



Oceanic lithosphere composition revisited: constraints from major element and modal relationships in mantle xenoliths from ocean islands

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Available major element and modal data on mantle xenoliths from ocean islands show that harzburgite and lherzolite peridotites fall in two main categories. Group OI1 samples do not show petrographic indications of metasomatism (hydrous minerals, apatite, poikilitic pyroxenes, melt – wall-rock reactions, etc.), although some metasomatism may be reflected in the incompatible trace elements. OI1 xenoliths have highly refractory major element and modal compositions. Group OI2 xenoliths, in contrast, have been significantly modified by interaction with ocean island magmas, which is reflected in their textures and modal compositions (poikilitic pyroxenes, evidence of reactions, the presence of hydrous minerals, evidence of the growth of clinopyroxene at the expense of orthopyroxene, etc.), and major element compositions. The OI1 peridotites correspond to residual mantle formed from a primordial source after 25-30 % partial melting, leaving a clinopyroxene- and garnet-free residue. The small amounts of clinopyroxene observed in these rocks have mainly formed through exsolution from orthopyroxene and recrystallization. It is likely that the high degree of melting indicated for the OI1 peridotites represents the combined result of repeated melting episodes over a long period of time. The OI1 peridotites represent those parts of the oceanic mantle lithosphere beneath ocean islands that are least affected by processes associated with the ocean-island formation. The original (pre-ocean-island) composi-

tion of the oceanic lithospheric mantle is best preserved in the most abundant major elements and in the modal relationships of the OI1 xenoliths.

The OI1 peridotites are, on average, more refractory than abyssal peridotites collected along mid-ocean ridges and fracture zones (MORP: mid-ocean ridge peridotites). This difference reflects compositional zoning in the abyssal lithospheric mantle. MORP represent the more fertile uppermost part that has been heavily infiltrated by MOR melts, and has suffered serpentinization and marine weathering. OI1-type peridotites constitute the highly refractory middle to deeper parts of the oceanic lithosphere, which are unaffected by such processes. We propose that the average composition of OI1 harzburgites (44.1 wt% SiO₂, 0.02 wt% TiO₂, 0.65 wt% Al₂O₃, 0.3 wt% Cr₂O₃, 7.9 wt% FeO*, 46.3 wt% MgO and 0.65 wt% CaO) represents a more realistic model for the composition of the bulk of the abyssal lithospheric mantle than estimates based on MORP. The fact that the stability field of spinel harzburgites expands to higher pressures with increasingly refractory compositions may explain why garnet-bearing lherzolites or harzburgites are absent from (available) mantle xenoliths suites from ocean islands. Highly refractory OI1 spinel-harzburgites have higher solidi than more fertile, clinopyroxene-bearing peridotites, and are likely to be resistant to further partial melting. They are also buoyant relative to less refractory, denser mantle material and may preferentially accumulate at the top of the convecting mantle, where they freeze to the base of newly formed abyssal lithosphere.