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Multi-stage silicate-carbonatite mantle metasomatism with K-Na-P-LREE enrichments near the Pacific margin of Siberia

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Many studies of mantle metasomatism focus on branding it either as 'silicate' or 'carbonatite', e.g. using La/Yb vs. Ti/Eu plots for clinopyroxene, seeking to identify its media and sources: basaltic melts vs. CO_2-rich fluids enriched in light rare earth elements (LREE) and low in high-field-strength-elements (HFSE). Yet, media with the 'carbonatite' signatures were also proposed to develop during fractionation of CO_2-bearing mafic melts, i.e. originate from 'silicate' sources. We report petrographic, chemical and Ca-Os-Sr-Nd isotope data on peridotite xenoliths in basalts near the Pacific coast of far eastern Russia that shed new light on the issue. The samples range from LREE-depleted spinel lherzolites to rocks with metasomatic pockets and veins containing alkali feldspar as well as Ti-Zr-Nb-rich and phosphate micro-phases. The latter samples, earlier ascribed to peculiar "alkali – Ti-oxide metasomatism", are enriched in K, Na, P, Sr and LREE, yet, paradoxically, show no whole-rock enrichments in Ti, Zr and Nb in spite of the presence of oxides rich in these elements (armalcolite, rutile, loveringite). We posit that the HFSE in these rocks were initially hosted by pyroxenes (less commonly, amphibole and phlogopite), but formed the oxide phases when these silicates were replaced by HFSE-free feldspar and olivine. The peridotite suite defines a continuous transition from 'silicate' to 'carbonatite' signatures and could be metasomatized by different batches of evolving alkali-rich, water- and HFSE-poor, CO_2-bearing media.

The metasomatism patently influences Sr-Nd isotope compositions. The $^{187}Os/^{188}Os$ vs. Al_2O_3 relations suggest post-melting additions of radiogenic Os in some metasomatized samples. The $d^{44/40}Ca$ are not correlated with La/Yb, Sr, other chemical indices of melting and metasomatism or radiogenic isotope ratios, either due to low Ca inputs by alkali-rich metasomatic media relative to initial Ca content, or PM-like compositions of the media. Overall, the mantle at the Pacific margin of NE Asia contains both melt-depleted and enriched domains with a range of chemical and isotope patterns. Unraveling its nature and origin requires an inclusive multi-discipline approach rather than relying on any specific chemical (e.g., La/Yb, Ti/Eu) or mineral indices of depletion or metasomatism.