

Glacial stratigraphic, till geochemical, and indicator mineral studies at the Sisson W-Mo and Mount Pleasant Sn-W-Mo-Bi-In polymetallic deposits, southwestern New Brunswick

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Abstract: During the Geological Survey of Canada's (GSC) Targeted Geoscience Initiative (TGI 4; 2010-2015), GSC and the New Brunswick Department of Energy and Mines (NBDEM) conducted indicator mineral case studies around the Sisson W-Mo and the Mount Pleasant Sn-W-Mo-Bi-In polymetallic deposits in New Brunswick. The objective is to document glacial dispersal patterns of W, Mo, Sn, and In-bearing indicator minerals and matrix geochemical signatures in till at varying distances down-ice of the deposits, in support of exploration in New Brunswick and other glaciated terrains. This is the first study to document glacial dispersal of W-bearing minerals around a significant W deposit.

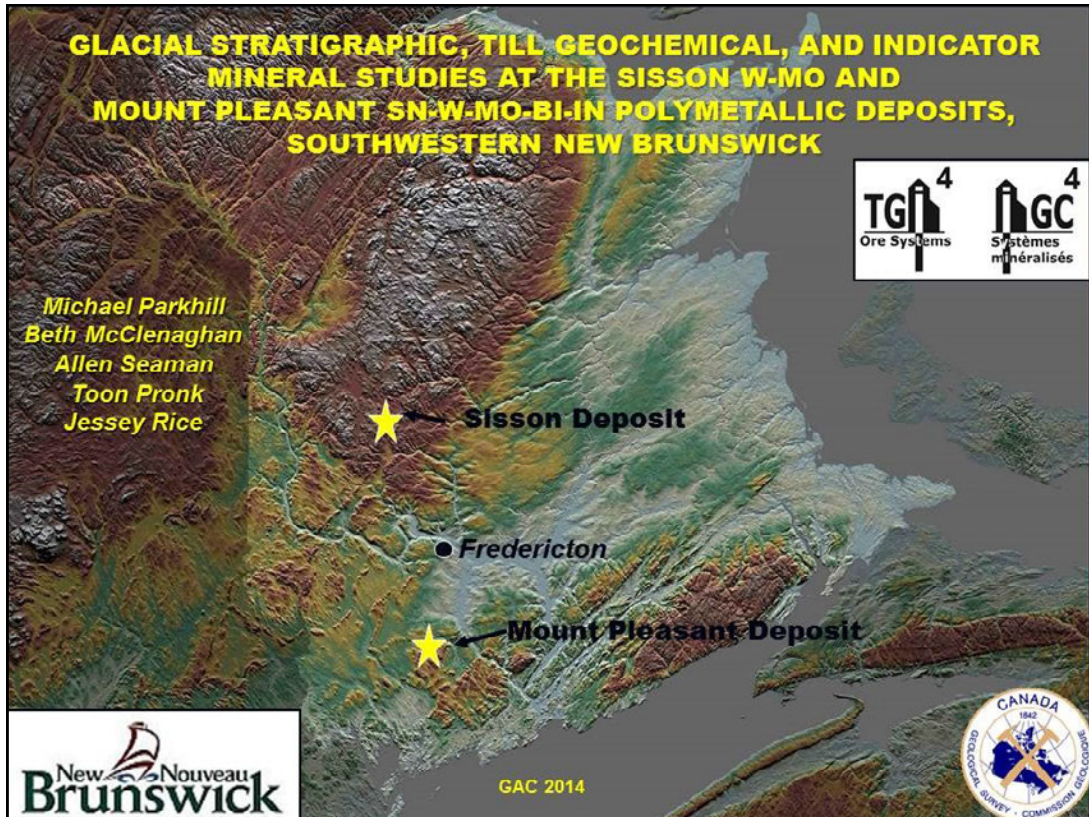
At Sisson, 3 tills are present: Illinoian Northumberland till, Early-Middle Wisconsinan Caledonia till, and the geochemically barren, Younger Dryas, Collins Pond till. This presented sampling challenges as the tills are deposited by ice flows from different source areas and are geochemically distinct but not easy to distinguish. At Sisson, 79 bulk till samples were collected up-ice, overlying, and up to 14 km down-ice (SE) of the deposit. The distribution of sample sites was guided by previous sampling by Kidd Creek Mines and the NBDEM. Stream water, silt, and bulk samples were collected at 16 sites at Sisson to characterize scheelite abundance, size, and shape for comparison with grains in the till. At the Adex-owned Mount Pleasant deposit, 22 bulk till samples were collected. Here, sampling was guided by previous work conducted by N. Szabo (University of New Brunswick) and the NBDEM.

Till sampling was optimized by first collecting 200 g till samples (61 at Sisson and 50 at Mount Pleasant) and determination of W, Mo, Sn, Bi, Sn, and Cu concentrations, using a portable XRF (pXRF) spectrometer. At Sisson, anomalous pXRF concentrations match previously known NBDEM anomalies in the glacial dispersal train extending 14 km to the SE, and correlate well with subsequent borate fusion and aqua regia/ICP-MS analyses of the <0.063 mm fraction of till (up to 815 ppm W, 65 ppm Mo, and 978 ppm Cu). Till, stream, and a suite of bedrock samples have been processed to produce heavy mineral concentrates for assessment of indicator minerals and to characterize the indicator mineral signature of each deposit. Scheelite is abundant in both deposits, and a significant indicator mineral in till down-ice. Other indicator minerals of the Sisson deposit include molybdenite, chalcopyrite, wolframite, Bi minerals, sphalerite, and galena. Cassiterite, topaz, beudantite, anglesite, and wolframite are indicators of the Mount Pleasant deposit.

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Parkhill, M.A., McClenaghan, M.B., Seaman, A.A., Pronk, A.G., and Rice, J.M., 2015. Glacial stratigraphic, till geochemical, and indicator mineral studies at the Sisson W-Mo and Mount Pleasant Sn-W-Mo-Bi-In polymetallic deposits, southwestern New Brunswick; *in* TGI 4 – Intrusion Related Mineralisation Project: New Vectors to Buried Porphyry-Style Mineralisation, (ed.) N. Rogers; Geological Survey of Canada, Open File 7843, p. 293-316.



New Brunswick

Acknowledgements




- Geological Survey of Canada – Targeted Geoscience Initiative (TGI-4)
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- Adex Mining
- Rex Boldon, Reid van Drecht, Mike Richards, Sarah Hashmi
- Overburden Drilling Mgnt. Ltd.




TGI⁴ Ore Systems

GC⁴ Systèmes minéralisés



TGI-4 Indicator Mineral and Till Geochemical Dispersal Studies





OBJECTIVE:
Document indicator mineral dispersal in till and stream sediments from various deposit types to provide industry with a proven indicator mineral methodology for exploration.

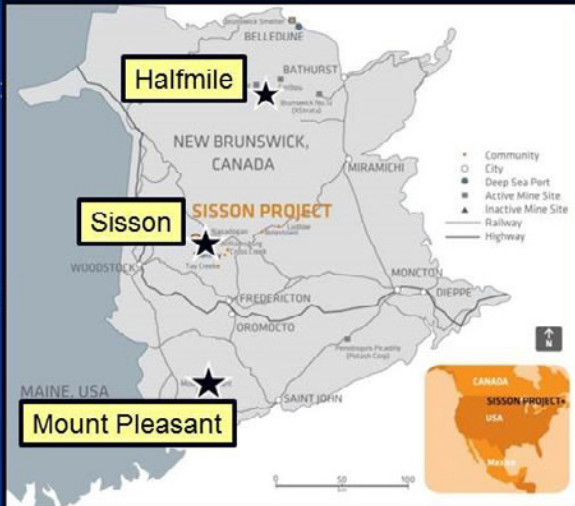
NEW BRUNSWICK PROJECTS


1. Intrusion hosted Sn-W-Mo deposits
 - Sisson
 - Mount Pleasant
2. Cu-Pb-Zn VMS deposits:
 - Bathurst Mining Camp
 - Halfmile Lake, TGI-3 & TGI-4

molybdenite












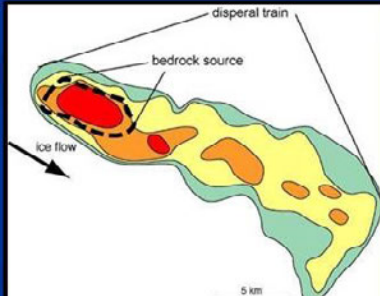
Properties of an Indicator Mineral



- Source-specific – deposit, bedrock
- Visually and chemically distinct
- Heavy (moderate to high density)
- Survives weathering and clastic transport
- Indicator minerals are silt to sand sized

(Averill, 2007)



Exploration target is larger than mineralized bedrock source

Rationale for Sisson/Mount Pleasant Study:

- Geology well documented
- Glacier eroded ore zone
- Access to deposit – Northcliff and Adex
- Till covered
- Glacial history and glacial dispersal trains outlined during NBGSB till geochemical surveys;
a guide to sampling of metal-rich till for indicator mineral studies
- No indicator mineral case studies have been published that document glacial dispersal from significant tungsten or tin deposits



“Sisson is the first tungsten (W) case study”



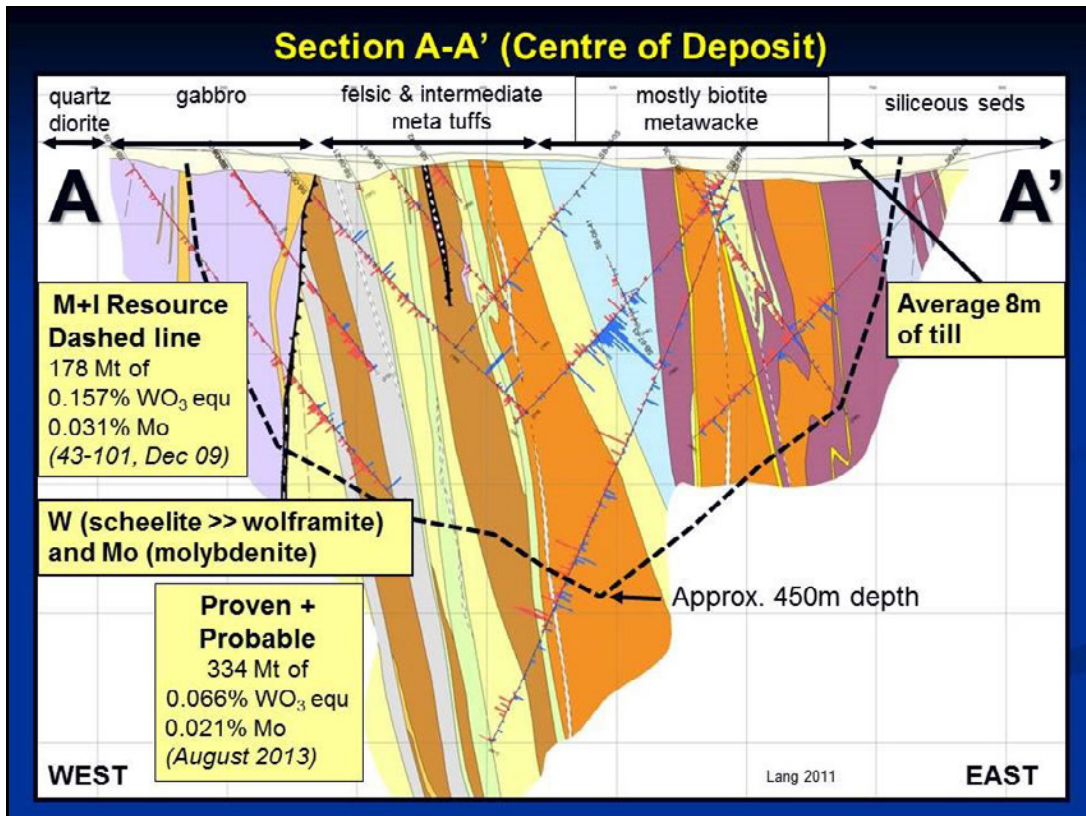
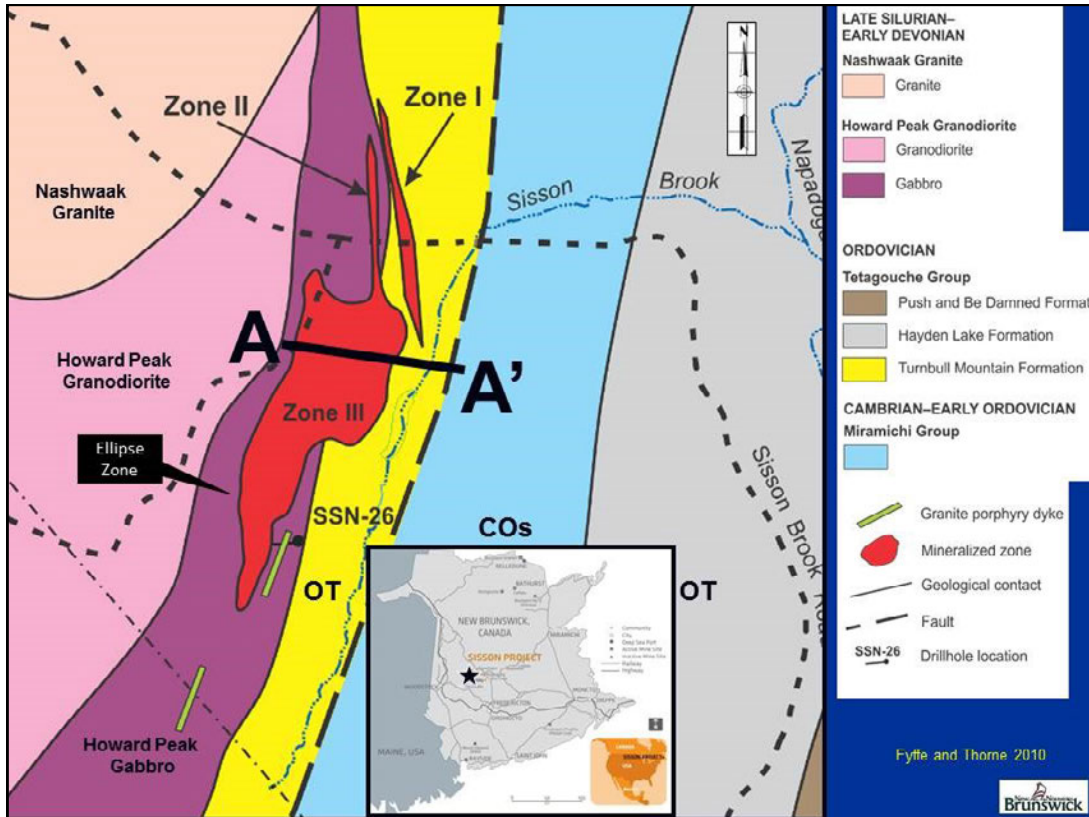
Sisson Exploration History

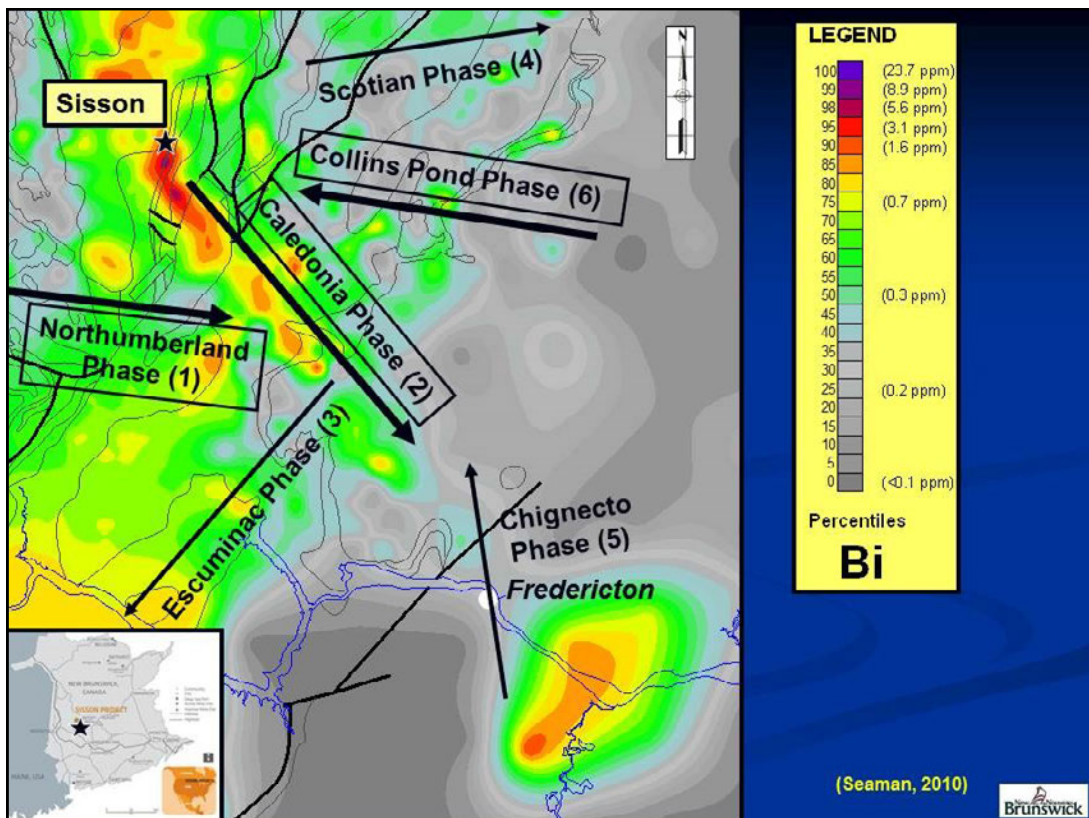
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|--------------------|---|
| Pre-1978 | W geochem anomalies |
| 1978 - 1984 | Kidd Creek Mines (TexasGulf) <ul style="list-style-type: none">■ Outlined 3 mineralized zones and W and Mo rich till up to 8 km down-ice |
| 2004 - 2009 | Geodex Minerals; <ul style="list-style-type: none">■ 46,500m of drilling■ Increased resource;■ Preliminary environmental, metallurgical, engineering studies and economic assessment |
| 2010 - 2012 | Geodex Joint venture with Northcliff 2010 <ul style="list-style-type: none">■ 11,000 m drilling in 2010-2011■ Initiated feasibility and EIA studies |
| 2013 - 2014 | 100% Northcliff owned; mining plan underway |

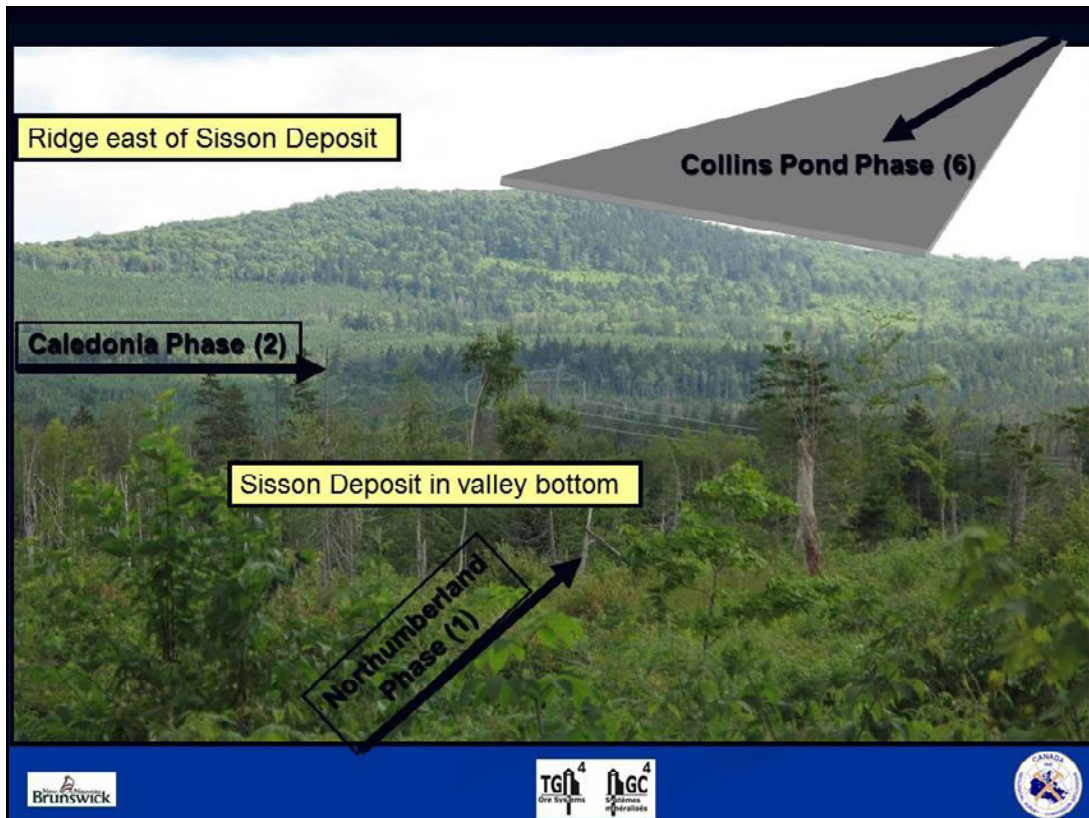
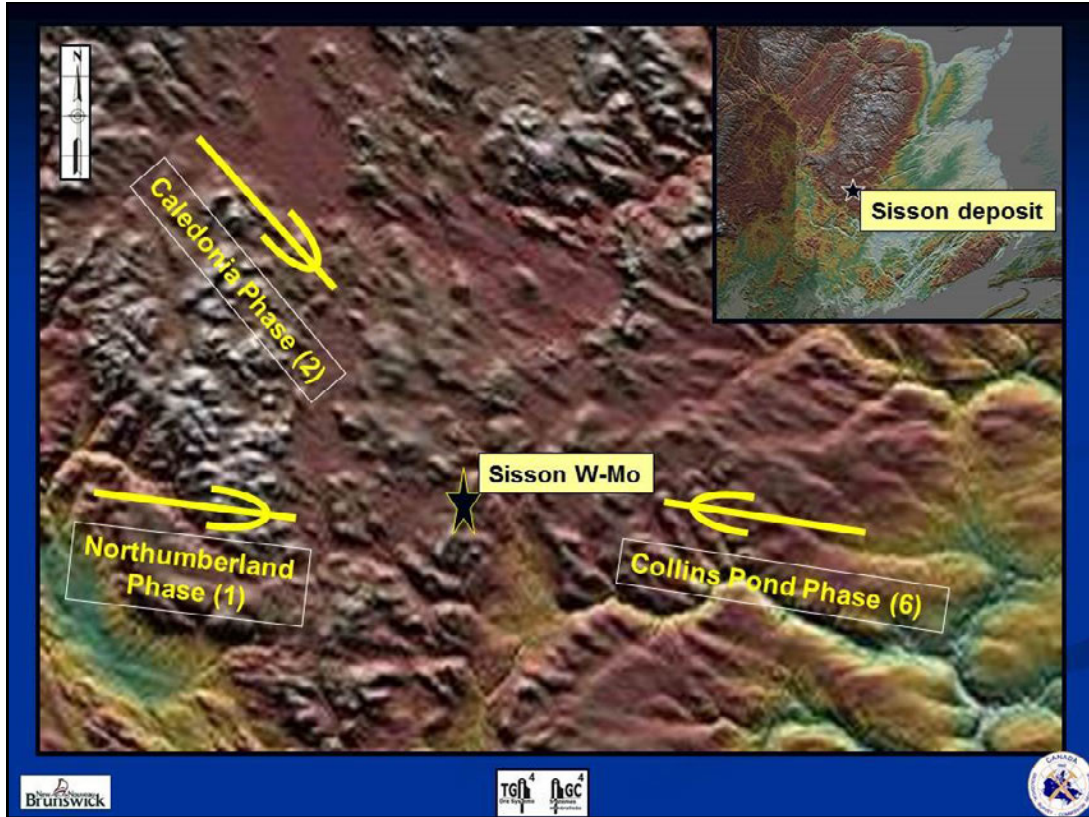


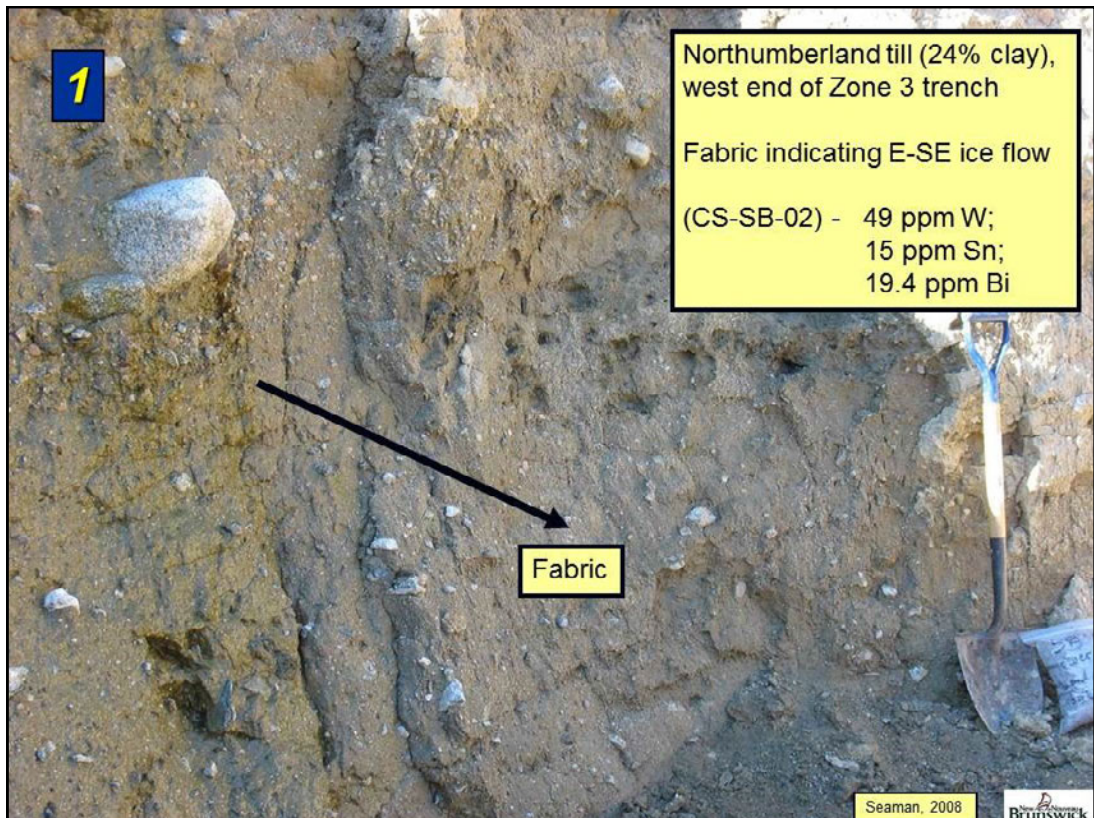
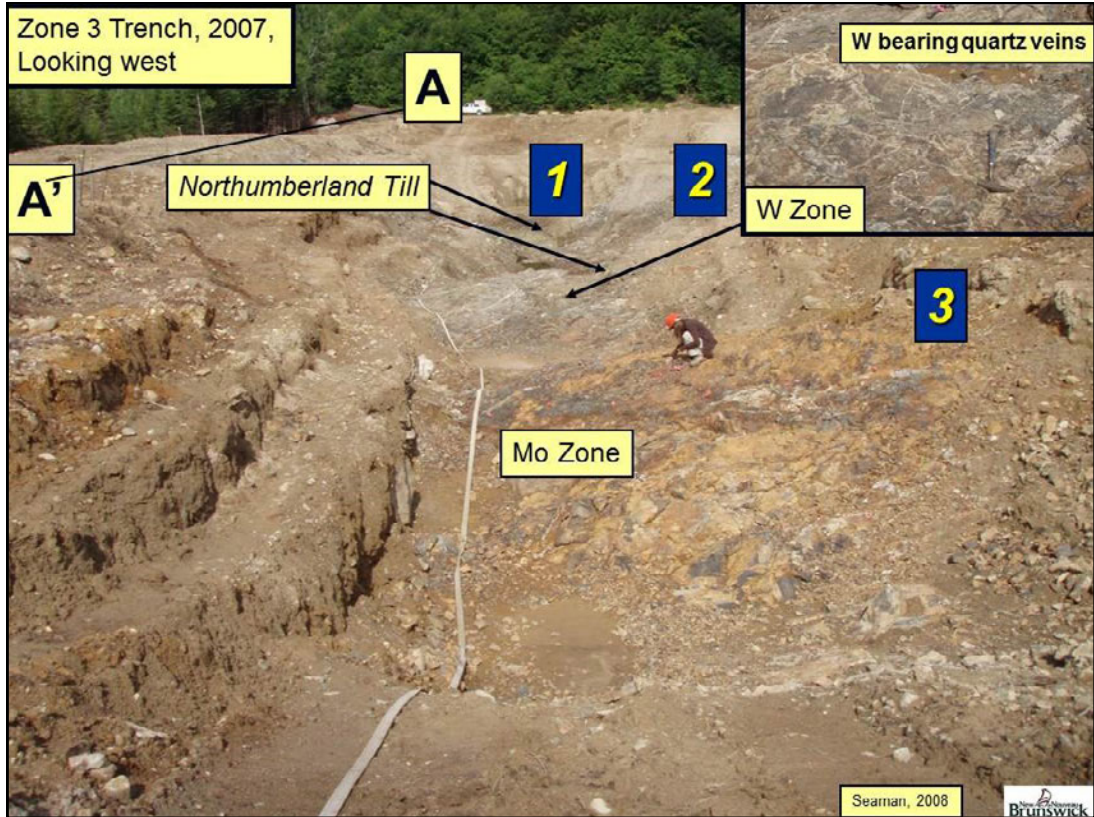
Lang 2011

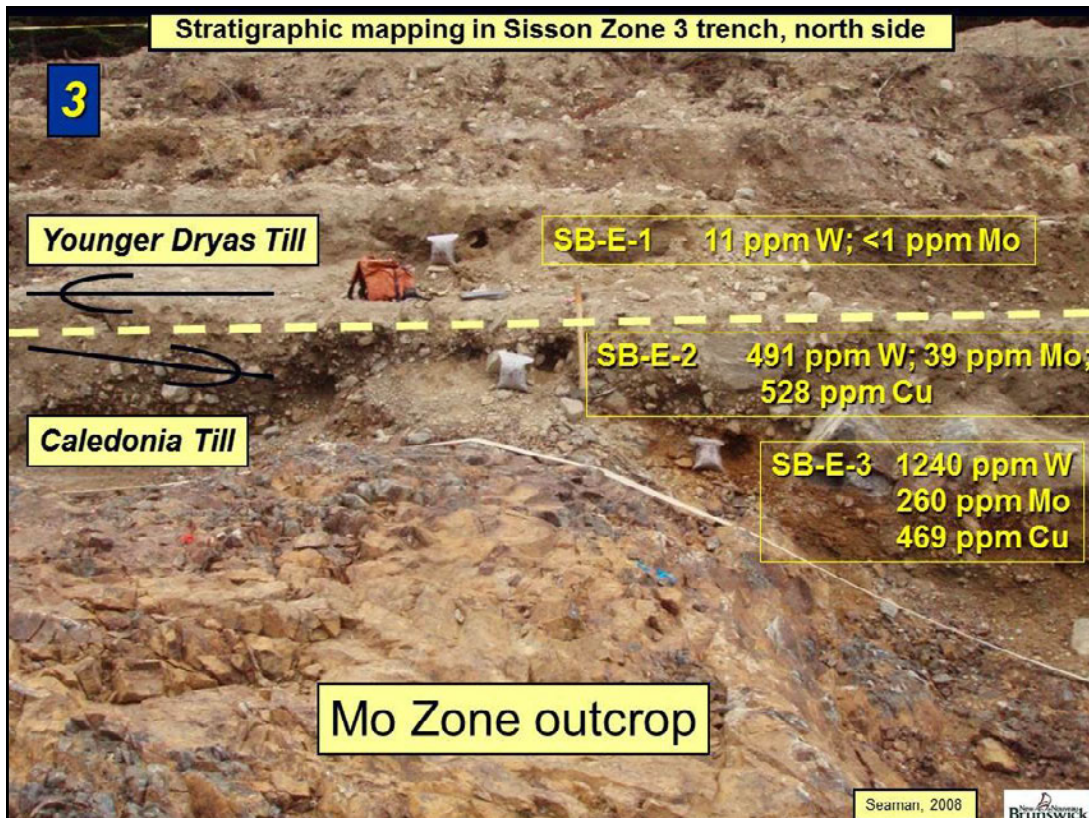












SISSON W-Mo deposit, TGI-4 CASE STUDY: Methodology

White Bucket 20 kg:
Overburden Drilling & Management-
 Heavy minerals (SG >3.2) recovered
 from bedrock, till and stream sediments
 by combination of tabling+ heavy liquids
 (N=59)

Large bag 5 kg:
Actlabs- Multielement analysis (N=80)

Univ. of Waterloo- Sarah Hashmi
 BSc, Win till geochemistry (N=25)

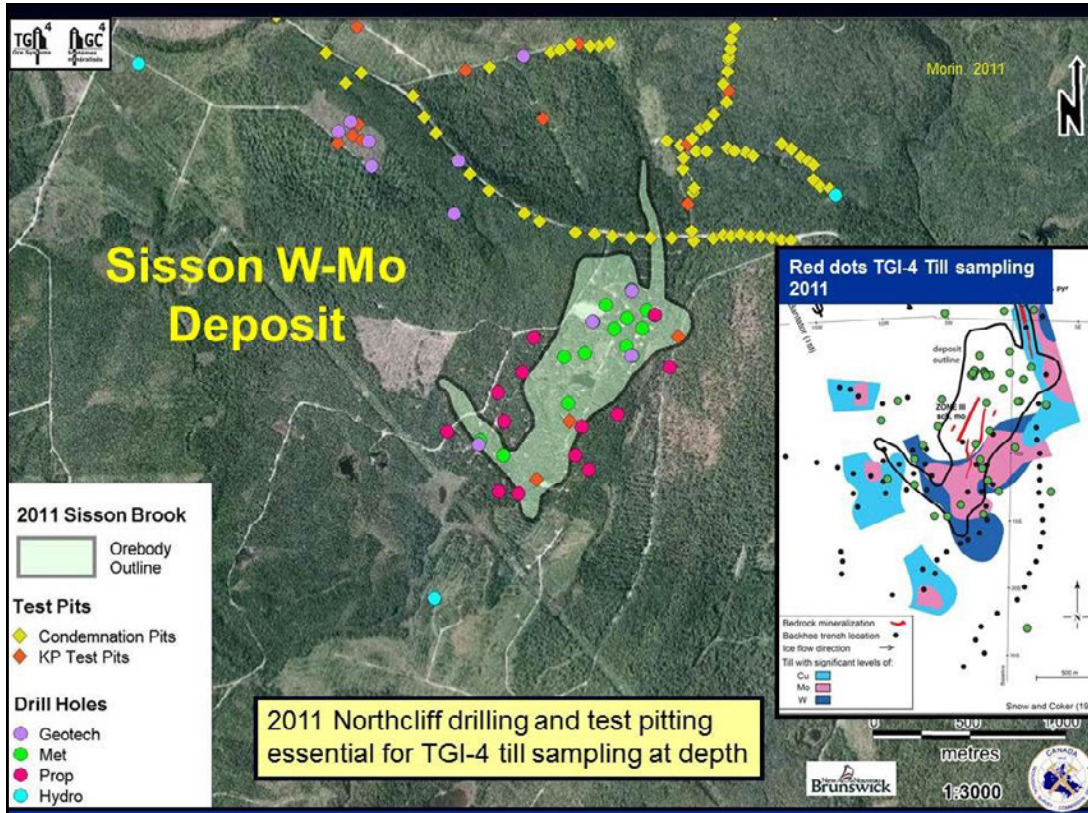
Small bag 0.5 kg:
NBGSB Bathurst- PXRf analysis

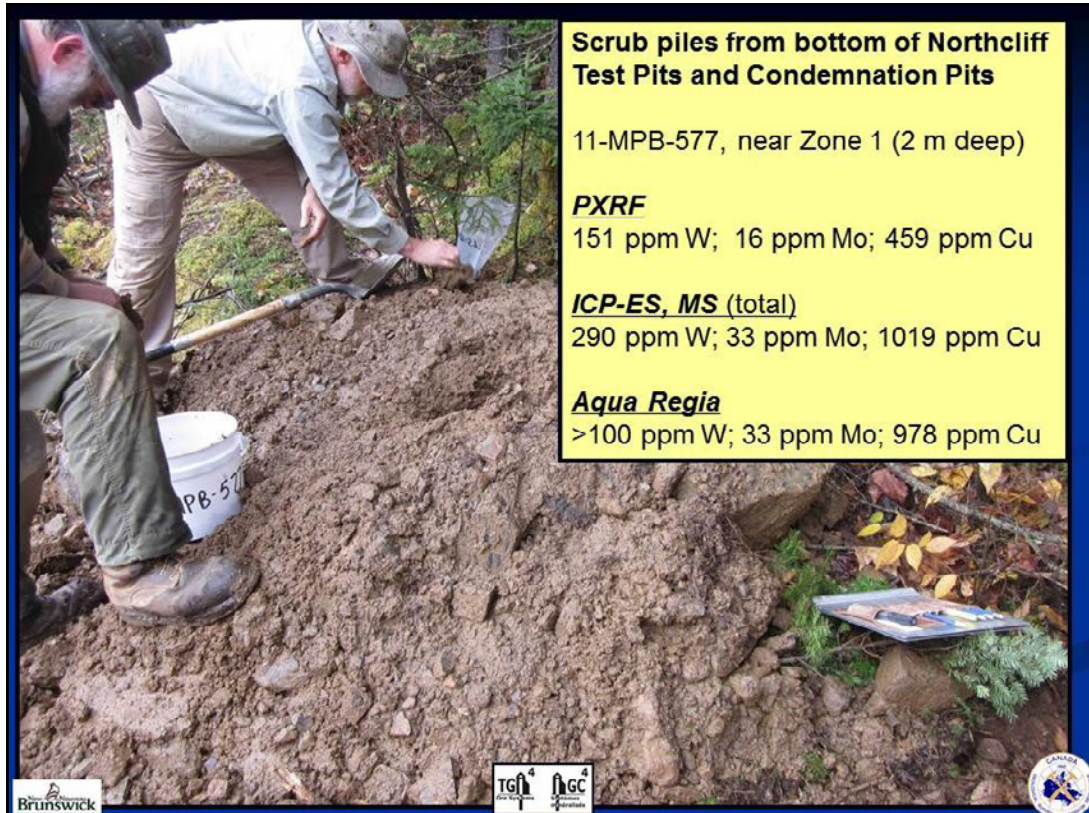
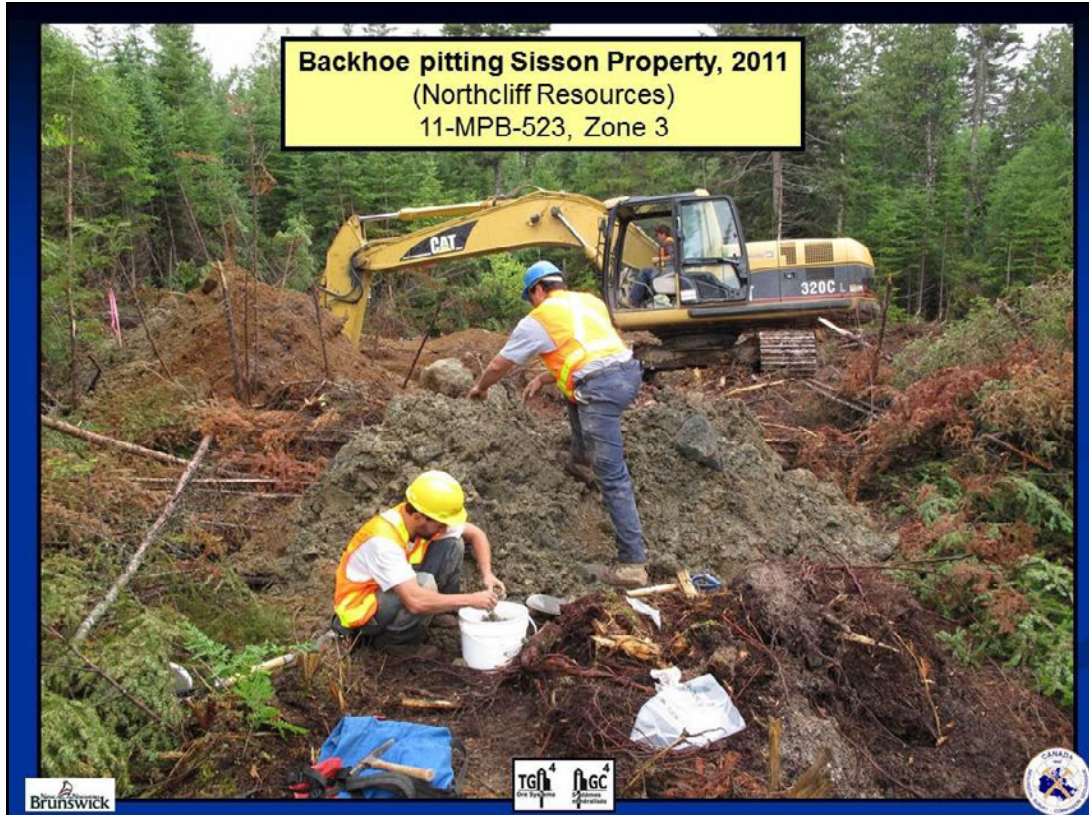
Sample of in situ till 0.25 kg:
Brock University- Jesse Rice, MSc,
 analysis of microfabrics in till

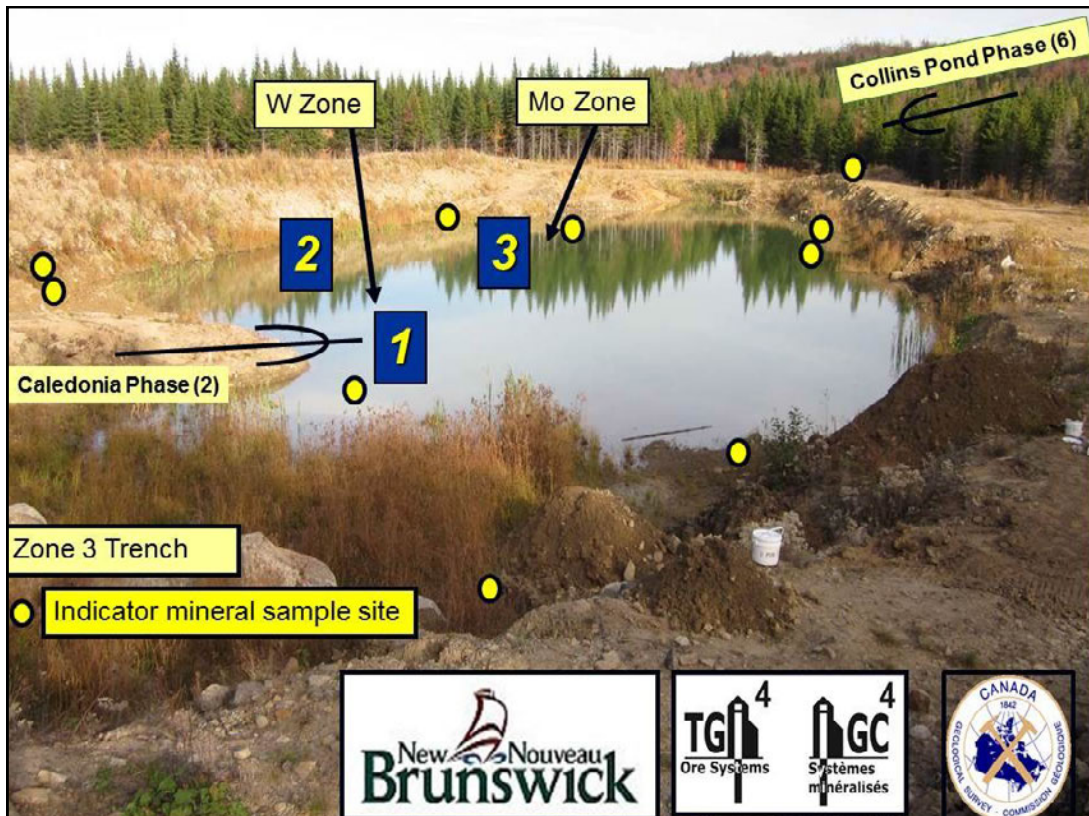
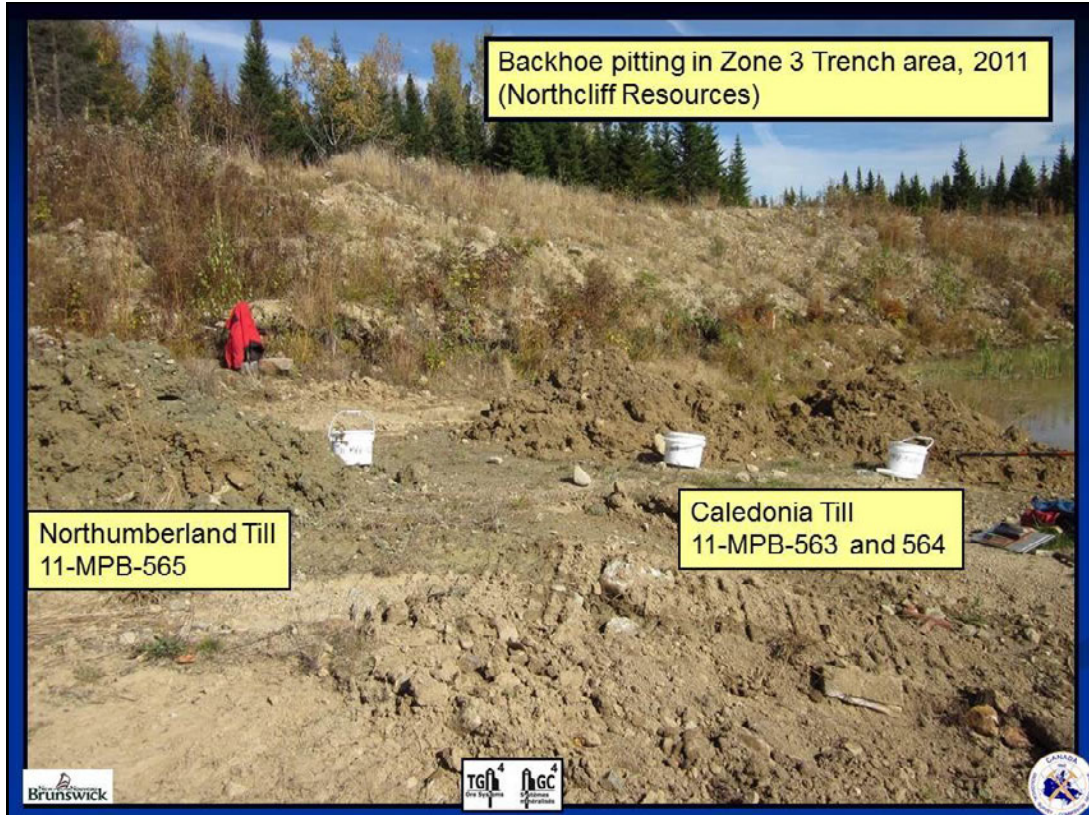
Bedrock samples (N=12)

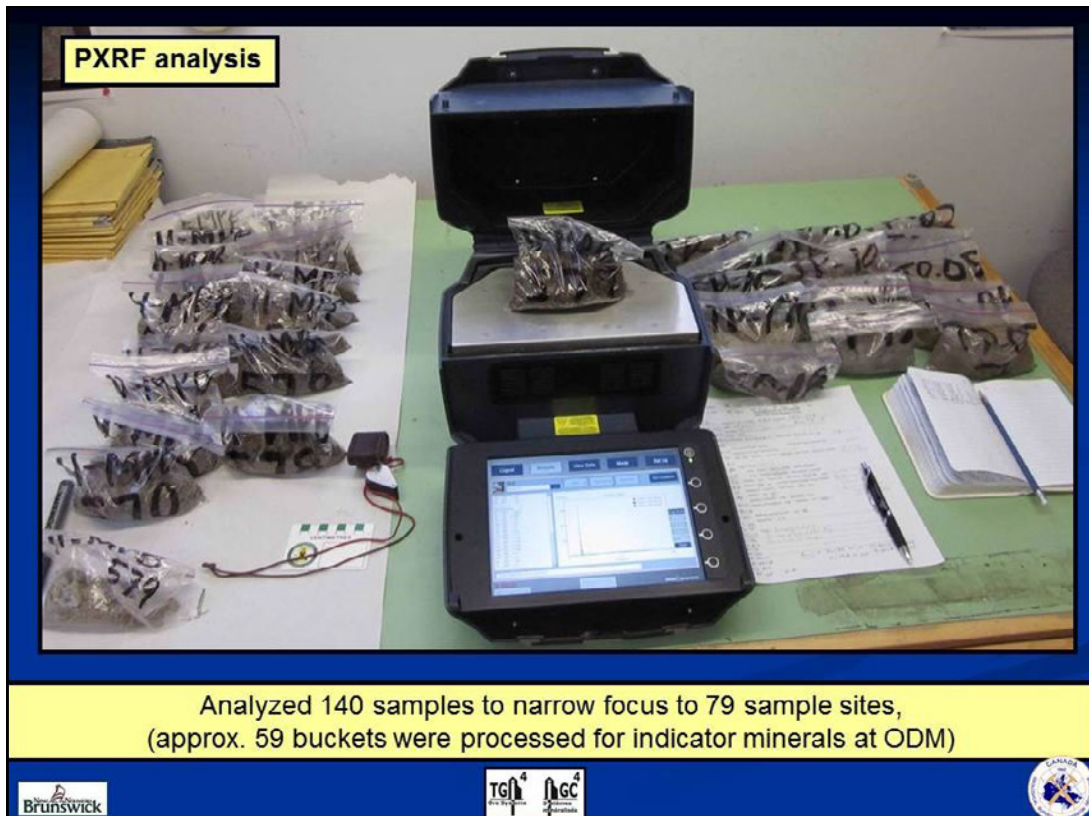
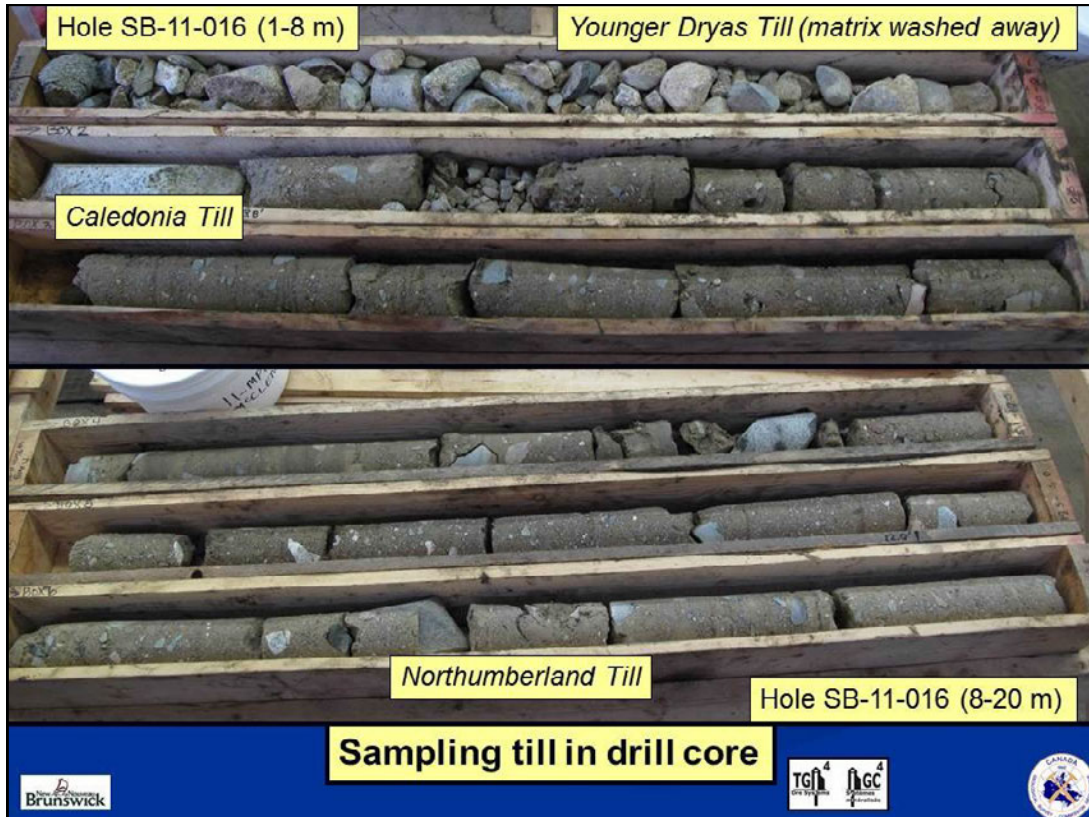


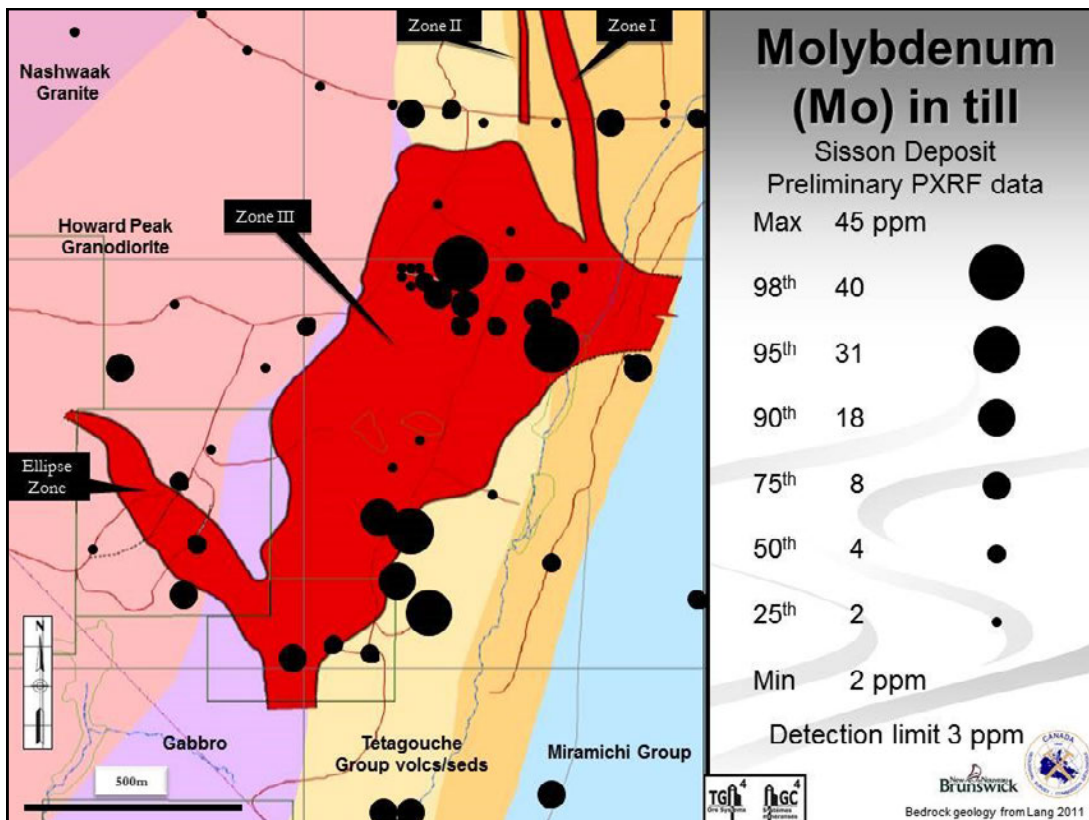
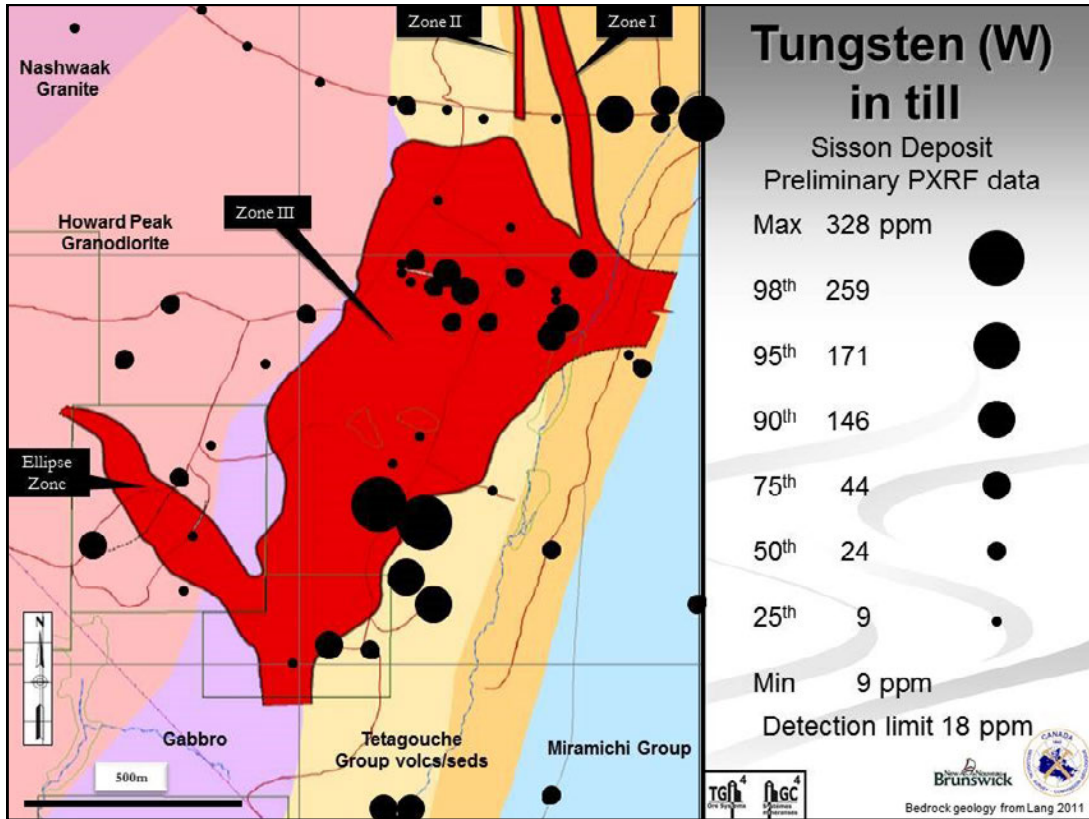
Hand dug pits (mostly up-ice and down-ice of the Main deposit area).

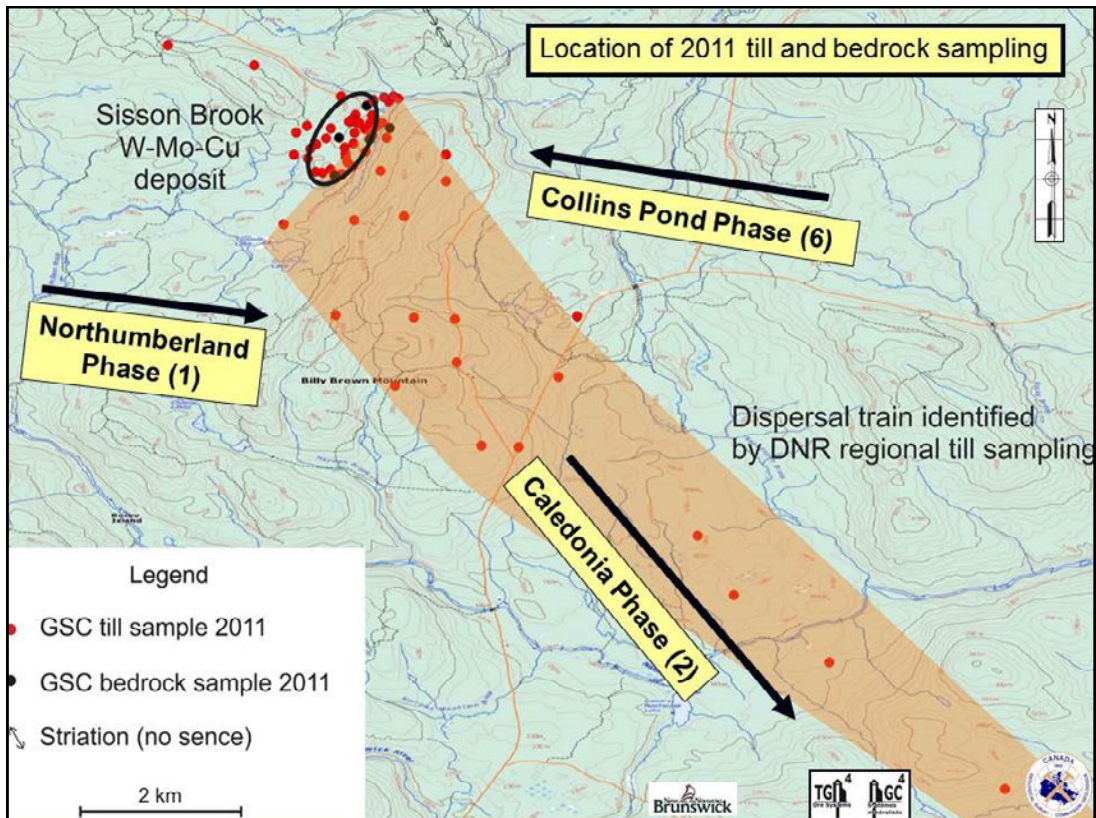
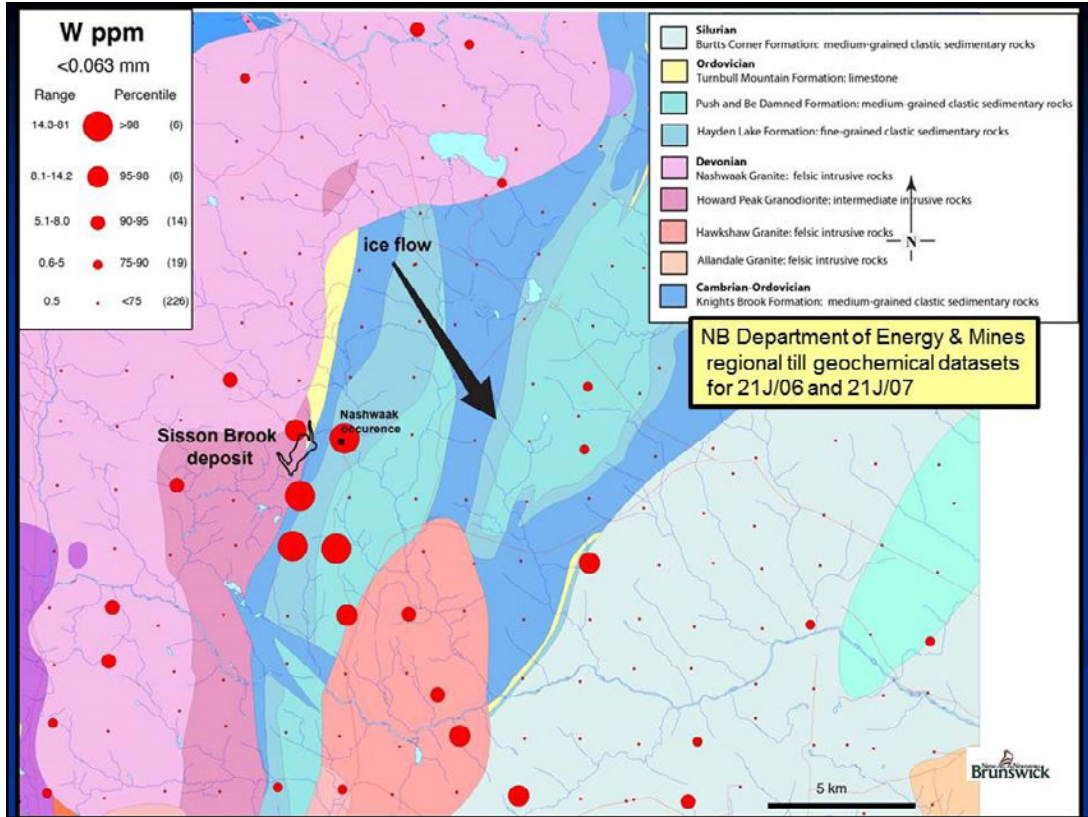


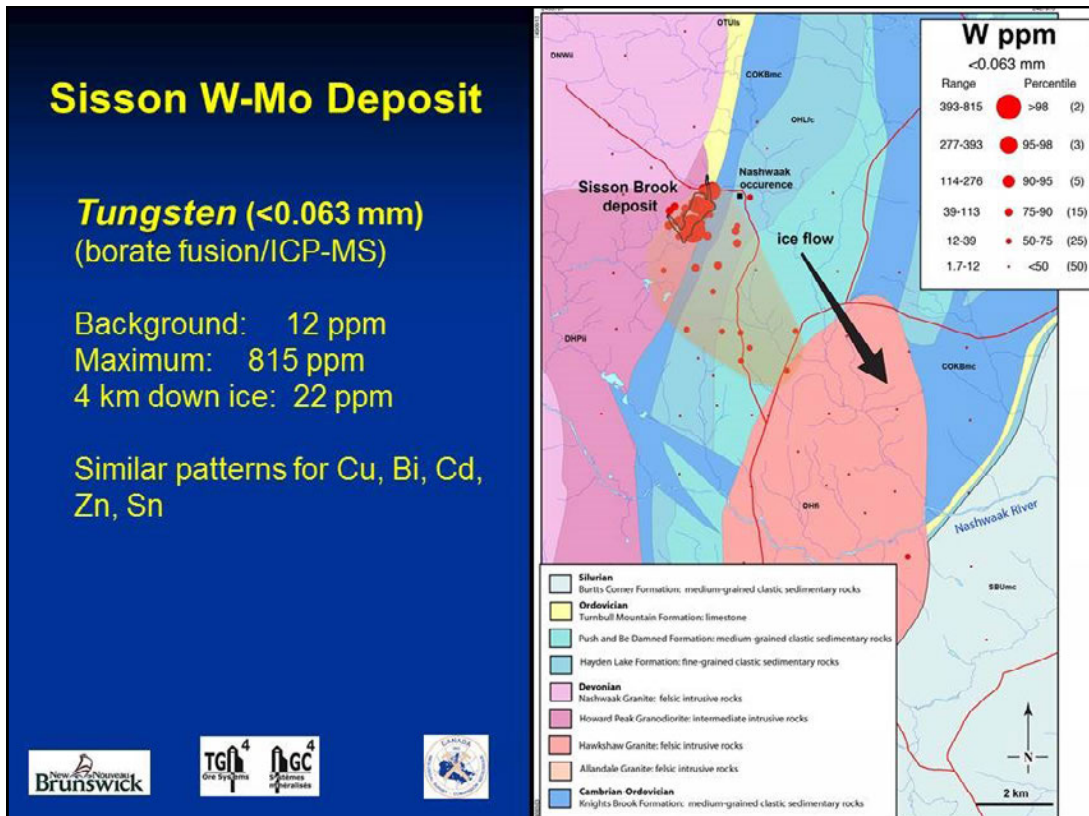
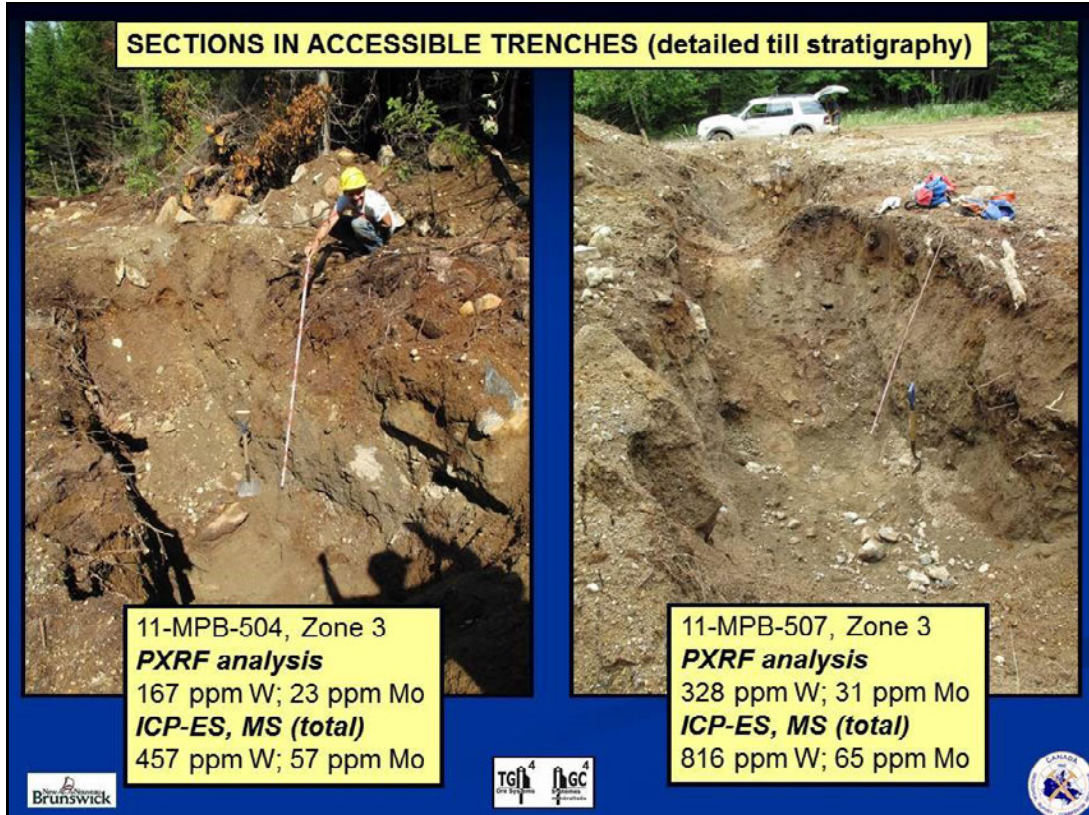


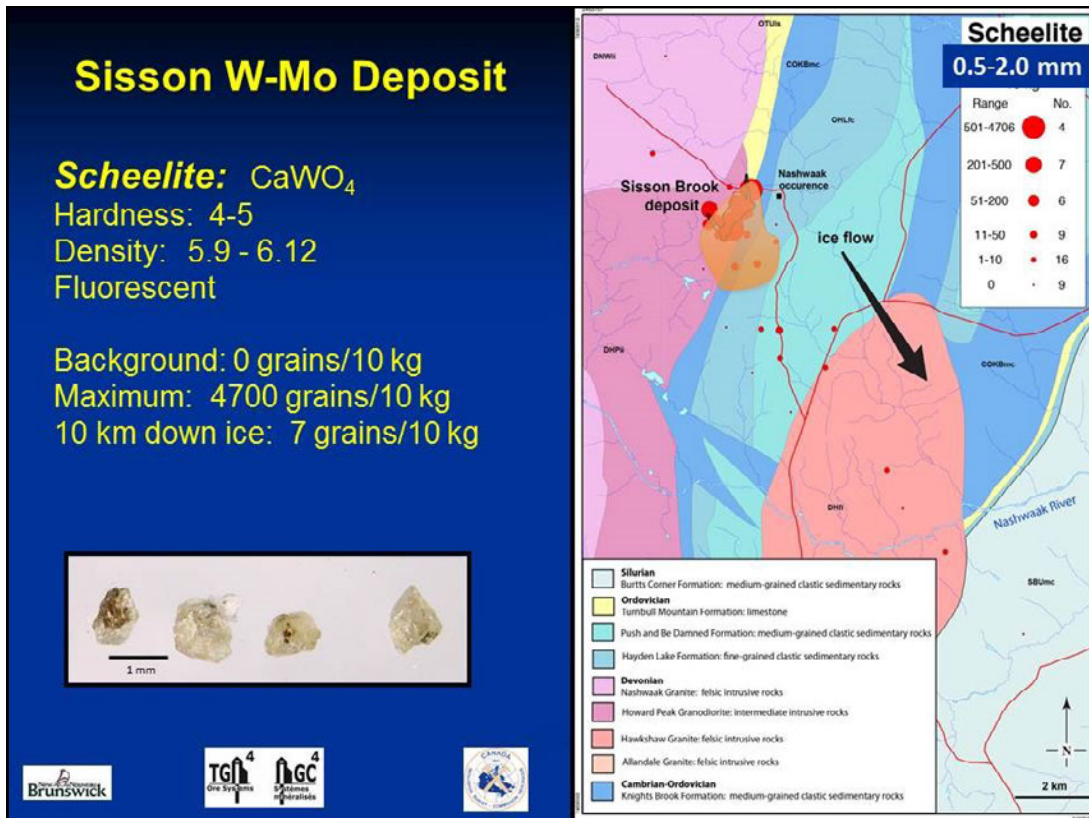
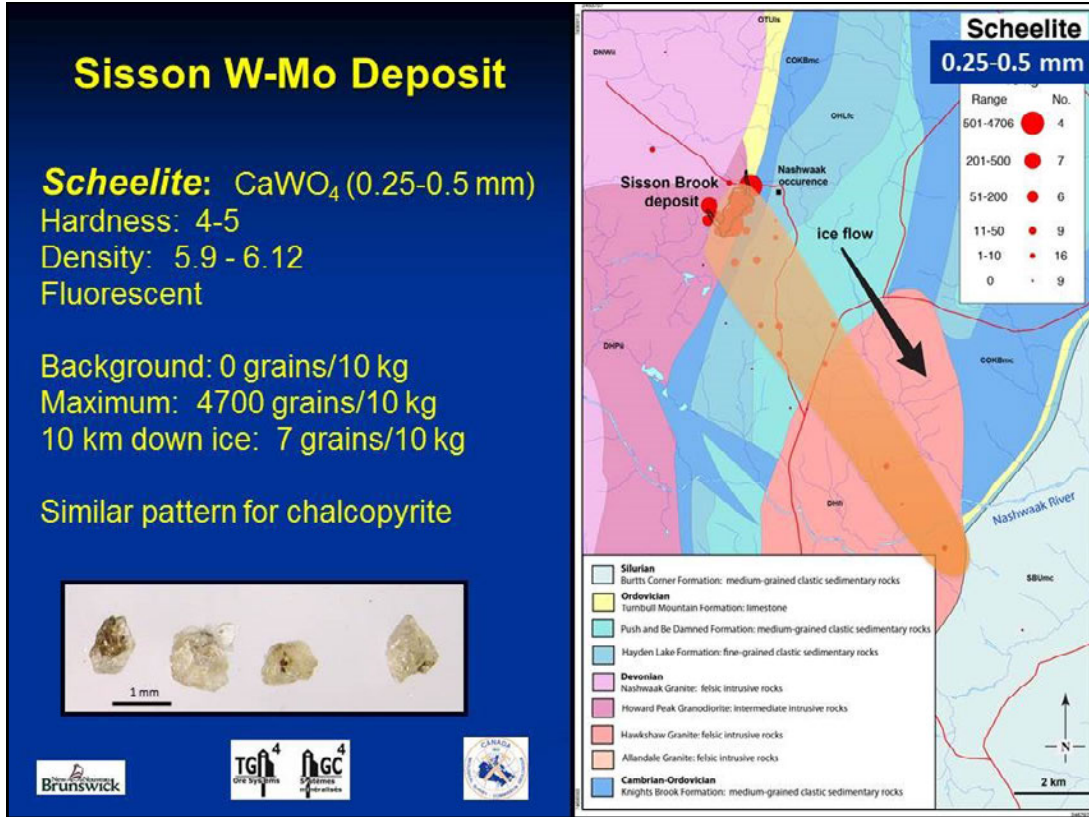








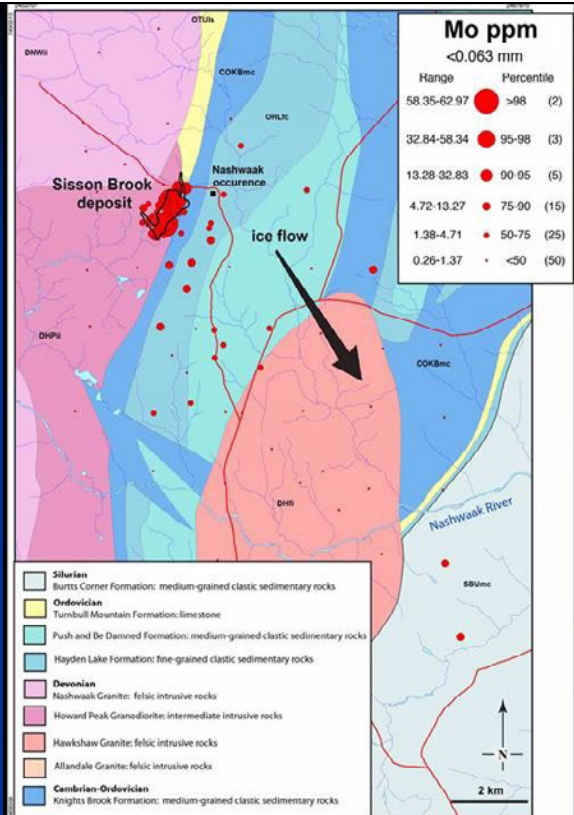




Sisson W-Mo Deposit

Molybdenum (<0.063 mm)
(borate fusion/ICP-MS)

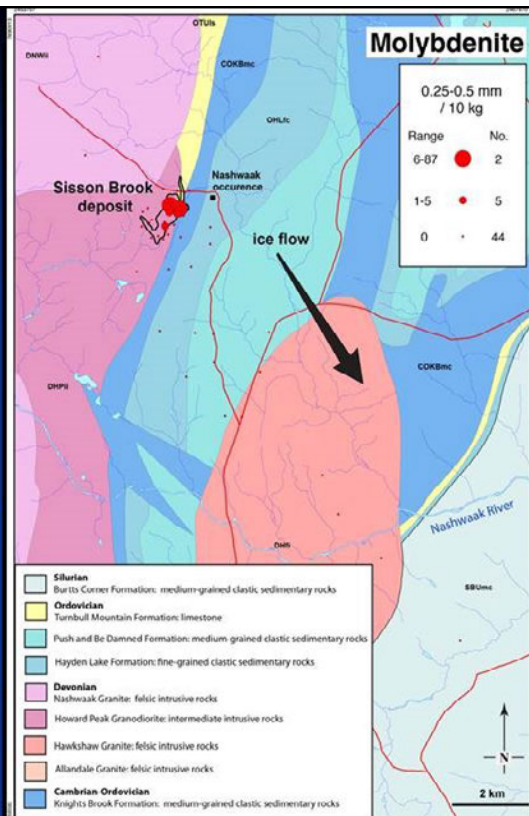
Background: 1 ppm
Maximum: 63 ppm
4 km down ice: 4 ppm



Sisson W-Mo Deposit

Molybdenite: MoS₂
Hardness: 1
Density: 5.5

Background: 0 grains/10 kg
Maximum: 87 grains/10 kg
Minimal glacial dispersal



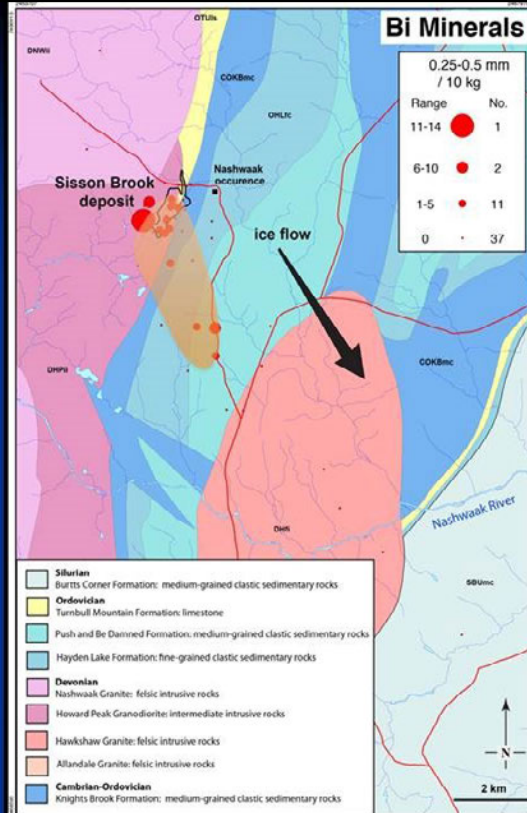
Sisson W-Mo Deposit

Bismuth Minerals:

Hardness: 2 to 4
Density: 6.8 to 9
Colour: silver grey-dark grey

Background: 0 grains/10 kg
Maximum: 14 grains/10 kg
4 km down ice: 4 grains/10 kg

Native Bismuth Bi
Bismuthinite Bi_2S_3
Bismutite $\text{Bi}_2(\text{CO}_3)_2\text{O}_2$
Joseite $\text{Bi}_4(\text{S,Te})_3$

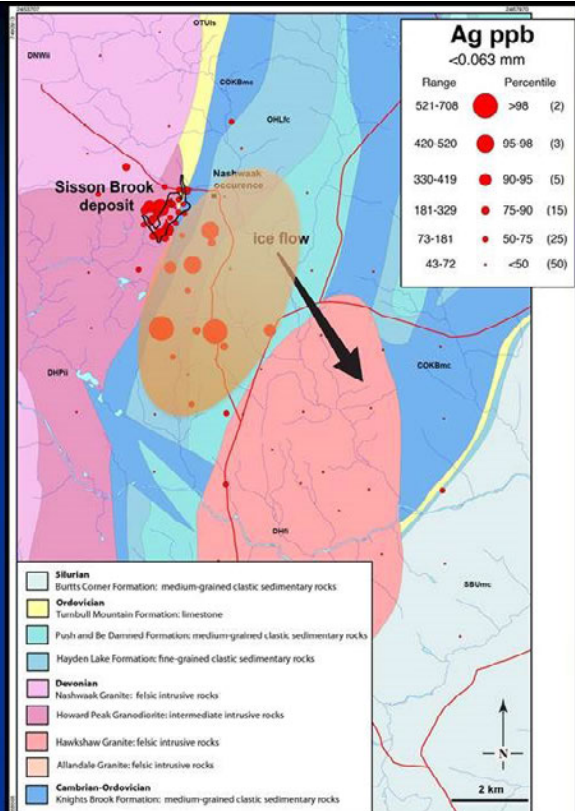


Sisson W-Mo Deposit

Silver (<0.063 mm) (aqua regia/ICP-MS)

Background: 72 ppb
Maximum: 708 ppb

- Similar patterns for: Pb, As, In
- Distal expression of intrusion?
or
- Mineralization from a different source in Ordovician-Silurian Tetagouche sedimentary rocks?



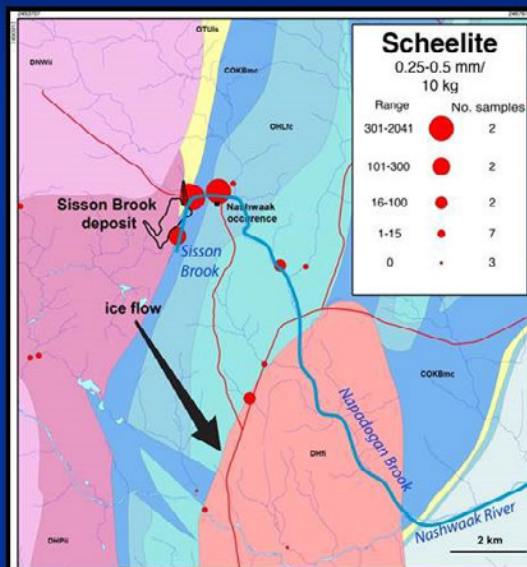
Stream Sediment Sampling Sisson 2012



- Stream samples collected at 16 sites up stream, overlying, and up to 8 km down stream from the deposit
- Collected stream water, silt, and bulk sample (10-12 kg) for heavy minerals
- Characterize scheelite abundance, size and shape for comparison with grains in till



Sisson W-Mo Deposit

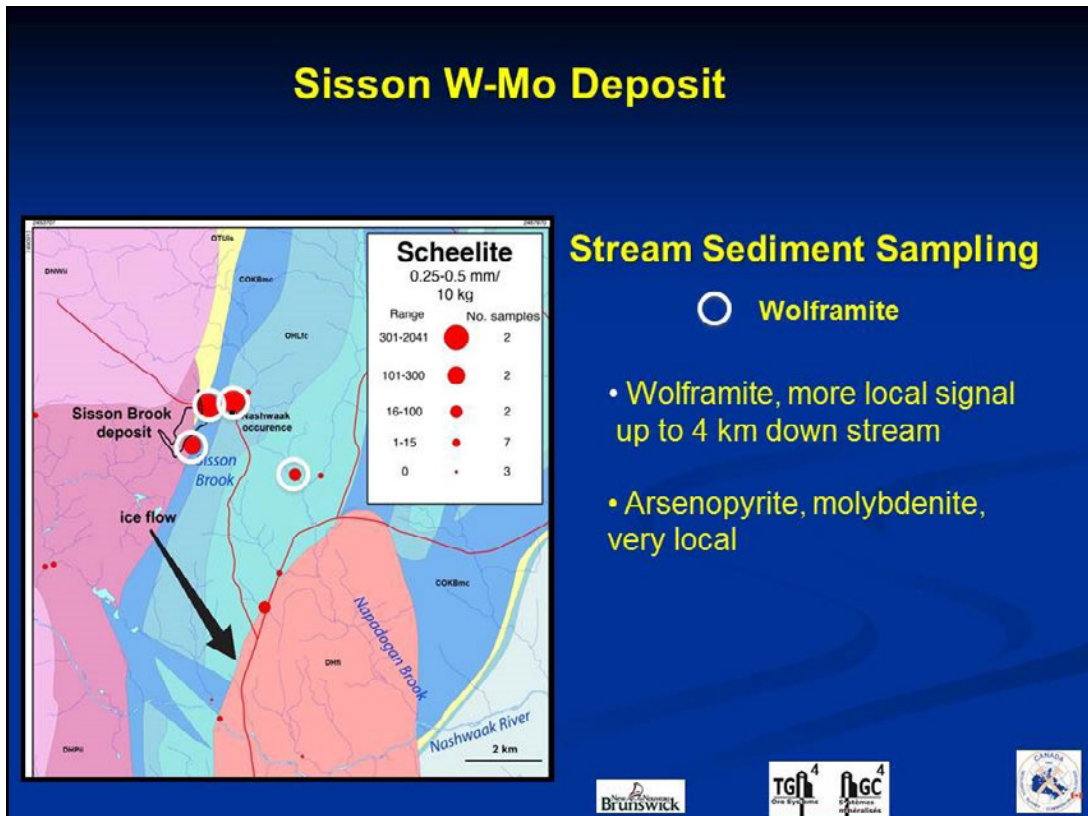
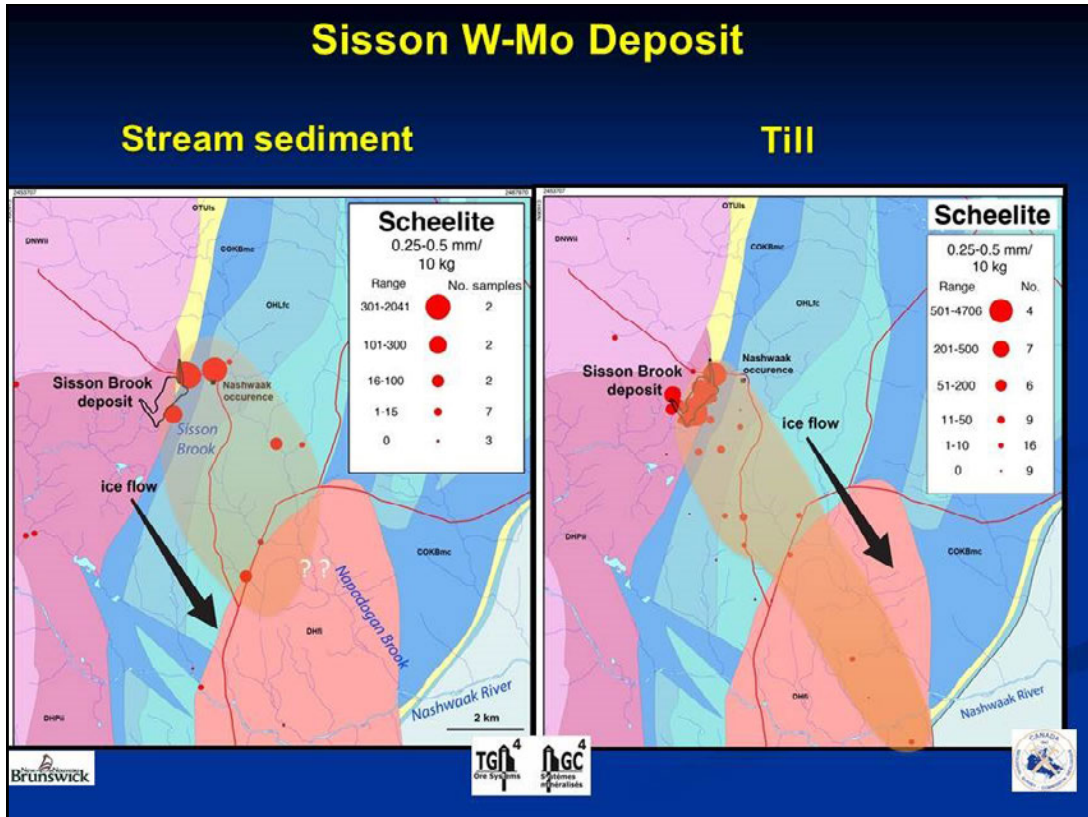


Stream Sediment Sampling

Well developed scheelite signature in stream sediments at least 4 km down stream

Background: 0 - 8 grains/10 kg
Maximum: 2041 grains/10 kg





Implications for Exploration - Sisson

SCHEELITE

- Indicator mineral of W mineralization, in till and stream sediments; Northcliff is currently using the methodology developed in this project.
- Physically robust, survives glacial and fluvial transport
- Silt to sand sized presence of coarse scheelite (>0.5 mm) indicator of proximity to source
- Abundant, 100s to 1000s of grains proximal to source
- Developed systematic method for scheelite grain counting under UV light, new service at commercial heavy mineral lab
- Wolframite, molybdenite, bismuth minerals, chalcopyrite, arsenopyrite also present
- Sample density: detectable and efficient at 5 km²
- **ADVANTAGES:** physical evidence of the presence of mineralization, morphology, and chemistry provide information about distance to, and nature of, bedrock source



Photo: Scheelite grains under UV light



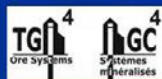
Implications for Exploration - Sisson

TILL GEOCHEMISTRY

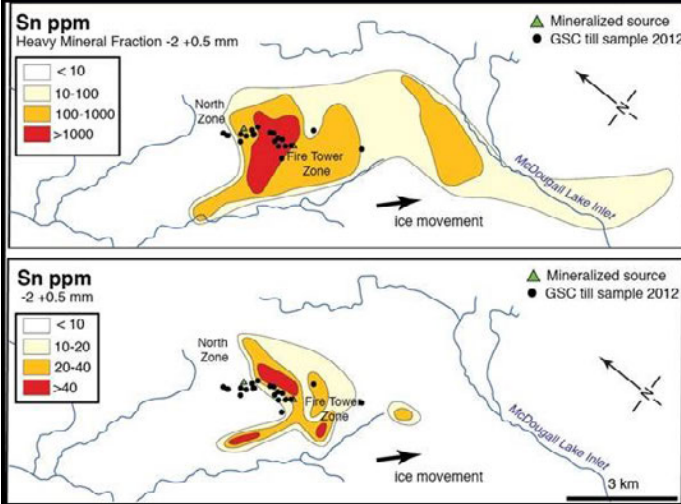
- Pathfinder elements for Sisson: W, Mo, Cu, Bi, As, Sn, Cd, Ag, In, Zn, Pb
- Recommend till geochemistry be used in combination with indicator minerals methods

NASHWAAK OCCURRENCE (900 m E of Sisson Deposit)

- Multi-element till geochemical anomaly overlying Tetagouche Group rocks, may be related to the intrusion? or other mineralization?
- Warrants further investigation



Mount Pleasant Sn-W-Mo-Bi-In Deposit



Glacial dispersal train identified by Szabo (1975) using till geochemistry: Sn, Cu, Pb, Zn, As

Dispersal train best defined by till geochemistry of heavy mineral fraction

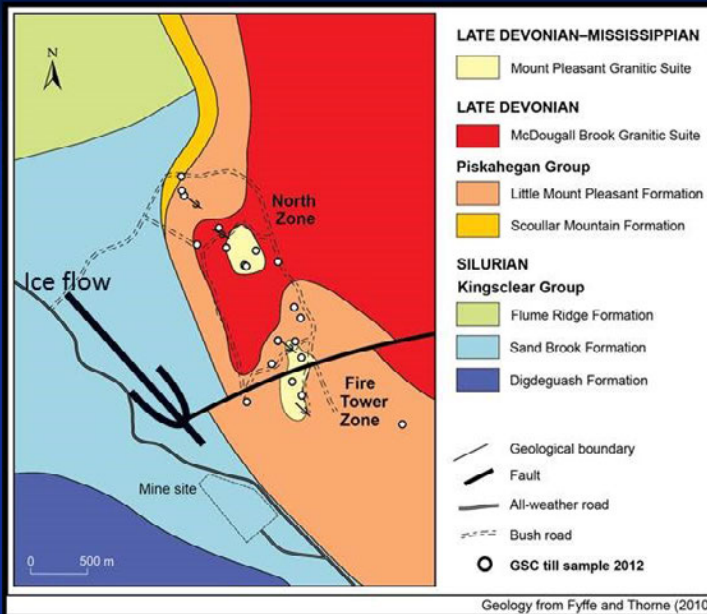
Polymetallic deposit, ideal test site for indicator mineral study of an intrusion-hosted deposit, focus on cassiterite and scheelite

Ideal test site for till geochemical study of indium

(Szabo, 1975)



Mount Pleasant Sn-W-Mo-Bi-In Deposit



2012 Till Sampling

25 till samples (15 kg)

Up-ice, overlying and down-ice of North Zone



