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Garnet pyroxenites from the External Ligurian ophiolites link mafic crust recycling to HIMU basalts genesis

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Pyroxenites represent a major form of heterogeneity in the upper mantle. Due to their lower solidus temperature, pyroxenites play a pivotal role in the magma genesis, contributing to the isotopic signature of the OIB. More specifically, the involvement of a garnet pyroxenite component, derived from recycling aged (>1.5 Ga) oceanic crust, was typically invoked to account for the origin of the HIMU component. However, testing this hypothesis remains challenging, due to the rare occurrence of recycled pyroxenites among natural samples. In addition, the few available data significantly depart from the highly radiogenic Pb isotopic values typical of HIMU basalts [1].

In this contribution, we present the first witness of recycled mantle pyroxenites bearing a HIMU-like signature. Our study deals with a Pb elemental and isotope investigation of garnet clinopyroxenite and websterite layers enclosed within the fertile mantle sequences of subcontinental lithospheric origin from the External Ligurian ophiolites (Italy). The garnet clinopyroxenites originated from gabbroic protoliths that underwent long-term storage into the mantle (1.5-2.0 Ga), as indicated by Sm-Nd and Lu-Hf systematics, which point to a HIMU affinity [2, 3]. Previous studies support an origin from gabbro-derived eclogitic melts for the garnet clinopyroxenites, whereas the websterites were interpreted as secondary (second-stage) pyroxenites.

High-precision in situ LA-ICP-MS measurements reveal that Pb preferentially partitions into clinopyroxene and garnet (Pb ≈ 0.05 ppm), whereas values below the detection limit are invariably displayed by sulphides. In Pb isotope diagrams, the pyroxenites define a rough positive correlation, with most garnet-bearing clinopyroxenites covering the whole spectrum of HIMU basalts, whereas the websterites display less radiogenic compositions, intermediate between DM and HIMU. Pb-Pb whole rock-clinopyroxene-garnet isochrons point to Paleoproterozoic ages, in the range of source differentiation ages proposed for HIMU basalts [4].

We propose that the garnet pyroxenites represent a rare combination of ages and time-integrated U/Pb and Th/Pb ratios, providing the first direct link between crustal recycling and HIMU basalts genesis.

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