Recycled cratonic mantle floating in the upper mantle since the Mesozoic tapped by intraplate alkaline basalts

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The origin of chemical heterogeneity of the mantle is critical to understanding the cycling of crust-mantle materials in deep Earth. With a purpose of tracing the recycled continental lithosphere material and its survival time scale in the deep mantle, we conducted Re-Os isotope analyses on the well-characterized Cenozoic and Mesozoic basalts from eastern China. The results indicate that Cenozoic nephelinites and basanites are characterized by relatively unradiogenic $^{187}Os/^{188}Os$ (0.142±0.020), whereas Cenozoic alkali basalts and tholeiites show more radiogenic $^{187}Os/^{188}Os$ (0.279±0.115) and Mesozoic basalts exhibit even more radiogenic $^{187}Os/^{188}Os$ (0.361±0.135). The chemical and isotopic compositions (e.g., Os-Sr-Nd isotopes, SiO_2 contents, Ba/Th and Ce/Pb ratios) of Cenozoic basalts systematically shift from nephelinites and basanites to alkali basalts and tholeiites towards Mesozoic basalts. Unradiogenic Os isotope and depleted Sr-Nd isotope compositions coupled with Mg-Zn isotope anomalies of Cenozoic nephelinites and basanites can be readily explained by melting of deep carbonated asthenosphere, whereas contribution of melts derived from enriched cratonic subcontinental lithospheric mantle (SCLM) is suggested to account for radiogenic Os isotope and enriched Sr-Nd isotope compositions coupled with near-normal mantle-like Mg-Zn isotopes of Cenozoic alkali basalts and tholeiites. The Cenozoic-erupted xenoliths from eastern China show similar chemical and isotopic characteristic as off-craton counterparts, demonstrating the presence of a juvenile ocean-type SCLM, of which melt derivative is, however, difficult to explain the compositional transition of alkaline lava series. Combined with the present-day observed upper-mantle tomography, we propose that the "ghost" signal of enriched SCLM tapped by Cenozoic basalts most likely was derived from the enriched pyroxenite dykes entrained in recycled cratonic SCLM which has been still floating in the asthenosphere since at least the Mesozoic. With the protection of refractory SCLM, the trapped enriched pyroxenite portion along with the recycled SCLM can last for at least hundreds of millions of years to constantly melt and pollute the upper mantle and ultimately contribute into the mantle heterogeneity and origin of mantle melts.