Indicator mineral methods in precious metal exploration

Indicator Mineral Methods in Mineral Exploration

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Indicator mineral methods in precious metal exploration

• Development of method
  – Focused on Au grains and less on accessory indicator minerals
    • Abundance and morphology
  – Linked to physical dispersal processes
    • Distance of transport
  – Consideration for chemical processes (fineness and inclusions)

• Environments of Application
  – Covered glaciated terranes
  – Tropical environments
  – Other environments?
    • define the problem first, then test
Till Gold Grain Morphology

Pristine

Modified

Reshaped

100 m

500 m

>1,000 to > 10,000 m

Distance of Transport

Courtesy ODM
Physical Dispersal of Gold Grains
Simple or Complex?

Courtesy
Other Important Characteristics

Associated minerals
Fineness of gold
Inclusions in gold grains
R.C. Gold Discoveries in Abitibi, 1984-1995

[Map showing geological features and discoveries in Abitibi]

Courtesy ODM

Geological legend:
- Paleozoic: Fossiliferous dolomite, sandstone
- Proterozoic: Sedimentary rocks, conglomerates, siltstone, stromatolite, and diabase
- Archean (2.5 to 2.8 billion years)
- Metamorphic rocks: Gneisses, derived from plutonic rocks
- Schists and paragneisses, derived from sedimentary rocks

Plutonic rocks:
- Migmatitic tonalite, granite, and gabbro
- Gneissic tonalite, granite, and gabbro
- Syn- to post-tectonic tonalite, granite, and gabbro
- Syntectonic tonalite, granite, and gabbro
- Anorthositic gabbro

Sedimentary rocks:
- Sandstones, conglomerates, and mudrocks

Volcanic rocks:
- Predominance of rhyolites and pyroclastic rocks
- Predominance of basalts and andesites, rare komatiites

Regional faults:

50 km
Gold Discovery - Rainy River, Ontario

Gold in bedrock

Courtesy: Nuinsco
Regional Gold Grains in Till, Rainy River, Ontario
Detailed Gold Grains in Till, Rainy River, Ontario

Courtesy: Nuinsco
Application to Tropical Environments

What do these environments have in common?
Application to Tropical Environments

Similarities with glaciated terranes.

Gold Survives

Canadian Inhabitants

Rex Brommecker
Tropical Environments

The Problem

- Extensive vertical weathering and erosion
- Surface accumulation of gold common in region
- Geomorphology of region is dynamic
- Lode source may not be in current placer drainage
French Guiana – Wayamaga and Cokioco

Sediments Au-ppb
- %U 0.5 - 34
- %U 34 - 104
- %U 104 - 216
- %U 216 - 458
- %U 458 - 859

Sediments As-ppm
- #S 0.25 - 4.7
- #S 4.7 - 10.6
- #S 10.6 - 20.7
- #S 20.7 - 49
- #S 49 - 195.3

 Courtesy WMC (r.i.p.)
# Cokioco vs. Wayamaga

<table>
<thead>
<tr>
<th></th>
<th>Cokioco</th>
<th>Wayamaga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Source</td>
<td>Not present (&lt;$1 million)</td>
<td>Present (&lt;1$ spent)</td>
</tr>
<tr>
<td>Placer Mining</td>
<td>Evident</td>
<td>Evident</td>
</tr>
<tr>
<td>Au Grains</td>
<td>V. Significant</td>
<td>Low</td>
</tr>
<tr>
<td>HMC Au</td>
<td>V. Significant</td>
<td>Weak</td>
</tr>
<tr>
<td>Stream Sediment Au</td>
<td>Significant</td>
<td>Weak</td>
</tr>
<tr>
<td>Stream Sediment As</td>
<td>Weak</td>
<td>Strong</td>
</tr>
</tbody>
</table>

The problem – how do you distinguish Wayamaga from Cokioco without spending $1m?
Gold Grain Study - Methods

- 10 kg panned to ~1 kg hmc
- Samples tabled and micropanned
- Examined by binocular microscope
- 0.25-0.5mm heavy mineral fraction extracted and logged
- Gold grains extracted and classified
- Suites of gold grains from two representative samples from each area examined by SEM and analysed by energy dispersive x-ray spectrometry
- All work done by ODM
Gold Grain Study - Abundance

Wayamaga
- N=8
- Min=23
- Max=243

Cokioco
- N=6
- Min=377
- Max=1800

- 20-50 Au grains/10 liters
- 50-100 Au grains/10 liters
- 100-500 Au grains/10 liters
- 500-2000 Au grains/10 liters

5 kms
Gold Grain Study - Morphology

Cokioco fully reshaped gold grains
Gold Grain Study - Morphology

Wayamaga slightly modified to fully reshaped gold grains

s.f.=983
s.f.=1000
s.f.=910
s.f.=969
s.f.=976
s.f.=1000
Gold Grain Study - Reshaping

Percentage of Reshaped Au Grains at Cokioco and Wayamaga

% reshaped

Cokioco Samples | Wayamaga Samples

- BA322510
- BA322516
- BA322520
- BA322527
- BA322630
- WYHMC-1
- WYHMC-2
- WYHMC-3
- WYHMC-4
- WYHMC-5
- WYHMC-6
- WYHMC-7
- WYHMC-8

% Reshaped
Gold Grain Size Distribution

Size Distribution of Gold Grains at Wayamaga and Cokioco

Micron Category

- % WAY
- % COK

Categories:
- <50
- 50-125
- 125-200
- 200-300
- >300

Y-axis: %
X-axis: Micron Category

Values:
- <50: % WAY 10, % COK 15
- 50-125: % WAY 35, % COK 40
- 125-200: % WAY 40, % COK 35
- 200-300: % WAY 20, % COK 15
- >300: % WAY 5, % COK 10

Legend:
- % WAY
- % COK
## Fineness of Gold Grains

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<thead>
<tr>
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<th>Wayamaga</th>
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<tbody>
<tr>
<td>N</td>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>Surface Fineness (average)</td>
<td>1000</td>
<td>988</td>
</tr>
<tr>
<td>Core Fineness (average)</td>
<td>1000</td>
<td>953</td>
</tr>
</tbody>
</table>
Inclusions and Entrained Minerals

Cokioco - presence of stable and/or entrained inclusions
Supergene gold

Cokioco - presence of possible supergene gold growth
Inclusions

Wayamaga - presence of unstable primary inclusions and gangue (e.g. Chalcopyrite, Ankerite and Sericite)
Results of Detailed Gold Grain Study
Cokioco vs. Wayamaga

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<tr>
<td>Reshaping</td>
<td>Complete</td>
<td>Partial</td>
</tr>
<tr>
<td>Grain Size</td>
<td>125-300 um</td>
<td>50-150 um</td>
</tr>
<tr>
<td>Leaching of Ag</td>
<td>Complete</td>
<td>Thin or absent</td>
</tr>
<tr>
<td>Inclusions</td>
<td>Stable</td>
<td>Unstable</td>
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Conclusion #1 – IM’s can indicate proximity to lode sources

Conclusion #2 – Canadians can be useful!
Indicator mineral methods in precious metal exploration

Summary

• Use of gold grain morphology, abundance, chemistry and other characteristics can be an effective exploration tool
  But….it must be used with a thorough understanding of the landscape evolution and surficial processes

• Define the problem first – then test in other environments

• Use of other indicator minerals and mineral chemistry may provide additional tools for enhancing the effectiveness of this method for precious metal exploration