

Paragenesis of Li minerals in the Nanyangshan rare-metal pegmatite, Northern China: Toward a generalized sequence of Li crystallization in Li-Cs-Ta-type granitic pegmatites

ZHAOYU YANG¹, RUCHENG WANG^{1,*†}, XUDONG CHE¹, LEI XIE¹, AND HUAN HU¹

¹State Key Laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Xianlin University Town, Nanjing 210023, China

ABSTRACT

The Nanyangshan Li-Cs-Ta (LCT) pegmatite is the largest of hundreds of pegmatite dikes in the eastern Qinling orogenic district, North China. The Nanyangshan pegmatite is strongly zoned into a contact zone, border zone, wall zone, intermediate zone, and core, with Li mineralization occurring predominantly in the intermediate zone. Inward through the intermediate zone, Li mineralization is divided into subzones of Spd (spodumene), Mbs (montebrasite), Elb (elbaite), and Lpd (lepidolite). Lithium minerals include spodumene, montebrasite, lithiophilite, elbaite, lepidolite, and possible former petalite. Paragenetic assemblages of Li minerals are variable, with spodumene ± Li-phosphates (montebrasite and lithiophilite), Fe-rich elbaite, lepidolite, and possible former petalite in the Spd subzone; Li-phosphates (main montebrasite and rare lithiophilite) + spodumene + Fe-bearing elbaite + lepidolite in the Mbs subzone; Fe-poor elbaite + lepidolite ± montebrasite in the Elb subzone; and lepidolite ± Fe-poor elbaite in the Lpd subzone. Whole-rock contents of Li₂O, P₂O₅, B₂O₃, and F are consistent with the high contents of various Li minerals. Spodumene was formed first and dominantly from a Li-saturated melt in the Spd subzone (1.66 wt% Li₂O). This subzone graduates into the P-rich Mbs subzone (3.75 wt% P₂O₅) with montebrasite gradually succeeding Li-aluminosilicates, followed by the appearance of abundant Fe-poor elbaite in the Elb subzone (1.04 wt% B₂O₃), reflecting the consumption of P in the melt. Lepidolite formed after early-formed Li phases in the F-rich Lpd subzone (2.03 wt% F), as indicated by replacement textures. Among the numerous LCT pegmatites worldwide, the Li mineralization sequence can be suggested as Li-aluminosilicates (commonly spodumene and less commonly petalite) → Li-phosphates (montebrasite-amblygonite and triphylite-lithiophilite) → elbaite → lepidolite, and can be regarded as a general sequence for Li mineralization.

Keywords: Spodumene, montebrasite-amblygonite, triphylite-lithiophilite, elbaite, lepidolite, pegmatite zonation; Lithium, beryllium and boron: Quintessentially crustal