Is Indian or Pacific mantle flowing beneath the southernmost Mariana intraoceanic arc?

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Earth's mantle is geochemically heterogeneous and is characterized by domains that display distinctive Pb-Hf-Nd isotopic ratios. Examining the spatial and temporal variations among these domains is important for reconstructing the long-term chemical evolution of the mantle. In the southernmost Mariana convergent margin, geochemical mapping of mantle depletion-fertility proxies (e.g., Nb/Yb) suggests that Pacific-type mantle flow exploited a slab tear to mix with Indian-type mantle, and that this mixture then melted to generate basalts in the southemost Marianas. Here, we investigate how this mantle flow has evolved over space and time. We interrogate the Pb-Hf-Nd isotopic composition of Pliocene-Quaternary basaltic to andesitic lavas from the forearc, the arc and the backarc basin spreading center and compare these data to Pb-Hf-Nd isotopic ratios of Eocene forearc basalts and boninites in the region. At the onset of subduction, lavas had a composition intermediate between Pacific and Indian mantle values suggesting that these domains communicated at that time. As the slab sank, it established a chemical barrier, isolating the Indian and Pacific mantle domains and allowing them to produce, separately in < 5 Ma, Indian-type, Eocene boninites and Miocene-Quaternary Mariana arc lavas. Mantle domains thus remained isolated for ≤ ~40 Ma. Recent slab tearing beneath the Santa Rosa Bank near Guam and possible detachment of the subducting Pacific plate induced quasi-toroidal and poloidal mantle flows, enabling the Pacific mantle to once more invade the Indian ambient mantle in Pliocene-Quaternary time and to produce mixed-source melts. The Hf-Nd compositional array of mixed basalts is explained by a 60:40 Indian-Pacific mixture. Lack of a compositional Hf-Nd gradient further suggests that the mantle domains are well mixed from the forearc to the backarc basin. Thus, slab tearing enabled strong mantle counter-flows that also promoted development of a robust backarc spreading center in the Malaguana-Gadao Ridge, characterized by an inflated morphology similar to the East Pacific Rise.