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Late Neoarchean–Paleoproterozoic tectonic evolution in the Khondalite Belt, North China Craton: Insights from geochemistry, geochronology, and noble gases of granitoid gneisses

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Granitoid rocks of late Neoarchean-early Paleoproterozoic age are widely exposed in the central segment of the Khondalite Belt (KB), North China Craton (NCC)[1]. However, tectonic evolution that generated these rocks remains unclear. In this study, we analyzed 17 rock samples from the Daqingshan area for their whole-rock geochemistry, zircon U-Pb geochronology, Sr-Nd-Hf-Pb and noble gas isotopes. By integrating these data with geological field observations, we propose a model to describe the tectonic evolution of the area, which provides a new insight for the development of the NCC during the late Neoarchean-early Paleoproterozoic period.

U–Pb analysis of zircons from twelve representative granitoid samples suggests that they were emplaced at ca 2.57-2.51 Ga, 2.45 Ga and 2.37-2.27 Ga, and underwent multi-stage metamorphism at ca 1.90–1.85 Ga. Lu–Hf isotopes in zircons show that the granitoids of 2.57-2.51 Ga and 2.45 Ga have positive zircon $e_{Hf(t)}$ values with an average of +3.91, and two-stage depleted mantle zircon Hf model ages (T_{DM2}) clustering around 2.7–3.0 Ga. This indicates a juvenile crustal source that formed at ca 2.7–3.0 Ga. While the granitoids of 2.37-2.27 Ga have negative zircon eHf(t) values with an average of -1.92, and two-stage depleted mantle zircon Hf model ages (T_{DM2}) clustering around 2.8–3.0 Ga. It indicates ancient crustal recycling that formed at ca 2.8–3.0 Ga. Whole-rock geochemical analysis of granitoid samples show characteristics of high total rare-earth-element (REE), enriched in light REE, and depleted in heavy REE. Primitive-mantle-normalized trace-elements show that the granitoid samples are depleted in high-field-strength elements (Nb, Ta, U and Ti) and enriched in large-ion lithophile elements (Ba, K, Rb and Sr). In general, the samples have geochemical characteristics consistent with cordilleran I-type granitoids, which are formed in subduction-related magmatic arcs. $^{3}He/^{4}He$ ratios extracted from granitoid samples by crushing and stepwise heating range from 5.34×10^{-8}-7.56×10^{-7}, indicating a typical crustal origin. $^{4}He/^{20}Ne$ ratios imply little air contamination. By combining rock geochemistry with noble gases, we present models for the crustal melting and magma mixing processes during the late Neoarchean–Paleoproterozoic tectonic evolution in the KB, NCC.