Pb isotope composition of recycled mantle pyroxenites: insights into the the HIMU source of oceanic basalts?

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Recycled mantle pyroxenites are believed to play a key role in the magma genesis contributing to the radiogenic Pb signatures within the sources of oceanic basalts. In particular, a garnet pyroxenite component derived from recycling of aged oceanic crust is widely advocated to explain the HIMU end-member in the OIB sources. However, natural examples of recycled pyroxenites are rare and the known examples do not meet the required Nd-Hf-Pb isotope characteristics of this component (e.g., Varas Reus et al., 2018). Here, we present Pb isotope systematics of garnet clinopyroxenites and websterites enclosed in fertile mantle sequences of the External Ligurian ophiolites (Northern Apennine). The garnet clinopyroxenite layers have gabbroic crustal precursors that experienced a long-lived evolution of recycling into the mantle (1.5-1.0 Ga), as inferred from Sm-Nd and Lu-Hf isotope systematics, which in addition point to a HIMU affinity (Montanini & Tribuzio, 2015). The garnet clinopyroxenites originated by crystallization of melts produced by partial melting of gabbro-derived eclogites, whereas the websterites were interpreted as secondary pyroxenites with a crustal geochemical fingerprint and a peridotite contribution.

Highly radiogenic present-day Pb isotope compositions were obtained for bulk rocks and clinopyroxene separates from garnet clinopyroxenites. In Pb isotope diagrams, samples exhibit a good positive correlation, with $^{206}Pb/^{204}Pb$ extending from MORB field toward the most extreme HIMU components (i.e., St. Helena and Mangaia hotspots). In particular, the pyroxenites and the clinopyroxene separates display somewhat higher $^{207}Pb/^{204}Pb$ and lower $^{208}Pb/^{204}Pb$ for a given $^{206}Pb/^{204}Pb$ than HIMU-type basalts. The less radiogenic values are shown by the websterites containing a peridotite component. Age-corrected Pb isotope compositions of clinopyroxene separates, assuming a melting event at 220 Ma as inferred from Nd-Hf isotopes, are strikingly similar to the most extreme HIMU-type basalts. High-precision LA-ICP-MS analyses of elemental Pb were also performed on the primary HP assemblage of the garnet clinopyroxenites (Al-rich clinopyroxene, garnet and Fe-Ni-Cu sulfides). The results show that clinopyroxene is the main carrier of Pb, whereas Pb is typically below detection limits in sulfides, in contrast with recent measurements on sulfides from abyssal peridotites and pyroxenites (e.g. D'Errico et al., 2019).

The Pb isotope compositions of studied pyroxenites require a long-term evolution of recycled MORB-type gabbros with high and variable U/Pb and Th/Pb ratios. We conclude that these rocks represent a special and rare combination of age and composition of subduction-modified recycled oceanic crust.

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