Geophysical Research Abstracts
Vol. 16, EGU2014-14498, 2014
EGU General Assembly 2014


# Geochemical asymmetry of the Crozet hotspot

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The Crozet archipelago (Indian Ocean) includes 5 islands showing contemporaneous volcanism and defining two geographical groups: the Eastern group includes the Possession and Est Islands, and the western group the Pingouins, Cochons and Apôtre Islands. The few Crozet samples that have been analyzed for their isotopic compositions (Possession: N=9; Est: N=15; Pingouins: N=13) reveal the presence of geochemical heterogeneities within the Crozet hotspot.

In this study we present new Sr-Nd-Pb-Hf isotopic compositions of 20 lavas samples from the Possession Island. The isotopic compositions, which display limited but significant variations, are characterized by intermediate values ($^{87}Sr/^{86}Sr$ = 0.703972 to 0.704986; $^{143}Nd/^{144}Nd$ = 0.512822 to 0.512873; $^{176}Hf/^{177}Hf$ = 0.282959 to 0.283100; $^{206}Pb/^{204}Pb$ = 18.8099 to 19.1660) akin to the "C" component. As mentioned by previous studies, lavas from the Possession and Est islands (eastern Islands) display comparable isotopic compositions. The western Pingouins Island lavas denote from Possession-Est lavas by having (for example) lower $^{87}Sr/^{86}Sr$ and higher $^{206}Pb/^{204}Pb$ ratios, approaching therefore the Fozo isotopic domain. The most striking results displayed by Crozet data, is the existence of two parallels arrays in the $^{206}Pb/^{204}Pb$ vs $^{208}Pb/^{204}Pb$ diagram. For a given $^{206}Pb/^{204}Pb$ ratio, Possession-Est lavas display higher $^{208}Pb/^{204}Pb$ ratio compared to Pingouins data. These linear isotopic arrays indicate significant heterogeneity within each of the two trends, both having distinct radiogenic and least radiogenic lead end-members. This observation strongly disagrees with the model of simple binary mixing between the Possession-Est and the Pingouins components proposed by Breton et al., (2013). We first propose to model the Possession-Est radiogenic lead end-members by recycling in the Crozet hotspot source 1Gy oceanic crust with $\sim$2% sediments. The Fozo-like signature of Pingouins lavas may be obtained with a similar model that involved recycling of gabbros instead of bulk oceanic crust. The nature and origin of the least lead radiogenic end-members is then addressed. We propose that those later end-members are best accounted by a depleted upper mantle that have been previously contaminated by a DUPAL component (between 1% to 3% by mass). I summary, the isotopic systematic of the Crozet Archipelago is best explained by a two-step mixing model that constrains the DUPAL component to be located in the upper mantle.

Our mixing model implies therefore the presence of two distinct isotopic domains within the Crozet hotspot. The eastern Islands sample one of them and the western Pingouins Islands samples the other one. As suggested for other hotspots showing bilateral asymmetry (e.g. Hawaii), we propose that both isotopic domains could correspond to extensively stretched heterogeneities forming vertical "geochemical filaments" in the Crozet mantle plume. We finally discuss this model in light of the location of the Crozet hotspot above the contour of African Large Low-Shear-Velocity Province in the deep mantle.