Melting experiments of bimineralic eclogite and the origin of ocean island basalts

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There is considerable evidence that mafic lithologies (pyroxenites) are present in the mantle and play important roles in the genesis of ocean island basalts (OIB). A problem in quantitative understanding of the role of pyroxenites in OIB genesis is pyroxenites' compositional diversity, which results in a wide range of melting behaviors. Though subducted MORB may be the volumetrically dominant source for mantle pyroxenite, experimentally produced melts from MORB-like pyroxenite are silica-saturated at high pressures [1], and cannot be silica-undersaturated like most OIB suites. On the other hand, most pyroxenites are more Mg-rich than MORB [2]. Our previous study on partial melting of Mg-rich garnet clinopyroxenite [3] demonstrated that pyroxenite partial melting can explain silica-undersaturated and Al-depleted signatures of OIB magmas if its bulk composition has normative olivine and its residual solid contains significant garnet and lacks olivine. However, it is unclear whether pyroxenites that meet the above requirements are commonly present in OIB source regions.

Bimineralic eclogites are common in worldwide xenolith suites [2] and are the likely consequence of extraction of small degree partial melts or siliceous hydrous fluids from subducted oceanic crust [4], suggesting that they may be an important type of heterogeneity in the mantle. We have done partial melting experiments on a bimineralic eclogite (B-ECL1) at 5 GPa using a multi-anvil apparatus at the Magma Factory, Tokyo Inst. Tech. The solidus temperature is just below 1575 degree C, which is higher than that of MORB composition [5]. In contrast, the liquidus temperature is between 1700 and 1725 degree C, which is close to the peridotite solidus. Thus, B-ECL1 has quite narrow melting interval (less than 150 degree C), and is not more refractory than peridotite as suggested by previous experiments on bimineralic eclogites [6,7]. Compositions of partial melts are silica-undersaturated, and mixing of 5 GPa partial melt of B-ECL1 and peridotite-derived melt (possibly of lower pressures) can explain major element characteristics of primitive OIB lavas, suggesting that subducted MORB that experience subduction-related modification is a potential source for mafic lithologies in OIB source regions.

References: [1] Pertermann & Hirschmann 2003, JGR, in press. [2] Hirschmann & Stolper 1996, CMP 124, 185. [3] Kogiso et al. 2001, EOS 82, S429. [4] Rapp & Watson 1995, J.Petrol. 36, 891. [5] Yasuda et al. 1994, JGR 99, 9401. [6] O'Hara 1963, Yb. CIW 62, 76. [7] Ito & Kennedy 1974, J. Geol. 82, 383.