



Use of indicator minerals in exploration

M. Beth McClenaghan
Geological Survey of Canada

and

Mary E. Doherty
International Geochemical Consultants

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Natural Resources
Canada

Ressources naturelles
Canada

Canada



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

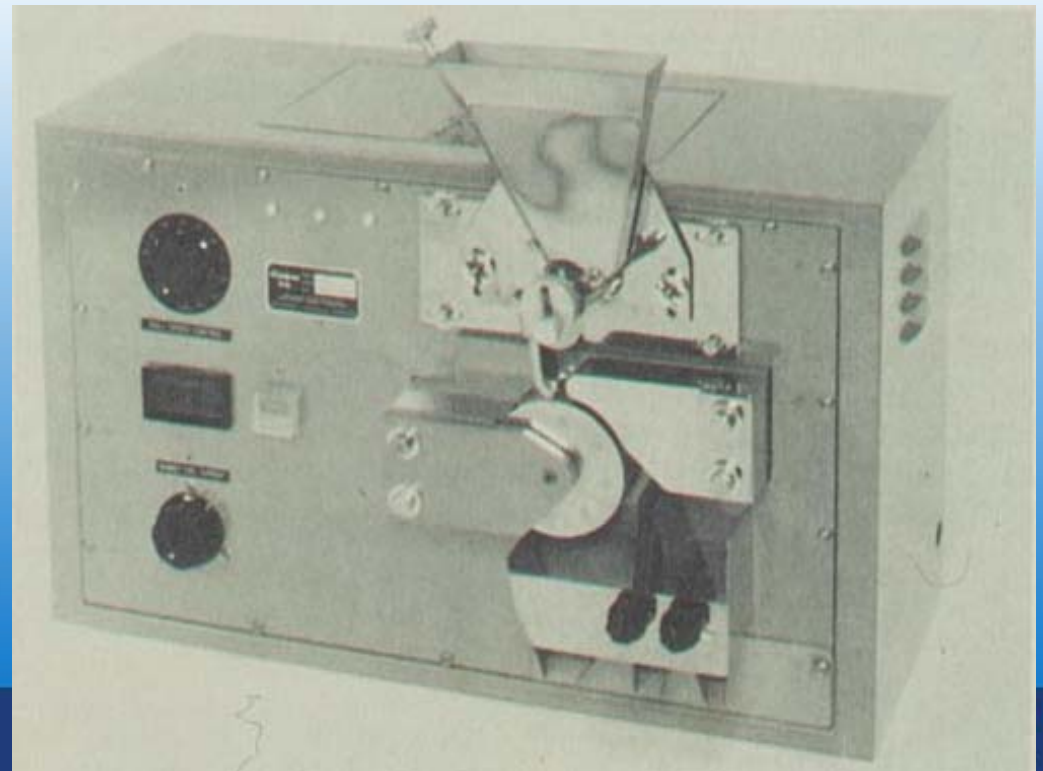
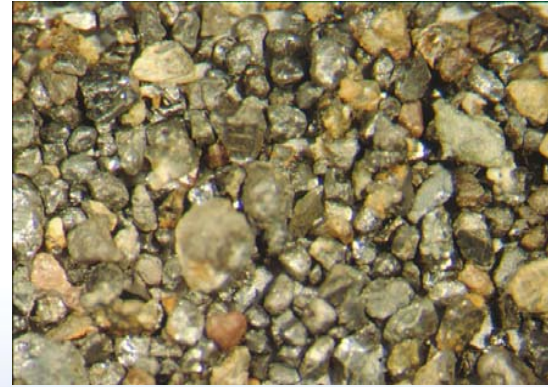
- Heavy liquids
 - Methylene iodide (MI, 3.3)
 - Diluted MI (e.g. 3.2)
 - Tetrabromoethane (TBE, 2.96)
 - NaPolyW (variable)
- Superpanner
- DMS
- Magstream



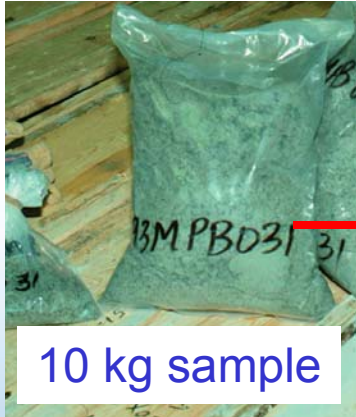
Ferromagnetic minerals



- 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

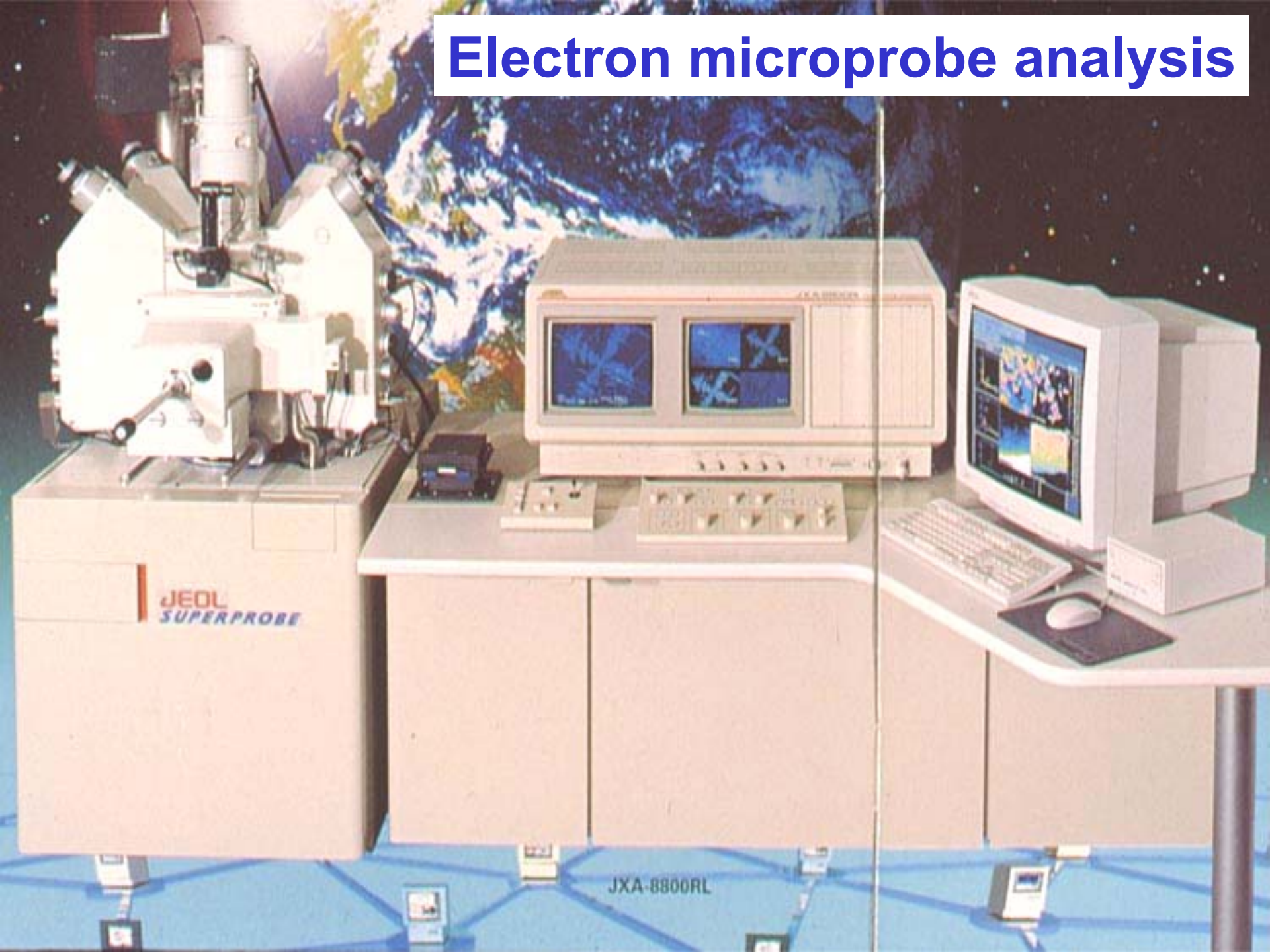


Picking



Heavy mineral concentrate

Electron microprobe analysis

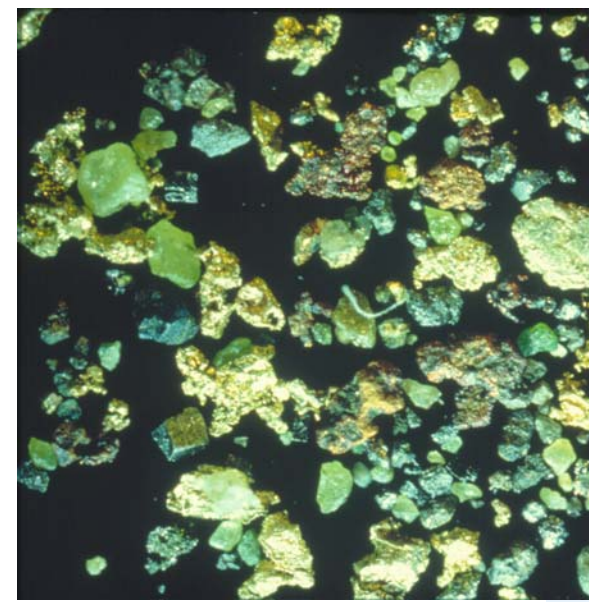


JEOL
SUPERPROBE

JXA-8800RL



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**



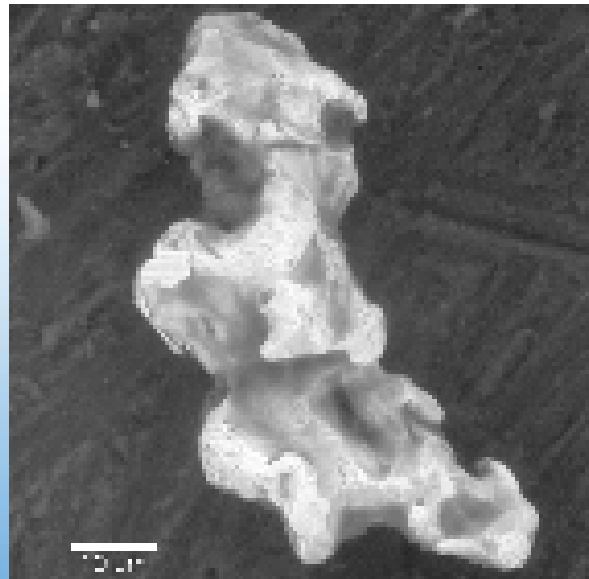


Gold grain shape

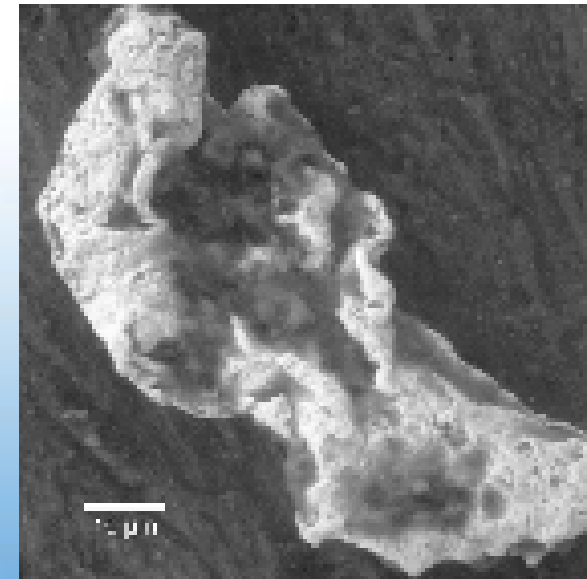
(DiLabio, 1990)



Pristine



Modified

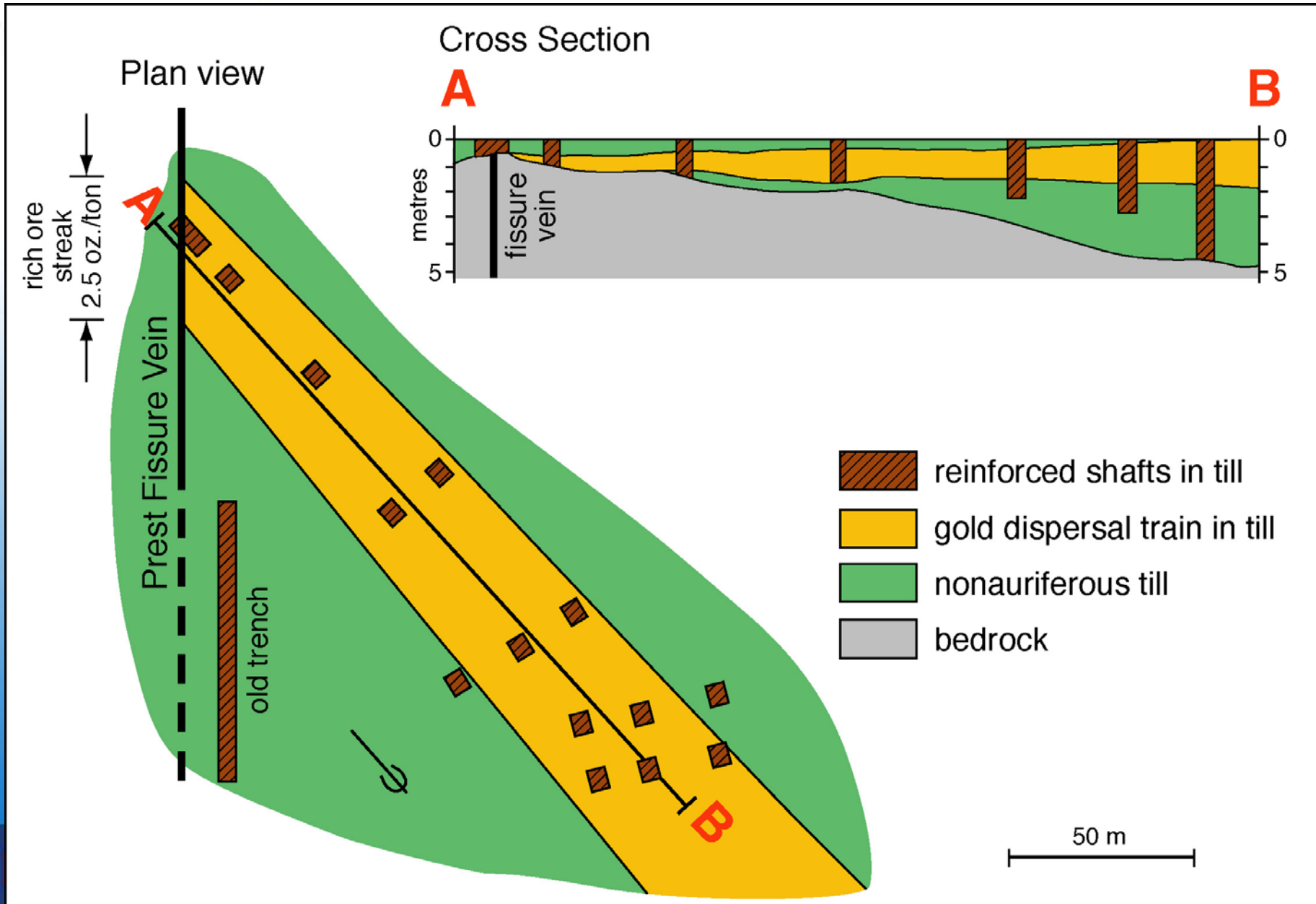


Reshaped

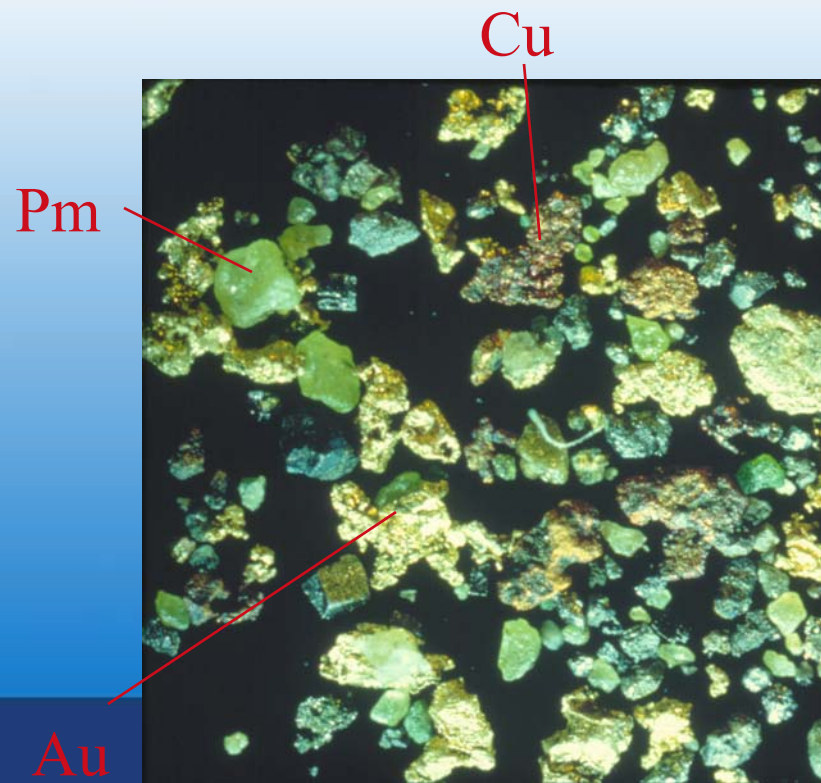
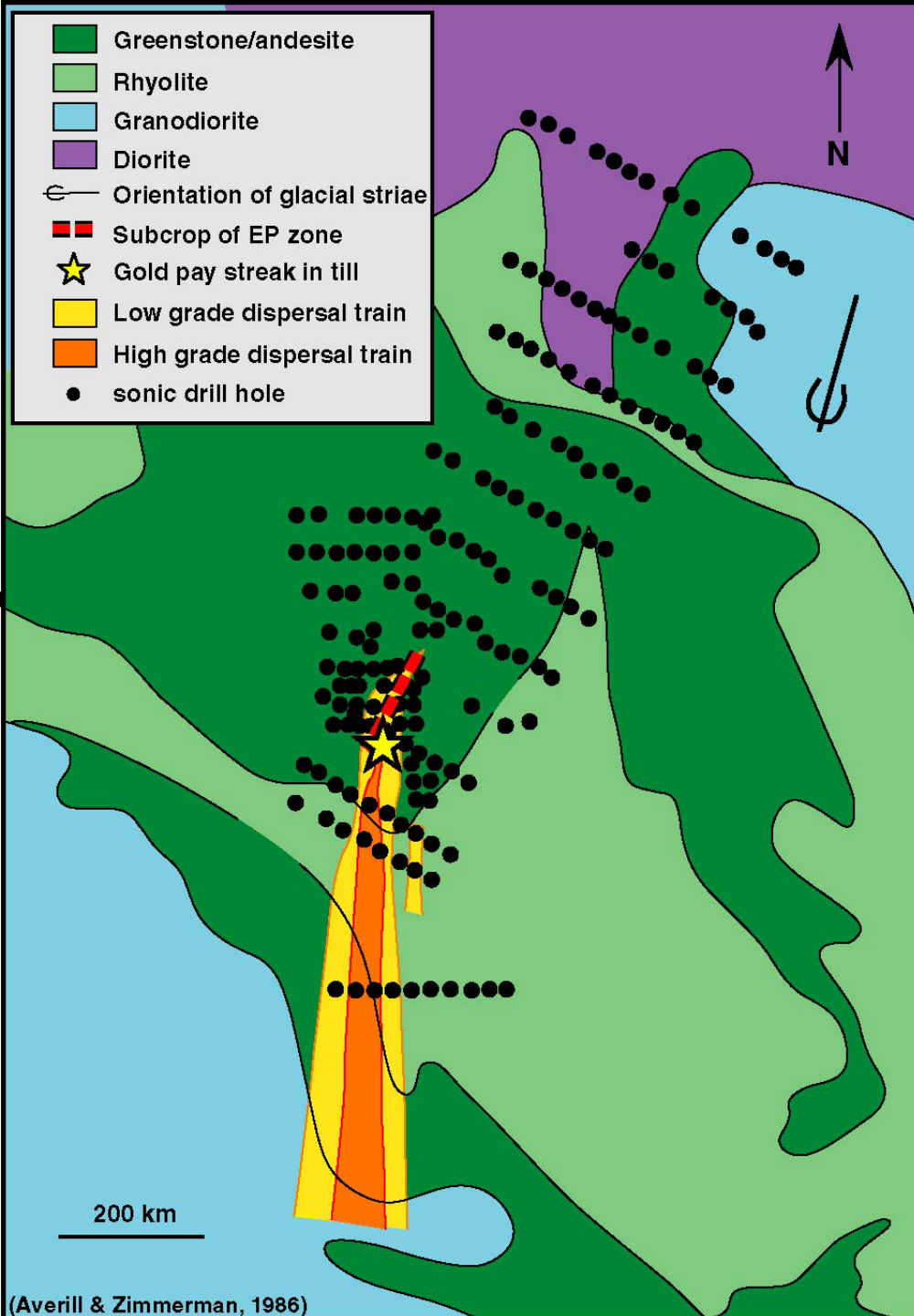
Increasing transport distance



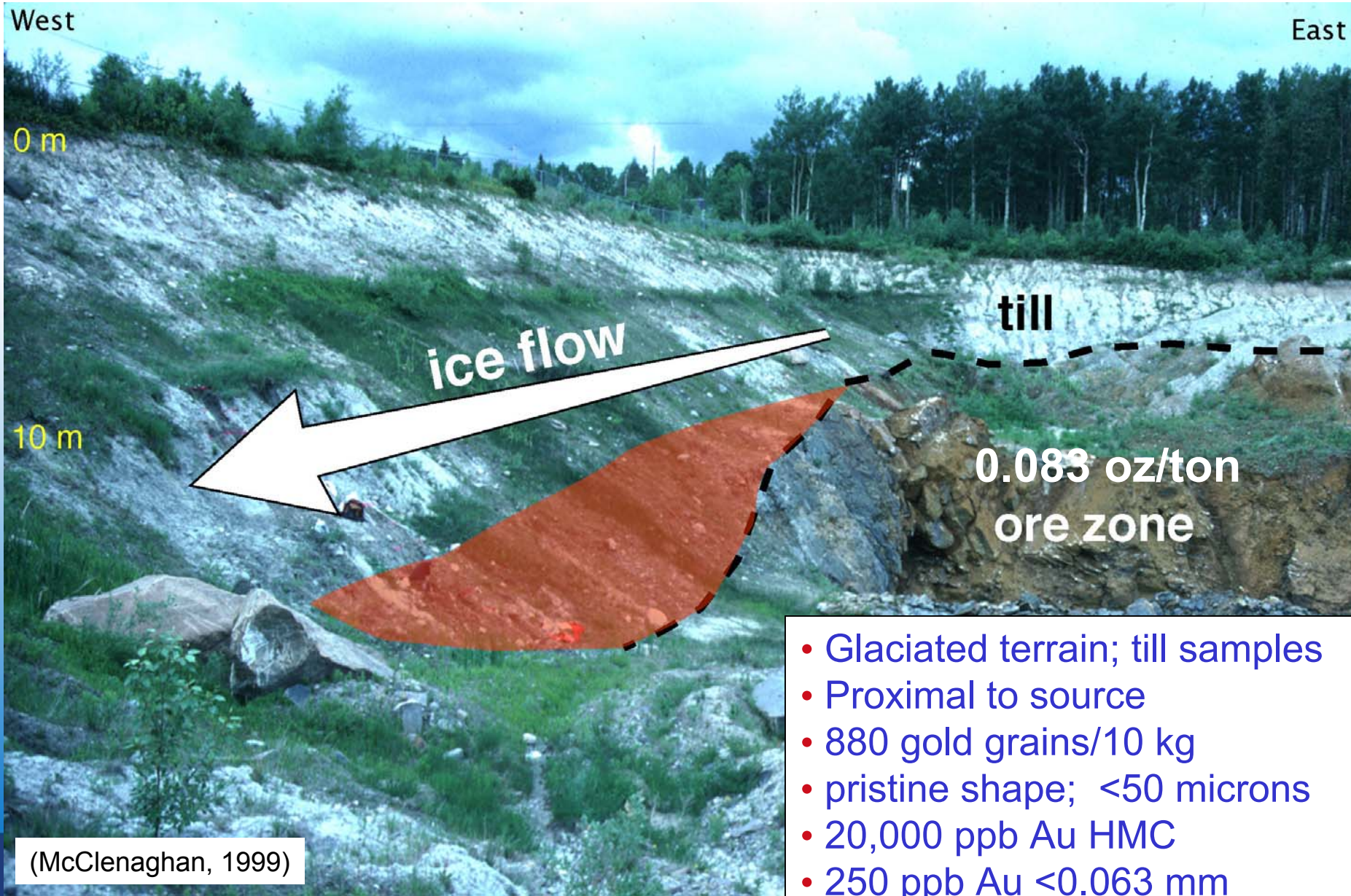
Nova Scotia, Canada



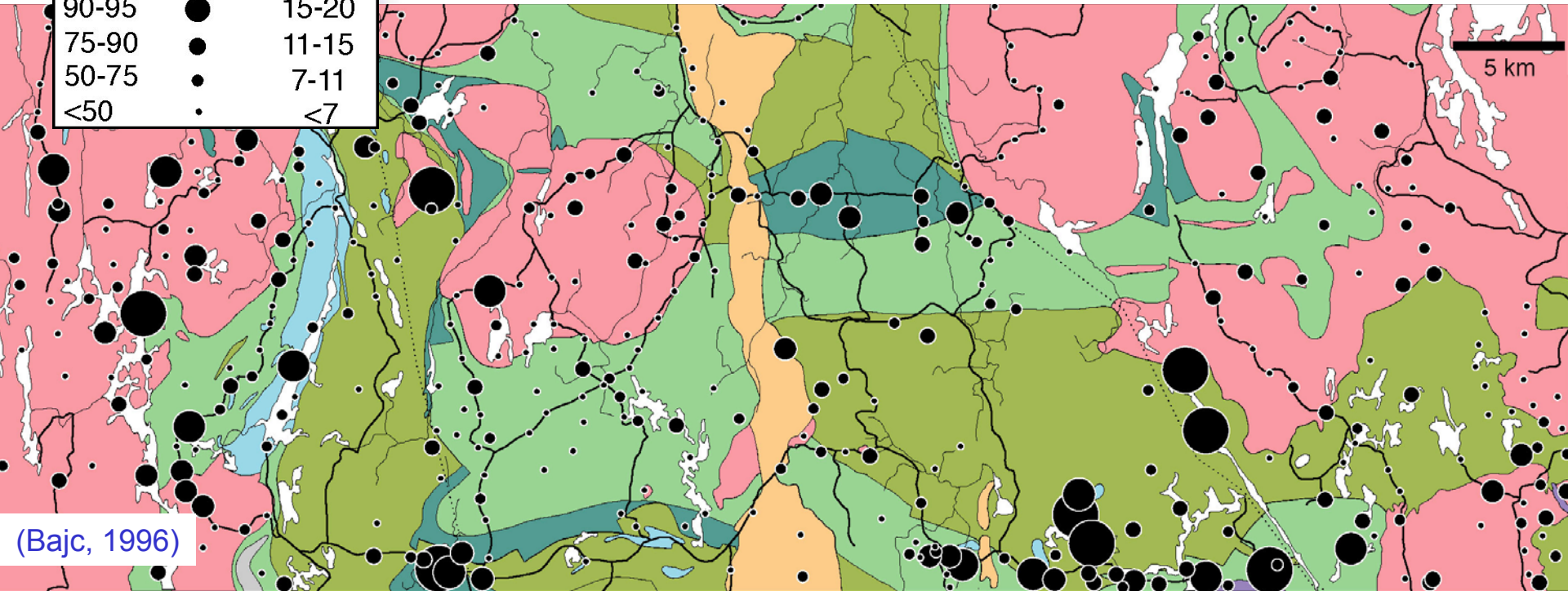
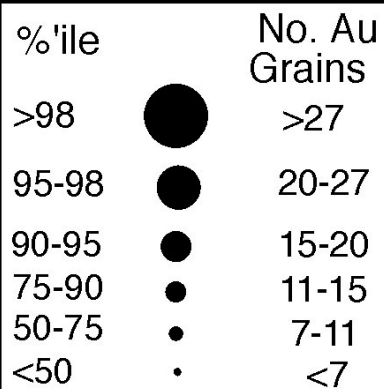
Waddy Lake, Saskatchewan, Canada



Pamour Mine, Timmins, Canada

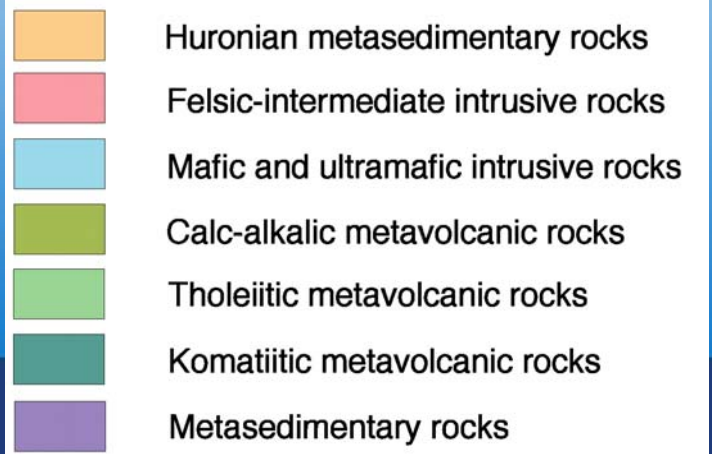


Timmins region, central Canada

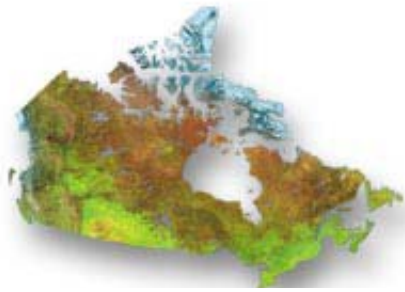


5 km

(Bajc, 1996)



- 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

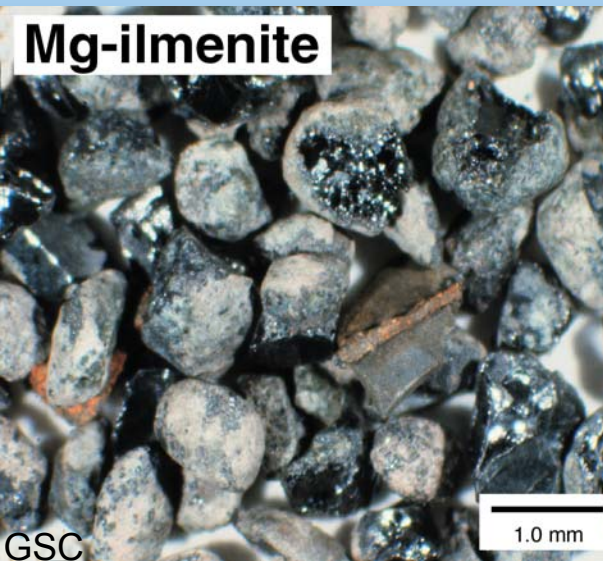


Kimberlite/Diamonds

- **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

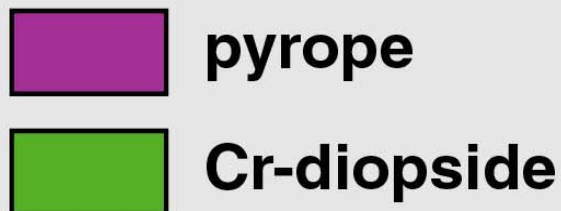
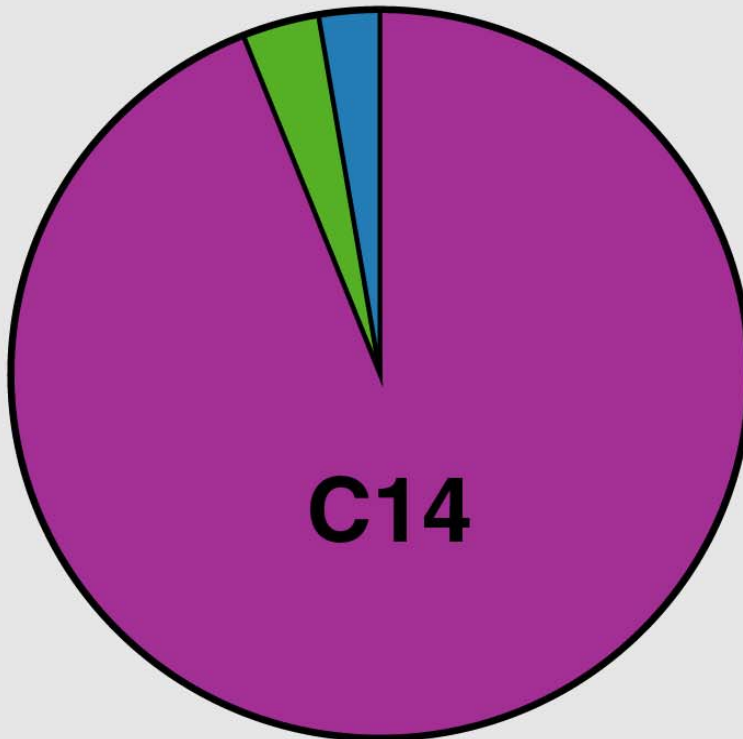


Kimberlite Indicator Minerals



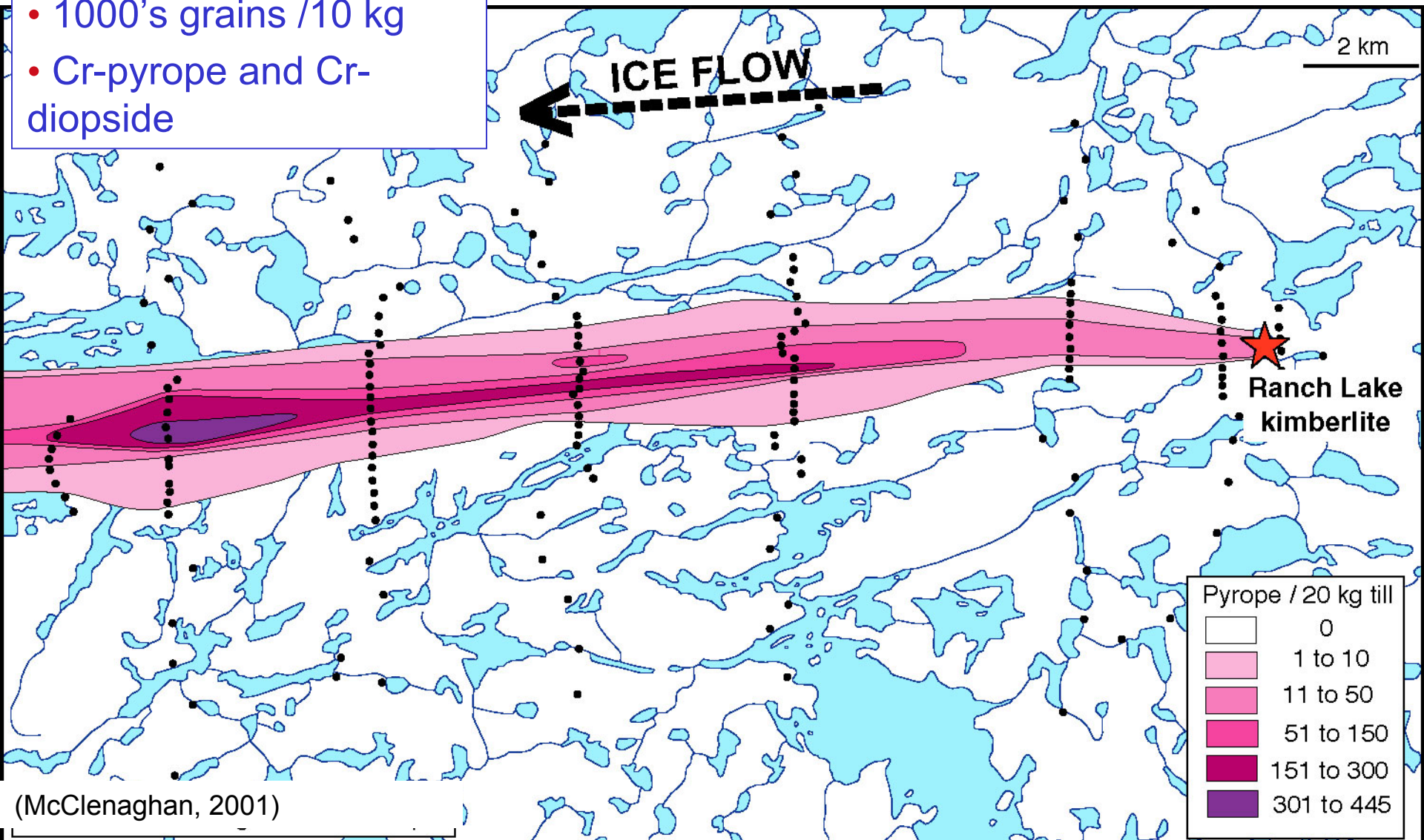
Relative abundance

0.25 to 0.5 mm



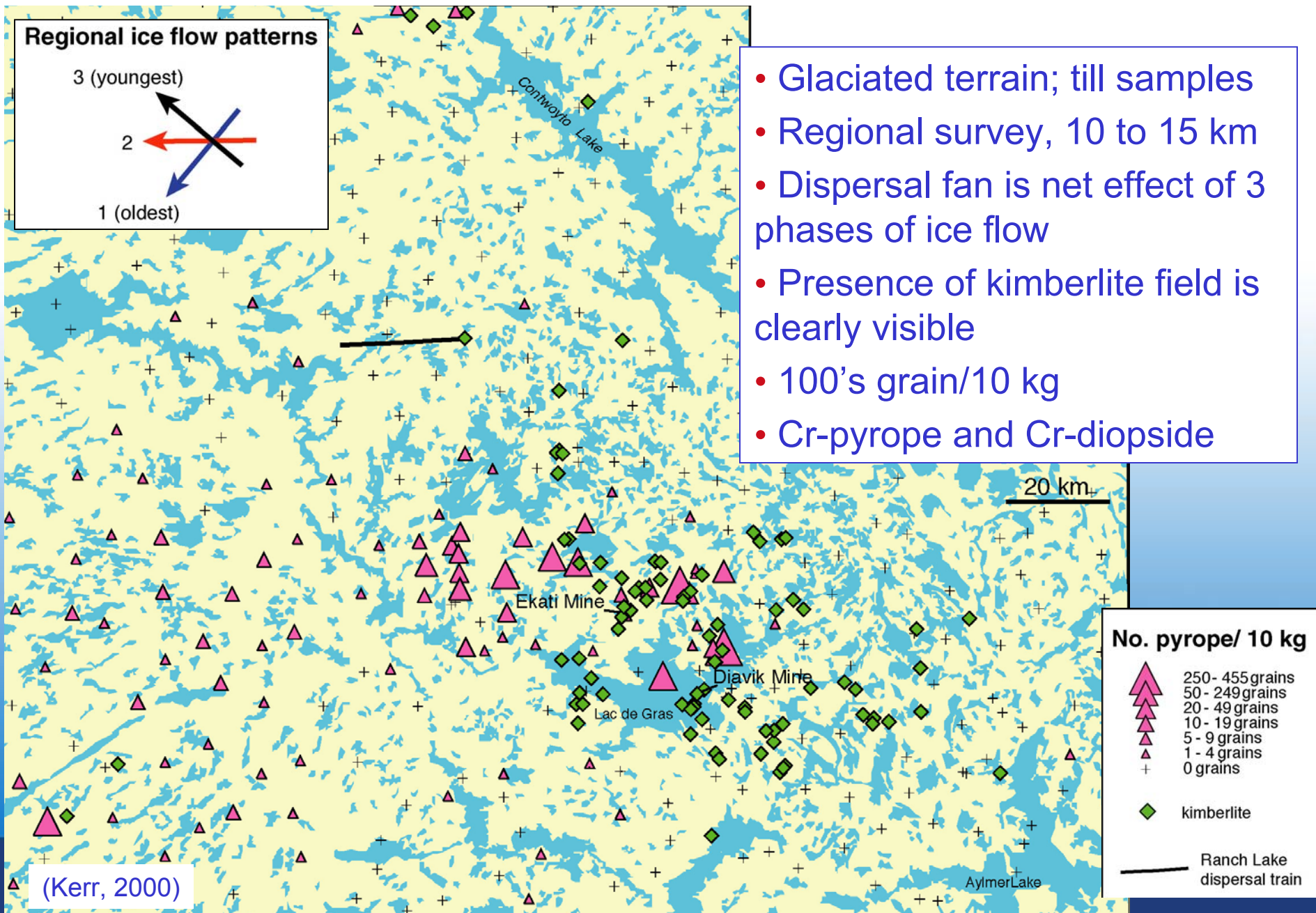
Ranch Lake, NWT, Canada

- Glaciated terrain; till samples
- Train formed by single phase of ice flow
- 1000's grains /10 kg
- Cr-pyrope and Cr-diopside



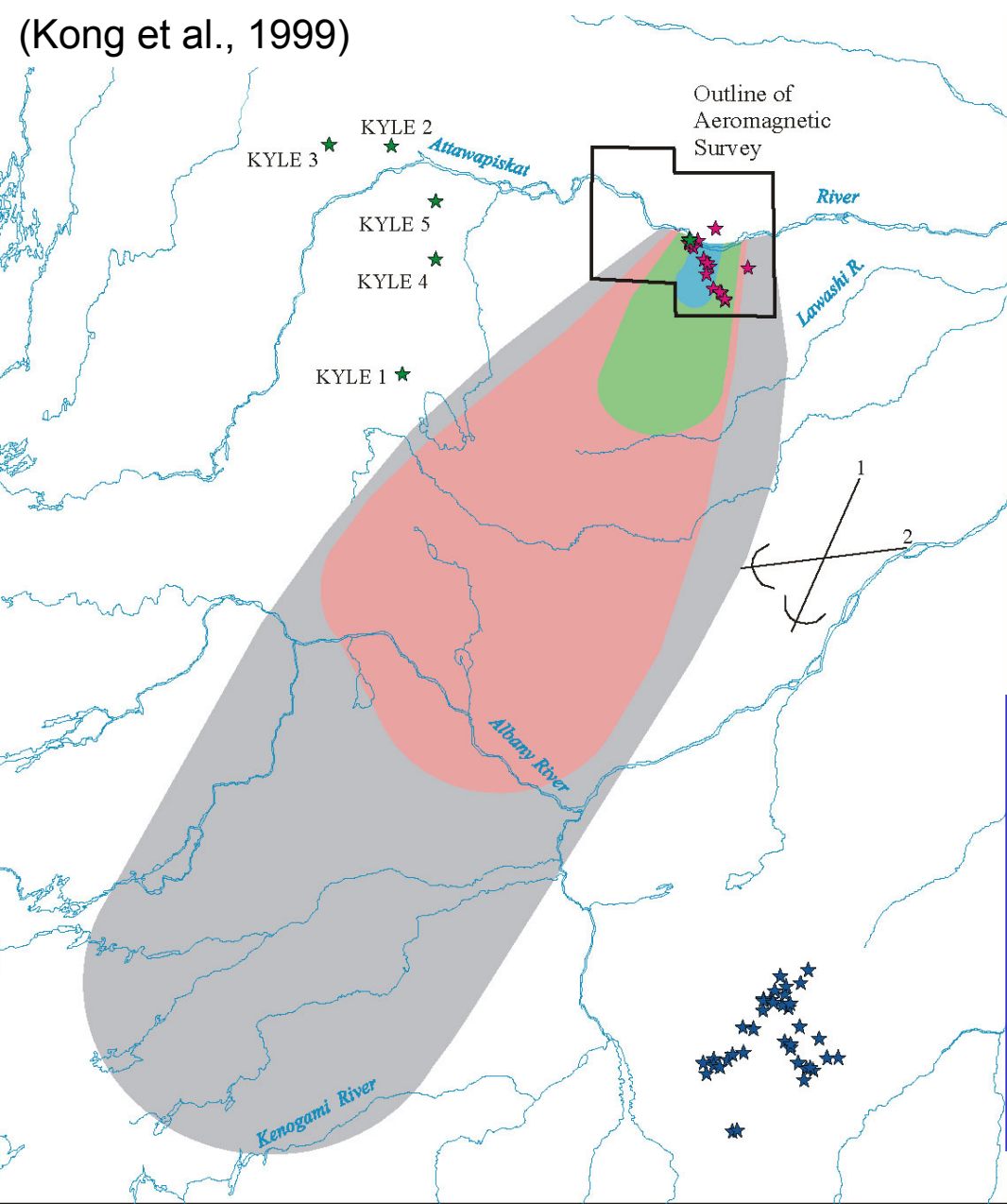
(McClenaghan, 2001)

Lac de Gras kimberlite field, NWT, Canada



(Kong et al., 1999)

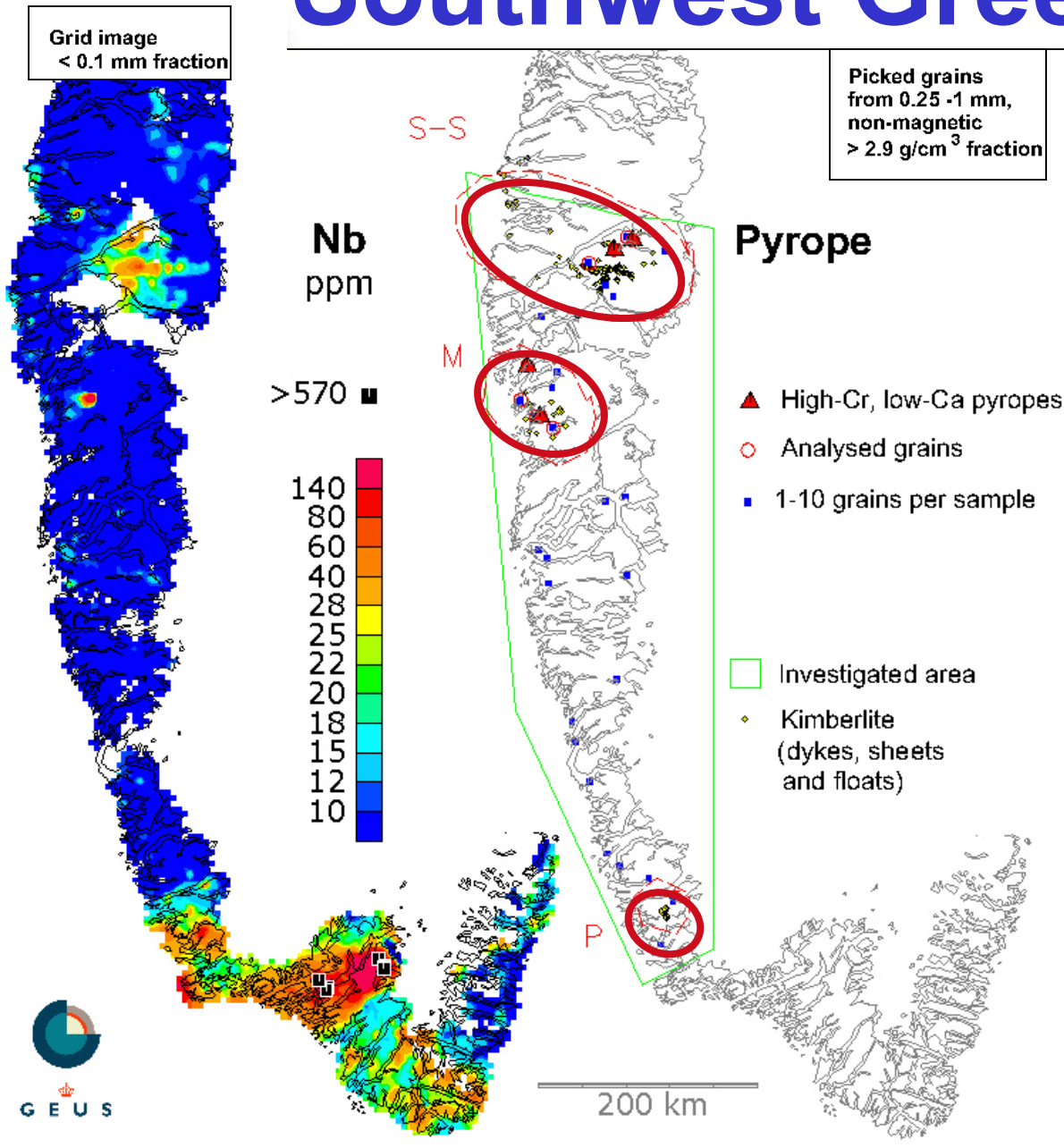
Attawapiskat kimberlite field, James Bay Lowland, Canada



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

★ Attawapiskat Kimberlite	0 25 50 75	■ Garnet	■ CPX
★ KWG/Spider Kimberlite	Kilometres	■ Ilmenite	■ Chromite
★ Selco/Esso Kimberlite			

Southwest Greenland



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

Kalahari Desert, southern Africa



Kalahari map removed-

contact Dr. Tom Nowicki at Mineral Services Canada for a copy of this figure

Email: Tom.Nowicki@mineralservices.com

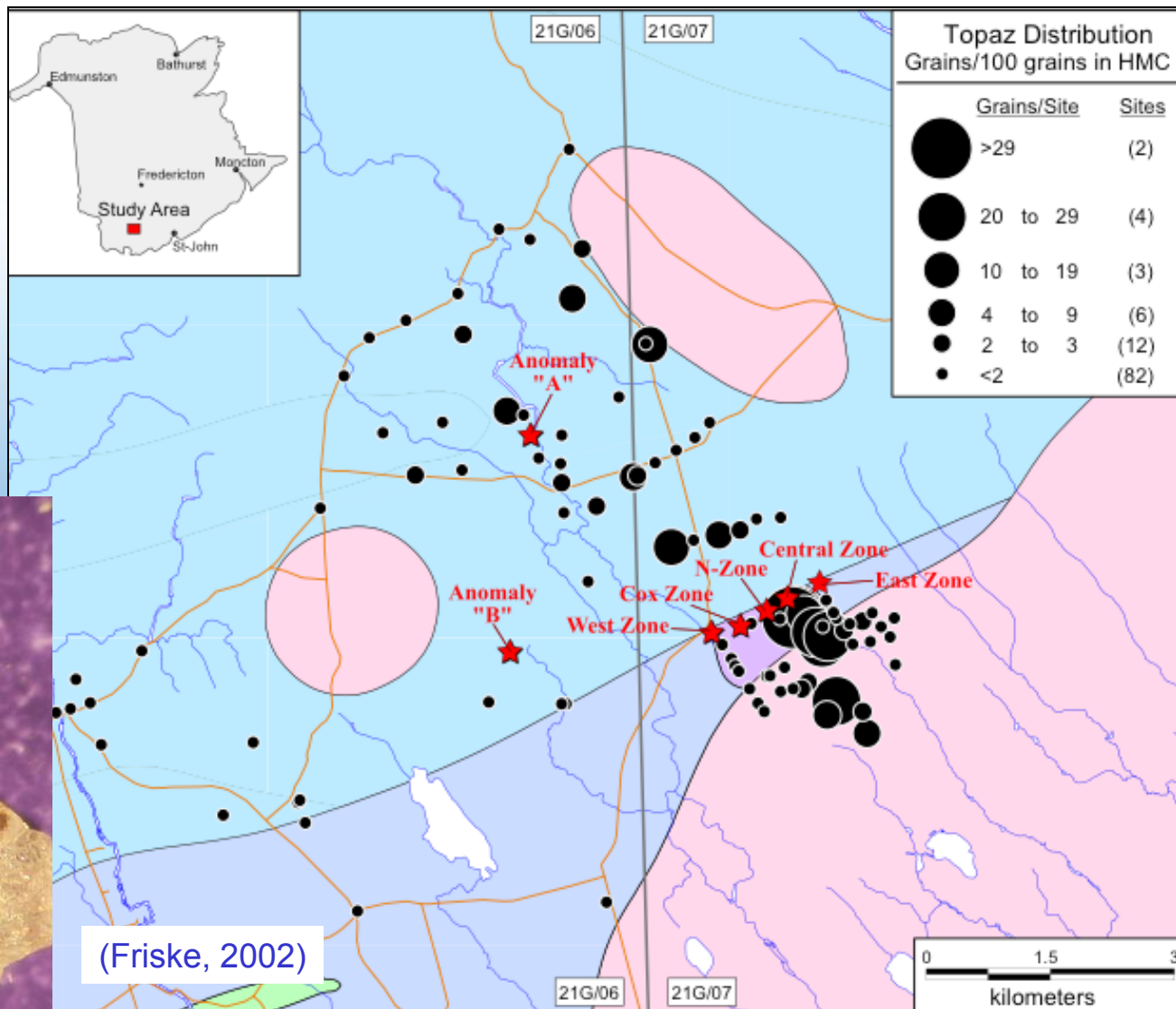
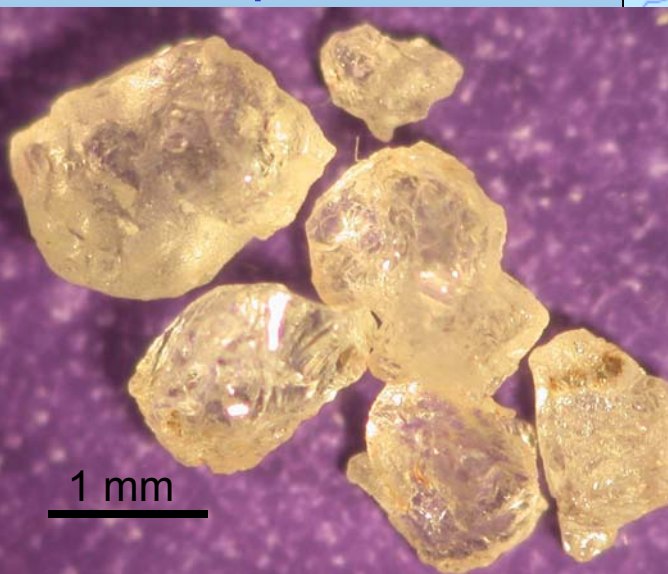
- Arid terrain
- Deflation surfaces sampled
- Mg-ilmenite and Cr-pyrope

New Brunswick, Canada



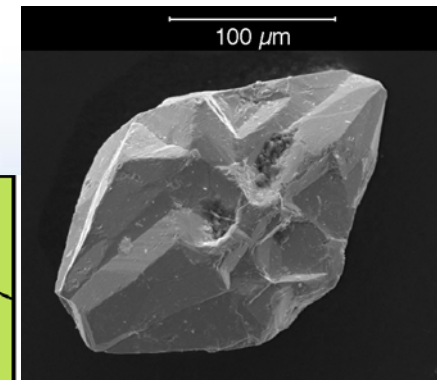
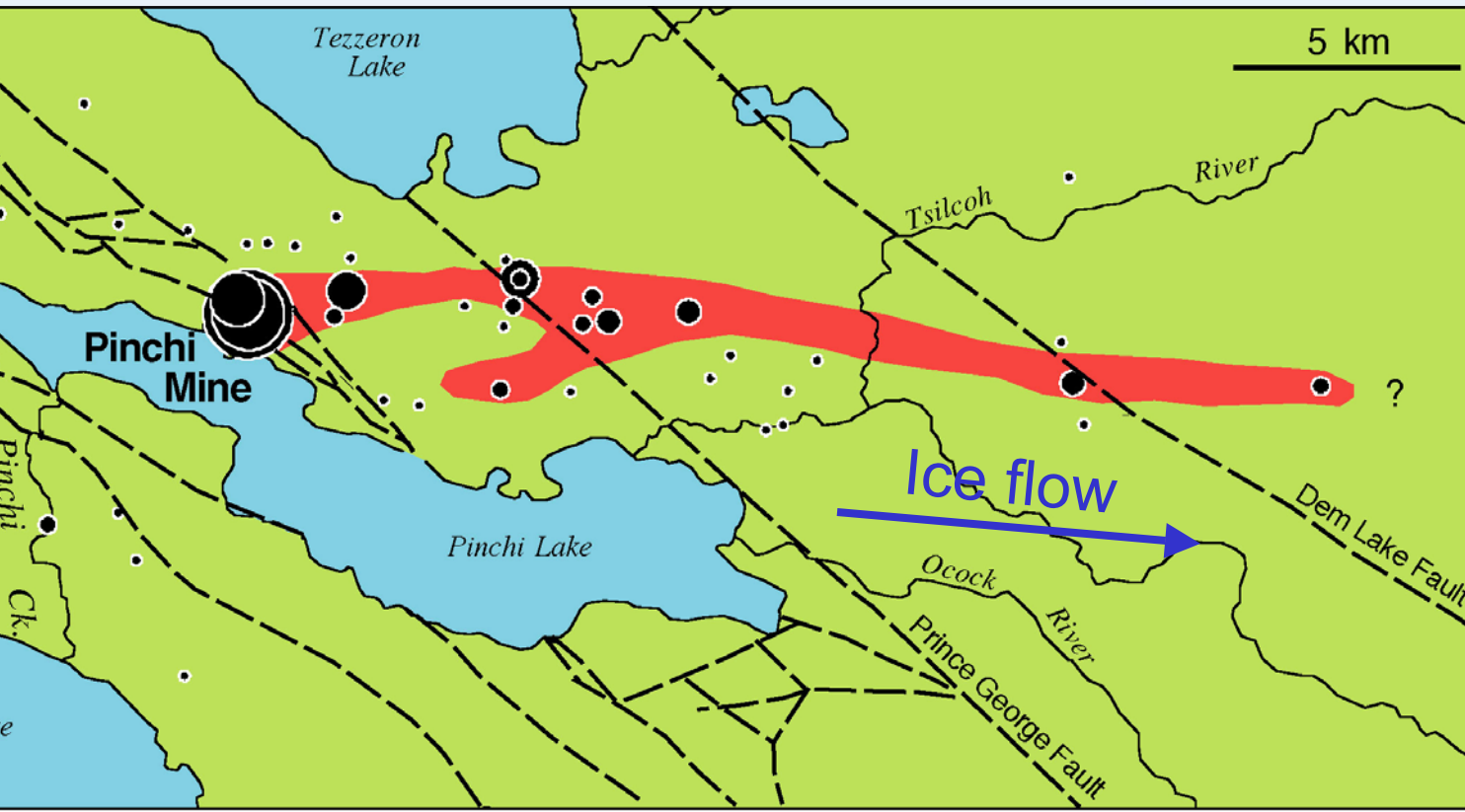
- Glaciated terrain
- Till sampled
- 10's of grains/10 kg

Topaz



Pinchi Hg Mine, British Columbia, Canada

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



No. cinnabar grains / (g) HMC
• 0
• 0.5 to 9
• 10 to 28
• 29 to 176
• 177 to 1199
• 1200 to 1581
• 1582 to 1875



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





Acknowledgments

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- Agnete Steenfelt, *Geological Survey of Denmark and Greenland*





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

