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Mineralization of Rare Metals in Pegmatite Triggered by Intensive Decompression

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Determining the crystallization temperature and pressure conditions during the magmatic evolution process is necessary and crucial to understanding the pegmatite system. However, these physical conditions of pegmatite are less constrained and the research focused on the complete pegmatite system is lacking. The theories of pegmatite formation and mineralization remain controversial on the undercooling of pegmatite [1].

The Jiajika Li deposit in the southeastern Songpan-Ganze Orogenic Belt, eastern Tibet is a classic example of a Li-Cs-Ta-type pegmatite (LCT-pegmatite) system. Based on systematic petrological, mineralogical, and geochemical studies of samples from surface outcrops in the typical pegmatite dikes and a 3211-m-depth scientific drill core in the Jiajika Li deposit, including the chemical and B isotopic compositions of successive generations of mica and coexisting tourmaline, we identified a continuous magmatic evolution process with Li enrichment and Li mineralization occurred in flux-rich melts. The crystallization temperature of the granite (670 ± 42 ℃) and the pegmatites (629 ± 68 ℃) was constrained by the equilibrium B isotope fractionation between paragenetic muscovite and tourmaline, and are in good agreement with the LREE saturation temperature index. By comparison, the formation temperatures are 606 ± 59 and 662 ± 68 ℃ for the Li-poor pegmatite and Li-rich pegmatite, and the crystallization pressures were constrained to be 512 ± 68 and 311 ± 51 MPa, respectively.

The evidence suggests that undercooling during the Li-mineralization in the Jiajika pegmatite system was controlled by intensive decompression with associated fluid exsolution, and chemical quenching that likely raised the liquidus temperature, rather than by a drop in temperature of the system. This observation is in marked contrast to models for Li-mineralization in typical LCT-pegmatites elsewhere, such as Evje-Iveland, Skåremyr, Tanco, and Himalaya pegmatites, where direct undercooling is more commonly invoked.

[1] McCaffrey, D. M., & Jowitt, S. M. (2023). *Earth-Science Reviews*, *244*.