Tourmaline: A tool for identifying and understanding Li-enrichment in Quebec pegmatites

Geotop strategic research centre, McGill University, Montreal, Canada

There is growing global demand for lithium as governments worldwide commit to decarbonation to combat climate change. Lithium's unrivalled energy density per unit mass makes it uniquely suited as a battery material for electric vehicles, one of the pillars of the green energy transition. Its demand is predicted to outstrip supply by 0.9 out of 2 Mt by 2030 *(IAE, 2023)*, which presents a major risk to achieving Paris climate agreement targets. Quebec hosts abundant Li-pegmatites, in particular in the James Bay Eeyou Istchee region, and has the potential to become a major supplier of this critical metal. This research project aims to develop tourmaline, a common mineral in these Li-pegmatites and their host rocks, as an indicator mineral of the physical and chemical conditions of Li-mineralisation. This will allow tourmaline to be used to understand the geological conditions required to lead to Li-enrichment, and use tourmaline to vector towards Li-pegmatites. The project is a collaborative effort in partnership with the Ministère des Ressources naturelles et des Forêts, Winsome Resources, Trieste Lithium, Brunswick Exploration, SOQUEM, PMET Resources and Rio Tinto Lithium. Students will be co-supervised by members of the research team, which includes Kim Berlo (McGill), Ross Stevenson (UQAM) and Vincent van Hinsberg (McGill).

We invite applications for three fully-funded graduate student opportunities hosted by the Geotop research centre (www.geotop.ca) at McGill University and UQAM in Montréal, Canada:

PhD1: ***An inventory of tourmalines in the James Bay Eeyou Istchee region and their links to the regional and local geology***

This project focuses on quantifying the metamorphic and geochemical conditions of the rocks that host the pegmatites, and the intrusives themselves. This will provide the regional context required for meaningful interpretation of tourmaline composition and improve our overall understanding of the geology of the James Bay region. An inventory of tourmaline occurrences in the area will be created to determine the diversity of tourmaline settings, colours, textures, and compositions, and identify correlations with the LCT pegmatites of the Vieux Comptoir Suite. The PhD student will use fieldwork, microscopy, bulk rock and mineral geochemistry, and thermodynamic modelling, in particular pseudosection modelling and geothermobarometry to constrain *P-T* conditions, Ar-Ar and U-Pb geochronology to constrain ages, and Li- and Sr-isotopes to help differentiate between tourmaline growth from fluid and melt, and provide information on elemental source reservoirs.

We invite applicants with an MSc degree in the geosciences and relevant research experience in geochemistry and/or petrology, as well as a keen interest in critical metals, pegmatites and thermodynamic modeling. This is a fully funded 3-year PhD position with a start date of early 2026.

For questions, please contact Dr. Vincent van Hinsberg (hinsberg@eps.mcgill.ca) and Dr. Ross Stevenson (stevenson.ross@uqam.ca).

PhD2: *Tourmaline as a petrogenetic indicator mineral in LCT-pegmatites*

This PhD project will extend tourmaline's petrogenetic indicator potential to pegmatite systems. This will allow for using tourmaline chemistry to determine the *P-T* conditions and composition of its formation environment, and use this to reconstruct the magmatic-hydrothermal evolution of the diverse pegmatites that host them to obtain 1) a better understanding of how these pegmatites form; 2) the critical parameters that lead to Li enrichment in pegmatites; and 3) diagnostic features in tourmaline suitable for Li-deposit vectoring. To use tourmaline as an indicator of the conditions of pegmatite formation, and the chemical changes during magmatic fractionation and across the magmatic-hydrothermal transition requires extending current thermometric calibrations, element partitioning data, and thermodynamic models to Li-bearing compositions. The PhD student will identify, describe and quantify the compositions of the tourmaline sample suite by a multi-analytical approach; use tourmaline synthesis and element partitioning experiments to map out stability relationships and element exchange; and use these data to extend the current Li-free tourmaline thermodynamic model to Li-bearing compositions.

We invite applicants with an MSc degree in the geosciences and relevant research experience in geochemistry and/or petrology, as well as a keen interest in critical metals, experiments and thermodynamic modeling. This is a fully funded 3-year PhD position with a start date of early 2026. For questions, please contact Dr. Vincent van Hinsberg (hinsberg@eps.mcgill.ca).

MSc: *Tourmaline LIBS analyses as a field tool for Li-vectoring*

This MSc project will develop hand-held analytical tools for field identification and compositional analysis of tourmaline for use by our exploration partners in the James Bay region in exploration vectoring to Li pegmatites, and Li-enriched zones within pegmatites. We will focus on Laser Induced Breakdown Spectroscopy (LIBS) a method particularly suited for the light elements Li and B, which are both structural components in Li-tourmaline. The student will develop the analytical and data processing routines to rapidly identify and compositionally characterise tourmalines in the field, and analyse for the diagnostic vectoring features identified by the research team.

We invite applicants with a BSc degree in the geosciences, material sciences or inorganic chemistry with relevant research experience in analytical methods and/or mineral characterisation, as well as a keen interest in critical metals, method development and multi-variate statistics. This is a fully funded 2-year MSc position with a start date of September 2026 or January 2027. For questions, please contact Dr. Kim Berlo (kim.berlo@mcgill.ca) and Dr. Vincent van Hinsberg (hinsberg@eps.mcgill.ca).