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Nd-Sr isotopic signatures of Aitutaki mantle xenoliths: Geochemical perspectives on the lithosphere–asthenosphere boundary

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Garnet-bearing mantle xenoliths provide geochemical information from deeper levels of the upper mantle, making them crucial for constraining the thermal and geochemical structure of the lithosphere–asthenosphere boundary (LAB). However, their occurrence is largely restricted to continental regions and observations from oceanic settings are rare (e.g., [1]).

At Aitutaki Island in the Cook Islands, lherzolites containing fine-grained mineral aggregates (FMAs) formed by the breakdown of garnet have been observed ([2]). From compositional zoning in pyroxenes, the Aitutaki FMA lherzolite xenoliths have recorded pressure increase followed by cooling at upper mantle, suggesting that this *P–T* evolution was most likely driven by small scale mantle convection (SSC)([2]). In order to discuss geochemical signature of upper mantle at the LAB, we analyzed major element compositions of whole rocks and constituent minerals, trace element and Nd-Sr isotopic compositions of clinopyroxene (Cpx) for the Aitutaki mantle xenoliths.

The major element compositions of whole rocks and minerals indicate that lherzolites, including those with and without FMAs, are fertile and lie within the compositional range between the primitive mantle and MORB source mantle. This indicates that the Aitutaki lherzolites represent mantle domains that have experienced limited melt extraction.

Chondrite normalized patterns of Cpx grains show that enriched in light REEs relative to heavy REEs, forming convex upward patterns with maxima at the middle REEs. The Cpx grains are exhibiting clear negative Zr anomalies closely resemble the modeled patterns for Cpx in peridotite that have transitioned from the garnet to the spinel stability fields ([3]). The Nd-Sr isotopic ratios of Cpx grains with negative Zr anomalies fall within the range of Cpx from abyssal peridotites ([4], [5]). Integrating these observations with major element characteristics suggest that the Aitutaki mantle xenoliths with negative Zr anomalies represent the fragment of an oceanic lithosphere ascended toward the LAB by SSC.

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[5] Salters & Dick (2002), *Nature* 418, 68-72.