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Contrasting compositions between phenocrystic and xenocrystic olivines in the Cenozoic basalts from central Mongolia: Constraints on source lithology and regional uplift

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Abstract

Two Cenozoic prominent features are spatio-temporally associated in central Mongolia, i.e., the continental basalts and regional uplift, but their genesis and relationship remain unclear. This study presents major- and trace-element compositions for olivine phenocrysts and xenocrysts, as well as data of bulk-rock geochemistry and Sr-Nd-Hf isotopes for the host basalts. The studied basalts mostly have trachybasalt compositions with high total alkali ($Na_2O + K_2O$ = 5.1–8.2 wt%) contents and all display OIB-like trace element patterns (e.g., spikes of Ba, Nb, and Ta and troughs of Th and U) and EM1-like Sr-Nd-Hf isotopic compositions. Compared to the partial melting products of mantle peridotite, these basaltic samples have higher FeO/MnO, Zn/Mn, and Zn/Fe ratios. Meanwhile, phenocrystic olivines are characterized by lower Ca, Mn, Mn/Zn, and Mn/Fe but higher Ni than their counterparts in the peridotitic melts, indicating a pyroxenite-rich mantle source. The above geochemical data suggest that the source of the studied basalts was mainly made up of secondary pyroxenite produced by the reaction of recycled oceanic crust with its ambient mantle peridotite. The calculated magma oxygen fugacities (ΔFMQ-0.26 to +0.42) and mantle melting temperatures (1343–1430 °C) do not support a genetic link with the stagnant Pacific slab or with a deep mantle plume. Instead, the far-field effect of India-Eurasia convergence possibly tapped the upper asthenospheric mantle, subsequent melting of which gave rise to the dispersive Cenozoic basalts. On the other hand, the xenocrystic olivines exhibit zoned textures with high-Fo (up to 92) cores and low-Fo (down to 76) rims, reflecting the melt-rock interaction. Preservation of zoned olivine xenocrysts indicates rapid magma ascent and widespread melt-rock reaction in the mantle lithosphere, which may modify the rheology and accelerate the mechanical erosion of mantle lithosphere. Consequently, mass deficit in the lithosphere could have caused isostatic uplift of central Mongolia in the Cenozoic.

Keywords: Cenozoic continental basalts, Central Mongolia, olivine chemistry, pyroxenite, regional uplift