GS2023-4

Preliminary examination of the Tappy, Eagle and F.D. No. 5 pegmatites in the Cat Lake–Winnipeg River pegmatite field, southeastern Manitoba (parts of NTS 52L5, 11)

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In Brief:

- A master's project was initiated focusing on selected Li-bearing pegmatites in the Cat Lake–Winnipeg River pegmatite field
- Observations and samples were taken at the Tappy, Eagle and F.D. No. 5 pegmatites
- Future work aims at accomplishing a robust time of emplacement and mineralogical report for these dikes

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Summary

This study is part of an M.Sc. thesis based at the University of New Brunswick, initiated in 2023 in collaboration with the Manitoba Geological Survey. During this summer's fieldwork, the first author examined three pegmatite sites in the Cat Lake–Winnipeg River pegmatite field, located in southeastern Manitoba, from June through August. Fieldwork focused on the Tappy, Eagle and F.D. No. 5 pegmatites. Field observations on the mineralogy and structure of the three pegmatites were made in order to provide a preliminary description of the three lithium-bearing dikes. Samples were also collected from each locality for further investigation.

Introduction

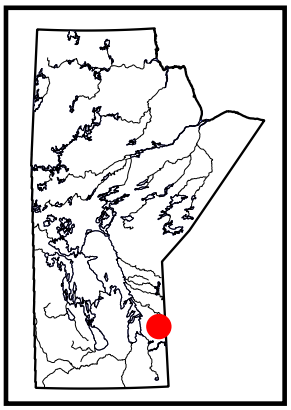
Global demand for battery metals such as lithium (Li) is experiencing a sharp rise due to the implementation of new modes of energy production, distribution and storage. Electric vehicle technology, along with new and improved electronics for both small- and large-scale consumers, have helped increase this interest. As the attention to critical materials grows, so does the need to mine resources such as Li. Pegmatites are one of the earth's prominent carriers of rare and critical elements, acting to concentrate incompatible elements within them (Černý et al., 2012). Manitoba is well positioned in the critical minerals field, with a long and successful history of exploration and production of lithium from Li-bearing pegmatites (Tanco mine). The Cat Lake–Winnipeg River pegmatite field, located in the Bird River domain of the Archean Superior province, hosts various pegmatites, some highly evolved and some simple (Černý et al., 1981).

This project has several objectives concerning the Tappy, Eagle and F.D. No. 5 pegmatites:

- conduct fieldwork to assess the geological setting, macroscopic zonation and structure of the different pegmatites
- use whole-rock lithogeochemistry, mineral chemistry and geochronological analysis to better understand the petrogenesis and crystallization ages of the pegmatites
- determine if there is a petrogenetic relationship between the Eagle and F.D. No. 5 pegmatites
- compare genetic and geochemical relationships to other pegmatites in the Cat Lake–Winnipeg River pegmatite field

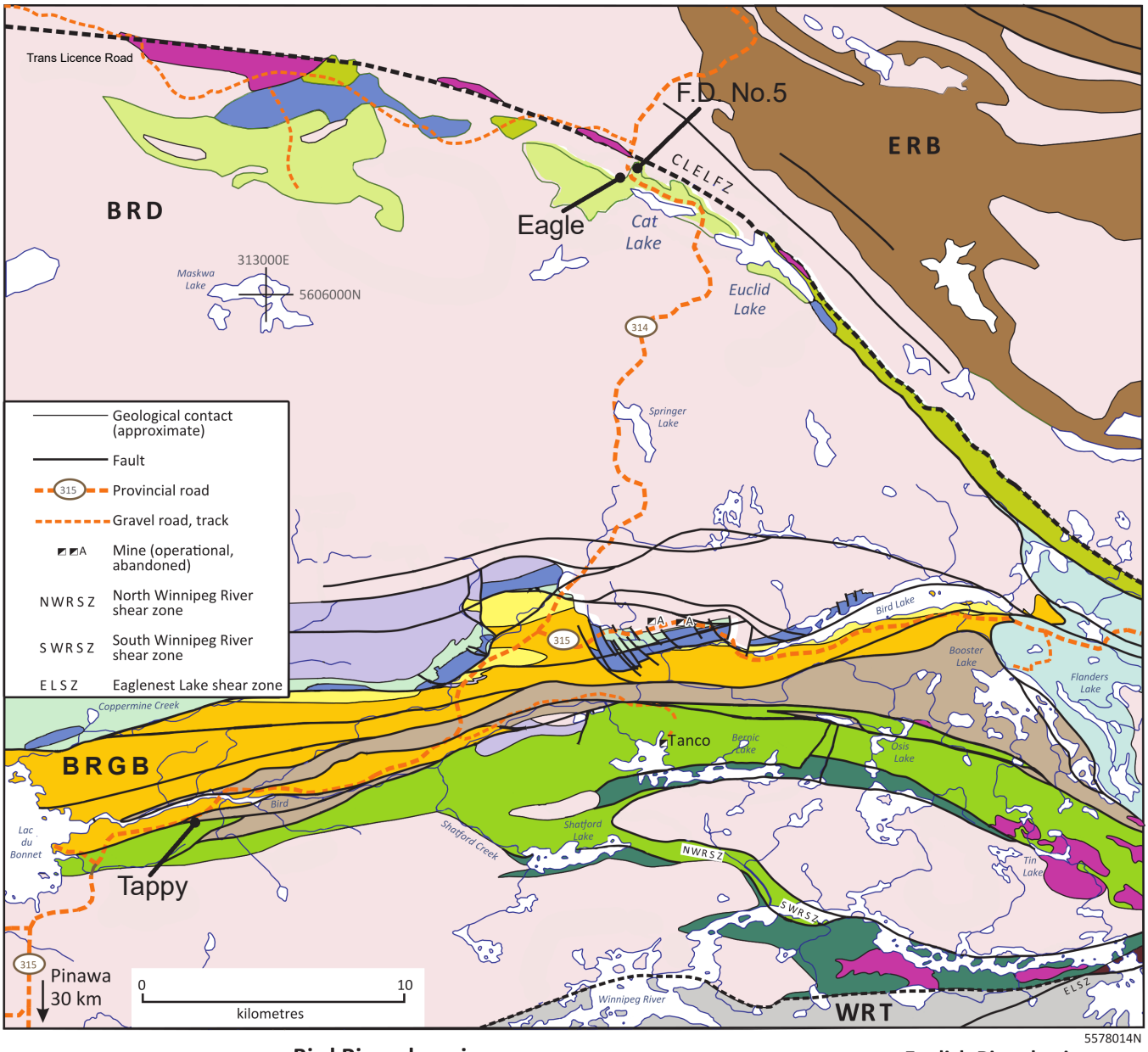
This information will help to build a better geological and mineralogical understanding of the pegmatite dikes' origin and aid exploration efforts in the area.

Regional geology



Compositionally, the Tappy, Eagle and F.D. No. 5 pegmatites can best be described as Li-bearing rare-element pegmatites that are broadly ascribed to the Li-Cs-Ta (LCT) family of pegmatites according to the classification by Černý and Ercit (2005). The Tappy pegmatite is located south of the Bird River along Provincial Road 315. The other two sites, the Eagle and F.D. No. 5 pegmatites, are located on the west and east sides, respectively, of Provincial Road 314 just north of Cat Lake. All three pegmatites are situated within the Cat Lake–Winnipeg River pegmatite field, approximately 200 km northeast of Winnipeg (Figure GS2023-4-1). Pegmatites in this region occur within the westernmost exposed portions of the Bird River domain, which is bounded to the north by the English River subprovince and to the south by the Winnipeg River terrane (Gilbert, 2008). The Cat Lake–Winnipeg River pegmatite field comprises two districts: the Winnipeg River district in the south and the Cat Lake district in the north (Černý et al., 1981).

The Tappy pegmatite occurs in the Winnipeg River pegmatite district, which extends east for approximately 50 km from Lac du Bonnet toward the Ontario border. It contains many pegmatites,



Bird River domain

Intrusive rocks

- S-type granite
- Granite, granodiorite, tonalite
- Gabbro, diorite, quartz diorite
- Pyroxenite, anorthosite, gabbro

Late sedimentary rocks

Flanders Lake formation

- Arenite, polymictic conglomerate

Booster Lake formation

- Greywacke, siltstone

Volcanic and sedimentary rocks

Bird River belt South Panel

Bernic Lake formation

- Heterolithic volcanic breccia, rhyolite, basalt, andesite

Eaglenest Lake formation

- Greywacke, siltstone

Southern MORB-type formation

- Basalt, aphyric; gabbro

Bird River belt North Panel

- Massive to fragmental, mafic to felsic volcanic and sedimentary rocks

Peterson Creek formation

- Massive to fragmental felsic volcanic rocks

Northern MORB-type formation

- Basalt, aphyric; gabbro

Cat Lake area

- Sedimentary and volcanic rocks, related gneiss
- Tholeiitic basalt

English River basin

- Paragneiss, granitoid intrusive rocks, migmatite, pegmatite

Winnipeg River terrane

- Tonalite, granodiorite, granitoid gneiss

- Domain or terrane boundary

Figure GS2023-4-1: *Tectonic assemblages of the Bird River greenstone belt (modified after Yang and Houlé, 2020). Locations of the studied pegmatites are shown with black arrows. Abbreviations: BRD, Bird River domain; BRGB, Bird River greenstone belt; CLELFZ, Cat Lake–Euclid Lake fault zone; ERB, English River basin; MORB, mid-ocean–ridge basalt; WRT, Winnipeg River terrane.*

both simple and Li-bearing, including the actively mined Tanco. The Tappy pegmatite is hosted within the Bird River greenstone belt (BRGB), a panel of supracrustal rocks described as a transitional oceanic-continental margin and composed of deformed and metamorphosed basalts, felsic volcanic to volcaniclastic rocks, and sedimentary rocks (Gilbert, 2008).

The other two pegmatites described in this study, the Eagle and F.D. No. 5 pegmatites, are located in the Cat Lake pegmatite district, which is located in the northern part of the Cat Lake–Winnipeg River pegmatite field. The Cat Lake pegmatite district lies to the north of the Maskwa Lake batholith within the northern part of the BRGB (Gilbert, 2008; Yang and Houlé, 2020). The northern part of the BRGB, which includes the Cat Lake pegmatite district, is separated from the ERB by the Cat Lake–Euclid Lake fault zone (see Figure GS2023-4-1; Yang and Houlé, 2020). This part of the BRGB is characterized by basalts, volcaniclastic and sedimentary sequences and other intrusive units overlying the older phases of the large Maskwa Lake batholith to the south (Yang and Houlé, 2020).

Geology of studied pegmatites

Tappy pegmatite

The Tappy pegmatite is a Li-rich spodumene-bearing pegmatite dike that is well exposed for more than 50 m (Bannatyne, 1985). It is narrowest at its southern end and broadens northward until eventually ending at a cliff (Figure GS2023-4-2). Another small outcrop with a composition similar to that of the Tappy pegmatite is visible roughly 100 m to the south; this is referred to as the Tappy South. The Tappy pegmatite is oriented north-south, with a strike ranging from 300° to 002°. At the widest extent of the pegmatite in the northern half of the exposure, the dike reaches almost 4 m in width, but the majority is less than 3 m in width, with the southern half having a maximum width of 1.5 m.

The Tappy pegmatite is hosted within foliated metamorphosed pillow basalt. The main foliation of the pillows strikes 243° and is subvertical. A pervasive, unevenly spaced cleavage through the metabasalt strikes 358° and is subvertical, which is similar to the strike of the pegmatite. The other structural feature is spaced fractures striking 300° and dipping 35° (Figure GS2023-4-3). Representative samples were taken from the Tappy pegmatite for geochemical analysis.

At the southernmost extent of the Tappy pegmatite, three distinct zones are visible. At this end, a light-coloured chilled margin less than 1 cm wide is present along much of the dike. Mineralogy is not easily discernible. Moving inward, the intermediate zone is present throughout the length of the pegmatite but has a variable thickness. It consists of quartz, feldspar and muscovite less than 0.5 cm in size. This area is partially hematized, with small veins of rust-coloured material running through it. The most distinct zone is the central zone, consisting of quartz, feld-

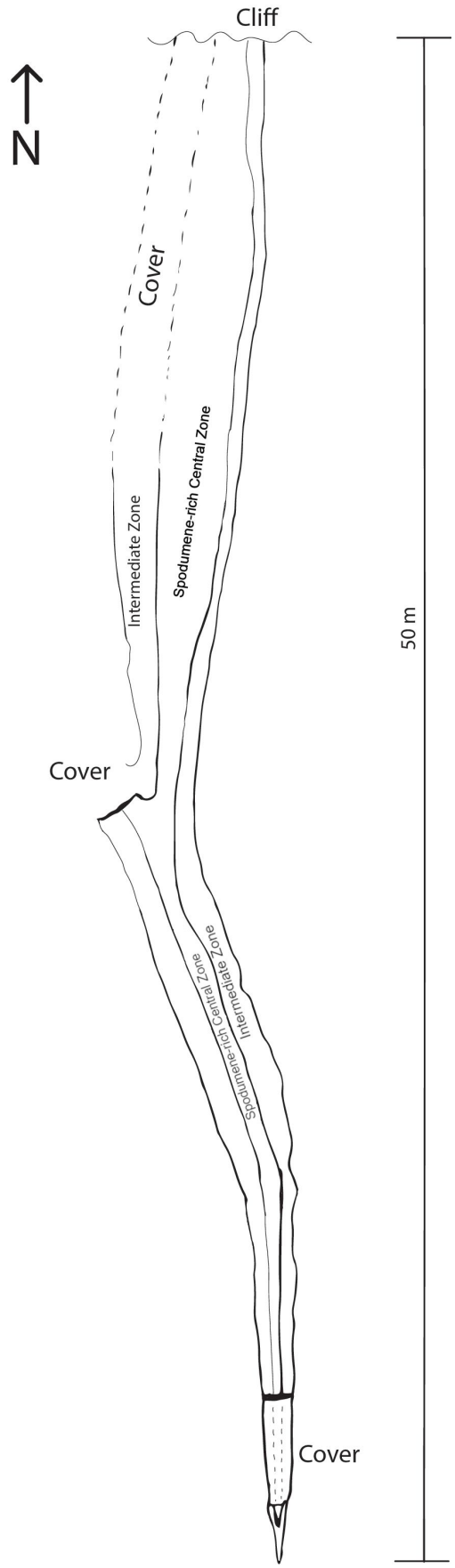


Figure GS2023-4-2: *Rough sketch of the Tappy pegmatite, showing its zonation, made during the 2023 field season. Proportions are not to scale so as to better show the approximate definition between the zones.*

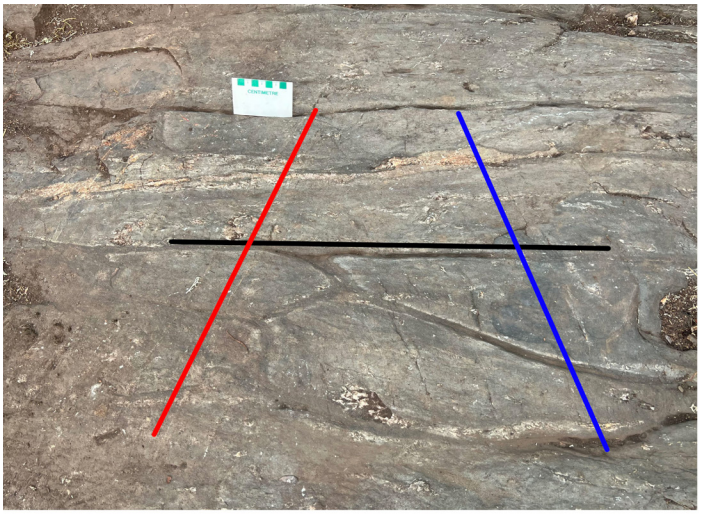


Figure GS2023-4-3: *Outcrop photograph of structures present in the pillow basalt around the Tappy pegmatite (facing northeast). The black line indicates the strike of the foliation in the pillowed metabasalts (063°, with subvertical dip). The red line indicates the spaced cleavages (striking 178° with subvertical dip) and the blue line indicates the other set of spaced cleavages (striking 300°).*

spar and muscovite but having a larger grain size (1–2 cm) than the intermediate zone. Hematization is also present in the central zone. Pervasive spodumene is readily visible, starting in the middle of the dike and extending northward. The size of the spodumene crystals increases northward, reaching 15 cm. It is unclear whether small grains of spodumene are present throughout the other zones of the pegmatite. Tantalite is observed as 1–3 mm crystals, which are most abundant in areas within the pegmatite that have larger sized crystals. Petrographic studies will provide more information on the distribution of minerals throughout the Tappy pegmatite.

Eagle pegmatite

The Eagle pegmatite outcrop consists of multiple, parallel dikes that trend east over an exposed area of bedrock (Bannatyne, 1985). Vegetation cover on the outcrop made it difficult to differentiate between the different dikes. However, it was sparse enough for thorough observation of the exposed areas. The dikes are hosted by a dominantly metagranitoid rock that is composed of variably deformed, mottled blue quartz and pink feldspar with minor biotite and hornblende. Moving to the south from the main exposure at Eagle, the metagranitoid grades into lighter-coloured rock composed of less biotite and more quartz. The southern part of the granitoid borders a weakly foliated and metamorphosed amphibolite (Bannatyne, 1985). The grains in this unit reach 1–3 mm. The amphibolite unit is weakly foliated, strikes 110° and borders the metagranitoid with a sheared boundary that also trends approximately 110°. The size of the grains within the metagranitoid unit is 0.5–1 cm. The granitoid extends from east to west for the majority of the exposure of the Eagle pegmatite. The pegmatite dikes of the Eagle range from approximately 10 cm to 9 m in width (Bannatyne, 1985). The composition of the pegmatites is relatively uniform, with variable modal percentages of feldspar, quartz, spodumene and white micas, and minor apatite, beryl and lepidolite.

The Eagle pegmatite exhibits crude zonation. In many parts, there is a visible chilled margin along the edge of the pegmatite, but it is never more than 1 cm thick. The nature of this zone made mineral identification impossible. Two main zones were observed: 1) an aplitic textured zone composed of white to pink aplitic quartz, feldspar, mica and minor garnet; and 2) a pegmatitic central zone composed of variably sized quartz, feldspar, mica and spodumene, with minor tourmaline, beryl and garnet (Figure GS2023-4-4). A third, less distinct zone within the Eagle dike is a mixture of both aplitic and pegmatitic textures.

In addition to field observations of the outcrops at the Eagle pegmatite, two drillcores were examined and logged (LT-21-09 and LT-21-11). The first drillhole (LT-21-09) is 89 m long and consists of granitic dikes crosscutting a dark, biotite-bearing granitoid rock. This hostrock is similar to that described for the Eagle pegmatite outcrop (Figure GS2023-4-4a). Core from this hole has multiple smaller pegmatites devoid of Li near the top of the hole and one larger spodumene-bearing pegmatite near the bottom. These smaller pegmatites are composed mainly of white feldspar, quartz and micas, and show varying degrees of hematization. The larger pegmatite near the end of drillhole LT-21-09 is 9 m in apparent width and consists of white feldspar, quartz that varies from clear to smoky, and spodumene. The foliated spodumene texture is abundant in this dike. Zones of this pegmatite are hematized to varying degrees.

The second drillhole (LT-21-11) is 119 m long and consists of granitic dikes crosscutting a very similar, granodiorite hostrock. This hole has a pattern similar to that in LT-21-09, with smaller pegmatites crosscutting the granodiorite near the top of the hole and one large, more mineralized pegmatite near the bottom. However, the core in drillhole LT-21-11 records more hostrock with some mafic volcanic xenoliths below the large pegmatite, due only to its greater length. The smaller pegmatites in the drillhole are composed mainly of white feldspar, quartz, and micas that show varying degrees of hematization (Figure GS2023-4-5a). The large pegmatite intersected in drillhole LT-21-11 is roughly 11 m in apparent width and consists of similar minerals to the pegmatite logged in drillhole LT-21-09. Various textures, such as a mixture of finer grained groundmass with comparatively large crystal sizes and foliated spodumene, are present in the pegmatites in both of the drillcores.

F.D. No. 5 pegmatite

The F.D. No. 5 pegmatite is composed of very coarse grained pegmatitic minerals in shades of pink to white. The pegmatite is hosted by a metagranodiorite similar to that observed at the Eagle and outcrops immediately northeast of it (Figure GS2023-4-6). Crystal size ranges from small (<1 cm) to large prismatic

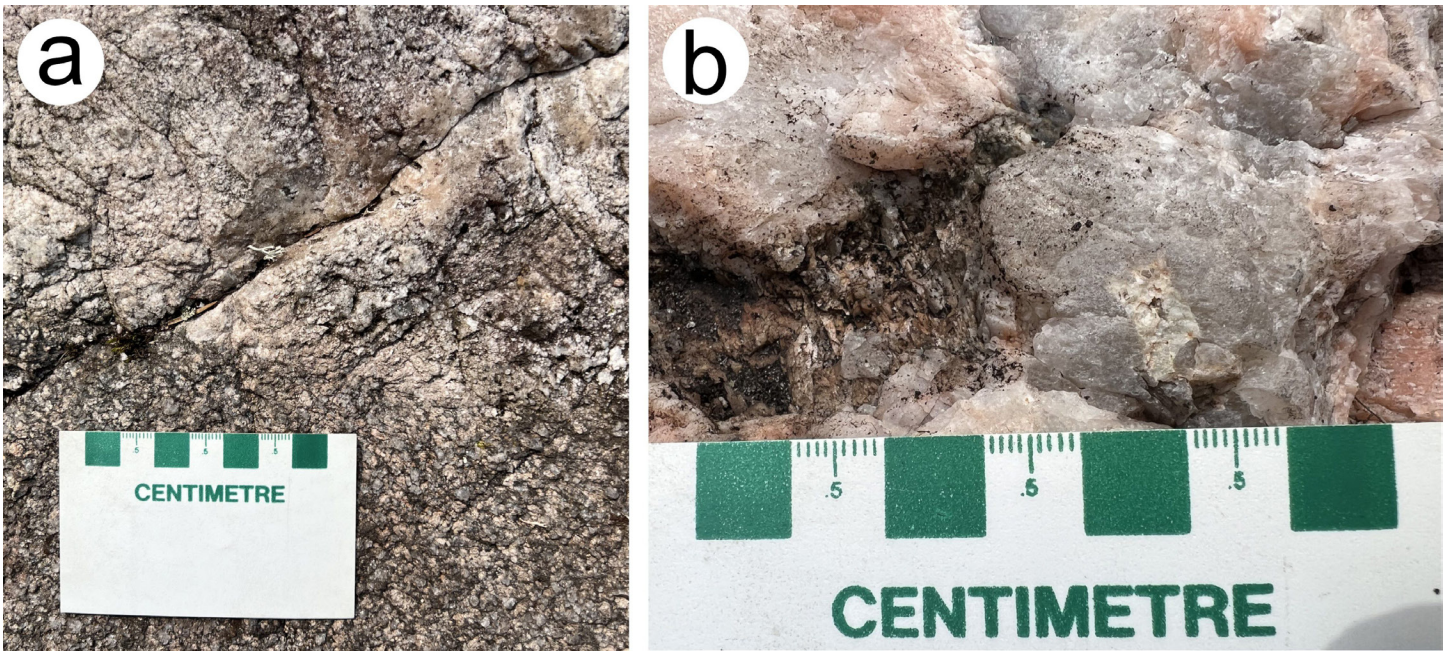


Figure GS2023-4-4: *Outcrop photographs of the Eagle pegmatite:* ***a)*** *border between the darker coloured metagranitoid country rock at the bottom and the lighter coloured aplitic section of pegmatite;* ***b)*** *detail of beryl in the eastern part of the pegmatite.*

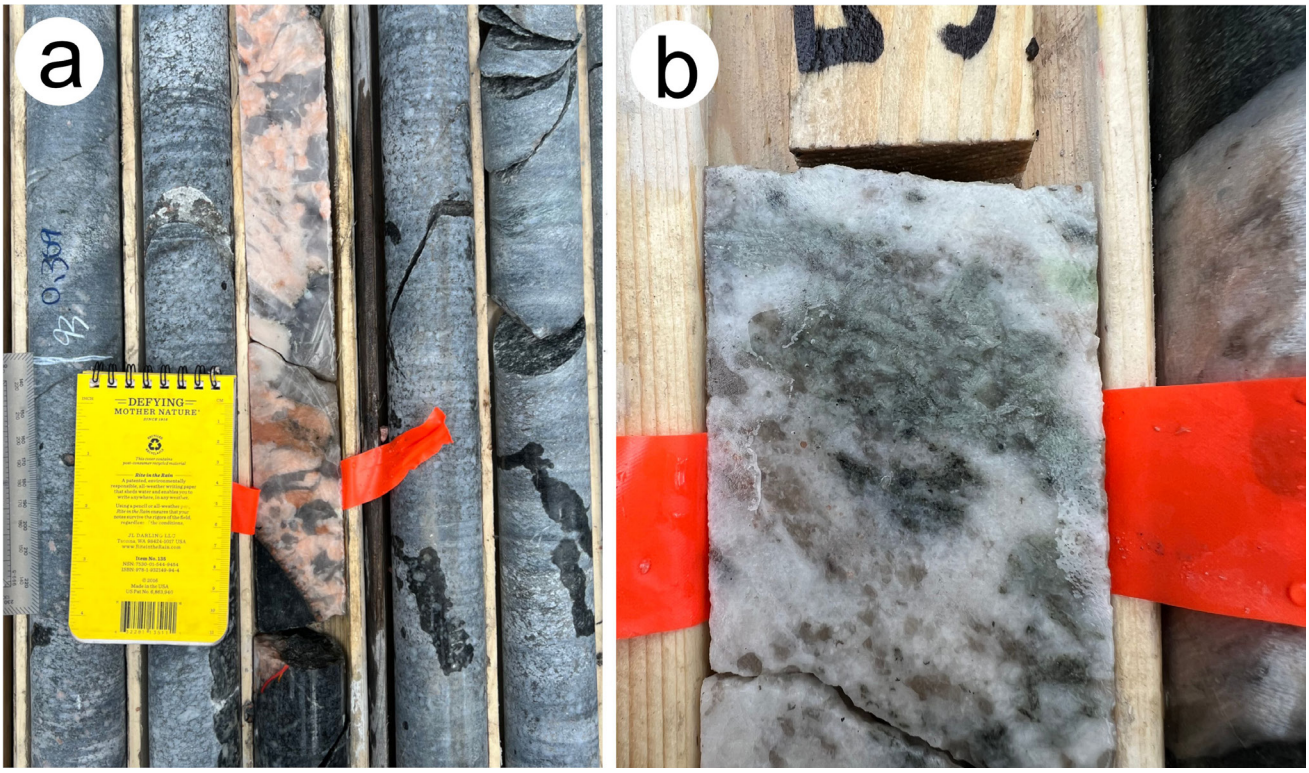


Figure GS2023-4-5: *Samples from drillhole LT-21-11:* ***a)*** *contact of a dike composed primarily of quartz and feldspar at 45 degrees to the core axis (95.8 m depth);* ***b)*** *green spodumene within a white dike (48.1 m depth). All core pictured is NQ (47.6 mm diameter).*

feldspars that reach over a metre in length but are sparsely distributed throughout the dike (Figure GS2023-4-7a). The exposure of the F.D. No. 5 pegmatite is composed primarily of quartz, feldspar and spodumene up to 4 cm and books of mica up to 7 cm wide. Spodumene is present in multiple areas throughout the pegmatite. Figure GS2023-4-7b shows a prominent exposure of one of these zones with large green spodumene crystals. Composition of this zone can locally be up to 80 modal percent spodumene, with other areas of high spodumene concentration being present elsewhere throughout the dike. Small veins

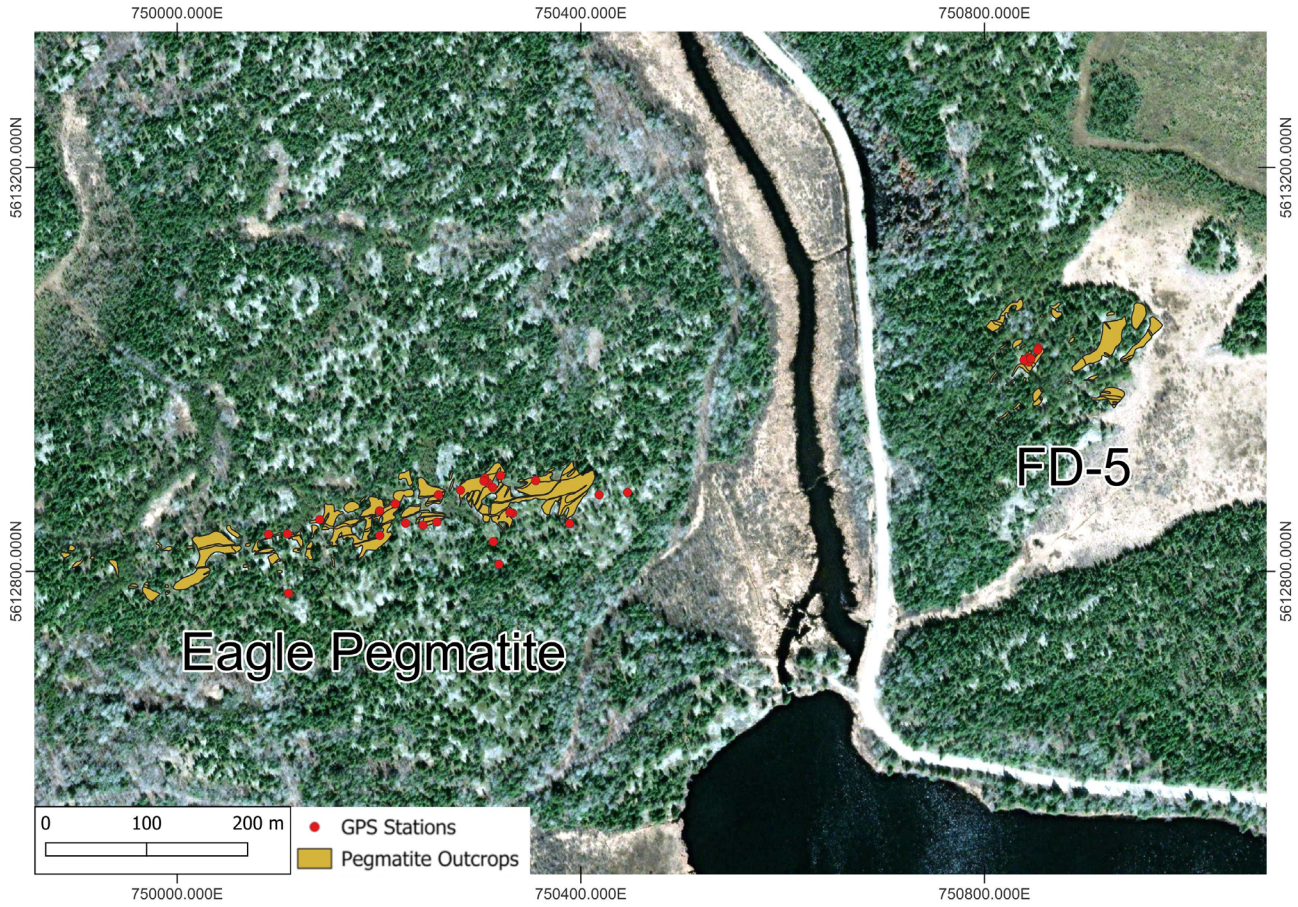


Figure GS2023-4-6: *Airphoto of the Eagle and F.D. No. 5 area with preliminary map of the pegmatite outcrops and larger bodies, showing the relationship between the Eagle and F.D. No. 5 dikes. Outcrop locations from D. Owens (unpublished data).*

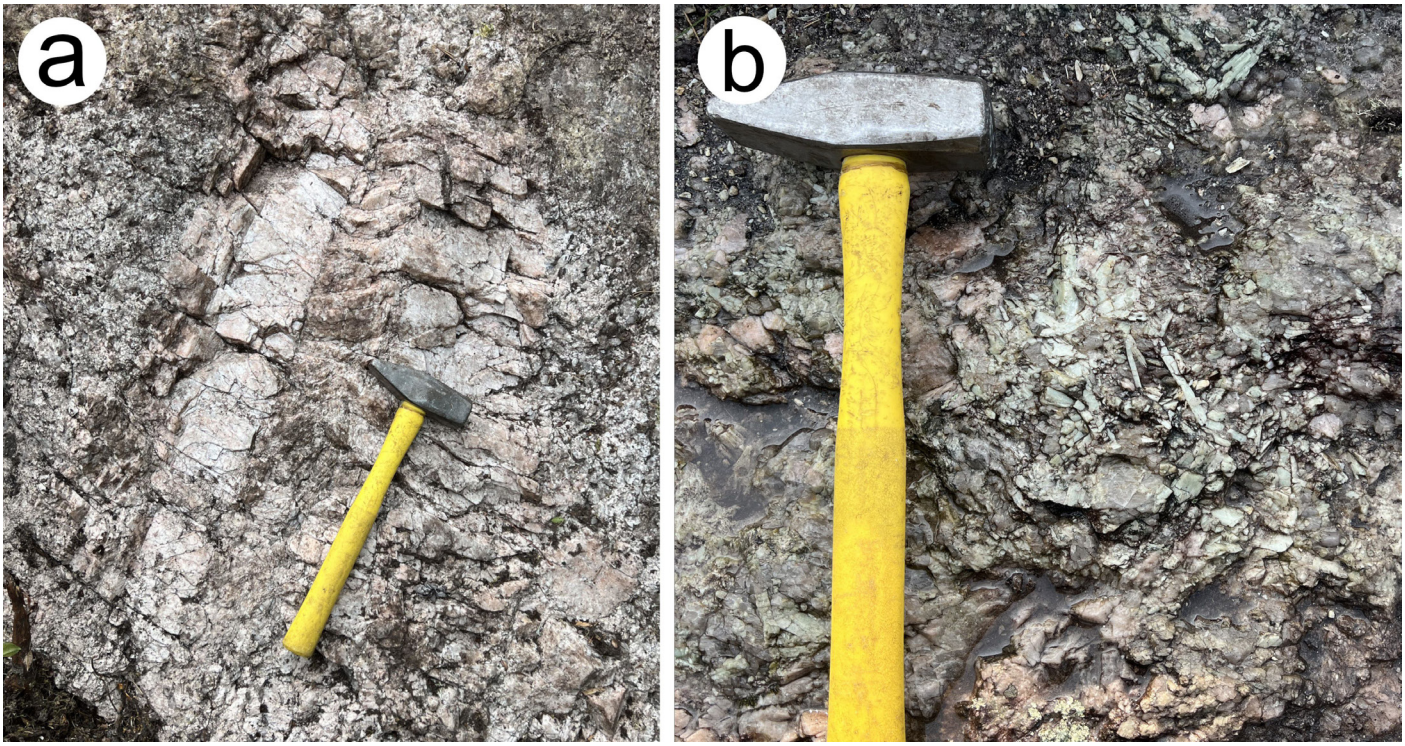


Figure GS2023-4-7: *Outcrop photographs of the F.D. No. 5 pegmatite:* ***a)*** *metre-scale feldspar crystal at the southeastern corner of the pegmatite;* ***b)*** *high concentrations of crystals of green spodumene (up to 10 cm in length).*

of black tourmaline (schorl) are also observed crosscutting the dike. Some areas of the F.D. No. 5 dike are composed of almost 15 modal percent beryl.

Economic considerations

The studied pegmatites are notable for their lithium enrichments and are easily accessible from existing provincial highways. This road accessibility is in contrast to other pegmatites in the region, which require longer, more challenging traverses or access by boat or helicopter. Regardless, the Cat Lake–Winnipeg River pegmatite field in southeastern Manitoba is prospective for Li-bearing pegmatites.

Lithium, primarily in the form of spodumene, is a prominent mineral present in all three pegmatites. The Tappy pegmatite stands out for its high spodumene concentration, often exceeding 60 modal percent in the central zone of the dike. Despite its smaller size, the Tappy pegmatite presents a simpler structural layout with well-defined zones, some of which are rich in spodumene. In contrast, the larger Eagle pegmatite, while still rich in spodumene, is characterized by a more complex textural assemblage, including aplite and mixed zonation. The F.D. No. 5 pegmatite contains significant spodumene, with a notable zone on its north side reaching a concentration of around 80 modal percent. Beryl, another mineral of interest, is less common, with only occasional occurrences, primarily in the F.D. No. 5 pegmatite.

Tantalite is most readily found in the Tappy pegmatite, forming small metallic crystals within spodumene- or quartz-rich zones. Although tantalite is present, it remains an accessory mineral and is therefore not in high concentrations. Further petrography, mineral chemistry and geochronological work will be conducted in the future at the University of New Brunswick to provide comprehensive mineralogical and petrogenetic information for these pegmatites in the Cat Lake–Winnipeg River pegmatite field of southeastern Manitoba.

Acknowledgments

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References

Bannatyne, B.B. 1985: Industrial minerals in rare-element pegmatites of Manitoba; Manitoba Energy and Mines, Geological Services, Economic Geology Report ER84-1, 96 p.

Černý, P. and Ercit, T.S. 2005: The classification of granitic pegmatites revisited; The Canadian Mineralogist, v. 43, p. 2005–2026.

Černý, P., London, D. and Novák, M. 2012: Granitic pegmatites as reflections of their sources; Elements, v. 8, p. 289–294.

Černý, P., Trueman, D.L., Zeihlke, D.V., Goad, B.E. and Paul, B.J. 1981: The Cat Lake–Winnipeg River and the Wekusko Lake pegmatite fields, Manitoba; Manitoba Department of Energy and Mines, Mineral Resources Division, Economic Geology Report ER80-1, 216 p.

Gilbert, H.P. 2008: Stratigraphic investigations in the Bird River greenstone belt, Manitoba (part of NTS 52L5, 6); *in* Report of Activities 2008, Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, p. 121–138.

Yang, X.M. and Houlé, M.G. 2020: Geology of the Cat Creek–Euclid Lake area, Bird River greenstone belt, southeastern Manitoba (parts of NTS 52L11, 12); Manitoba Agriculture and Resource Development, Manitoba Geological Survey, Geoscientific Report GR2020-1, 105 p., 1 map at 1:20 000 scale.