

Supplementary Information

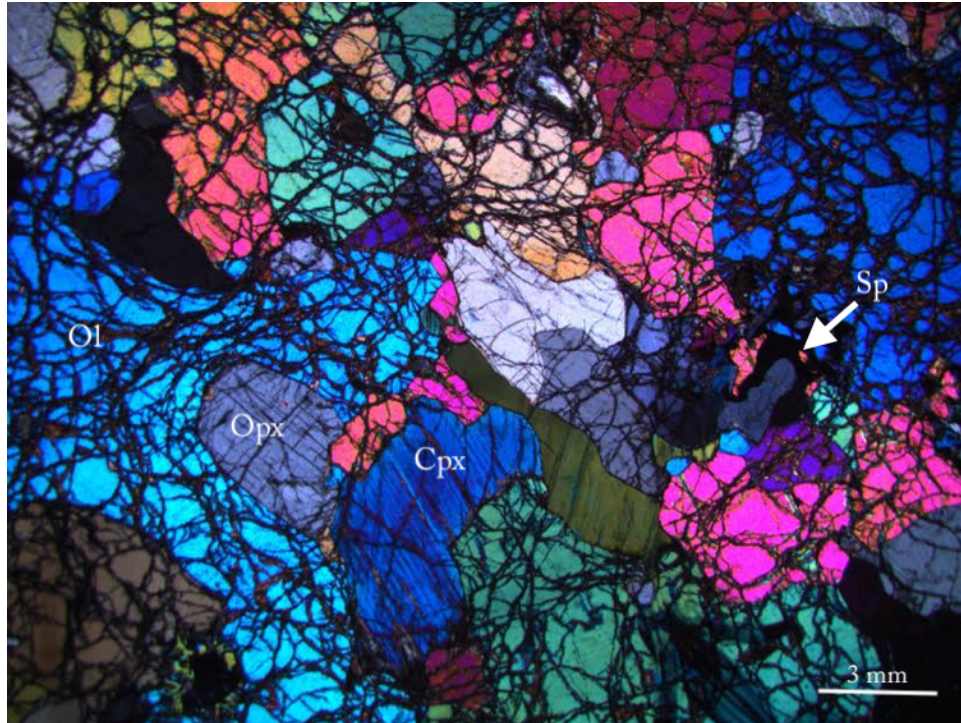
Journal: *Nature Communications*

Title: Recycled arc mantle recovered from the Mid-Atlantic ridge

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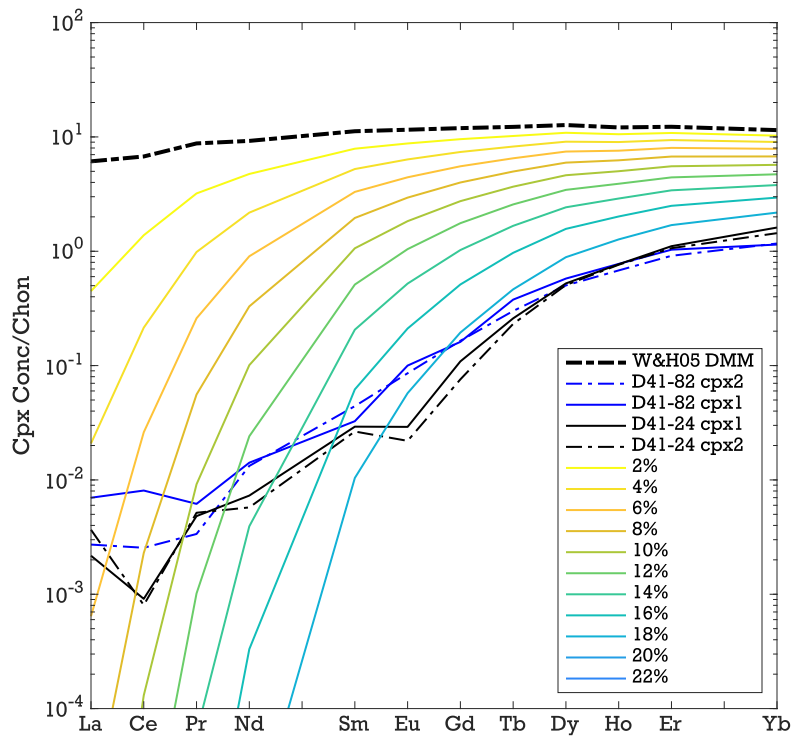
Supplementary Figure 1.



Title: Photomicrograph of exceptionally fresh 16°N peridotite

Protogranular harzburgite under crossed nicols. Textures are consistent with primary Cpx, not exsolved from Opx. Field of view is 2.5 cm. Ol, Sp, Cpx, Opx are olivine, spinel, clinopyroxene, and orthopyroxene, respectively.

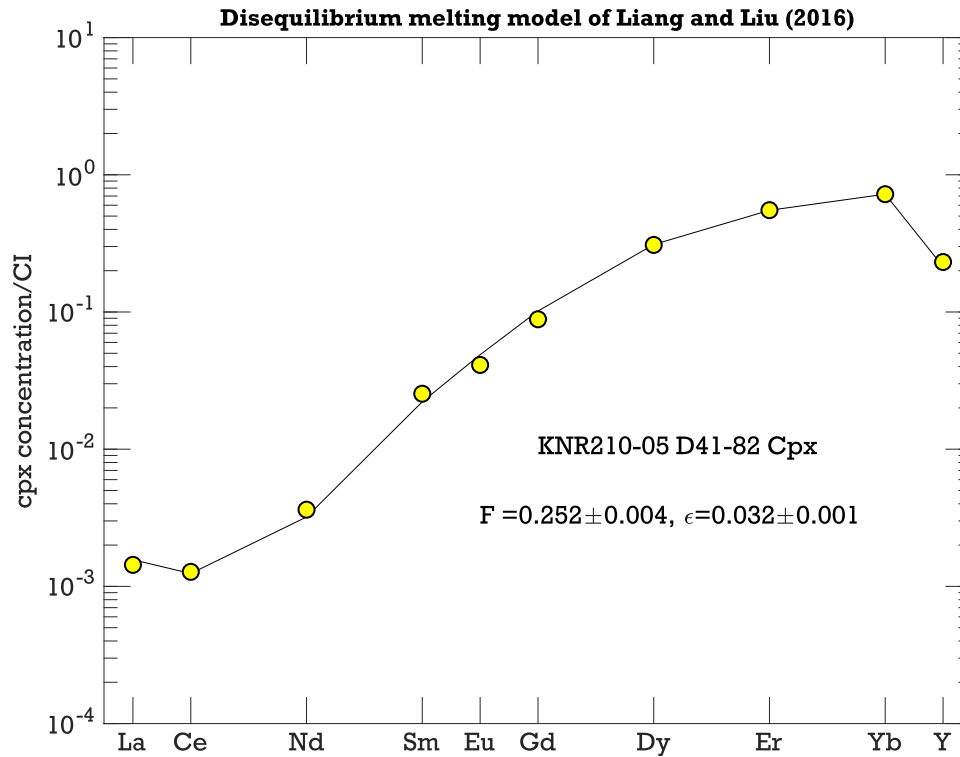
Supplementary Figure 2.



Title: Fractional melting model of rare earth elements in 16°N peridotite clinopyroxene

Spider diagram of REE with anhydrous fractional melting model of spinel-bearing peridotite utilizing MatLab script of Warren¹ and references therein, modified using anhydrous melting modes of Wasylenki et al.². Partition coefficients from Sun and Liang³. Note that anhydrous melting is unable to replicate observed REE abundances before Cpx exhaustion. Shown are the median values of five measurements per grain for the samples in this study, normalized to chondrite values of Anders and Grevesse⁴. Thick black dashed line indicates depleted MORB mantle (DMM) values suggested by Workman and Hart⁵.

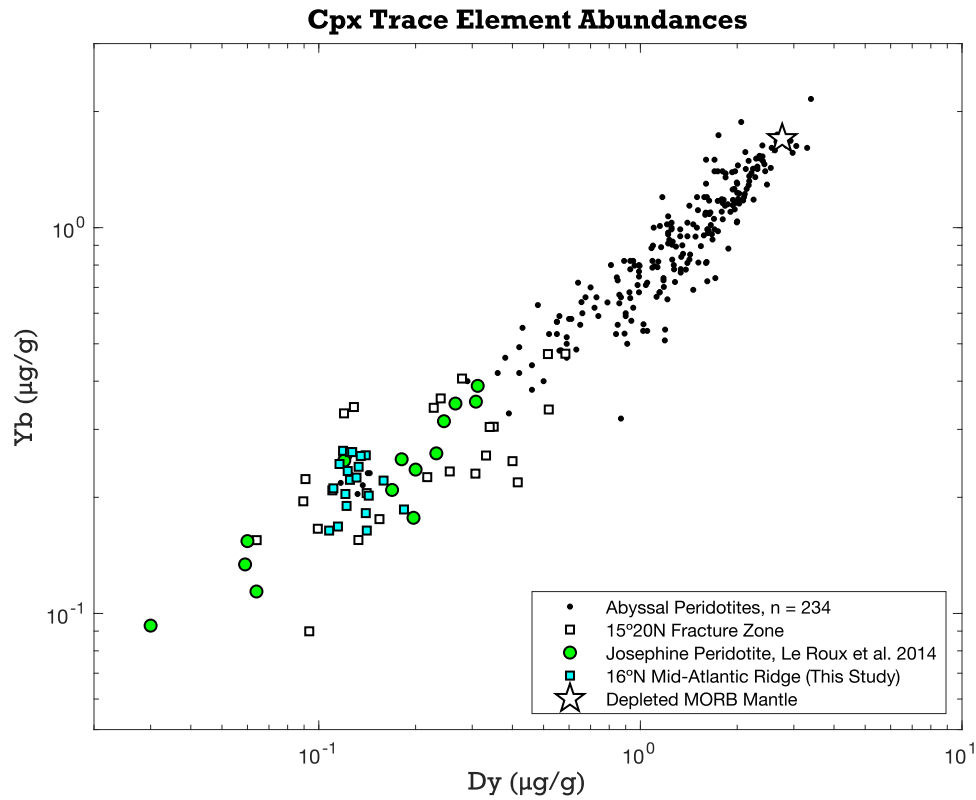
Supplementary Figure 3.



Title: Disequilibrium melting model of 16°N clinopyroxene rare earth elements

REE + Y fractional disequilibrium melting model of Liang and Liu⁶, modified to incorporate hydrous melting parameters with starting mineral modal abundances of Workman and Hart⁵ DMM. Partition coefficients are from Sun and Liang³, with hydrous melting modes of Bizimis et al.⁷. Values are normalized to chondrite values of Anders and Grevesse⁴.

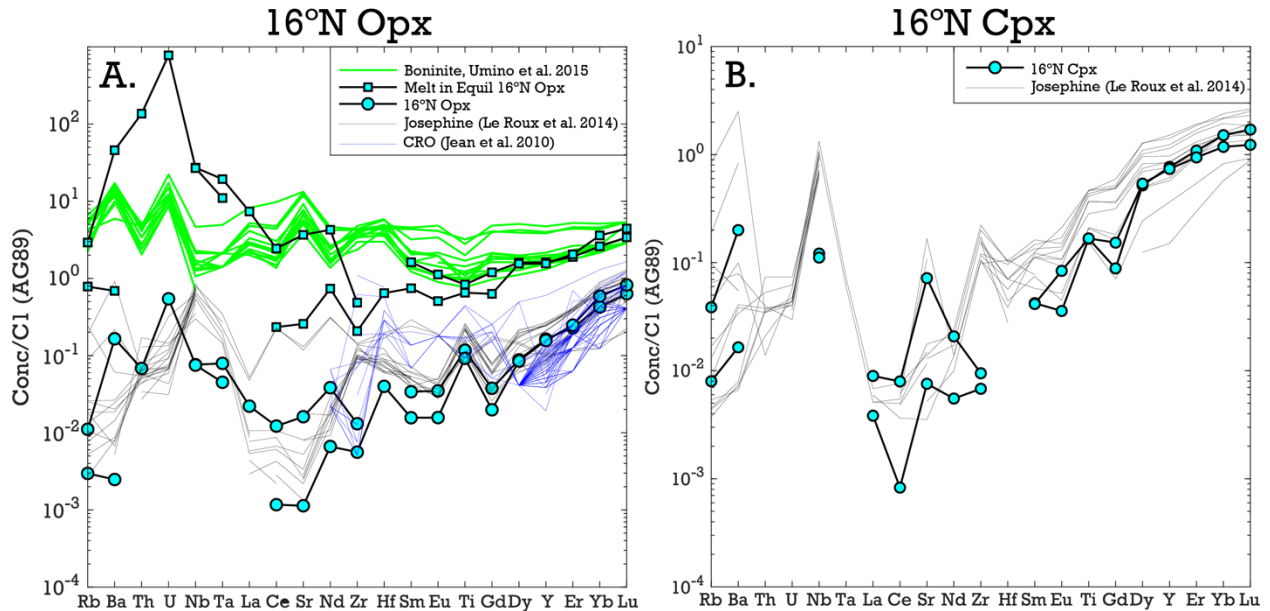
Supplementary Figure 4.



Title: Heavy rare earth element concentrations from peridotite clinopyroxene

Clinopyroxene Yb vs. Dy abundances in log-log space, illustrating the highly depleted nature of mantle both in the 16°N and 15°20'N Fracture Zone regions compared to the abyssal peridotite compilation of Warren¹. Also plotted is data from an SSZ environment, the Josephine peridotite, for comparison. Josephine peridotite data from Le Roux et al.⁸.

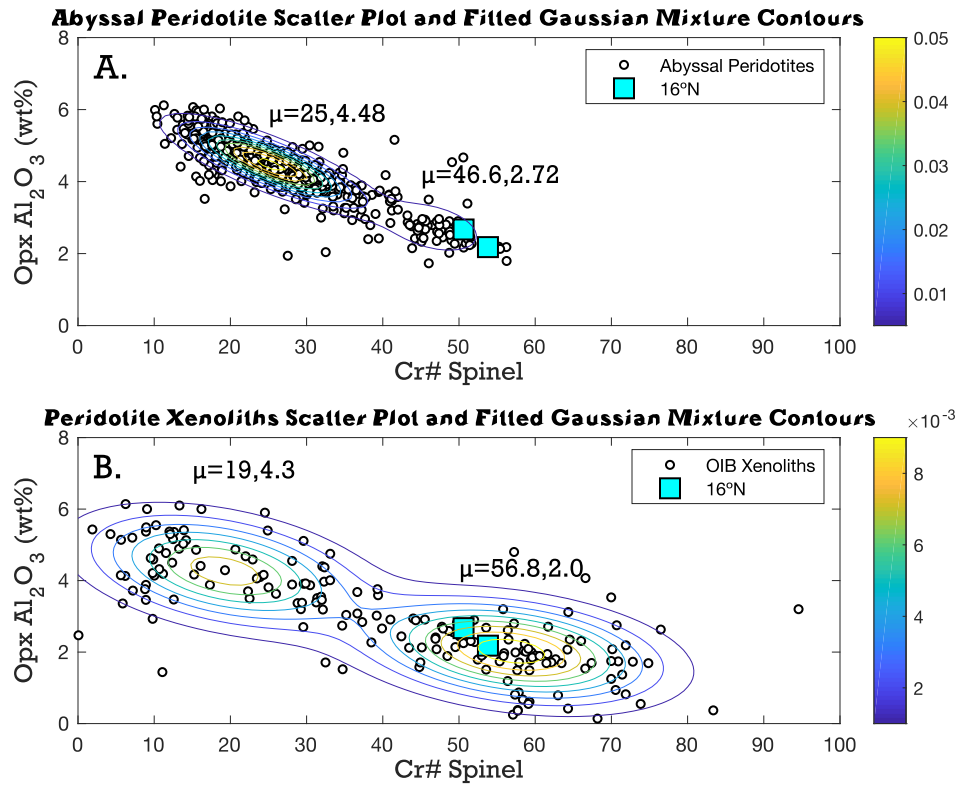
Supplementary Figure 5.



Title: Spider diagram of pyroxene trace element abundances and calculated equilibrium melts

A. Calculated melts in equilibrium with 16°N Opx (blue squares) as well as 16°N Opx trace element concentrations (blue circles) normalized to chondritic values of Anders and Grevesse ⁴. Calculated melts show extreme fluid immobile element depletion and fluid mobile element enrichments, consistent with flux melting and interaction with boninitic-like melts. **B.** 16°N Cpx. Thin lines are literature data from the Josephine peridotite and Coast Range Ophiolite (CRO) peridotites^{8,9}. Boninite data from Unimo et al.¹⁰. Opx-melt partition coefficients from the literature^{11,12}.

Supplementary Figure 6.



Title: Statistical analysis of abyssal peridotite and ocean island basalt-derived peridotite xenoliths

Probability density contours of Opx Al₂O₃ content and spinel Cr# from A. mid-ocean ridge peridotites (MORP) from Warren et al.¹ and B. ocean island basalt hosted peridotite xenoliths from Simon et al. created using MATLAB Statistics toolbox. Probability contours are color-coded, while mixing calculations suggest two populations with mean values (μ) listed in each figure. We note that abyssal peridotite data show a heavy sampling bias toward fracture zones (~75% of samples) compared to the stochastic sampling of ocean island basalt xenoliths.

Supplementary References

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