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Petrology, phase equilibria modeling and zircon U-Pb geochronology of Paleoproterozoic mafic granulites from the Fuping Complex, North China Craton

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The North China Craton (NCC) is one of the largest and oldest cratons in eastern Eurasia, and has witnessed the collisional assembly of major continental blocks at 2.1–1.8 Ga, broadly coeval with the incorporation of the craton within the global supercontinent Columbia. One of the popular tectonic classifications of NCC sub-divides the craton into the Western Block, Eastern Block and Trans-North China Orogen. The Fuping Complex is one of the important basement terranes within the central segment of the Trans-North China Orogen where mafic granulites are exposed as boudins within tonalite-trondhjemite-granodiorite (TTG) gneisses. Garnet in these granulites shows compositional zoning with homogeneous cores formed in the peak metamorphic stage, surrounded by thin rims with an increase in almandine and decrease in grossular content suggesting retrograde decompression and cooling. Petrologic and phase equilibria studies including pseudosection calculation using THERMOCALC define a clockwise P–T path. The peak mineral assemblages comprise garnet + clinopyroxene + amphibole + quartz + plagioclase + K-feldspar + ilmenite ± orthopyroxene ± magnetite with metamorphic P–T conditions estimated at 8.2–9.2 kbar, 870–882 °C (15FP-02), 9.6–11.3 kbar, 855–870 °C (15FP-03) and 9.7–10.5 kbar, 880–900 °C (15FP-06), respectively. The pseudosections for the subsequent retrograde stages based on relatively higher H_2O contents from P/T–M(H_2O) diagrams define the retrograde P–T conditions of <6.1 kbar, <795 °C (15FP-02), 5.6–5.8 kbar, <795 °C (15FP-03), and <9 kbar, <865 °C (15FP-06), respectively. Data from LA-ICP-MS zircon U–Pb dating show that the mafic dyke protoliths of the granulite were emplaced at ∼2327 Ma. The metamorphic zircons show two groups of ages at 1.90–1.96 Ga (peak at 1.92–1.93 Ga) and 1.80–1.89 Ga (peak at 1.83–1.86 Ga), consistent with the two metamorphic events widely reported from different segments of the Trans-North China Orogen. The 1.93–1.92 Ga ages are considered to date the peak granulite-facies metamorphism, whereas the 1.83–1.86 Ga ages are correlated with the retrograde event. Thus, the collisional assembly of the major crustal blocks in the North China Craton might have occurred during 1.93 to 1.90 Ga, marking the final cratonization of the North China Craton.