Elemental Discrimination between Peridotite and Pyroxenite Melts in MORB and Hawaiian Glasses

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Introduction

Basaltic melts are understood to originate in the mantle as partial melts of spinel or garnet peridotite that may contain pyroxenite veins from recycled crust. The chemical effect of having a two-phase mantle on the composition of basalt is not well understood. Systematically higher Fe/Mn ratios in Hawaiian Ocean-Island Basalts (OIBs) relative to Mid-ocean Ridge Basalts (MORB) and Icelandic OIBs may be due to such core-mantle interaction or due to Mn-retention in pyroxenite-rich mantle sources [1]. The discrimination of these two effects is a first-order issue in mantle geochemistry. To discriminate between pyroxenite and peridotite sources, we report precise, new measurements of the abundances of 69 elements, including all major elements, determined by laser ablation ICP-MS on glasses from MORB and Loihi seamount.

Experimental

Laser ablation ICP-MS analyses were performed at the Plasma Analytical Facility (NHMFL) using methods described elsewhere [2].

Results and Discussion

The Ga/Al and Ge/Si ratios are not significantly fractionated during crystal-liquid fractionation processes but proved to be sensitive to the source mineralogy. Precise partition coefficients (D) for these elements have recently become available [2]. Employing the new D values [2], we find that Ga/Al ratios are sensitive to the garnet/spinel ratio and effectively discriminate MORB from Hawaiian lavas. Germanium is compatible in garnet, incompatible in olivine, while pyroxenes do not fractionate the Ge/Si ratio during partial melting. Despite the general belief that Hawaiian lavas have a higher percentage of pyroxenite melt, and that this melt is variably distributed among the different Hawaiian volcanoes, we found intervolcanic differences to be unresolved. We also found that the data within a single volcano trends at a high angle to the mixing line between pyroxenite and peridotite melts [1].

Conclusions

Our study [1] found that on a plot of Ge/Si vs. Fe/Mn melts of peridotite and pyroxenite sources can be discriminated. Pyroxenite sources have higher Fe/Mn and lower Ge/Si ratios than peridotite melts. Hawaiian lavas failed to show a significant discrimination in Ge/Si ratio, and are collectively higher in Fe/Mn ratio than MORB. No variation in the extent of pyroxenite melt could be resolved between lavas from Ko'olau and other islands despite the general view that such lavas have significantly higher pyroxenite melts in their source.

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References

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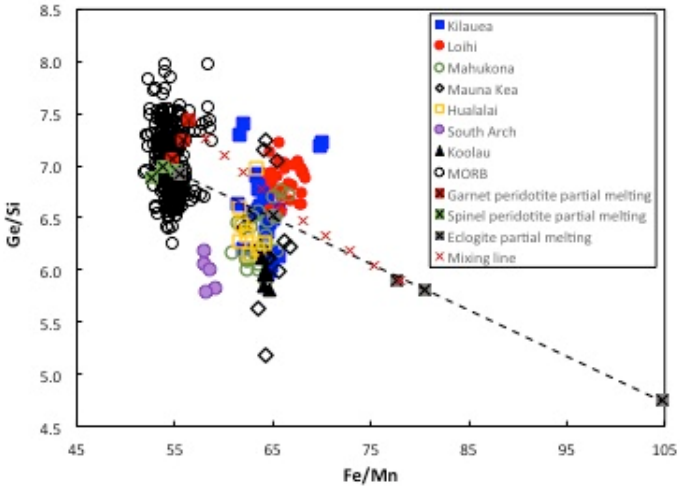

Fig.1 The Ge/Si ratio plotted against the Fe/Mn ratio is found here to be an effective discrimination tool for melts from peridotite vs. pyroxenite sources.