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Ages and Hf isotopes of igneous zircons from Neoproterozoic TTG gneisses in the Eastern Block, North China Craton: Tectonic implications

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Available zircon ages indicate that the plutonic protoliths of Neoproterozoic TTG (tonalitic-trondhjemitic-granodioritic) gneisses in the Eastern Block were emplaced at two phases, with the earlier one at 2.75-2.65 Ga and the younger one at 2.55-2.50 Ga. Although the 2.75-2.65 Ga rock associations are only exposed in the Luxi and Qixia areas, the ~2.7 Ga igneous event must have occurred across the whole Eastern Block and was a major crustal accretionary or mantle-extraction event that formed a thick mafic crust beneath the whole Eastern Block based on the following lines of evidence:

(1) The 2.75-2.65 Ga TTG rocks in the Luxi granite-greenstone terrane have positive $\epsilon_{\text{Hf}}(t)$ values (+2.7 to +10.0), with most zircon Hf model ages close to the rock-forming ages, which provides robust evidence that the ~2.7 Ga event that formed the 2.75-2.65 rock associations was a crustal accretion (mantle extraction) event, not a crust-reworking event.

(2) The 2.55-2.50 Ga TTG rocks in the Eastern Block possess mildly positive to slightly negative $\epsilon_{\text{Hf}}(t)$ values, with most zircon Hf model ages pointing to 2.8-2.6 Ga, similar to rock-forming ages of the 2.75-2.65 Ga TTG gneisses in the Luxi granite-greenstone terrane, suggesting that the 2.55-2.50 Ga rocks in the Eastern Block were mainly derived from the partial melting of an early Neoproterozoic (2.75-2.65 Ga) juvenile crust that formed at ~2.7 Ga. As the 2.55-2.50 Ga TTG gneisses are ubiquitous over the whole Eastern Block, the 2.7 Ga event must have occurred over the whole Eastern Block, forming an early Neoproterozoic juvenile crust that experienced partial melting or reworking to form the 2.55-2.50 Ga TTG rocks.

(3) TTG rocks are generally considered to have been derived from the partial melting of a thickened mafic crust (eclogite or rutile/garnet-bearing amphibolite). This means that an early Neoproterozoic (2.75-2.65 Ga) juvenile crust formed by the ~2.7 Ga event should be a mafic-dominant crust, which is either a lower continental crust or an oceanic crust. In this case, the ~2.7 Ga event in the Eastern Block may have represented a Large Igneous Province event that formed the main body of the Eastern Block. This study was financially supported by the sub-project of a NSFC Major Project, entitled "Continental Crust Growth-Stabilization and Initiation of the Early Plate Tectonics" (Project Code: 41890831) and HKU Seed Fund for Basic Research (201811159089).

