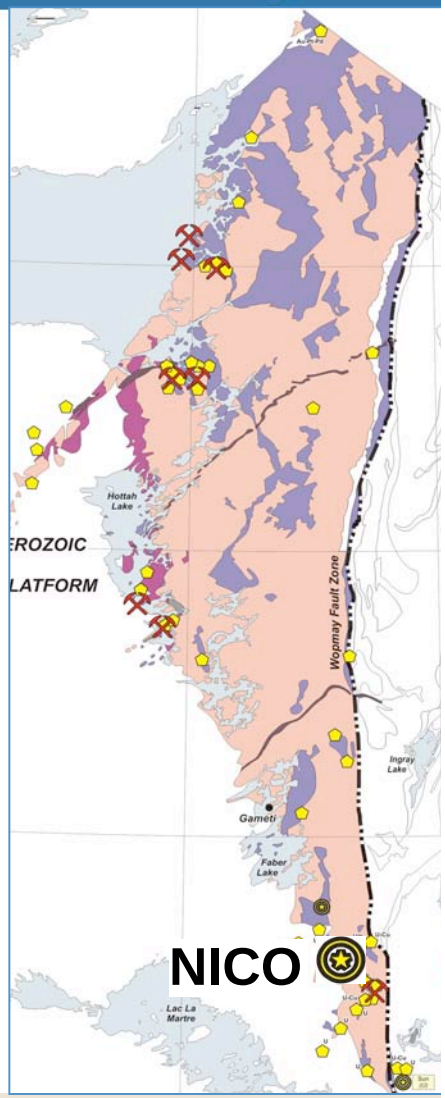
HEAVY MINERAL SIGNATURE OF THE NICO CO-AU-BI DEPOSIT, GREAT BEAR MAGMATIC ZONE, NORTHWEST TERRITORIES, CANADA

I. McMartin, L. Corriveau, G. Beaudoin,
S. Averill and I. Kjarsgaard



24th IAGS Workshop B
Indicator Mineral Exploration Technology
May 31, 2009

Ressources naturelles Canada
Natural Resources Canada
GEM
TGI3 Program
NORTHWEST TERRITORIES GEOSCIENCE OFFICE
>>> www.nwtgeoscience.ca
Canada

Project Objectives

Great Bear Magmatic Zone Iron Oxide Copper-Gold (IOCG) project

Refine IOCG(U) exploration criteria and genetic models to increase our ability in finding IOCG mineralization in the GBMZ and in other Canadian Shield IOCG settings

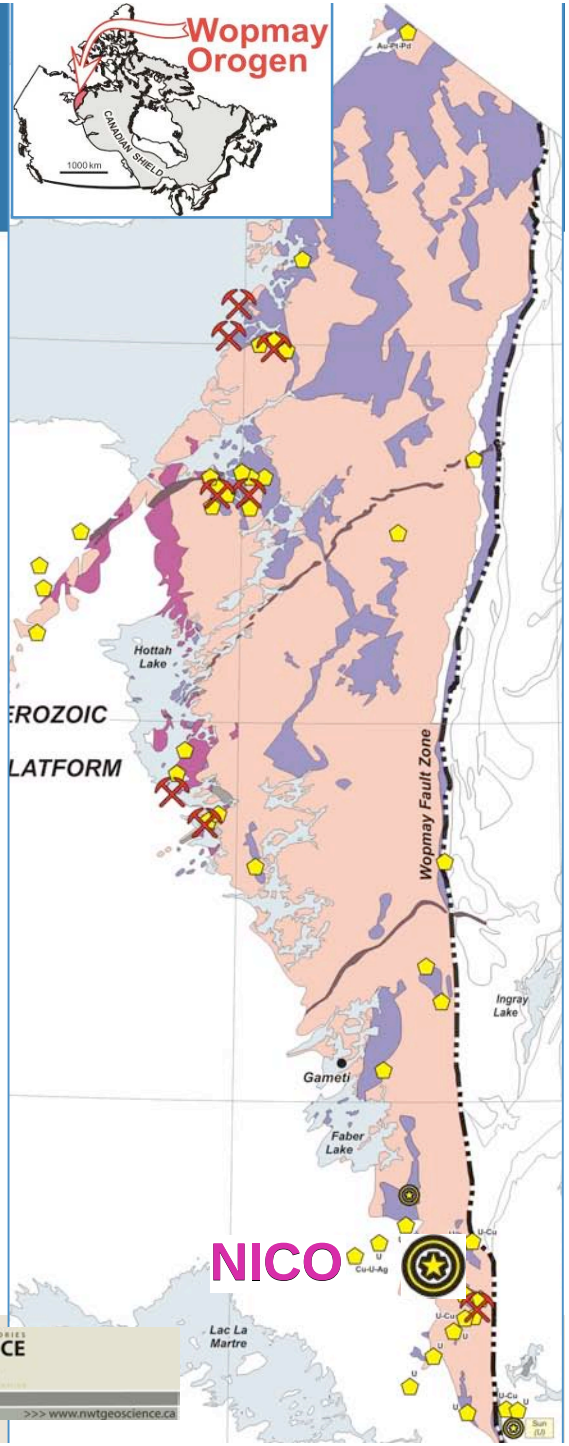
Sub-project Objectives

Indicator mineral and geochemical method development for Iron Oxide Copper-Gold exploration

Establish a practical guide to geochemical and indicator mineral exploration for IOCG/U mineralization in glaciated terrain

- Document IOCG rock and till indicator mineral & geochemical signatures from deposits in the Great Bear
- Develop and test new techniques to evaluate uniqueness and distinctiveness of IOCG minerals
- Extract criteria to help in interpretation of existing and future till/esker/stream sediment surveys

Orientation study around the NICO Co-Au-Bi deposit in the GBMZ in 2007



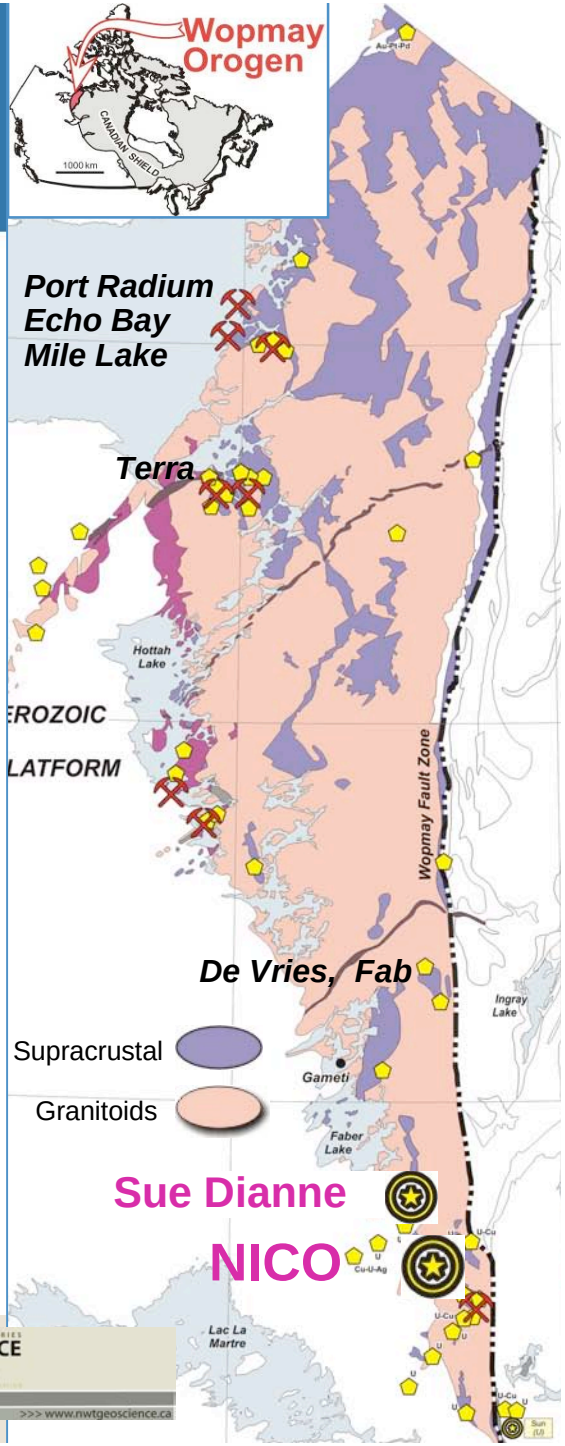
Regional Context - NICO

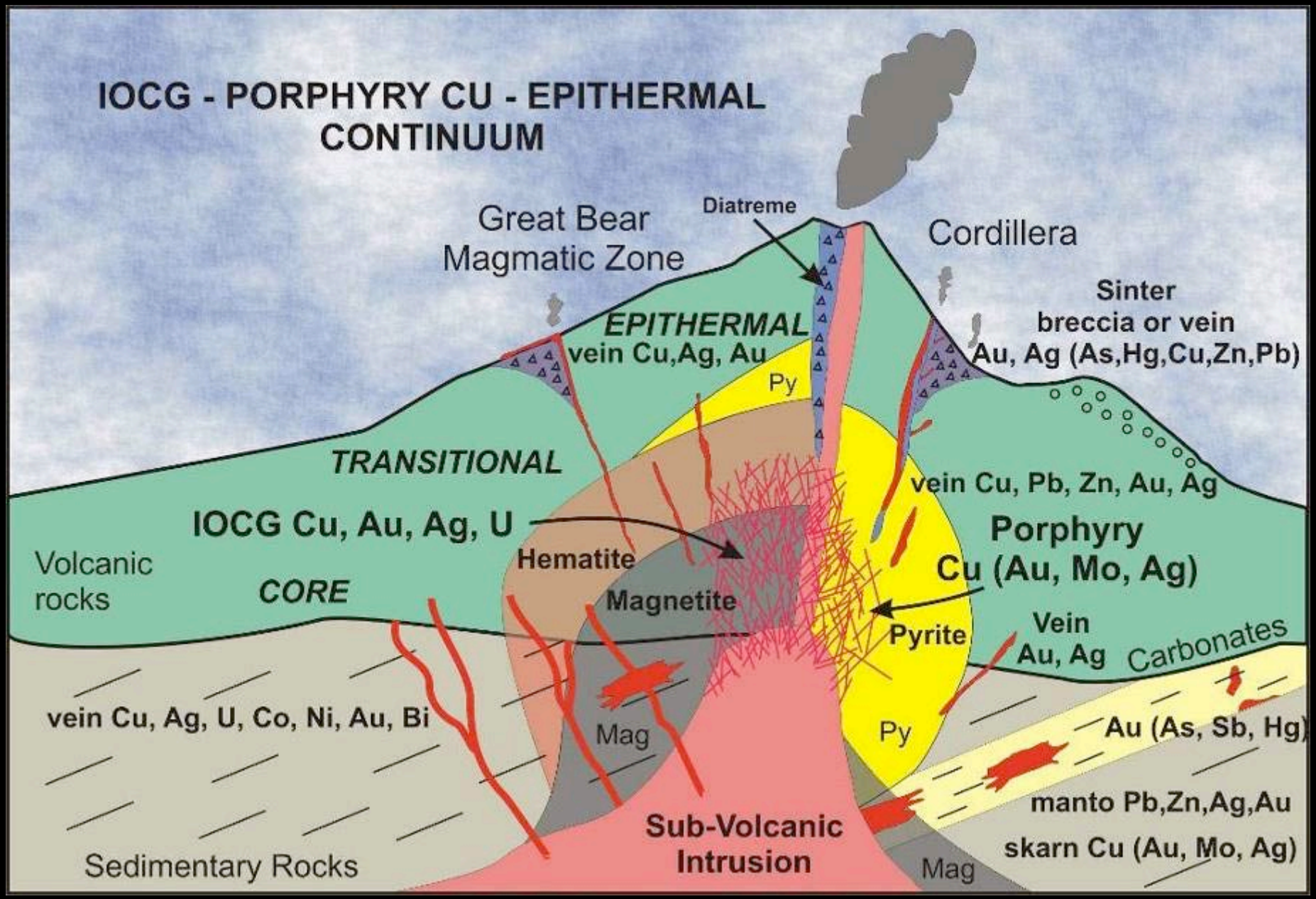
The Great Bear Magmatic Zone, Wopmay Orogen, NWT Canada's premier IOCG setting

NICO: 21.8 Mt @ 1.08g/t Au, 0.13% Co, 0.16% Bi

Sue Dianne: 17 Mt @ 0.72% Cu, 2.7g/t Ag

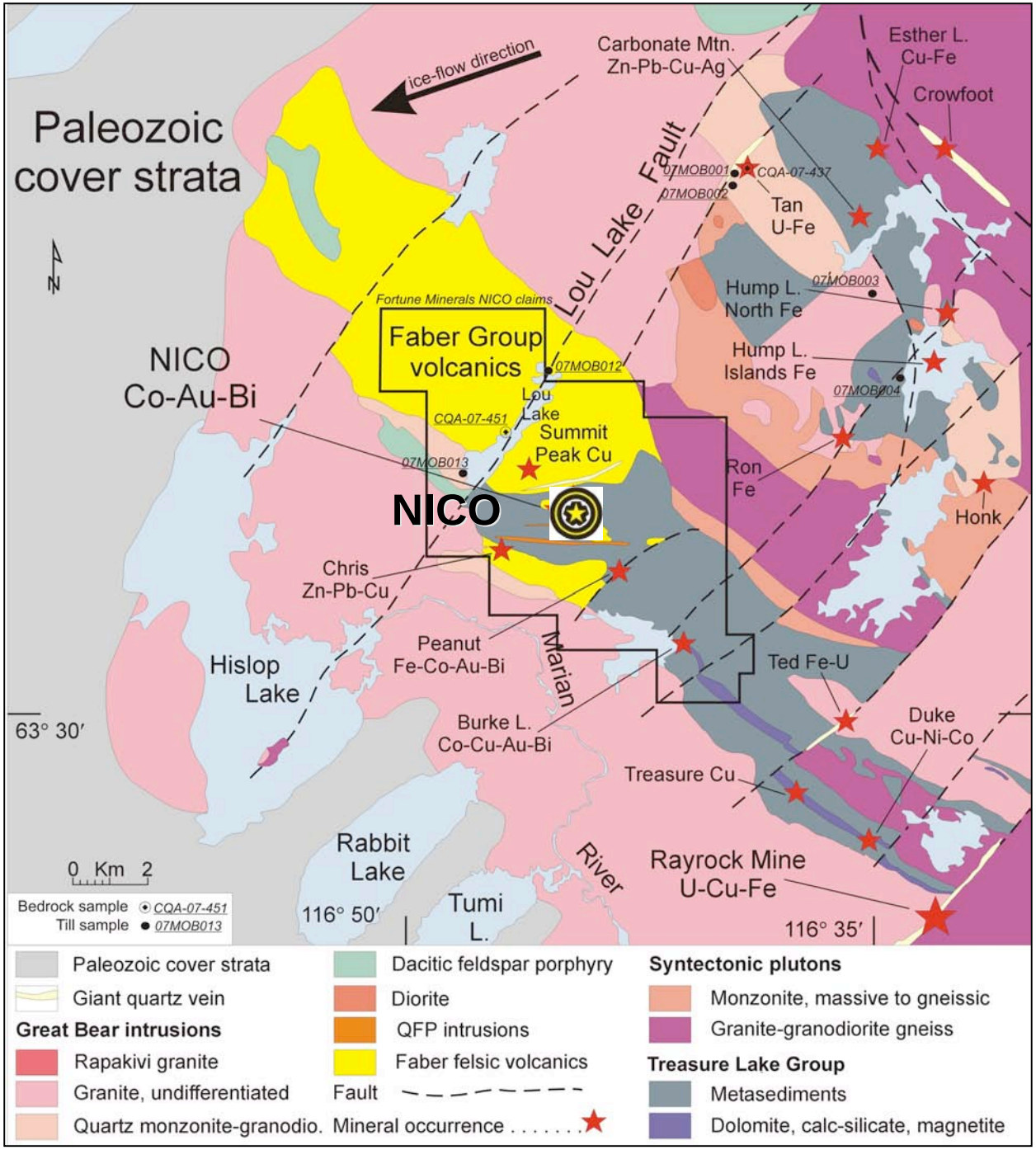
- **polymetallic U/Ag past-producing mines, prospects or mineral occurrences along 450 km of this magmatic arc**
- **variety of IOCG system and mineralization types**
- **polymetallic, with base, precious and strategic metals as well as energy (Cu, Bi, Co, Ag, Au, U, Ni, etc.)**
- **large alteration footprint – allow for effective regional scoping of IOCG(U) systems**
- **potential for some major discoveries**

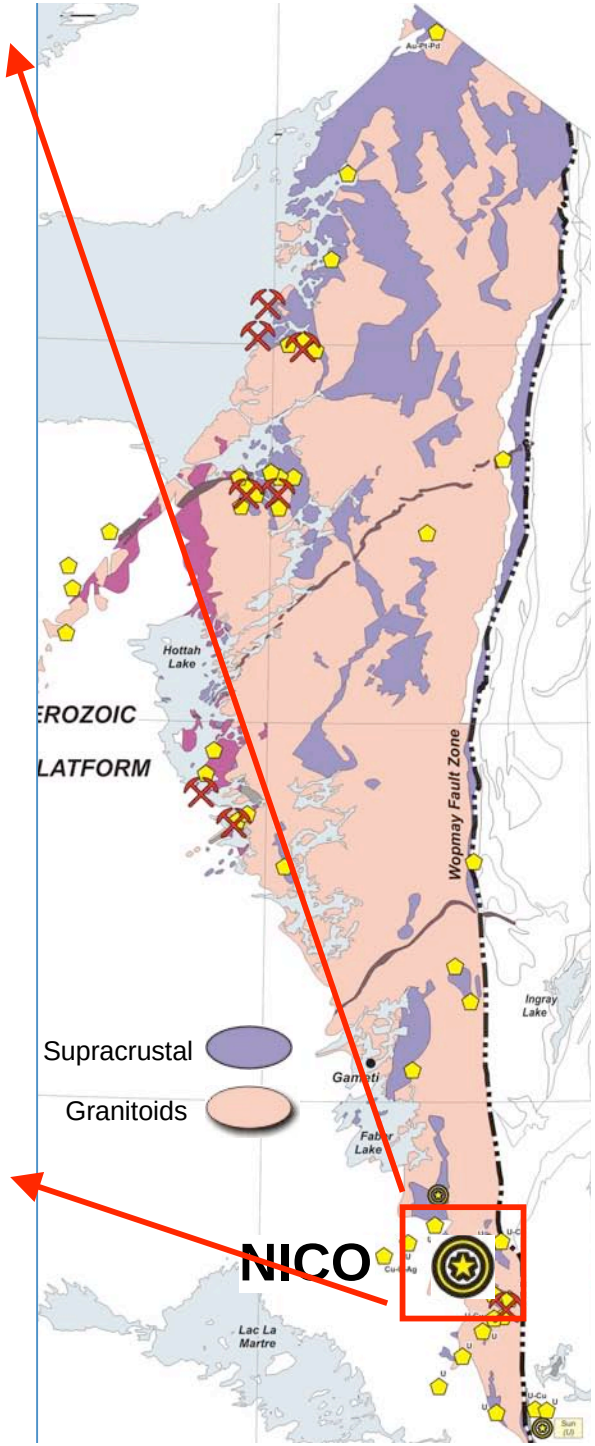


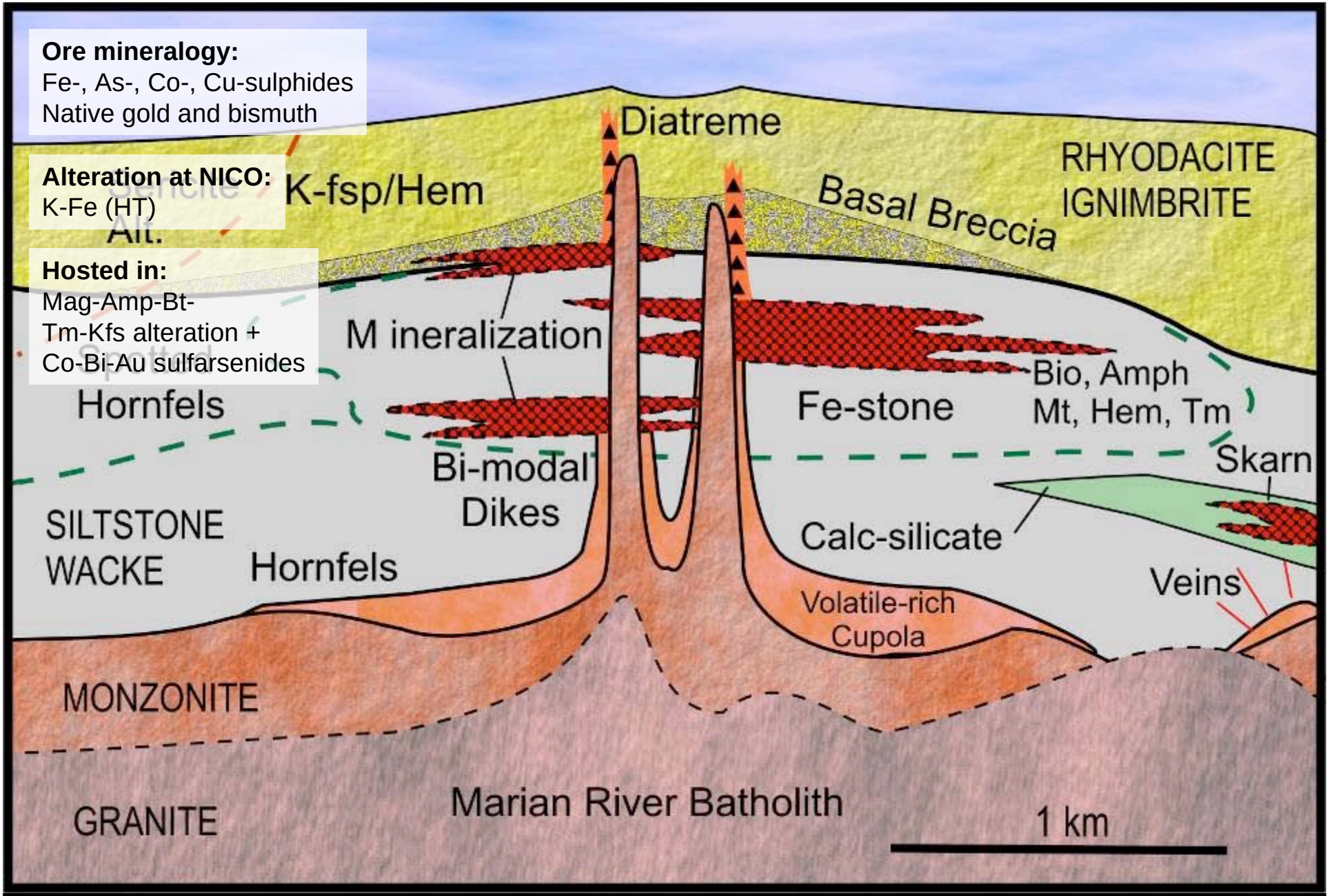


From Corriveau et al., 2008, YK Geoscience Forum

NICO test site

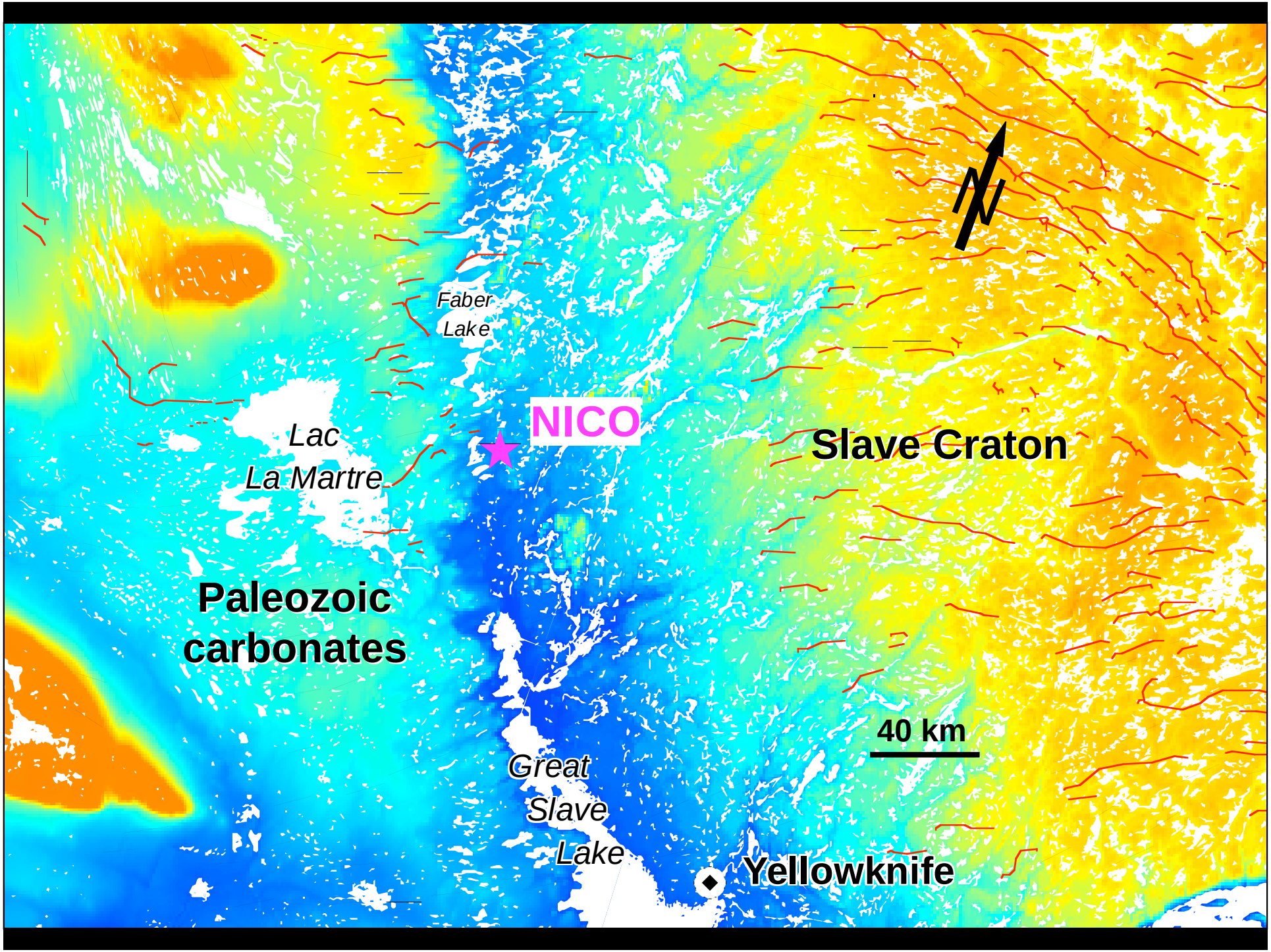

Paleozoic cover strata
ice-flow direction
Carbonate Mtn. Zn-Pb-Cu-Ag
Esther L. Cu-Fe
Crowfoot
Lou Lake Fault
07MOB001
CQA-07-437
07MOB002
Tan U-Fe
Hump L. North Fe
07MOB003
Hump L. Islands Fe
07MOB004
Fortune Minerals NICO claims
Faber Group volcanics
07MOB012
Lou Lake Summit Peak Cu
CQA-07-451
07MOB013
NICO Co-Au-Bi
NICO
Ron Fe
Honk
Chris Zn-Pb-Cu
Peanut Fe-Co-Au-Bi
Marian
Ted Fe-U
Hislop Lake
Burke L. Co-Cu-Au-Bi
Duke Cu-Ni-Co
63° 30′
Treasure Cu
Rabbit Lake
River
Rayrock Mine U-Cu-Fe
0 Km 2
Bedrock sample CQA-07-451
Till sample 07MOB013
116° 50′
Tumi L.
116° 35′
Paleozoic cover strata
Giant quartz vein
Great Bear intrusions
Rapakivi granite
Granite, undifferentiated
Quartz monzonite-granodio.
Dacitic feldspar porphyry
Diorite
QFP intrusions
Faber felsic volcanics
Fault
Mineral occurrence
Syntectonic plutons
Monzonite, massive to gneissic
Granite-granodiorite gneiss
Treasure Lake Group
Metasediments
Dolomite, calc-silicate, magnetite

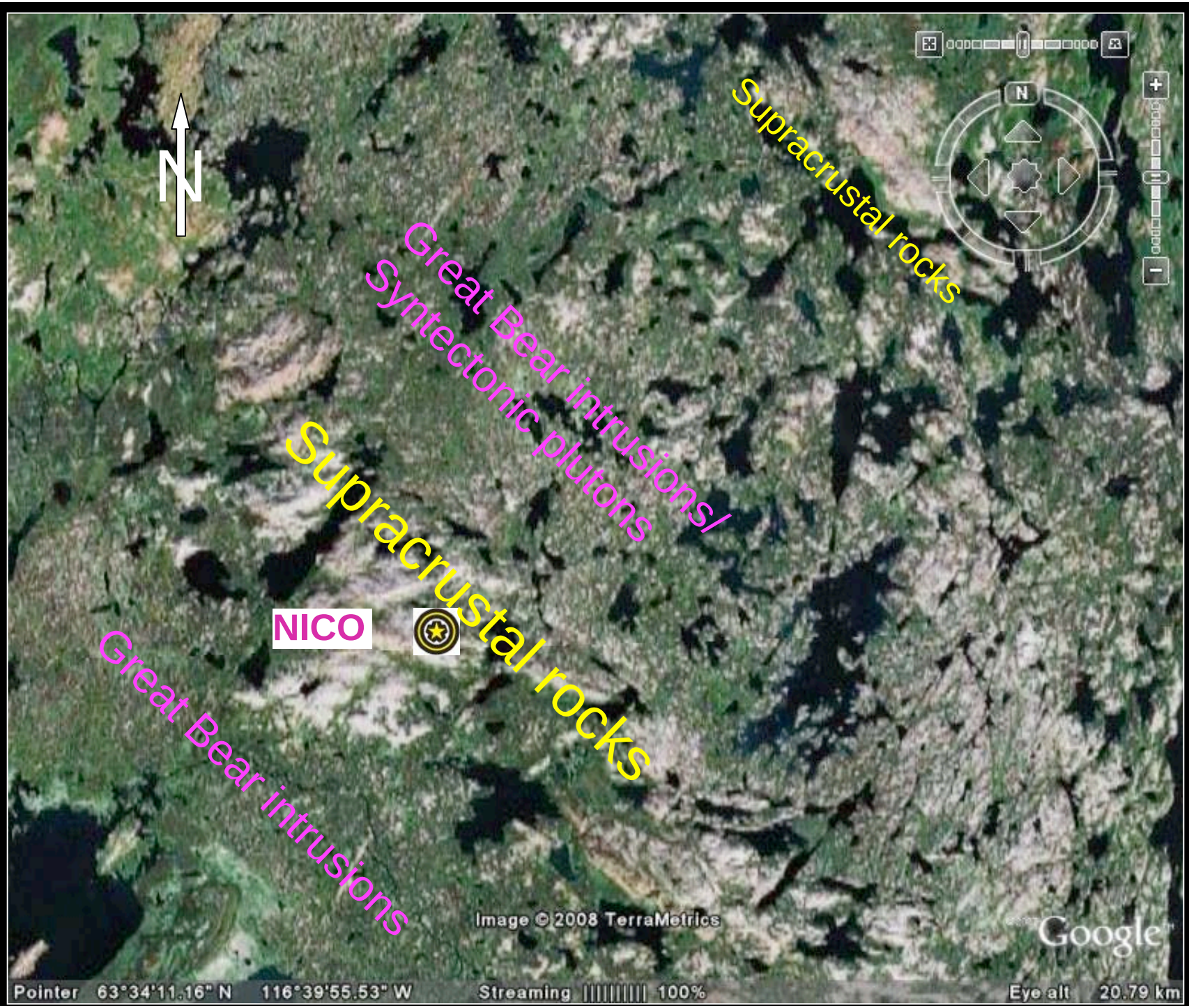

Hottah Lake
EROZOIC
LATFORM
Wopmay Fault Zone
Ingray Lake
Supracrustal
Granitoids
NICO
Lac La Martre



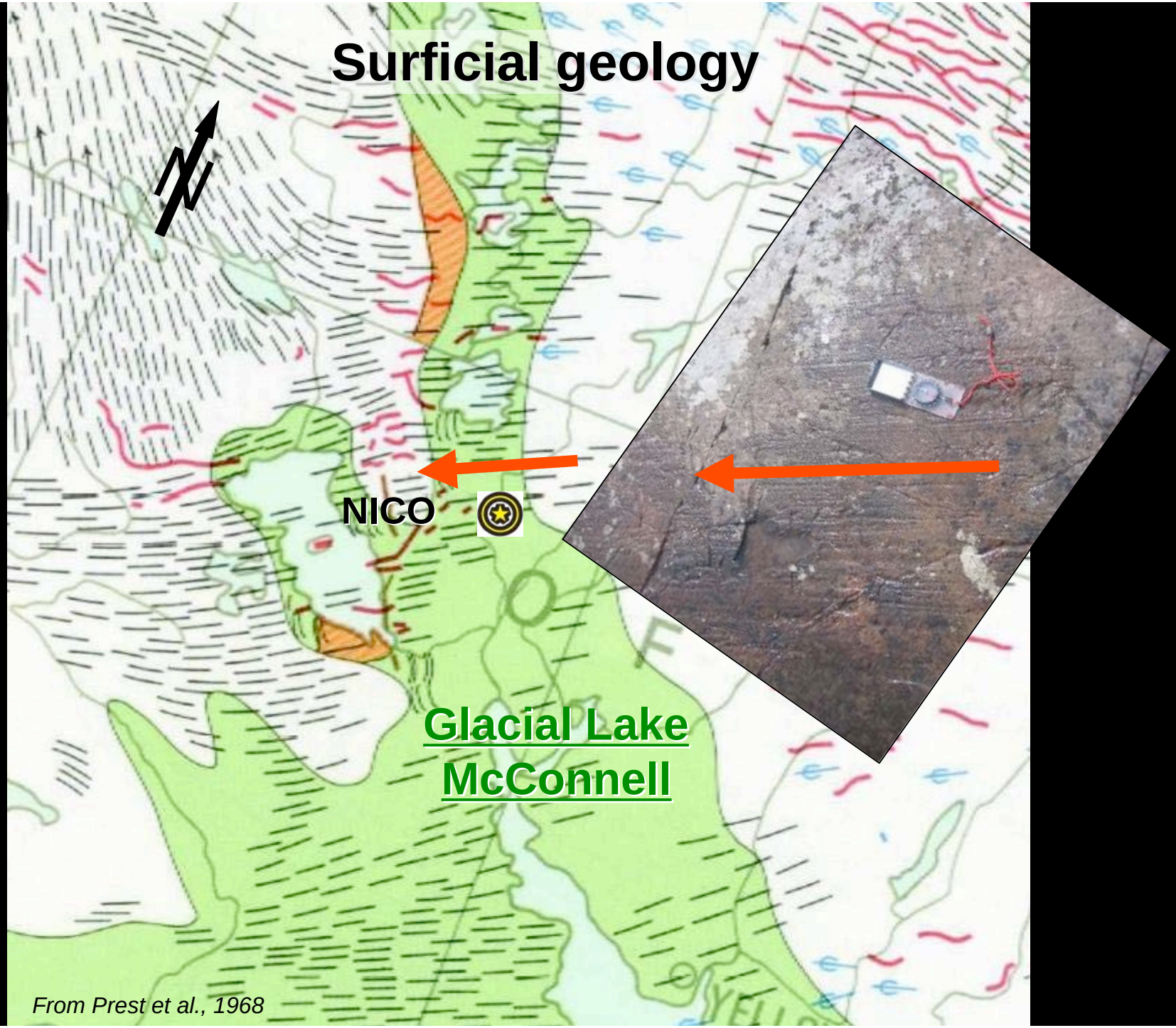
NICO Setting Schematic

From Mumin et al., 2008, GAC 2008 Short Course


Faber
Lake
NICO
Lac
La Martre
Slave Craton
Paleozoic
carbonates
40 km
Great
Slave
Lake
Yellowknife

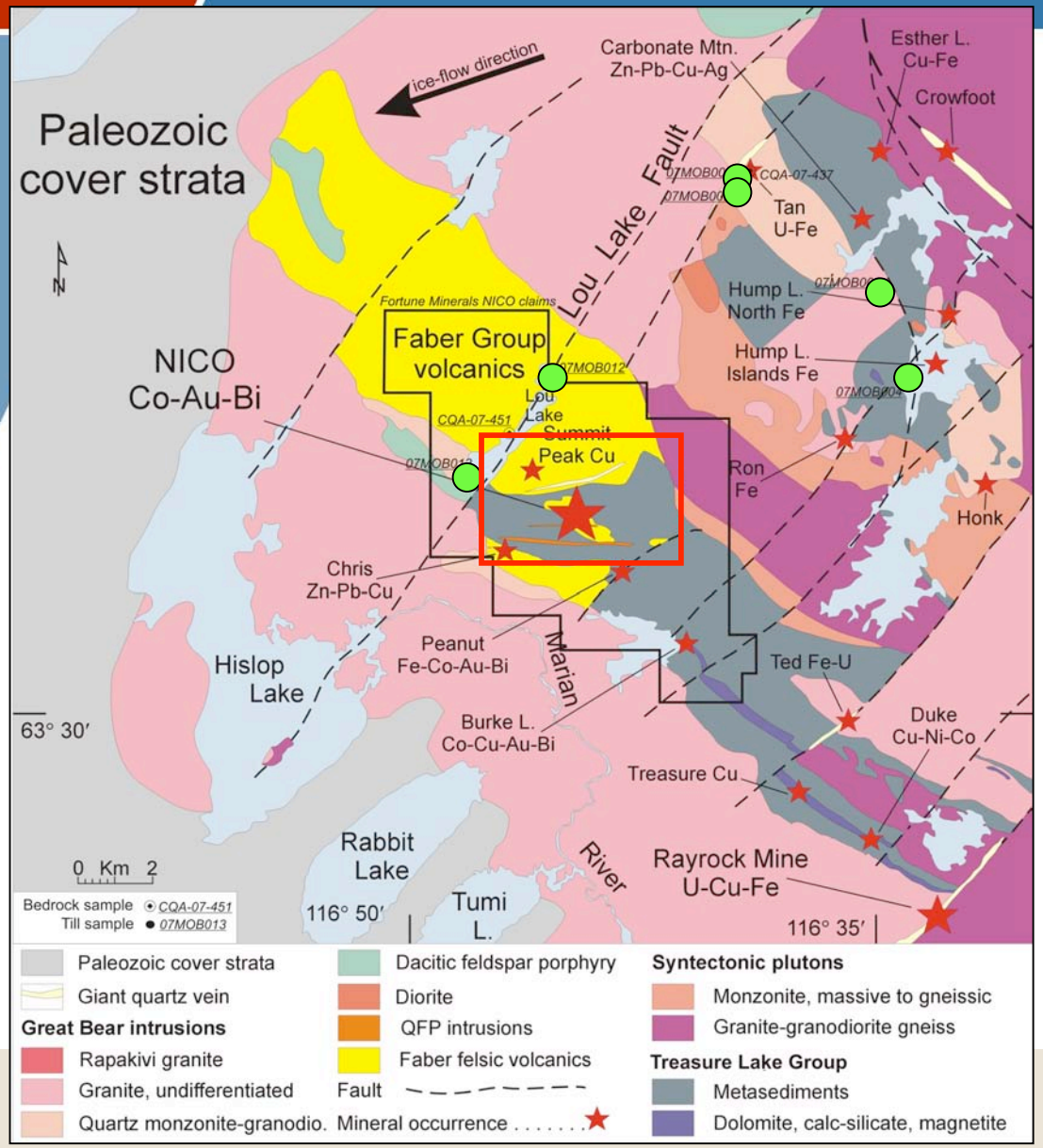

N
Supracrustal rocks
Great Bear intrusions/
Syntectonic plutons
Supracrustal rocks
NICO
Great Bear intrusions
Image © 2008 TerraMetrics
Google
Pointer 63°34'11.16" N 116°39'55.53" W
Streaming 100%
Eye alt 20.79 km

Surficial geology



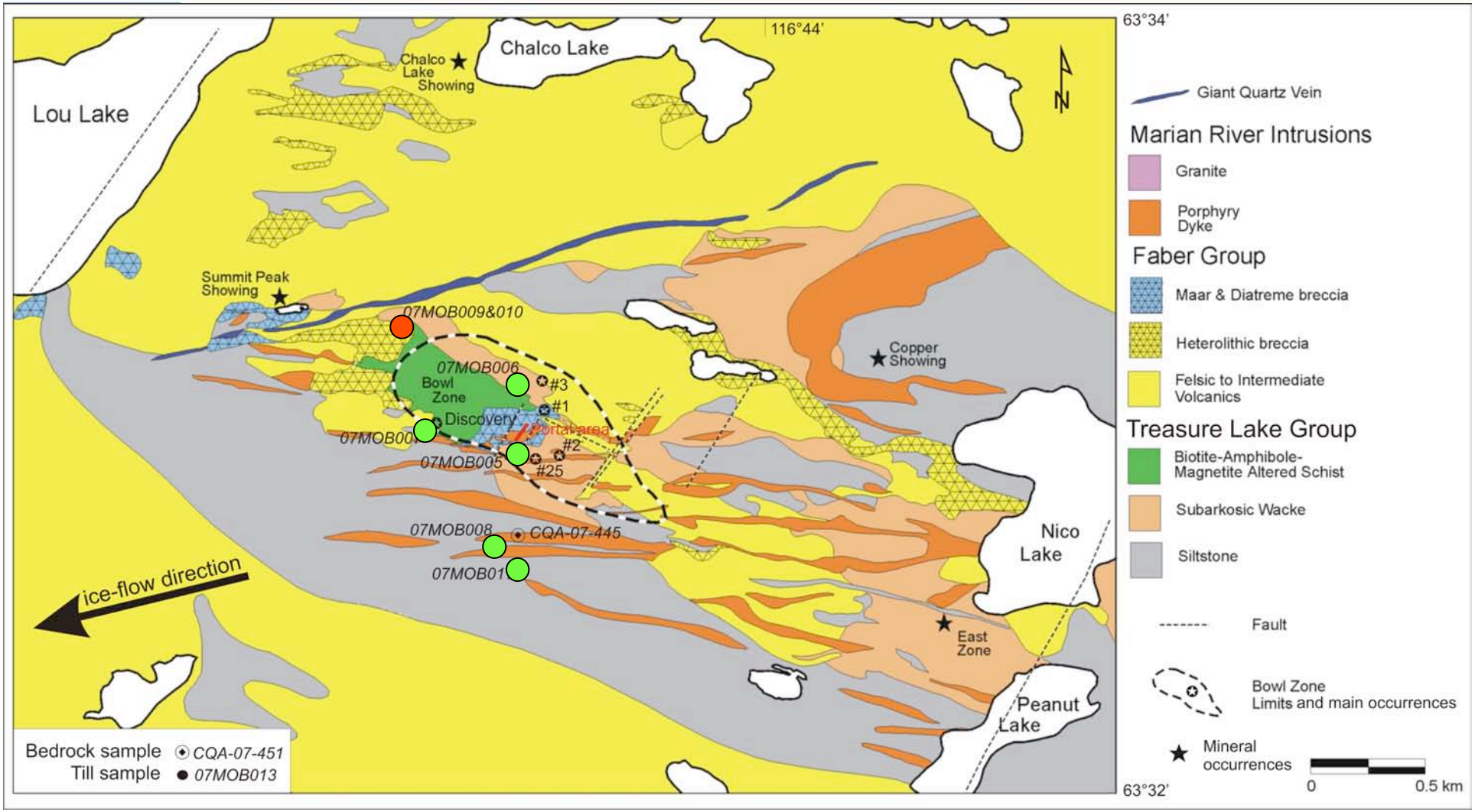
From Prest et al., 1968

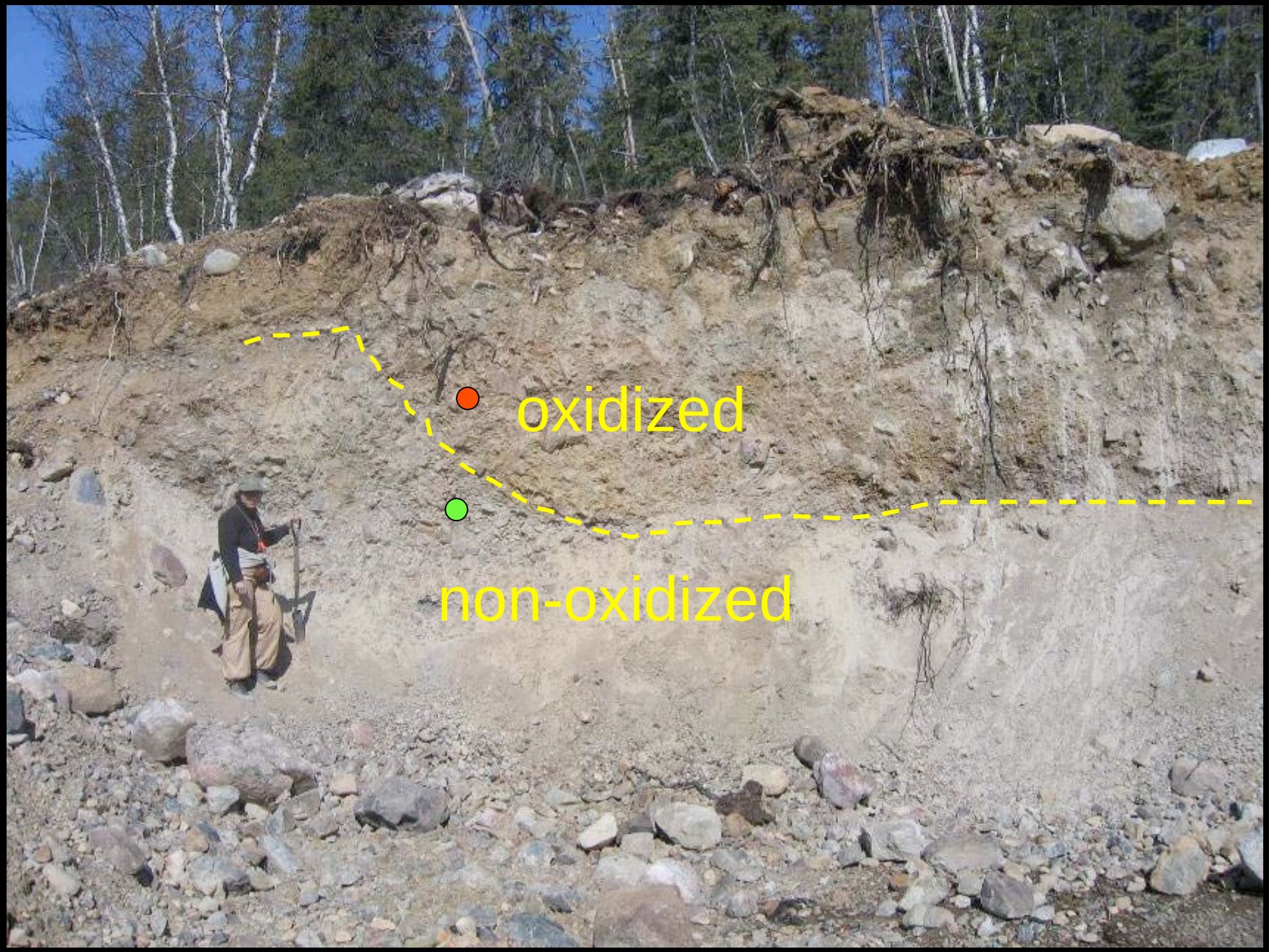
Till sampling



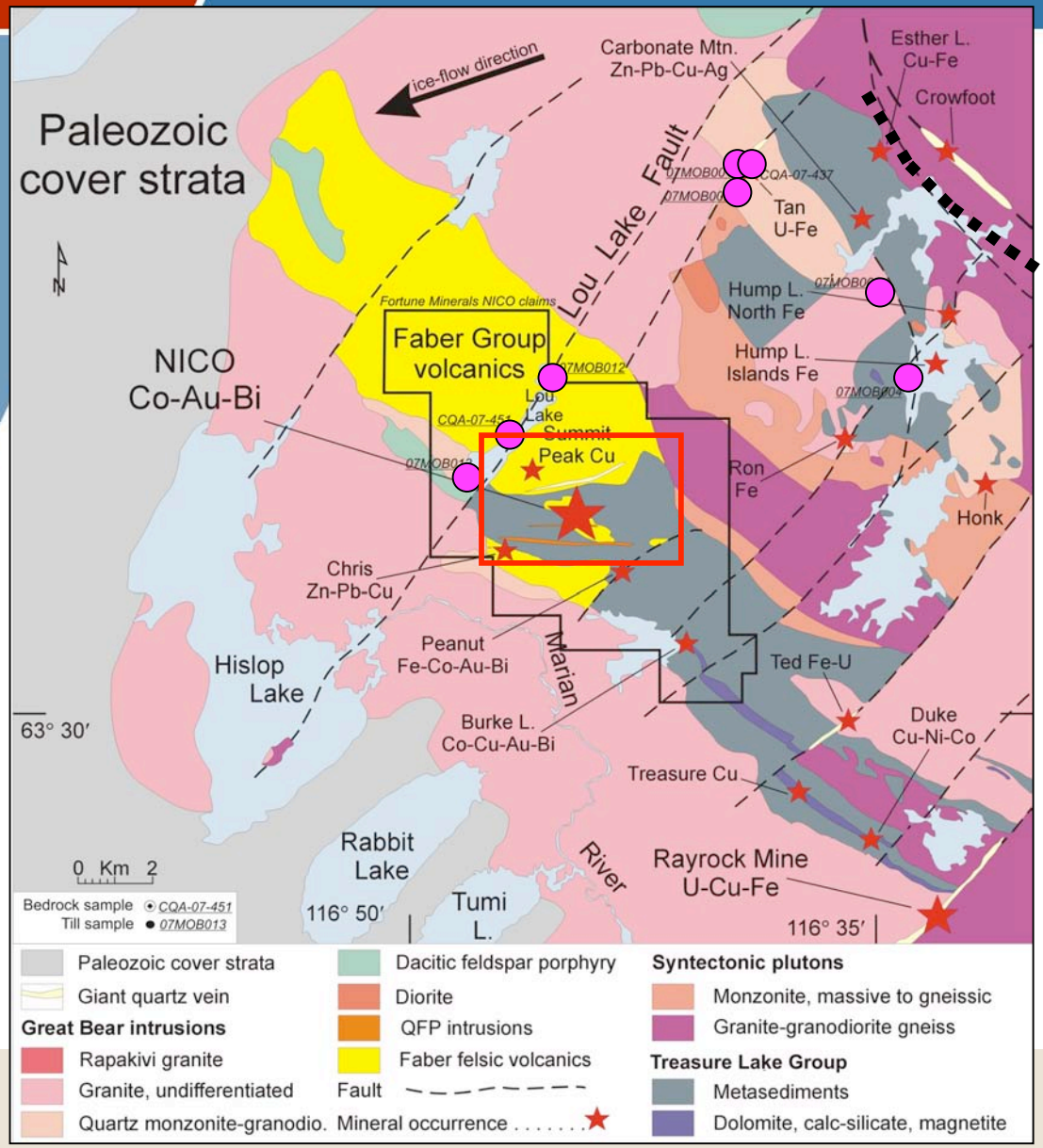
- ✓ **13 till samples collected over and down-ice (west) from mineralization, host rocks and alteration zones, and in background terrain (3 and 10 kg)**

Till sampling



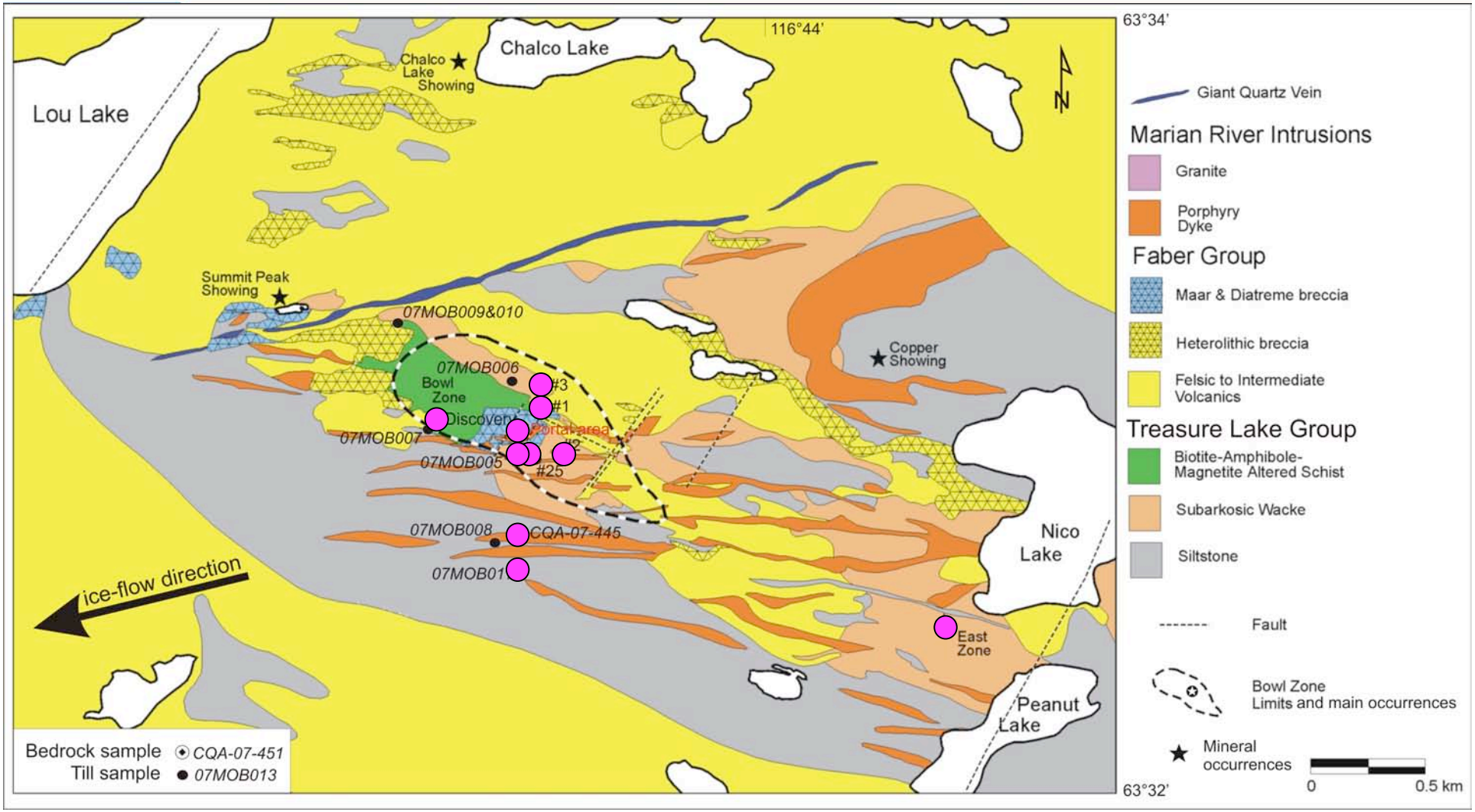

oxidized
non-oxidized

Bedrock sampling



- ✓ **27 representative bedrock samples at each drift sampling site + additional sites in the vicinity of and at nearby occurrences (2-3 kg)**

Bedrock sampling



Analytical procedures

Glacial sediments

- Matrix texture and color
- Pebble lithology (4-8 mm), 200 counts
- <0.063 mm and <0.002mm: aqua regia, ICP-OES + MS, 36 elements package
- <0.063 mm: Au + 34 elements by INAA; Au + PGEs by fire assay
- Heavy mineral processing and picking (0.18-2 mm); gold grain counts (<2 mm)
- SEM examination and photography of selected grains; electron microprobe of selected grains
- NFM-HMCs: Au + PGEs by FA-ICP-MS on <2 mm, pulverized; ICP-MS, aqua regia on <0.063 mm; binocular examination of 0.063-0.25 mm

Bedrock samples

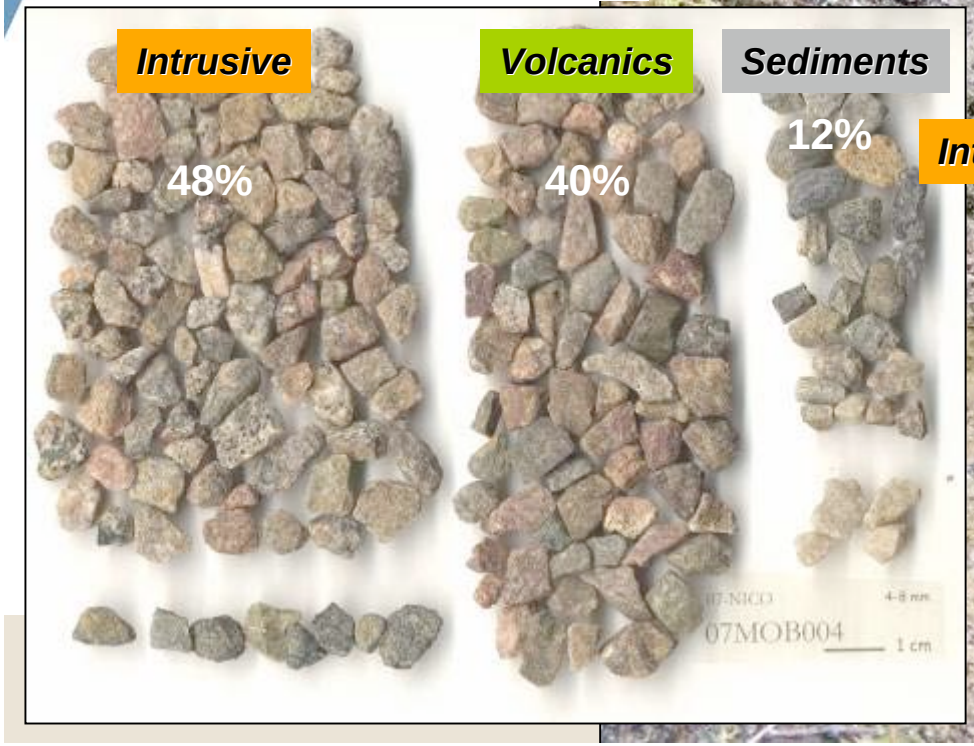
- Detailed pre-processing binocular microscope description
- Heavy mineral picking (0.18-2 mm) and gold grain counts on pulverized samples
- SEM examination and photography of selected grains; electron microprobe of selected grains
- Lithogeochemistry

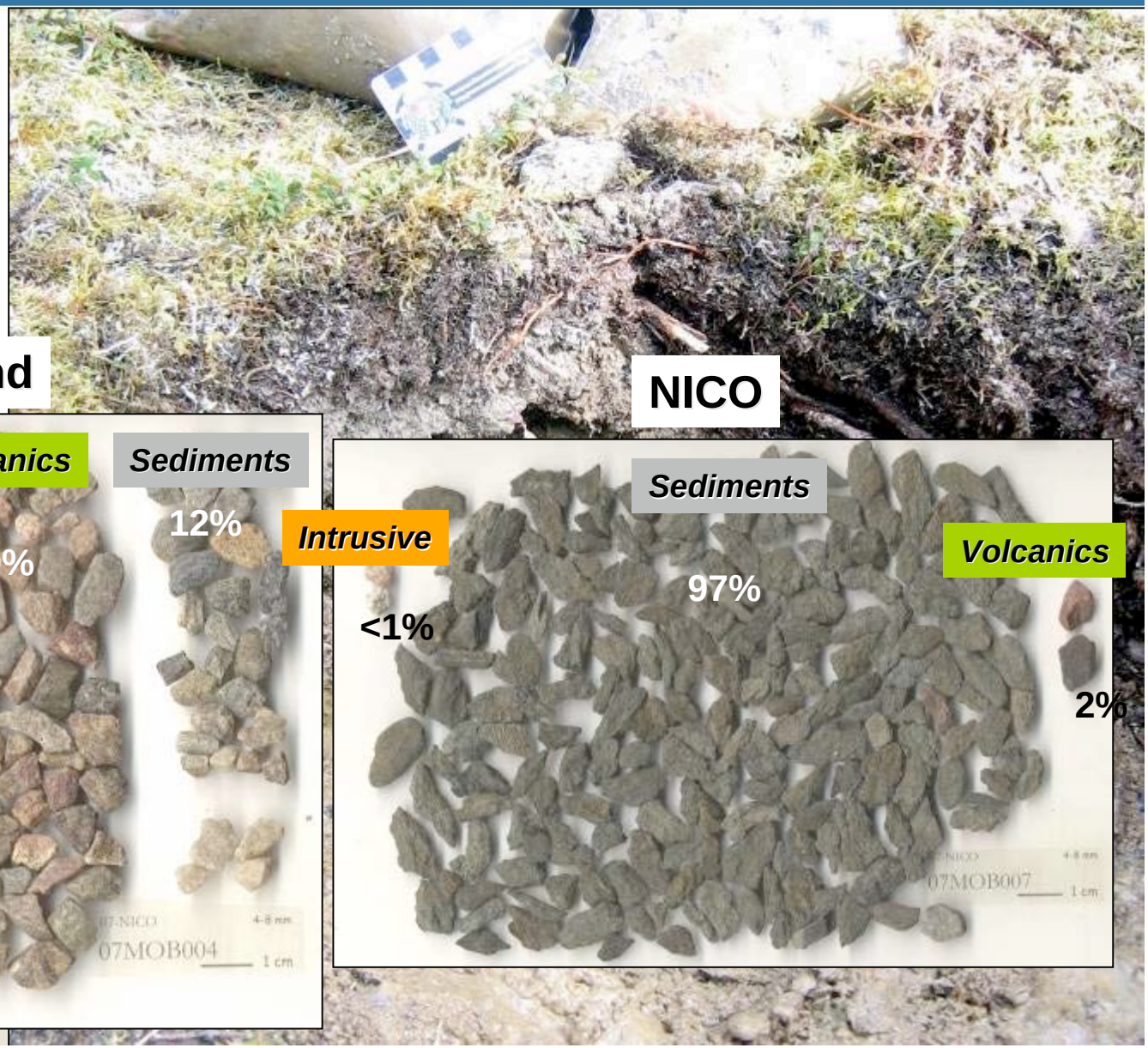
Results

Till is locally derived:

- Olive brown color
- Sandy silt texture
- Local pebble provenance
- Vary from 52 to 99 % supracrustals

Background

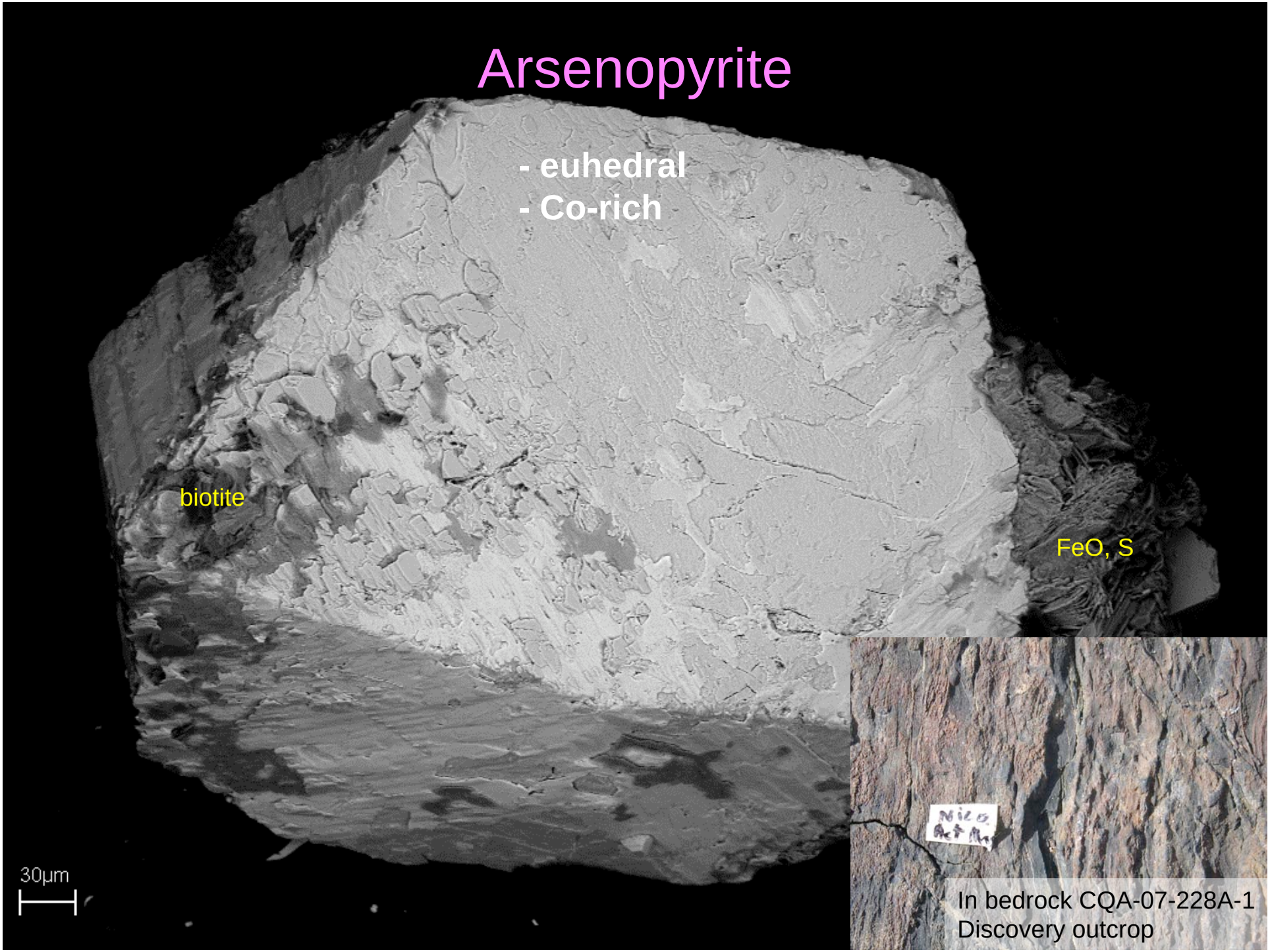




Heavy minerals (SG > 3.2: 0.25-2 mm)

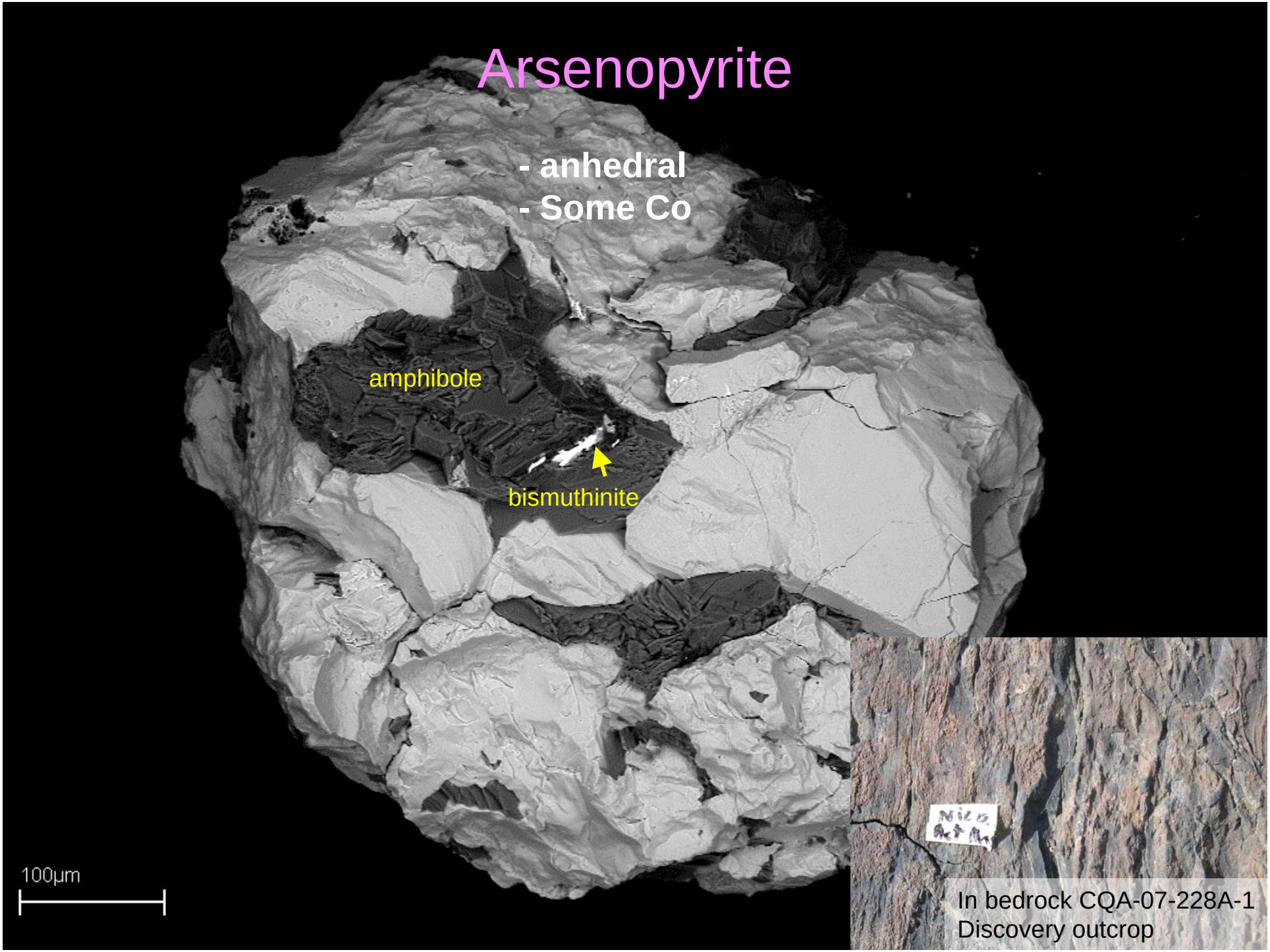
Mineral species	Bedrock	Till (from 50% of concentrate)
Arsenopyrite	16 out of 27 samples trace amounts to >60 000 grains 0.25-1 mm	None
Cobaltite	2 out of 27 samples 1 to 2 grains 0.25-0.5 mm	None
Bismuthinite	2 out of 27 samples inclosed in arsenopyrite <0.1mm	1 out of 13 samples 1 grain 0.25-0.5 mm

Arsenopyrite

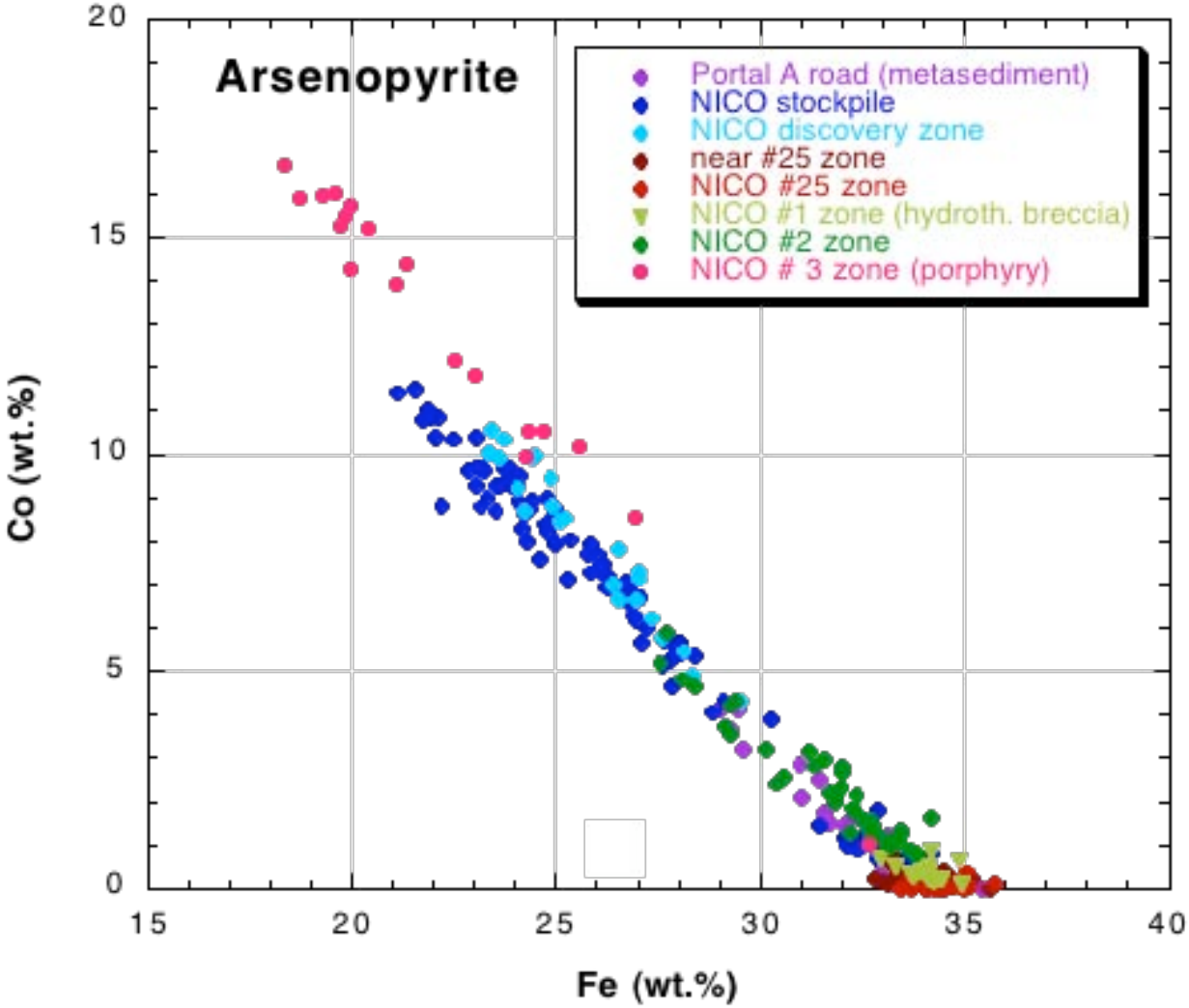


Arsenopyrite

- anhedral
- Some Co



Arsenopyrite



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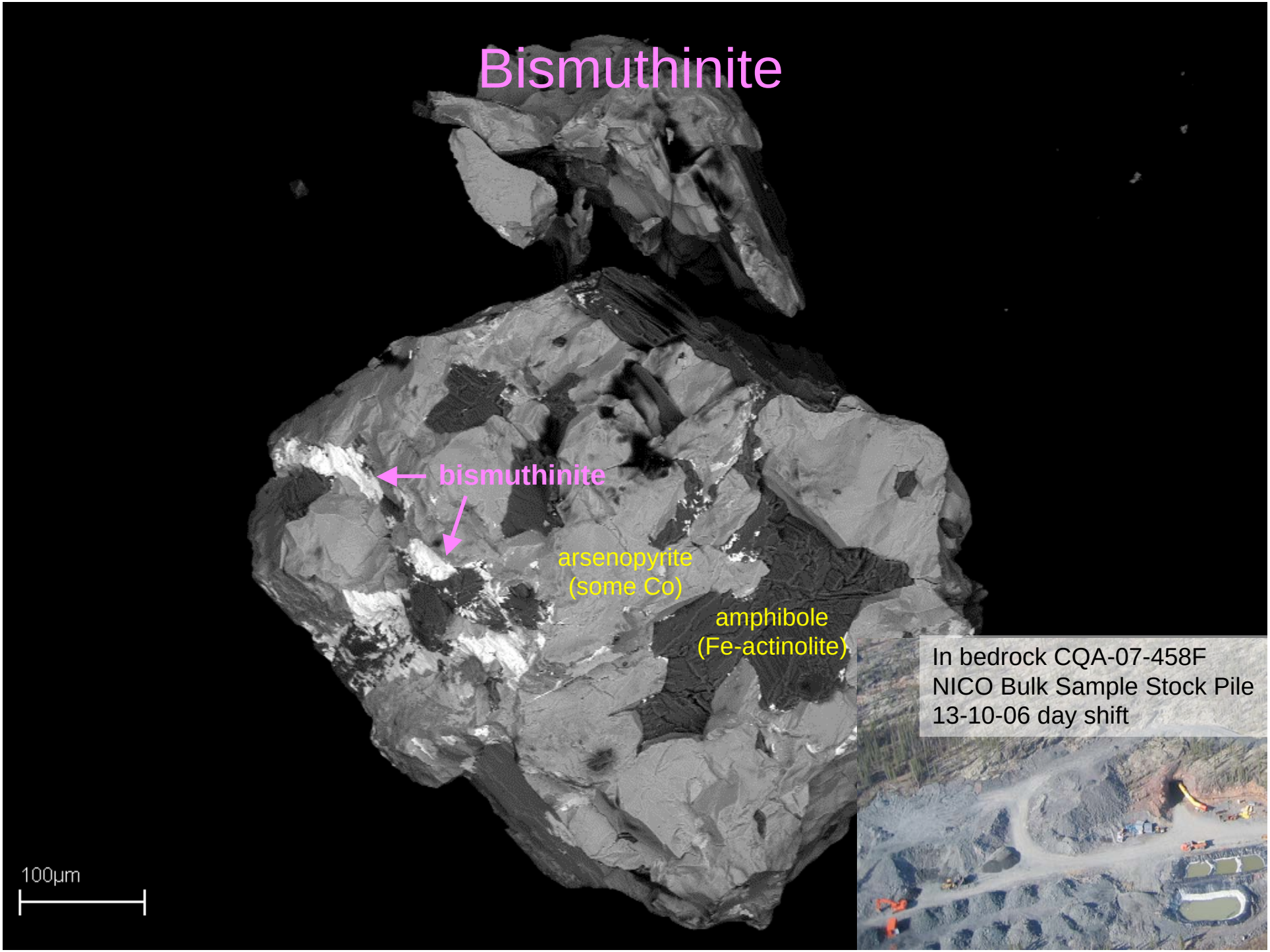
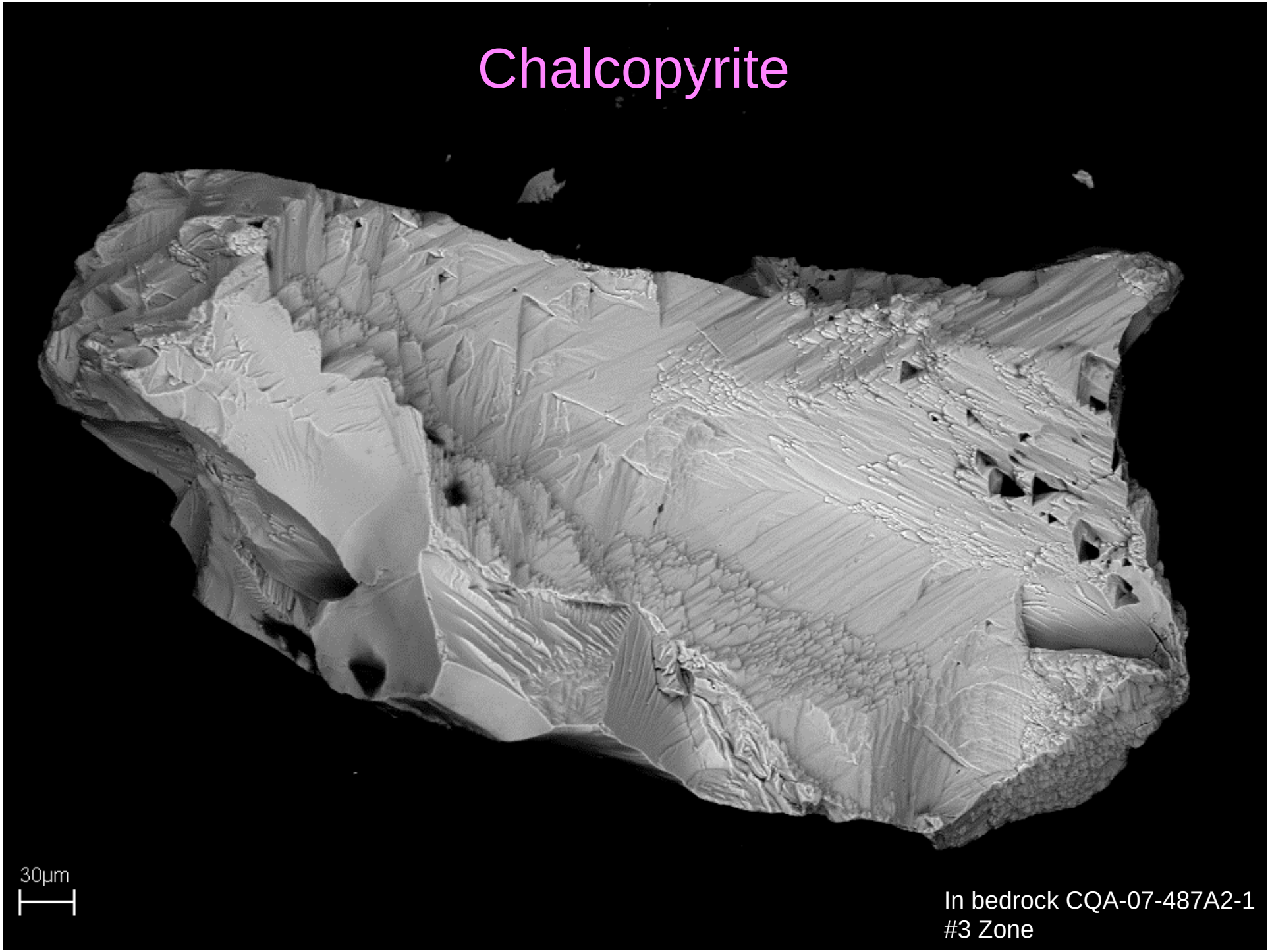
Bismuthinite



Heavy minerals (SG > 3.2: 0.25-2 mm)

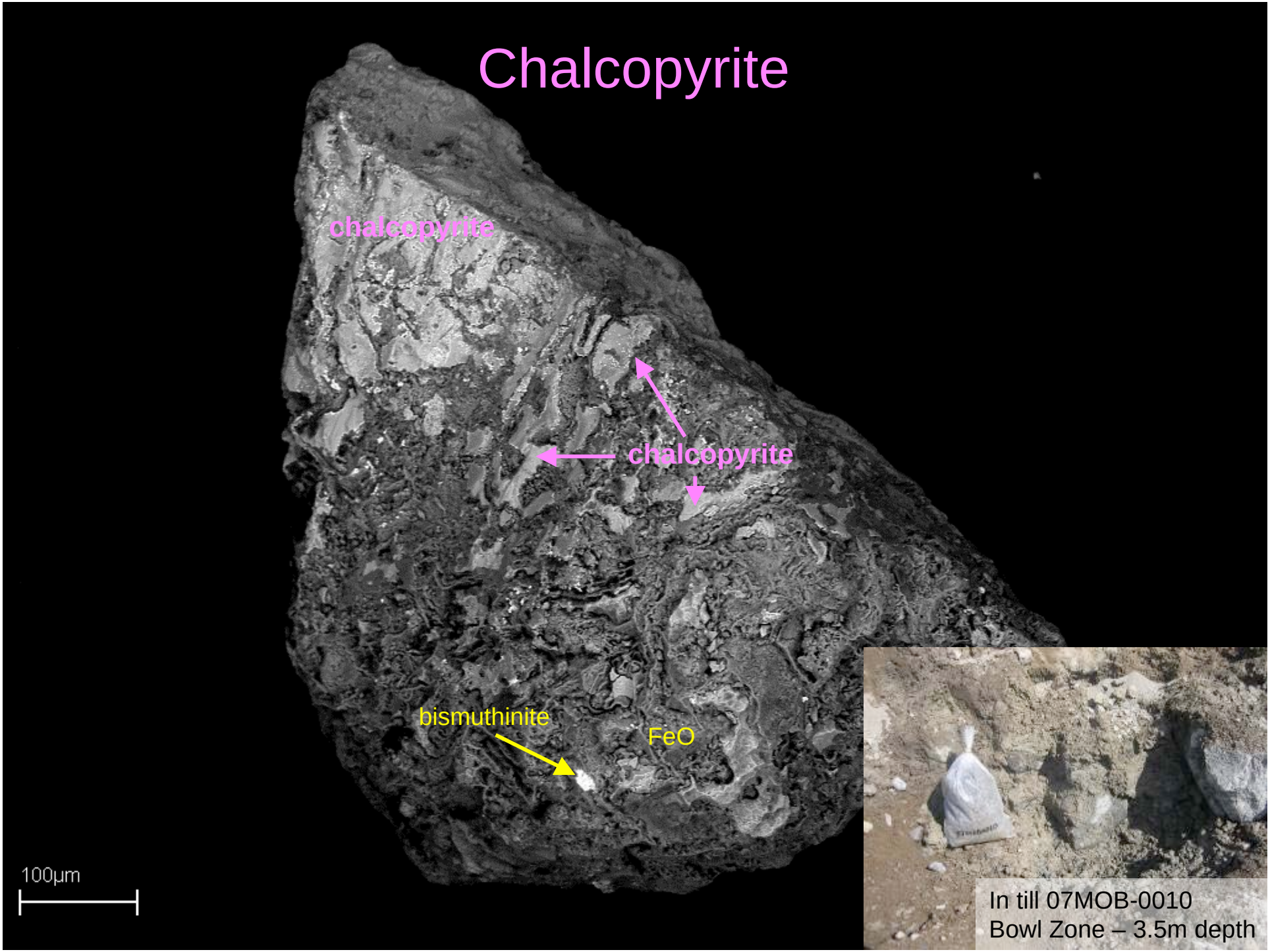
Mineral species	Bedrock	Till (from 50% of concentrate)
Chalcopyrite	8 out of 27 samples trace amounts to ~1000 grains 0.25-0.5 mm	1 out of 13 samples 8 grains 0.25-1 mm
Molybdenite	1 out of 27 samples up to 50 grains 0.25-0.5 mm	None
Pyrite	17 out of 27 samples trace amounts to ~5000 grains 0.25-0.5 mm	6 out of 13 samples trace amounts 0.25-0.5 mm

Chalcopyrite



In bedrock CQA-07-487A2-1
#3 Zone

Chalcopyrite



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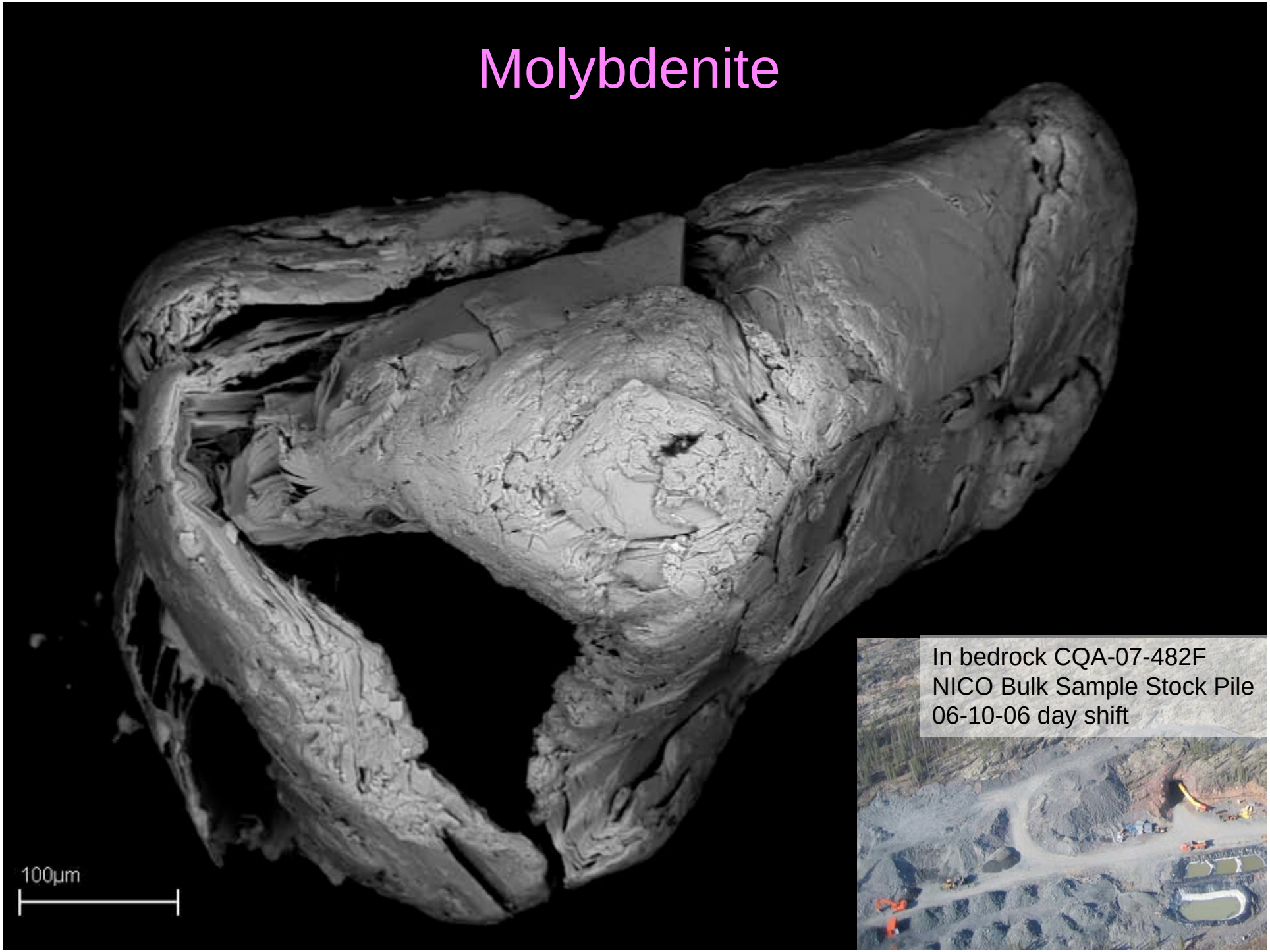
Molybdenite



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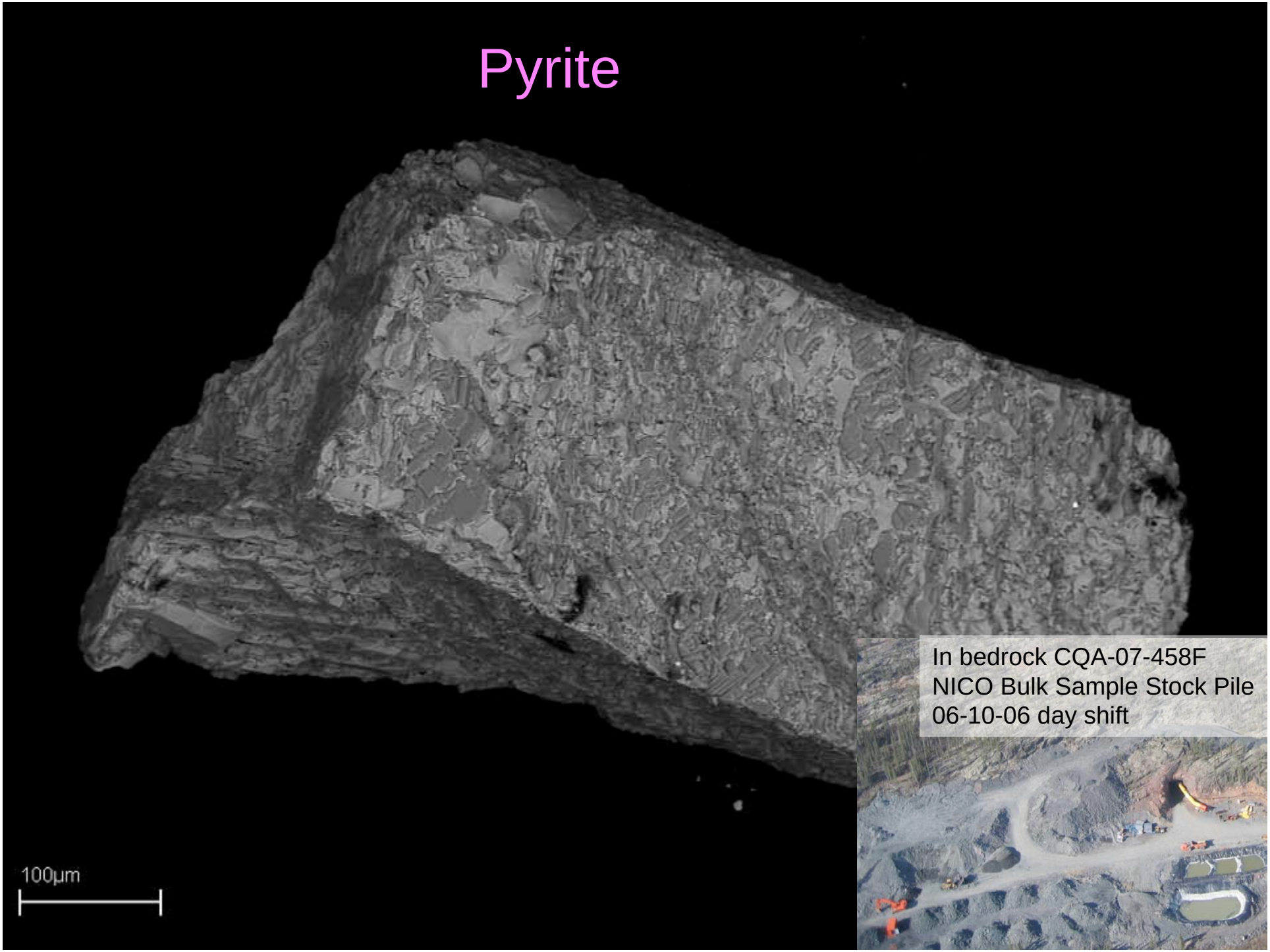
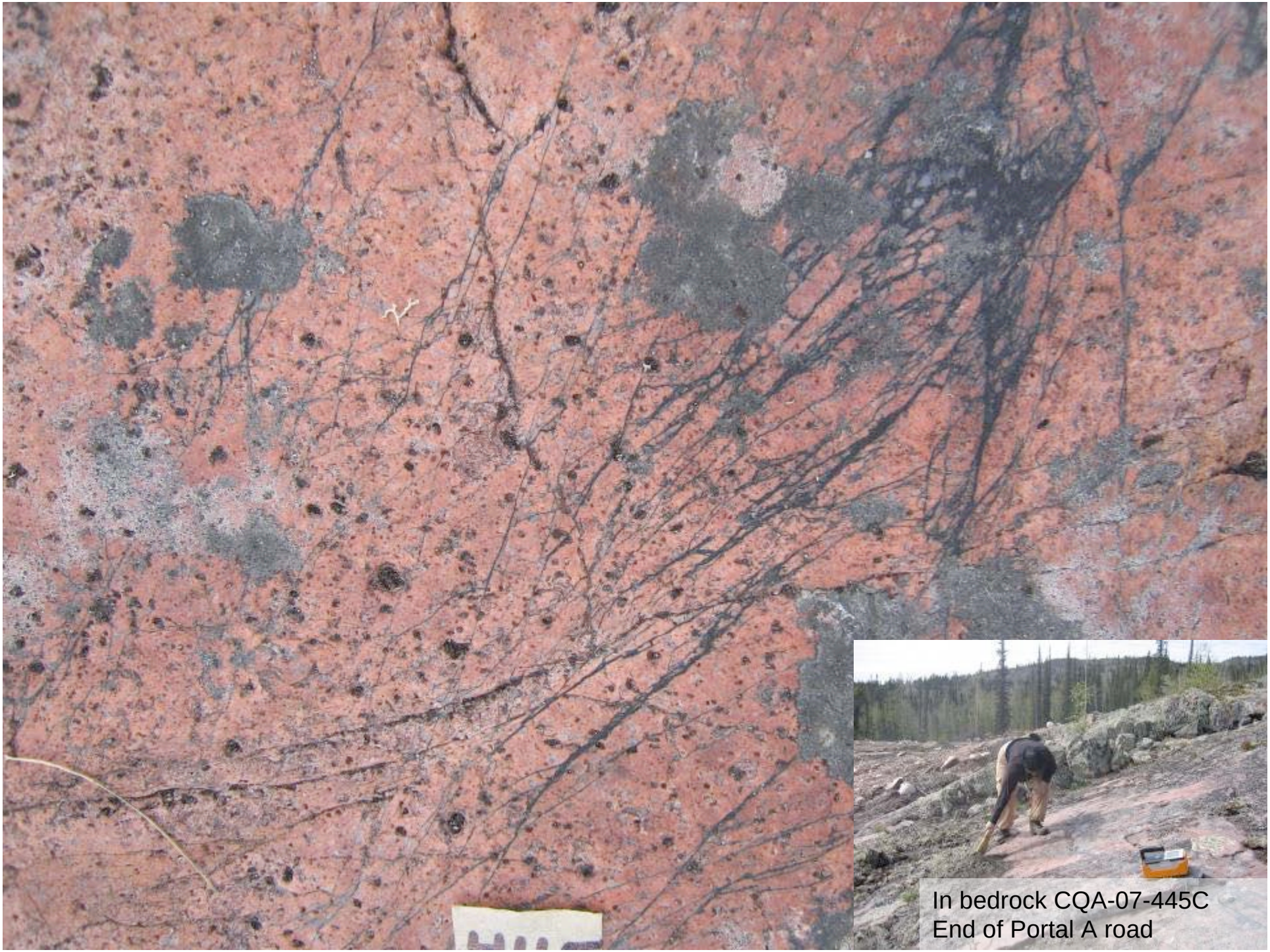
Pyrite


100µm
In bedrock CQA-07-458F
NICO Bulk Sample Stock Pile
06-10-06 day shift

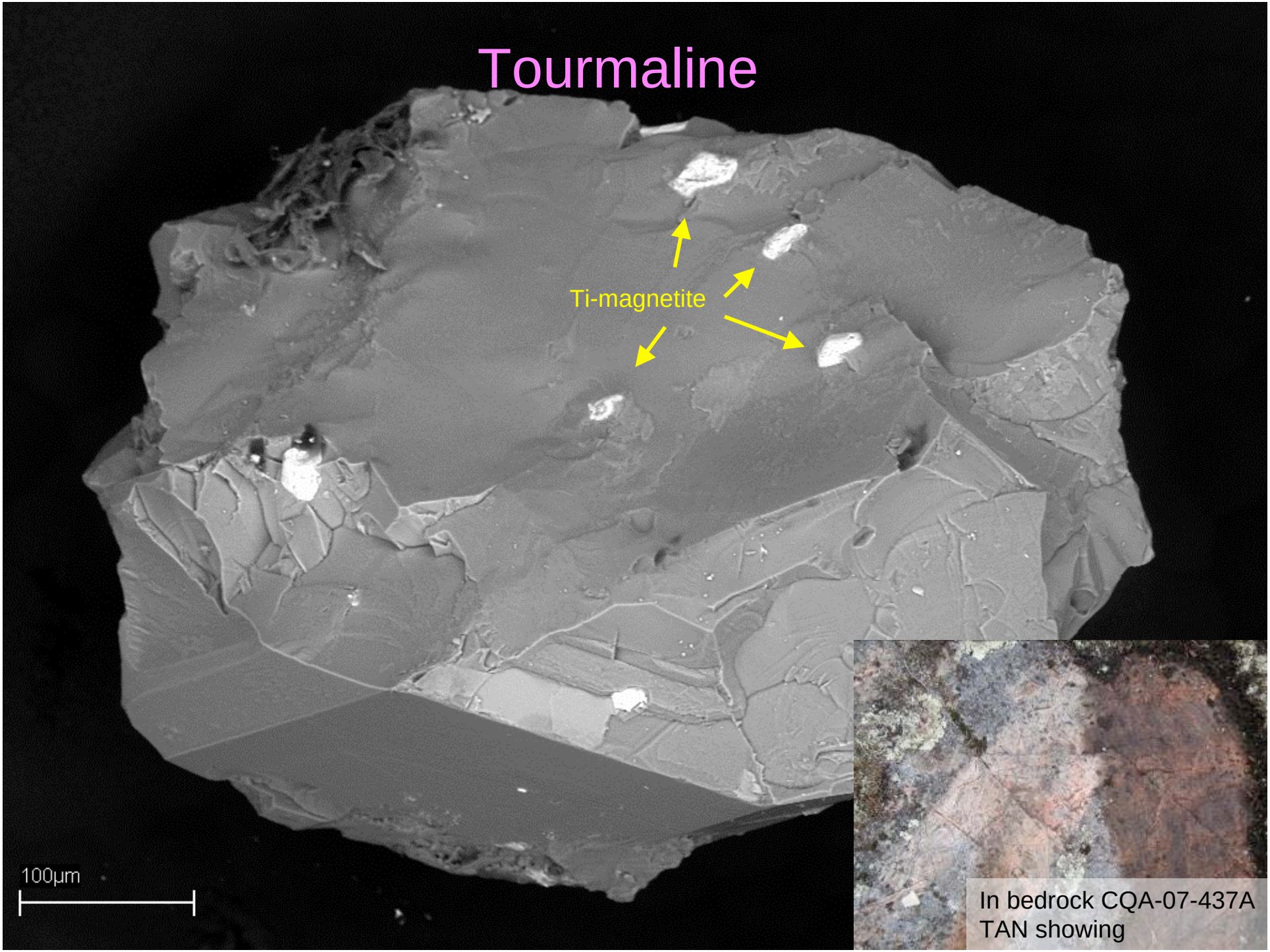
Heavy minerals (SG > 3.2: 0.25-2 mm)

Mineral species	Bedrock	Till (from 50% of concentrate)
Tourmaline	3 out of 27 samples 150 to 650 grains <0.05mm (intergrown with quartz) or 0.25-0.5 mm	9 out of 13 samples trace amounts 0.25-0.5 mm
Ferroactinolite/ actinolite	7 out of 27 samples trace to minor amounts 0.25-0.5 mm	1 out of 13 samples >21 grains 0.25-0.5 mm
Magnetite	All 0.01-35.20 g /table conc. 0.25-2 mm individual grains, bdk fragments or inclusions in mineral grains	All 0.5-128.1 g /table conc. 0.25-2 mm individual grains, bdk fragments or inclusions in mineral grains

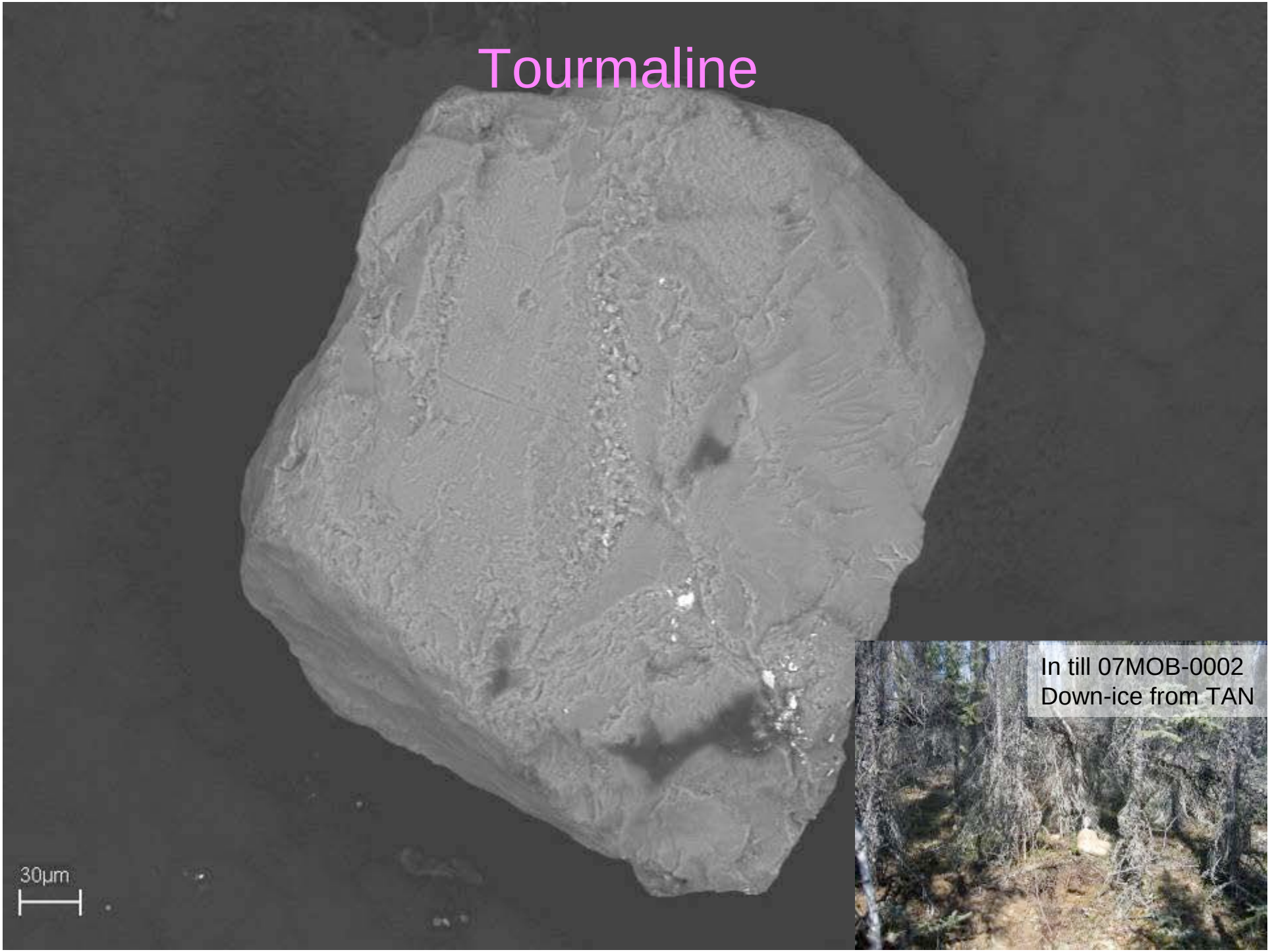


In bedrock CQA-07-445C
End of Portal A road

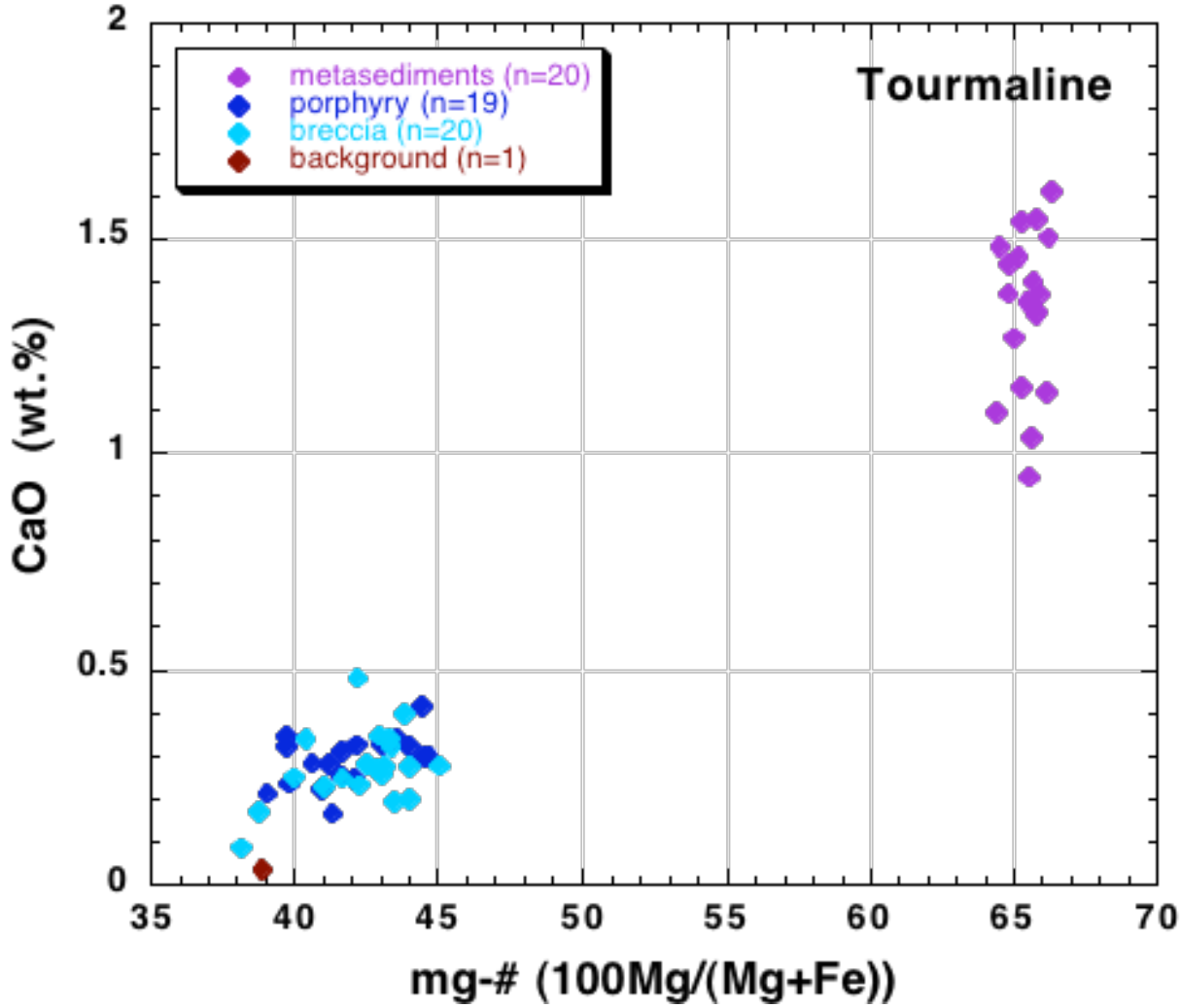
Tourmaline



Tourmaline



Tourmaline


metasediments (n=20)
porphyry (n=19)
breccia (n=20)
background (n=1)
Tourmaline
CaO (wt.%)
mg-# (100Mg/(Mg+Fe))
0
0.5
1
1.5
2
35
40
45
50
55
60
65
70

Heavy minerals (SG > 3.2: 0.25-2 mm)

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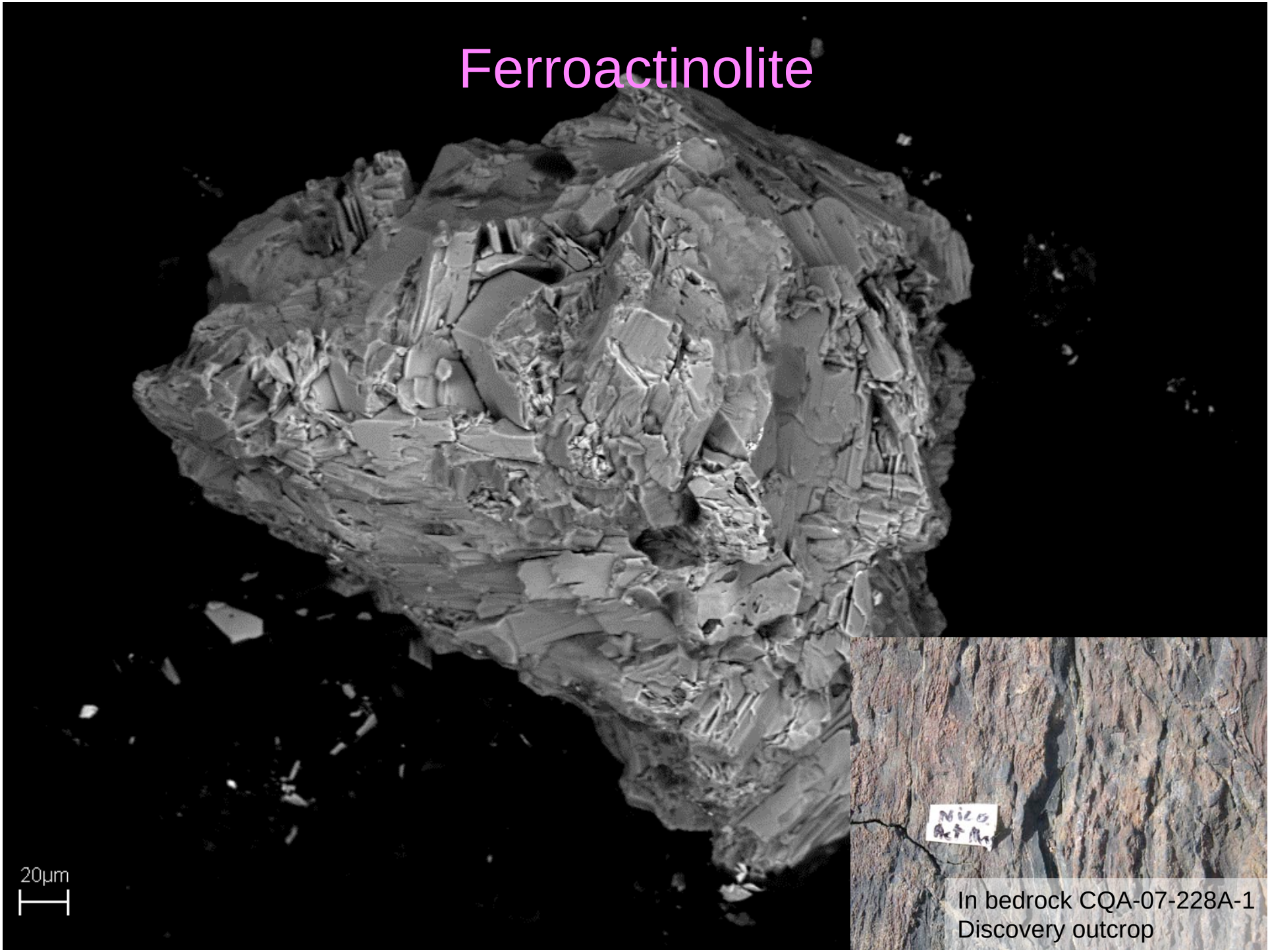
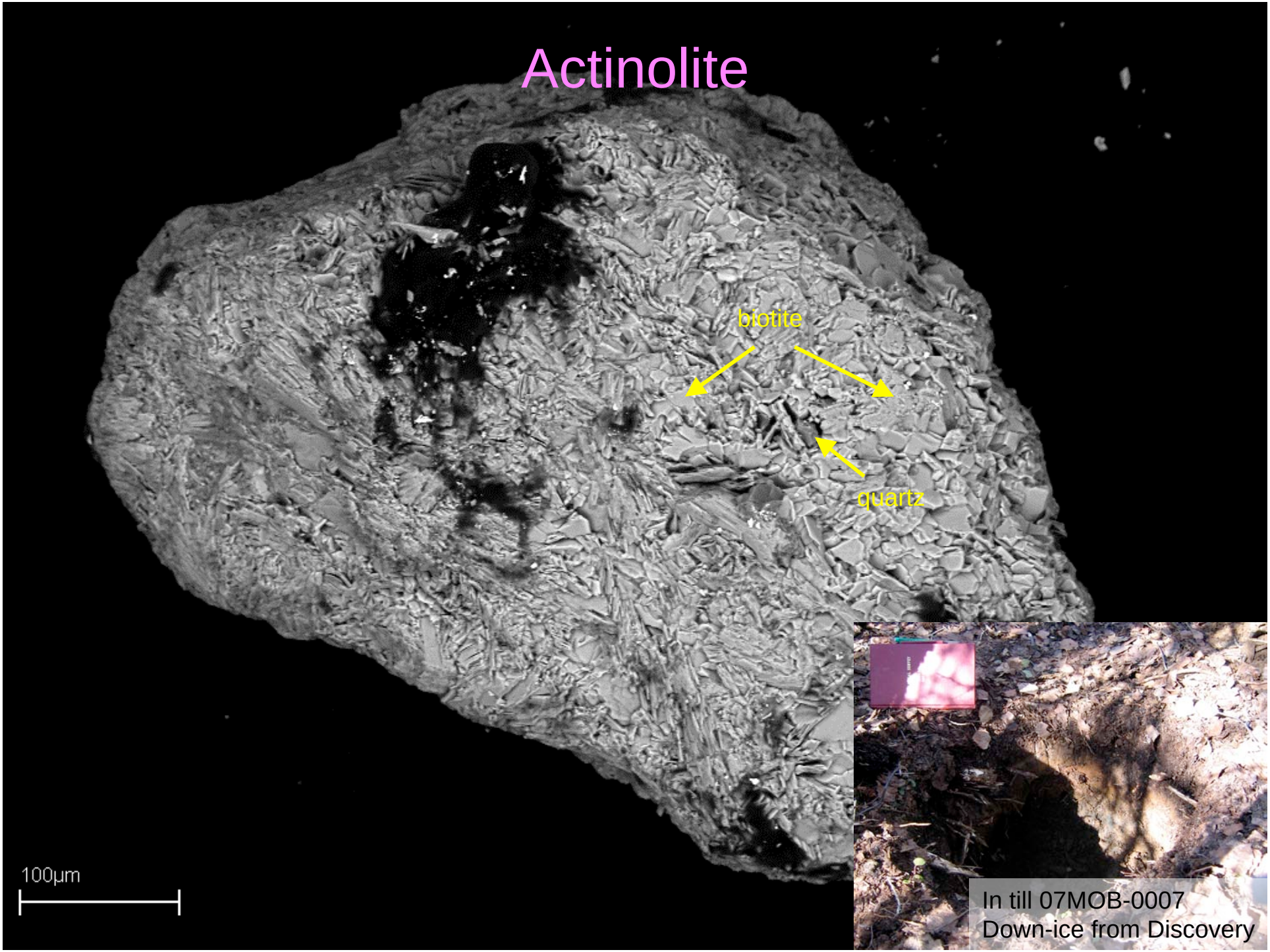
Ferroactinolite

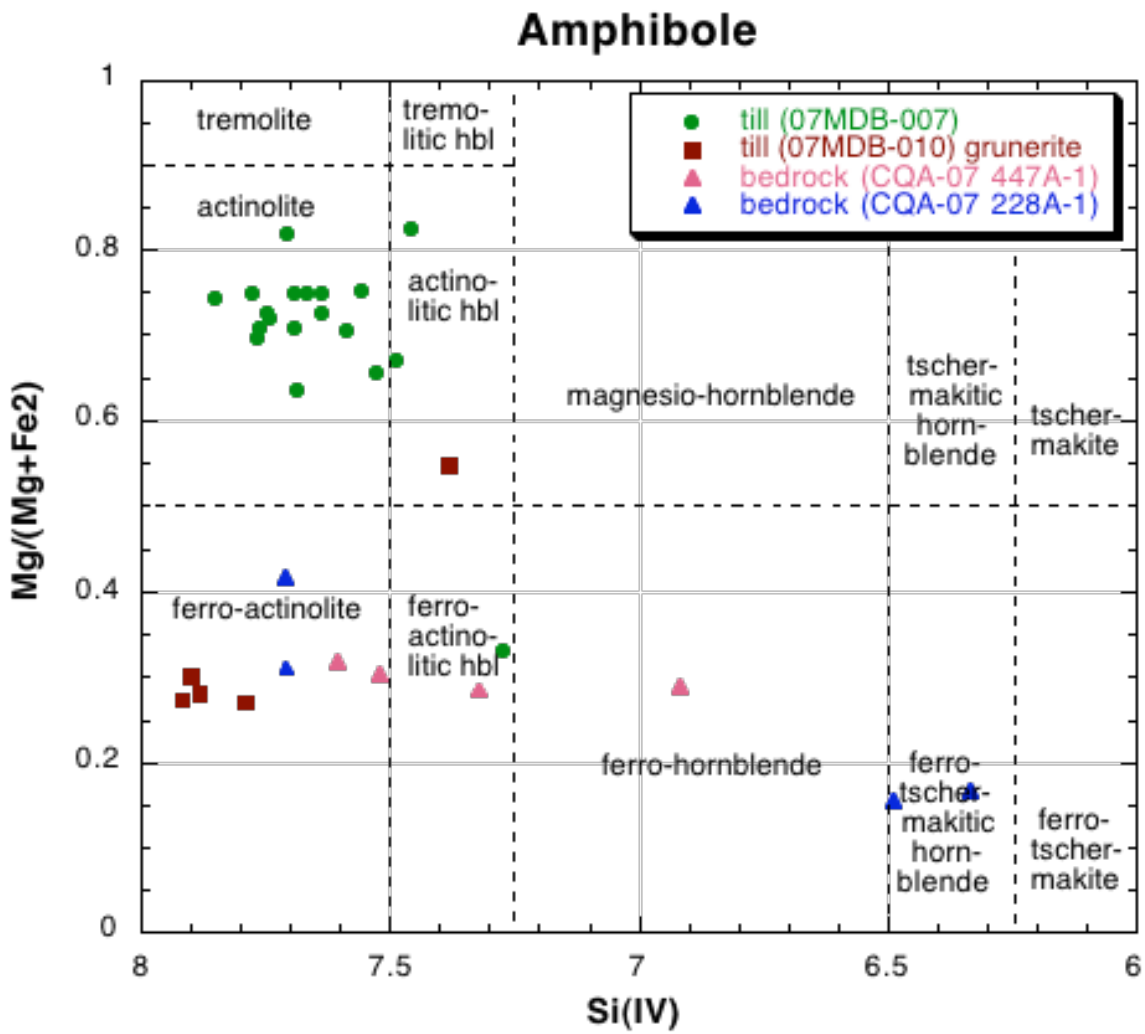


In bedrock CQA-07-228A-1
Discovery outcrop

Actinolite


biotite
quartz
100µm
In till 07MOB-0007
Down-ice from Discovery

Amphibole


Amphibole
till (07MDB-007)
till (07MDB-010) grunerite
bedrock (CQA-07 447A-1)
bedrock (CQA-07 228A-1)
tremolite
tremo-
litic hbl
actinolite
actino-
litic hbl
magnesio-hornblende
tscher-
makitic
horn-
blende
tscher-
makite
ferro-actinolite
ferro-
actino-
litic hbl
ferro-hornblende
ferro-
tscher-
makitic
horn-
blende
ferro-
tscher-
makite
Mg/(Mg+Fe2)
Si(IV)
1
0.8
0.6
0.4
0.2
0
8
7.5
7
6.5
6

Heavy minerals (SG > 3.2: 0.25-2 mm)

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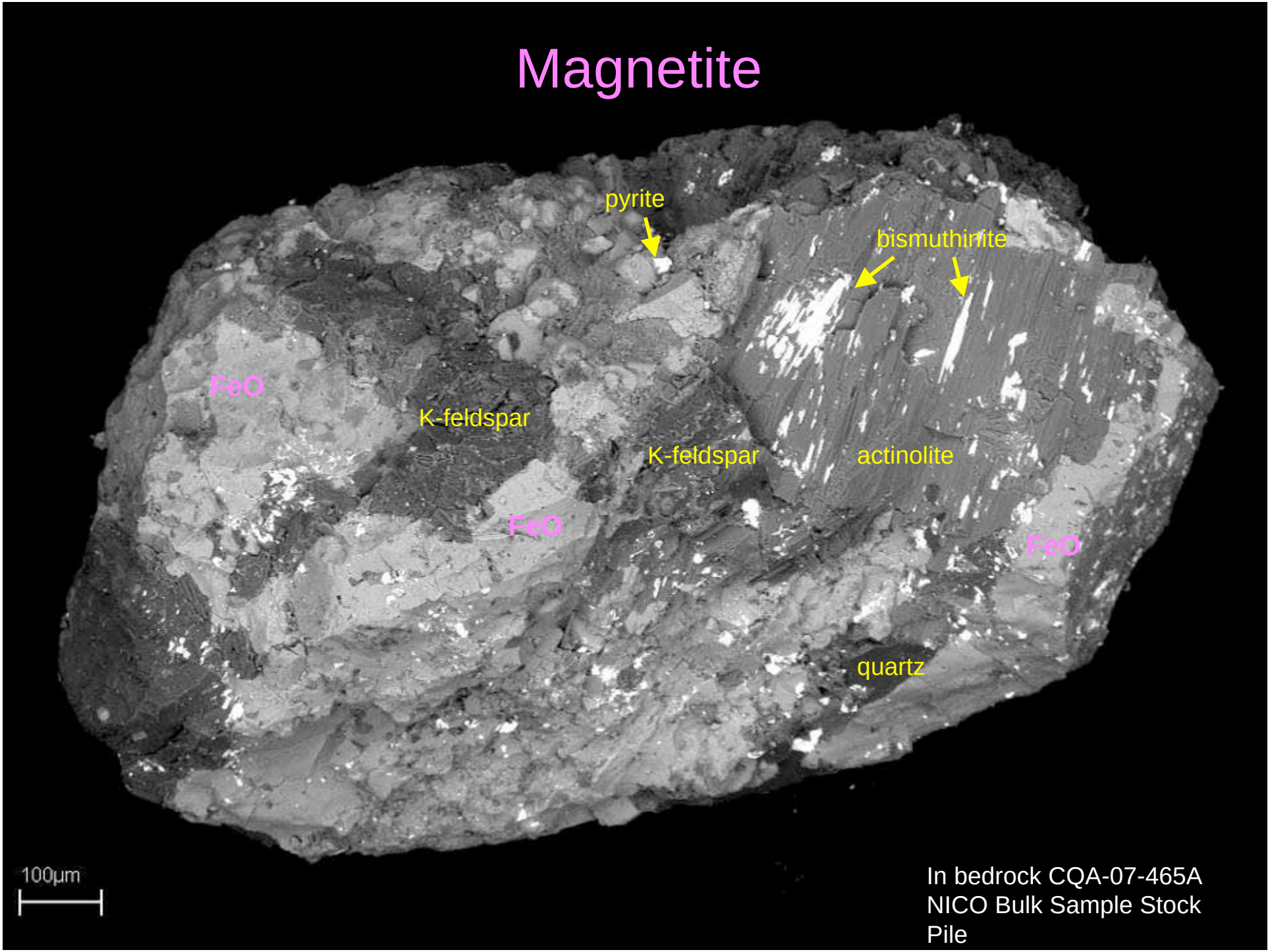
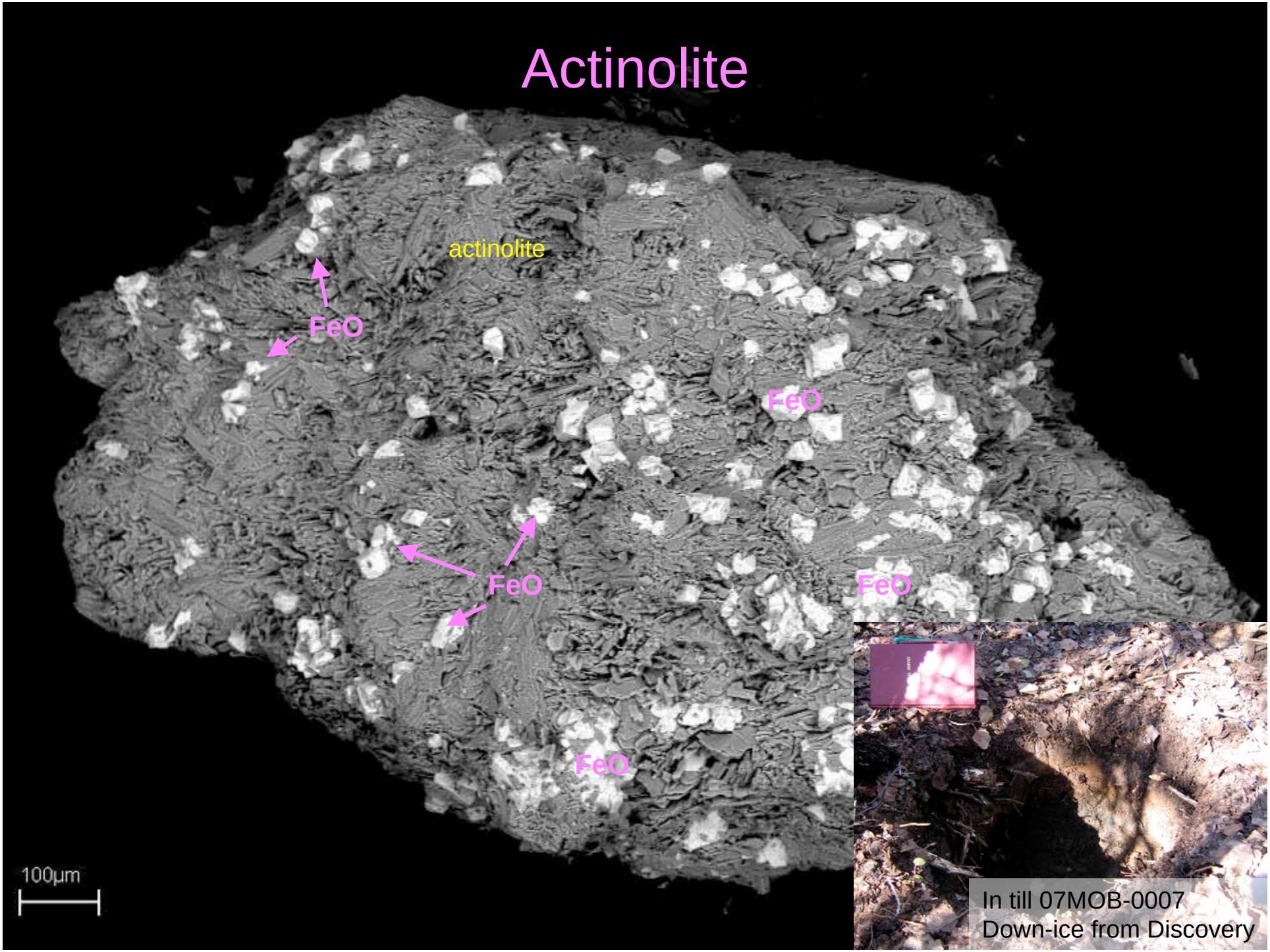
Magnetite

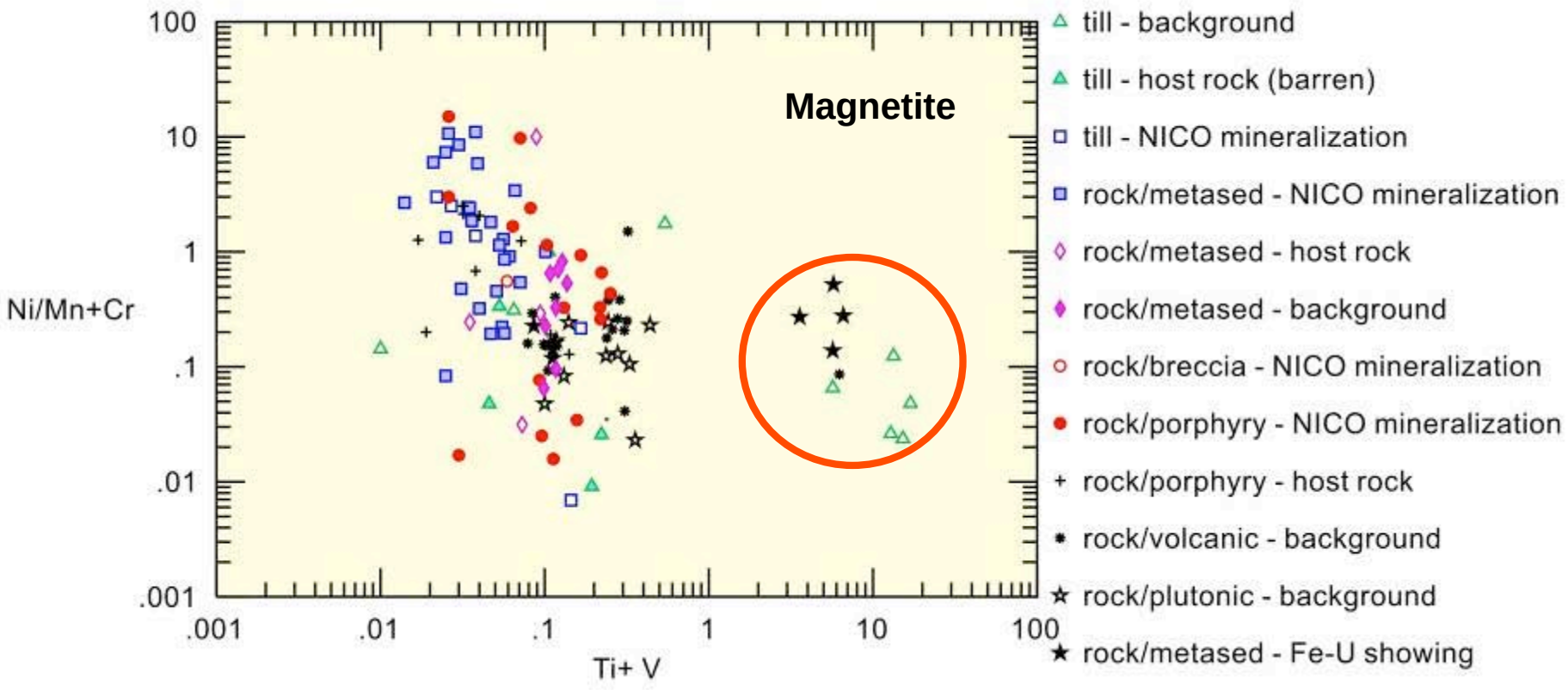


In bedrock CQA-07-465A
NICO Bulk Sample Stock Pile

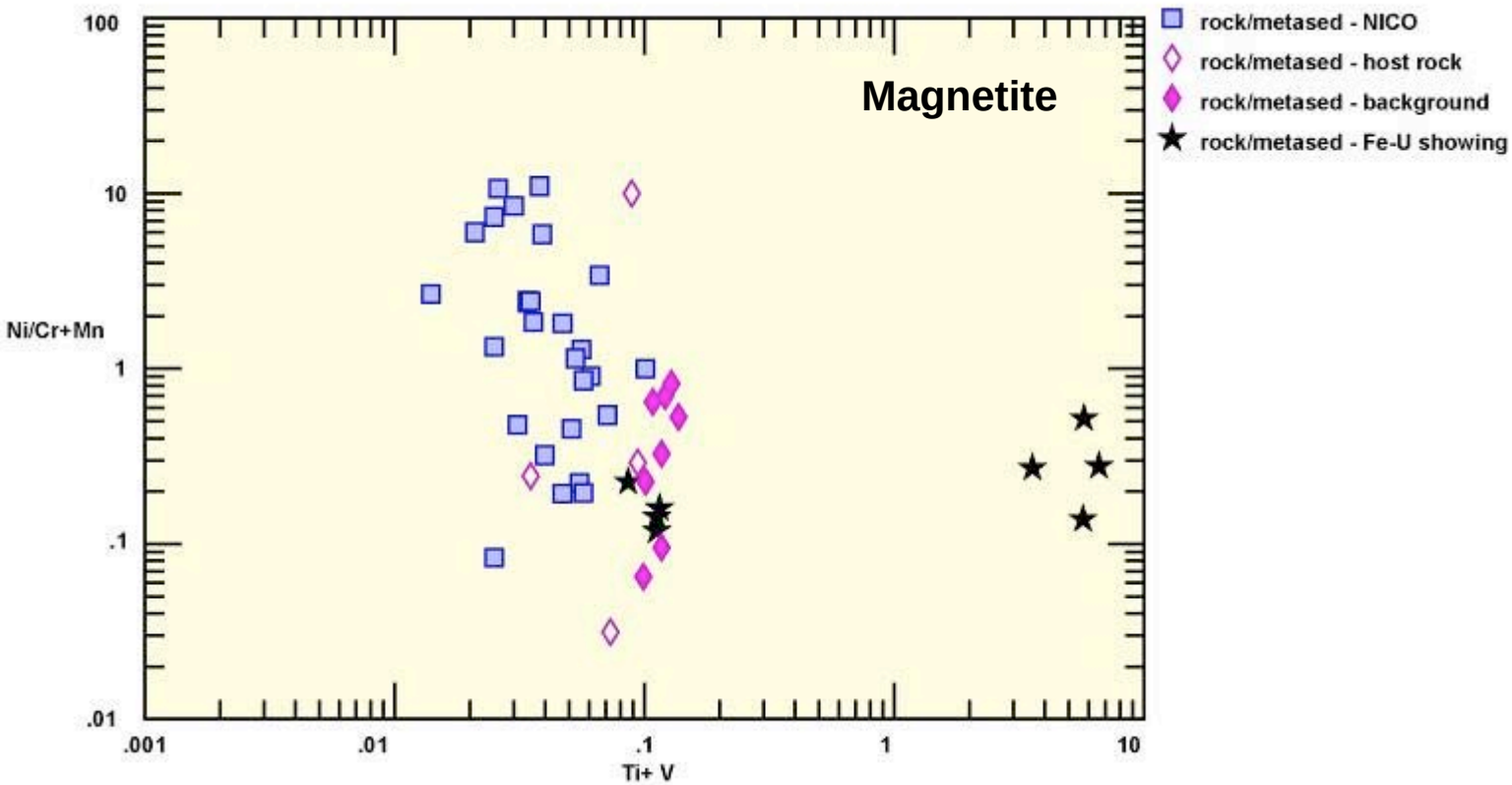
Actinolite


actinolite
FeO
FeO
FeO
FeO
FeO
100µm
In till 07MOB-0007
Down-ice from Discovery

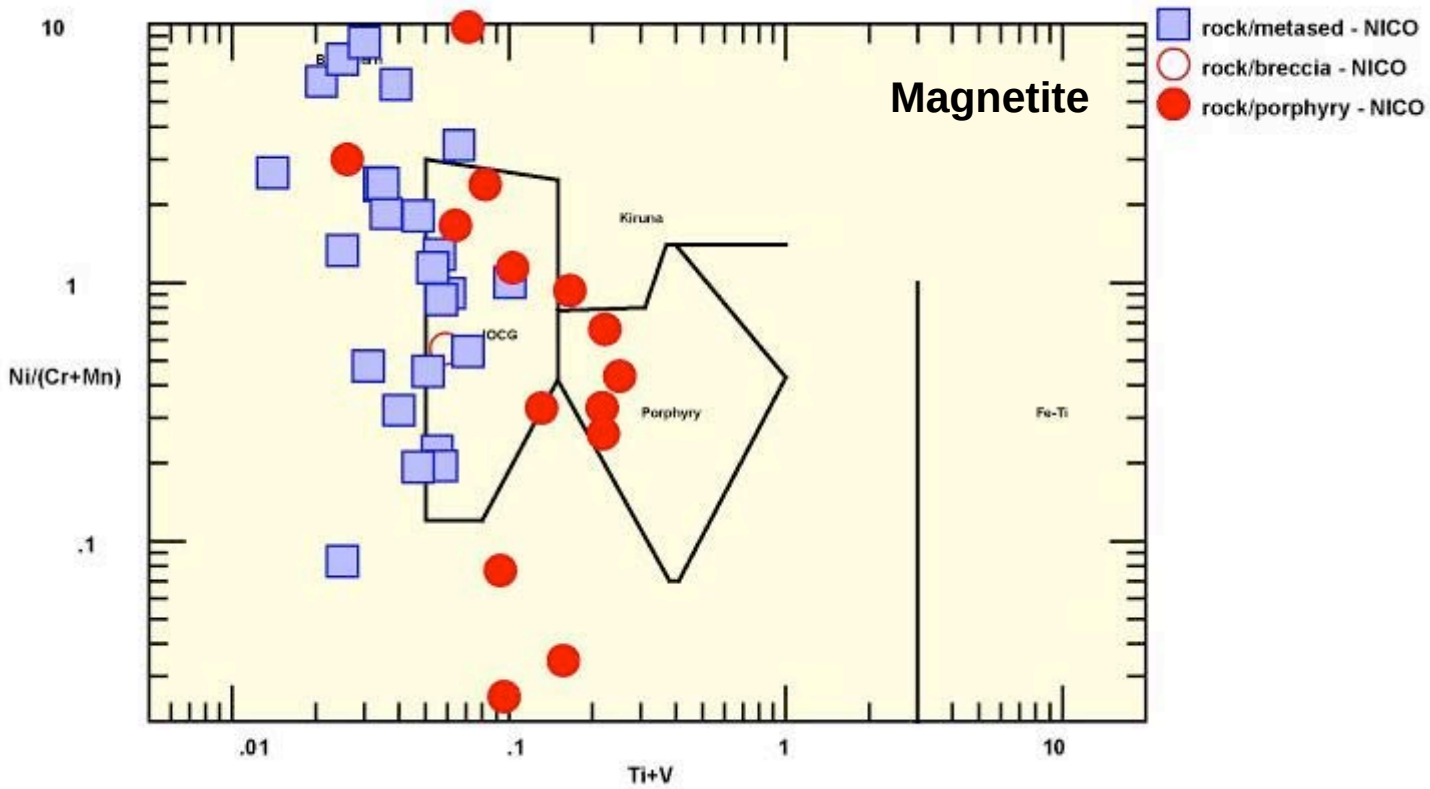
Magnetite - all



Magnetite - metasediments

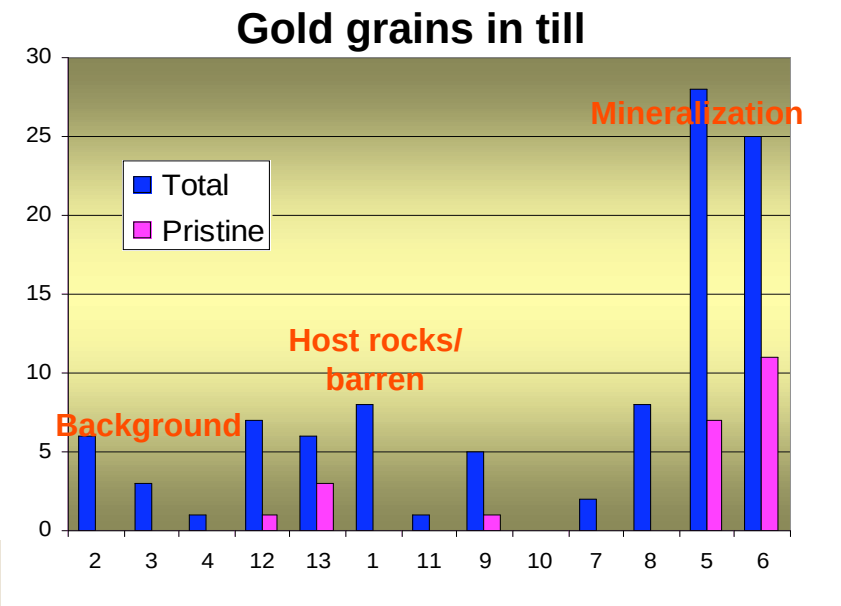


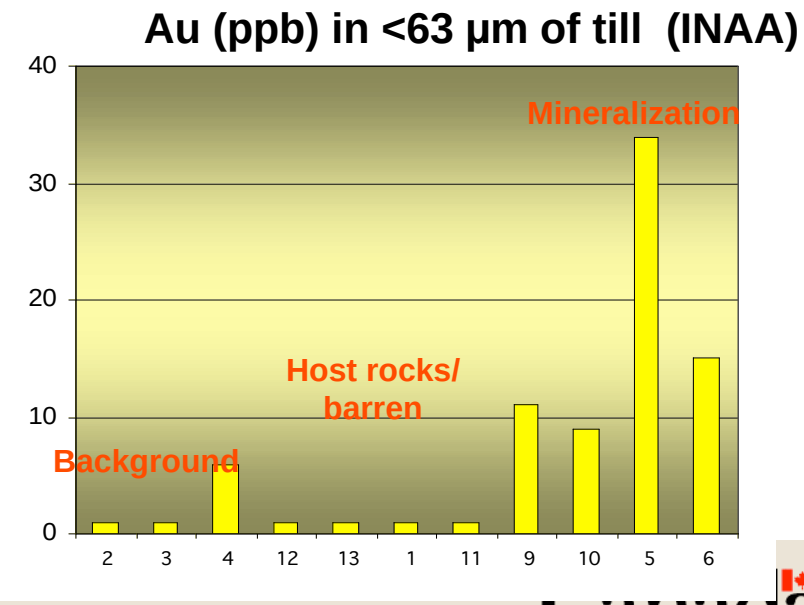
Magnetite – NICO bedrock



Heavy minerals (SG > 3.2: <2 mm)

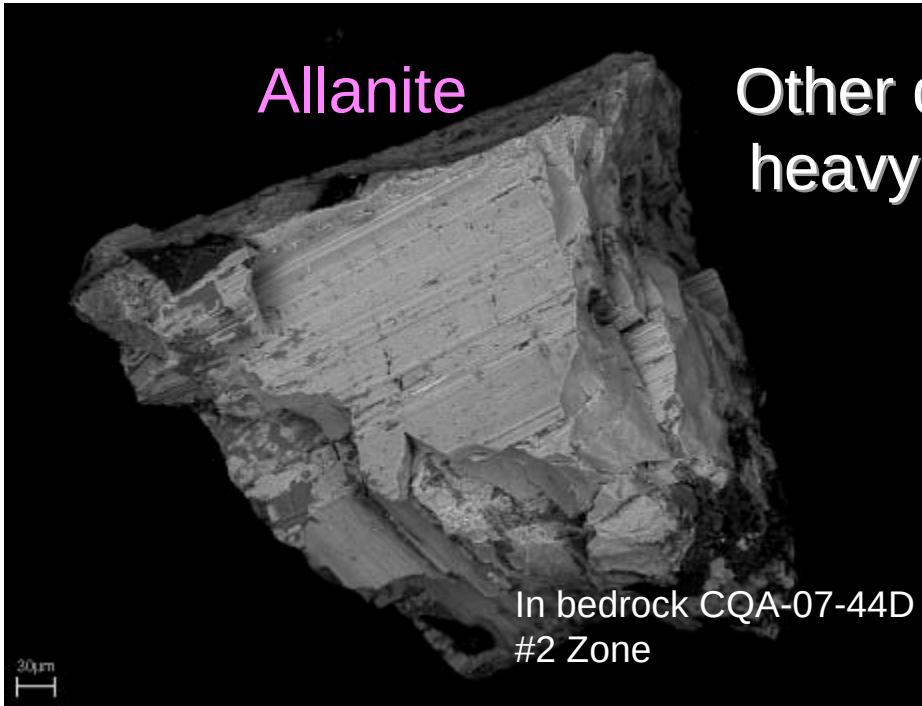
Mineral species	Bedrock	Till (from 50% of concentrate)
Gold	4 out of 27 samples 1 to 2 grains <125 µm Pristine shape	12 out of 13 samples 1 to 28 grains <50 µm Pristine to reshaped





Other distinctive heavy minerals

Allanite



In bedrock CQA-07-44D
#2 Zone

Scheelite

In bedrock CQA-07-465A
NICO Bulk Sample Stock Pile
08-03-07 night shift

Bismutite

In till 07MOB-0010
Bowl Zone – 3.5m depth

Gedrite

In till 07MOB-0010
Bowl Zone – 3.5m depth

Summary – NICO

- Many of the sulphides that are highly to moderately abundant in the bedrock are not chemically stable hence are poorly preserved in surface till samples (i.e. arsenopyrite, chalcopyrite, pyrite).

- Some of the heavy minerals are present as small inclusions intergrown in sometimes lighter minerals so it is difficult to recover them in the sand-fraction HMCs (i.e. bismuthinite, tourmaline).

- Some of the minerals are not abundant enough in bedrock to show up in till, too soft to survive glacial transport, or not sufficiently heavy (i.e. scheelite, molybdenite, cobaltite , ferroactinolite).

- Magnetite occurs in all samples and fractions, and its composition using discriminant diagrams shows some potential for fingerprinting mineralization.

- Gold grain abundance, size and shape remains a valuable tool.

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