

Specialized lithium-cesium-tantalum (LCT) pegmatites are currently an essential mineral exploration target because of the need for Li and other critical commodities necessary to fuel our future electric economy. The Brazil Lake North, South & newly discovered Army Road pegmatites in Yarmouth County, Nova Scotia, Canada contain significant amounts of spodumene (~15 wt. % on average) which may be destined for this purpose. Hosted by sheared and isoclinally folded, upper greenschist-to-lower amphibolite Ordovician-to-Silurian pelitic schists, mafic schists, and orthoquartzites of the White Rock Formation, these vertical, ribbon-like, lensoid cross-section pegmatite dykes strike NE -SW, dip steeply SE in rocks that dip steeply NW, are generally 10-25 m thick, and extend 150 m vertically. Although sub-cropping over more than 200 m, their long axes rake shallowly SW, extending > 1.2 km down-rake, and all three pegmatite dykes are open in that direction.

The pegmatites consist predominantly of coarse-to-very coarse quartz (QZ), albite (AB), microcline (KS), muscovite (MS), and spodumene (SP), with minor/trace and generally small crystals of tourmaline (schorl, elbaite), apatite, zircon, beryl, epidote, cassiterite, columbite, and tantalite. An informal mineral resource for the Brazil Lake camp has reached 10.01 M tonnes of 1.20 % Li₂O after extensive drilling (~25,600 m) in 2022-2023. Assays responsible for this resource were obtained via Na₂O₂ fusion-ICP-MS analyses, which includes Li₂O and most major oxides and pathfinder elements. Unfortunately, this analytical method can't measure Na₂O, P₂O₅, and Zr, and it wasn't calibrated for the pegmatite concentrations of SiO₂, MgO, and TiO₂, so these six elements were analyzed via LiBO₃ fusion-ICP-MS, making all major oxides and pathfinder elements available for litho-geochemical evaluation.

Major oxides were examined using Pearce element ratio analysis to estimate the five principle mineral modes via linear combinations of SiO₂, Al₂O₃, Na₂O, K₂O, and Li₂O (which collectively sum to > 98 wt. %, not counting the H₂O in muscovite, which on average contributes ~0.54 wt. %). These reveal that the pegmatites exhibit minor primary zoning, as many drill core intersections do not contain spodumene in their first 2-3 meters. This suggests that spodumene was not initially on the liquidus, but because inside these exterior zones, spodumene is present, it likely joined the liquidus shortly after emplacement. Lastly, a 4 m wide core zone has been identified in one DDH consisting only of large spodumene crystals growing from the outside in within a matrix of coarse-grained, gray quartz. Other zoning features are absent, likely because of variations caused by small numbers of coarse-grained crystals (a nugget effect). However, it is important to note that, because of the high abundances of these five principal minerals (with average minimum concentrations of ~5.50 wt. % KS), this nugget effect predictably creates variance but at the same time surprisingly creates only modest sampling bias for these minerals, facilitating the calculation of accurate Li resource estimates.

Secondary zoning occurs in all three pegmatites due to deuteric alteration of the tops and sides of the pegmatites, producing a more limited mineral suite consisting of quartz, albite, and muscovite. Two metasomatic reactions appear to be responsible for destroying K-feldspar and spodumene in these locations: $KAlSi_3O_8 + Na^+ \Rightarrow NaAlSi_3O_8 + K^+$ (-8 % vol. change) and: $3LiAlSi_2O_6 + K^+ + 2H^+ \Rightarrow KAl_3Si_3O_{10}(OH)_2 + 3SiO_2 + 3Li^+$ (-8 % vol. change). These alteration reactions produce saccharoidal or cleavelanditic albite with beaded quartz and minor inter-crystalline muscovite.

Because quartz, albite, microcline, and muscovite are commonly LCT pegmatite by-products, their grades and tonnages can be estimated using the calculated Pearce element ratios, allowing inclusion of these industrial minerals in the deposit resource estimate, a feature that significantly enhances deposit economics. Trace amounts of Ta, Rb, and Be and other critical elements could also provide additional byproduct value.

Clifford R. Stanley, Dept. of Earth & Environmental Science, Acadia University, Wolfville, Nova Scotia, Canada, B4P 2R6, cliff.stanley@acadiau.ca; +1(902) 670-0817.