GS2025-3

Preliminary investigations into mica, cesium and quartz mineralization in the Cat Lake–Winnipeg River pegmatite field, southeastern Manitoba (parts of NTS 52L6, 11)

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In Brief:

- High Cs grades in drill core from the Cat Lake-Winnipeg River pegmatite field are limited to strongly foliated, biotite-rich country rock along pegmatite contacts
- The quartz and pollucite zones of the Tanco pegmatite have highly variable contacts, locally marked by spodumene and quartz intergrowths
- The habits and distribution of micas were described at the Tanco pegmatite and are highly variable

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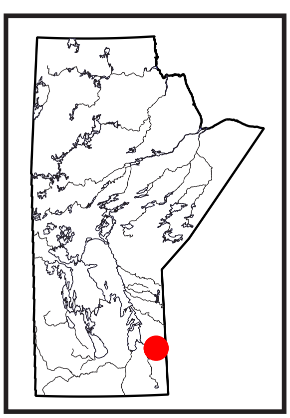

Summary

Details of the preliminary results of an investigation into cesium and quartz mineralization at the Tanco pegmatite and other selected pegmatites in the Cat Lake–Winnipeg River pegmatite field during the 2025 field season are given in this report. This project is a collaboration between the Manitoba Geological Survey, the University of New Brunswick, The University of British Columbia, New Age Metals Inc. and the Tantalum Mining Corporation of Canada Limited-Sinomine Resource Group Co., Ltd. Included within this report is an overview of the different varieties of mica present at the Tanco mine, an investigation into high-cesium (>1000 ppm) intervals in drillcore from the Cat Lake–Winnipeg River pegmatite field, and preliminary characterizations of the quartz and pollucite zones hosted within the Tanco pegmatite. Notable preliminary results of these investigations include: the observation that high-grade cesium intervals in the Cat Lake–Winnipeg River pegmatite field are limited to strongly foliated, biotite-rich country-rock intervals along pegmatite contacts; the identification of a distinct striped or banded pattern and local colour/opacity zonation within the quartz zone of the Tanco pegmatite; and the identification of internally zoned quartz±albite veinlets within the pollucite zone of the Tanco pegmatite. In future studies, the causes of these phenomena will be investigated, with the goal of characterizing the relationship between quartz and pollucite mineralization in the Tanco pegmatite, and their relationship to the late-stage magmatic-hydrothermal system documented in many highly fractionated pegmatites.

Introduction

Canadian rare-element pegmatites are known sources of ‘critical minerals’ (e.g., Cs, Li, Nb, Ta, Sn and rare-earth elements) considered essential for Canada’s economic or national security (Natural Resources Canada, 2025), as well as of industrial minerals such as high-purity quartz and feldspars (e.g., London, 2018). However, the way such pegmatites form and become enriched in these resources is currently not fully understood.

The Tanco pegmatite in southeastern Manitoba is a rare-element–Li subclass, complex type, petalite subtype pegmatite of the Li-Cs-Ta (LCT) family (classification after Černý and Ercit, 2005), which is currently being mined for Cs and Li and used to be mined for Ta (Martins et al., 2024). At one point, the Tanco mine was estimated to contain approximately 80% of current global reserves of Cs (Gilbert et al., 2008). The Tanco pegmatite is a part of the larger Cat Lake–Winnipeg River pegmatite field, which is overall considered prospective for many critical and industrial minerals (Černý et al., 1981). The Tanco pegmatite and Cat Lake–Winnipeg River pegmatite field have historically been the subject of many local- and regional-scale studies (e.g., Černý et al., 1981; 1996; London, 1985; Morgan and London, 1987; Stilling, 1998; Stilling et al., 2006; Camacho et al., 2012; Breasley et al., 2022; 2024; 2025; Martins et al., 2024; Nambaje et al., 2024); however, few of these studies have focused on Cs mineralization in the region, despite its abundance at the Tanco mine and its prospectivity elsewhere in the Cat Lake–Winnipeg River pegmatite field.

The Tanco pegmatite displays complex internal zonation of mineral assemblages, including a ‘pollucite zone’, which comprises up to 75% pure pollucite, as well as a ‘quartz zone’ that occurs as massive lenses of essentially monomineralic quartz and represents a highly evolved pegmatitic core (Černý et al., 1996). These two zones are commonly found in direct contact with each other (Černý et al., 1996; Stilling et al., 2006; Martins et al., 2024), suggesting a possible genetic relationship between the two. The existence of an extensive zone of massive pollucite has interesting implications for late-

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stage magmatic-hydrothermal processes in the Tanco pegmatite area, given the strong incompatibility of Cs, as well as the potential involvement of fluid immiscibility and/or late-stage hydrothermal processes in the formation of massive pollucite (Dittrich et al., 2019). The aim of this project is to investigate the nature, distribution and controls on quartz and Cs mineralization within the Tanco deposit, including the potential involvement of fluid immiscibility processes (London, 1986; London et al., 1998). This includes a study of the various forms of mica present at the Tanco mine, to gain insight into the complex magmatic-hydrothermal processes responsible for the formation of the deposit, as well as a study of pegmatite-related Cs mineralization elsewhere in the Cat Lake–Winnipeg River pegmatite field, to more generally investigate the behavior of Cs in local pegmatite systems.

Access to the Tanco mine for the 2025 season was delayed due to wildfires in the area. As a result, fieldwork began with the process of compiling a comprehensive list of different mica varieties at the Tanco mine based on samples from the University of Manitoba. This was followed by examination and sampling of recent pegmatite-bearing drillcore from the Cat Lake–Winnipeg River pegmatite field, with drillcore data and core-yard access provided by New Age Metals Inc. Once access to the Tanco mine was granted, fieldwork for the rest of the season consisted mostly of logging and sampling drillcore that crosscut the quartz and pollucite zones of the Tanco pegmatite, based on cross-section and historical core logs.

In total, 18 drillcores (Tantalum Mining Corporation of Canada Limited-Sinomine Resource Group Co., Ltd., unpublished data) recovered from the Tanco pegmatite were logged, with 146 quartz samples and 28 pollucite samples selected. Samples were collected from an additional 10 drillcores, but they were not logged in full. In addition to these samples, an additional 14 non-quartz or pollucite drillcore samples were selected, comprising material which could prove useful in future studies. Limited underground access was also granted, allowing for the collection of 14 mine samples, mostly comprising pollucite-zone or wall-zone material.

Geological setting

The Cat Lake–Winnipeg River pegmatite field is in the Neoarchean Bird River greenstone belt (BRGB) of the western Superior Province in southeastern Manitoba. The BRGB is situated between the English River basin and Winnipeg River terrane, and forms part of an east-trending supracrustal belt, which extends for 150 km from Lac du Bonnet in the west to Separation Lake (Ontario) in the east (Figure GS2025-3-1; Gilbert et al., 2008; Yang and Houlé, 2020). Mineral deposits within the BRGB include shear-hosted gold, magmatic Ni–Cu–Cr–platinum-group element and Li-Cs-Ta rare-element pegmatites (e.g., Černý et al., 1981, Nambaje et al., 2024).

The Cat Lake–Winnipeg River pegmatite field is divided into two districts, these being the Winnipeg River and the Cat Lake–

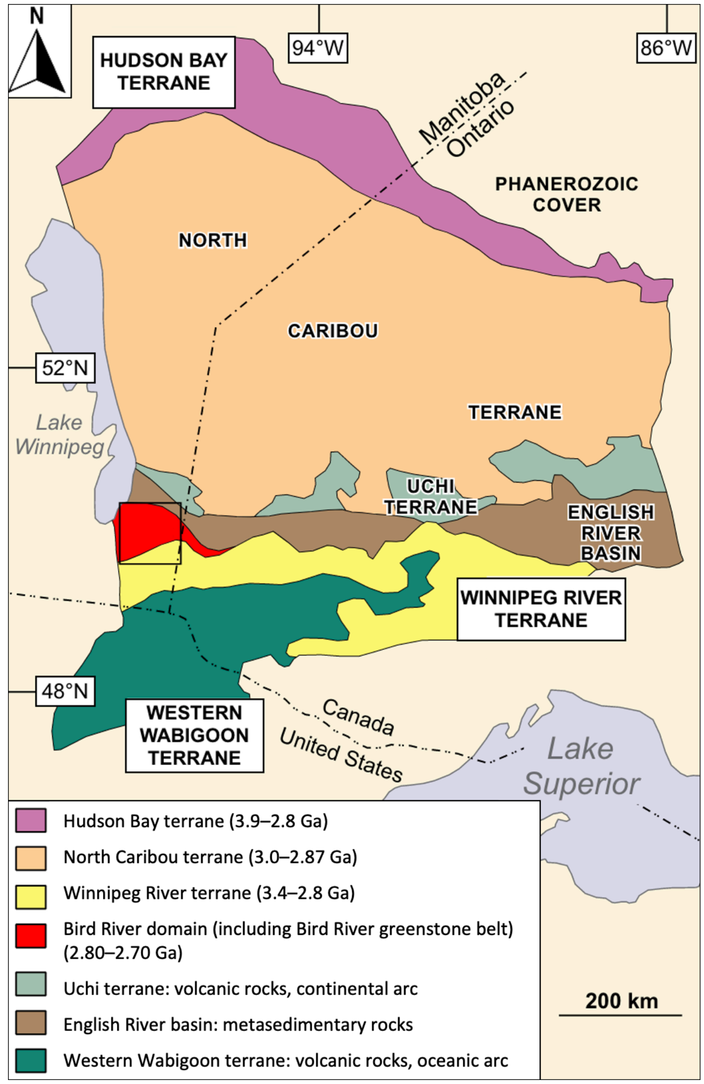

Figure GS2025-3-1: *Simplified geology of the western Superior Province showing the location of the Bird River greenstone belt (modified from Gilbert et al., 2008; Yang and Houlé, 2020), with the area of Figure GS2025-3-2 outlined in black.*

Maskwa Lake districts (Černý et al., 1981). Pegmatites of these districts are then further divided into several distinct pegmatite groups, including the Greer Lake, Eagle-Irgon, Rush Lake and Bernic Lake groups, the latter of which includes the Tanco pegmatite (Černý et al., 1981). Pegmatites investigated and sampled in this study include the Tanco pegmatite, as well as the Silverleaf pegmatite of the Greer Lake group, the Eagle and Magpie pegmatites of the Eagle-Irgon group and the RL-7 pegmatite of the Rush Lake group (Figure–GS2025-3-2). These pegmatites are briefly described below, with a separate section dedicated to the larger and more complex Tanco pegmatite.

The Tanco pegmatite

The Tanco pegmatite (Bernic Lake group; Figure GS2025-3-2) is hosted by the Tanco gabbro, dated at 2723.1 ±0.8 Ma (Gilbert et al., 2008). This gabbro is part of the larger Bernic Lake forma-

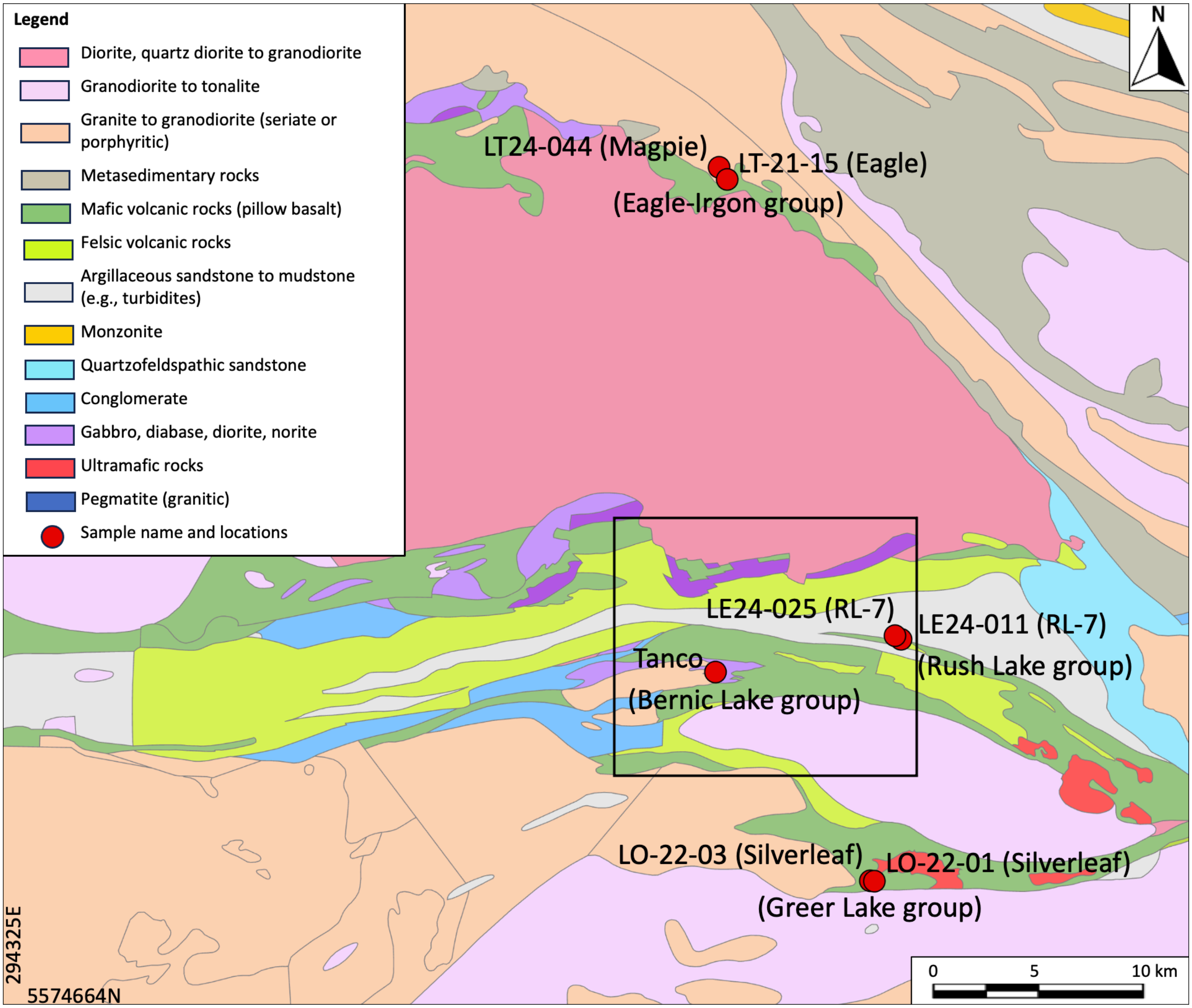

Figure GS2025-3-2: *Geology of the Bird River greenstone belt (modified from Manitoba Geological Survey, 2022; Nambaje et al., 2024), with names and locations of sampled drillcores and pegmatites, as well as their respective pegmatite groups. The area of Figure GS2025-3-3 is outlined in black.*

tion, which is characterized by a dominantly mafic, volcanic-rich unit dated at 2724.6 ±1 Ma located in the southern portion of the BRGB (Figure GS2025-3-3; Gilbert et al., 2008). The Tanco gabbro and Bernic Lake formation are metamorphosed to greenschist and amphibolite facies (Černý et al., 1981).

The Tanco pegmatite is a subhorizontal, essentially undeformed, bilobate, saddle-shaped body about 1520 m long, 1060 m wide and up to 100 m thick. Its volume has been estimated as approximately 21 850 000 m^3, with a mass of approximately 57 430 000 tonnes and an average density of 2.63 g/cm^3 (Stilling et al., 2006). Uranium-lead dating of tantalite minerals from the pegmatite has yielded intrusive ages ranging from 2647.4 ±1 Ma (Kremer, 2010) to 2641 ±3 Ma (Camacho et al., 2012).

The Tanco pegmatite displays a complex internal zonation of mineral assemblages (Figure GS2025-3-4b), with nine major zones described in total, as well as several subzones and transitional zones. The mineralogy and petrography of all zones is described in detail by several authors (e.g., Stilling et al., 2006; Breasley et al., 2022; Martins et al., 2024) and is briefly outlined below, with a focus on the major zones of the pegmatite.

The hostrock of the Tanco pegmatite is commonly referred to as 'amphibolite' but is synonymous with the Tanco gabbro. It generally comprises 54% hornblende, 37% plagioclase, 4% ilmenite, 4% quartz and 1% apatite, with minor epidote, biotite, chlo-

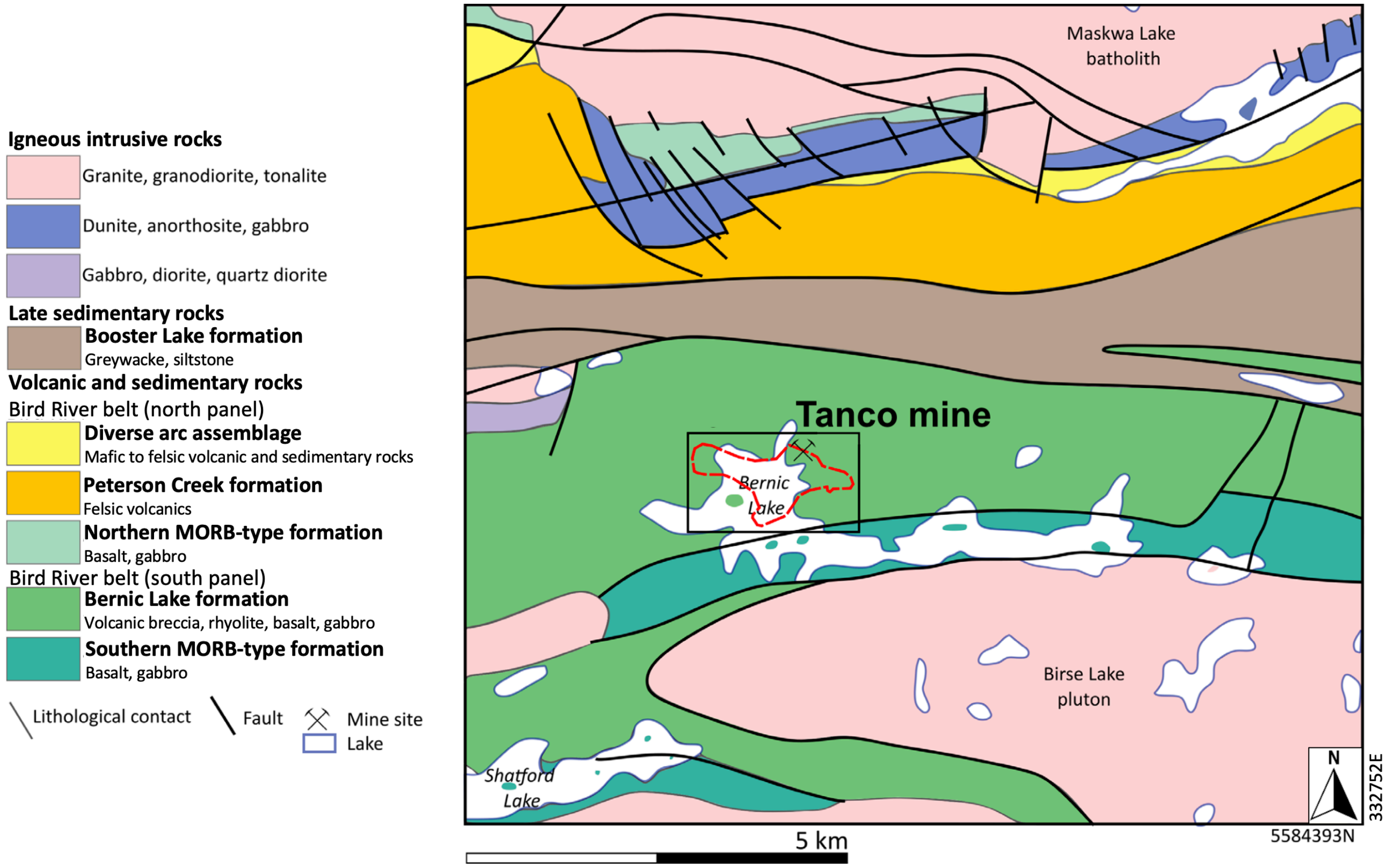

Figure GS2025-3-3: *Location and surrounding geology of the Tanco pegmatite (surface projection of the deposit indicated by dashed red line; Stilling et al., 2006) of the Cat Lake–Winnipeg River pegmatite field (modified from Gilbert, 2008; Breasley et al., 2021, 2022, 2024). The location of the Tanco mine is labeled and the area of Figure GS2025-20-4a is outlined in black. Abbreviation: MORB, mid-ocean–ridge basalt.*

rite and almandine (Morgan and London, 1987; Breasley et al., 2022; Martins et al., 2024).

The border zone of the Tanco pegmatite represents the portion of the pegmatite that crystallized first along the hostrock contact. It comprises a <30 cm thick zone of fine-grained quartz and albite and locally includes minor apophyses, which intrude into the hostrock (Stilling et al., 2006; Breasley et al., 2022; Martins et al., 2024).

The wall zone (zone 20; Figure GS2025-3-4b) comprises simple pegmatite up to 35 m thick, which roughly approximates the Tanco pegmatite's bulk composition. It is composed of megacrystic microcline-perthite, quartz, albite and Li-muscovite. Minor components include beryl, tourmaline and muscovite (Černý, 2005; Breasley et al., 2022; Martins et al., 2024).

The aplitic albite zone (zone 30; Figure GS2025-3-4b) is locally up to 16 m thick, and generally comprises aplitic albite, quartz and muscovite, with minor Ta-oxides, beryl, apatite, tourmaline, cassiterite, ilmenite, zircon and sulphides. It has a distinct pale blue-white colour, with local dark brown to black clots of Ta/Nb-bearing minerals (Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024).

The lower intermediate zone (zone 40; Figure GS2025-3-4b) is up to 25 m thick and is also known as the 'mixed zone' due to its highly variable mineralogy. It comprises medium- to coarse-grained perthite, albite, quartz, amblygonite and spodumene (including spodumene and quartz intergrowths [SQUI]). Minor components include Li muscovite, lithiophilite, lepidolite, petalite and Ta-oxides. It is distinguished from zone 50 (see below) by the presence of abundant feldspars (Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024).

The upper intermediate zone (zone 50; Figure GS2025-3-4b) is up to 24 m thick and is the most enriched in Li mineralization, comprising giant (up to 13 m long) crystals of spodumene, quartz and amblygonite. Minor components include microcline-perthite, pollucite, lithiophilite, petalite, eucryptite, Ta-oxides, albite and Li muscovite. The presence of minor quartz pods, triphylite and apatite is noted in historical drill logs (Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024).

The central intermediate zone (zone 60; Figure GS2025-3-4b) is up to 45 m thick and is thought to be entirely metasomatic in origin. Known as the 'muscovite and quartz alteration after microcline' (MQM) zone, it is also the most enriched in

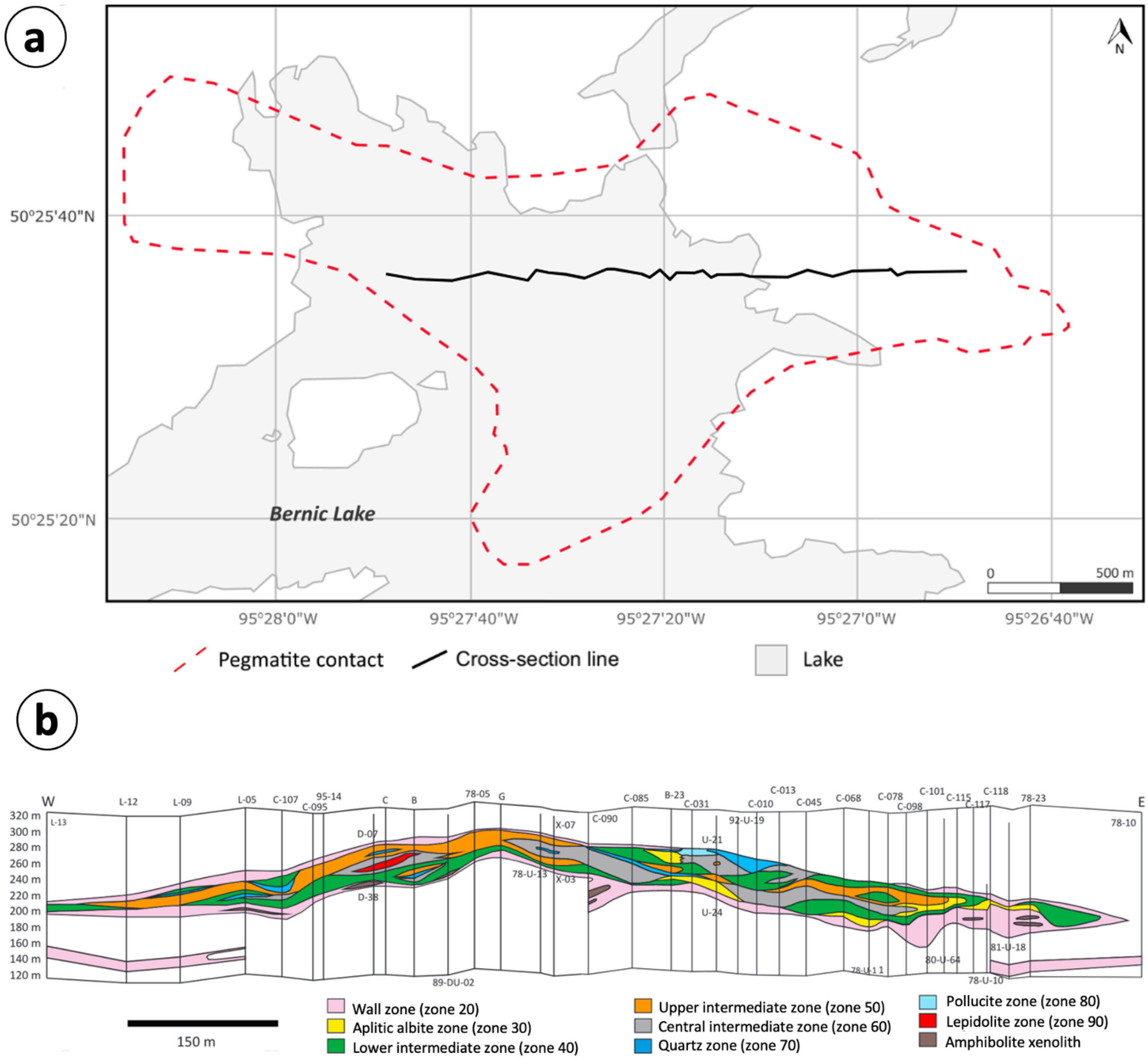

Figure GS2024-3-4: The Tanco pegmatite of the Cat Lake–Winnipeg River pegmatite field: ***a)*** *location of the deposit (projected to surface) and path of cross-section shown in (b), modified from Stilling et al. (2006) and Breasley et al. (2022);* ***b)*** *east-west cross-section (looking north) of the Tanco pegmatite, showing major zones (based on drillcore data), and drillcore names and locations (modified from Stilling et al., 2006; Breasley et al., 2022; Martins et al., 2024).*

Ta mineralization. It also comprises medium- to coarse-grained microcline-perthite, quartz, albite and muscovite, with minor beryl, Ta-oxides, zircon, ilmenite, spodumene, sulphides, lithiophilite, apatite and cassiterite (Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024).

The quartz zone (zone 70; Figure GS2025-3-4b) represents a highly evolved pegmatitic core and comprises massive monomineralic quartz lenses, with minor amblygonite, spodumene and possible petalite (Stilling et al., 2006; Breasley et al., 2022; Martins et al., 2024).

The pollucite zone (zone 80; Figure GS2025-3-4b) comprises up to 75% pure pollucite, with minor quartz, spodumene, petalite, muscovite, lepidolite, albite, microcline and apatite (Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024). Alteration of pollucite to adularia and clay minerals in this zone has resulted in a characteristic texture known as the 'tapioca' texture (Černý et al., 1981, Figure 90).

The lepidolite zone (zone 90; Figure GS2025-3-4b) is <18 m thick and is thought to have formed due to metasomatism. It features abundant fine-grained to saccharoidal Li-muscovite as replacement of primary feldspar. The zone comprises dominantly Li-muscovite, lepidolite and microcline-perthite, with minor albite, quartz, beryl, cassiterite, zircon and Ta-oxides (including abundant microlite; Černý et al., 1996; Breasley et al., 2022; Martins et al., 2024).

Other pegmatites studied during the 2025 season

The Silverleaf pegmatite (Greer Lake group; Figure GS2025-3-2) is a metabasalt-hosted, Li-bearing pegmatite with a surface exposure of approximately 80 m by 45 m. It comprises spodumene, quartz, feldspar, muscovite, lepidolite, garnet and apatite (Bannatyne, 1985; Nambaje et al., 2024). Uranium-lead isotopic ages for zircon megacrystic fragments from the Silverleaf pegmatite range from about 2660 to 2600 Ma (Camacho et al., 2012). A more detailed description of mineral assemblages in the Silverleaf pegmatite can be found in Bannatyne (1985).

The Eagle pegmatite (Eagle-Irgon group; Figure GS2025-3-2) is a metagranodiorite-hosted Li-mineralized pegmatite comprising several dikes with thicknesses varying between 10 cm and 9 m. Its mineralogy is mostly uniform, consisting of varying modal percentages of feldspar (hematized plagioclase±K-feldspar), quartz, green spodumene and white micas, with minor apatite, beryl and lepidolite (Roush et al., 2023; Nambaje et al., 2024).

The Magpie pegmatite (Eagle-Irgon group; Figure GS2025-3-2) is located north-northwest of the Eagle pegmatite. It is noted to contain localized spodumene zones, based on drillcore from New Age Metals Inc. (New Age Metals Inc., 2024). Little additional information is available.

The RL-7 pegmatite (Rush Lake group; Figure GS2025-3-2) comprises abundant microcline and quartz, subordinate albite, and rare biotite, muscovite and schorl (black tourmaline). It is unzoned but becomes increasingly coarse grained toward the centre (Černý et al., 1981). Little additional information is available regarding this pegmatite.

Micas of the Tanco pegmatite

Micas (e.g., muscovite, biotite, lepidolite) are common components of most peraluminous granitic pegmatites and are one of several minerals that can be used to quantify the evolution of such pegmatites via incompatible trace-element mineral chemistry. The trace-element contents of micas can range from tens of parts per million to high weight-percent values, and as such they are particularly useful as a window into the complex magmatic-hydrothermal processes in pegmatites (e.g., Benn et al., 2022).

Micas of the Tanco pegmatite are highly variable in terms of grain size, colour and crystal habit, with certain variations being local to specific zones of the pegmatite. Past studies of micas of the Tanco pegmatite, for example Rinaldi et al. (1972) and Van Lichtervelde et al. (2008), focused on Li-Rb-Cs micas and micas associated with Ta mineralization, respectively. The latter study found that micas of the Tanco pegmatite can contain up to 2.15 wt. % Cs_2O. Higher weight-percent values were found to be associated with coarser grained, more highly fractionated primary or magmatic-metasomatic event-derived micas, whereas fine-grained micas associated with later aqueous fluid-derived metasomatism were shown to be less evolved, with lower Cs_2O contents (Van Lichtervelde et al., 2008). The relationship between Cs concentrations, fractionation and metasomatic fluids demonstrated by micas of the Tanco pegmatite suggests that a review of these highly variable micas could shed light on Cs-enrichment processes in the pegmatite.

Zone 20 commonly contains pegmatitic (i.e., >2.5 cm) tabular crystals or 'books' of greenish to silver muscovite (Figure GS2025-3-5a). Biotite is also locally observed and this zone is seemingly the only zone of the Tanco pegmatite in which biotite appears. Curvilamellar to botryoidal masses of mica in the Tanco pegmatite produce a particularly common texture, which is colloquially referred to as 'ball-peen' texture. In cross-section, ball-peen micas are observed to form radial masses and are commonly associated with radial to tabular cleavelandite, suggesting a possible paragenetic relationship. Ball-peen silver muscovite and lavender Li-muscovite are common within zone 20. Most micas within zone 20 appear to be primary; however, local fine-grained, green muscovite is also present, which may represent a secondary alteration product after K-feldspar.

Micas within zone 30 are saccharoidal and are generally incorporated into the aplite, which makes up most of this zone. The micas consist of green muscovite and purple lepidolite, with the latter being locally incorporated into the banded textures that are common in this zone (Figure GS2025-3-5b). It is possible that saccharoidal micas within zone 30 represent later metasomatic alteration of the aplite or, alternatively, represent compositional variations in the melt during episodic aplite crystallization.

Micas within zone 40 are highly varied, and include muscovite, Li-muscovite, paragonite and lepidolite. Muscovite locally exhibits a likely primary, pegmatitic, tabular habit within this zone, but is also a common component of later alteration assemblages. These include muscovite+Li-muscovite after rubellite (Figure GS2025-3-5c), fine-grained muscovite+cookeite after spodumene and fine- to medium-grained pale green to yellow-green muscovite+paragonite after feldspar, with local ball-peen habit. Muscovite also occurs as rims on amblygonite-montebrasite crystals in association with apatite within zone 40. In addition to being part of the alteration assemblage after rubellite, Li-muscovite also occurs as likely primary, grey to lavender curvilamellar masses (Figure GS2025-3-5d). Lepidolite in zone 40 locally shows both medium- to coarse-grained tabular and ball-peen habits (Figure GS2025-3-5e).

Micas within zone 50 mostly comprise different varieties of muscovite and share some similar modes of occurrence with those of zone 40, including muscovite+cookeite after spodumene, muscovite+paragonite after feldspar and muscovite+apatite rims on amblygonite-montebrasite. In addition to the above, micas within zone 50 include medium- to coarse-grained, late-stage

***Figure GS2025-3-5**: Assorted micas from the Tanco pegmatite of the Cat-Lake–Winnipeg River pegmatite field: **a)** pegmatitic muscovite (+albite) from zone 20; **b)** saccharoidal lepidolite (+aplitic albite, quartz) from zone 30, showing compositional banding; **c)** muscovite+Li-muscovite after rubellite (+quartz) from zone 40; **d)** coarse-grained ball-peen Li-muscovite (+quartz, albite) from zone 40; **e)** coarse-grained tabular lepidolite (+quartz, K-feldspar) from zone 40; **f)** coarse-grained late-stage green muscovite (+primary lepidolite, albite, quartz) from zone 50; **g)** massive saccharoidal grey muscovite from zone 50; **h)** saccharoidal pale green muscovite after microcline+quartz and wodginite (black specks) from zone 60; **i)** coarser grained green mica veining microcline and aplitic albite from zone 60; **j)** saccharoidal lepidolite veining in pollucite from zone 80; **k)** saccharoidal lepidolite (+Ta-oxides) from zone 90. Coin diameter is 3 centimetres.*

green muscovite (Figure GS2025-3-5f), as well as fine-grained muscovite, quartz and albite intergrowths. Several varieties of saccharoidal-textured muscovite are found within zone 50, including saccharoidal green to purple muscovite veins in pollucite, as well as saccharoidal grey muscovite associated with wodginite mineralization (Figure GS2025-3-5g).

Zone 60 is defined by the presence of abundant very fine grained to saccharoidal, metasomatic green muscovite after microcline feldspar, which is locally associated with Ta-oxides (Figure GS2025-3-5h). Green mica within zone 60 may also occur as a coarser grained variety in the matrix of apparent hydrothermal breccias (Figure GS2025-3-5i), with local ball-peen habit. Purple Li-muscovite and lepidolite are locally present within zone 60, generally as coarse-grained tabular to curvilamellar masses. Coarse-grained Li-muscovite within zone 60 was noted by Van Lichtervelde et al. (2008) to be relatively geochemically evolved and possibly representative of magmatic metasomatism associated with Ta mineralization. However, fine-grained green muscovite after microcline was noted to be less evolved and was linked to later aqueous fluid-derived metasomatism.

No samples from zone 70 are included within the Tanco collection of the University of Manitoba, but observations conducted as part of this study show that rare lenses of SQUI and K-feldspar within zone 70 are locally associated with dark green, yellow-green and grey muscovite.

A few mica-bearing samples from zone 80 are included within the Tanco collection of the University of Manitoba. These samples locally feature Li-Rb muscovite veining or alteration of pollucite. In an investigation regarding paragenetic relationships between zones 80 and 90 of the Tanco pegmatite, Breasley et al. (2024) also showed that mesh-like veining of lepidolite within zone 80 (Figure GS2025-3-5j) is found close to the contact with zone 90.

Finally, in addition to previously mentioned, fine-grained to saccharoidal lepidolite and Li-muscovite present within zone 90 (Figure GS2025-3-5k), samples from the Tanco collection also show the presence of local coarser grained Li-muscovite within zone 90.

Cesium in the Cat Lake–Winnipeg River pegmatite field

In addition to the investigation into mica variations in the Tanco pegmatite, an investigation into Cs mineralization in granitic pegmatites of the Cat Lake–Winnipeg River pegmatite field was initiated as part of this project. Drillcores were selected based on the presence of high-grade Cs intervals (>1000 ppm), with some intervals grading over 5000 ppm Cs. In total, six drillcores were studied and sampled (Figure GS2025-3-2).

It was noted that high-grade Cs intervals consistently comprised metasedimentary or metabasaltic hostrock adjacent to pegmatite, rather than the actual pegmatite dikes themselves (Figure GS2025-3-6a–f). Even in drillcores from the generally granodiorite-hosted Eagle-Irgon group, it was observed that high-grade Cs intervals occurred specifically in strongly foliated amphibolite lenses within the host granodiorite, rather than within the granodiorite itself (Figure GS2025-3-6a, f).

Restriction of high-grade Cs intervals to metamorphic hostrocks was interpreted to represent metasomatism by Cs-bearing hydrothermal fluids, which could have separated from pegmatitic melts due to fractionation processes (e.g., London et al., 1998). Preliminary geochemical analysis shows that high-grade Cs intervals are consistently associated with low K/Rb ratios, supporting an origin linked to metasomatism by highly evolved fluids.

In most cases, no visible change in hostrock colour or mineralogy appeared to accompany Cs enrichment; therefore, it is difficult to determine how far from the pegmatite the enrichment extends into the hostrock, particularly given the large (generally 0.5–1 m) assay intervals. However, in some cases, Cs-enriched

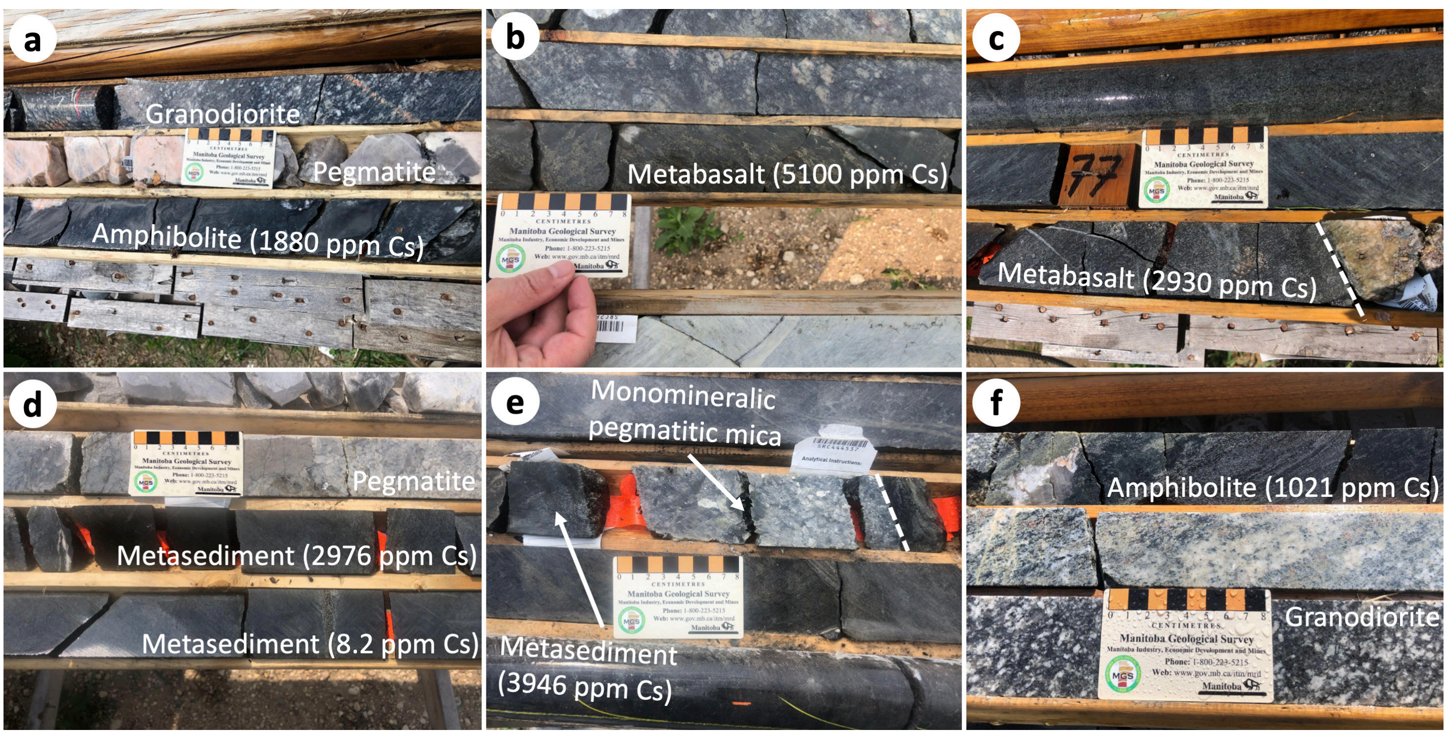

Figure GS2025-3-6*: Photographs of samples from drillcores recovered from the Cat Lake–Winnipeg River pegmatite field:* ***a)*** *a primarily granodiorite-hosted pegmatite immediately underlain by a high-grade Cs amphibolite interval from drillhole LT-21-15 (Eagle pegmatite, Eagle-Irgon group);* ***b)*** *a particularly high-grade Cs metabasalt interval underlying a zone of strongly metasomatically altered rock from drillhole LO-22-01 (Silverleaf pegmatite, Greer Lake group);* ***c)*** *an interval of high-grade Cs metabasalt immediately above a pegmatite contact from drillhole LO-22-03 (Silverleaf pegmatite, Greer Lake group);* ***d)*** *metasedimentary rock underlying a pegmatite from drillhole LE24-011 (RL-7 pegmatite, Rush Lake group), with the interval directly adjacent to the pegmatite containing significant Cs concentrations not seen in the more distal interval;* ***e)*** *high-grade Cs metasedimentary rock immediately above a minor pegmatite dike comprising monomineralic greenish mica from drillhole LE24-025 (RL-7 pegmatite, Rush Lake group);* ***f)*** *a high-grade Cs amphibolite lens within granodiorite from drillhole LT24-044 (Magpie pegmatite, Eagle-Irgon group). Scale bar is in centimetres.*

hostrock was visibly crosscut by veins (Figure GS2025-3-6c, f) or was visibly altered (Figure GS2025-3-6b). All high-grade Cs intervals were observed to contain biotite as a major modal component. It is theorized that Cs is primarily contained within biotite, which is known to readily incorporate Cs into its crystal structure via adsorption, given the negative surface charge, specific surface area and frayed edge sites of biotite (Kwon et al., 2021; 2024).

Quartz zone of the Tanco pegmatite

Based on the logged drillcores, the quartz zone of the Tanco pegmatite has an apparent thickness ranging from 35 cm to 39 m. A common property of the quartz zone appears to be internal zonation of quartz colours, with grey intervals up to 10 cm along the contacts, zoning inward to more common translucent white, colourless, or pinkish quartz. Such zoned intervals may also locally have opaque, milky white to very pale yellow intervals up to 2.3 m long at their centre, which were interpreted to potentially represent cryptic amblygonite inclusions or pods. Conversely, quartz from other zones tends to be grey or 'smoky' in colour. Another characteristic property of zone 70 quartz appears to be the local presence of a striped or banded texture. These textures were generally restricted to zone 70 quartz but were locally observed within large quartz crystals from zone 20 as well.

Local SQUI pods are common within the quartz zone. These SQUI pods have an apparent thickness of up to 2.5 m and tend to have sharp contacts with surrounding quartz, suggesting that they may represent later veining. Contacts between the quartz and SQUI pods also tend to be associated with abundant dark green to yellow-green muscovite. The muscovite is generally restricted to the SQUI pods themselves and is not present in the surrounding quartz. Local lenses of K-feldspar are also present within the quartz zone and show a similar association with green to grey muscovite. Quartz within these lenses is generally grey, rather than white.

Contact relationships

The quartz zone of the Tanco pegmatite contacts many of the previously described zones, with contacts varying from sharp to gradational. However, contacts between the quartz zone and hostrock are consistently sharp (Figure GS2025-3-7a).

Sharp contacts between zones 70 and 20 are locally marked by brownish green muscovite, or by cleavelanditic albite oriented orthogonally to the contact and growing alongside quartz. Gradational contacts between the two are locally marked by the presence of coarse-grained SQUI, associated with minor green muscovite (Figure GS2025-3-7b). Both types of contacts locally show gradation from grey quartz of zone 20 into white quartz of zone 70.

Contacts between zones 70 and 30 vary from sharp to gradational. Sharp contacts are locally marked by SQUI veins associated with yellow-green muscovite, whereas gradational contacts may be marked by extensive zones of intermixed quartz+albite mottling. Both types of contacts locally show gradation from grey to white quartz. It was noted that along one contact, grey quartz appeared to take on a saccharoidal texture.

Contacts between zones 70 and 40 vary from sharp to gradational. Sharp contacts commonly feature orthogonal cleavelanditic albite growths, resembling those described in zone 20, and are locally associated with cleavelandite and lepidolite intergrowths. Gradational contacts commonly feature intermixed quartz and K-feldspar or albite mottling like those described in zone 30; they are locally associated with green muscovite. Other contact associations observed between zones 70 and 40 include local compositionally banded albite, quartz and grey muscovite-bearing aplite above gradational contacts (Figure GS2025-3-7c), as well as sharp to gradational contacts between zone 40 SQUI and zone 70 quartz.

Contacts between zones 70 and 50 vary from sharp to gradational but are consistently marked by SQUI mineralization plus or minus green muscovite. Contacts between zones 70 and 60 also vary from sharp to gradational and are commonly marked by K-feldspar and/or fine-grained green muscovite veining in zone 70 quartz. Sharper contacts between the two zones locally contain white beryl. Only one instance of zone 70 in contact with zone 80 was observed in the core from the study area, with a sharp contact marked by greenish SQUI. Similarly, one instance of zone 70 in sharp contact with zone 90 was observed.

Pollucite zone of the Tanco pegmatite

Based on the logged drillcores, pollucite-zone lenses of the Tanco pegmatite range from 0.55 to 12.7 m in apparent thickness. This agrees with the findings of Černý et al. (1996), who noted that the largest pollucite-zone body associated with the pegmatite is 12 m thick. Zone 80 pollucite ranges from colourless to white to light grey and is recognizable due to its distinct 'tapioca' texture, which is characterized by a speckled appearance caused by alteration to adularia, muscovite and spodumene (Černý et al., 1996). From conversations held with geologists working at the Tanco mine, it would appear that not all pollucite of the Tanco pegmatite shows the tapioca texture and that this texture may be restricted to zone 80 pollucite.

In addition to pollucite, zone 80 lenses were commonly veined by micas, including lepidolite and/or grey to yellow-green muscovite (Figure GS2025-3-8a, b). Another common observation was the presence of thin, grey quartz veinlets, with local albite rims (Figure GS2025-3-8c). Local lenses of cleavelandite+spodumene, SQUI, grey quartz or white K-feldspar were also observed. Small blue apatite crystals were locally observed scattered throughout zone 80 pollucite and were sometimes associated with quartz veins or K-feldspar lenses.

Zone 80 was observed in contact with zones 20, 40, 50 and 70 (Figure GS2025-3-8d, e, f). Contacts between zone 80 and other zones are invariably sharp and locally marked by white

Figure GS2025-3-7*: Core box photographs of drillcore from the Tanco pegmatite of the Cat Lake–Winnipeg River pegmatite field showing quartz-zone contacts:* ***a)*** *sharp upper contact (dashed white line) with the hostrock and gradational lower contact with zone 60 marked by green muscovite veining in quartz;* ***b)*** *gradational upper contact with zone 20 marked by coarse SQUI (box outlined in white) and sharp lower contact (dashed white line) also with zone 20;* ***c)*** *compositionally banded aplite (box outlined in white) along the upper contact of the quartz zone with zone 40. Scale bar is in centimetres.*

to dark green SQUI. In one drillcore, zone 80 is underlain by a 7.4 m long interval of alternating SQUI and pollucite lenses in approximately equal parts, with local K-feldspar, quartz and mica. This was interpreted to possibly represent the 'low-grade pollucite zone' or 'zone 58', which locally surrounds zone 80 (Breasley et al., 2022; Martins et al., 2024); this interval featured a sharp contact with the underlying zone 40, marked by smoky quartz.

Future work

Future investigations into mica, quartz and pollucite at Tanco will make use of the observations described here in tandem with selected samples. The goal of these studies will be to fully understand and characterize the nature and distribution of quartz and cesium mineralization in the Tanco pegmatite. This will include an investigation into possible relationships between quartz and cesium mineralization and the complex magmatic-hydrothermal processes indicated by the variable mica compositions and habits of the Tanco pegmatite. These investigations will comprise detailed petrography, micro X-ray fluorescence spectrometry, electron probe microanalysis, scanning electron microscopy, laser-ablation inductively coupled plasma–mass spectrometry, scanning electron microscope-cathodoluminescence, fluid- and melt-inclusion analyses, as well as temperature determination using the Ti-in-quartz (TitaniQ) geothermometer (see Wark and Watson, 2006).

Economic considerations

The Cat Lake–Winnipeg River pegmatite field is considered prospective for both critical minerals such as Cs, Li and Ta, as well as for industrial minerals such as high-purity quartz and feldspar (Černý et al., 1981). In particular, the Tanco mine was once estimated to contain approximately 80% of current global reserves of Cs (Gilbert et al., 2008). Although not currently exploited as a resource at the Tanco mine, the presence of massive, potentially high-purity quartz within zone 70 of the Tanco pegmatite could also be of economic interest at some point in the future. Detailed spatial and geochemical characterizations of zones 70

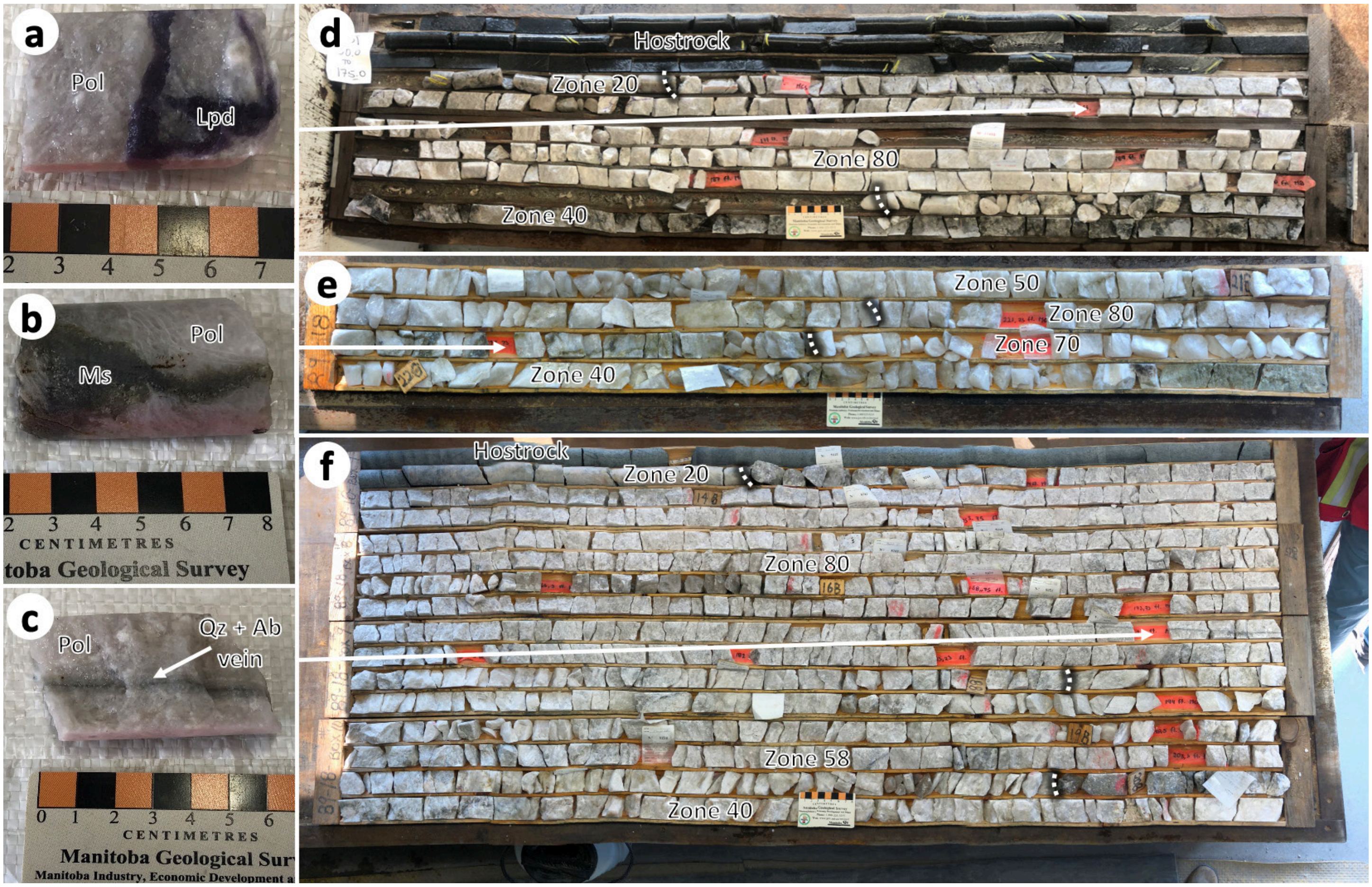

***Figure GS2025-3-8**: Sample and core box photographs of various drillcores from the Tanco pegmatite of the Cat Lake–Winnipeg River pegmatite field containing zone 80 (sharp contacts indicated by dashed white lines): **a)** pollucite sample showing lepidolite (Lpd) veining in zone 80 pollucite (Pol); **b)** pollucite sample showing green muscovite (Ms) veining in zone 80 pollucite (Pol); **c)** pollucite sample showing a zoned quartz (Qz)+albite (Ab) vein in zone 80 pollucite (Pol); **d)** pollucite zone showing sharp contacts with zones 20 and 40; **e)** zone 80 showing sharp contacts with zones 50 and 70; **f)** zones 80 and 58 showing sharp contacts with zones 20 and 40.*

and 80 of the Tanco pegmatite will be conducted at a future point in this project, with the potential to both facilitate exploitation of high-purity zone 70 quartz as a new resource for the mine and to enable more efficient mining of Cs ore at the Tanco mine, as well as other Cs deposits in Cs-bearing pegmatites.

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