The origin of the Pliocene Wangqing River alkali picrite, NE China

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The Wangqing River picrite in the Yanbian area 200 km northeast of the Changbai Mountain provides a new key to understand the origin of widespread Cenozoic volcanism in East Asia. The picrite occurs within an NE-trend valley of the Wangqing River, formed as a small volcano of ~1 km in diameter and ~100 m in height with grey volcanic ash soil remains on the caldera. The eruption age is 5.05±0.05 Ma based on ^{40}Ar-^{39}Ar dating.

The picrite is rich in olivine phenocrysts and has no xenocrysts. The whole rock has 41.2-43.9% SiO_2, 12.4-20.0% MgO, 3.2-5.7% total alkali (Na_2O+K_2O) and Na_2O/K_2O ratio of 1-4, and enrichment in LILE and HFSE, depletion in Pb, K, Zr, and Hf, showing similar trace element pattern like most sodic OIB-type basalts in Eastern China. The EM1 signatures ($(^{87}Sr/^{86}Sr)_I$ = 0.70423-0.70447, $\varepsilon_{Nd}(t)$ = 0.06-1.17) suggest an involvement of recycled materials. Coupled Nd-Hf isotopes exclude the input of oceanic sediments. Relatively high olivine $\delta^{18}O$ value (6.0±0.1‰) is consistent with a contribution from the recycled upper oceanic crust.

The olivine phenocrysts have Fo value of 87.2-88.2, high CaO content (0.22-0.28 %) but low Fe/Mn ratio (60.1-67.3) and Ni (1058-1898 ppm), indicating a fertile peridotite mantle source rather than pyroxenite. The 1150±50°C crystallisation temperature from aluminium in olivine-spinel thermometry and ~7.6 Ra olivine $^3He/^4He$ values suggest a MORB-like mechanism rather than plume-origin, consistent with the proposed blocking effect of the stagnant Pacific slab. Further, the olivine-bearing melt inclusions show a broad range of composition distribution covering low-Si, intermediate-Si and high-Si groups as previously classified, supporting the vertical heterogeneity of the Eastern Asian Big Mantle Wedge.