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The P-T Path of Magmatic-Hydrothermal Evolution of Jiajika Pegmatite-type Li deposit

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Pegmatite is characterized by dominantly coarse-giant crystal size and unique textures. The Li-Cs-Ta (LCT)-family pegmatite, which typically carries incompatible elements of Li, Rb, Cs, Be, B, F, and P, is one of the most important critical metal resources in the world [1]. The Jiajika pegmatite-type lithium deposit in the south-eastern Songpan Ganze Orogenic Belt is a classic LCT-family pegmatite system with typical spatial zonation and a super-large metallogenic scale.

It is crucial to constrain the physiochemical conditions and chemical compositions of magma during the magmatic-hydrothermal evolution for understanding the metallogenic processes in the pegmatite system. Although liquidus undercooling has been acknowledged in the experimental petrology, thermodynamic modelling, and pegmatite in nature, it remains controversial how does undercooling control the mineralization of pegmatite [2].

Based on a systematic petrological, mineralogical, and geochemical study along the entire 3211-m-depth scientific drill core in the Jiajika pegmatite-type lithium deposit, a four-stage magmatic-hydrothermal evolution process has been proposed, including the magmatic stage, the magmatic-hydrothermal stage, the hydrothermal stage, and the secondary metasomatism stage. Combining the texture and chemical composition of mica and tourmaline, both the magmatic and hydrothermal mineralization stages were recognized in the Jiajika pegmatite-type lithium deposit.

The crystallization temperature of granite and pegmatite has been constrained using the boron isotope geothermometer based on the equilibrium boron isotope fractionation between paragenetic muscovite and tourmaline. The crystallization temperature of granite is determined to be 670 ± 42 ℃, and that of different types of pegmatites keeps nearly consistent with an average of 625 ± 63 ℃, which is in good agreement with the LREE saturation temperature. With the isometric condition of the fluid inclusion in quartz, the crystallization pressures have been derived to be 226 - 414 and 376 - 661 MPa for Li-rich pegmatite and Li-poor pegmatite. Based on these results, the P-T path of magmatic-hydrothermal evolution has been constructed in the Jiajika pegmatite-type lithium deposit.