

Barium Isotope Fingerprint for Recycled Ancient Sediment in the Source of EM1-Type Continental Basalts

YI-SHAN CHENG^{1,2}, JIAN-QIANG LIU², LIHUI CHEN²,
KAIYUN CHEN², JIAN ZHAO², XIAOJUN WANG², GANG
ZENG³ AND HONGFU ZHANG¹

¹Zhejiang University

²Northwest University

³Nanjing University

The origin of the enriched mantle 1 (EM1) endmember, characterized by low $^{206}\text{Pb}/^{204}\text{Pb}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios in ocean island basalts, has long been debated. This is because melting of surrounding peridotite, together with the EM1 component, can dilute the “EM1 fingerprints” in these rocks. Cenozoic continental potassic basalts from northeast China exhibit extreme radiogenic isotope compositions, featuring the lowest $^{206}\text{Pb}/^{204}\text{Pb}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios in the world, and therefore are considered to be the continental equivalents of EM1-type OIBs. These rocks, formed by low-degree partial melting (expressed by high La/Yb ratios), may better preserve information about the EM1 origin compared to plume-derived OIBs. Here, we present barium isotope data for these well-characterized EM1-type continental basalts to constrain their nature and origin. Our results show that these basalts have $\delta^{138/134}\text{Ba}$ values ranging from -0.1‰ to 0.08‰ ($n = 19$), which are lower than the depleted MORB mantle ($\delta^{138/134}\text{Ba} = 0.03\text{‰}$ to 0.05‰). The light Ba isotope compositions of the EM1-type continental basalts are not induced by post-magmatic alteration, crustal contamination, fractional crystallization, or various degrees of partial melting. Correlations between $\delta^{138/134}\text{Ba}$ and K/U, Ba/Th, U/Pb, ϵNd and $^{206}\text{Pb}/^{204}\text{Pb}$ suggest a heterogeneous source involving binary mixing between the lithospheric mantle and an EM1 component. Modeling reveals that the observed light $\delta^{138/134}\text{Ba}$ and extremely low $^{206}\text{Pb}/^{204}\text{Pb}$ EM1 component of Cenozoic continental basalts can be attributed to the involvement of recycled ancient sediments to the source. Our findings provide new evidence that Ba isotopes have great potential to trace crustal recycling processes in Earth's deep mantle.