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Crustal thickening in the Neoarchean: geochemical records by potassic granitoids from the Taihua Complex in the North China Craton and worldwide

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The Earth system shows many fundamental changes during the Neoarchean. In this period, the diversification of felsic rocks initiated, and crustal composition changed from sodic TTGs-dominated to potassic granites-dominated. However, the mechanism that drove this change remains uncertain.

Here we report a geochemical study of Neoarchean TTG gneisses and potassic granites from the Taihua Complex in the North China Craton. The ca. 2.65 Ga TTG rocks are characterized by low K_2O/Na_2O ratios of <0.6, high Sr/Y and $(La/Yb)_N$ ratios, positive Eu anomalies, positive zircon $\varepsilon_{Hf}(t)$ values of 0.9 to 5.2, zircon $\delta^{18}O$ values of 6.3-6.5‰, which are attributed to partial melting of the basaltic oceanic crust at depths of >35 km. The ca. 2.65 Ga potassic granites have high K_2O/Na_2O ratios of >0.6, low Sr/Y and $(La/Yb)_N$ ratios, negative Eu anomalies, zircon $\varepsilon_{Hf}(t)$ values of -0.4 to 8.0, zircon $\delta^{18}O$ values of 7.0-8.4‰, which are ascribed to partial melting of the mafic continental crust at shallower depths of <35 km. Compared to the ca. 2.65 Ga potassic granites, the ca.2.55-2.50 Ga potassic TTGs show higher $(La/Yb)_N$ and Sr/Y ratios, suggesting their derivation from partial melting of the thickened continental crust. The increases of both Sr/Y and $(La/Yb)_N$ ratios from the ca. 2.65 Ga potassic granites to the ca. 2.55-2.50 Ga potassic TTGs reflect a process of the crustal thickening.

Using a filtered global geochemical database of potassic granites within the age range of 4.0-2.4 Ga, we find that the potassic granites have higher K_2O but similar or lower Na_2O contents compared to the TTGs. This argues against the formation of potassic granites through partial melting or fractionation of TTGs. Instead, the mafic continental crust is suggested as a possible source because of high K_2O contents compared to primary oceanic crust. The ages of Archean potassic granites show peaks at 2.8-2.6 Ga. The Sr/Y and $(La/Yb)_N$ ratios of global potassic granites begin to increase in the Neoarchean, suggesting the continental crust was gradually thickened in this stage.