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Transition Metal Geochemistry of Ko'olau lavas

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Hawaiian shield lavas are too siliceous to be in equilibrium with garnet peridotite. Hauri (1996) and Huang and Frey (2005) proposed that dacitic melts from eclogite mix with picritic melts from garnet peridotites to yield high- SiO_2 lavas. Alternatively, Sobolev et al. (2005, 2007) proposed a two-stage reaction model in which partial melts from eclogite first react with peridotite, and form a secondary garnet pyroxenite (SGP). Addition of varying amounts of partial melts from SGP to picritic magma could explain the high SiO_2 content and high Ni content in olivine observed in Hawaiian shield lavas. For example, Makapu'u-stage Ko'olau lavas, characterized by the highest SiO_2 content at a given MgO content, require >90% contribution from partial melts of SGP, implying a very high mass ratio of eclogite:peridotite in the mantle source. Complementing previously reported precise Fe/Mn ratios (Huang et al., 2007), we have precisely analyzed the entire first-row transition metals in Ko'olau and Kilauea lavas by ICP-MS. Here, we use Sc and Mn abundances to test the two models proposed for the origin of high-Si magmas from Hawaii. Both Sc and Mn are moderately incompatible during partial melting of garnet peridotite, but strongly compatible during partial melting of eclogite or SGP. Sc_{15} (abundance adjusted to $\text{MgO}=15\%$) ranges from 19 to 24ppm in Makapu'u-stage Ko'olau lavas, 21 to 28ppm in Kalihi-stage Ko'olau lavas, 24 to 30ppm in Mauna Kea lavas, 27 to 42ppm in Detroit Seamount lavas. For comparison, EPR MORB has Sc_8 (abundance adjusted to $\text{MgO}=8\%$) of 41 ± 5 . Our calculations indicate an upper limit of 20ppm Sc in SGP, assuming $[\text{Sc}]=25\text{ppm}$ in peridotite and 50ppm in eclogite. Since Sc is compatible during partial melting of SGP, the resulting partial melts are too low in Sc to explain the Makapu'u-stage Ko'olau lavas. Rather, the lower Sc_{15} in Makapu'u-stage Ko'olau lavas are consistent with adding up to 30% dacitic magma ($[\text{Sc}]=8.6\text{ppm}$) to picritic magma ($[\text{Sc}]=27\text{ppm}$). Using MnO content, Huang et al. (2007) also concluded that Makapu'u-stage Ko'olau lavas sampled up to 30% dacitic magma. Consequently, we

imply an eclogite:peridotite mass ratio of 1:5 for the source of Makapu'u-stage Ko'olau lavas, significantly less than the estimate of Sobolev et al. (2005; 2007).

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