Heterogeneous mantle domains in a modern OCT: new insights from the West Iberian margin (ODP Legs 149 and 173)

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Magma-poor ocean-continent transition zones (OCTs) represent wide areas of tectonically uplifted mantle. While an important body of literature has dealt with the investigation of fossil analogues (e.g. Picazo et. al., 2016, and references therein), studies on mantle sequences exhumed in modern OCTs remain a few (e.g. McCarthy et al., 2020), leaving our knowledge somehow fragmentary. In particular, how, where and when lithospheric breakup occurs, the timing of melt production, and the nature of the mantle source involved remain hotly debated issues.

Among the best-documented continental margins worldwide, the West Iberian margin represents a unique site where mantle has been accessed through scientific drilling more than three decades ago (e.g. Boillot et al., 1989). However, these peridotites have remained poorly characterized, partly because of their pervasive serpentinization.

In this contribution, we present the results of an in situ petrological and geochemical study performed on a set of mantle peridotites from ODP Holes 899B, 1068A, and 1070A. In Hole 899B, relatively fresh spinel- and plagioclase-bearing harzburgites (cpx ≈ 2-8 vol.%) occur. In contrast, highly serpentinized plagioclase lherzolites and spinel harzburgites were sampled in Holes 1068A and 1070A.

Hole 899B spinel harzburgites bear refractory compositions, as attested by the low clinopyroxene contents (≈ 2-3 vol.%), coupled to moderate spinel Cr# (0.230-0.343) and low pyroxene Yb_N (≈ 1-2). Geochemical modeling based on pyroxene trace element compositions points to significant degrees of melt extraction (up to ≈ 15%), starting in the garnet stability field, followed by post-melting metasomatism.

Holes 899B and 1068A plagioclase-bearing samples share remarkable similarities, i.e. frequent occurrence of (altered) plagioclase rims mantling elongated dark spinel, Na_2O- and Al_2O_3-rich clinopyroxene associated with high TiO_2 spinel (up to 0.66 wt%). Clinopyroxene shows convex-upward REE patterns, yielding negative Eu anomalies and higher HREE contents compared to abyssal peridotites. Hence, these peridotites are not simple partial melting residues but experienced melt-rock interaction processes and re-equilibration in the plagioclase stability field.

Hole 1070A peridotites exhibit contrasting signatures, as highlighted by the presence of Na_2O-rich, Al_2O_3-poor clinopyroxene coupled to spinel with high Cr# (0.246-0.428) and TiO_2 below the detection limit. Orthopyroxene trace element investigation of these samples revealed hump-shaped patterns with variable LREE-MREE fractionation (La_N/Sm_N= 0.003- 0.16) and low Yb_N (≈ 1-2).

Our new data attest a wide spectrum of petrological and geochemical characters shown by mantle rocks exhumed in a modern OCT. This heterogeneous nature possibly reflects a complex interplay between rifting-related processes and previous depletion history inherited from the last Wilson cycle.

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