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Involvement of recycled carbonates and silicates in the petrogenesis of lamproites in the North China Craton

KAIZHANG YU[1], YONGSHENG LIU[2] AND WEI CHEN[3]

[1]China University of Geosciences
[2]Yangtze University
[3]China University of Geosciences, Wuhan

Lamproites, rare ultrapotassic alkaline rocks, are significant for their origin from volatile-rich metasomatized lithospheric mantle. However, the exact mantle source assemblage and metasomatic agent remain a subject of debate. Here, geochemical evidences of lamproites from the northern North China Craton are conducted to elucidate their petrogenesis and provide insight into deep carbon cycles.

In-situ phlogopite Rb-Sr and apatite U–Pb dating yielded a consistent emplacement age of ~212 Ma. The studied lamproites exbibit high MgO and K_2O, low Al_2O_3 and TiO_2 contents, and geochemical signatures similar to orogenic lamproites. Based on the previous melting experiments, phlogopite pyroxenites are identified as potential mantle source of these lamproites. Their high large ion lithophile element contents, negative high field strength element anomalies, and enriched Sr-Nd isotopic values indicate a metasomatized mantle source influenced by recycled crustal material. The $\delta^{26}Mg$ (-0.22 to -0.36‰) of lamproites vary from the range of the normal mantle to lower values, negatively correlating with CaO/Al_2O_3 and Sr/Nd ratios, suggesting a carbonate metasomatized mantle source. Additionally, Mg-Sr isotopes display a positive correlation. Binary mixing simulations indicate that the lamproites originated from the mixing of enriched mantle sources metasomatized by both calcium carbonate and silicate sediments via subducted slabs. The carbonate metasomatism is likely associated with the subduction of Paleo-Asian Oceanic slab, consistent with other coeval alkaline magmas in adjacent areas, while the mantle modification by silicate sediments may be related to an earlier metasomatic event. Overall, this study demonstrates that lamproites act as key carriers of deep carbon cycle, highlighting the role of subducted carbonates in modifying the lithospheric mantle and driving alkaline magmatism.