Stepwise magmatism and structural reactivation facilitates LCT pegmatite formation: Insights from central Sweden.

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Introduction

Two main geological processes are thought to produce volatile-rich melts that crystallize rare element-bearing granitic pegmatites. The classic scenario envisages such melts as late-stage, residual differentiates of crystallizing fertile granites (e.g., London 2016). Alternatively, pegmatitic melts may develop directly during low-degree partial melting of fertile supracrustal ± plutonic rocks, thus bypassing the need for a progenitor granite stage (e.g., Müller et al. 2017). While assessing controls on melt formation at the time of pegmatite emplacement is critical to understanding these mineral systems, constraining tectonothermal factors active during earlier stages in the evolution of host/source rocks may help identify processes that indirectly facilitate pegmatite formation. As part of the EIS project (Horizon Europe grant no. 1010557357; https://eis-he.eu), we present a case study from the Järkvissle LCT pegmatite system in central Sweden to highlight the role stepwise, superimposed magmatism, metamorphism and deformation plays in the formation of LCT pegmatites.

The Järkvissle Li-Sn-Ta pegmatite field, central Sweden

The Paleoproterozoic (c. 2.0 – 1.8 Ga) Bothnian Basin in central Sweden contains several LCT (lithium-caesium-tantalum)-type granitic pegmatite prospects. The best example is the c. 1.8 Ga Järkvissle Li-Sn-Ta prospect which comprises a c. 2 x 7 km field of c. N-S-oriented, subvertical pegmatite dykes intruding a polydeformed package of metasedimentary and intercalated mafic metavolcanic rocks. Important ore minerals at Järkvissle include spodumene, petalite, cassiterite and columbite group minerals, while accessory tourmaline, apatite, beryl and uraninite also occur.

Stepwise tectonothermalism, structural reactivation, and late-stage pegmatite formation

Metasupracrustal rocks and meta-granitoids in the Järkvissle area have been affected by at least two stages of ductile deformation. An early event (D_1) is evidenced by bedding parallel S_{0-1} foliations with variable orientations. A second event (D_2) is characterized by major and parasitic, moderate to tight, c. NNW-aligned F_2 folds, and axial planar cleavages (S_2) that affect S_{0-1} planar fabrics. The eastern limb of a major F_2 fold shows evidence of high-strain, syn-D_2 dextral shearing, and hosts the Järkvissle pegmatite field. Southwest and east of the Li prospect, foliated leucogranites with local migmatitic features (diatexite) represent a phase of high-grade metamorphism - possibly linked to D_2 deformation.

Small volume, weakly deformed to massive pegmatitic granite and pegmatite bodies crosscut metasedimentary rocks and migmatitic leucogranites, and tend to intrude along steep, pre-existing structures. At the Järkvissle prospect, internally massive spodumene-bearing dykes have wavy and sometimes folded forms, and locally deflect $S_{1/2}$ planar fabrics or crosscut tightly folded syn-D_2 quartz-feldspar veins. These observations indicate a late phase of structural reactivation (D_3 at c. 1.8 Ga?) along the earlier formed F_2 fold limb was exploited by evolved melts, leading to syn-tectonic pegmatite emplacement and Li-Sn-Ta mineralization. Thus, stepwise tectonothermal overprinting and late-orogenic structural reactivation are important pre-conditions for LCT pegmatite formation.

References

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