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Chemical Geodynamics of Asthenospheric Outflow in the western Pacific: Philippine Sea Back-arc Basin Mantle Source of the Yap Trench Forearc Lavas

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We present new major and trace element chemistry and Sr, Nd, and Pb isotope data from basalts, recovered from the forearc setting of the Yap Trench in the western Pacific, and discuss their melt evolution and petrogenesis within the framework of the geodynamic interactions among the Caroline Plate, the Caroline ridge, and the Philippine Sea plate. These rocks have mid-ocean ridge basalt (MORB)-like geochemical features, including medium Fe contents, tholeiitic affinity, high TiO_2 values at a given Fe_2O_3/MgO ratio, Ti/V, Nb/Y, Ba/Yb, and Ba/Th ratios similar to those of back-arc basin basalts (BABB), and trace element patterns commonly displayed by MORB and BABB lavas. However, these basalts are characterized by highly radiogenic Sr and Pb contents, reminiscent of western Pacific sediments. We suggest that forearc magmatism was responsible for the origin and petrogenesis of these rocks. Forearc magmatism was induced by the shrinking of the Philippine Sea plate, which squeezed out the underlying back-arc basin asthenosphere with Indian–type ambient mantle characteristics to invade the forearc mantle of the Yap Trench and causes lithospheric extension. Upwelling and decompression melting of this mantle produced MORB-like lavas in the narrow forearc setting. An apparent slab tear or gap in the subducting plate facilitate the penetration of the mantle outflow. The collision of the Caroline Ridge subducted more sediments into the mantle wedge. Melting of the subducted sediments and the invasion of the Indian-type asthenosphere into the forearc account for the highly radioactive Sr and Pb isotopes of the MORB-like lavas.