-0.51264) and Sr (0.70510-0.70544) ratios overlap the mean isotopic composition of the archipelago flood basalts.

A few archipelago lavas (< 10% of the sample population) reflect interactions of the Kerguelen Plume with either (1) a depleted MORB-type component or (2) the Kerguelen Plateau. (1) Group-D basalts, (depleted flood basalts) erupted between 30 and 25 Ma in the north-central part of the archipelago (Yang et al., 1998), have the highest $^{176}Hf/^{177}Hf$ (0.28307-0.28294) and $^{143}Nd/^{144}Nd$ (0.51288-0.51266), and the lowest $^{87}Sr/^{86}Sr$ (0.7040-0.7046) in the archipelago. Among archipelago lavas, they define the radiogenic end of the archipelago Hf-Nd array and reflect mixing between a depleted SEIR-type component and the Kerguelen Plume. (2) The evolved archipelago lavas (< 10 Ma) have low $^{176}Hf/^{177}Hf$ (0.28276-0.28267) and $^{143}Nd/^{144}Nd$ (0.51260-0.51249). They also have low parent/daughter abundance ratios ($^{176}Lu/^{177}Hf$ to 0.0031 and $^{147}Sm/^{144}Nd$ to 0.088). In addition, they have lower $^{206}Pb/^{204}Pb$ (18.14-18.03) relative to archipelago flood basalts. In a $^{143}Nd/^{144}Nd$ - $^{176}Hf/^{177}Hf$ plot these evolved lavas are systematically below the mantle-crust array, and form a trend roughly parallel to, and below, the linear array for archipelago flood basalts. A comparable relationship is indicated in a $^{143}Nd/^{144}Nd$ vs. $^{208}Pb^*/^{206}Pb^*$ diagram. Their Sr-Nd-Hf-Pb isotopic compositions overlap those of basalts from Elan Bank (ODP Site 1137) on the Central Kerguelen Plateau, which reflect continental crust contamination (Ingle et al., 2000). The isotopic similarities between the Elan Bank basalts and the evolved archipelago lavas suggest that the latter have interacted with the plateau.

The Hf isotopic systematics for Crozier basalts place additional constraints on the Kerguelen Plume source. The Hf-Nd array for the Crozier section has a shallower slope (0.59) than the individual arrays for other archipelago sections and the mantle array as a whole (1.2-1.8). Hf-Nd isotopic ratios for the Crozier section plot distinctively above the mantle array as also observed for Koolau (Hawaii) lavas. In addition, they form a trend overlapping the nonradiogenic Hf-Nd end of the compositional field of Koolau lavas that are inferred to reflect a significant fraction of recycled pelagic sediment in the mantle source of Hawaiian lavas (Blichert-Toft et al., 1999). In a Hf-Pb diagram, the Crozier lavas with their low $^{176}Hf/^{177}Hf$ and high $^{206}Pb/^{204}Pb$ clearly point toward the average composition (Godfrey et al., 1997; Vervoort et al., 1999) of modern pelagic sediments. The Hf-Pb relationship for the Crozier basalts contrasts with that for Hawaiian shield basalts, where low $^{176}Hf/^{177}Hf$ is associated with low $^{206}Pb/^{204}Pb$, which requires a 3 Gy U-Pb (Blichert-Toft et al., 1999). The Kerguelen Plateau lavas show evidence for shallow interaction of the plume-derived magmas with continental crust fragments associated with Gondwanaland break-up. In contrast, the isotopic systematics of the Crozier volcanic section could reflect deep recycling of a high-Lu/Hf component, i.e. comparable to modern pelagic sediments, within the mantle source of the Kerguelen Plume.

Ingle SP, Weis D, Frey FA, Nicolaysen K, Scoates JS, Duncan RA, *AGU Spring meeting,* (2000).

Nicolaysen K, Frey FA, Hodges KV, Weis D, Giret A, *Earth Planet. Sci. Lett.*, **174**, 313-328, (2000).

Yang H-J, Frey FA, Weis D, Giret A, Pyle D, Michon G, *J. of Petrol.*, **39**, 711-748, (1998).

Blichert-Toft J, Frey FA, Albarede F, *Science*, **285**, 879-882, (1999).

Godfrey LV, Lee DC, Sangrey WF, Halliday AN, Salters VJM, Hein JR, White WM, *Earth Planet. Sci. Lett.*, **151**, 91-105, (1997).

Vervoort JD, Patchett PJ, Blichert-Toft J, Albarede F, *Earth Planet. Sci. Lett.*, **168**, 79-99, (1999).