Nd-Sr-Pb ISOTOPE COMPOSITIONS OF GANRET PYROXENITES FROM KA`ULA, HAWAII: IMPLICATIONS FOR PLUME-LITHOSPHERE INTERACTION

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Introduction

The presence of garnet pyroxenite xenoliths on O`ahu and Ka`ula Islands, Hawaii, provides the rare opportunity to investigate the composition of the deeper oceanic mantle lithosphere, the composition of the plume, and the nature of plume-lithosphere interaction in two dimensions, downstream from the present-day center of the Hawaiian plume. The Ka`ula-Ni`ihau-Kaua`i islands form a cross-trend relationship to the Hawaiian ridge which further allows to investigate the lateral compositional variations in the lithosphere and its relationship to the Hawaiian swell.

Results and Discussion

The Nd, Sr and Pb isotope compositions were determined on pure clinopyroxene (cpx) mineral separates at the Geochemistry division, NHMFL, on a Finnigan MAT-262 TIMS. Major element compositions were determined by electron microprobe at the U. Of Hawaii, and trace elements by LA-ICP-MS at RSES, ANU. The Ka`ula cpx major and trace element compositions (e.g.: Mg# 0.79-0.83, LREE enrichments, high Dy/Yb) overlap those of the O`ahu pyroxenites [1]. Thermobarometric calculations suggest that the Ka`ula pyroxenites equilibrated at 22-24 Kb pressure (65-75Km depth) and 1300-1500 C, similar to the range of the O`ahu pyroxenites. The above observations are consistent with a high-pressure cumulate origin for the Ka`ula pyroxenites, as previously suggested for the Oahu pyroxenites [1]. The Ka`ula pyroxenite Sr-Nd compositions (\(87\)Sr/\(86\)Sr =0.70312-0.70326, \(\varepsilon_{Nd} = 7.2-8.9\)) overlap those of the O`ahu-Ka`uai post erosional lavas and the O`ahu pyroxenites, falling at the isotopically depleted end of the Hawaiian lavas. In terms of Pb isotopes, however, the Ka`ula pyroxenites extend to lower \(206\)Pb/\(204\)Pb (<18.0) than the post erosional lavas (Fig. 1). New Pb isotope data on the O`ahu pyroxenites also presented here extends to both lower and higher \(206\)Pb/\(204\)Pb ratios than the post erosional lavas (Fig. 1).

Conclusions

The similarities between the O`ahu and Ka`ula pyroxenites, some 200 km apart, suggest the widespread presence of pyroxenitic material in the deeper (>60km) Pacific lithosphere between O`ahu and Ka`ula-Kaua`i. This is consistent with seismic observations suggesting erosion and replacement of the deeper lithosphere between O`ahu - Kaua`i by the plume. The variable \(206\)Pb/\(204\)Pb ratios in the pyroxenites suggest that they are cumulates from plume-related melts that either do not escape to the surface or their heterogeneous compositions are lost in the averaging effect of erupted lavas. The low \(206\)Pb/\(204\)Pb ratios are consistent with an origin from a long-term depleted component (low time-integrated U/Pb), previously suggested from the Hf-Nd isotope systematics of the Oahu pyroxenites [1].

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References