# Indicator Mineral and Till Geochemical Signatures of the East Kemptville Sn-Zn-Cu-Ag Deposit, Southwestern Nova Scotia, Canada

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## Introduction

An indicator mineral and till geochemical case study around the East Kemptville Sn-Zn-Cu-Ag deposit was conducted during the summer of 2018 as a continuation of surficial mapping and sampling activities in southwest Nova Scotia. In this region, multiple phases of ice flow during the Wisconsinan glaciation produced thick glacial sediment cover and complex glacial dispersal patterns that have hindered exploration for buried mineralization in southwestern Nova Scotia (Stea and Grant, 1982).

The objectives of this study were (1) to characterize the type and abundance of indicator minerals and elements in till at varying distances from a known tin deposit using modern surficial exploration methods; and (2) to compare the mineralogical and elemental data in till and bedrock heavy-mineral concentrates to previous till and bedrock mineralogy studies in the region and also to recent till geochemical studies of Sn and W mineralization from intrusion-related deposits.

The study was a collaborative effort between the Nova Scotia Department of Energy and Mines and the Geological Survey of Canada and was also part of a B. Sc. Honours thesis project at Acadia University (Smith, 2019). In this report of activities, an overview of the field and analytical methods is provided.

## Background

Till geochemistry has been used successfully for Sn exploration in glaciated terrain (e.g. Szabo et al., 1975; Toverud, 1982; Peuraniemi et al. 1984; Finck et al. 1990), and it was an integral part of the discovery of the East Kemptville deposit. Shell Canada Resources followed up on the discovery of mineralized boulders with a regional till-geochemistry program that identified a large glacial dispersal train of tin extending up to 50 km southeast of the deposit (Wilson and Richardson, 1980; Rogers et al. 1990). Further regional prospecting and till geochemical programs conducted in the 1970s and 1980s identified several areas with anomalous Sn and numerous mineral occurrences associated with the East Kemptville shear zone, a zone of pervasive shearing along the north edge of the South Mountain Batholith near East Kemptville (e.g. O'Reilly and Kontak, 1992; Horne et al., 2006). The most notable mineralization in the area is the greisen-hosted East Kemptville Sn-Zn-Cu-Ag deposit that is associated with Zn, Cu, Ag, and In. Other granite- and metasediment-hosted shear- and replacement-style Sn and base metal mineral prospects include Duck Pond (Sn-Cu-Zn-In), Pearl Lake (Sn-Zn-Cu-In) and Dominique (Sn-Zn-Cu-In) (O'Reilly, 2016) (Figure 1).

Most published reports of till-sampling programs for Sn and W exploration carried out in the 1970s and 1980s (e.g. Lindmark 1977; Brundin & Bergstrom 1977; Toverud 1984; Johansson *et al*. 1986) used heavy mineral methods that were different between each study and not available in commercial labs and geochemical methods that were time consuming and expensive. Recent studies on the use of indicator minerals and geochemistry around Sn and W deposits in New Brunswick used modern methods of till analysis for which the determination of Sn and W content is now routine and inexpensive. Example studies includes those conducted at the Sisson W-Mo deposit (McClenaghan et al., 2014a, 2017) and the Mt. Pleasant Sn-W-Mo-Bi-In deposit (McClenaghan et al., 2014b, 2016). These studies and others are also amongst the first detailed indicator mineral

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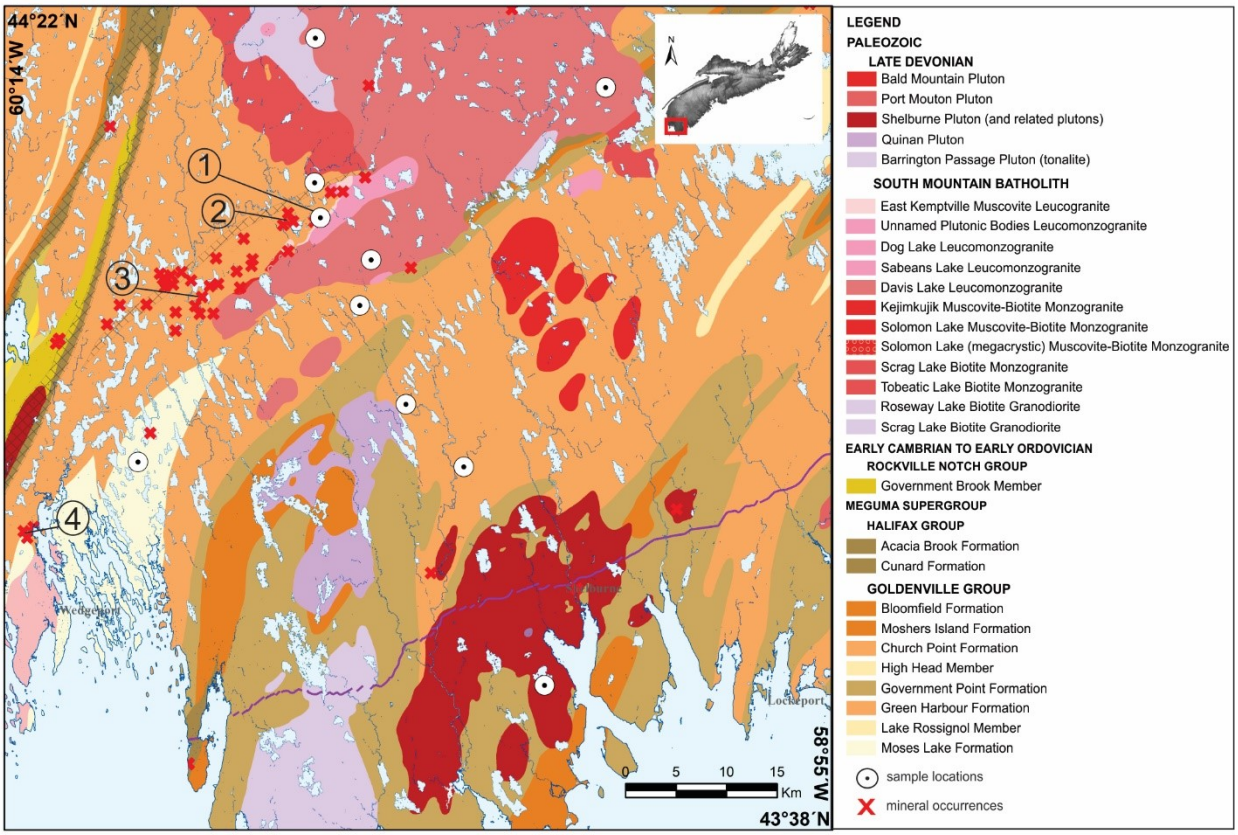


**Figure 1.** Sample locations underlain by bedrock geology (White, 2012). The study area is indicated by the red box in the inset map. Mineral occurrences are marked by red crosses; those discussed in text include 1. East Kemptville Sn-Zn-Cu-Ag deposit, 2. Duck Pond Sn-Cu-Zn-In prospect, 3. Pearl Lake Sn-Cu-Zn-In prospect, and 4. Dominique Sn-Cu-Zn-In prospect.

studies of till around major Sn and W deposits in glaciated terrain. These new studies produced a more extensive list of indicator minerals and elements than previously identified because of the broader suite of elements that can now be determined using modern analytical techniques.

# Methods

Fieldwork was conducted by truck and helicopter over the summer of 2018. Ten sites were sampled for till at varying distances from the deposit and along a previously identified southeast-trending till dispersal train: five sites were down-ice (southeast) of the deposit, one site overlay the deposit, one site was up-ice (northwest) of the deposit, and three sites were sampled to represent the regional background. Two sites were sampled as field duplicates.

Samples were collected either from hand-dug test pits or from roadcuts following the Geological Survey of Canada protocols for processing glacial sediments for the recovery of indicator minerals and geochemical analyses of tills (McClenaghan et al., 2013; Plouffe et al., 2013). At each site, two samples were taken from the C-horizon at ~90 cm depth: a small sample (1–3 kg) was taken for geochemical analysis of till matrix and archiving, and a large sample (10–15 kg) was taken to ensure sufficient recovery of indicator minerals. Samples were collected in clean, 6 mm clear plastic bags, secured with cable lock ties, and then stored and shipped in 20 L plastic pails. Field data collected at each site included GPS co-ordinates, general site description, sample description (soil horizon, texture, Munsell colour, lithology of clasts, relative percentages of clasts, matrix description [i.e. percent sand, silt, clay] and sample depth), and the description and measurement of any ice-flow indicators.

The small (1–3 kg) till samples were dried and sieved to the <63 µm fraction (-230 mesh) to recover the silt plus clay fraction. Two separate

aliquots from the <63 µm fraction were submitted to Bureau Veritas (Vancouver, BC). The first was a 30 g aliquot that was analyzed using a modified aqua regia digest ($HCl:HNO_3$ in a 1:1 ratio) followed by inductively coupled plasma-mass spectrometry (ICP-MS). The second aliquot was 0.2 g and was analyzed using lithium metaborate/ tetraborate fusion followed by a nitric acid digestion, inductively coupled plasma emission spectroscopy, and ICP-MS. This borate fusion analysis digested all mineral phases and determined the total element content that is optimal for determining tin concentrations. Two field duplicate samples were taken for quality assurance/quality control (QA/QC) purposes. Six CANMET certified reference standards (TILL-1 and TILL-4) were inserted into the sample suite to evaluate analytical accuracy.

The large (10–15 kg) till samples were shipped to Overburden Drilling Management Limited (ODM), Ottawa, Ontario, for indicator mineral processing. Samples were processed using a combination of tabling, panning and heavy liquid (methylene iodide) separation at a specific gravity of 3.2 to produce 0.25 to 0.5 mm, 0.5 to 1.0 mm, and 1.0 to 2.0 mm non-ferromagnetic heavy mineral fractions for picking of indicator minerals. Fractions were examined for gold, metallic oxide (e.g. cassiterite $SnO_2$), and silicate indicator minerals. Two blank samples were inserted at beginning and in the middle into the indicator mineral sample batch to monitor cross-contamination.

Four bedrock samples collected from the East Kemptville mine site were also submitted to ODM for heavy mineral recovery to compare with the indicator minerals recovered in till samples. Bedrock heavy-mineral concentrates were produced from these samples by reducing their grain size to <2 mm using electric pulse disaggregation. The <2 mm fraction was then processed using tabling and heavy liquid methods similar to those used for till samples to recover 0.25 to 0.5 mm, 0.5 to 1.0 mm, and 1.0 to 2.0 mm non-ferromagnetic heavy mineral fractions for picking of indicator minerals.

# Results to Date

Indicator minerals identified in till down-ice of the deposit include cassiterite, wolframite, scheelite, and topaz. Indicator minerals recovered in the 0.25 to 0.5 mm fraction define glacial dispersal of at least 50 km southeast of the deposit; cassiterite was identified 30 km southeast and topaz 50 km southeast of the East Kemptville deposit. Elevated concentrations of indicator elements in the <63 µm fraction of till include Sn, Cu, Zn, Ag, and In. Tin was found in elevated concentrations up to 50 km southeast of the deposit, along the previously published Sn dispersal train defined by Shell Canada Resources. Pathfinder elements identified in till include W, Mo, Cs, Bi, As, and Cd.

# Future Work

All data, including sample site and location data, till-matrix geochemical data, and indicator mineralogy data for till and bedrock samples will be released along with QA/QC data from duplicate and blank samples in an upcoming open file report from the Nova Scotia Department of Energy and Mines.

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