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In-situ formation of Indian Mantle in global subduction zones

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The isotopic signatures of Sr-Nd-Pb-Hf-Os in mid-ocean ridge basalts (MORB) in the Indian Ocean are clearly distinct compared with their Atlantic/Pacific (A/P) counterparts. The origin of this isotopic distinction has been a matter of debate since its discovery by Dupré and Allègre (1983). Current models advocate: (i) delamination of ancient, negatively buoyant lower crust/lithosphere from a supercontinent; (ii) contamination of A/P-style mantle with plumes (the original association with the DUPAL anomaly); or (iii) long-term overprint by a subduction component (SC) surrounding a former supercontinent. The sum of various stable and radiogenic isotope proxies appears to support a delamination scenario, but alternatives, or the combination of the aforementioned scenarios, are possible. Irrespective of the origin of the Indian mantle domain, isotopic signatures similar to those of Indian MORB and hot-spots are observed in arc/back-arc systems associated with western Pacific subduction zones. These isotope signatures have been regarded as unequivocally derived from Indian-type mantle, and accordingly used to trace eastward flow of that type of mantle.

Here we show the majority of igneous rocks associated with subduction zone systems mimic Indian-type mantle in Pb isotope space, but are distinct in Hf-Nd isotope co-variations. We suggest isotopic signatures believed to be derived from Indian mantle in subduction zones are the result of medium-term subduction overprint of evolving A/P-type mantle wedges. This feature results from the relative mobility of U-Pb>Sm-Nd>Lu-Hf in subducted slab-derived components and Th/U (k) fractionation in the mantle wedge. Elevation of k in the wedge from 2.6 (MORB) to about 6-12 can account for the shift in Pb isotope space over a duration of ca. 100-200 Myrs; "decoupling" of Hf-Nd isotopes reflect the subduction component vs mantle wedge contribution. More generally, "Pseudo-Indian mantle" is noted as common in subduction zones globally, and not limited to the western Pacific, supporting the in-situ generation of isotope signatures akin to Indian mantle. Radiogenic ingrowth in modified wedge mantle requires shallow storage of affected parts of the mantle wedge over tens to hundreds of millions of years. Convection models support the feasibility of this scenario, provided that wedge rheology is modified through hydration (as is required by Th addition) in, at least, a small region of the wedge center. We argue that most if not all Indian-mantle signatures in global subduction zones are not related to the actual Indian mantle domain and associated geotectonic models employing this proxy in subduction zones need revision