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Metasomatized spinel peridotite xenoliths from the Quaternary intraplate alkali basalt, Jeju Island, South Korea

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Spinel harzburgite to lherzolite xenoliths are entrapped in Quaternary intraplate alkali basalts on Jeju Island, South Korea. These xenoliths are unusual in containing late-stage secondary orthopyroxene, free of deformation and exsolution that is replacing olivine as the main pervasive metasomatic mineral. These xenoliths are characterized by high Mg# in olivine, orthopyroxene, and clinopyroxene (89-93) and variable Cr# of spinel (9-53), representing residues left after variable degrees of melt extraction (~25%). In contrast to their depleted major-element compositions, clinopyroxenes in the xenoliths are enriched in most incompatible trace elements. Clinopyroxenes display enrichment in light rare earth elements (LREE) or spoon-shaped REE with a general enrichment in La over Ce, and depletion in high field strength elements (HFSE; e.g., Nb-Ta, Zr-Hf, Ti). Orthopyroxenes (either primary or secondary) are characterized by low TiO_2, high Al_2O_3, and moderate CaO contents, and resemble those of sub-continental arc peridotites from the eastern Pacific. The geochemical evidence, in addition to the formation of secondary orthopyroxene, indicates that Jeju peridotite xenoliths have been subjected to different degrees of metasomatism by subduction-related silica- and LREE-enriched fluids (or melts). However, chemical equilibrium is evident between the primary and secondary orthopyroxene, implying that the duration of post-metasomatic high temperatures enabled complete resetting/reequilibration of the mineral compositions. The metasomatic enrichment pre-dates the host Jeju Quaternary magmatism, and a genetic relationship with the host magmas is considered unlikely. We therefore propose that the Jeju peridotite xenoliths went through a two-stage evolution, with their composition primarily controlled by early fractional melt extraction, which was subsequently modified by residual slab-derived fluids (or melts). Following enrichment in the peridotite protolith in the mantle wedge, the upper mantle beneath proto-Jeju Island was transformed from a subarc environment to an intraplate environment. The Jeju peridotites, representing old subarc fragments, were subsequently transported to the surface, incorporated into ascending Quaternary intraplate alkali basalt. The result of this study implies that long term material transfer in the transformation of geotectonic setting from a subarc to intraplate may have played a significant role in the evolution of the subcontinental lithospheric mantle, resulting in the enriched mantle domains, such as EMI or EMII.