GEOLOGICAL SURVEY OF CANADA
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Indicator mineral signatures of the Sisson W-Mo deposit, New Brunswick: Part 1 bedrock samples

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ABSTRACT
As part of the Geological Survey of Canada's Targeted Geoscience Initiative 4 (TGI-4), till, stream sediment, and bedrock samples were collected around the Sisson W-Mo deposit in west-central New Brunswick to determine the indicator mineral signature that is indicative of an intrusion-hosted W-Mo deposit. This open file describes the results for 12 bedrock samples from mineralization as well as host rocks around the deposit. These samples were examined as polished thin sections and <2.0 mm heavy mineral concentrates. In this study, the indicator minerals that characterize the Sisson W-Mo deposit include: scheelite, wolframite, molybdenite, chalcopyrite, sphalerite, galena, pyrite, and native bismuth.

INTRODUCTION
In contrast to till geochemical methods, there have been limited case studies conducted around significant W-Mo deposits to document their indicator mineral signature dispersed in till. The Sisson W-Mo deposit was chosen for an W-Mo deposit indicator mineral study because the deposit: (1) has bedrock geology that is well known; (2) subcrops, and thus was exposed to glacial erosion; (3) is till covered; and, (4) has a previously identified till geochemical dispersal train down ice and thus metal-rich till should be available for sampling.

This study was carried out as part of the Geological Survey of Canada's (GSC) Targeted Geoscience Initiative 4 (TGI-4), a collaborative federal geoscience program with a mandate to provide industry with the next generation of geoscience knowledge and innovative techniques that will result in more effective targeting of buried mineral deposits. The study is a collaborative effort between the GSC, the New Brunswick Department of Energy and Mines (NBDEM), Northcliff Resources Limited, and Hunter Dickinson Incorporated. The purpose of this open file is to describe and interpret the raw indicator mineral data for bedrock samples that were reported in GSC Open File 7387 (McClenaghan et al., 2013).

LOCATION AND ACCESS
The Sisson W-Mo deposit is in west-central New Brunswick (Fig. 1) at UTM coordinates 5136900N and 650350E (NAD27) in the Coldstream NTS map area (NTS 21 J/06). It is 60 km north-northwest of Fredericton and is easily accessed by logging roads.

GEOLOGY
Local bedrock geology
The Sisson deposit is a bulk tonnage W-Mo deposit that has been explored by various companies over the past 50 years. The geology of the deposit area is summarized below from Nast and William-Jones (1991), Marr (2009), Fyffe et al. (2008, 2010), and Rennie (2012). The deposit occurs at the eastern contact of the Nashwaak Granite and Howard Peak Granodiorite plutons (Fig. 2). The Howard Peak Granodiorite grades eastward into and becomes intermixed with a gabbro. Both the gabbro and granodiorite are transected by granitic dykes that are likely offshoots of the Nashwaak pluton. These plutons are part of a group of Late Silurian to Early Devonian plutonic rocks which form a NE-trending belt that underlies the Miramichi Highlands in central New Brunswick. The intrusive belt also hosts the Lake George Sb deposit 60 km south of the Sisson deposit, the Burnt Hill

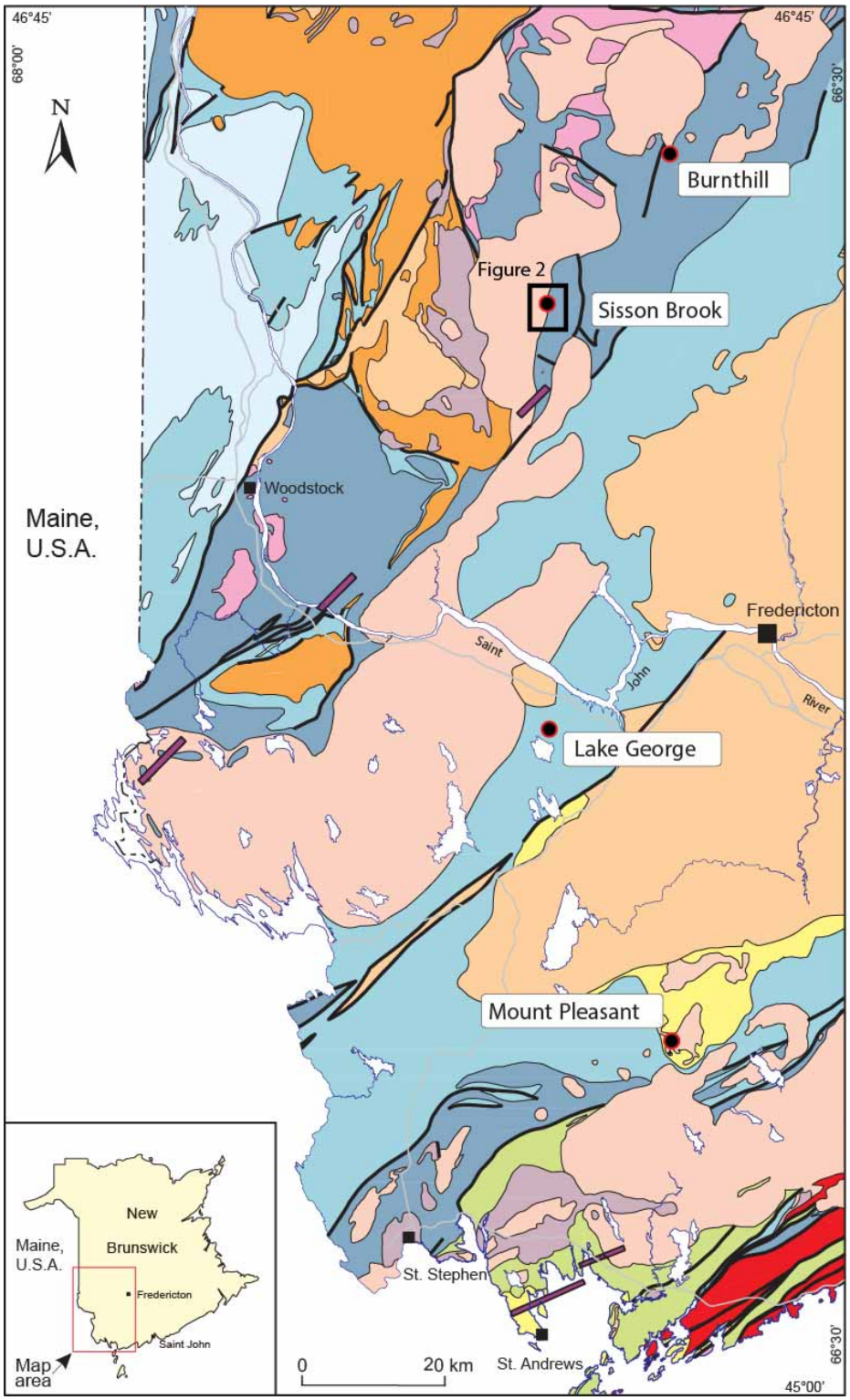

Figure 1. Bedrock geology of west-central and southern New Brunswick showing the location of the Sisson W-Mo deposit and other significant deposits (modified from Fyffe et al., 2010).

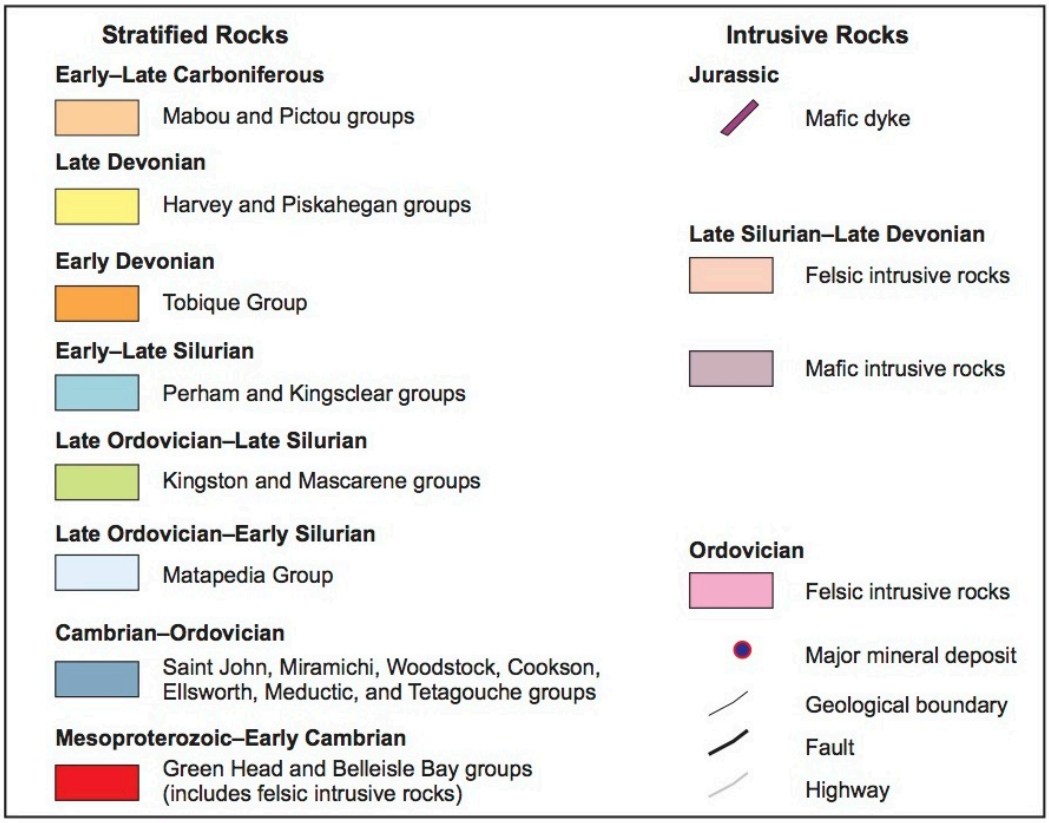

Figure 1. continued. Bedrock geology legend (modified from Fyffe et al., 2010).

W, Sn, and Mo showings 30 km northeast of the Sisson deposit, and the Mount Pleasant W-Mo-Sn-In deposit to the south (Fig. 1).

East of the Howard Peak Granodiorite are Cambro-Ordovician tuffaceous volcanic and sedimentary rocks of the Turnbull Mountain Formation (Fig. 2) of the Tetagouche Group, a belt of strongly deformed Cambro-Ordovician rocks that extends from the Bathurst area in northern New Brunswick through the Sisson Brook area and into the southwestern corner of the New Brunswick. Immediately east of these Turnbull Mountain Formation rocks are quartzite and shale of the Miramichi Group. This package is overlain to the east by additional rocks of the Tetagouche Group including pyritiferous black shale intercalated with felsic volcanic rocks and mafic volcanic rocks of the Hayden Lake Formation as well as wacke and shale of the Push and Be Dammed Formation (Fig. 2)

Deposit geology

The Sisson deposit is a large, structurally controlled, intrusion-related W-Mo deposit consisting of four wide and steeply-dipping zones of vein and fracture-controlled W and Mo mineralization (Fig. 2) that straddle the strongly sheared contact of the Howard Peak Granodiorite (Nast and Williams-Jones 1991; Marr, 2009; Rennie 2012). Zone III

(scheelite/molybdenite) and the adjacent Zones I and II (chalcopyrite, wolframite) of the Sisson deposit were discovered by Texasgulf Sulphur/Kidd Creek Mines Limited between 1978 to 1982 through geophysical surveys, trenching, soil sampling, and drilling (Snow and Coker, 1987; Marr, 2009; Rennie, 2012). The property was further explored by various operators between 1997 and 2004. In 2007, Geodex Minerals Limited excavated a large exploration trench to expose the bedrock surface of Zone III and in 2008 they drilled additional holes that led to the discovery of the Ellipse Zone.

Zones I, II, and III strike roughly north-south and the Ellipse zone strikes northwest-southeast. The zones merge and are part of a much larger hydrothermal mineralizing system with an area of at least 9 km^2. Mineralization in all four zones subcrops at the till-bedrock interface and is open at depth. Zone III and the Ellipse Zone are the largest and best explored parts of the deposit and contain molybdenite and scheelite in sheeted quartz veins and stockworks. Zones I and II contain younger veins with chalcopyrite, wolframite and more pyrite and pyrrhotite. The centre of Zone III contains the highest Mo concentrations. Moderate grades of Mo occur in the south part of Zone III and in the Ellipse Zone. Zones I and II and the north part of Zone III contain almost no Mo. The highest concentrations of Cu and associated elements are in Zones I and II. The deposit has elevated concentrations of Cu, Zn, Pb, Bi, and As that are directly related to late quartz-scheelite and sulphide-rich veins and their sericite-sulphide envelopes. Scheelite ranges from <100 µm to 1 cm in size. Overall, wolframite is a minor mineral in the deposit. Mineralization is likely related to the presence of a buried granitic stock at depth that was the heat source for a hydrothermal system and metals. Lang and Zahovskis (2013) reported resource estimates for the deposit of 383 Mt at 0.067% WO_3 and 0.021% Mo (measured and indicated) and 178 Mt 0.051 WO_3 and 0.021% Mo (inferred), making it one of the largest tungsten deposits in the world. Table 1 lists the ore minerals present in the Sisson deposit.

METHODS

Twelve bedrock samples were collected from mineralization (6 samples) as well as host rocks (6 samples) in the surrounding area to determine the minerals indicative of W-Mo mineralization in the Sisson deposit. Outcrops on the Sisson property and surrounding area are scarce due to the extensive cover of till averaging about 8 m in thickness (Marr, 2009), thus most bedrock samples used in this study were from drill core provided by Northcliff Resources Limited. Bedrock samples were examined in detail as polished thin sections (PTS) and a sample split was sent to Overburden Drilling Management Limited (ODM), Ottawa, for processing to recover indicator minerals.

Bedrock sample numbers, lithologies, and locations are listed in Appendix A. Colour photographs of polished slabs of selected bedrock samples are included in Appendix B. Bedrock sample locations for proximal samples are plotted in Figure 2, using the UTM coordinates of the drill hole collar. Petrographic descriptions of bedrock samples are listed in Appendix C and photomicrographs and backscattered electron (BSE) images of selected PTS are included in Appendix D. Multiple thin sections (A-D) were made of two bedrock samples in order to examine the mineralogy of a larger volume of each sample.

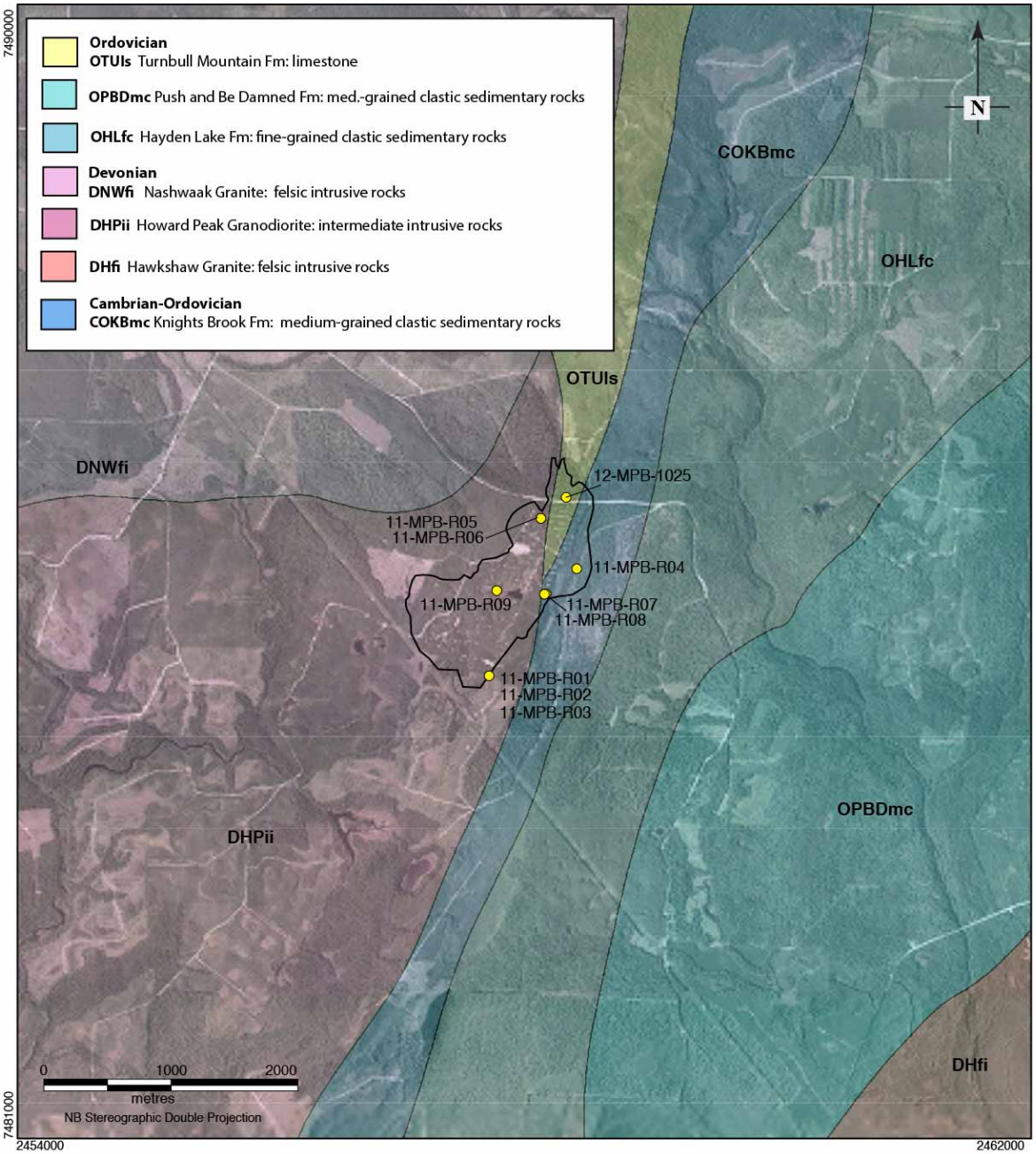

Figure 2. Location of bedrock samples (yellow dots) at the Sisson W-Mo deposit. Deposit subcrop outline in black from Rennie (2012). Bedrock geology modified from Smith and Fyffe (2006).

Mineral	Formula	Hardness	Specific Gravity	Presence in bedrock reported by others	Size range in PTS in this study (mm)	Size range in bedrock HMC in this study (mm)	Size range in till HMC in this study (mm)
W Minerals							
scheelite	$CaWO_4$	4-5	5.9 - 6.12	Nast & Williams-Jones (1991); Marr (2009)	0.1-0.5	0.025-2.0	0.025-2.0
wolframite	$(Fe,Mn)WO_4$	4.5	7.1 - 7.5	Nast & Williams-Jones (1991); Marr (2009)	0.04-0.08	0.025-2.0	0.025-1.0
Sulphides, Oxides							
molybdenite	MoS_2	5.5	1.0	Nast & Williams-Jones (1991); Marr (2009)	≤ 0.3	0.05-2.0	0.075-2.0
pyrite	FeS_2	5-5.02	6.5	Nast & Williams-Jones (1991); Marr (2009)	0.015-2.2	0.025-2.0	0.025-0.05
marcasite	FeS_2	6.0-6.5	4.89	no	not observed	0.025-0.10	not observed
chalcopyrite	$CuFeS_2$	3.5	4.1 - 4.3	Nast & Williams-Jones (1991); Marr (2009)	0.04-2.2	0.1-2.0	0.2-2.0
sphalerite	(Zn,Fe)S	3.5-4	3.9 - 4.2	Nast & Williams-Jones (1991); Marr (2009)	≤ 2.2	0.05-1.0	0.05-2.0
galena	PbS	2.5	7.2 - 7.6	Nast & Williams-Jones (1991); Marr (2009)	not observed	0.05-0.075	0.05
pyrrhotite	$Fe_{(1-x)}S$ (x=0-0.17)	3.5-4	4.58 - 4.65	Nast & Williams-Jones (1991); Marr (2009)	0.05-2.2	0.025-0.25	not observed
arsenopyrite	FeAsS	5.0	6.07	Nast & Williams-Jones (1991); Marr (2009)	not observed	not observed	0.05-2.0
mottramite	$Pb(Cu,Zn)(VO_4)(OH)$	3.5	5.9 - 6.0	no	not observed	not observed	0.250.5
Bi Minerals							
bismuthinite	Bi_2S_3	2.0	6.8 - 7.2	no	not observed	not observed	0.25-1.0
bismutite	$Bi_2(CO_3)O_2$	4.0	7.0	no	not observed	not observed	0.025-2.0
native bismuth	Bi	2-2.5	9.7 - 9.8	Nast & Williams-Jones (1991); Marr (2009)	0.01	not observed	0.025-1.0
joseite	$Bi_4(S,Te)_3$	2.0	8.1	no	not observed	not observed	0.025-0.5
Ag Minerals							
hessite	Ag_2Te	7.2-7.9	1.5-2	Nast & Williams-Jones (1991)	not observed	not observed	not observed
acanthite	Ag_2S	7.2-7.4	2-2.5	Nast & Williams-Jones (1991)	not observed	not observed	not observed

Table 1. Indicator minerals in the Sisson deposit (from Nast and Williams-Jones 1991; Marr, 2009) and those found in bedrock polished thin sections (PTS) and heavy mineral concentrates (HMC) and till samples from this study (McClenaghan et al., 2013).

Sample processing

Bedrock sample processing procedures used to produce heavy mineral concentrates and pick out indicator minerals are described in detail in GSC OF 7387 (McClenaghan et al., 2013). Samples were processed such that the most mineralized samples were processed last to limit carry-over contamination of ore minerals between samples. Data for samples are listed in the ODM raw data files in McClenaghan et al. (2013) in the order they were processed.

Each bedrock sample was disaggregated using an electric pulse disaggregator (EPD) to preserve natural grain sizes, textures, and shapes. The <2.0 mm material of each bedrock sample was then processed to produce a non-ferromagnetic heavy mineral concentrate for picking indicator minerals, using a shaking table and heavy liquid separation at specific gravity (SG) of 3.2 as outlined in McClenaghan et al. (2013). Quartz 'blank' bedrock samples were inserted into the bedrock batch at the beginning and after each bedrock sample to monitor cross contamination between samples. Blank samples are identified by the letters 'QBK' in their sample number. The results for the quartz blank samples are reported along with the bedrock samples in McClenaghan et al. (2013).

The 0.25-0.5, 0.5-1.0, and 1.0-2.0 mm non-ferromagnetic fractions of bedrock samples were examined by ODM and potential indicator minerals of W-Mo mineralization counted/selected including: scheelite, wolframite, and sulphide minerals including the

minerals listed in Averill (2001, see Table 3). In addition, potential indicators of massive sulphide deposits including ODM's magmatic or metamorphosed massive sulphide indicator mineral (MMSIM®) suite were scanned for. This suite is an indicator mineral assemblage is used to explore for a broad spectrum of sulphide-associated deposits (Averill, 2001).

RESULTS

Quality assurance/quality control

Indicator minerals recovered in the quartz blanks and bedrock samples that immediately preceded each blank are listed in Table 2. The first quartz blank at the beginning of the batch contains 1 pyrite grain in the 0.25-0.5 mm fraction. The pan concentrates of most blank samples contain 1 to 2 grains of pyrite. No other indicator minerals were found in the pan concentrates or the 0.25-0.5 mm fractions of the blank samples. These very low to zero indicator mineral grain counts in the blanks indicate that carry over between bedrock samples, even highly mineralized ones such as 11-MPB-R05, is negligible.

Scheelite

Scheelite ($CaWO_4$) was found in PTS samples 11-MPB-R01 (splits A1, A2, C, D) - R02B, and -R05. It occurs as medium grained (0.2 mm to 2 mm) rounded to ragged, extremely poikilitic grains intergrown with quartz, biotite, and amphibole (Appendix D). Scheelite ranges in grain size from 100 µm to 0.5 mm. Scheelite in the Sisson bedrock samples contains variable amounts of Mo. Scheelite in 11-MPB-R01 has intermediate MoO_3 contents (R01-A1: 0.39 to 0.77 wt%, R01-A2: 0.27-0.60 wt.%) and scheelite in 11-MPB-R02B has a high Mo content (~1 wt.%). Sample 11-MPB-R05 is a quartz-pyrrhotite vein where scheelite replaces wolframite, and here scheelite contains no Mo. Instead, scheelite contains abundant inclusions of wolframite (up to 75 µm in size). Scheelite trace elements contents for the Sisson deposit are the focus of a study being carried out at Laurentian University as part of this TGI-4 Project (Poulin et al., 2013) and results will be reported in subsequent GSC Open Files.

Scheelite was identified in bedrock heavy mineral concentrates (HMC) by its pale yellow colour (Fig. 3a), cleavage, and bright blue-white fluorescence under short wave UV light. In bedrock HMC, it varies in size from 25 µm to 2.0 mm (Table 3). It was recovered from mineralized samples 11-MPB-R01, -R02, -R05, -R06, and -R07.

Wolframite

Wolframite ($(Fe,Mn)WO_4$) varies in size in PTS, from minute inclusions (a few microns in size) in scheelite (Appendix D) to discrete grains up to 40 µm. Wolframite was identified in bedrock HMC by its black colour, prismatic crystal form, softness (H=4.5, can be scratched with a needle), and reddish brown streak (Fig. 3b). Small grains were recovered from the pan concentrate of sample 12-MPB-1025 (75-200 µm) and coarse (0.25 to 2.0 mm) grains were recovered from samples 11-MPB-R05, -R06, and 12-MPB-1025 (Table 3).

Sample	Material	Pan Concentrate	Cpy	Scheelite	Wolfram	Moly	Sphal	Bismutite	Py
2011 QBK-1	blank	1 grain pyrite (50 µm)	0	0	0	0	0	0	1
11-MPB-R02	Qtz feldspar porphyry dyke	~10 grains galena (50-75 µm) ~500 grains scheelite (50-150 µm) ~5000 grains pyrite (25-250 µm)	0	300	0	4	0	0	1500
QBK-R02	blank	1 grain pyrite (50 µm)	0	0	0	0	0	0	0
11-MPB-R04	biotite wacke	~3000 grains pyrite (25-250 µm)	0	0	0	0	0	0	300
QBK-R04	blank	No sulphides	0	0	0	0	0	0	0
11-MPB-R07	mafic tuff	~5000 grains scheelite (50-200 µm) ~3000 grains pyrite (25-200 µm)	0	300	0	0	0	0	1500
QBK-R07	blank	1 grain pyrite (75 µm)	0	0	0	0	0	0	0
11-MPB-R06	felsic tuff	5 grains chalcopyrite (150 µm) 3 grains molybdenite (150 µm) ~100 grains scheelite (50-100 µm) ~100,000 grains pyrrhotite (25-250 µm) ~500 grains pyrite (50-200 µm)	40	120	24	6	0	0	300
QBK-R06	blank	No sulphides	0	0	0	0	0	0	0
11-MPB-R03	gabbro	~50 grains scheelite (50-100 µm) ~3000 grains pyrite (25-200 µm)	0	1	0	0	0	0	1000
QBK-R03	blank	1 grain pyrite (75 µm)	0	0	0	0	0	0	0
11-MPB-R01	high grade mineralization	~50,000 grains scheelite (50-200 µm) ~30 grains molybdenite (50-250 µm) ~10,000 grains pyrite (25-250 µm)	1	1200	0	600	0	0	1000
QBK-R01	blank	1 grain pyrite (50 µm)	0	0	0	0	0	0	0
11-MPB-R05	mineralized quartz vein	~3000 grains chalcopyrite (100-200 µm) ~2000 grains sphalerite (50-200 µm; may include visually similar wolframite) ~10,000 grains scheelite (25-200 µm) ~20,000 grains pyrrhotite (25-250 µm) ~20,000 grains pyrite (25-200 µm)	1800	3000	1500	0	300	0	50
QBK-R05	blank	2 grains pyrite (50 µm)	0	0	0	0	0	0	0
11-MPB-R08	granodiorite	~15 grains pyrite (25-50 µm)	0	0	0	0	0	0	0
QBK-R08	blank	2 grains pyrite (50 µm)	0	0	0	0	0	0	0
11-MPB-R10	granite	5 grains pyrite (50-100 µm)	0	0	0	0	0	0	1
QBK-R10	blank	1 grain pyrite (50 µm)	0	0	0	0	0	0	0
11-MPB-R11	altered granite	~50 grains pyrite (25-75 µm) SEM checks: 4 of ~70 anatase versus spinel candidates = 4 anatase (25-75 µm)	0	0	0	0	0	0	60
QBK-R11	blank	1 grain pyrite (25 µm)	0	0	0	0	0	0	0
11-MPB-R09	mafic crystal tuff	~10,000 grains pyrite (25-250 µm)	4	4	0	0	0	0	8000
2012 QBK-1	blank	2 grains pyrite (50 µm)	0	0	0	0	0	0	0
12-MPB-2025	high grade mineralization	~100,000 wolframite (75-200 µm) ~100 grains chalcopyrite (75-150 µm) ~5000 grains arsenopyrite (25-150 µm) ~20,000 grains pyrite (25-200 µm)	50	0	15000	0	0	0	1500

Table 2. Indicator minerals recovered from bedrock samples compared to those in quartz blanks inserted in the bedrock batches. Samples are listed in the order that they were processed. Each quartz blank that was processed immediately following a bedrock sample is grouped together with the preceding bedrock sample and outlined by black lines. Potential contamination is highlighted in yellow. Data summarized from McClenaghan et al. (2013).

Sample	Pan concentrate				0.25-0.5 mm							0.5-1.0 mm			1.0-2.0 mm		
	Scheelite pan conc	Wolfram pan conc	Moly pan conc	Chalcopy pan conc	Scheelite 0.25-0.5 mm	Wolfram 0.25-0.5 mm	Moly 0.25-0.5 mm	Chalcopy 0.25-0.5 mm	Sphalerite 0.25-0.5 mm	Arsenopy 0.25-0.5 mm	Pyrite 0.25-0.5 mm	Scheelite 0.5-1.0 mm	Wolfram 0.5-1.0 mm	Moly 0.5-1.0 mm	Scheelite 1.0-2.0 mm	Wolfram 1.0-2.0 mm	Moly 1.0-2.0 mm
11MPB-R01	50,000	0	30	0	712	0	356	1	0	0	594	89	0	59	1	0	2
11MPB-R02	500	0	0	0	396	0	5	0	0	0	1980	34	0	0	0	0	0
11MPB-R03	50	0	0	0	1	0	0	0	0	0	962	0	0	0	0	0	0
11MPB-R04	0	0	0	0	0	0	0	0	0	0	533	0	0	0	0	0	0
11MPB-R05	10,000	0	0	3000	22026	11013	0	13216	2203	0	367	3671	587	0	140	95	0
11MPB-R06	100	0	3	5	252	50	13	84	0	0	630	126	126	4	8	8	0
11MPB-R07	5000	0	0	0	386	0	0	0	0	0	1931	33	0	0	1	0	0
11MPB-R08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11MPB-R09	0	0	0	0	0	0	0	6	0	0	11006	0	0	0	0	0	0
11MPB-R10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11MPB-R11	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0
12-MPB-1025	0	100,000	0	0	0	34811	0	116	0	186	3481	0	0	0	0	0	0

Table 3. Abundance of selected indicator minerals in bedrock samples examined in this study. Counts reported are for pan concentrates (not normalized), and for the 0.25-0.5, 0.5-1.0, and 1.0-2.0 mm fractions normalized to 1 kg sample weight.

Molybdenite

Molybdenite was observed in PTS samples 11-MPB-R01A1 and 11-MPB-R01D, where it occurs in deformed micaceous aggregates up to 0.25 mm in long dimension, intergrown with epidote and/or chlorite. In bedrock HMC, molybdenite (Fig. 3c) was recovered from the pan concentrate of sample 11-MPB-R01 (50 to 250 µm) and the coarser 0.25 to 2.0 mm fractions of samples 11-MPB-R01, -R02, and -R06 (Table 3).

Chalcopryite

Chalcopyrite occurs in trace amounts in most bedrock PTS examined. It is coarsest in the vein in sample 11-MPB-R05, but do not exceed 2.2 mm in size. In bedrock HMC, chalcopyrite (Fig. 3d) occurs in the pan concentrate (100 to 200 µm) of samples 11-MPB-R05 and -R06 and in the coarser (0.25 to 2.0 mm) fractions of samples 11-MPB-R05, 11-MPB-R06 and 12-MPB-1025 (Table 3).

Pyrite

Pyrite occurs in trace amounts in most bedrock PTS samples examined. It is coarsest in the vein in sample 11-MPB-R05, but do not exceed 2.2 mm in size. Pyrite is present in most pan concentrates of HMC samples (25-250 µm size), and in the 0.25 to 0.5 mm fraction of all bedrock samples except 11-MPB-R08. A photo of coarser pyrite in sample 11-MPB-R01 is shown in Figure 3e.

Arsenopyrite

No arsenopyrite was observed in PTS. In the bedrock HMC for sample 12-MPB-1025, 80 grains were recovered from the 0.25 to 0.5 mm fraction and ~5000 grains (25-150 µm) from the pan concentrate.

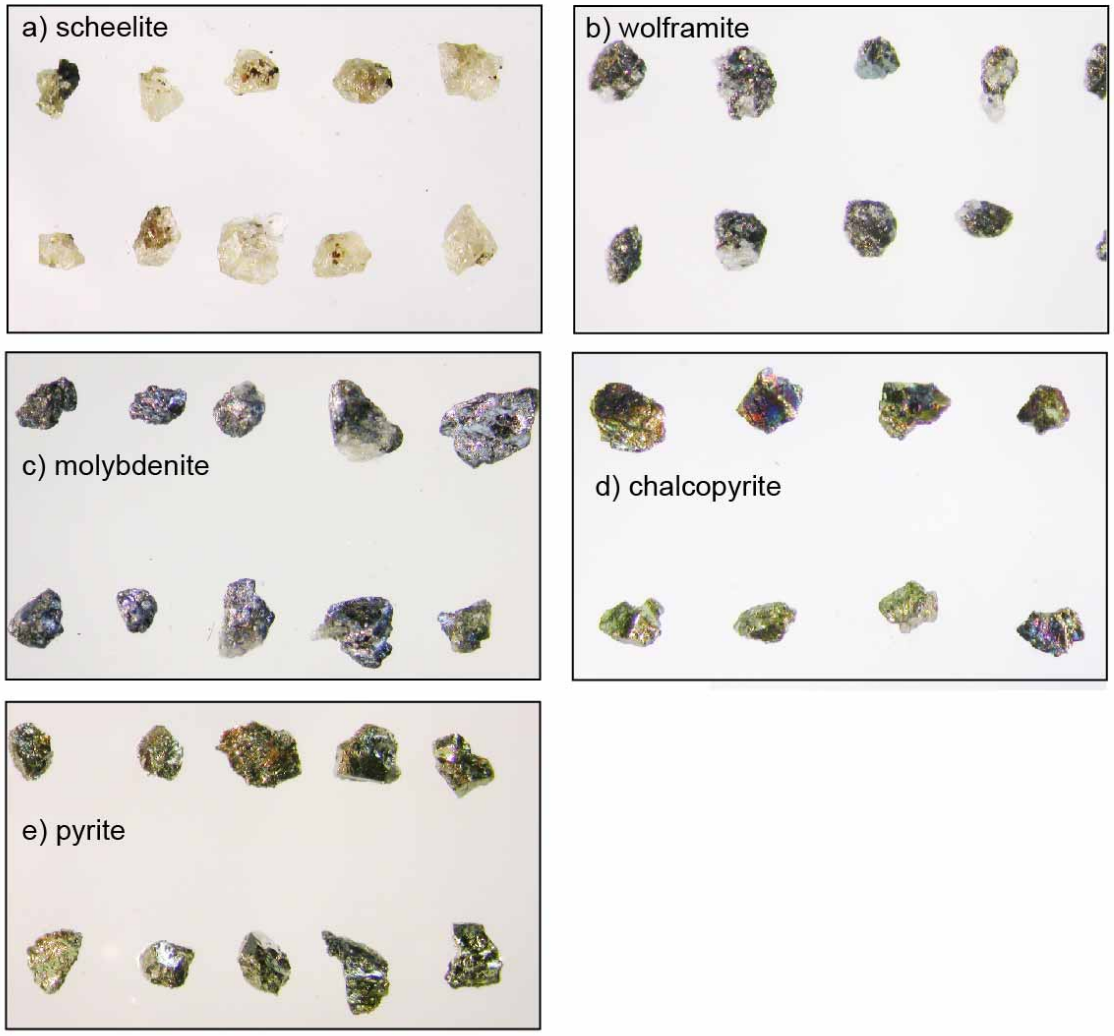

Figure 3. Colour photographs of indicator minerals in bedrock heavy mineral concentrates: a) scheelite in sample 11-MPB-R07, 0.5-1.0 mm; b) wolframite in sample 11-MPB-R06, 0.25-0.5 mm; c) molybdenite in sample 11-MPB-R01, 0.5-1.0 mm; d) chalcopyrite in sample 11-MPB-R05, 0.5-1.0 mm; e) pyrite in sample 11-MPB-R01, 0.5-1.0 mm (photos provided by Overburden Drilling Management Ltd.).

Native bismuth

Native Bi was observed in PTS sample 11-MPB-R05 up to 10 µm in size (Appendix D). No Bi minerals were identified in HMC fractions of bedrock samples.

Sphalerite

Sphalerite was identified in PTS sample 11-MPB-R05, where it occurs intergrown with chalcopyrite in grains up to 1.2 mm in size. In HMC, sphalerite grains were recovered from the 0.25-0.5 mm fraction (300 grains) and 0.5-1.0 mm fractions (5 grains) of sample 11-MPB-R05.

Galena
No galena was observed in PTS. In HMC, galena between 50 to 200 µm in size was recovered from pan concentrates of bedrock samples 11-MPB-R02 and 11-MPB-R05.

Pyrrhotite
Pyrrhotite occurs in trace amounts in most bedrock samples. It is coarsest in the vein in sample 11-MPB-R05, but does not exceed 2.2 mm in size. In HMC, pyrrhotite was recovered from the pan concentrate (25-250 µm) of sample 11-MPB-R05 and -R06. No pyrrhotite was observed in the coarser fractions of the non-ferromagnetic HMC. The ferromagnetic HMC was not examined for pyrrhotite.

CONCLUSIONS AND IMPLICATIONS FOR EXPLORATION

This open file describes the indicator mineral data for 12 bedrock samples for which the raw indicator mineral data were reported in GSC Open File 7387 (McClenaghan et al., 2013). These 12 bedrock samples, though very small samples of the Sisson deposit and surrounding area, provide insights into the types and size range of minerals that are indicative of the Sisson W-Mo mineralization. Both PTS and heavy mineral concentrates were examined as both can provide information on the presence and size of indicator minerals. Arsenopyrite and galena were not seen in PTS, only in bedrock HMC, emphasizing need to examine both media to document the indicator mineral suite and size range.

The primary ore minerals seen in bedrock samples include scheelite, wolframite, and molybdenite. They are heavy minerals (Table 1) that are visually distinct and easily recovered by common surficial sample processing methods (cf., McClenaghan, 2011) used to recover indicator minerals. Secondary ore minerals including chalcopyrite, bismuth, galena, sphalerite, arsenopyrite, pyrrhotite, and pyrite, are much less abundant in the rocks but still useful indicators of the polymetallic nature of the Sisson deposit. This suite of primary and secondary indicator minerals will be useful for W-Mo exploration in the region using till and stream sediment sampling.

These indicator minerals are most abundant in the pan concentrate (<0.25 mm) and the 0.25-0.5 mm fractions of bedrock, and thus it is likely that they will be most abundant in these same size fractions in till and stream sediments derived from the deposit. They are also present in coarser fractions up to 2.0 mm in size. It is likely that they will also be present in the coarser fractions (0.5 to 2.0 mm) of till proximal to source.

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deposit and local area. An earlier version of this open file was reviewed by R. Paulen (GSC).

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Appendix C: Bedrock polished thin section descriptions

by Ingrid M. Kjarsgaard

Abbreviations
Anh. – anhedral
Cpy – chalcopyrite
Euh. – euhedral
Ifc. – interference colours
Py – pyrite
Po - pyrrhotite
Qtz – quartz
Subh.- subhedral
Tr. - trace
PPL – plane polarized light
RL – Reflected light
XPL – cross polarized light

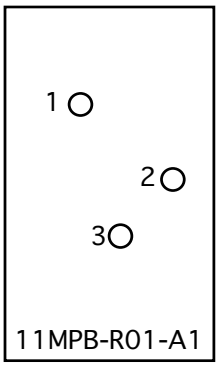
Grain Sizes
Coarse grained >2 mm
Medium grained 0.2 mm to 2 mm
Fine grained <0.2 mm
Very fine grained <50 µm

11-MPB-R01-A1 Chlorite-epidote-altered diorite with qtz-epidote-cpy-molybdenite-vein

Lithology: high grade mineralization in Howard Peak Gabbro
Description: abundant sericite-altered plagioclase intergrown with anhedral quartz and abundant fine grained red brown biotite that is gradually altered (from the lower right corner to the center of the section) to green chlorite + titanite, with increasing amounts of epidote altering plagioclase. In the upper right corner semi-massive chlorite is overprinted by semi-massive epidote bordering a quartz-epidote-cpy-molybdenite vein. At the boundary between host rock and vein abundant granular magnetite has developed, that is rimmed by epidote. Remnants of olive green hornblende are part of the primary mineral assemblage, but now mostly replaced by chlorite ± titanite. Zircon, apatite and titanite-altered ilmenite are accessory minerals in the host rock. Rare poikilitic scheelite occurs in biotite rich matrix.

Quartz (12%) anhedral deformed grains filling interstices between feldspar; medium grained interlocking in coarse quartz portions of vein

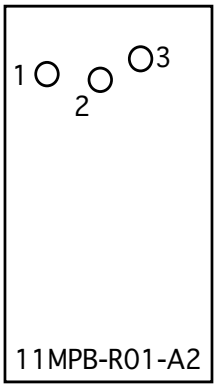
Plagioclase (53%) medium grained euhedral to subhedral blocky grains altered by very fine grained sericite, chlorite and epidote.
Biotite (12%) abundant fine grained subhedral olive brown to reddish brown flakes surrounding and partially overprinting feldspar, gradually replaced by green chlorite
Pumpellyite (tr.) fine grained colourless "bloated" medium relief aggregates with low ifc. (1.order grey to white) intergrown with biotite
Chlorite (15%) as fine grained anh. green alteration of biotite, introduced through chlorite-titanite±epidote veinlets
Actinolite (tr.) as minute acicular green inclusions in quartz
Epidote (7%) as fine granular alteration of plagioclase grading into semi-massive overprint at top of section; coarse euhedral crystals in vein at top of section.
Sericite (tr.) very fine grained flaky alteration of plagioclase
Calcite (tr.) as fine grained anhedral specs intergrown with epidote in vein and in matrix
Titanite (<1%) very fine grained pale brown high relief aggregates in chlorite; rimming and replacing ilmenite in fine granular aggregates
Scheelite (tr.) colourless subhedral poikilitic extremely high relief grains (≤0.3 mm) intergrown with biotite in matrix (low anomalous blue grey to I. order yellow ifc.)
Apatite (tr.) fine grained euhedral to subhedral rounded grains in
Ilmenite (tr.) fine grained granular aggregates rimmed by titanite
Zircon (tr.) fine gr. high relief square grains with medium high ifc.
Molybdenite (tr.) fine gr. (≤100 µm) deformed fibrous to flaky, grey reflecting intergr. with qtz
Chalcopyrite (tr.) medium gr. (≤2 mm) anhedral intergr. with coarse epidote in vein
Pyrrhotite (tr.) fine grained (≤0.2 mm) anhedral intergr. with cpy, altered
Pyrite (tr.) rare, very fine gr. (≤ 40 µm) euh. to anh. grains disseminated in matrix



1. poikilitic scheelite in chlorite-epidote
2. poikilitic scheelite in biotite-fsp
3. anh. scheelite in biotite ass. with apatite

11-MPB-R01-A2 Altered diorite with cpy + py
Lithology: high grade mineralization in Howard Peak Gabbro
Description: abundant medium to coarse grained kaolinite altered feldspar (mostly plagioclase) is surrounded by abundant coffee brown biotite intergrown with green hornblende and quartz. Euhedral apatite, zircon, anhedral ilmenite-titanite aggregates and rare poikilitic scheelite are accessory minerals. Lace-like pyrite, minor chalcopyrite and rare pyrrhotite occur disseminated in silicate matrix (particularly ass. with MgFe-silicates). Pyrite poikiloblasts are associated with an amphibole filled veinlet.

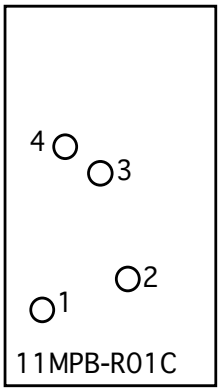
Quartz (12%) anhedral deformed grains filling interstices between feldspar
Plagioclase (55%) medium to coarse grained euhedral to subhedral blocky grains altered by very fine grained kaolinite, biotite and chlorite.
Biotite (27%) abundant fine grained subhedral coffee brown flakes surrounding and partially overprinting feldspar, intergrown with green hbl
Hornblende (5%) fine to medium grained green subhedral poikilitic grains intergrown with biotite and quartz; as minute acicular green inclusions in quartz
Chlorite (tr.) as fine grained anh. green alteration in plagioclase and repl. coarser (primary ?) biotite
Epidote (tr.) as fine granular alteration of plagioclase grading into semi-massive overprint at top of section; coarse euhedral crystals in vein at top of section.
Pumpellyite (tr.) fine grained colourless "bloated" medium relief aggregates with low ifc. (1.order grey to white) intergrown with biotite
Titanite (tr.) very fine grained pale brown high relief rimming and intergrown with ilmenite in granular aggregates
Scheelite (tr.) colourless anhedral poikilitic extremely high relief grains (≤0.4 mm) intergrown with biotite in matrix (low anomalous blue grey to I. order yellow ifc.)
Apatite (tr.) fine grained euhedral to subhedral rounded grains in
Ilmenite (tr.) fine grained granular aggregates rimmed by titanite
Zircon (tr.) fine gr. high relief square grains with medium high ifc.
Chalcopyrite (tr.) fine gr. intergr. with pyrite; medium grained (≤0.5 mm), anhedral in vein
Pyrite (tr.) fine gr. poikiloblastic cubes (≤0.9 mm) ass. with hornblende filled veinlets.
Pyrrhotite (tr.) fine gr. (≤0.2 mm) integrown with biotite



1. several poikilitic scheelite grains in alt. fsp-hbl-bio
2. medium gr. poikilitic scheelite (0.4 mm) in biotite-fsp
3. many fine gr. subh. scheelite grains in biotite ass. with apatite

11-MPB-R01-C Altered (grano-)diorite with qtz-calcite-scheelite vein
Lithology: high grade mineralization in Howard Peak Gabbro
Description: strongly biotite altered (grano-)diorite consisting of medium grained sericite ± clinozoisite-chlorite-calcite-altered plagioclase interstitial quartz and abundant fine grained pale olive to tan biotite. Opaques are rare and consist of fine grained euhedral to subhedral pyrite, very fine grained chalcopyrite, and very fine grained ilmenite coated by titanite. The assemblage is bordered at the bottom of the section by a coarse composite vein with a thin central calcite-chlorite-titanite vein bordered on both sides by coarse quartz. Scheelite is found as colourless subhedral blocky extremely high relief grains (≤0.4 mm) in the quartz band between the central calcite-chlorite-vein and the host rock. It is also found as anhedral ragged poikilitic grains intergrown with biotite in the host rock matrix

Quartz (15-20%) anhedral deformed grains filling interstices between feldspar; medium grained interlocking in coarse quartz portions of vein
Plagioclase (60%) medium grained euhedral to subhedral blocky grains altered by very fine grained sericite, chlorite, clinozoisite and trace calcite.
Biotite (25%) abundant fine grained subhedral olive brown to reddish brown flakes surrounding and partially overprinting feldspar
Pumpellyite (tr.) fine grained colourless medium relief aggregates with low ifc. (1.order grey to pale yellow) intergrown with biotite
Chlorite (5%) as fine grained anh. green alteration of plagioclase, coarser rimming calcite vein, intergrown with titanite and quartz
Actinolite (tr.) as minute acicular green inclusions in quartz
Clinozoisite (tr) as fine granular alteration of plagioclase
Sericite (tr.) very fine grained flaky alteration of plagioclase
Calcite (tr.) in thin vein in center of quartz vein and as extremely fine grained anhedral specs altering plagioclase.
Titanite (<1%) very fine grained pale brown high relief aggregates in chlorite lining calcite vein; rimming and replacing ilmenite in fine granular aggregates
Scheelite (<1%) colourless subhedral blocky extremely high relief grains (≤0.4 mm) in quartz band of vein; as anhedral ragged poikilitic grains intergrown with biotite in matrix (low anomalous blue grey to I. order yellow ifc.)
Apatite (tr.) fine grained euhedral to subhedral rounded grains in
Ilmenite (tr.) fine grained granular aggregates rimmed by titanite
Zircon (tr.) fine gr. high relief square grains with medium high ifc.
Pyrite (tr.) fine grained euhedral to subhedral disseminated grains (≤0.15 mm) in matrix of host rock
Chalcopyrite (tr.) very fine grained (≤50 μm) anhedral associated with pyrite

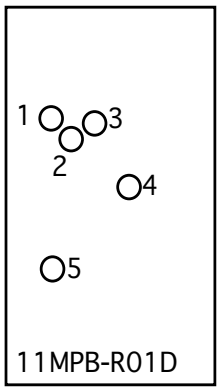


1. blocky scheelite (anomalous blue grey ifc.) in qtz-cc-chlorite vein
2. several scheelite grains in vein with titanite chlorite-cc and qtz
3. anhedral poikilitic scheelite intergrown with bio and pumpellyite(?)
4. coarse poikilitic scheelite in qtz-biotite matrix

11-MPB-R01-D Altered (grano-)diorite with biotite-prehnite (?) vein
Lithology: high grade mineralization in Howard Peak Gabbro
Description: strongly biotite altered diorite consisting of medium to coarse grained clinozoisite-chlorite-altered plagioclase, interstitial quartz and abundant fine grained pale coffee brown biotite and pumpelleyite aggregates. Opaques are rare and consist of fine grained euhedral to subhedral pyrite, molybdenite, and very fine grained ilmenite coated by titanite. Apatite and zircon occurs as accessory mineral. The assemblage is cut by a thick quartz vein with a central prehnite vein. Scheelite is colourless, subhedral blocky grains with extremely high relief (≤0.45 mm) in the quartz vein, but also as poikilitic grains (≤0.4 mm) intergrown with biotite in the host rock matrix

Quartz (15%) anhedral deformed grains filling interstices between feldspar; medium grained interlocking in coarse quartz portions of vein
Plagioclase (63%) medium to coarse grained euhedral to subhedral blocky grains altered by very fine grained sericite, chlorite. Tightly spaced albite twin lamellae still visible .
Biotite (20%) abundant fine grained subhedral coffee brown to reddish brown flakes interstitial to plag
Pumpellyite (tr.) fine grained colourless medium relief aggregates with low ifc. (1.order grey to pale yellow) intergrown with biotite
Prehnite (1-2%) colourless radiating aggregates with I.-2. order ifc. filling vein
Chlorite (tr.) as fine grained anh. green alteration of plagioclase, minor aggregates in vein
Actinolite (tr.) as sprays of fine gr. acicular green inclusions in quartz
Epidote (tr) very rare, rimming sulphides
Sericite (tr.) very fine grained flaky alteration of plagioclase
Calcite (tr.) in thin vein in center of quartz vein and as extremely fine grained anhedral specs altering plagioclase.
Titanite (<1%) very fine grained pale brown high relief aggregates rimming and replacing ilmenite in fine granular aggregates
Scheelite (<1%) colourless subhedral blocky extremely high relief grains (≤0.4 mm) in quartz- prehnite vein; as anhedral ragged poikilitic grains intergrown with biotite in matrix
Apatite (tr.) fine grained euhedral to subhedral rounded grains
Ilmenite (tr.) fine grained granular aggregates rimmed by titanite
Zircon (tr.) fine gr. high relief square grains with medium high ifc.
Pyrite (tr.) fine grained euhedral to subhedral disseminated grains (≤0.25 mm) in matrix of host rock
Chalcopyrite (tr.) very fine grained (≤50 µm) anhedral disseminated grains in matrix
Pyrrhotite (tr.) fine grained (≤0.175 mm) anhedral intergr. with cpy and py
Molybdenite (tr.) fine gr. deformed micaceous aggeregates (≤0.3 mm), with grey reflectance, intergr. with biotite and chlorite

1) two molybdenite flakes and small scheelite intergrown with biotite, quartz and prehnite in vein



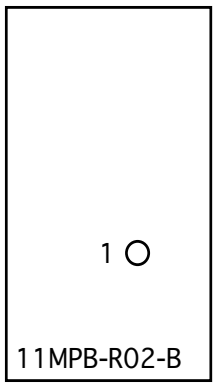
2) coarse blocky scheelite grain in quartz with dark red brown biotite
3) prehnite vein, anh scheelite in veinlet
5) anhedral scheelite (yellow ifc.) in qtz with acicular actinolite inclusion surrounded by bio
4) coarse anhedral scheelite (orange ifc.) in biotite and qtz

11-MPB-R02A Meta-granite with carbonate vein
Lithology: Quartz feldspar porphyry dyke
Description: felsic assemblage with ca. 50% quartz and abundant carbonate-kaolinite-sericite-altered feldspar with pockets of fine grained chlorite-titanite- altered biotite is cut diagonally by a vein filled with splintery carbonate.

Quartz (50%) medium gr., anhedral granoblastic patches interstitial to feldspar
Feldspar (42%) coarse grained anhedral highly altered by kaolinite, sericite and calcite
Biotite-Chlorite (2%) fine grained subhedral coffee brown flakes interstitial to fsp, strongly altered by khaki green chlorite
Sericite (tr.) very fine grained alteration of feldspar
Calcite (6%) coarse, bladed, splintery filling vein; fine gr. anh. alteration in feldspar
Titanite-Rutile (tr.) extremely fine grained aggregates in chlorite replacing biotite
Apatite (tr.) fine grained euhedral to subhedral rounded grains
Zircon (tr.) fine gr. euhedral very high relief grains with medium high ifc.
Pyrite (tr.) rare, very fine grained euhedral to subhedral disseminated grains (≤60 μm) in quartz and in carbonate
Chalcopyrite (tr.) rare, very fine grained (≤30 μm) anhedral intergrown with pyrite

11-MPB-R02B Meta-granite with allanite + zircon
Lithology: Quartz feldspar porphyry dyke
Description: recrystallized quartz intergrown with coarse kaolinite-sericite-altered feldspar with pockets of fine grained chlorite-titanite- altered biotite that also contain zoned brown allanite grains. The assemblage is cut by several generations of quartz- and/or calcite-veins, one of which contains anhedral scheelite.

Quartz (45%) medium gr., anhedral granoblastic patches interstitial to feldspar
Feldspar (52%) coarse grained anhedral highly altered by kaolinite, sericite and calcite
Chlorite (5%) sage-green chlorite almost totally replacing former biotite; also as pale green anhedral alteration in plag.
Biotite (tr.) rare, fine grained red brown flakes in aggregates interstitial to qtz-fsp
Sericite (see fsp) very fine grained alteration of feldspar
Carbonate (tr) fine gr, bladed, splintery in qtz veinlets; fine gr. anh. alteration in feldspar
Titanite-Rutile (tr.) extremely fine grained aggregates in chlorite replacing biotite
Allanite (tr.) fine gr. red brown zoned grains causing pleochroic haloes in chlorite patches
Zircon (tr.) fine gr. euhedral very high relief grains with medium high ifc.
Scheelite (tr.) one elongate 1.0 x 0.15 mm anhedral high relief grain, filling portion of veinlet
Pyrite (tr.) one fine grained cube (200 µm) ass. with calcite veinlet
Chalcopyrite (tr.) rare, very fine grained (50 µm) anhedral intergrown with calcite ass. with pyrite



1) elongate scheelite in quartz veinlet

11-MPB-R03 Meta-gabbro (amphibolite) no scheelite
Lithology: Howard Peak Gabbro
Description: medium to coarse grained slightly deformed tabular plagioclase is intergrown with medium grained olive brown to green hornblende and red brown biotite with minor disseminated apatite, anhedral ilmenite, pyrrhotite, chalcopyrite and pyrite.

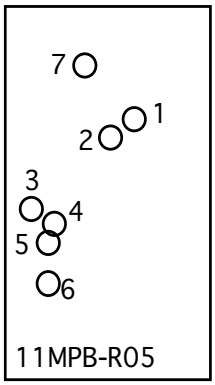
Quartz (tr.) fine gr., anhedral grains interstitial to feldspar
Plagioclase (48%) medium to coarse grained anhedral highly altered by kaolinite, sericite and calcite
Hornblende (45%) medium grained subhedral olive brown to green pleochroic zoned grains with very fine grained ilmenite oriented inclusions intergrown with plag.
Biotite (5%) fine to medium grained red brown flakes in aggregates intergrown with hbl
Chlorite (tr.) fine gr. sage green with khaki ifc. anhedral ass. with, biotite and hbl
Pumpellyite (tr.) fine grained colourless "bloated" medium relief aggregates with low ifc. (1.order grey to white) intergrown with biotite
Sericite (see fsp) very fine grained alteration of feldspar
Carbonate (tr) fine gr, bladed, splintery in qtz veinlets; fine gr. anh. alteration in feldspar
Ilmenite (1%) extremely fine grained oriented inclusions in amphibole, coarser anhedral disseminated grains associated with biotite
Magnetite (tr.) fine gr. anh. grains with ilmenite exsolution lamellae intergrown with pyrite
Apatite (tr.) fine gr. colourless subhedral rounded grains intergrown with all other minerals
Pyrrhotite (tr.) fine grained (≤0.25 mm) anhedral with pentlandite flames intergrown with cpy in amphibole-biotite
Pyrite (tr.) fine grained euhedral to lace-like grains (≤0.25 mm)
Chalcopyrite (tr.) rare, very fine grained (≤50 μm) anhedral intergrown with pyrrhotite

11-MPB-R04 Sericite schist with trace pyrite and extremely fine gr. diss. ilmenite, no scheelite
Lithology: Turnbull Mountain Fm: biotite wacke
Description: extremely fine grained strongly foliated slightly sheared and banded quartz-biotite-sericite schist with alternating layers of quartz-biotite, sericite-ilmenite, sericite-biotite and pure lenticular quartz layers some which are cut by anastomosing quartz veins.
Quartz (40%) fine grained granoblastic forming matrix of quartz-biotite bands and almost monomineralic layers and anastomosing veins
Sericite (30%) extremely fine grained and strongly aligned in massive layers with very fine grained disseminated ilmenite; coarser crystals growing across foliation and intergrown with biotite
Biotite (25%) reddish brown - very fine grained in quartz-biotite bands; coarser grains rimming and outlining disturbances in sericite layers
Chlorite (5%) a) olive brown anhedral with very low ifc. intergrown with biotite (alteration of amphibole ?); b) pale green with violet- blue ifc. in quartz bands
Ilmenite (tr.) as extremely fine grained rods aligned with foliation and disseminated in sericite bands

Pyrite (tr.) fine gr. euhedral cubes (≤0.25 mm) in quartz-chlorite band or lens
Chalcopyrite (tr.) very fine grained (≤40 µm) anh. in quartz lenses
Pyrrhotite (tr.) very fine grained (≤50 µm) anh. in quartz lenses

11-MPB-R05 Pyrrhotite-quartz vein with scheelite, chalcopyrite and sphalerite
Lithology: mineralized quartz vein
Description: coarse anhedral quartz is intergrown with coarse anhedral pyrrhotite, minor chalcopyrite and sphalerite. Schlieren of an olive green micaceous alteration mineral (chlorite ± sericite) as well as anhedral calcite occur in the quartz matrix. Scheelite occurs as euhedral to subhedral grains intergrown with po or as discrete grains in quartz. Many of the grains contain inclusions of very dark red translucent to opaque wolframite and euhedral pyrrhotite laths.

Quartz (90%) fine to coarse anhedral deformed matrix
Pyrrhotite (6%) coarse anhedral grains (≤ 2.2 mm) interstitial to qtz
Chalcopyrite (1%) fine to medium gr. (≤1 mm) anhedral intergrown with pyrrhotite and sphalerite
Sphalerite (1%) medium gr. (≤1.2 mm) deep red translucent subh. to anh. grains intergrown with cpy
Pyrite (1%) fine to medium gr. blocky euh. to subh. grains (≤1.2 mm) in aggregates in quartz
Scheelite (tr.) medium gr. subhedral to euh. grains (≤0.4 mm) intergrown with po or in qtz matrix; some contain inclusions of euh. Po, subh. Wolframite and native bismuth
Wolframite (tr.) as dark deep red anhedral inclusions (≤ 75 µm) in scheelite
Chlorite (tr.) fine grained olive green micaceous aggregates in veins and schlieren in quartz rimmed by sericite
Sericite (tr.) very fine gr. intergrown with chlorite; coarser rimming po; one coarser deformed aggregate in quartz matrix



1) scheelite enclosing altered wolframite
2) sph intergrown with coarse sericite
3) coarse sphalerite intergr. with cpy in qtz
4) euhedral scheelite intergr. with po in qtz
5) scheelite with po inclusions intergr. w po and qtz
6) altered inhomogeneous scheelite in qtz with py and olive green alteration
7) scheelite with dark po and wolframite or hematite inclusions.

11-MPB-R06 Meta-granite
Lithology: Turnbull Mountain Fm: felsic tuff
Description: deformed quartz-feldspar-muscovite-biotite schist with "augen"-texture and trace pyrrhotite introduced along thin veinlets.

Quartz (50%) fine to medium grained anhedral slightly mylonitized surrounding feldspar "augen"
K-Feldspar (20%) fine to medium gr. anh. deformed blocky grains forming "augen"
Plagioclase (16%) fine gr., more altered than K-fsp (by sericite ± calcite)
Muscovite (1%) fine gr. poikilitic grains intergrown with feldspar and qtz
Biotite (1-2%) fine grained reddish brown in aggregates with sulphides and ilmenite interstitial to qtz-fsp.
Chlorite (tr.) olive brown to sage green replacing biotite
Carbonate (tr.) very fine grained alteration of plagioclase
Apatite (tr.) fine gr. subhedral medium relief colourless grains with inclusions
Ilmenite (tr.) as fine grained anhedral partly altered grains ass. with biotite
Zircon (tr.) extremely high relief euhedral grain with medium ifc.
Scheelite (tr.) very fine gr. (40 µm) extremely high relief anh. grain in alt. K-fsp
Chalcopyrite (tr.) very fine grained (≤0.1 mm) anh. in pyrrhotite
Pyrrhotite (tr.) fine grained (≤0.3 mm) anh. intergrown with cpy associated with coarser muscovite

11-MPB-R07 Amphibolite with ilmenite, titanite and lace-like pyrite
Lithology: Turnbull Mountain Fm: mafic tuff
Description: foliated and deformed amphibolite with abundant green hornblende in augen texture surrounded by finer grained biotite quartz and fine granular ilmenite-titanite.

Hornblende (75%) fine to medium grained porphyroblasts with rounded or ragged edges forming "augen"
Biotite (13%) fine grained tan flakes rimming amphibole
Quartz (5%) fine granular surrounding amphibole
Feldspar (5%) fine granular surrounding amphibole
Ilmenite (1%) fine grained lenticular intergrown with fine granular titanite forming trails between amphibole "augen"
Titanite (1%) fine granular translucent high relief grains intergrown with ilmenite forming trails between amphibole "augen"
Pyrite (tr.) very fine grained (≤50 µm) lace-like aggregates rimming amphibole associated with vein cross-cutting amphibolite

11-MPB-R08 Meta-granite with zircon and titanite, no scheelite
Lithology: Howard Peak Granodiorite
Description: medium grained slightly metamorphosed granite consisting of coarse subhedral slightly perthitic alkali-feldspar. medium grained deformed quartz. plagioclase and dark brown biotite with accessory apatite, ilmenite and zircon.

Quartz (40%) fine to medium grained anhedral deformed grains with undulous extinction
K-Feldspar (37%) medium to coarse gr. subh. slightly perthitic grains
Plagioclase (20%) fine to medium gr., subhedral more altered than K-fsp (by sericite ± calcite)
Muscovite (tr.) rare, fine gr. subh. intergrown with biotite
Biotite (3%) fine to medium grained dark brown anhedral interstitial to qtz-fsp, slightly chlorite altered
Chlorite (tr.) green, replacing biotite
Apatite (tr.) very fine gr. subhedral medium relief colourless grains
Ilmenite (tr.) as fine grained anhedral inclusions in biotite
Zircon (tr.) extremely high relief euhedral grain with medium ifc.

11-MPB-R09 Biotite-fsp-schist
Lithology: Turnbull Mountain Fm: mafic crystal tuff
Description: abundant subhedral blocky feldspar grains surrounded by fine grained red brown biotite in net-like texture and fine granular quartz. Fine grained poikilitic ilmenite is intergrown with biotite and trace sulphides (pyrrhotite and pyrite) occur disseminated throughout. Apatite and zircon occur as accessory minerals. Mint green poikilitic mica (fuchsite or biotite?) is intergrown with K-feldspar.

Quartz (10%) fine grained anhedral slightly deformed grains intergrown with biotite in interstices between feldspar
Alkali feldspar (58%) medium grained euhedral to subhedral blocky grains. slightly altered by very fine grained sericite, chlorite and actinolite
Plagioclase (10%) fine to medium grained subhedral blocky grains altered by very fine grained sericite, chlorite and actinolite
Biotite (21%) abundant fine grained subhedral orange brown to reddish brown flakes surrounding feldspar;
Muscovite/Biotite 2 (tr.) fine gr. poikilitic green pleochroic grains intergrown with feldspar
Chlorite (tr.) as fine grained anh. green alteration in feldspar
Apatite (tr) as fine gr. subhedral colourless grains with "dusty" cores due to abundant submicroscopic inclusions
Sericite (tr.) very fine grained flaky alteration of plagioclase
Calcite (tr.) as fine grained anhedral specs intergrown with olive green alteration
Ilmenite (tr.) fine grained poikilitic granular aggregates intergrown with biotite
Zircon (tr.) fine gr. high relief grains with medium high ifc.
Pyrite (tr.) fine grained (≤0.25 mm) blocky euhedral to lace like intergrown with qtz-fsp

Chalcopyrite (tr.) very fine grained (≤50 μm) anhedral associated with pyrite
Pyrrhotite (tr.) fine grained (≤0.25 mm) anhedral, disseminated

11-MPB-R10 Coarse granite with coarse biotite, no scheelite
Lithology: Nashwaak Granite
Description: coarse anhedral alkali feldspar is intergrown with coarse quartz, medium grained plagioclase and deep red brown biotite. Zircon, apatite and ilmenite occur as accessory minerals.

Quartz (33%) medium grained anhedral deformed grains with undulous extinction
K-Feldspar (30%) coarse gr. anh. slightly perthitic oikocrysts enclosing euh. plag and biotite grains
Plagioclase (24%) fine medium gr., subhedral to euhedral intergrown with qtz and alkali-feldspart
Sericite (tr.) fine gr. alteration of feldspar
Biotite (13%) fine to medium grained dark red brown euhedral intergrown with qtz-fsp, rarely chlorite altered
Chlorite (tr.) rare, green, replacing biotite
Titanite (tr.) fine gr. high relief pale brown with very high ifc. intergrown with chlorite repl. biotite
Apatite (tr.) very fine gr. subhedral medium relief colourless grains
Ilmenite (tr.) as fine grained anhedral inclusions in biotite
Zircon (tr.) extremely high relief euhedral grains with medium ifc.

11-MPB-R11 felsic breccia, no opaques or scheelite
Lithology: altered Nashwaak Granite
Description: coarse quartz intergrown with strongly kaolinite-sericite-altered feldspar that in many cases is polished out of the section, and minor muscovite. The section contains a brecciated area (vein?) containing abundant subhedral to euhedral bladed to prismatic quartz with fine grained interstitial altered fsp and sericite. There are no opaques or trace minerals in this section.

Quartz (75%) medium to coarse grained anhedral deformed grains with undulous extinction; bladed to prismatic euhedral in brecciated area
Feldspar (25%) medium to coarse gr. subh. to euhedral replaced by fine gr. kaolinite and/or sericite
Muscovite (1-2%) fine to medium gr. subh. deformed and slightly altered "books" intergrown with qtz-fsp
Biotite (tr.) rare, very fine grained brown euhedral inclusions in qtz-fsp