

Existence of the big mantle wedge beneath East Asia continental margin before 123 Ma

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The big mantle wedge (BMW) formed by the Izanagi-Pacific slab stalling in the mantle transition zone (MTZ) provides a fascinating model accounting for the intraplate magmatism and anatectic earthquake >1800 km distal from the trench in East Asia. Although it is widely postulated that the BMW has existed at the peak time of the lithospheric thinning (~125 Ma) beneath Eastern China, robust evidence remains to be further provided. This study presents Ba-Mg isotope data for a ~123 Ma-old OIB-type Daixi diabase in SE China whose mantle source contains recycled igneous crusts derived from the extinct Izanagi slab. Results show that the diabase has $\delta^{138/134}\text{Ba}$ (−0.08‰ to 0.04‰) slightly lower than those of the terrestrial mantle (−0.03-0.05‰). These values are negatively correlated with $^{87}\text{Sr}/^{86}\text{Sr}$, $\text{K}_2\text{O}/\text{TiO}_2$, K/La , and $\text{K}_2\text{O}/\text{Na}_2\text{O}$, pointing to the incorporation of subducted sediments in its mantle source. In addition, the diabase also has lower $\delta^{26}\text{Mg}$ (−0.67‰ to −0.35‰) than the terrestrial mantle (−0.25 ± 0.04‰), reflecting the source hybridization by marine carbonates. However, the Daixi endmember enriched source resulted from the addition of carbonate-bearing sediments has abnormally higher K/U (~30,500) and Hf/Hf^* (~1.68) ratios than the UCC (~8605, ~1.18) and the GLOSS (~11,000, ~0.61). It requires incipient melting of carbonated sediments in the MTZ (410-660 km) where peritectic liebermannite and majorite are formed after Na-rich, Ca-carbonate melt extraction during which Th, U, and some LREE are selectively removed while K, Ba, Zr, and Hf are preferentially retained. Previous experimental investigations showing that carbonate-bearing sediments must initially melt in the MTZ (20-22 GPa) if they did not melt at subarc depth (6-9 GPa) also suggest that the diabase has its root in the MTZ. These findings reveal that the carbon cycling associated with the subduction of Izanagi-Pacific plates in Eastern China was initiated 123 Ma ago, significantly earlier than previously documented (~106 Ma). They provide compelling evidence for the MTZ origination of Mesozoic OIB-type intraplate basalts related to the Izanagi slab subduction in Eastern China. They also place important constraints on the robustness that the BMW beneath Eastern Asia has existed before 123 Ma ago.