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

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Indicator Mineral Exploration Technology
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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
NICO Supracrustal Granitoids

Faber Group volcanics

Paleozoic cover strata

NICO Co-Au-Bi

Hislop Lake

Rabbit Lake

NICO

NICO

Supracrustal Granitoids

Great Bear intrusions

Rapakivi granite

Granite, undifferentiated

Quartz monzonite-granodiorite. Mineral occurrence . . . . . .

Dacitic feldspar porphyry

Diorite

QFP intrusions

Faber felsic volcanics

Syntectonic plutons

Monzonite, massive to gneissic

Granite-granodiorite gneiss

Treasure Lake Group

Metasediments

Dolomite, calc-silicate, magnetite
Ore mineralogy:
Fe-, As-, Co-, Cu-sulphides
Native gold and bismuth

Alteration at NICO:
K-Fe (HT)

Hosted in:
Mag-Amp-Bt-Tm-Kfs alteration + Co-Bi-Au sulfarsenides

NICO Setting Schematic
From Mumin et al., 2008,
GAC 2008 Short Course
Surficial geology

Glacial Lake McConnell

From Prest et al., 1968
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
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

Intrusive 48%
Volcanics 40%
Sediments 12%

Intrusive 97%
Volcanics 2%
Sediments <1%
## Heavy minerals (SG > 3.2: 0.25-2 mm)

<table>
<thead>
<tr>
<th>Mineral species</th>
<th>Bedrock</th>
<th>Till (from 50% of concentrate)</th>
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<tbody>
<tr>
<td><strong>Arsenopyrite</strong></td>
<td>16 out of 27 samples</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>trace amounts to &gt;60,000 grains</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.25-1 mm</td>
<td></td>
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<tr>
<td><strong>Cobaltite</strong></td>
<td>2 out of 27 samples</td>
<td>None</td>
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<td></td>
<td>1 to 2 grains</td>
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<td></td>
<td>0.25-0.5 mm</td>
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<tr>
<td><strong>Bismuthinite</strong></td>
<td>2 out of 27 samples</td>
<td>1 out of 13 samples</td>
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<tr>
<td></td>
<td>inclosed in arsenopyrite</td>
<td>1 grain</td>
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<tr>
<td></td>
<td>&lt;0.1 mm</td>
<td>0.25-0.5 mm</td>
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</table>
Arsenopyrite
- euhedral
- Co-rich

In bedrock CQA-07-228A-1
Discovery outcrop
Arsenopyrite
- anhedral
- Some Co

amphibole
bismuthinite

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

![Graph showing arsenopyrite content vs. Co and Fe concentrations](image)
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Bismuthinite

In bedrock CQA-07-458F
NICO Bulk Sample Stock Pile
13-10-06 day shift

Bismuthinite

arsenopyrite (some Co)

amphibole (Fe-actinolite)

100μm
### Heavy minerals (SG > 3.2: 0.25-2 mm)

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<td><strong>Chalcopyrite</strong></td>
<td>8 out of 27 samples trace amounts to ~1000 grains 0.25-0.5 mm</td>
<td>1 out of 13 samples 8 grains 0.25-1 mm</td>
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<td><strong>Molybdenite</strong></td>
<td>1 out of 27 samples up to 50 grains 0.25-0.5 mm</td>
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<td><strong>Pyrite</strong></td>
<td>17 out of 27 samples trace amounts to ~5000 grains 0.25-0.5 mm</td>
<td>6 out of 13 samples trace amounts 0.25-0.5 mm</td>
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Chalcopyrite

In bedrock CQA-07-487A2-1
#3 Zone
### Heavy minerals (SG > 3.2: 0.25- mm)

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Pyrite

In bedrock CQA-07-458F
NICO Bulk Sample Stock Pile
06-10-06 day shift
**Heavy minerals** (SG > 3.2: 0.25-2 mm)

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<th>Mineral species</th>
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<tr>
<td><strong>Tourmaline</strong></td>
<td>3 out of 27 samples 150 to 650 grains &lt;0.05mm (intergrown with quartz) or 0.25-0.5 mm</td>
<td>9 out of 13 samples trace amounts 0.25-0.5 mm</td>
</tr>
<tr>
<td><strong>Ferroactinolite/actinolite</strong></td>
<td>7 out of 27 samples trace to minor amounts 0.25-0.5 mm</td>
<td>1 out of 13 samples &gt;21 grains 0.25-0.5 mm</td>
</tr>
<tr>
<td><strong>Magnetite</strong></td>
<td>All 0.01-35.20 g /table conc. 0.25-2 mm individual grains, bdk fragments or inclusions in mineral grains</td>
<td>All 0.5-128.1 g /table conc. 0.25-2 mm individual grains, bdk fragments or inclusions in mineral grains</td>
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In bedrock CQA-07-445C
End of Portal A road
Tourmaline

Ti-magnetite

In bedrock CQA-07-437A
TAN showing
# Heavy minerals (SG > 3.2: 0.25-2 mm)

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Ferroactinolite

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

![Amphibole Graph](image-url)
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Actinolite
Magnetite - all

- Magnetite

![Graph showing Magnetite data with various markers for different geological contexts.](image)

- till - background
- till - host rock (barren)
- till - NICO mineralization
- rock/metased - NICO mineralization
- rock/metased - host rock
- rock/metased - background
- rock/breccia - NICO mineralization
- rock/porphyry - NICO mineralization
- rock/porphyry - host rock
- rock/volcanic - background
- rock/plutonic - background
- rock/metased - Fe-U showing
Magnetite - metasediments

![Graph showing Magnetite distribution with different markers for rock/metased - NICO, rock/metased - host rock, rock/metased - background, and rock/metased - Fe-U showing.](image-url)
**Heavy minerals (SG > 3.2: <2 mm)**

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<td><strong>Gold</strong></td>
<td>4 out of 27 samples&lt;br&gt;1 to 2 grains&lt;br&gt;&lt;125 µm&lt;br&gt;Pristine shape</td>
<td>12 out of 13 samples&lt;br&gt;1 to 28 grains&lt;br&gt;&lt;50 µm&lt;br&gt;Pristine to reshaped</td>
</tr>
</tbody>
</table>

### Gold grains in till

![Graph showing gold grains in till](image)

### Au (ppb) in <63 µm of till (INAA)

![Graph showing Au (ppb) in till](image)
In till 07MOB-0010
Bowl Zone
– 3.5m depth

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

Allanite
In bedrock CQA-07-44D
#2 Zone

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

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

Other distinctive heavy minerals
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.
Thanks to
GSC, NTGO and academia colleagues,
Fortune Minerals,
Consorminex