Partial melting of heterogeneous mantle in OIB source regions

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The hypothesis that key components in OIB source regions derive from recycled crustal lithologies, now more than 20 years old, explains many aspects of OIB geochemistry, but is not universally accepted. Important observations consistent with the recycling hypothesis are correlations between isotopic signatures of distinct mantle reservoirs and indications of distinct partial melting behaviour that can be linked to recycled lithologies. Such data require an understanding of the melting behaviour of candidate lithologies. A substantial body of experimental data now exist on the partial melting of pyroxenite under nominally anhydrous conditions. These data reveal that most plausible pyroxenite compositions have lower solidi than peridotite. Thus, they are likely to be sampled preferentially by weak plumes and at the periphery of stronger plumes. In stronger plumes they may supply high-degree melts with recycled isotopic signatures that mix with smaller-degree partial melts of less exotic peridotitic sources. Many pyroxenites also produce undersaturated (*ne*-normative) partial melts, which may explain why OIB with strong signatures of recycling are almost universally alkalic rather than tholeiitic. An important consideration related to the behaviour of pyroxenites in OIB source regions is the effects of the length scale of heterogeneities. Partial melts of pyroxenite derived from very small bodies will react with surrounding peridotite and lose their distinctive character. Preliminary analysis of melt extraction and reaction times suggests that melt may escape pyroxenite bodies wider than a few meters without equilibration with peridotite, but it remains unclear how or if pyroxenite-derived melts can retain their integrity during transport through overlying peridotite.

Mantle isotopic heterogeneity beneath northern Kyushu, SW Japan

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Northern Kyushu Cenozoic volcanism occurs over a vast area and comprises a number of centers; each center, in turn, is made up by scattered, small, monogenetic volcanoes with ages ranging from about 0 to 10 Ma, producing mainly olivine basalts and olivine alkali basalts. Representative fresh samples from each center were analyzed for chemical compositions, including Sr, Nd, and Pb isotopes. Although there are evolved types resulted from olivine and clinopyroxene fractional crystallization, most of the basalts are primitive in compositions with SiO_2 ranging from 44 to 53 wt%, MgO = 5 to 11 wt% and FeO* = 8 to 15 wt%. Primitive mantle normalized incompatible trace element patterns are broadly oceanic island basalt (OIB)-like. Isotopic compositions of basalts from different centers plot within distinct fields regardless of eruption age and show a general correlation between enriched mantle type 1 (EM1-like) and type 2 (EM2-like), with $^{206}Pb/^{204}Pb$, respectively, = 17.80 and 18.40, $^{87}Sr/^{86}Sr$ = 0.7043 and 0.7052, $\Delta 8/4Pb$ = 115 and 60. Besides, the EM1- and EM2-like are also distinct in trace element characteristics. For instance, although the basalts in general show high ratios of light (LREE)/ heavy rare earth element (HREE), low LREE/HFSE (high field strength element) and generally high large ionic lithophile element (LILE) suggesting an enriched source region, crustal contamination free EM2-like samples have lower LILE/HFSE and HFSE/LREE compared with the EM1-like lavas. The data plotted together with those from the Sea of Japan reveal a complicated, three-component correlation, in that, (1) low $^{87}Sr/^{86}Sr$, low $^{208}Pb/^{204}Pb$ and $\Delta 8/4Pb$ Dupal anomaly-bearing (EM1-tainted) basalts from the Japan Sea Basin represent the most depleted end member; (2) high $^{87}Sr/^{86}Sr$, $^{208}Pb/^{204}Pb$, $\Delta 8/4Pb$ Ulreung-Dog island (within the Sea of Japan) lavas, being the most EM1-rich in the region, define the second apex; (3) the northern Kyushu basalts, with the most EM2-rich samples forming the third apex, are embedded within the triangle. Based on the isotopic mixing model and the fact that chemical compositions of basalts at each center are relatively homogeneous, however, different from center to center, suggesting spatial factor may be important, we propose that, while the mantle beneath northern Kyushu is very much similar to that of the Sea of Japan, represented by a spectrum of depleted MORB-EM1 (Dupal-like) hybrids believed to be present throughout the East Asian asthenosphere, the EM2-like component may be acquired from shallower levels, possibly in the lithosphere mantle.