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Geology, origin and emplacement of the Sirmac lithium pegmatites in the Frotet-Evans greenstone belt, Superior Province, Quebec

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Archean LCT-type pegmatites within Quebec's Superior Province occur as dike swarms intruding the supracrustal rocks of the Eeyou Istchee James Bay region. Despite their widespread occurrence, their origin, structural geometry, precise timing, and mechanisms of emplacement remain enigmatic. Among these, the Sirmac deposit, situated in the Frotet-Evans greenstone belt, comprises three primary mineralized dikes, the largest of which extends 600 meters in length and 30 meters in width, with an estimated resource of 0.27 Mt at 1.4% Li_2O (NI 43-101, 2023).

The dikes intrude metamorphosed sandstone, conglomerate, and basalt, which have undergone greenschist to amphibolite facies conditions and are locally overprinted by hydrothermal assemblages of biotite, tourmaline, and holmquistite. The host rocks exhibit a north-dipping foliation, accompanied by a shallowly plunging stretching lineation. The dikes themselves follow a NW-SE orientation, predominantly as steeply dipping bodies, though some shallow-dipping examples are present. The absence of internal tectonic or magmatic fabrics suggests that the pegmatites likely exploited pre-existing extensional fractures during their emplacement. Collectively, these features point to a late-orogenic, D_3 transpressional regime as the most plausible tectonic setting for their formation. Texturally, the mineralized pegmatites are zoned, comprising: 1) coarse-grained quartz-spodumene cores; 2) heterogranular zones of quartz-feldspar-spodumene, with accessory muscovite, tourmaline, biotite, apatite, garnet, and beryl; and 3) an aplitic border facies enriched in garnet and apatite. Late-stage, muscovite-rich aplite dikes crosscut the pegmatites. Geochemically, the pegmatites display a systematic increase in Li_2O, Cs, and Rb/Sr ratios, transitioning from aplite to spodumene-rich zones. Muscovite-dominated pegmatites have also been documented, but their temporal and genetic relationship to the mineralized dikes remains unresolved. The normative composition of the pegmatites coupled to major, trace and rare earth elements allowed to define a differentiation trend evolving from borders to cores. Also, mineral chemistry and isotope geochemistry are underway in order to establish a geochemical model for the emplacement and sources of the pegmatites. Textural similarities and the spatial clustering of mineralized dikes suggest they may have been emplaced during a single, protracted magmatic event. Nevertheless, further investigations, particularly geochronological studies, are essential to emphasize the tectono-magmatic controls governing the emplacement of barren versus mineralized dikes.