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Formation of ultra-depleted mantle peridotites from the Kamuikotan unit, Japan

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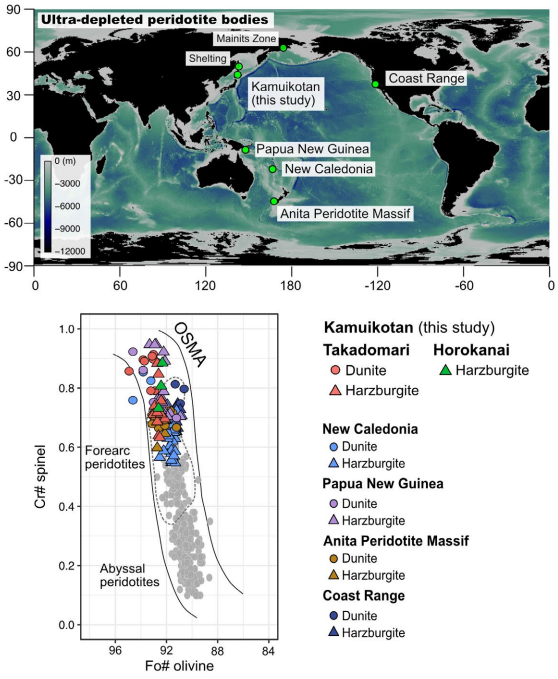

The extent of partial melting of peridotites is a function of temperature, pressure, and fluid supply. Understanding the petrogenesis of ultra-depleted peridotites is essential for elucidating mantle potential temperature and the role of water in the mantle [1]. We analyzed the major and trace element compositions of ultra-depleted peridotites from the Kamuikotan unit, Japan. We then applied geochemical models to constrain their formation conditions [2].

The peridotites are characterized by minerals with high Mg/Fe and Cr/Al ratios, and olivine and orthopyroxene with low Ti and Y contents. The mineral compositions suggest that these peridotites are among the most depleted peridotites on Earth. Furthermore, orthopyroxene compositions characterized by Zr and Sr enrichments relative to Ti and Y depletion cannot be solely explained by melt extraction from typical mantle compositions. Our influx melting model reproduces orthopyroxene trace element compositions of ultra-depleted harzburgites formed after high degrees of slab-fluid influx melting at a low influx rate.

The instantaneous fractional melts equilibrated with residues produced by the melting model and the melts, which were equilibrated with amphiboles, align with trace elements patterns of boninites, indicating that ultra-depleted harzburgites are residues after extraction of refractory melts. High temperatures and a continuous fluid supply are therefore key to the formation of ultra-depleted peridotites and boninites during subduction initiation.

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[2] Nishio, I., Morishita, T., Tamura, A., Itano, K., Takamizawa, S., Ichiyama, Y., Arai, S., Barrett, N., Szilas, K. (2023), Formation of Ultra-Depleted Mantle Peridotites and Their Relationship With Boninitic Melts: An Example From the Kamuikotan Unit, Hokkaido, Japan. JGR Solid Earth 128, e2022JB025066.