Formation of hybrid mantle pyroxenites by reaction between mafic layer-derived melts and peridotites: Implications for OIB source heterogeneity

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Current models for the production of OIB assume that melts derived from mafic layers in the mantle (recycled oceanic crust) react with peridotites to form secondary hybrid pyroxenites that, upon further melting, are the source of the HIMU component in OIB. Concordant mantle pyroxenites in residual MORB-source mantle in the Jurassic Pindos Ophiolite have Os isotope compositions consistent with such an origin as hybrid pyroxenites (Sergeev *et al*., this volume).

Here, we will present key textural and petrological observations on mantle pyroxenites from the Greek Pindos and Othris Ophiolites that support an origin as relics of replacive, hybrid pyroxenites formed by melt-rock reactions between peridotites and pyroxene-saturated melts. Textural remnants of the protolith peridotite are preserved as small enclaves and as orientation families of olivine and clino-pyroxene inclusions. These pyroxene-saturated melts were almost certainly derived from the melting of mafic lithologies.

In the Totalp Massif near Davos, Switzerland, mantle rocks from an ocean-continent transition between Adria and the Alpine Tethys are preserved without significant Alpine metamorphic overprint. The mantle rocks contain metre-scale mafic layers in the form of garnet-clinopyroxenites with gabbroic compositions. Other pyroxenites include garnet-free clinopyroxenites, websterites, and olivine-websterites. Zoned pyroxenites, with garnet-bearing clinopyroxenite centers and websteritic-to-orthopyroxenitic margins provide a key link between the different types of pyroxenites and have been studied in detail. We will present textural and petrological evidence that suggests that the websteritic-to-orthopyroxenitic margins are formed by melt-rock reactions between wall-rock peridotites and melts derived from the melting of mafic layers. Recent Os isotope data are fully consistent with such an origin.

The Pindos, Othris and Totalp cases provide a general petrological model for the formation of hybrid mantle pyroxenites. This model fits remarkably well with the ‘double-distillation’-type models for the formation of OIB. Our model predicts that $^{187}Os/^{188}Os$ isotope ratios of hybrid pyroxenites are radiogenic (0.14 to 0.20), which is very similar to estimates for the HIMU components in OIB.

Structure and geochemistry of the incipient oceanic crust of the Red Sea and the rifted margin of Western Arabia

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The continental-oceanic crust boundary and an incipient oceanic crust of the Red Sea opening are exposed within the Arabian plate along a narrow zone of the Tihama Asir coastal plain in SW Saudi Arabia. Dike swarms, layered gabbros, granophyres and basalts of the 22 Ma Tihama Asir (TA) continental margin ophiolite represent products of magmatic differentiation formed during the initial stages of rifting between the African and Arabian plates. Nearly 4-km-wide zone of NW-trending sheeted dikes are the first products of mafic magmatism associated with incipient oceanic crust formation following the initial continental breakup. Gabbro intrusions are composed of cpx-ol-gabbro, cpx-gabbro, and norite/troctolite, and are crosscut by fine-grained basaltic dikes. Granophyre bodies intrude the sheeted dike swarms and are locally intrusive into the gabbros. Regional Bouger gravity anomalies suggest that the Miocene mafic crust represented by the TA complex extends westward beneath the coastal plain sedimentary rocks and the main trough of the Red Sea. The TA complex marks an incipient Red Sea oceanic crust that was accreted to the NE side of the newly formed continental rift in the earliest stages of seafloor spreading. Its basaltic to trachyandesitic lavas and dikes straddle the subalkaline–mildly alkaline boundary. Incompatible trace element relationships (e.g. Zr-Ti, Zr-P) indicate two distinct populations. The REE concentrations show an overall enrichment compared to N-MORB; light REEs are enriched over the heavy ones ($(La/Yb)_n > 1$), pointing to an E-MORB influence. Nd-isotope data show ε_{Nd} values ranging from +4 to +8, supporting an E-MORB melt source. The relatively large variations in ε_{Nd} values also suggest various degrees of involvement of continental crust during ascent and emplacement, or by mixing of another mantle source.