

The growth, reworking and evolution of early Precambrian crust in the Jiaobei terrane, the North China Craton: Constraints from U-Th-Pb and Lu-Hf isotopes, and REE concentrations of zircon from granitoid gneisses

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The early Precambrian crustal growth and reworking of the North China Craton (NCC), its tectonic subdivision and amalgamation, and its major magmatic and metamorphic events are important issues of considerable controversy. The high-grade metamorphic Jiaobei terrane located at southeastern NCC, mainly composed of Archean and Paleoproterozoic granitoid gneiss and metamorphic supracrustal rocks, is generally considered to be the southern extension of the Jiao-Liao-Ji belt which has commonly been regarded as a Paleoproterozoic active belt on the eastern margin of the NCC.

To better understand the growth, reworking, metamorphism and tectonic evolution of the Jiaobei terrane, Jiao-Liao-Ji belt as well as NCC, we have conducted a coupled LA-ICP-MS U-Th-Pb dating, trace element and in situ Hf isotopic study of zircons from Archean and Paleoproterozoic granitoid gneisses which mainly comprise Archean TTGs (tonalite-trondjemite-granodiorite) and Paleoproterozoic deformed monzogranitic gneisses, undeformed syenogranites and pegmatitic granites. A comprehensive dataset of CL-images, Th/U ratios, REE (rare earth element) concentrations, $^{176}\text{Lu}/^{177}\text{Hf}$ and $^{176}\text{Lu}/^{177}\text{Hf}$ ratios of distinct zircon domains from the early Precambrian granitoid gneisses is presented. The results defined three stages of Archean continental crustal growth by TTGs magmatisms at ~ 2.9 , 2.7 and 2.5 Ga, respectively. The TTGs have positive zircon $\varepsilon_{\text{Hf}(t)}$ values, and two-stage Hf model ages clustering at ca. 3.3 - 2.7 Ga. We also defined multi-stage Paleoproterozoic granitic magmatisms by remelting of continental crust during 2.2 - 2.0 and 1.8 Ga. The Paleoproterozoic granitoids show negative $\varepsilon_{\text{Hf}(t)}$ values, and two-stage Hf model ages mainly ranging from 3.2 - 2.7 Ga. We also obtained two groups of metamorphic ages of ~ 2.5 and ~ 1.86 Ga. The ~ 2.5 Ga metamorphic event which is widely occurrences in the NCC is thought to be linked to underplating of large amounts of mantle-derived magma, and the 1.86 Ga metamorphic event which is occurrences in western Khondalite belt, Trans-North China Orogen and Jiao-Liao-Ji belt is thought to be linked to arc (continent) -continent collision responding to assembly of supercontinent Columbia.

Based on our new results, combined with the previous researches, we summarized that the growth and evolutionary history of early Precambrian continental crust in the Jiaobei terrane is following: 1) $> \sim 2.9$ Ga, the Jiabei terrane were dominated by basic crust (oceanic crust) with limited early Archean continental crust which had been denuded; 2) At ~ 2.9 Ga, 2.7 Ga and 2.5 Ga, the ~ 3.3 - 2.7 Ga juvenile thickened basaltic lower crust experienced episodic partial melting accompanied with remelting of continental crust triggered by upwelling of mantle plume, and formed the Archean continental crust consisting of plenty of TTGs and minor continental crust-remelted (high K) granites; 3) During ~ 2.2 - 2.0 Ga, the continental crust took place rifting and thinning caused by upwelling of mantle materials, resulting in formation of ~ 2.2 - 2.0 Ga granitoids by remelting of the continental crust; 4) During ~ 1.95 - 1.85 Ga, the Jiaobei terrane underwent granulite to high amphibolite facies metamorphism caused by collision-related tectonic processes and closing of the rift; 5) At ~ 1.8 Ga, the continental crust underwent extension and thinning again caused by upwelling of mantle materials, which resulted in formation of ~ 1.8 Ga granites by remelting of the continental crust.

Keywords: The Jiabei Terrane, Early Precambrian geology, Continental crustal growth, Archean TTGs gneiss, North China Craton