Use of indicator minerals in exploration

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Presentation Outline

- Indicator minerals
- Processing methods
- Examples from regional surveys & case studies
  - Gold
  - Kimberlite
  - Topaz
  - Mercury
- Summary
- Acknowledgments
Indicator mineral

- A mineral that suggests the presence of a mineral deposit
Indicator minerals

- Occur mainly in the host rock
- Abundant
- Visually (and chemically) distinct
- Moderate to high density
- Silt or sand-sized (0.063 to 2.0 mm)
- Survive weathering and/or clastic transport
Indicator mineral surveys

- Media
- Spacing
- Sample Size
- Collection
- Processing
- Pre-concentration

- Concentration
- Ferromagnetics
- Classification
- Picking
- Morphology
- Mineral chemistry
- Interpretation & follow-up
Stream sediment sampling
Glacial sediment sampling-thin drift
Glacial sediment sampling-thick drift
Eolian sand sampling
Processing

• Disaggregate
• Screen gravel
  – >2 mm (10 mesh)
  – >1 mm (20 mesh)
  – >4 mm (5 mesh)
• Retain gravel for lithology
Pre-concentration

• Density
  jig, table, pan, spiral, wheel, heavy liquid

• Size
  Silt to very coarse sand

• Magnetism
  reject non-paramagnetic
Concentration

- **Heavy liquids**
  - Methylene iodide (MI, 3.3)
  - Diluted MI (e.g. 3.2)
  - Tetrabromoethane (TBE, 2.96)
  - NaPolyW (variable)

- **Superpanner**
- **DMS**
- **Magstream**
Ferromagnetic minerals

- Separator
- Hand magnet
Recovery of indicator minerals

10 kg sample

Shaking table

Pan gold grains

Heavy Liquid separation MI 3.2 SG

Magnetic separation

Indicator minerals

Picking

Heavy mineral concentrate
Electron microprobe analysis
Gold deposits

- **Indicator Mineral:** Gold
- **Size range:** silt (10 µm) to coarse sand (2.0 mm)
- **Abundance:** >5 grains/10 kg
- **Sample media:** till, stream sediments
- **Diagnostic Features:** abundance, size & shape
- **Used with sediment geochemistry**
Gold grain shape

(DiLabio, 1990)

Pristine  Modified  Reshaped

Increasing transport distance
Waddy Lake, Saskatchewan, Canada

(Averill & Zimmerman, 1986)
Pamour Mine, Timmins, Canada

- Glaciated terrain; till samples
- Proximal to source
- 880 gold grains/10 kg
- Pristine shape; <50 microns
- 20,000 ppb Au HMC
- 250 ppb Au <0.063 mm

(McClenaghan, 1999)
Timmins region, central Canada

- Glaciated terrain; till samples
- Regional survey
- 0 to 139 gold grains/10 kg
- Modified to reshaped grains
- Greater transport distances
- Associated with structure and/or lithology

(Bajc, 1996)
Kimberlite/Diamonds

- **Indicator Minerals**: Cr-pyrope, Eclogitic garnet, Mg-ilmenite, Cr-diopside, Chromite, Forsteritic olivine

- **Size range**: medium to very coarse sand (0.25 to 2.0 mm); more abundant in & cost effective to pick 0.25-0.5 mm fraction

- **Abundance**: >1 grain/10 kg

- **Sample media**: glacial sediments, stream sediments, eolian sediments

- **Diagnostic Features**: abundance, relative abundance, and surface textures
Kimberlite Indicator Minerals

- Cr-pyrope
- Cr-diopside
- Chromite
- Mg-ilmenite
- Olivine
- E-garnet
Relative abundance

0.25 to 0.5 mm

C14

Diamond L.

- pyrope
- Cr-diopside
- Mg-ilmenite
- chromite
Ranch Lake, NWT, Canada

- Glaciated terrain; till samples
- Train formed by single phase of ice flow
- 1000’s grains /10 kg
- Cr-pyrope and Cr-diopside
Lac de Gras kimberlite field, NWT, Canada

- Glaciated terrain; till samples
- Regional survey, 10 to 15 km
- Dispersal fan is net effect of 3 phases of ice flow
- Presence of kimberlite field is clearly visible
- 100’s grain/10 kg
- Cr-pyrope and Cr-diopside
Attawapiskat kimberlite field, James Bay Lowland, Canada

- Glaciated terrain
- Thick cover overlying till
- Stream sediments sampled
- Glacial transport to SW
- Fluvial transport NE
- Mg-ilmenite and pyrope
Southwest Greenland

- Glaciated terrain
- Regional stream sediment survey
- Glacial and fluvial transport
- 1 to 10 grains
- Cr-pyrope

(Steenfelt, 2002)
Kalahari Desert, southern Africa

- Arid terrain
- Deflation surfaces sampled
- Mg-ilmenite and Cr-pyrope

Kalahari map removed- contact Dr. Tom Nowicki at Mineral Services Canada for a copy of this figure
Email: Tom.Nowicki@mineralservices.com

(Williams et al, 2003)
New Brunswick, Canada

- Glaciated terrain
- Till sampled
- 10’s of grains/10 kg

(Friske, 2002)
Pinchi Hg Mine, British Columbia, Canada

- Glaciated terrain, till samples
- Cinnabar grains (HgS)
- 1000’s grain/10 kg
- Dispersal distance >20 km
Summary

• Overview of the application of indicator minerals to exploration
• Definition of indicator mineral and characteristics that make them useful
• Many aspects to consider when applying these methods, from sample media, processing, to interpretation
• Focused on gold grains because indicator mineral methods are well established for gold exploration and had success
• Focused on kimberlite indicator minerals because of explosion in diamond exploration activity in last 10 years
• Methods allow exploration for broad range of commodities in most terrains
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Indicator Mineral Session

- Regional distribution of *kimberlite* indicator minerals, Slave Craton, Northwest Territories and Nunavut, Canada
- Case history of an indicator mineral survey for *nickel* exploration, Canada
- Indicator minerals for *Ni-Cu-PGE* exploration
- Forecasting lode *gold* potential from physical and chemical characteristics of placer gold grains – an example from French Guiana
- Hydrothermal zircon: a resistate mineral with potential use as an indicator/pathfinder in exploration
- Rutile geochemistry as a guide to mineralization at the Northparkes porphyry *copper* deposit, New South Wales, Australia