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A subduction influence on ocean ridge basalts outside the Pacific subduction shield

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The plate tectonic cycle produces chemically distinct mid-ocean ridge basalts (MORB) and arc volcanics, with the latter enriched in elements such as Ba, Rb, Th, Sr and Pb and depleted in Nb owing to the water-rich flux from the subducted slab. Basalts from back-arc basins (BABB), with intermediate compositions, show that such a slab flux can be transported behind the volcanic front of the arc and incorporated into mantle flow. Hence it is puzzling why melts of subduction-modified mantle have rarely been recognized in MORB. In this study we report the first MORB samples with distinct arc signatures, akin to BABB, from the Arctic Gakkel Ridge (Fig. 1) [1]. A new high precision dataset for 576 Gakkel MORB samples suggests a pervasive subduction influence in this region. This influence can also be identified in Atlantic and Indian MORB but is nearly absent in Pacific MORB (Fig. 2a). Such a hemispheric-scale upper mantle heterogeneity reflects subduction modification of the asthenospheric mantle which is incorporated into mantle flow, and whose geographical distribution is controlled dominantly by a "subduction shield" that has surrounded the Pacific Ocean for 180Myr (Fig. 2a and b). Simple modeling suggests that a slab flux equivalent to ~13% of the output at arcs is incorporated into the convecting upper mantle. Our finding also provides additional evidence for the gateway of Pacific mantle outflow to Atlantic and Indian as a consequence of shrinking Pacific Ocean. The Caribbean and easternmost Southeast Indian Ocean with Pacific-like trace element signatures are likely gateways for Pacific mantle outflow, whereas the Drake passage, with strong subduction signals, might not be such a gateway.

Reference

[1] Yang, Langmuir, Cai, Michael, Goldstein & Chen (2021), *Nature communications* 12, 1-10.

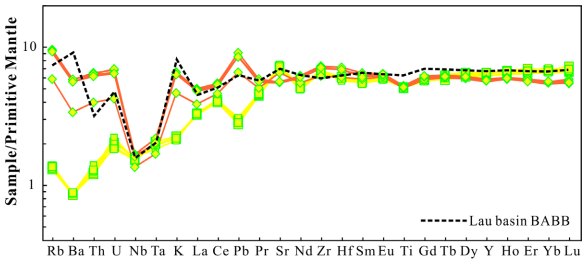

Fig. 1. Primitive mantle normalized trace element diagram for BABB-like Gakkel MORB.

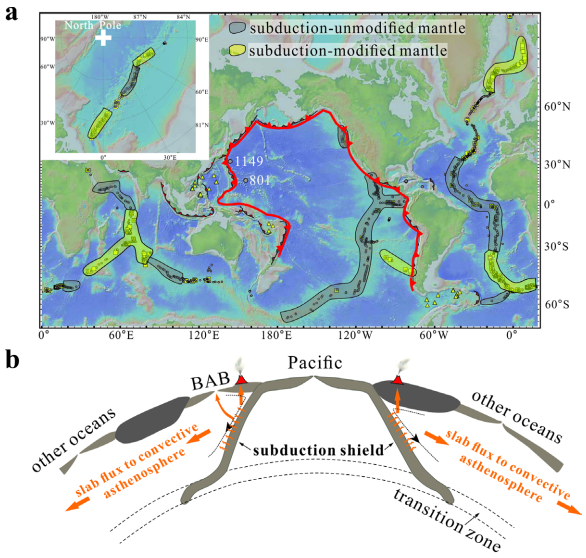

Fig. 2. The subduction influence on ocean ridge basalts outside the Pacific subduction shield.