

Hf-Isotopes from Heard Island: A HIMU-MORB Connection?

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Introduction

Lavas of Heard Island, located on the Kerguelen Plateau 440 km south-east of Kerguelen, show the largest range of isotopic compositions among oceanic islands ($^{87}\text{Sr}/^{86}\text{Sr} = 0.7047\text{--}0.7079$; $^{143}\text{Nd}/^{144}\text{Nd} = 0.5127\text{--}0.5124$; $^{206}\text{Pb}/^{204}\text{Pb} = 18.83\text{--}17.79$; $^{187}\text{Os}/^{188}\text{Os} = 0.134$ to 0.175). They are extremely well-correlated and consistent with binary mixing (Barling et al., 1994). The isotopic and trace element characteristics of the isotopically enriched mixing end-member clearly point to an ancient continental crustal origin (Barling et al., 1994), implying that the binary mixtures are between "mantle" and "continental" components. Based on the isotopic and trace element variations, it has been suggested that both Heard and Kerguelen lavas are affected by shallow contamination by continental crust (Class et al., 1996). Although there is mounting evidence for the presence of continental fragments within the Kerguelen Plateau (Weis et al., 1999), the Heard "continental" component has low $^{207}\text{Pb}/^{204}\text{Pb}$ and $^{208}\text{Pb}/^{204}\text{Pb}$ compared to Kerguelen Plateau continental crust contaminated samples. In addition, correlations between Os-isotope ratios and other isotopes support a deep mantle origin for the Heard Island "continental" end-member (Barling et al. 1997), indicating that this component is ancient subducted continental crust.

The "mantle" Heard Island end-member has been interpreted as sampling the most pristine plume source material seen at Heard Island, an interpretation supported by Class et al. (1996), on the basis of the evolution of Kerguelen plume isotopic compositions over the past 117 Ma, and by its high $^3\text{He}/^4\text{He}$ ($R/R_A = 18$; Hilton et al., 1995). However, despite its isotopic "plume credentials", the major and trace element composition of lavas representing this end-member are unusual and point to a source containing amphibole, biotite, Fe-Ti oxides and apatite, indicating a shallow mantle origin (Barling et al., 1994).

Results and Discussion

To this data set we now add Hf-isotope data for Heard lavas ranging in $^{87}\text{Sr}/^{86}\text{Sr}$ from 0.7047 to 0.7060 and in $^{143}\text{Nd}/^{144}\text{Nd}$ from 0.5127 to 0.5125. For these lavas $^{176}\text{Hf}/^{177}\text{Hf}$ ranges from 0.28285 to 0.28272, and as expected correlate with the other isotopes. The $\epsilon_{\text{Hf}}\text{--}\epsilon_{\text{Nd}}$ array is linear (Figure 1), but shallow compared to the main mantle array (i.e. 1.04 for the Heard array as compared to 1.49 for the mantle array (Blichert-Toft et al., 1999)). $\epsilon_{\text{Hf}}\text{--}\epsilon_{\text{Nd}}$ arrays shallower than that of the mantle array have been noted for other plume derived suites, for example Hawaii, where these lavas have been interpreted as reflecting the involvement of continental crust derived sediments with Hf-isotope ratios lying on the high Hf side of the mantle array (Blichert-Toft et al., 1999). However, although Heard lavas reflect the presence of a "continental" end-member,

the Heard Hf-Nd isotope array skirts the low Hf side of the mantle array. Thus if the Heard "continental" end-member has high Hf isotopic ratios as suggested for the Hawaiian suite, then the Heard "mantle" component must lie on the low Hf side of the mantle array in order for the Heard suite as a whole to lie on the low Hf side of the mantle array.

Like the Heard "mantle" end-member, HIMU and low-Hf MORB lie on the low Hf side of the mantle array. Since it is clear from Sr, Nd and Pb isotopic data, that HIMU and MORB are not involved in the Heard source (Barling et al. 1994), it may be that Heard "mantle" end-member shares a process in common with the formation of HIMU and/or MORB components. This process results in low Lu/Hf and/or high Sm/Nd relative to typical mantle as represented by the Hf-Nd mantle array and therefore has implications for the process(es) involved.

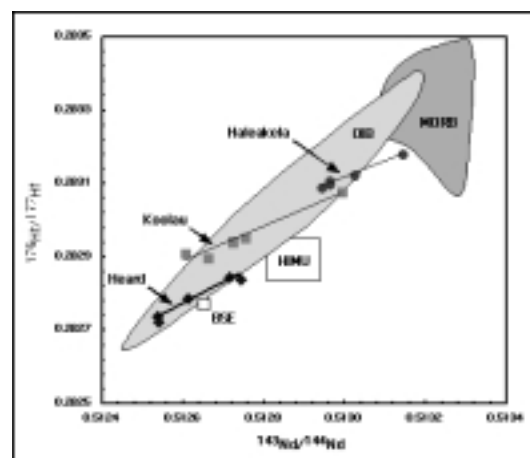


Figure 1: $^{176}\text{Hf}/^{177}\text{Hf}$ versus $^{143}\text{Nd}/^{144}\text{Nd}$ in Heard lavas. Additional data from Blichert-Toft et al, (1999) and Salters and White (1998).

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