Presence of eclogite in the magma source region of Hawaiian plume

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Occurrence of silica-rich tholeiite in the shield stage of Hawaiian hot spot is an enigma because almost all other OIB yeilds only silica deficient alkalic basalts. Pyroxenite source has been proposed for magma genesis in Hawaiian plume (Sobolev et al, 2005), on the other hand, Takahashi and Nakajima (2002) emphasized the importance of eclogite in the same source region. In order to understand magma genesis in Hawaiian plume, we carried out basalt peridotite reaction melting experiments under dry and wet conditions between 3 and 8 GPa, 1300 to 1500°C, 1 to 24hrs. Extensive pyroxenite forming reaction took place in the experiments >1 wt% H_2O. On the other hand, under dry conditions, basalt/peridotite reaction was prohibited by thin film of Opx reaction band as long as peridotite remains subsolidus even up to 100% melting of basalt layer. In the experiments with 0.1 to 0.5 wt% of H_2O, 100 to 300 micron thick Opx-rich reaction band was formed at the basalt/peridotite contact.

Based on our experiments, we propose that pyroxenite forming reaction takes place only locally surrounding eclogite blocks in Hawaiian plume. Large eclogite blocks would preserve their basaltic chemistry until final melting stage (melting reaction above dry peridotite solidus). We show that silica-rich Hawaiian tholeiite magma can be produced by eclogite/peridotite reactive melting at ~3GPa 1470-1520°C. On the other hand, melting of mafic pyroxenite produce silica deficient alkalic basalt magma at the same conditions.

Unique occurrence of silica-rich tholeiite in Hawaiian hot spot in contrast with prevailing occurrence of silica-deficient alkali basaltic magma in other OIBs may be explained by the difference in size of entrained former oceanic crust (eclogite). Based on the reconstruction of Koolau volcano by geochemical study of giant Nuuanu landslide blocks, Takahashi and Nakajima (2002) suggested that eclogite block which supplied Makapuu stage silica-rich tholeiite exceeds 1000km^3. On the otherhad, OIB magma source in most hot spots may be smaller pyroxenite body formed by eclogite/peridotite reaction during plume upwelling.

Takahashi and Nakajima (2002) AGU Monograph vol.128, *Hawaiian Volcanoes,* 403-418
Sobolev et al, (2005) Nature Vol.434, 590-597.