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Garnet clinopyroxenite layers from the mantle sequences of the Northern Apennine ophiolites (Italy): evidence for recycling of crustal material

A. Montanini (1), R. Tribuzio (2,3), and M. Thirlwall (4)

(1) Dipartimento di Fisica e Scienze della Terra, Universita' di Parma, Italy (alessandra.montanini@unipr.it), (2) Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Italy, (3) CNR - Istituto di Geoscienze e Georisorse, U.O. Pavia, Italy, (4) Department of Geology, Royal Holloway, University of London, UK

The origin of garnet pyroxenite layers in the External Liguride ophiolitic peridotites has been investigated by means of whole-rock and mineral geochemistry and Nd-Hf-O isotope data. The External Liguride mantle represents a peridotite-pyroxenite sequence of subcontinental origin emplaced at a fossil ocean-continent transition. The pyroxenite assemblage (garnet + Al-Na-rich clinopyroxene + sulphides $\pm$ graphite) testifies to an early stage of equilibration in the lowermost continental lithosphere at $\sim$2.8 GPa and 1100°C. The garnet clinopyroxenites are mafic rocks with high Al, Fe, Ca and Na contents and evolved Mg# values (66-71). Bulk rock REE patterns, mirrored by trace element mineral compositions, show severe LREE depletions (Ce_N/Sm_N = 0.08-0.19) and small positive Eu anomaly; HREE range from flat with Lu_N = 5-8 to enriched, with Lu_N= 13-24. The garnet clinopyroxenite major and trace element characteristics are consistent with recycling of plagioclase-bearing mafic protoliths that underwent high degree of partial melting in the garnet stability field. Trace element models show that both pyroxenites with different HREE fractionation may have formed as cumulates from melt of an eclogite precursor linked by small amount of garnet fractionation. In alternative, pyroxenites with flat and HREE-enriched patterns may represent, respectively, residual rock after eclogite melting and crystal/liquid accumulation from eclogite melt in the outer part of the former eclogite body. Lu-Hf isotope correlations suggest a Triassic age for the melting event. The Nd-Hf isotopic compositions of the garnet pyroxenites recalculated subtracting the radiogenic growth after the Triassic fractionation (ε_{Nd} = + 4.3 to +7.2, ε_{Hf} = + 2.8 to + 12.0) lies below the terrestrial mantle array, in agreement with recycled ancient MORB protholiths. The lack of an apparent oceanic crustal signature provided by oxygen isotope composition ($\delta^{18}O$ = 4.9-5.4 ‰) may be reconciled through recycling of the basal section of oceanic crust or delamination of continental lower crust. The peridotite-pyroxenite sequence of this study may be envisaged as an old veined lithospheric mantle containing garnet-bearing layers derived from recycled crust. Rifting-related asthenospheric ascent may have caused melting of the pre-existing mafic heterogeneities. Another plausible scenario, involves infiltration into the lithospheric peridotite of melts derived from streaks of recycled crust in the ascending asthenosphere. Whatever the provenance of the mafic heterogeneities (lowermost continental lithosphere vs. convecting mantle), both scenarios depicted above involves refertilization of the subcontinental lithosphere above upwelling asthenosphere through redistribution of melts derived from recycled crustal rocks. Involvement of such material in the source of the Jurassic MORB-type ophiolites from the Alpine-Apennine belt could account for the garnet geochemical signature and moderate Nd isotope variability of the ophiolitic crustal rocks.