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Surface and Mantle Expression of the Early Permian Tarim Mantle Plume

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The mantle process during the Early Permian Tarim plume event is revealed by flood basalt and mantle xenoliths.

Permian Tarim flood basalts have typical two pulses' eruption. The first pulse of the Tarim flood basalt was erupted at 291-290Ma, characterized by OIB-like Zr/Nb (∼5.83), Nb/La and Ce/Pb ratios, and PUM-like initial $^{187}Os/^{188}Os$ ratios (0.1308-0.1329). They're plotted along a 290±11Ma isochron, implying a pristine "plume mantle" source. The second pulse of the Tarim flood basalt was erupted at 283-281 Ma, with Zr/Nb (∼13.6), Nb/La and Ce/Pb ratios similar or close to the lower crust and initial $^{187}Os/^{188}Os$ ratios (0.1743∼19.6740) that deviated from the ∼290 Ma isochron line, indicative of significant crustal assimilation.

Mantle-derived peridotite and pyroxenite xenoliths hosted in Cenozoic alkali basalts (∼20 Ma) are found in the Xikeer, western Tarim Block. Based on their petrographic and geochemical characteristics, peridotite xenoliths can be divided into three groups. Group 1 peridotites, with the presence of the high Mg-number of olivines (91-93) and spinel-pyroxenes clusters, experienced high-degree melt extraction (∼17% fractional melting) from garnet- to spinel-stable field. Groups 2 and 3 peridotites, characterized by the clinopyroxenes with spoon-shaped and highly fractionated REE patterns respectively, underwent extensive silicate melt metasomatism at low melt/rock ratios (<1). Numerical modelling shows that the Xikeer pyroxenites may result from the reaction between Group 1 peridotites and a primitive Permian picritic melt at a high melt/rock ratio (>15) and that the host basanite is incapable of being the metasomatic agent. The Re-Os isotopic systematics of the Xikeer peridotites and pyroxenites yield an isochron of 290±11 Ma, virtually identical to the age of Tarim flood basalts. Their PUM-like Os initial ratios and convecting mantle-like ε_{Nd}(t=290 Ma) strongly suggest that the Xikeer mantle xenoliths derive from the plume mantle. We propose that the Xikeer xenolith suite recorded mantle 'auto-refertilization' process, i.e., they may have been initially formed by melt extraction from the convecting mantle and, shortly after, was refertilized by plume melts during the Early Permian.