

Discovery of the first Archean spodumene pegmatite field in China and its indication to assembly of North China Craton

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The Neoproterozoic was a crucial period in Earth's evolutionary history. Cratons completed their aggregation and tended towards stabilization during this time. Large-scale accumulations of microcontinents and associated collision-orogenic events led to a global peak in lithium mineralization. In China, lithium mineralization events mainly occur in the Phanerozoic, and there are few reports of Archean mineralization events. By establishing the metallogenic pedigree of rare-metal pegmatites in China and examining the relationship between tectonic evolution and rare-metal mineralization, we suggest that the North China Craton has the most favorable conditions for producing Archean pegmatites in China.

Through detailed field investigations, we have, for the first time in China, discovered the Archean spodumene pegmatites in the Yanlingguan area of central Shandong province (Fig.1). Through columbite U-Pb dating, we have accurately determined the two-stage Li-Nb-Ta metallogenic events in the Archean in North China, which occurred at (2609 ± 13) Ma and (2502 ± 9) Ma. The 2609 Ma mineralization event corresponds to the formation of the Yanlingguan greenstone belt in the eastern block of the North China Craton, while the 2502 Ma mineralization event corresponds to the large-scale crust-melt granite event related to the cratonization of the North China Craton. Based on mineralogical research, the $w(\text{Li}_2\text{O})$ of spodumene in the Yanlingguan pegmatites is 7.66-7.93 %, which is close to the theoretical upper limit of $w(\text{Li}_2\text{O})$ in spodumene and represents a high-quality lithium resource. The Yanlingguan pegmatites also contain elbaite, Cs-rich feldspar, manganotantalite and apatite, making it a typical LCT-type (Li-Cs-Ta) pegmatite. Compared with deposits of the same type of Neoproterozoic, the Yanlingguan pegmatites have higher crystallization temperature and pressure conditions, so there is no production of petalite. The frequent continental-continental collisions in the ~2.50 Ga North China Craton, accompanied by multi-stage magmatic activities, provided a continuous heat supply for the progressive partial melting of the Archean basement, creating ideal conditions for the enrichment of rare-metal elements and the formation of spodumene pegmatites. The 'terrigenous component-rich basement + microcontinental tectonic belt' can be used as an important prospecting indicator for pegmatite-type rare-metal resources in the North China Craton.

