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Early Cretaceous high-silica granite in the central southern part of North China: Implications for thinning and reworking of lower crust

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The North China Craton is widely regarded to have experienced considerable lithospheric thinning during the late Mesozoic. However, how the lower crust responded to the lithospheric thinning remains topics of debate. Here we report zircon U-Pb-Hf isotopes, whole-rock geochemistry and Nd-Pb isotopic compositions for the Tianmushan pluton in Xinyang (Henan Province) from the central southern part of the craton. Zircon U-Pb dating of three texturally distinguishable phases from this pluton yield concordant ages of 122.6 ± 1.9 Ma and 122.9 ± 2.0 Ma for monzogranites, 121.8 ± 2.4 Ma for porphyritic monzogranite, and 120.2 ± 1.0 Ma for syenogranite. All the studied rocks have high SiO_2 (74.56–77.80 wt%) and total alkali (K_2O+Na_2O = 8.11–9.10 wt%), and low Al_2O_3 (12.0–13.4 wt%), $Fe_2O_3^T$ (0.24–2.86 wt%) and MgO (0.09–0.26 wt%) contents with weakly peraluminous characteristic (A/CNK=1.02–1.13). They are also enriched Ga, Nb, Y, and depleted in Ba, Sr, Eu and compatible elements, characterizing by high $Fe_2O_3^T/(Fe_2O_3^T + MgO)$, K_2O/MgO, $10^4Ga/Al$ and Nb/Y ratios. These geochemical features show that the Tianmushan pluton belongs to A_1-type granite that generated mainly by melting of crustal rocks with subsequently extensive fractional crystallization under low pressure. Furthermore, the granites show negative whole-rock $\varepsilon_{Nd}(t)$ values (-10.8 to -10.1), zircon $\varepsilon_{Hf}(t)$ values (-12.8 to -5.2), and relatively high initial Pb isotopes with $(^{206}Pb/^{204}Pb)_i$ ratios of 17.2833–17.6280, $(^{207}Pb/^{204}Pb)_i$ of 15.4774–15.5103 and $(^{208}Pb/^{204}Pb)_i$ of 38.1792–38.3587, respectively. They are comparable to the mafic granulitic xenoliths but different from those of the southern basement rocks in the craton (such as the Taihua and Xiong'er Groups), suggesting that the mafic lower crust could be the potential source for the Tianmushan granites. Together with the lithologic architecture and seismic profile of the deep crust beneath Xinyang area, we proposed that the lower crust beneath the central southern part of North China have been further reworked and thinned in an extensional intracontinental environment after delamination in the early Cretaceous. The environment may be triggered by asthenosphere upwelling attributed to rollback of the subducting Paleo-Pacific Plate.

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