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Contribution to the Geological Survey of Canada's Targeted Geoscience Initiative 4 (TGI-4) Program (2010-2015)

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ABSTRACT

A study of indicator minerals in bedrock was carried out at the Mount Pleasant Sn-W-Mo-Bi-In deposit, in New Brunswick. This study was conducted as part of the Geological Survey of Canada's (GSC) Targeted Geoscience Initiative 4 (TGI-4). It included mineralogical identification of polished thin sections and of heavy mineral concentrates produced from disaggregated bedrock samples. Indicator minerals identified in bedrock samples include the main ore minerals, cassiterite, molybdenite and sphalerite, as well as chalcopyrite, pyrite, galena, arsenopyrite, fluorite, and topaz. Although the deposit is well known for its wolframite content, it was not found in any of the rocks examined in this study. This absence is likely due to the small number of bedrock samples examined in this study.

INTRODUCTION

The Geological Survey of Canada (GSC), through its Targeted Geoscience Initiative 4 (TGI-4) Program (2010–2015), and the New Brunswick Department of Energy and Mines initiated a study of geochemical and mineralogical dispersal patterns to identify key indicator minerals of buried intrusion-hosted polymetallic mineralization. Two intrusion-hosted polymetallic deposits in west-central New Brunswick were investigated (Fig. 1): the Mount Pleasant Sn-W-Mo-Bi-In deposit (this study) and the Sisson W-Mo deposit (McClenaghan et al., 2013a,b,c).

The Mount Pleasant polymetallic deposit was chosen as an indicator mineral test site because the deposit (1) is known to contain cassiterite and wolframite, two well known indicator minerals; (2) has well documented local geology; (3) outcrops and is directly overlain by till and thus was exposed to glacial erosion; (4) is road-accessible; and (5) has a previously identified till geochemical dispersal train down-ice (southeast) (Szabo et al., 1975), which served to focus sampling of metal-rich till. This study is one of the first detailed indicator mineral studies around a major Sn deposit in glaciated terrain.

The specific objectives of the research project were (1) to determine which indicator minerals, and their specific trace element signatures, are indicative of an intrusion-hosted polymetallic Sn deposit; and (2) to establish practical methods for recovery of these indicator minerals from the glacial sediments and outline techniques for their identification that can be routinely applied during exploration for intrusion-hosted polymetallic mineralization in glaciated terrain.

The indicator mineral content of three bedrock samples from the Mount Pleasant deposit were first presented in McClenaghan et al. (2014). The purpose of this report is to present the results of two additional bedrock samples from the same deposit and to compare and describe the indicator mineral results of the five samples. These data will be used in subsequent GSC reports to evaluate the indicator mineral content of till samples collected down-ice of the Mount Pleasant deposit.

Location and access

The Mount Pleasant deposit is in southern New Brunswick (Fig. 1) in the McDougall Lake map area (NTS 21 G/07) at latitude 45°26'N and longitude 66°49'W. The mine site is 60 km south of Fredericton and is easily accessed by a mine access road that extends northwest from Highway 785.

GEOLOGY

Bedrock geology

The bedrock geology of the Mount Pleasant area, which is summarized below, is from several sources, including Petruk (1972), Kooiman et al. (1986), Sinclair (1994), Invemo and Hutchinson, (2004), Sinclair et al. (2006), and McCutcheon et al. (2010, 2013). The deposit is in the Appalachian Orogen within two subvolcanic intrusions in the Late Devonian Mount Pleasant Caldera Complex, along the north flank of the Saint George Batholith. The McDougall Brook and the Mount Pleasant granitic suites are related to the early and late stages of caldera development, respectively. The deposit contains Sn, W, Mo, Bi, and In mineralization that is genetically related to highly evolved granitic rocks of the Mount Pleasant

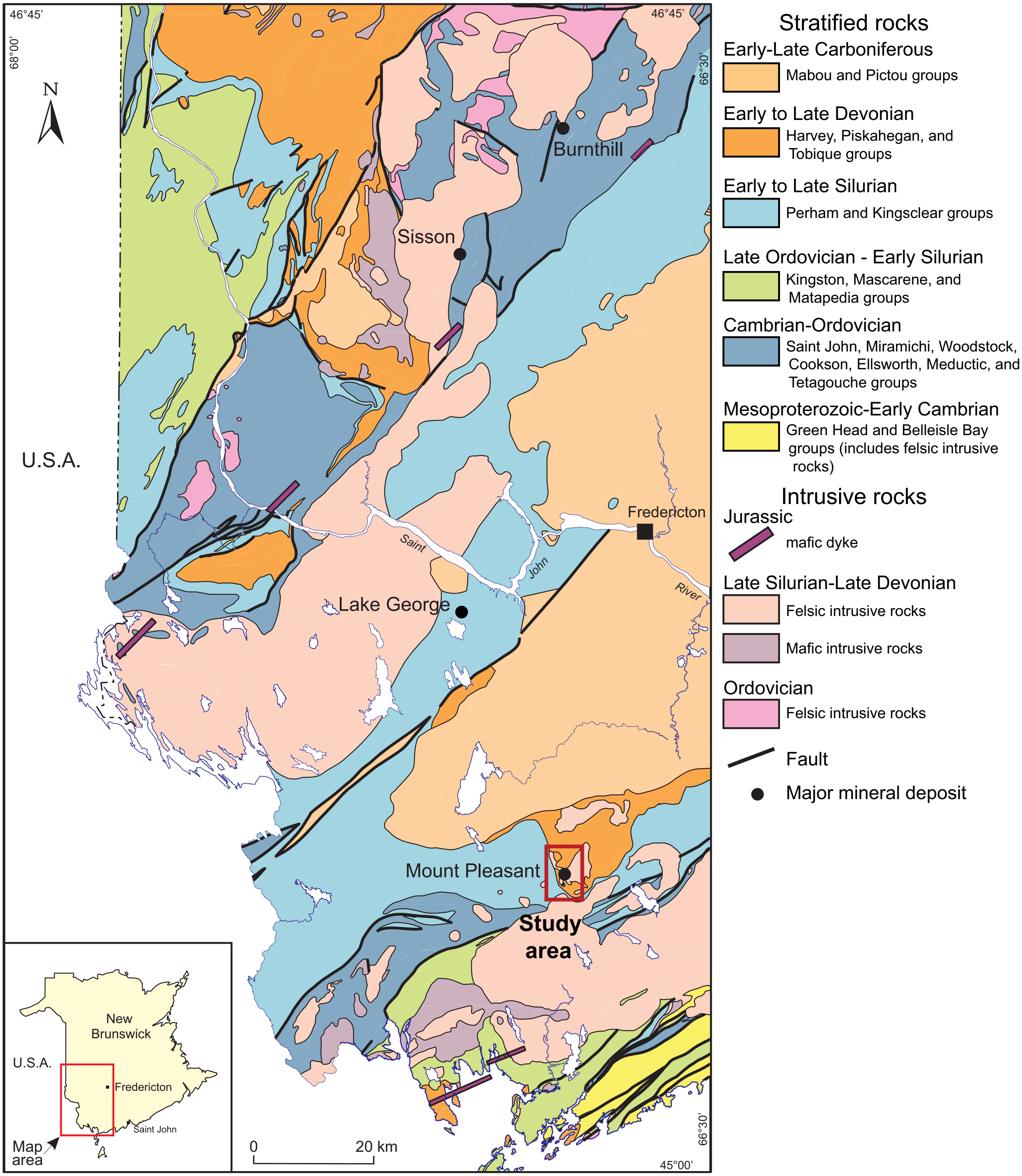

Figure 1. Bedrock geology map of west-central and southern New Brunswick showing the location of the Mount Pleasant Sn-W-Mo-Bi-In deposit and other significant deposits (modified from McCutcheon et al., 2010).

Granitic Suite (Granites I, II, III), and is enriched in incompatible elements F, Li, Rb, Cs, U, Th, and Nb. Granite I, and its related breccia, hosts W-Mo-Bi mineralization; Granite II hosts Sn-In mineralization (Figs. 2, 3). The deposit consists of three mineralized zones, which are, from north to south, the North Zone, the Saddle Zone, and the Fire Tower Zone. Both the North and Fire Tower zones outcrop or subcrop beneath till (Fig. 2), and thus were exposed to glacial erosion and likely contributed mineralized debris to the overriding

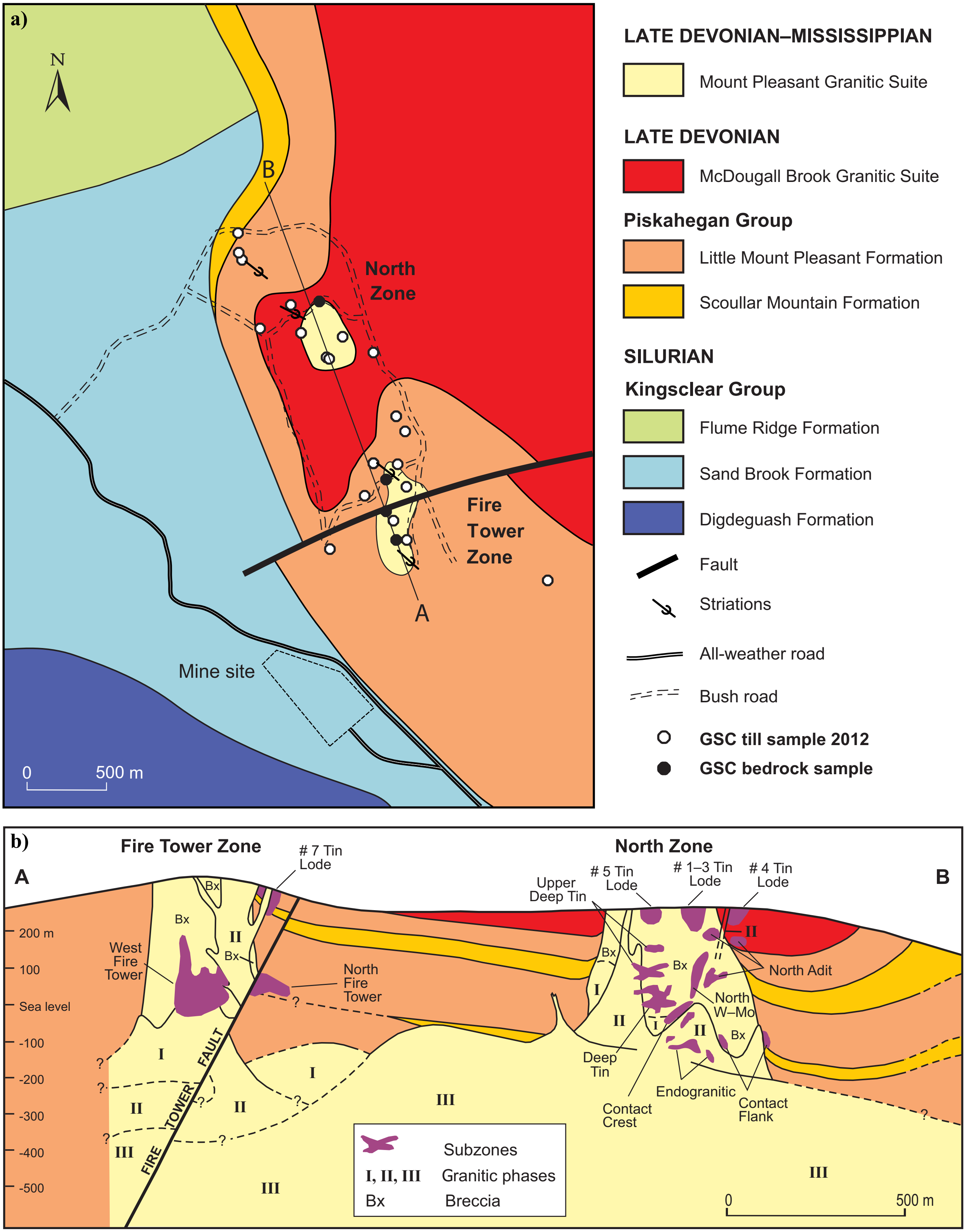

Figure 2. a) Geological map of the Mount Pleasant deposit showing the location of the Fire Tower and North zones. Line A-B indicates the location of the cross-section shown in Figure 2b; **b)** cross-section A-B through the North Zone and Fire Tower Zone at the Mount Pleasant deposit, showing the location of ore subzones (purple) (modified from McCutcheon et al. (2010).

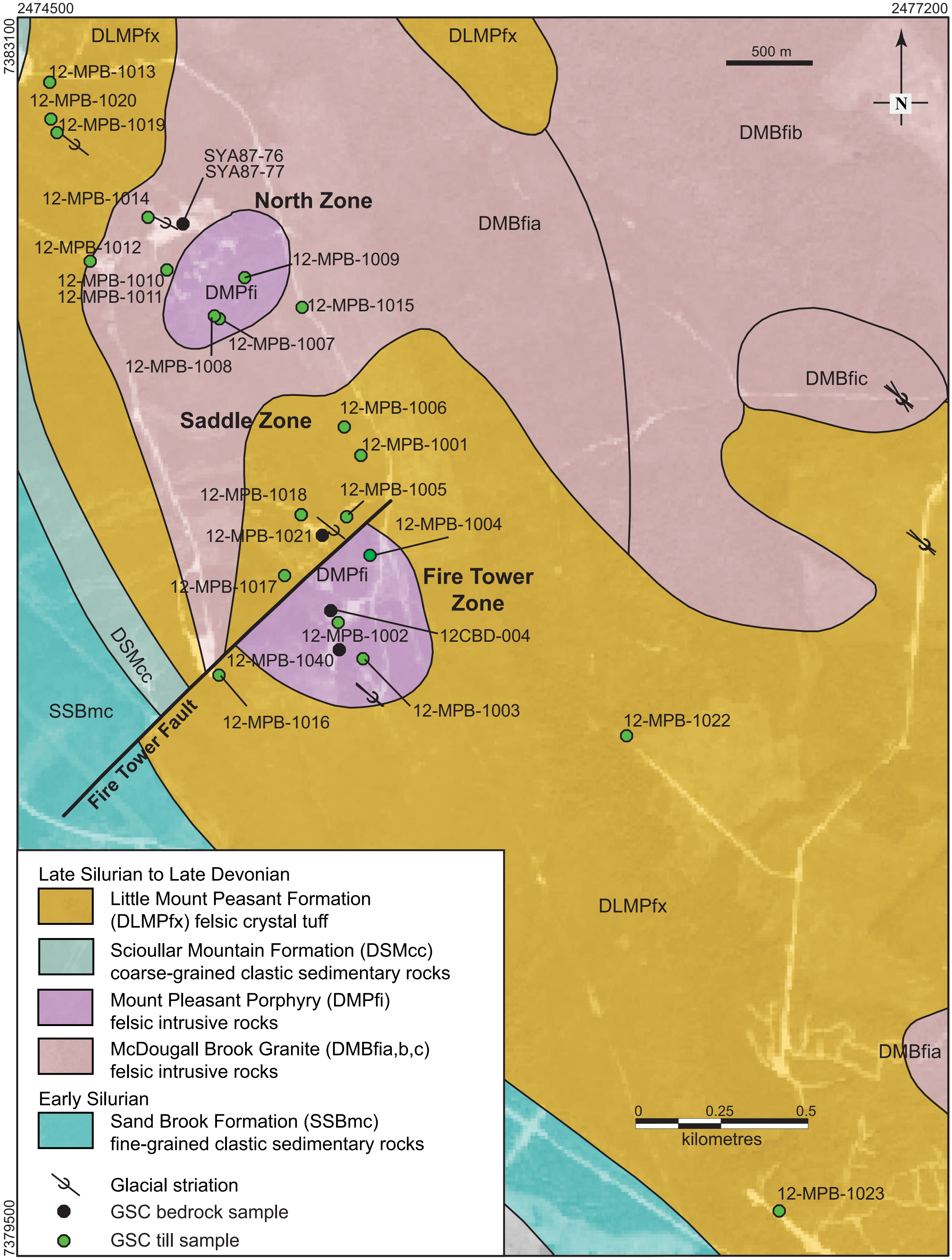

Figure 3. Location of GSC bedrock (black dots) and till (green dots) samples proximal to the Mount Pleasant deposit with an airphoto in the background (bedrock geology from McLeod et al., 2005). Location of samples SYA-87-76 and SYA-87-77 is approximate.

glacier. The North Zone consists of older W-Mo mineralization and younger Sn-In mineralization, some of which is at or near surface (Fig. 3). The Sn-In zones contain cassiterite, arsenopyrite, loellingite, sphalerite, and chalcopyrite as well as additional sulphide minerals (see Table 1). The Fire Tower Zone contains predominantly large tonnage, low-grade mineralization with some small In-bearing Sn-base metal resources. The main ore minerals are wolframite and molybdenite with minor native bismuth and bismuthinite. Gangue minerals include cassiterite, arsenopyrite and loellingite, quartz, topaz, and fluorite. The Fire Tower Zone also contains small In-bearing Sn-base metal zones in irregular veins and breccias with cassiterite and wolframite together with sulphide minerals (see Table 1). Indium in the Mount Pleasant deposit occurs mainly as a solid solution between sphalerite and roquesite, but also occurs in chalcopyrite and stannite (Petruk, 1972; Sinclair et al., 2006).

As of October 2008, the NI 43-101 resource estimate of the Fire Tower Zone is an indicated resource of 13.489 million tonnes at 0.33% WO_3, 0.21% MoS_2, 0.57 % As, and 0.06% Bi, as well as an inferred resource of 0.8417 million tonnes at 0.26% WO_3, 0.20% MoS_2, 0.21 % As, and 0.04 % Bi (McCutcheon et al., 2013). As of February 2012, the NI 43-101 mineral resource estimate of the North Zone is an indicated resource of 12.4 million tonnes averaging 0.38% Sn, 0.86% Zn, and 64 ppm In, as well as an inferred resource of 2.8 million tonnes averaging 0.30% Sn, 1.13% Zn, and 70 ppm In (McCutcheon et al., 2013).

A Cu and Pb stream sediment anomaly on the west flank of Mount Pleasant in the 1950s lead to the area being staked for follow-up exploration to (Parrish and Tully, 1976). Subsequent surface trenching and stripping, diamond drilling, geophysical surveys, and soil geochemical surveys resulted in the discovery of a significant Sn-W resource. A mine and a mill was constructed in 1980 (McCutcheon et al., 2010, 2013), however, falling W prices led to the closure of the mine in 1985.

METHODS

Sampling

A total of five bedrock samples, each weighing between ~0.3 and 1 kg, were collected for a mineralogical study with the objective of comparing the indicator mineral content of till and bedrock. Bedrock sample locations are listed in Appendix A and plotted on Figure 3. The following five samples were collected:

- sample 12-MPB-1021: sulphidized fluorite-vein grab sample from the waste rock pile on the north side of the North Zone;
- sample 12-MPB-1040: rhyolite-chert breccia with fluorite-filled vugs from a bedrock outcrop at the Fire Tower Zone;
- sample 12-CBD-004: sulphidized and veined quartz breccia from the Fire Tower Zone;
- sample SYA-87-76: sulphide-cassiterite mineralized breccia from the North Zone (Sinclair, 1994);
- sample SYA-87-77: cassiterite mineralized breccia from the North Zone (Sinclair, 1994).

Colour photographs of the five bedrock samples are included in Appendix B1. Petrographic descriptions of bedrock samples 12-MPB-1021 and 12-MPB-1040 are included, along with photomicrographs, in Appendix B2. Multiple polished thin sections (PTS) were made of bedrock samples 12-MPB-1021 and 12-MPB-1040 in order to examine the mineralogy of a large volume of each sample.

Sample processing and indicator mineral picking

Bedrock samples were processed at Overburden Drilling Management Ltd. (ODM), Ottawa to produce two batches of heavy mineral concentrates for indicator mineral picking. Batch 1 was submitted in 2012 and included samples 12-MPB-1021, 12-MPB-1040, and 12-CBD-004. Results were presented in McClenaghan et al. (2014). Batch 2 was processed in 2014 and includes samples SYA-87-76 and SYA-87-77. Results from Batch 2 are presented in this report. This report and McClenaghan et al. (2014) contain the original reports from ODM.

Each bedrock sample was first examined and described by geologists at ODM (Appendix B3) and then disaggregated using a custom built CNT Spark-2 electric pulse disaggregator (EPD), which was used instead of a conventional rock crusher in order to preserve natural grain sizes, textures, and shapes. The weight of material disaggregated ranged from 72 to 1050 g. The <2.0 mm fraction of each bedrock sample was then processed at ODM to produce a non-ferromagnetic heavy mineral concentrate to be used for picking indicator minerals. Weights of all fractions of samples 12-MPB-1021, 12-MPB-1040, and 12-CBD-004 are reported in McClenaghan et al. (2014) and for samples SYA-87-76 and SYA-87-77 in Appendix B4 of this report.

The <2.0 mm fraction of each sample was passed over a shaking table. The heavy table concentrate was micro-panned to recover any fine-grained gold, sulphide, and other indicator minerals. The minerals in the panned concentrates were counted and their size and shape characteristics recorded and then returned to the sample. The heavy table concentrate was then sieved at 0.18 mm. The 0.18 to 2.0 mm pre-concentrate was then further refined using heavy liquid separation in meth-

Table 1. Indicator minerals in the Mount Pleasant deposit (Petruk, 1972, 1973; Parrish, 1977; Kooiman et al., 1986; Sinclair et al., 2006) and those found in bedrock polished thin sections (PTS), bedrock heavy mineral concentrates (HMC), and till heavy mineral concentrates (HMC) from this TGI-4 study.

Mineral	Formula	Hardness	Specific Gravity	Presence reported by others	Identified in bedrock PTS in this study	Identified in bedrock HMC in this study	Identified in till HMC in this study
Tin minerals							
cassiterite	SnO_2	6-7	6.8-7	Petruk (1972)	no	yes	yes
stannite	Cu_2FeSnS_4	3.5-4	4.3-4.5	Petruk (1972)	no	no	no
kësterite	$Cu_2(Zn,Fe)SnS_4$	4.5	4.54-4.59	Petruk (1972)	no	no	no
ferrokësterite	$Cu_2(Fe,Zn)SnS_4$	4.0	4.5	Parrish (1977)	no	no	no
stannoidite	$Cu_8Fe_3Sn_2S_{12}$	4	4.3	Petruk (1972)	no	no	no
mawsonite	$Cu_6Fe_2SnS_8$	3.5-4	4.7	Petruk (1972)	no	no	no
Tungsten minerals							
scheelite	$CaWO_4$	4-5	5.9-6.12	Parrish (1977)	no	no	yes
wolframite	$(Fe,Mn)WO_4$	4.5	7.1-7.5	Petruk (1972)	no	no	yes
Sulphide and arsenide minerals							
molybdenite	MoS_2	1	5.5	Petruk (1972)	no	no	yes
pyrite	FeS_2	5-5.02	6.5	Petruk (1972)	yes	yes	yes
marcasite	FeS_2	6.0-6.5	4.9	Petruk (1972)	no	no	no
sphalerite	$(Zn,Fe)S$	3.5-4	3.9-4.2	Petruk (1972)	yes	yes	no
pyrrhotite	$Fe_{(1-x)}S$ (x=0-0.17)	3.5-4	4.58-4.65	Petruk (1972)	no	no	no
arsenopyrite	$FeAsS$	5	6.1	Petruk (1972)	no	yes	yes
loellingite	$FeAs_2$	5.0	7.1-7.7	Petruk (1972)	no	no	yes
ferrimolybdite	$Fe_2(MoO_4)3{\bullet}8(H_2O)$	2.5-3	4-4.5	Parrish (1977)	no	no	no
scorodite	$Fe(AsO_4){\bullet}2(H_2O)$	3.5-4	3.1-3.3	Parrish (1977)	no	no	no
Bismuth minerals							
bismuthinite	Bi_2S_3	2	6.8-7.2	Petruk (1972)	no	no	no
native bismuth	Bi	2-2.5	9.7-9.8	Petruk (1972)	no	no	no
arsenobismite	$Bi_2(AsO_4)(OH)_3$	3	5.7	Parrish (1977)	no	no	no
zairite	$Bi(Fe,Al)_3[(OH)_6(PO_4)_2])$	4.5	4.4	no	no	no	yes
Copper minerals							
chalcopyrite	$CuFeS_2$	3.5	4.1-4.3	Petruk (1972)	no	yes	no
covellite	CuS	1.5-2.0	4.6-4.76	Petruk (1972)	no	no	no
tennantite	$(Cu,Fe)_{12}As_4S_{13}$	3.5-4	4.6-4.7	Petruk (1972)	no	no	no
bornite	Cu_5FeS_4	3.0	4.9-5.3	Petruk (1972)	no	no	no
chalcocite	Cu_2S	2.5-3	5.5-5.8	Parrish (1977)	no	no	no
roquesite	$CuInS_2$	3.5-4	not reported	Petruk (1973)	no	no	no
digenite	Cu_9S_5	2.5-3	5.6	Parrish (1977)	no	no	no
famatinite	Cu_3SbS_4	3-4	4.6	Parrish (1977)	no	no	no
Lead minerals							
galena	PbS	2.5	7.2-7.6	Petruk (1972)	yes	yes	yes
wittichenite	Cu_3BiS_3	2.5	6.3-6.7	Petruk (1973)	no	no	no
galenobismutite	$PbBi_2S_4$	2.5-3	6.9-7.1	Petruk (1972)	no	no	no
aikinite	$PbCuBiS_3$	2-2.5	6.1-6.8	Petruk (1972)	no	no	no
cosalite	$Pb_2Bi_2S_5$	2.5-3	6.4-6.8	Petruk (1972)	no	no	no
krupkaite	$PbCuBi_3S_6$	4	7.0	Petruk (1972)	no	no	no
beudantite	$PbFe_3(AsO_4)(SO_4)(OH)_6$	4.0	4.1-4.3	no	no	no	yes
anglesite	$Pb(SO_4)$	2.5-3	6.3	no	no	no	yes
plumbogummite	$PbAl_3(PO_4)_2(OH)_5{\bullet}HO_2$	4-5	4-5	no	no	no	yes
Au and Ag minerals							
freibergite	$(Ag,Cu,Fe)_{12}(Sb,As)_4S_{13}$	3.5-4	4.85-5	Petruk (1973)	no	no	no
pyrargyrite	Ag_3SbS_3	2.5	5.9	Petruk (1973)	no	no	no
native silver	Ag	2.5-3	10-11	Petruk (1972)	no	no	no
gold	Au	2.5-3	16-19.3	Parrish (1977)	no	no	yes
Alteration minerals							
topaz	$Al_2SiO_4(F,OH)_2$	8	3.5-3.6	Petruk (1972)	yes	yes	yes
fluorite	CaF_2	4	3.01-3.25	Petruk (1972)	yes	yes	yes
tourmaline (black)	$NaAl_3Al_6(BO_3)_3(Si_6O_{18})(O,OH)_4$	7	3	Petruk (1972)	no	no	yes
columbite	$(Fe,Mn)(Nb,Ta)_2O_6$	6.0	5.3-7.3	Petruk (1972)	no	no	

Table 2. Abundance of mineral grains in the non-ferromagnetic 0.25–0.5 mm heavy- and the 0.25–2.0 mm mid-density fractions of bedrock samples: **a)** raw data; **b)** data normalized to 1 kg sample weight. Data from McClenaghan et al. (2014) and Appendix B4.

A) Raw counts reported by ODM

	Weight	SG >3.2: 0.25-0.5 mm									SG 3.0–3.2; 0.25–2.0 mm	
Sample	<2.0 mm fraction (g)	Cassiterite	Fluorite	Chalcopyrite	Sphalerite	Galena	Arsenopyrite	Pyrite	Goethite	Topaz	Sphalerite	Fluorite
12-MPB-1021	245.5	0	120,000	50	140,000	200	0	50	0	50,000	4	140,000
12-CBD-004	64.7	23	0	0	3000	0	18	120	0	2500	2000	0
12-MPB-1040	583.7	0	2500	0	0	0	0	0	0	3000	0	15,000
SYA-87-76	551.5	90,000	12,000	200	0	0	350,000	12,000	0	120,000	NA	NA
SYA-87-77	1001.1	4000	8000	200	0	0	200	100	0	700,000	NA	NA

B) Counts normalized to 1 kg weight

	Weight	SG >3.2: 0.25-0.5 mm									SG 3.0–3.2; 0.25–2.0 mm	
Sample	<2.0 mm fraction (g)	Cassiterite	Fluorite	Chalcopyrite	Sphalerite	Galena	Arsenopyrite	Pyrite	Goethite	Topaz	Sphalerite	Fluorite
12-MPB-1021	245.5	0	488,798	204	570265	815	0	204	0	20,3666	16	570,265
12-CBD-004	64.7	355	0	0	46368	0	278	1855	0	38,640	30,912	0
12-MPB-1040	583.7	0	4283	0	0	0	0	0	0	5140	0	25,698
SYA-87-76	551.5	16,3191	21,759	363	0	0	634633	21759	0	21,7588	NA	NA
SYA-87-77	1001.1	3996	7991	200	0	0	200	100	0	69,9231	NA	NA

ylene iodide diluted to a specific gravity (SG) of 3.2 to produce two fractions: a) SG >3.2 and, b) SG <3.2.

The SG >3.2 heavy mineral fraction was further refined using a hand magnet to remove the ferromagnetic fraction. The non-ferromagnetic fraction was sieved into four size fractions: 0.18–0.25, 0.25–0.5, 0.5–1.0, and 1.0–2.0 mm. The 0.18–0.25 mm fraction was archived. The 0.25–0.5 mm fraction was further subjected to paramagnetic separation using a Carpco® magnetic separator at 0.6, 0.8, and 1.0 amps to facilitate mineral identification in this fine-size fraction based in part on the minerals' magnetic properties. For sample, the SG <3.2, light to mid-density fraction of Batch 1 was further processed using heavy liquid methylene iodide diluted to SG 3.0 to produce a mid-density fraction (SG 3.0–3.2) for examination.

At ODM, quartz 'blank' bedrock samples (12-MPB-BLK, 12-MPB-1021BLK, 12-CBD-004BLK) were inserted into the bedrock Batch 1 and two blanks into bedrock Batch 2 (BLANK-1, BLANK-2) to monitor potential cross contamination between samples. The results for the quartz blank samples are reported along with the bedrock samples in McClenaghan et al. (2014) or in Appendix B4.

The 0.25–0.5, 0.5–1.0, and 1.0–2.0 mm non-ferromagnetic heavy mineral (SG >3.2) and the -0.25–2.0 mm mid-density (SG 3.0–3.2) fractions of the bedrock samples were then examined with a binocular microscope by trained personnel at ODM and indicator minerals were counted/selected; these included cassiterite, scheelite, fluorite, gold, and sulphide minerals. The visual identification of a limited number of mineral grains was verified with a scanning electron microscope (SEM). Mineral grain abundances in the five bedrock samples are reported as raw counts (Table 2a) and normalized to a 1 kg sample weight (Table 2b).

RESULTS

Quality assurance/quality control

In Batch 1, blank sample 12-MPB-1021BLK was processed after bedrock sample 12-MPB-1021 and was found to contain 2 grains of pyrite (~50 µm) in the pan concentrate. In Batch 2, sample Blank-2 was processed after bedrock sample SYA-87-76 and was found to contain 2 grains of arsenopyrite (~50 µm) in the pan concentrate. All other quartz blank samples were found to contain no heavy or mid-density minerals. These very low to zero heavy mineral grains counts obtained for the blank samples indicate that carryover from these highly mineralized samples was minimal to undetectable.

Cassiterite

Cassiterite was identified in bedrock heavy mineral concentrates by its grain luster, typical yellow-brown colour, and prismatic crystal habit. Quartz was often attached to the cassiterite grains. The identification of some unusual looking grains was confirmed using the SEM. Cassiterite was recovered from three bedrock samples, varying in abundance from 350 grains/kg in sample 12-CBD-004 to 163,000 grains/kg in sample SYA-87-76 (Table 2b). Most grains were recovered from the 0.25–0.5 mm fraction. A few coarser (0.5–1.0 mm) grains were recovered from sample SYA-87-76. Cassiterite grains (50–1000 µm) were also recovered from the pan concentrate of samples SYA-87-76 and SYA-87-77. Cassiterite was not identified in the PTS of either of the two bedrock samples examined (Appendix B4).

Sphalerite

Thousands of sphalerite grains in the 0.25–0.5 mm and 0.25–2.0 mm >3.2 SG fraction were recovered from samples 12-MPB-1021 and 12-CBD-004 (Table 2). Some coarse grains (0.5–2.0 mm) are also present in sample 12-CBD-004 (McClenaghan et al., 2014). Sphalerite grains were also recovered from the mid-density fraction of samples 12-MPB-1021 and 12-CBD-004 because they were intergrown with the lighter quartz and feldspar. Sphalerite was also observed in the PTS of sample 12-MPB-1021 (Appendix B4).

Galena

Galena was observed on the PTS of sample 12-MPB-1021 and in the HMC of the disaggregated bedrock sample. The HMC contained 815 grains/kg in the 0.25–0.5 mm fraction (Table 2b). The pan concentrate contained ~50,000 grains that are 25–200 µm fraction (McClenaghan et al., 2014).

Pyrite

Pyrite was observed on the PTS of sample 12-MPB-1021 as inclusions in sphalerite. Also, it was identified in the HMCs of disaggregated bedrock samples 12-MPB-1021, 12-CBD-004, SYA-87-76, and SYA-87-77. Samples contained between ~100 and ~21,000 grains/kg in the 0.25–0.5 mm fraction (Table 2b) and up to 100s of grains (25–500 µm) in the pan concentrate (Appendix B4 and McClenaghan et al., 2014).

Chalcopyrite

Chalcopyrite was observed in the PTS of sample 12-MPB-1021 as inclusions in sphalerite and in the HMC of disaggregated bedrock samples 12-MPB-1021, SYA-87-76, and SYA-87-77. Samples contained a few hundred grains/kg in the 0.25–0.5 mm fraction (Table 2b) and 10s of grains (75–200 µm) in the pan concentrate (Appendix B4 and McClenaghan et al., 2014).

Arsenopyrite

Arsenopyrite was recovered from the HMC of disaggregated bedrock samples 12-CBD-004, SYA-87-76, and SYA-87-77. Samples contained 100s to 100,000s grains/kg in the 0.25–0.5 mm fraction (Table 2b), 1000s of grains (50–1000 µm) in the pan concentrate, and 100s of grains in the 0.5–2.0 mm fraction (Appendix B4 and McClenaghan et al., 2014).

Molybdenite

Molybdenite was observed only in the pan concentrate of bedrock sample 12-CBD-004, which contained 6 grains that are 75–300 µm in size (McClenaghan, et al., 2014).

Topaz

Topaz was recovered from all five bedrock samples, varying in abundance from ~5000 grains/kg in the 0.25–0.5 mm fraction of sample 12-MPB-1040 to ~700,000 grains/kg in sample SYA-87-77 (Table 2b). Coarse topaz (0.5–2.0 mm) was recovered from the HMC of samples 12-CBD-004, 12-MPB-1040, SYA-87-76, and SYA-87-77 (Appendix B4 and McClenaghan et al., 2014). No grains were identified in the pan concentrates. Topaz was identified in PTS of samples 12-MPB-1021 and 12-MPB-1040.

Fluorite

Purple to clear fluorite was observed in PTSs of samples 12-MPB-1021 and 12-MPB-1040, as well as in the 0.25–0.5 mm fraction of HMCs of samples 12-MPB-1021, 12-MPB-1040, SYA-87-76, and SYA-87-77. Contents varied from ~4000 to ~500,000 grains/kg (Table 2b). Coarse fluorite (0.5–2.0 mm) was recovered from the HMC of sample 12-MPB-1040 (McClenaghan et al., 2014). Small fluorite grains (75–150 µm) were also recovered from the pan concentrate of bedrock sample 12-MPB-1021.

Wolframite

Wolframite, known to occur in the Mount Pleasant deposit (Petruk 1972, 1973; Parrish, 1977; Kooiman et al., 1986; Sinclair et al., 2006), was not observed in any of the heavy mineral concentrates or the PTS.

CONCLUSIONS

This open file describes the indicator mineral data of five bedrock samples from the Mount Pleasant Sn-W-Mo-Bi-In deposit in New Brunswick. These bedrock samples, though small samples of the Mount Pleasant deposit, provide some insights into the types and size range of minerals that are indicative of the Sn-W-Mo-Bi-In mineralization. Both PTS and heavy mineral concentrates were examined, as both can provide information on the presence and size of indicator minerals. Cassiterite, arsenopyrite, and molybdenite were not seen in PTS of the two bedrock samples, only in bedrock HMCs, emphasizing the need to examine both media to document the indicator mineral suite and size range. Although it is well documented that the deposit contains wolframite, none was observed in the five samples examined in this study. Although the five bedrock samples provide some insights on the type of indicator minerals at Mount Pleasant they do not provide a complete account of the deposit's mineralogy.

The primary ore minerals seen in bedrock samples include cassiterite, molybdenite, and sphalerite. These heavy minerals (Table 1) are visually distinct and can easily be recovered by surficial sample processing methods (cf., McClenaghan, 2011) commonly used to recover indicator minerals. Additional indicator minerals observed in bedrock samples include chalcopyrite, galena, arsenopyrite, pyrite, topaz, and fluorite. This combined suite of indicator minerals will be useful for exploration of intrusion-hosted polymetallic deposit (Sn-W-Mo-Bi-In) in glaciated regions using till and stream sediment sampling. In this study, these indicator minerals are most abundant in the pan concentrate (<0.25 mm) and the 0.25–0.5 mm fractions of bedrock samples, and thus it is likely that these minerals will be most abundant in these same size fractions in till and stream sediments derived from the deposit. They will also likely be present, but less abundant, in coarser (0.5–2.0 mm) fractions of till and stream sediments.

ACKNOWLEDGMENTS

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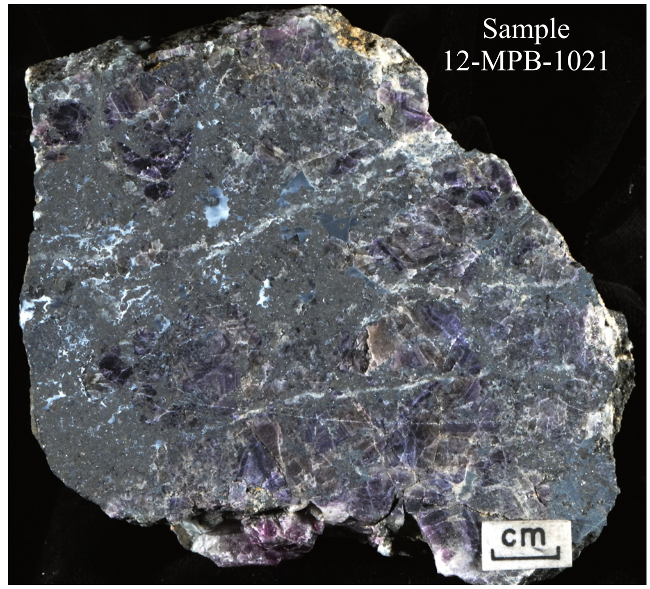
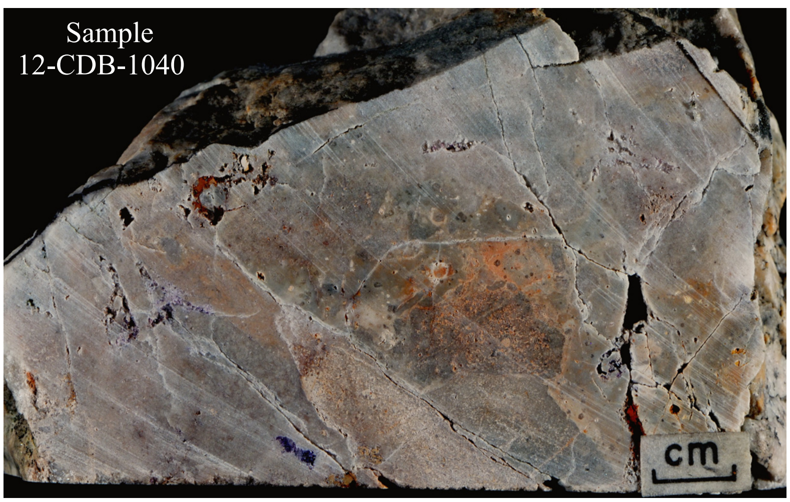
APPENDIX B. Descriptions and photographs of bedrock samples

Appendix B1. Photographs of bedrock hand samples





Appendix B2. Petrographic descriptions of samples (I.M. Kjarsgaard)

Sample 12-MPB-1021: Fluorite-sphalerite-topaz assemblage

Description: yellow to dark brown zoned sphalerite with minute chalcopyrite, galena, and pyrite inclusions is enclosed by patches of very fine-grained, pale grey-greenish chlorite and intergrown with euhedral to subhedral colourless topaz crystals and aggregates in a matrix of massive, mostly colourless to faintly violet fluorite.

Sphalerite (30%): subhedral to massive, zoned (yellow-brown to dark brown translucent) with oriented inclusions of very fine chalcopyrite and anhedral irregular pyrite and galena;

Chalcopyrite (2%): very fine-grained rounded and oriented inclusions in sphalerite, mostly in cores;

Pyrite (tr.): very fine-grained, anhedral inclusions in sphalerite;

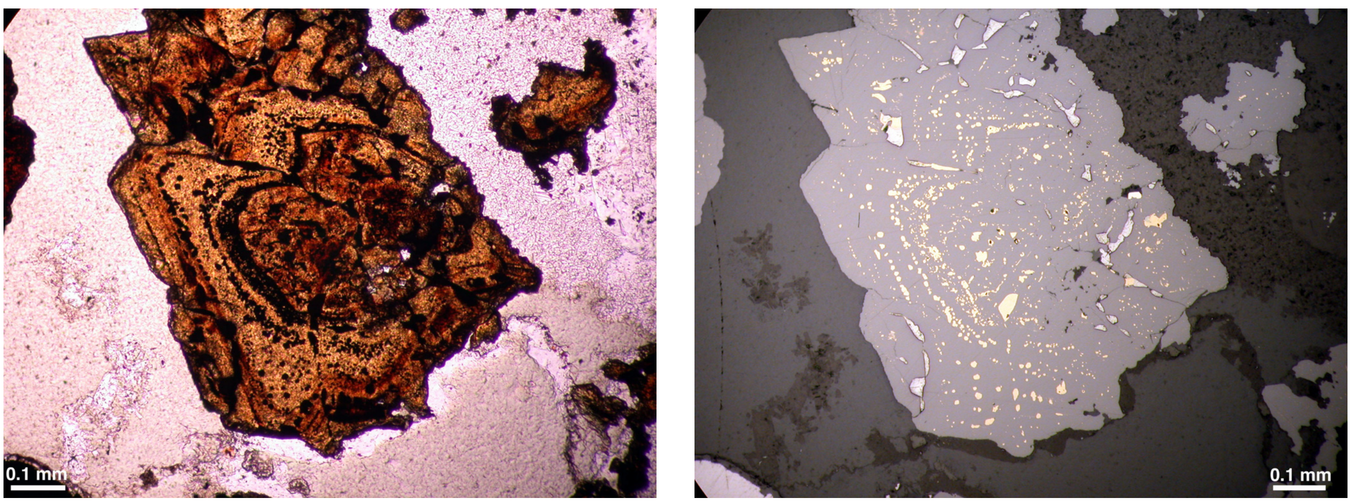
Galena (1%): very fine-grained, anhedral inclusions in sphalerite; coarser outside sphalerite, intergrown with actinolite;

Fluorite (41%): semi-massive, colourless with irregularly distributed faint violet colouration; very good cleavage and textured surface;

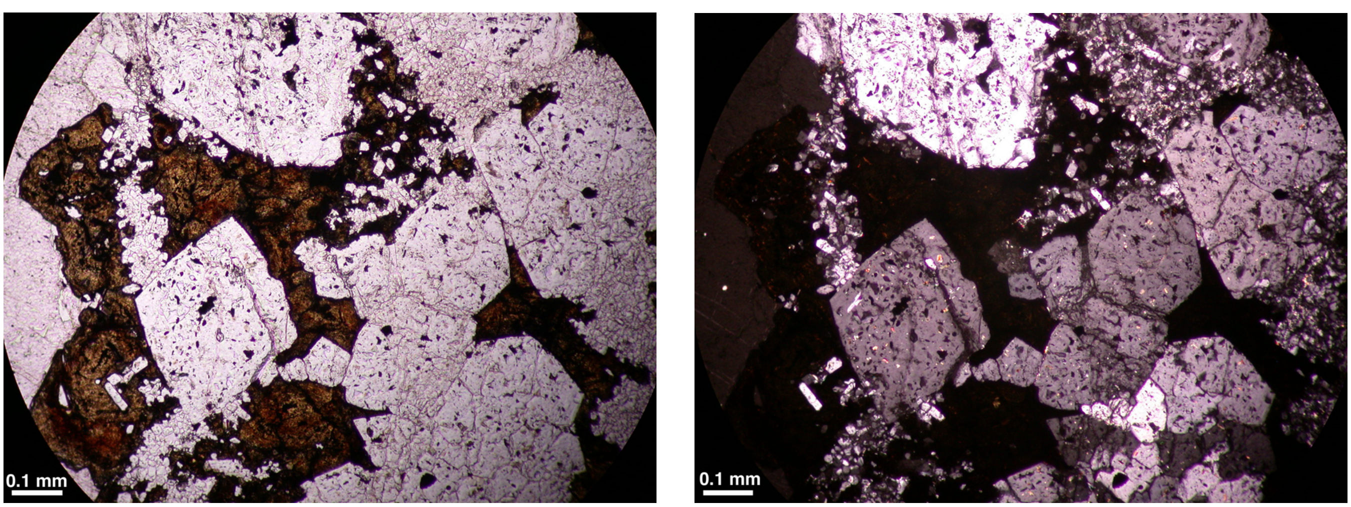
Topaz (12%): very fine- to medium-grained, euhedral to subhedral, colourless grains with pitted surface and low interference colour; as discrete crystals or aggregates intergrown with sphalerite and fluorite;

Chlorite (13%): pale greyish green, very fine-grained equigranular masses surrounding sphalerite in lower portion of section;

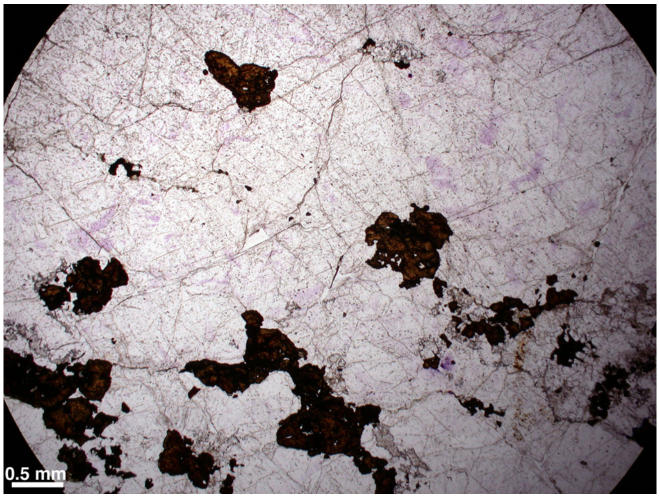
Actinolite ? (1%): colourless to pale green fine-grained acicular aggregates surrounding sphalerite, and intergrown with galena, low 1st grey to yellow interference colour.



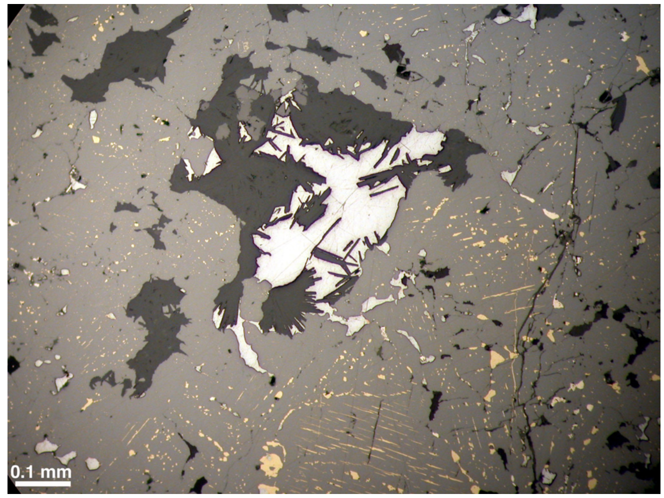
Sample 12-MPB-1021 (1): chalcopyrite, galena, and pyrite inclusions in zoned sphalerite in chlorite. F.o.V. 0.98 x 1.31 mm; left photograph taken under plane polarized light, right photograph under reflected light.



Sample 12-MPB-1021 (2): pitted euhedral topaz crystals (clear) intergrown with sphalerite (brown). F.o.V. 1.04 x 1.37 mm, left photograph taken under plane polarized light, right photograph under cross polarized light.



Sample 12-MPB-1021 (3): massive fluorite (clear with faint violet areas) hosting sphalerite (brown) and fine-grained topaz aggregate (at right). F.o.V. 4.59 x 6.12 mm, plane polarized light.



Sample 12-MPB-1021 (4): galena (white) intergrown with actinolite (dark) interstitial sphalerite with chalcopyrite inclusions. F.o.V. 0.98 x 1.31 mm, reflected light.

Sample 12-MPB-1040A: Rhyolite-chert breccia with fluorite-filled vugs

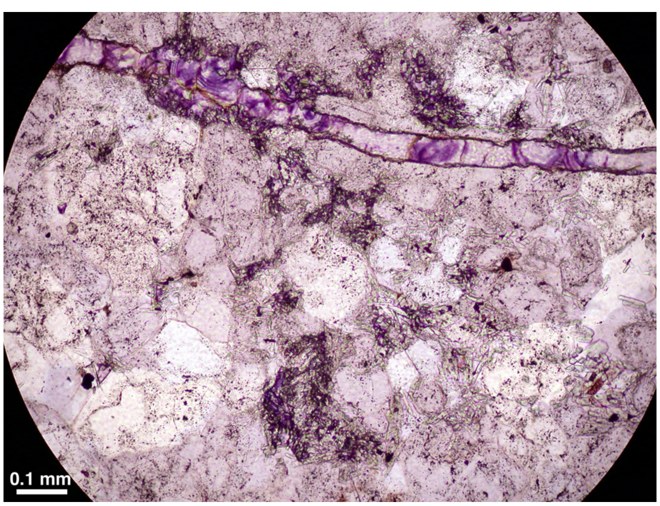
Description: approximately 40% of the section consists of two large angular slightly brownish rhyolite fragments that have been thermally altered. The fine-grained equigranular quartz-feldspar matrix, which has been recrystallized and possibly silicified, contains ≤1.5 mm euhedral quartz phenocrysts with an outer inclusion-rich fringe that is the result of reheating. The rhyolite fragments are set in a cherty matrix consisting of fine granular recrystallized anhedral quartz that opens into miarolitic cavities filled with colourless to purple fluorite into which euhedral quartz crystals project. Several areas of the chert show very fine-grained aggregates of a colourless, low-birefringence, columnar mineral (topaz?, beryl?) interstitial to quartz.

Quartz (98%): fine granular, anhedral recrystallized, forming matrix, both in rhyolite (finer grained, silicified feldspar) and in chert (medium- to very fine-grained); former grain boundaries outlined by inclusion-rich zones, late overgrowths; clear euhedral crystals projecting into fluorite-filled vugs;

Fluorite (1%): colourless with irregularly distributed violet coloration, textured surface, filling vugs;

Topaz/beryl (1%): very fine-grained colourless acicular aggregates interstitial to quartz near fluorite veinlets;

Fe-alteration mineral (tr.): orange-brown very fine-grained alteration mineral filling small interstices in quartz.



Sample 12-MPB-1040A (2): fluorite veinlet through chert and in pockets with fine-grained topaz. F.o.V. 1.03 x 1.36 mm; plane polarized light.

Appendix B2 continued.

Sample 12-MPB-1040B: Fluorite veinlets in chert

Description: a cherty matrix, consisting of fine equigranular recrystallized anhedral quartz, is cut by thin veinlets filled with colourless to violet, zoned fluorite and an unidentified orange-brown alteration mineral, as well as euhedral quartz crystals in wider areas of the veins. Very fine-grained acicular colourless aggregates of topaz (?) occur interstitial to quartz in the vicinity of the fluorite veinlets.

Quartz (97%): fine granular, anhedral recrystallized, massive matrix, former grain boundaries are outlined by inclusion-rich zones; clear euhedral crystals in coarser areas of veinlets (vugs);

Fluorite (2%): colourless with irregularly distributed violet colouration, textured surface, filling veinlets;

Topaz (?): very fine-grained colourless acicular aggregates interstitial to quartz near fluorite veinlets;

Fe-mineral ?? (1%): orange-brown very fine-grained alteration mineral filling veinlets and occurs together with fluorite; contains minute spherical aggregates of hematite and/or goethite.

Appendix B3. Descriptions of bedrock hand samples

Sample 12-MPB-1021: sulphidized fluorite vein (sawn 8 cm hand specimen)
Coarse (up to 2 cm), open space filling, distinctly colour zoned (purple, pink, colourless, pale brown) fluorite crystals (70%) cemented with finer grained (0.1–1 mm), mostly massive to locally disseminated black sphalerite (30%) with minor galena (<1%) and trace finer grained (<0.1 mm) pyrite. Disseminated phase of sphalerite is intergrown with similar-sized grains (0.3–1 mm) of mostly colourless fluorite and up to 10% harder, greasy grey, quartz-like topaz (SEM confirmed).

Sample 12-MPB-1040: brecciated and mineralized quartz vein (sawn 10 cm hand specimen)
Pale buff, semi-aphanitic quartz vein weakly and patchily jigsaw brecciated with 10% coarser grained (0.3–2 mm), vuggy, crystalline cement consisting subequally of fluorite (mostly as purple to nearly black, tourmaline-like crystals but locally as botryoidally brown masses; both black and brown phases SEM confirmed), colourless hexagonal quartz crystals (SEM confirmed; no topaz identified) and amorphous limonite/goethite representing oxidized sulphides of unknown mineralogy.

Sample 12-CBD-004: sulphidized and veined quartz breccia (sawn 7 cm hand specimen)
Pale grey, nonmagnetic, polyphase breccia consisting of fragments of quartz ranging in size from 0.1 mm to 5 cm, with the largest fragment internally finely brecciated at 0.1–0.3 mm scale with local coarser patches at 0.5–1 mm scale. Fine breccia is semi-mylonitic with minimal porosity and is cemented with 1–5% black sphalerite (SEM confirmed) and traces of molybdenite and pyrite. Coarser breccia is more porous and cemented with up to 20% black sphalerite occurring as aggregates of fine (0.1–0.3 mm) crystals. Breccia is cut by a 1.5 cm wide quartz vein, mostly very fine-grained with local coarse-grained patches, mineralized with 3% disseminated sphalerite, 1% pyrite, and trace fluorite.

Sample SYA-87-76: sulphide-cassiterite mineralized breccia (15x10x1 cm cut slab)
Grey to buff to white, nonmagnetic polyphase breccia consisting of 60 to 70%, 2 to 7 cm, rounded to sub-rounded fragments. Visible fragments comprise (1) green, very fine-grained chloritic basalt; (2) pale quartz-feldspar porphyry; (3) buff to grey silica-arsenopyrite-cassiterite fragments, and (4) silica-fluorite-chalcopyrite-pyrite fragments. Numbers 3 and 4 appear to represent re-brecciated, alteration assemblages. The breccia matrix forms ~30% of the samples and comprises cryptocrystalline to very finely crystalline silica (SEM confirmed) ± feldspar with minor hexagonal quartz crystals to 1 mm in size, and finely interstitial to finely crystalline masses of sulphides and cassiterite with arsenopyrite > cassiterite > pyrite > chalcopyrite. The grain size of the sulphide minerals and cassiterite is typically <0.3 mm but some arsenopyrite grains reach 1 mm in size. Although most sulphides and cassiterite occur in re-brecciated alteration fragments and the breccia matrix, the basalt and quartz-feldspar porphyry fragments are also weakly mineralized. Chalcopyrite and pyrite are most abundant in fluorite-rich altered fragments (No. 4). Aggregate sulphide + cassiterite content in the sample is ~15%. Aggregate fluorite content is 1 to 2%. Distinct topaz was not observed but is assumed to be present as alteration is similar to that of sample SYA-87-77.

Sample SYA-87-77: cassiterite mineralized breccia (25x10x2 cm cut slab)
Grey to buff-white, nonmagnetic breccia. Rounded, elongate fragments, which can exceed 9 cm in length, are aligned imparting a distinct fabric/bedding to the sample. Fragments appear to represent both country rock (crystal tuff or possibly quartz-feldspar porphyry and chloritic basalt) and very fine-grained to cryptocrystalline altered rock fragments with indistinct outlines (possibly including breccia matrix material) composed of quartz, topaz (SEM confirmed), sericite (SEM confirmed, possibly including K-feldspar) and minor plagioclase and epidote. The proportion of topaz is indeterminate due to its fine grain-size and similar appearance to other light coloured silicate minerals. Altered fragments and/or matrix material are mineralized with trace amounts of pyrite and chalcopyrite and 4 to 5% disseminated to streaky cassiterite (SEM confirmed), most of which has a grain size of less than 0.5 mm. Disseminated to patchy, pink-purple fluorite (0.5%) is present in the more mafic fragments. The sample also contains a trace of pink almandine with grain size of <0.2 mm.