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Geochronology and Geochemistry of Late Neoarchean TTG gneisses in East Hebei, North China Craton: Implications for crustal growth and petrogenesis

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Tonalite-trondhjemite-granodiorite (TTG) rocks constitute the dominant components of the Earth's earliest-formed continental crust, and their petrogenesis is hotly debated. Here, we present new zircon U-Pb-Hf isotopic data and whole-rock geochemical data for TTG gneisses from East Hebei, eastern North China Craton (NCC), with the aim of exploring the petrogenesis of Neoarchean TTG rocks.

Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) zircon U-Pb dating shows that the TTG gneisses have emplacement ages of 2554 to 2547 Ma and metamorphic ages from 2510 to 2485 Ma. Zircons of the TTG gneisses exhibit concentrated positive $\varepsilon_{Hf}(t)$ values of +5.0 to +7.5 with crustal model ages ranging from 2673 to 2578 Ma, which are close to the corresponding U-Pb ages. It suggests that the TTG gneisses were probably originated from juvenile crust and the late Neoarchean is a significant period of crustal growth in East Hebei.

Geochemical analysis reveals that all the TTG gneisses have low loss on ignition values (LOI = 0.24–1.67 wt.%) and weak Ce anomalies (0.95–1.14), suggesting minor late alteration. The TTG gneisses contain high SiO_2 (65.54–72.84 wt.%), Al_2O_3 (14.21–18.30 wt.%), and Na_2O (3.89–6.84 wt.%) contents, but low concentrations of K_2O (0.45–2.31 wt.%, Na_2O/K_2O = 2.17–15.2), MgO (0.31–1.88 wt.%), and compatible element (e.g., Cr =2.67–51.4 ppm, Co =1.45–12.3 ppm, and Ni =2.52–26.7 ppm). They yield high Sr (296–1113 ppm) and low Y (0.80–7.20 ppm) and Yb (0.06–0.58 ppm) contents, with high Sr/Y (94.81–1420) and $(La/Yb)_N$ (16.20–89.09) ratios. In addition, the TTG gneisses have very low concentrations of Nb (0.18–6.02 ppm) and Ta (0.003–0.17 ppm), but high Nb/Ta (20.00–103.33) and Zr/Sm (24.36–238.64) ratios. The geochemical characteristics, together with the concentrated positive zircon $\varepsilon_{Hf}(t)$ values, indicate a high-pressure type for these TTG gneisses, which were likely generated by partial melting of juvenile thickened lower crust, leaving rutile-bearing eclogites as residues.

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