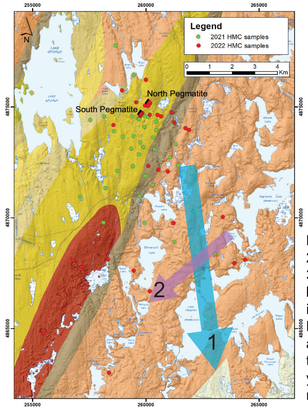
Geological Survey of Canada
Scientific Presentation 157

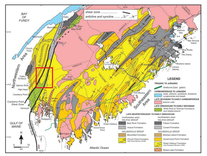
INDICATOR MINERAL STUDIES AT THE BRAZIL LAKE LCT PEGMATITES, SOUTHWEST NOVA SCOTIA

M.B. McClenaghan[1], D.M.Brushett[2], C.E. Beckett-Brown[1], R.C. Paulen[1], J.M. Rice[1], A. Haji Egeh[1], and A. Nissen[3]

INTRODUCTION

Indicator mineral research is currently being undertaken in partnership with the Nova Scotia Department of Natural Resources and Renewables at the Brazil Lake lithium-cesium-tantalum (LCT) pegmatites in southwest Nova Scotia as part of the Geological Survey of Canada's Targeted Geoscience Initiative (TGI) program focused on critical minerals. The pegmatites, discovered in 1960, are well known from previous detailed bedrock mapping and surficial studies, and are informally named based on their relative geographic positions as the South and North pegmatites. Both pegmatites are covered by 2-3 m of till except where the South pegmatite outcrops. Spodumene-rich boulders are common on the surface of the till down ice of the North pegmatite. For these reasons, the pegmatites are excellent sites to test indicator mineral exploration methods for Li and associated critical elements (e.g., Ce, Ta).





Bedrock geology of southwestern Nova Scotia (modified from White, 2010; White et al., 2012, 2018). Location of study area is indicated by the red box.

Bedrock geology of the Brazil Lake study area (White et al., 2012) superimposed on a LiDAR hillshade image (azimuth of 315°) showing the glacially streamlined landscape and the location of till samples collected for indicator mineral analysis in 2021 (green dots) and in 2022 (red dots) around the Brazil Lake pegmatites (black lines). Regional ice flow directions are indicated by the 2 arrows: 1) older ice flow that shaped the local landscape and transported drift and 2) purple younger, less vigourous ice flow that remobilized debris material across the tops of the landforms.

REFERENCES

Kontak, D.J. 2006. Nature and origin of an LCT-suite pegmatite with late-stage sodium enrichment, Brazil lake, Yarmouth County, Nova Scotia; The Canadian Mineralogist, v. 44, p. 563-598.

Kontak, D.J. and Kyser, T.K. 2009. Nature and origin of an LCT-suite pegmatite with late-stage sodium enrichment, Brazil Lake, Yarmouth County, Nova Scotia. II Implications of stable isotopes (δ18O, δD) for magma source, internal crystallization and nature of sodium metasomatism; The Canadian Mineralogist, v. 47, p. 745-764.

Kontak, D.J., Groat, L.A., and Barnes, E.M. 2003. Comparison of the Brazil Lake, Nova Scotia, and Little Nahanni, N.W.T., LCT pegmatite suites; in Mining Matters for Nova Scotia 2003, Nova Scotia Department of Natural Resources, Report ME 2003-02, Program with Abstracts, p. 8.

Kontak, D.J., Creaser, R., Heaman, L., and Archibald, D.A. 2005. U-Pb tantalite, Re-Os molybdenite, and 40Ar/39Ar muscovite dating of the Brazil Lake pegmatite, Nova Scotia: a possible shear-zone related origin for an LCT-type pegmatite; Atlantic Geology, v. 41, p. 17-29.

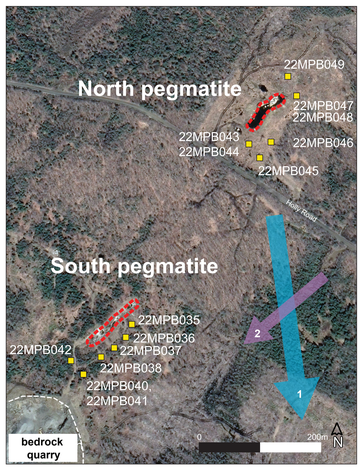
McClenaghan, M.B., Spirito, W.A., Plouffe, A., McMartin, I., Campbell, J.E., Paulen, R.C., Garrett, R.G., Hall, G.E.M., Pelchat, P., and Gauthier, M.S., 2020. Geological Survey of Canada till sampling and analytical protocols: from field to archive, 2020 update; Geological Survey of Canada, Open File 8591,

Taylor, F.C. 1967. Reconnaissance geology of the Shelburne map-area, Queen's, Shelburne, and Yarmouth counties, Nova Scotia; Geological Survey of Canada, Memoir 349, 83 p.

White, C.E. 2010. Stratigraphy of the Lower Paleozoic Goldenville and Halifax groups in southwestern Nova Scotia; Atlantic Geology, v. 46, p. 136-154.

White, C.E., Fisher, B.F., McKinnon, J.S., and Ehler, A.L. 2012. Digital geological data generated as part of geological mapping of the Meguma Terrane of southwestern Nova Scotia (1998-2010), Shelburne, Digby, Yarmouth, Annapolis, Queens, and Lunenburg counties, Nova Scotia; DP ME 127, Version 1.

White, C.E., Barr, S.M., and Linnemann, U. 2018. U-Pb (zircon) ages and provenance of the White Rock Formation of the Rockville Notch Group, Meguma terrane, Nova Scotia, Canada: evidence for the "Sardian gap" and West African origin; Canadian Journal of Earth Sciences, v. 55, p. 589-603.



Location of the backhoe trenches (yellow squares) dug north, east, and southeast (down ice) of the North and South pegmatites to collect large till samples for heavy mineral analysis. Pegmatites subcrops are outlined by dashed red lines. Regional ice flow directions are indicated by the large arrows labelled as 1 (older) and 2 (younger).

BEDROCK SAMPLING

Photo 1. Exposed subcropping surface of the North pegmatite (photo courtesy of D. Archibald, St. Francis Xavier University).

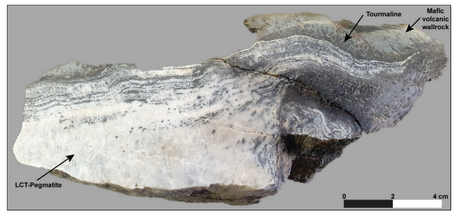


Photo 2. Black tourmaline crystals in the margin of the South pegmatite (photo by Chris Beckett-Brown. NRCan photo 2022-586).

Photo 3. Black tantalite, seen here in the North pegmatite, is a useful indicator mineral of LCT pegmatites that can be recovered from till samples (photo courtesy of Donnelly Archibald, St. Francis Xavier University).

The bedrock geology and mineralogy of the Brazil Lake LCT-type pegmatite has been well studied (Taylor, 1967; Kontak et al., 2003; Kontak, 2006; Kontak and Kyser, 2009). The pegmatite is hosted within sedimentary and mafic volcanic rocks of Silurian age. A minimum age for the pegmatite of 395 Ma (U-Pb) is known from tantalite (Kontak et al., 2005). The pegmatite is characterized by coarse crystals of spodumene and K-feldspar, with intergranular spodumene, muscovite, albite, and quartz. There are some notable accessory phases including, for example, tourmaline, apatite, tantalite, beryl, sphalerite, and cassiterite.

A total of 14 bedrock samples were collected, of these five pegmatite samples were collected for detailed analyses of potential indicator minerals. These five samples were submitted for disaggregation and examination of minerals to identify the indicator mineral signature of the pegmatite. A preliminary list of indicator minerals includes mid-density (e.g., spodumene, tourmaline, blue apatite) and high-density mineral species (e.g., tantalite, cassiterite, spahalerite). This list is expected to expand as the detailed studies progress. One specific indicator mineral, tourmaline, is found predominantly at the contact of the pegmatite and the wallrock as mm-cm scale crystals growing perpendicular into wallrock (see figure to left). Blue apatite crystals (Photo 4a) are found predominantly in association with albite, variety clevelandite, or in zones of sacchroidal albite. Grains of tantalite (Photos 3, 4b) can be found within albite-rich zones as well as along fractures of quartz grains (see figure below left). Chemical analysis of indicator mineral will be undertaken to help distinguish prospective grains (i.e., sourced from the pegmatite) from background bedrock sources.

One important aspect of our research is the challenge to identify detrital spodumene grains in till. It is difficult to visually identify because of its unremarkable color, morphology, and moderate density of 3.18 g/cm^3, which places it in the mid-density fraction (2.8-3.2 SG). The entire mid-density fraction is challenging to examine because it contains significant amounts of other light-coloured minerals (e.g. quartz, feldspars, apatite, sillimanite). Sillimanite has an intermediate density of 3.24 g/cm^3 and thus is recovered from both the mid- and high-density mineral fractions. In photo 4c) and 4d) below, can you tell the difference between spodumene and sillimanite? Electromagnetic separation of the mid-density fraction has improved the ability to identify spodumene relative to sillimanite. Fluorescence characteristics of spodumene are being tested as a possible defining characteristic.

Photo 4. Indicator minerals of the Brazil Lake LCT pegmatites: a) blue apatite; b) tantalite; and c) spodumene; d) sillimanite (not an indicator mineral) can be misidentified as spodumene in heavy mineral concentrates and methods are being developed to facilitate mineral identifications (photos courtesy of Michael J. Bainbridge Photography).

SURFICIAL SAMPLING

A total of 44 bulk till samples were collected from 41 sites for the recovery of indicator minerals and matrix geochemistry. Samples sites varied from hand-dug holes, till exposures in borrow pits, exposures along local roads, to backhoe trenches dug on the down-ice (south-southeast) side of both the North and South pegmatites. The surface till in the region is a stony sand till, locally referred as the Beaver River till. This sandy nature of this till is ideal for the recovery of indicator mineral. Till exposed in the trenches contained abundant spodumene pebbles and small cobbles, indicating that the local till should display strong indicator mineral and matrix geochemical signatures derived from erosion of the pegmatites.

Two till samples were collected at each site, from moderately oxidized till, following GSC protocols described in McClenaghan et al. (2020):
i) small sample (~6 kg) for geochemical analysis of the <0.63 mm and 1-2 mm fraction of the till matrix,
ii) large bulk (~15 kg) sample for recovery of indicator minerals from the sand size fraction and pebbles for lithological analysis.

The 15 kg till samples were shipped to the commercial heavy mineral processing lab Overburden Drilling Management Ltd., in Ottawa, for recovery of mid-density (specific gravity (SG) 2.8-3.2) and high-density (>3.2 SG) minerals that are indicators of LCT pegmatites (see flow chart to the right). Minerals are examined in the 0.25-2.0 mm non-ferromagnetic fraction using a binocular microscope, counted, photographed, and selected grains removed for mineral chemistry. The <0.25 mm will be examined using automated mineralogy methods (Mineral Liberation Analysis) at Queen's University to determine indicator mineral abundances in the finer size fraction.

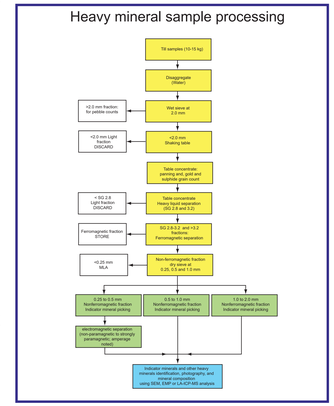


Photo 5. Close up photograph showing the stony sandy nature of the local till (photo by Beth McClenaghan. NRCan photo 2022-587).

Photo 6. Typical till exposure in backhoe trench showing the stony sandy nature of the local till that was sampled (photo by Beth McClenaghan. NRCan photo 2022-588).

Photo 7. Spodumene-bearing float boulders are common on surface down ice of the North pegmatite (photo by Beth McClenaghan. NRCan photo 2022-589).

Photo 8. Spodumene clasts from the pegmatite are common in till trenches down ice (photo by Beth McClenaghan. NRCan photo 2022-590).

Photo 9. Visitors to the field site from St. Francis Xavier University (photo by Abeer Haji Egeh. NRCan photo 2022-591).

ACKNOWLEDGEMENTS

This research is funded by the Geological Survey of Canada's Targeted Geoscience Initiative (TGI) and the Nova Scotia Department of Natural Resources and Renewables. The authors thank John Wightman and Cliff Stanley for access to the property, field visits, and advice that guided the field work. Mitch Maracle, Acadia University, is thanked for his assistance with field work and till sample collection. Donnelly Archibald, St. Francis Xavier University, is thanked for bringing a student field trip to the Brazil Lake pegmatites during our field work and for sharing field photographs. The GSC thanks the Acadia First Nations for their consultations and visits to the field site for this project. Staff at the Carleton Country Outfitters store are thanked for excellent service and support during the multi-year sampling project.

[1]Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario
[2]Nova Scotia Department of Natural Resources and Renewables, Geoscience and Mines Branch, 1701 Hollis Street, Halifax, Nova Scotia
[3]Department of Geology, Saint Mary's University, 923 Robie Street, Halifax, Nova Scotia

For more information, contact M.B. McClenaghan (beth.mcclenaghan@nrcan-rncan.gc.ca).

2023

Publications in this series have not been edited; they are released as submitted by the author.

Permanent link: https://doi.org/10.4095/331686

This publication is available for free download through GEOSCAN (https://geoscan.nrcan.gc.ca/).

Presented at: Atlantic Geoscience Society 2023 Colloquium
Date presented: February 3-4, 2023

Recommended citation
McClenaghan, M.B., Brushett, D.M., Beckett-Brown, C.E., Paulen, R.C., Rice, J.M., Haji Egeh, A., and Nissen, A., 2023. Indicator mineral studies at the Brazil Lake LCT pegmatites, southwest Nova Scotia; Geological Survey of Canada, Scientific Presentation 157, 1 poster. https://doi.org/10.4095/331686

Natural Resources Canada | Ressources naturelles Canada

Canada