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Structural and temporal controls on LCT pegmatite emplacement at the Galaxy deposit (Superior Province, Quebec)

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The Galaxy Li-deposit (110.2 Mt @ 1.30% Li_2O; total resources; 43-101, 2023) is located in the metasedimentary Nemiscau subprovince of the Superior Province, ~5 km to the south of the Lower Eastmain greenstone belt. Lithium mineralization is hosted in a swarm of spodumene–muscovite–tourmaline–garnet–coltan LCT pegmatite dikes that dip steeply (>70°) westward. The dikes were preferentially emplaced within a competent sandstone unit trending ESE–WNW, over a length of approximately 1.5 km and a width of ≥250 m, at the contact with a less competent cordierite-bearing wacke and pelitic rocks metamorphosed under amphibolite facies conditions. The geometry and localization of the dikes are interpreted to reflect this competency contrast, which promoted extensional fracturing within the sandstone. The mineralized pegmatites occur at the northern margin of a broader barren pegmatite swarm rooted in an upper amphibolite to granulite facies migmatitic dome. Barren pegmatites include earlier E-W dikes containing muscovite-garnet-tourmaline-apatite±biotite, and later, more evolved N-S dikes that locally contain beryl.

The metasedimentary host rocks record a penetrative E-W-trending S_2 foliation that formed in a compressional setting. This fabric is overprinted by a E-W to NE-SW-trending S_3 crenulation cleavage associated with dextral shearing. The Li-pegmatites crosscut the S_2 foliation, but they are affected by late F_3 folding and boudinaged, suggesting that dextral transcurrent D_3 shearing was synchronous with and controlled pegmatite emplacement.

Pegmatite-derived zircons are U-rich, therefore LA-ICP-MS U-Pb dating was combined with chemical abrasion to reduce the effects of Pb-loss. The maximum depositional age of the host metasedimentary rocks was determined to be between ca. 2725 – 2710 Ma. Migmatization within the dome occurred at ca. 2675 Ma, and was coeval with emplacement of the barren E-W dikes. Crosscutting N-S dikes containing beryl were emplaced at ca. 2660 Ma, marking progressive melt evolution, from anatectic leucosome to Li-mineralized pegmatites over ~15 m.y.

These results highlight the combined effects of (1) district- to deposit-scale stratigraphic and structural controls; (2) early crustal anatexis; and (3) progressive melt evolution, culminating with emplacement of Li-pegmatites within vertical conduits during D_3 transcurrent shearing, which are mainly represented by extensional sites.