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Understanding the Archean crustal growth in South China: petrological, geochemical, isotopical constraints from the Yudongzi terrane

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Understanding the compositional diversity of the Neoarchean TTG (tonalite-trondhjemite-granodiorite)-assigned plutonic complexes is critical to unveil the early plate tectonic operation and crustal growth process, we conducted an integrated study of the Archean Yudongzi terrane, NW South China, which obtained petrological, geochronological, geochemical, and isotopic (including whole rock Sr-Nd, in situ zircon U-Pb-Lu-Hf-O) data on granitic gneisses, paragneisses and amphibolites.

Our results show that granitic gneisses of the Yudongzi terrane are characterized by three compositionally distinct groups in terms of geochemical and mineralogical features, with Group-I having high Sr/Y ratios (231-685), high positive Eu anomalies (average Eu/Eu*=8.88) and high Mg# (54.7-68.6), Group-II displaying moderate Sr/Y ratios (34-230), inconspicuous positive Eu anomaly (average Eu/Eu*=1.51) and moderate Mg# (39.8-54.9), both of which belonging to typical Na-rich TTG rocks, and Group III exhabiting high K2O (4.01-6.13 %), Th (13-41 ppm) and Rb (45-80 ppm) contents, negative Eu anomalies (average Eu/Eu*=0.87) and low Mg# (39-43), coinciding well with typical late- to post-orogenic high-K granites. Compared to the granitic gneisses, the paragneisses and amphibolites show less fractionated REE patterns with inapparent Nb-Ta and Ti depletion. SIMS zircon U-Pb dating of zircons indicates that the TTG rocks was formed at ca. 2.69 Ga and underwent significant metamorphism at 2.5 Ga, distinctly different from the basement rocks of the Kongling terrane. Dating of detrital zircons from the paragneisses range from 2584 to 2717 Ma and peak at ca. 2.7 Ga. Such age patterns are consistent with those of the granitic gneisses, indicating that the detritus making up of the paragneisses might derived from the granitic gneisses. In-situ zircon Hf-O isotopic analysis (THfC =2.9-3.3 Ga; δ18O= 5.8$\pm$0.2‰ of TTGs indicates a source origin involving mantle-derived magma and varying degrees of crustal assimilation as supporting by coupling whole-rock Nd model ages (TNdC =2.9-3.3 Ga), while which of the amphibolites suggest their Archean protolith was hydrothermal alterated by supracrustal materials during Paleoproterozoic.

The compositional diversity of TTGs can be dominantly ascribed to various residual mineralogy after partial melting of mafic precursors that occurred under different pressure conditions accompanied by discrete contribution from lower crustal compositions, although crystallization and cumulate processes are demonstrated to be important during magma generation of the high Sr/Y series of Group I TTGs. The high-K granites are considered to be formed by re-melting of TTG compositions that partly responsible for the regional ca. 2.5 Ga metamorphism during the post-orogenic stage. Subduction setting, thus are proposed to be accounting for the coexistence and refurnishment of diverse Archean granitoids in the Yudongzi terrane. The 1.85 Ga metamorphism recorded by the amphibolites was synchronous with global Paleoproterozoic collisional events that led to final assembly of the Columbia supercontinent.

Keyword: Archean; Yudongzi; TTG; high-K; evolution