IRON/MANGANESE RATIO AND MANGANESE CONTENT IN SHIELD LAVAS FROM KO'OLAU VOLCANO, HAWAI'I

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Introduction

Humayun et al. [1] reported distinctly higher Fe/Mn (~67) in Hawaiian shield lavas compared with Icelandic lavas (58-61) with similar MgO content. The ~10% Fe excess in Hawaiian lavas was interpreted as the result of core-mantle interaction based on the assumption that the mantle source of Hawaiian shield lavas is olivine-dominated peridotite [1]. Alternatively, Sobolev et al. [2] proposed that the high Fe/Mn in Hawaiian shield lavas is the result of partial melting of olivine-free garnet pyroxenite. These two models, core-mantle interaction and garnet pyroxenite, predict different relationship between SiO_2 content and Fe/Mn. Specifically, the Sobolev et al. model predicts a strong correlation between SiO_2 content and Fe/Mn. In contrast, the core-mantle interaction model does not predict any SiO_2-Fe/Mn correlation. In order to distinguish these two models, we measure the Fe/Mn in Ko'olau and Kilauea shield lavas, which exhibit large SiO_2 variation.

Experimental

The Fe/Mn ratio was determined with a Thermo Finnigan Element1 magnetic-sector inductively coupled plasma mass spectrometer (ICP-MS) at the Geochemistry Division, NHMFL, using methods described previously [1].

Results and Discussion

In Fig. 1, Fe/Mn is plotted against olivine-adjusted SiO_2 (SiO_2*) content in Ko'olau and Kilauea lavas. Except for two Ko'olau lavas (KOO-55 and 55D), other Ko'olau and Kilauea lavas fall on a horizontal trend with no obvious difference in Fe/Mn with increasing SiO_2* content. Partial melts of garnet peridotite are also plotted for comparison. Hawaiian lavas have higher Fe/Mn than partial melts of garnet peridotite. Four mixing lines are plotted in Fig. 1 to show the effect of the SiO_2-rich endmembers, dacite, and the high SiO_2 melt of the secondary garnet pyroxenite (Sobolev et al., 2005; submitted), on Fe/Mn. In detail, two picritic melt compositions are used in the modeling: the average composition of partial melts of garnet peridotite at 3-4 GPa, which has Fe/Mn of 52.8, and a hypothetical picritic melt of Fe-rich garnet peridotite, which has Fe/Mn of 64.4, similar to those in Hawaiian lavas (Fig. 1). Obviously, Sobolev et al. model predicts a strong correlation between Fe/Mn and SiO_2 content, which is inconsistent with the nearly horizontal trend formed by Hawaiian shield lavas. In contrast, this horizontal trend can be explained as a mixing line between a dacite melt and a picrite melt generated from a Fe-rich peridotite. The presence of high-FeO mantle source beneath Hawaii may be accounted for by core-mantle interaction [1].

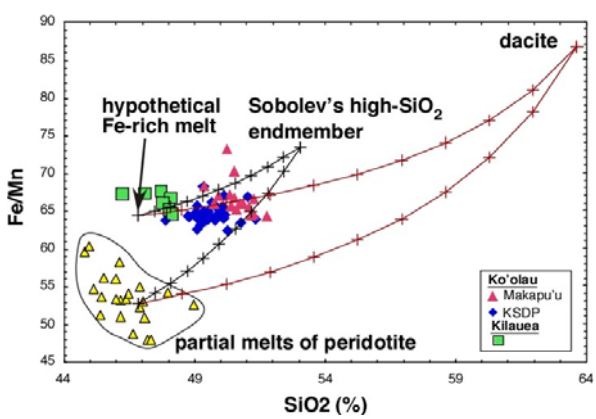

Figure 1. Fe/Mn and olivine-adjusted SiO_2 content in Hawaiian shield lavas

Conclusions

The high Fe/Mn in Hawaiian shield lavas is not the result of partial melting of garnet pyroxenite proposed by Sobolev et al. [2]. Rather, it reflects a FeO-rich mantle beneath Hawaii, which may be the result of core-mantle interaction [1].

References

[1] Humayun, M., *et al*., Science, **306**, 91-94 (2004).
[2] Sobolev, A.V., *et al*., Nature, **434**, 590-597 (2005).