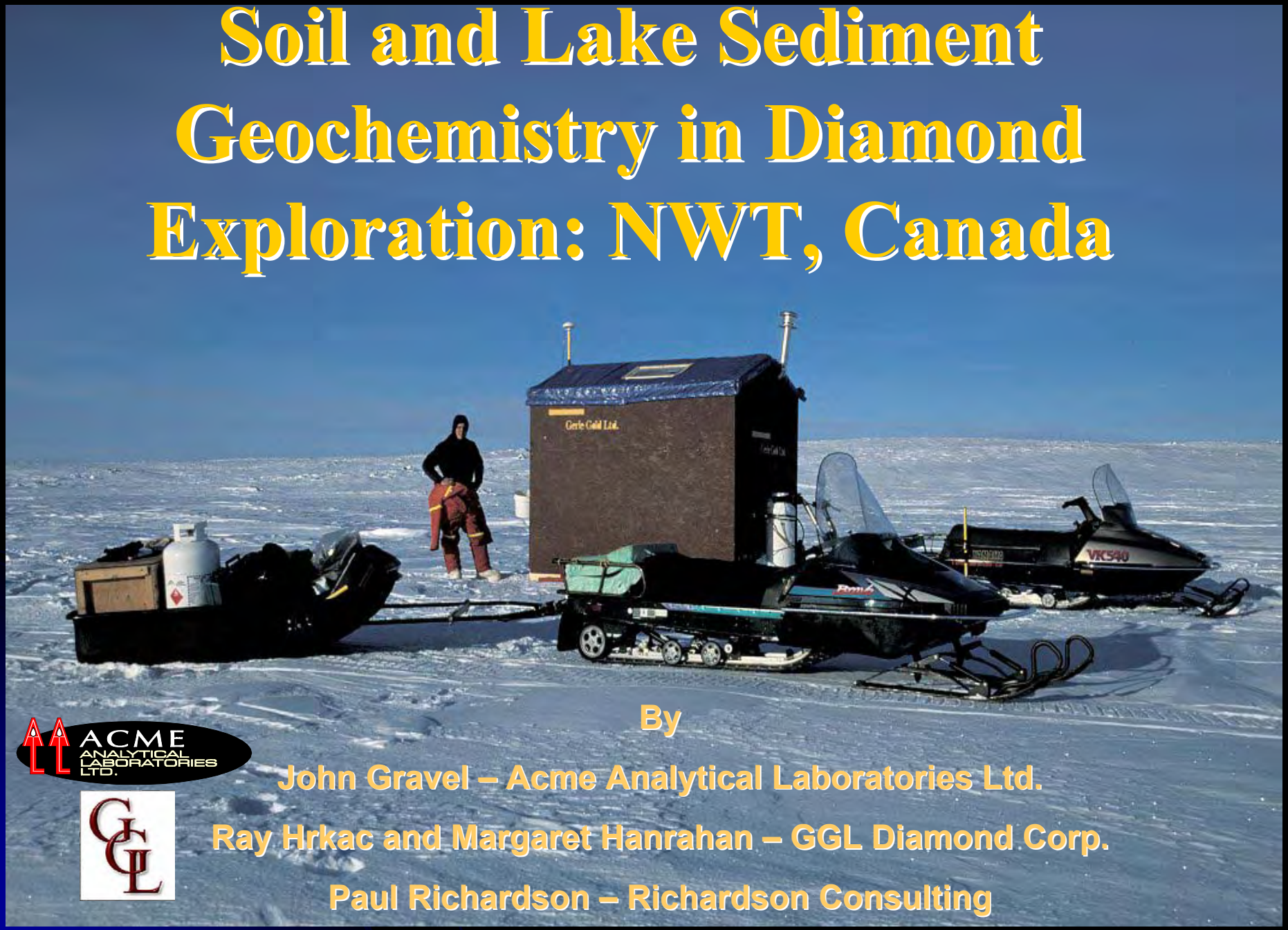
Soil and Lake Sediment Geochemistry in Diamond Exploration: NWT, Canada



By

John Gravel – Acme Analytical Laboratories Ltd.

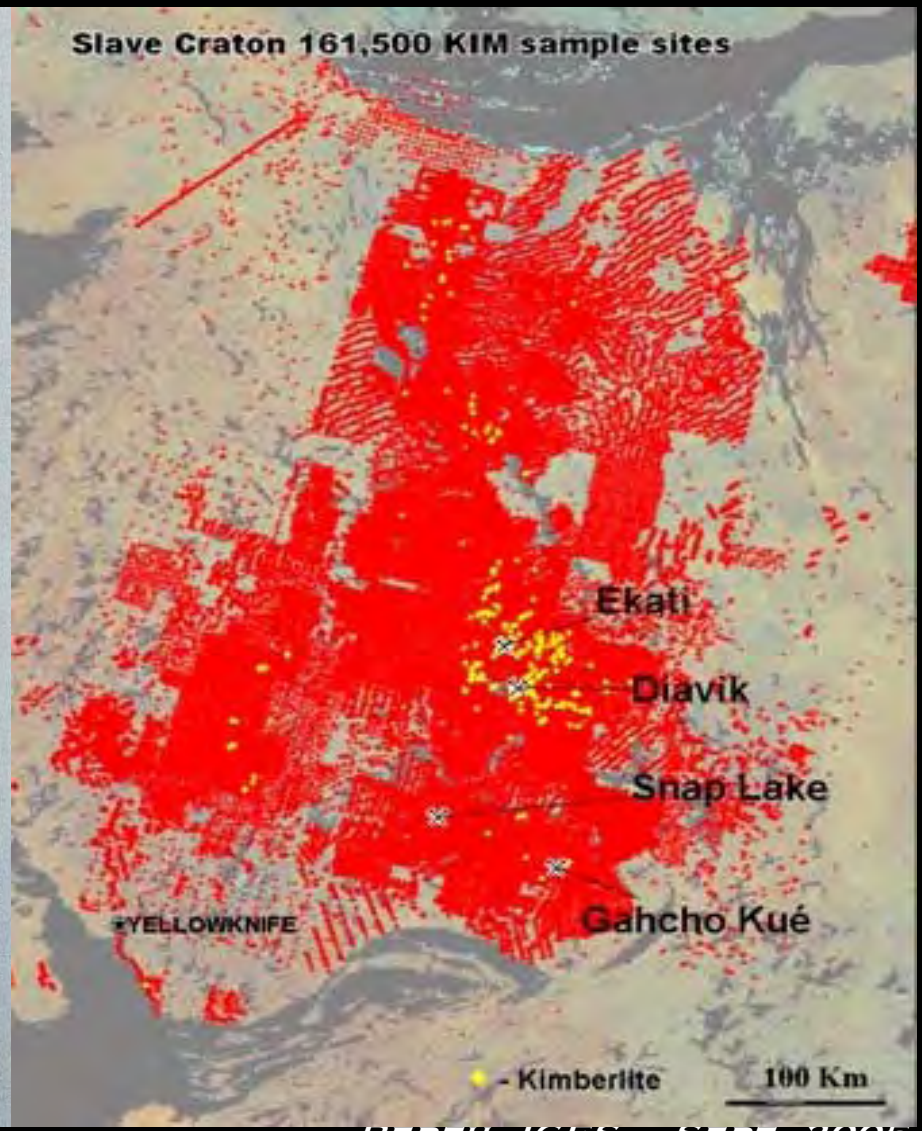
Ray Hrkac and Margaret Hanrahan – GGL Diamond Corp.

Paul Richardson – Richardson Consulting

Diamond Exploration using Geochemistry Kimberlite Indicator Minerals

- Bulk sampling of alluvium, glacial drift and loams followed by heavy mineral concentration of Kimberlite indicator grains
  - Counting of grains, mapping of dispersion trails, grain chemistries and microscope examination of grain surfaces.
- Applied with great success by Chuck Fipke in discovery of Canada's first economic diamond mine (1991).
- Subsequently used extensively across the Slave Craton of northern Canada to discover kimberlites.

Diamond Exploration using Geochemistry
Kimberlite Indicator Minerals



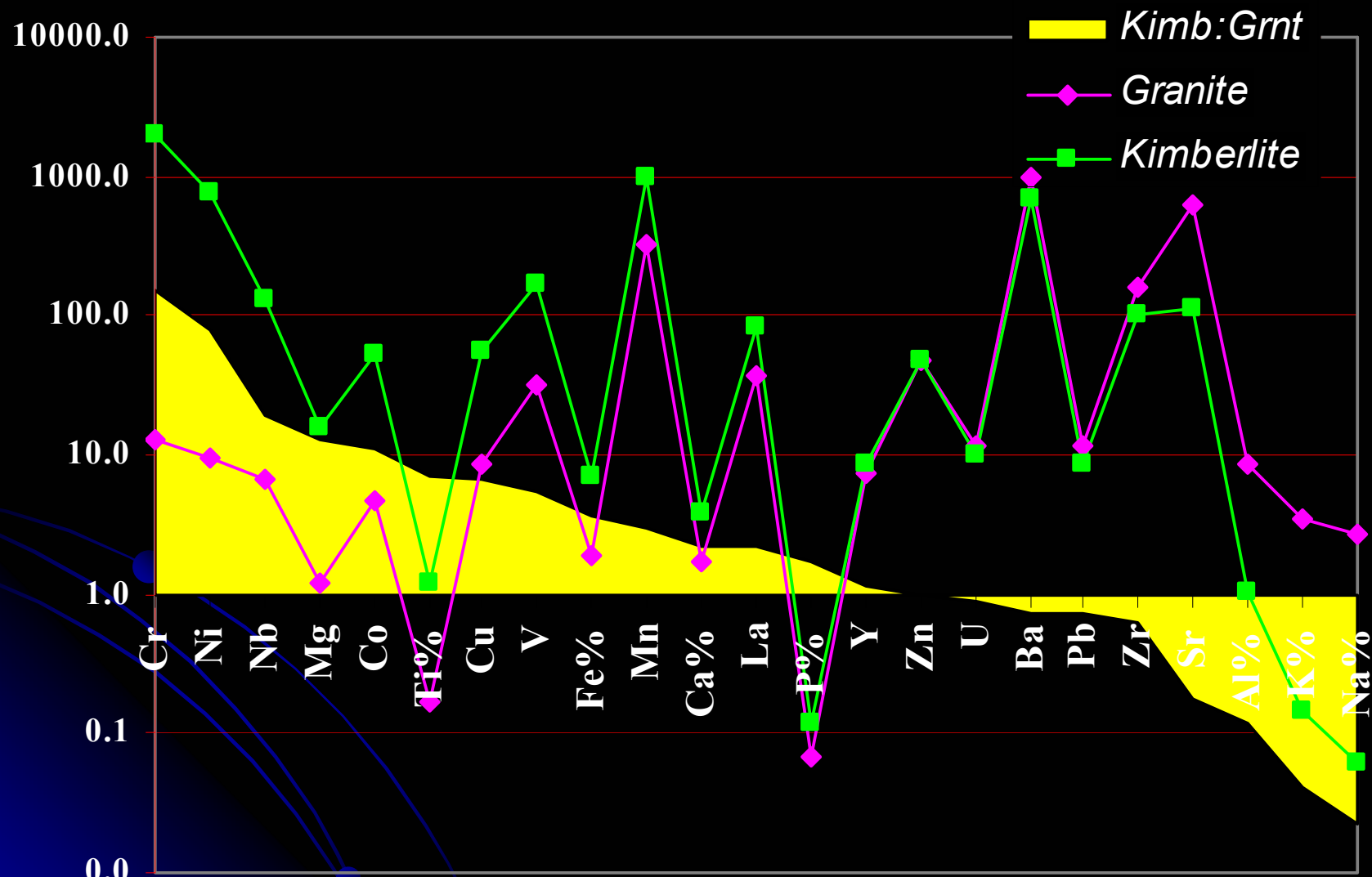
GGL begins NWT Diamond Exploration (1992)

- Alternative exploration methods to establish an edge.
- Consultant Dr. Stan Hoffman proposes soil and lake sediment geochemistry for rapid definition of kimberlite's unique geochemical signature.
- Integrated with conventional KIM surveys and part of the toolbox including geophysics, surficial mapping, structural analysis, etc.
- Advantages (circa 1992) included:
  - Low analytical cost (1/20th of indicator mineral analysis),
  - Rapid turnaround for data (2 weeks versus 1 - 6 months for KIM analysis) and
  - New ICP-MS packages coming on stream providing low detection limits for a wide range of elements.

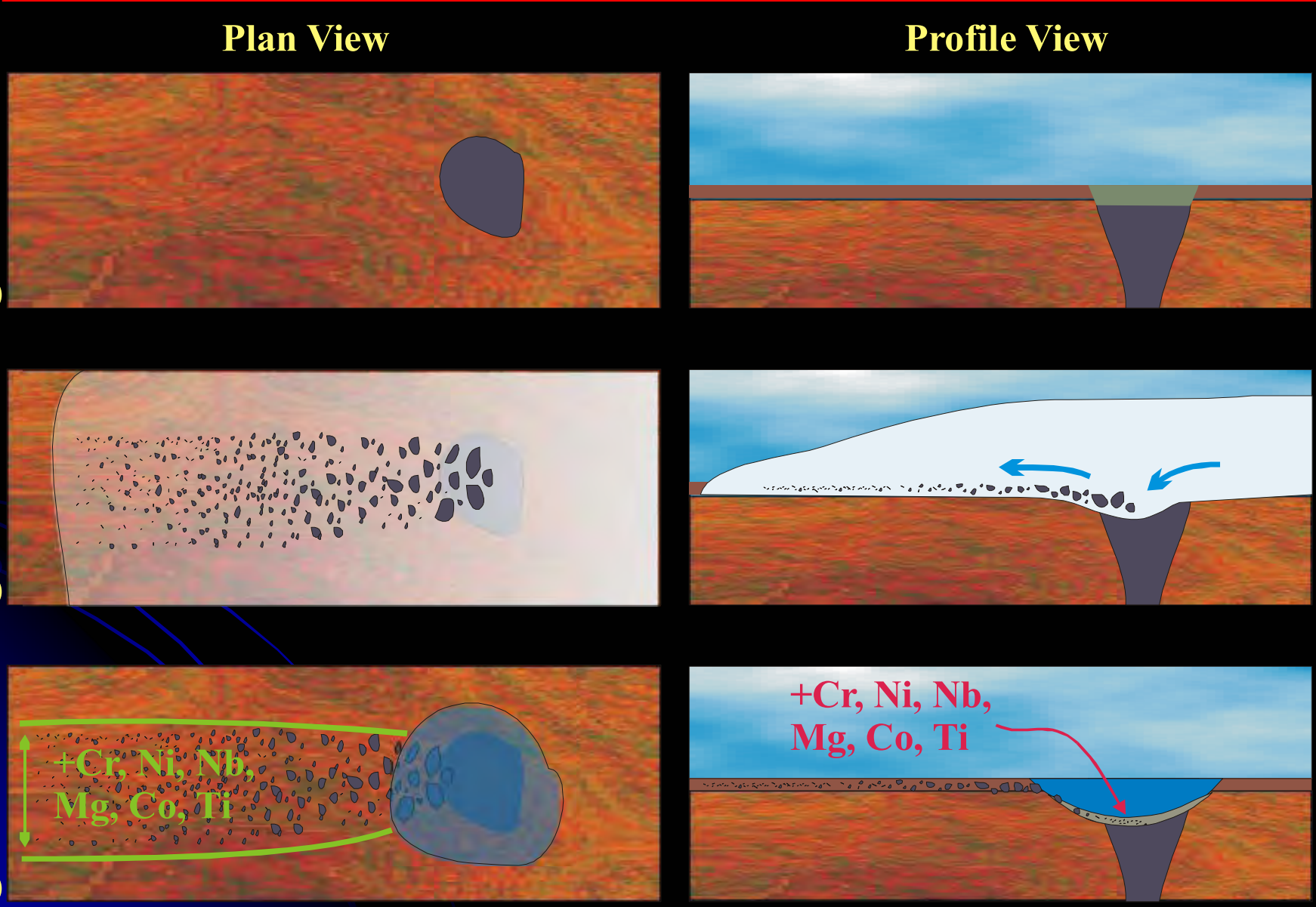
Premise for Geochemical Surveys

- Unique chemical signature:
  - Kimberlite is a peralkaline ultrabasic (elevated K)
  - Also enriched in incompatible elements (ie. Nb) and REEs
  - Likely to contrast strongly with local host rocks.
- Comprises mantle derived rocks that are unstable at surface and weather rapidly. Thus they likely erode easily and form topographic depressions with debris plumes extending down-ice in an arctic post-glacial terrain. Hence are good targets for geochemical exploration via:
  - Regional lake sediment surveys, and
  - Regional soil lines oriented perpendicular to glacial trend.

Premise for Geochemical Surveys



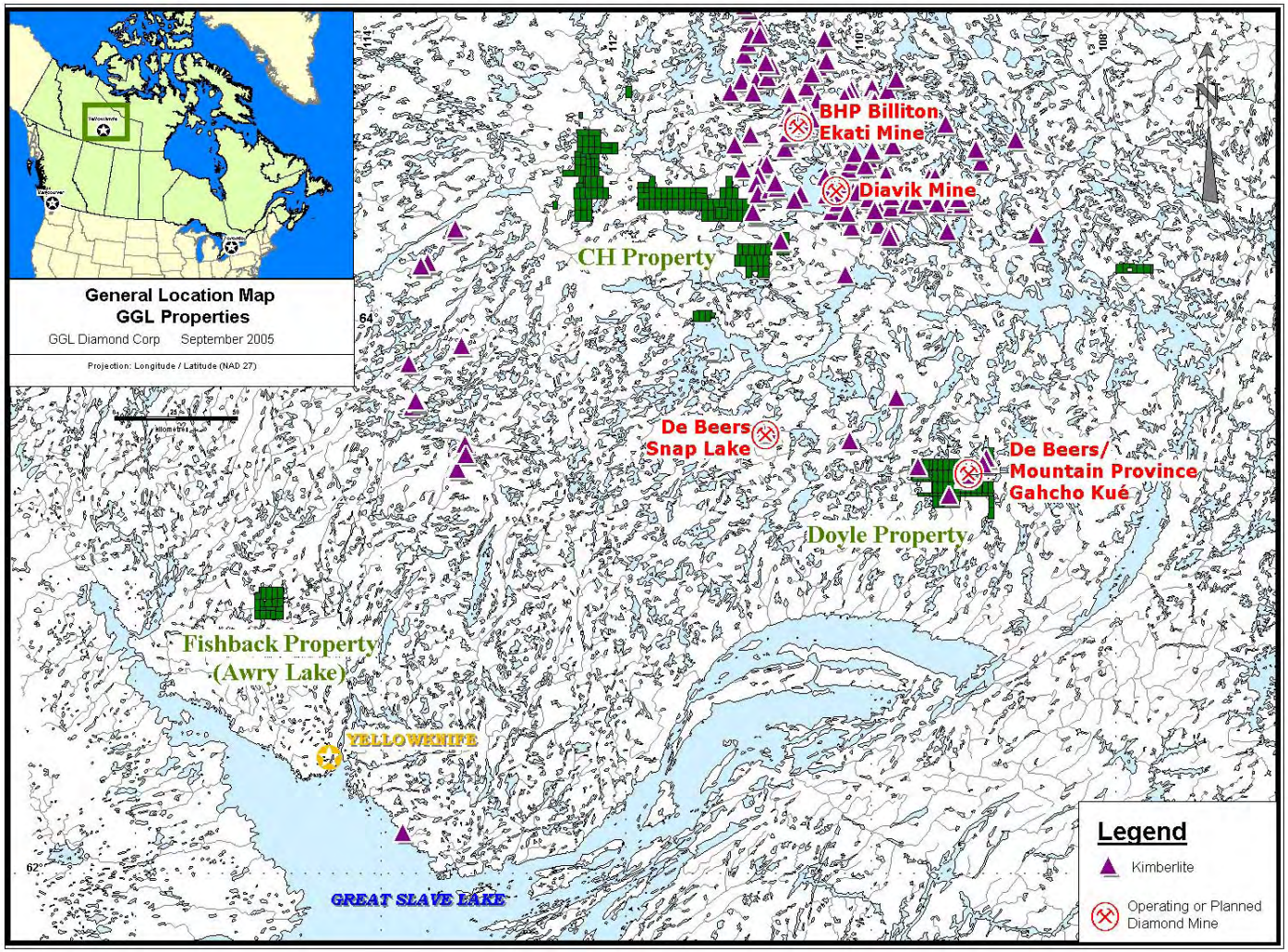
Premise for Geochemical Surveys



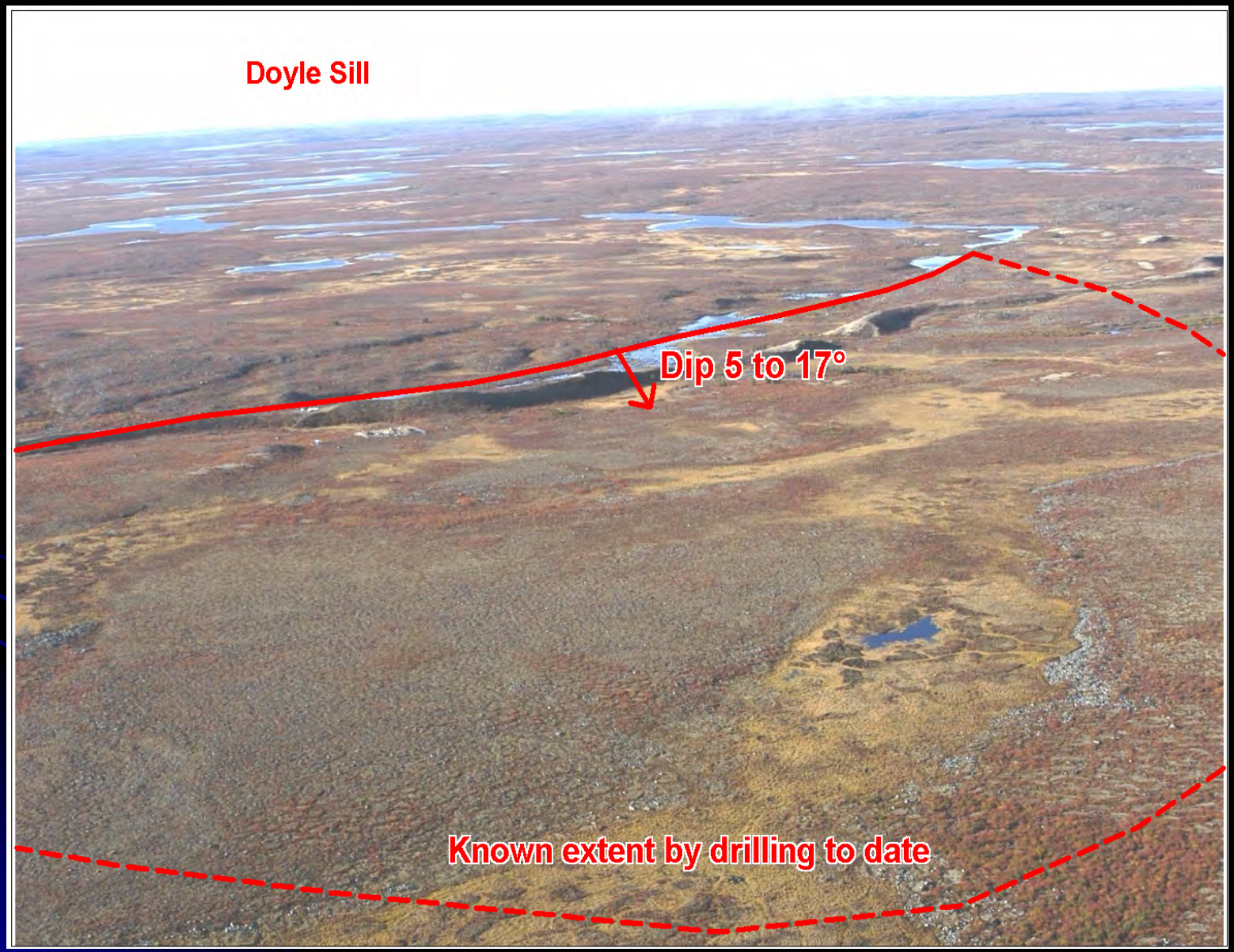
Premise for Geochemical Surveys

- Literature search in 1992 yielded limited case studies in glaciate terrains.
  - Conventional knowledge states that soil surveys are effective but generally limited to the immediate vicinity of the intrusion.
  - No reference was found for conducting lake sediment geochemistry.
  - Considerable body of work published since this time with large contribution by Beth McClenaghan and Bruce Kjarsgaard of the GSC.

Doyle Lake Case Study



Doyle Lake Case Study



Doyle Lake Case Study

- Soil survey integrated with KIM survey
  - 1 kg samples from “frost boils”
  - Reconnaissance sampling at 200m X 1000m density, detailed sampling at 50m X 100m density.
  - Analysis by Acme Labs in Vancouver, Canada
    - Samples dried and sieved to -63 microns.
    - Group 1E - 4-Acid digestion / ICP-ES for 35 elements.
    - Group 1EX - 4-acid digestion / ICP-MS for “kimberlite package” (41 elements + REEs)
  - QA/QC using lab duplicates and reference materials also a project reference material developed early on.
- Dr. Hoffman predicts discovery of kimberlite in area

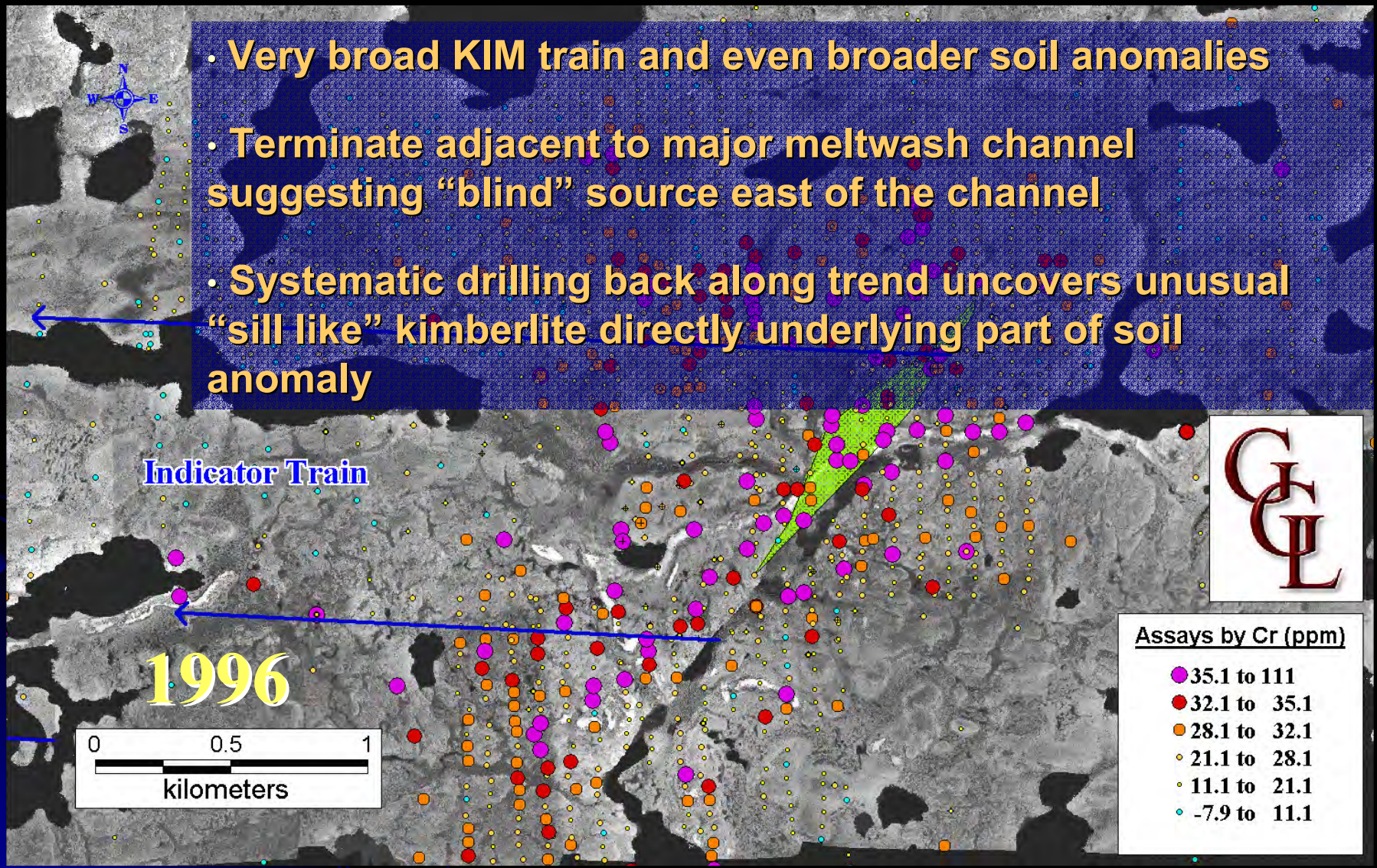
Doyle Lake Case Study

Doyle Lake Case Study

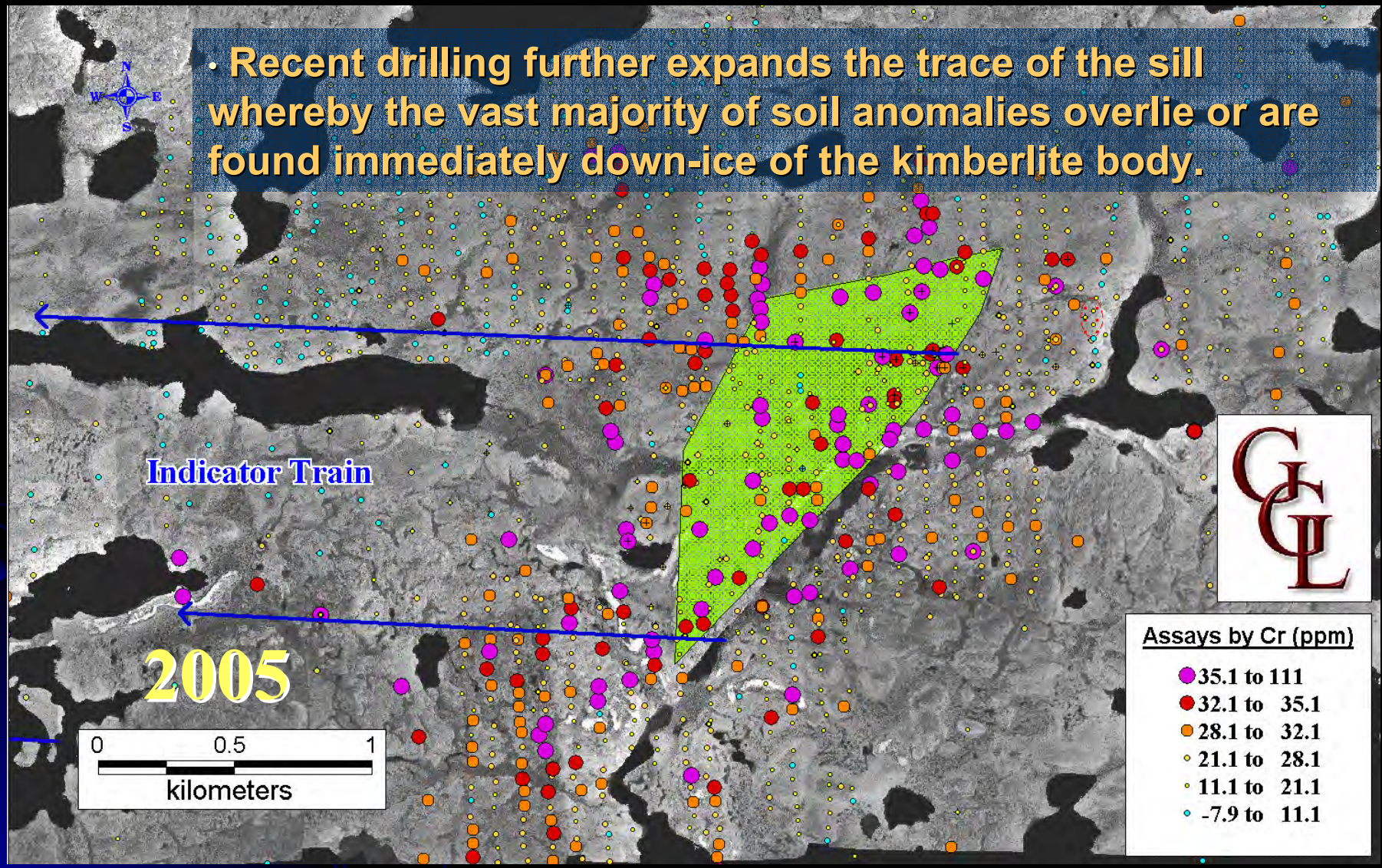
Group 1EX "kimberlite suite"

	Detection			Detection			Detection			Detection			Detection	
Au	0.1	ppm	Co	0.2	ppm	Na	0.001	%	Sr	1	ppm	Nd*	0.2	ppm
Ag	0.1	ppm	Cr	0.1	ppm	Nb	0.1	ppm	Ta*	0.1	ppm	Sm*	0.2	ppm
Al*	0.01	%	Cu	0.1	ppm	Ni	0.1	ppm	Th	0.1	ppm	Eu*	0.2	ppm
As	1	ppm	Fe*	0.01	%	P	0.001	%	Ti*	0.001	%	Gd*	0.2	ppm
Ba*	1	ppm	K	0.01	%	Pb	0.1	ppm	U	0.1	ppm	Tb*	0.2	ppm
Be*	1	ppm	La	0.1	ppm	Rb	0.1	ppm	V	1	ppm	Dy*	0.2	ppm
Bi	0.1	ppm	Li	0.1	ppm	S	0.1	%	W*	0.1	ppm	Ho*	0.2	ppm
Ca	0.01	%	Mg*	0.001	%	Sb	0.1	ppm	Y	1	ppm	Er*	0.2	ppm
Cd	0.1	ppm	Mn	1	ppm	Sc	1	ppm	Zn	0.1	ppm	Tm*	0.2	ppm
Ce	1	ppm	Mo	0.1	ppm	Sn*	0.1	ppm	Zr*	1	ppm	Yb*	0.2	ppm
												Lu*	0.2	ppm

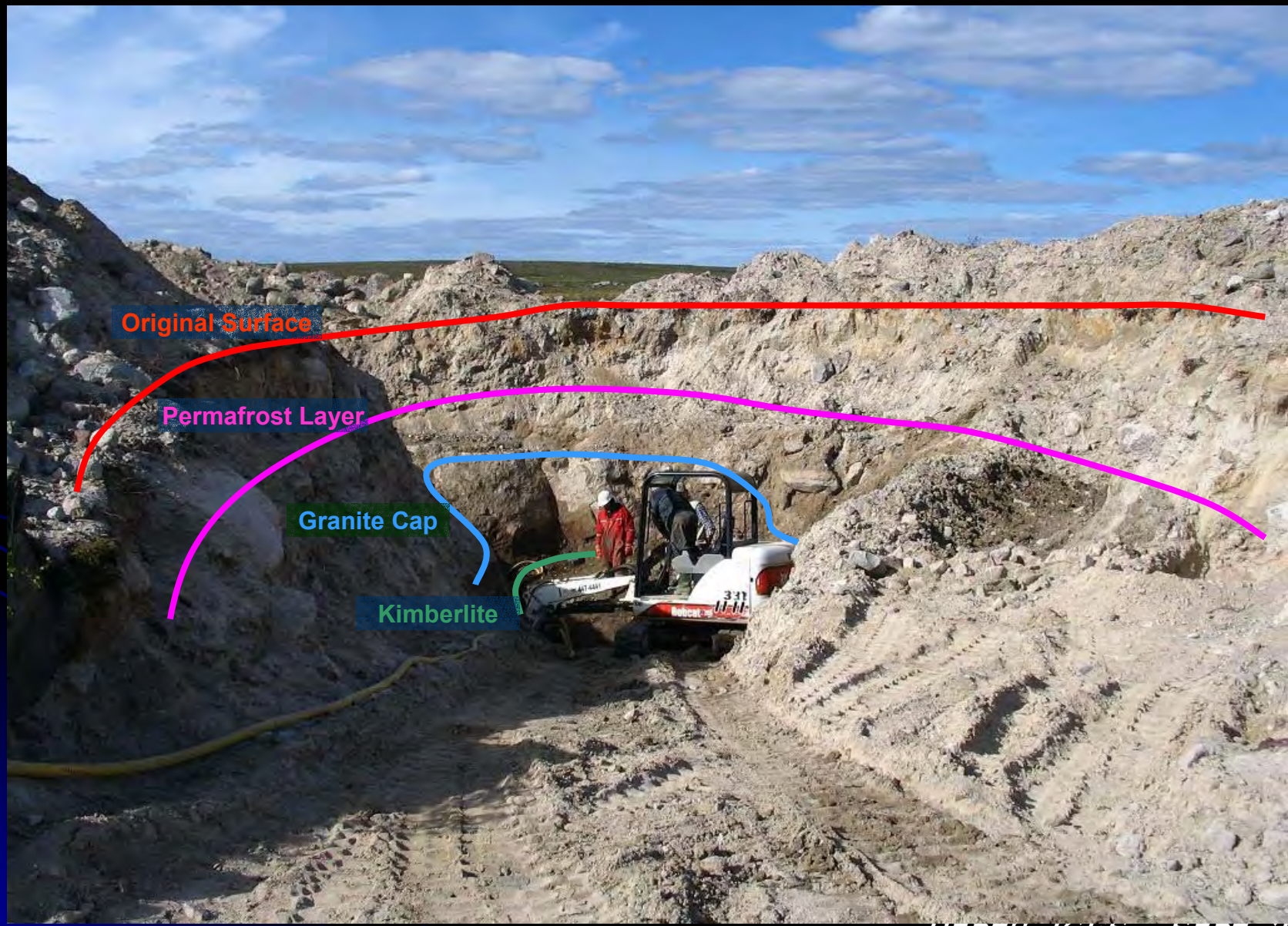
Discovery of Doyle Lake Kimberlite Sill



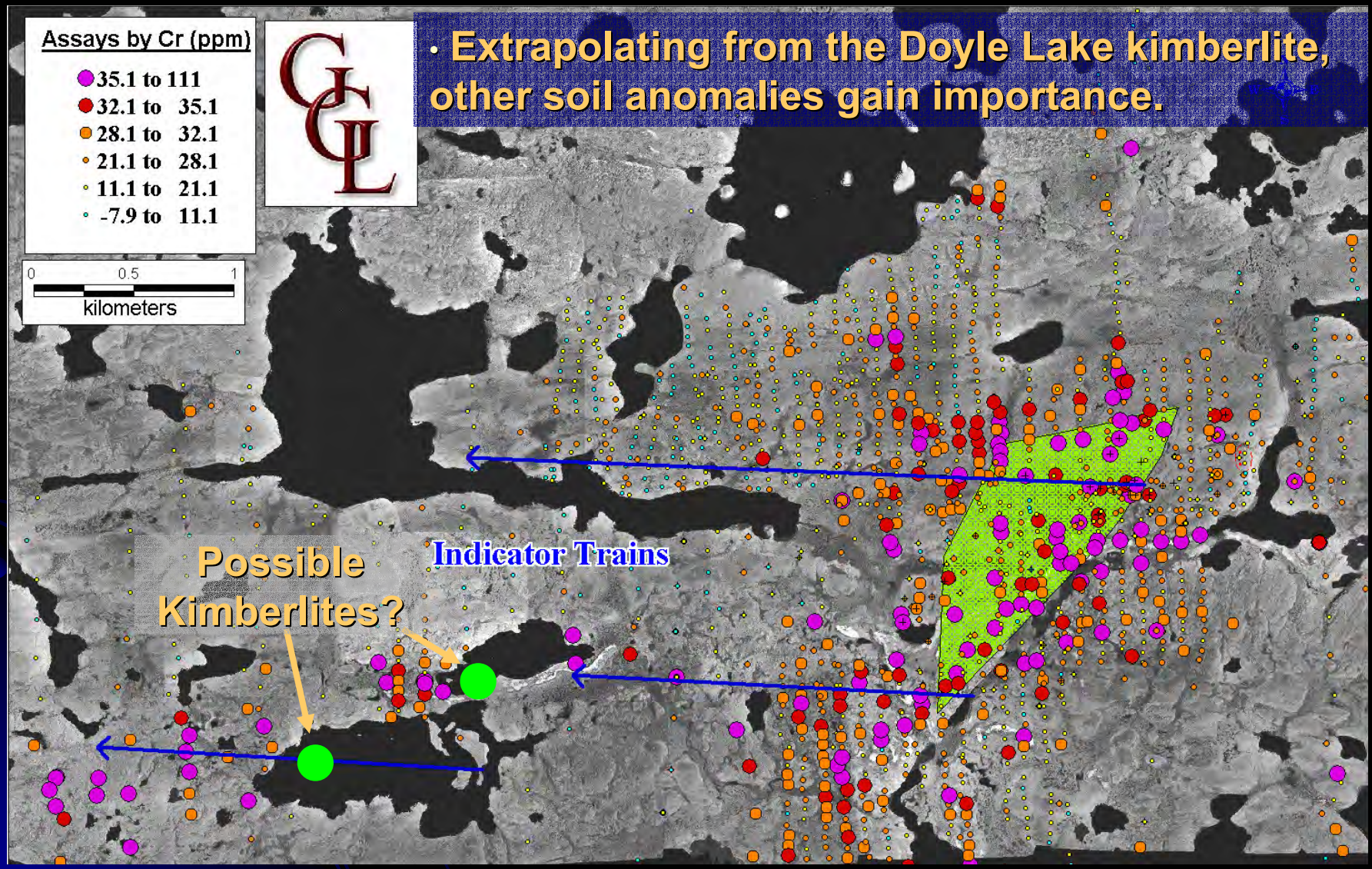
Discovery of Doyle Lake Kimberlite Sill



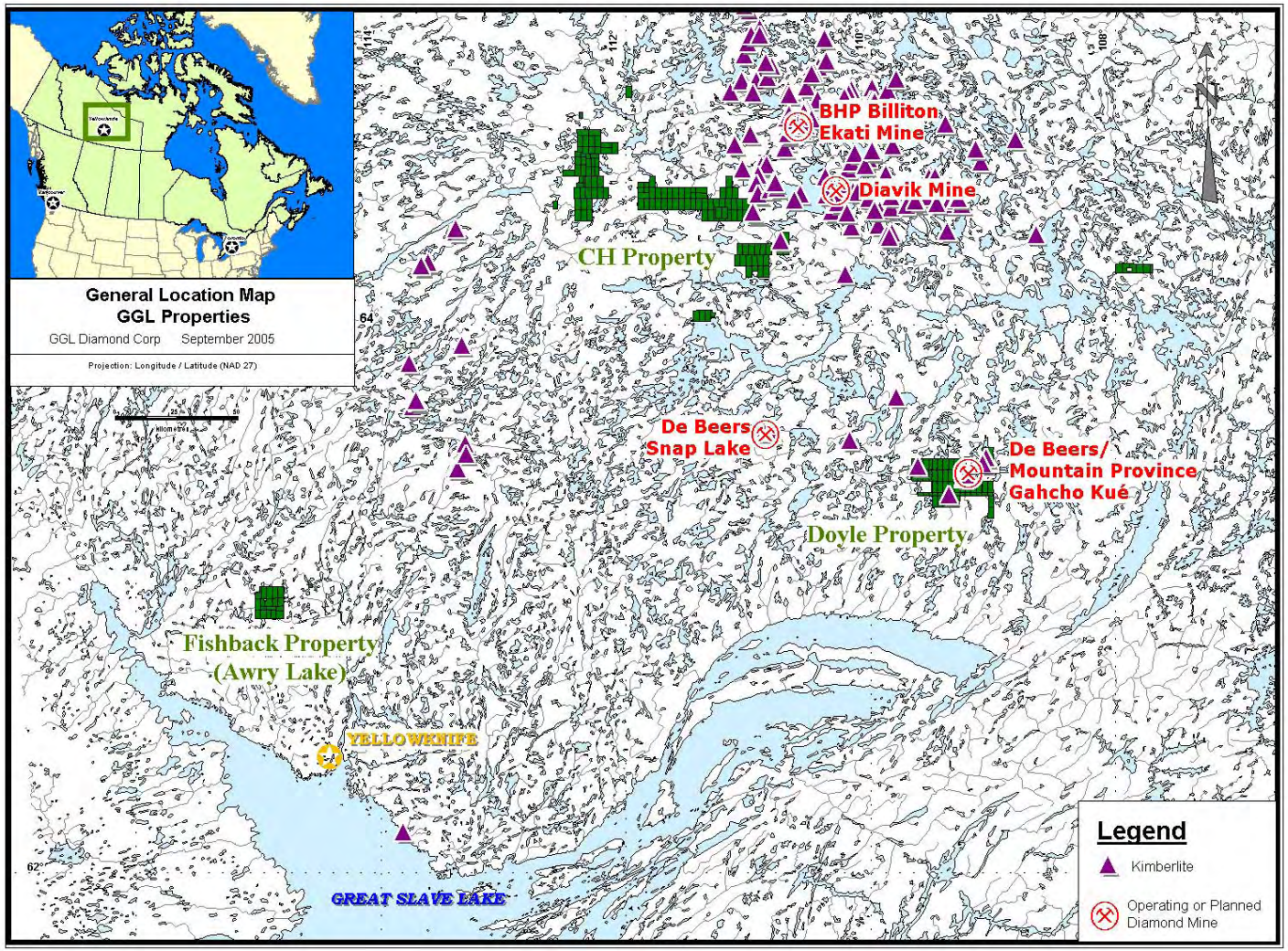
Bulk Sampling the Doyle Lake Kimberlite



Discovery of Doyle Lake Kimberlite Sill



Awry Lake Case Study



Awry Lake Case Study

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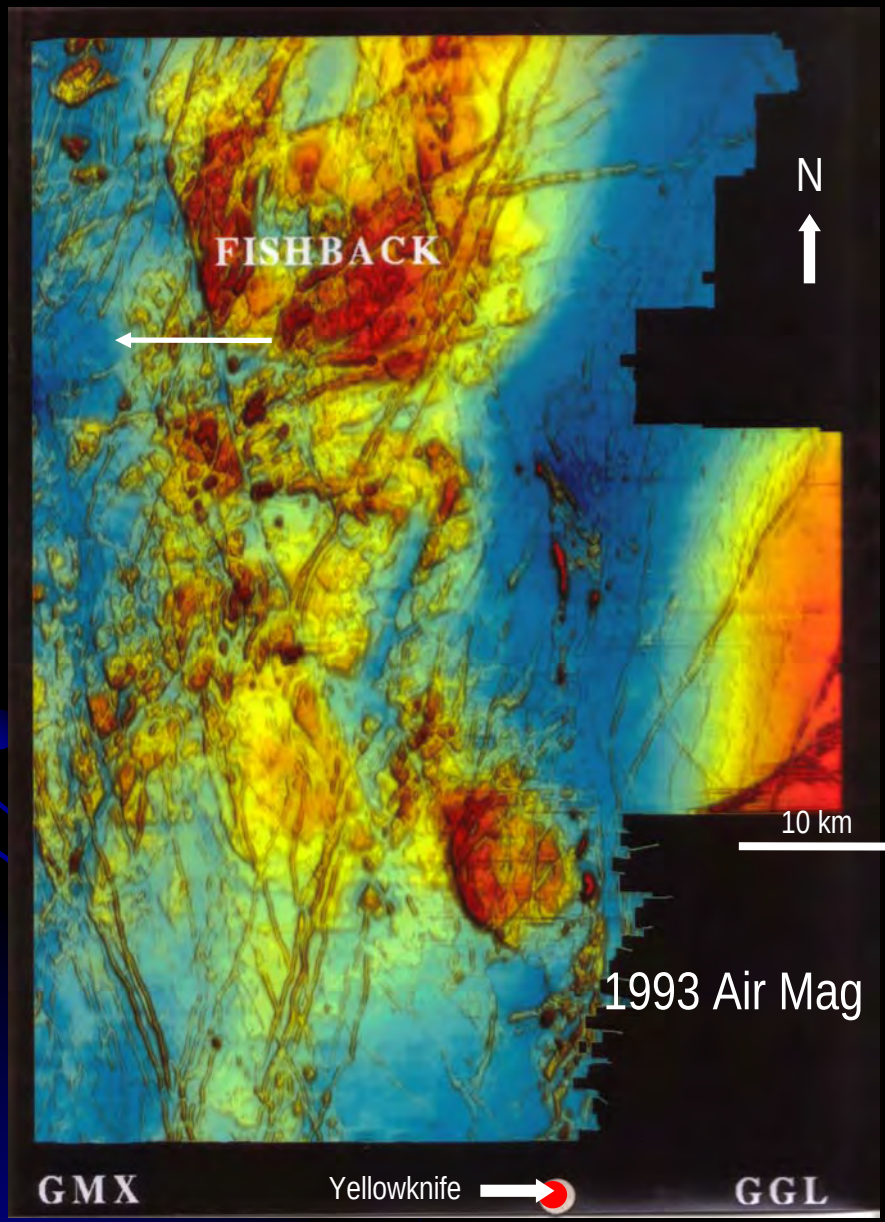


1993

Geophysical interpretation of regional air mag data identifies a discontinuity in regional structures

Awry Lake Case Study

1994

Weakly anomalous kimberlite indicator mineral train leads to the south shore of Awry Lake

Lake sediment sampling is conducted at two locations targeting magnetic lows.

Gerle Gold Ltd.

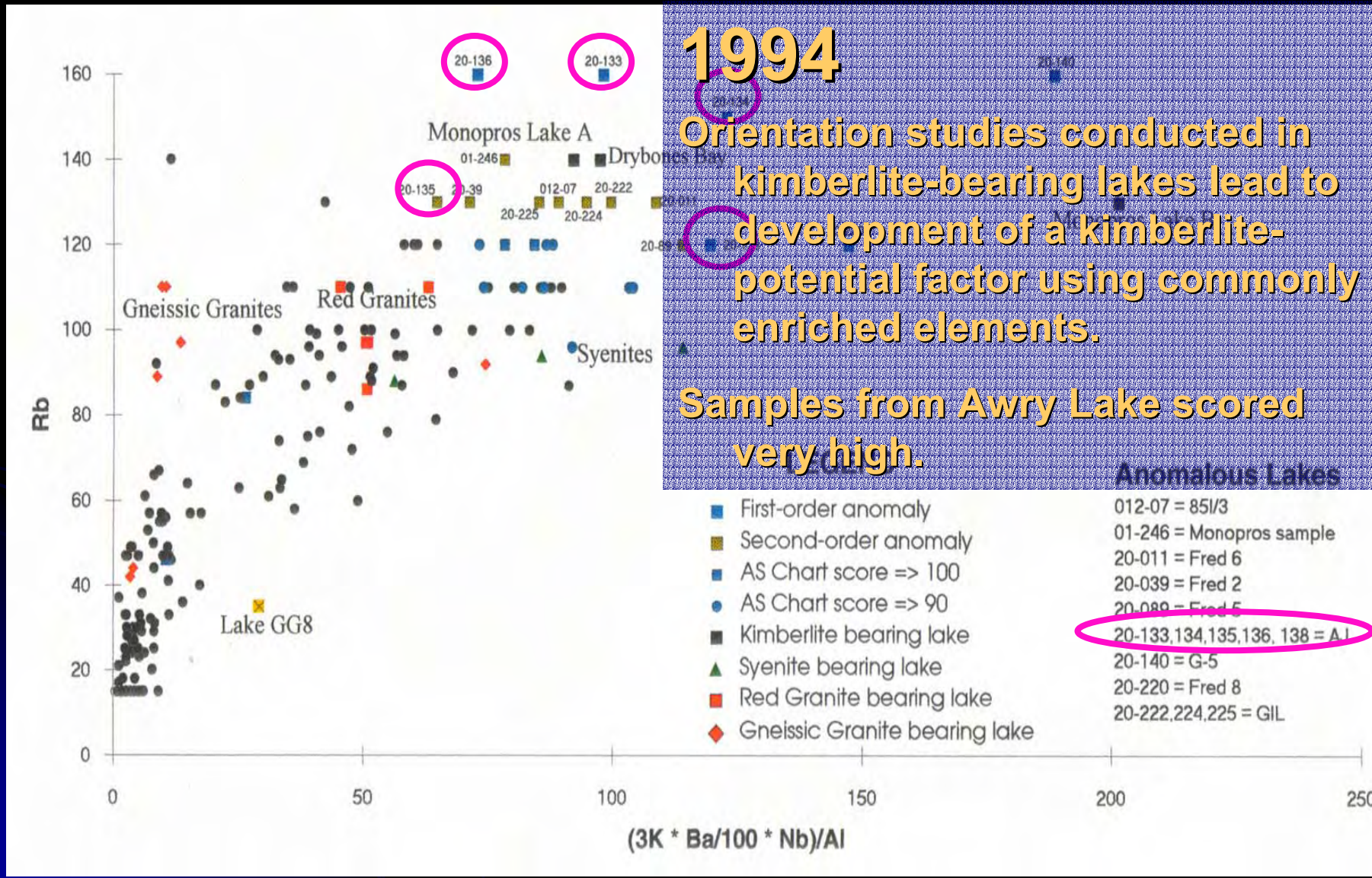
Project: 713	Fishback Lake Area AJ Claim with Lake Sediments, Indicators and Mag
Date:01/03/2000	
Author: Chris Hrkac	
Office: YK	
Drawing: 000008CH	
Declination: ~25.5° E	
Scale: 1:20000	Projection: NAD 27 (Canada Mean) Zone 12

Anomalous Indicator Sample

Anomalous Lake Sediment Sample

0 0.25 0.5 kilometres

Awry Lake Case Study

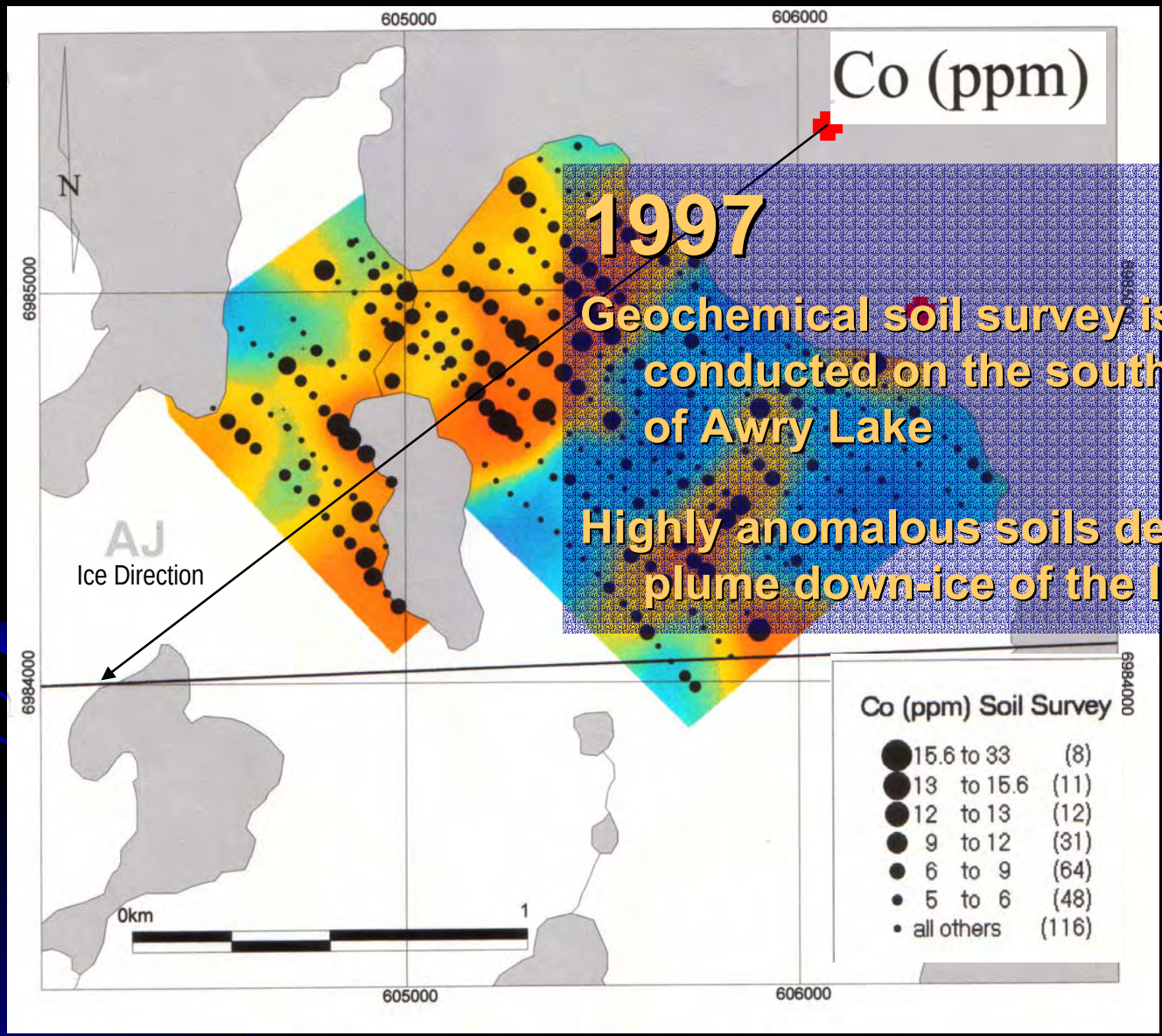


1994

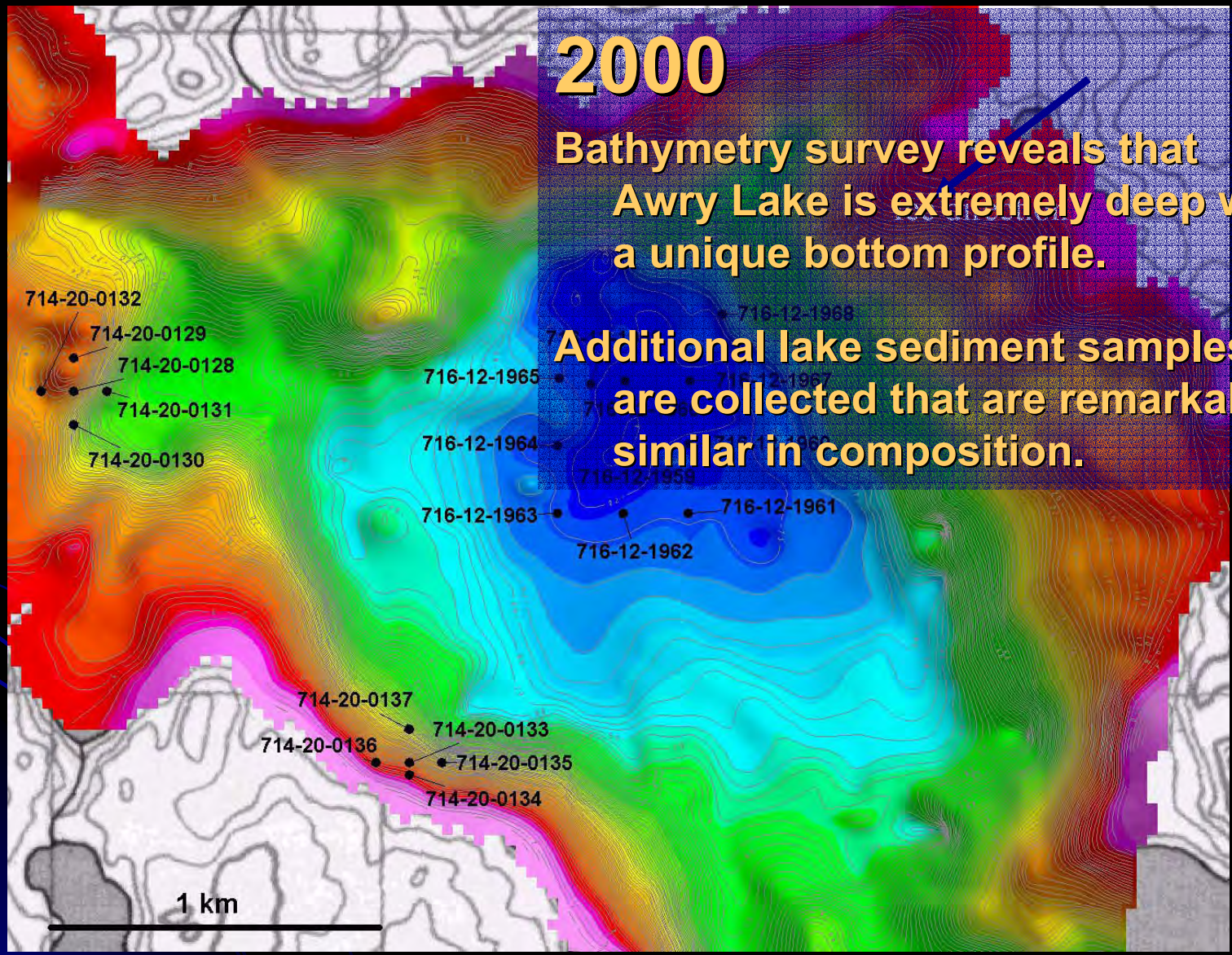
Orientation studies conducted in kimberlite-bearing lakes lead to development of a kimberlite-potential factor using commonly enriched elements.

Samples from Awry Lake scored very high.

Awry Lake Case Study



Awry Lake Case Study



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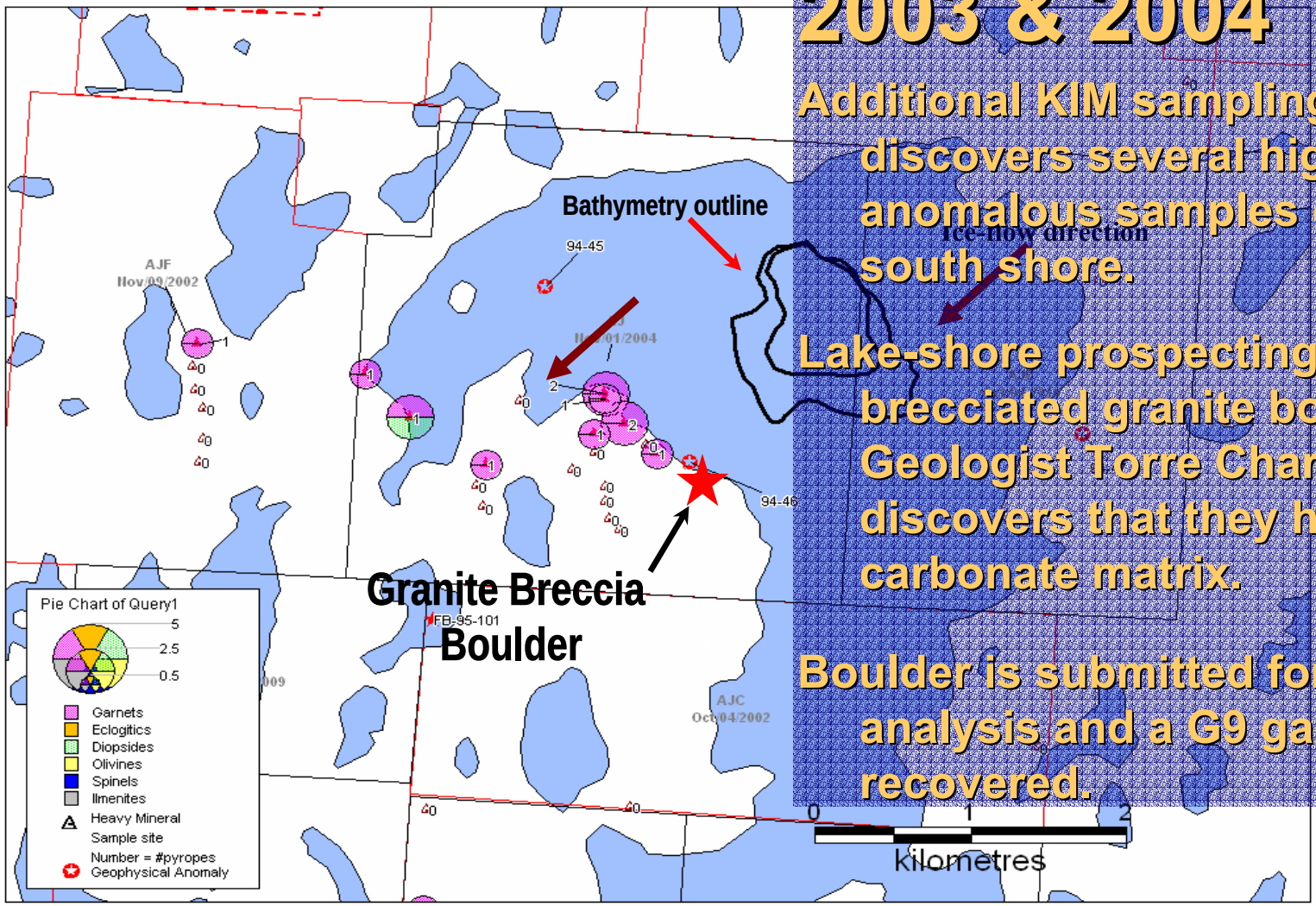


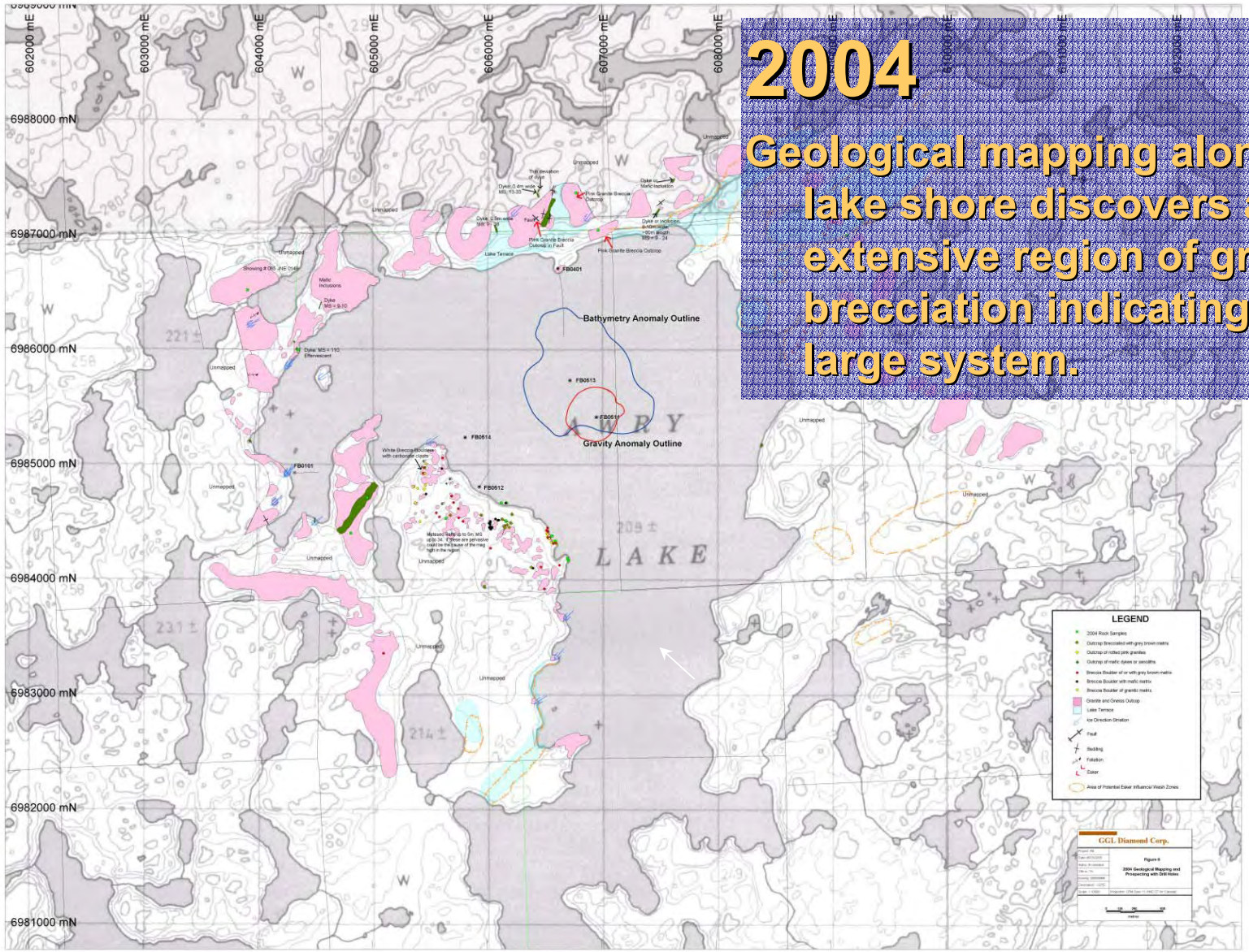
2003 & 2004

Additional KIM sampling discovers several highly anomalous samples on south shore.

Lake-shore prospecting finds brecciated granite boulders. Geologist Torre Charter discovers that they have a carbonate matrix.

Boulder is submitted for KIM analysis and a G9 garnet is recovered.

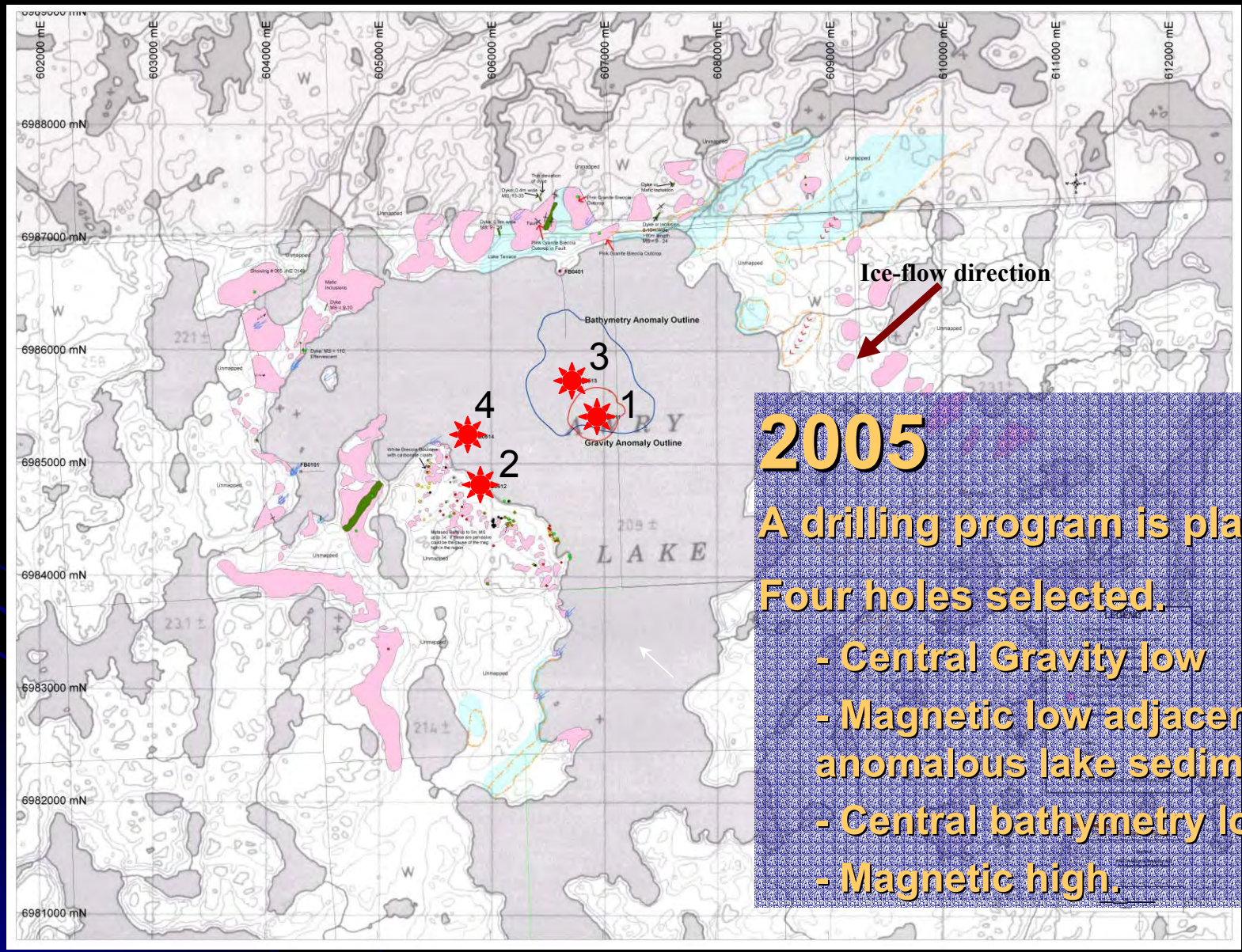
Awry Lake Case Study



2004

Geological mapping along the lake shore discovers an extensive region of granite brecciation indicating a very large system.

Awry Lake Case Study



2005

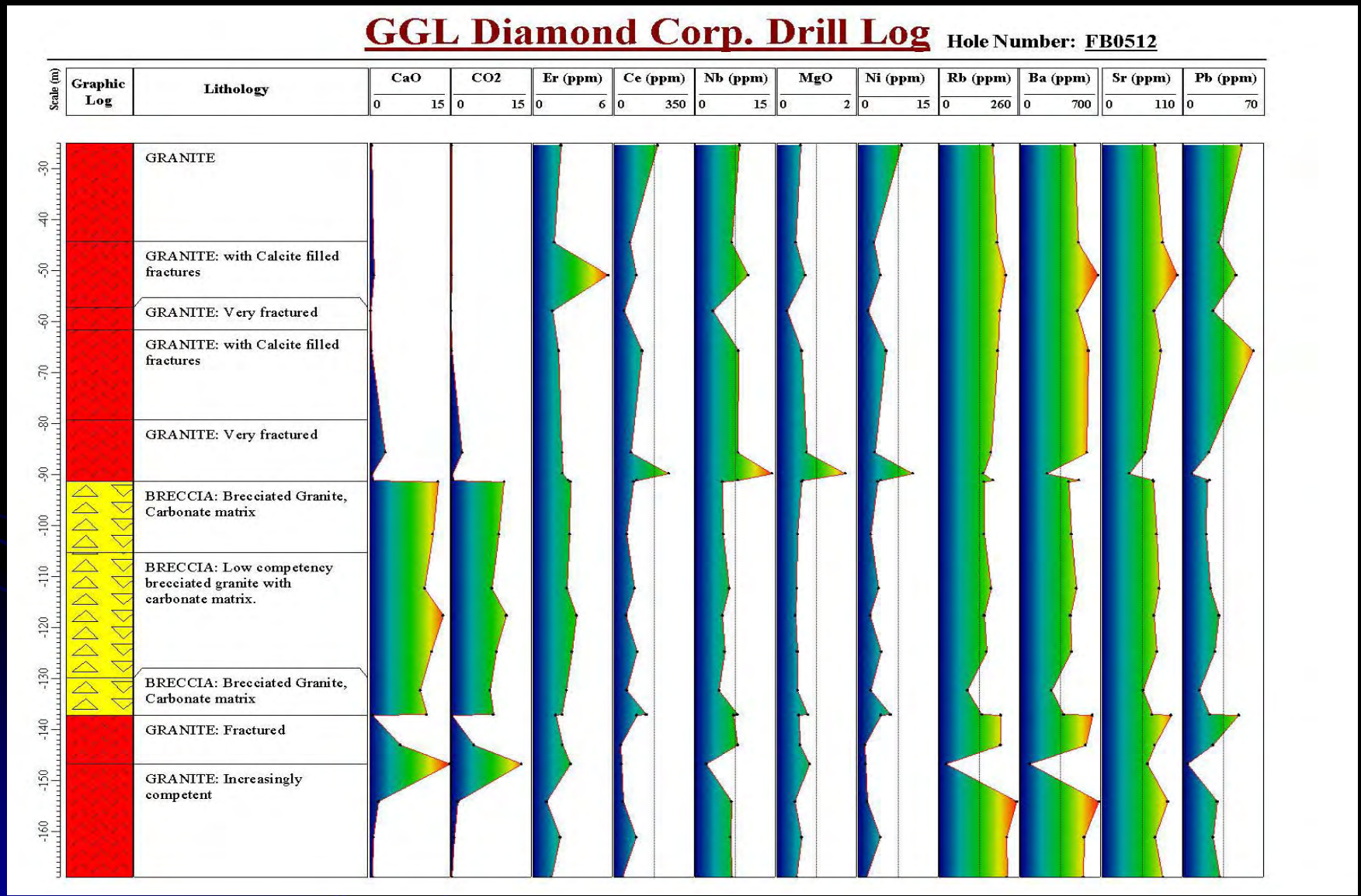
A drilling program is planned

Four holes selected.

- Central Gravity low
- Magnetic low adjacent to anomalous lake sediments
- Central bathymetry low
- Magnetic high.

Awry Lake Case Study

Drilling on Awry Lake Anomalies

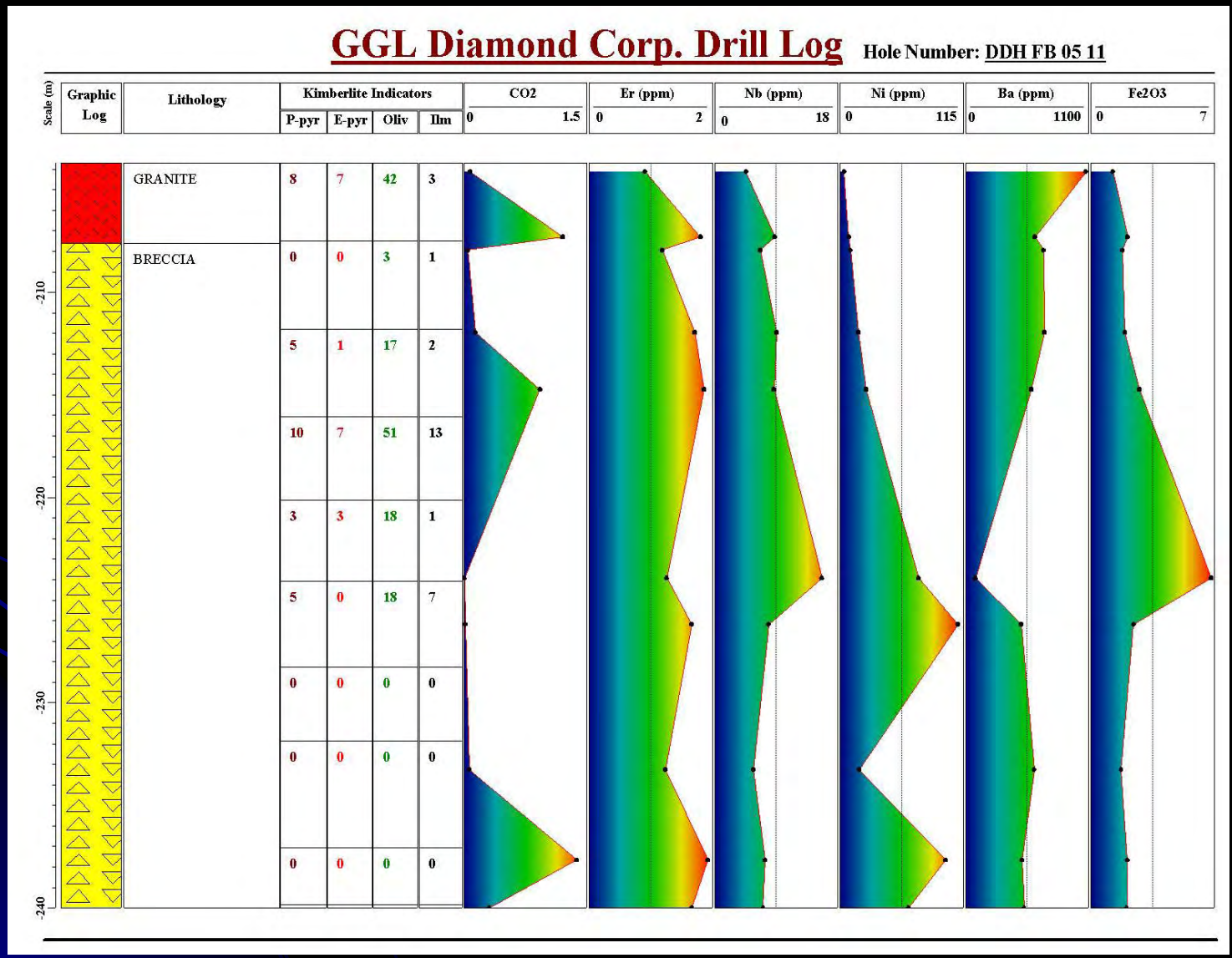


Drilling on Awry Lake Anomalies

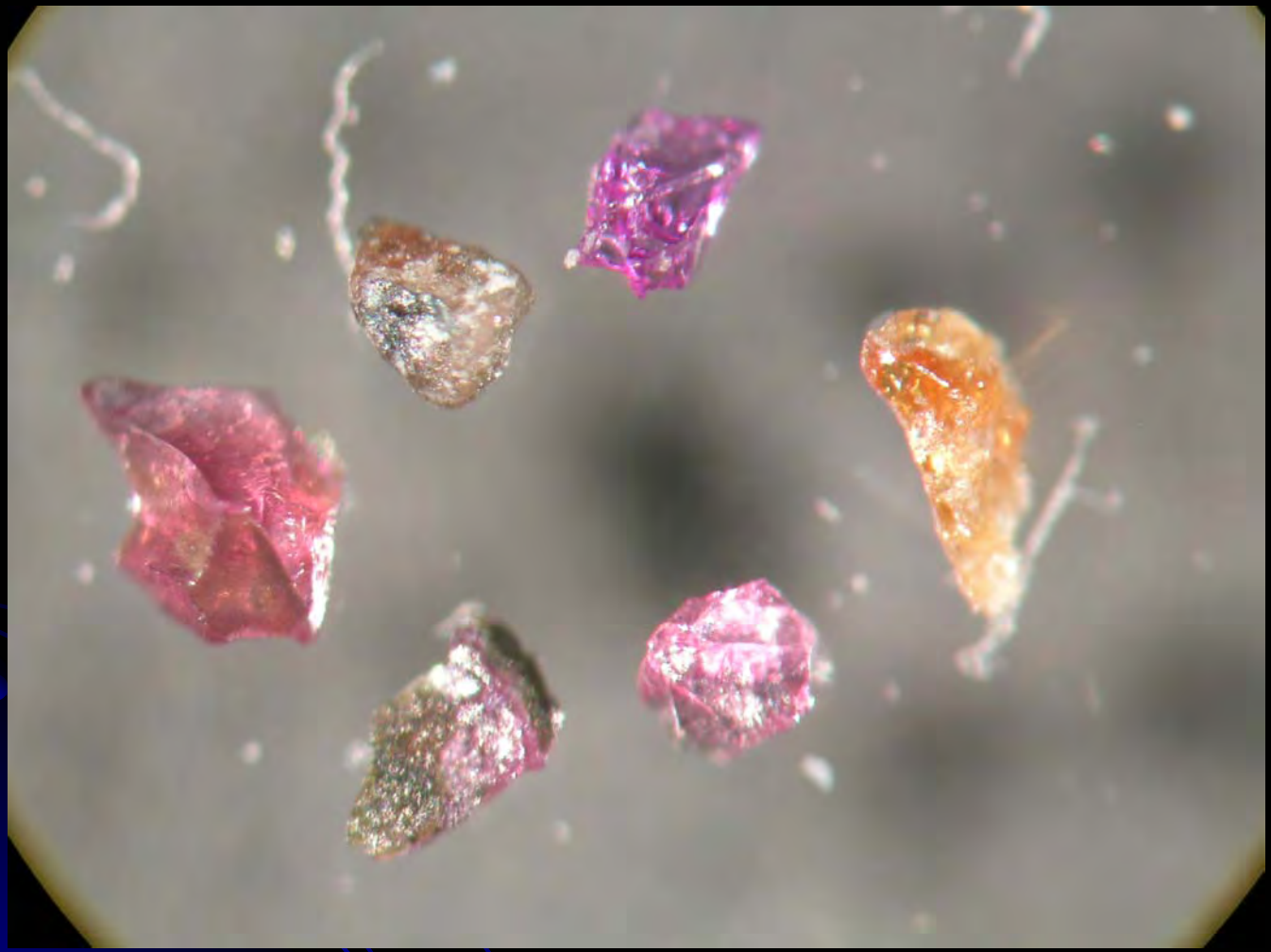
Granite Breccia

Carbonate filled fracture

Drilling on Awry Lake Anomalies



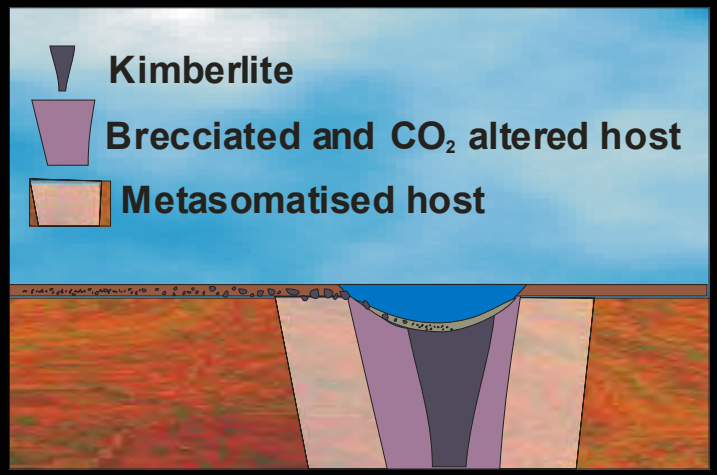
Drilling on Awry Lake Anomalies

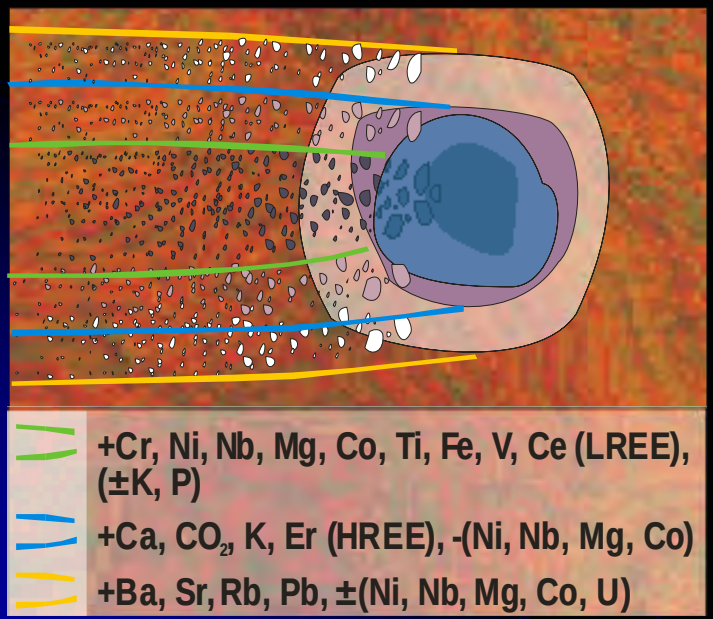


Recovered Pyrope and Eclogitic garnets with selvages of kimberlite still attached.

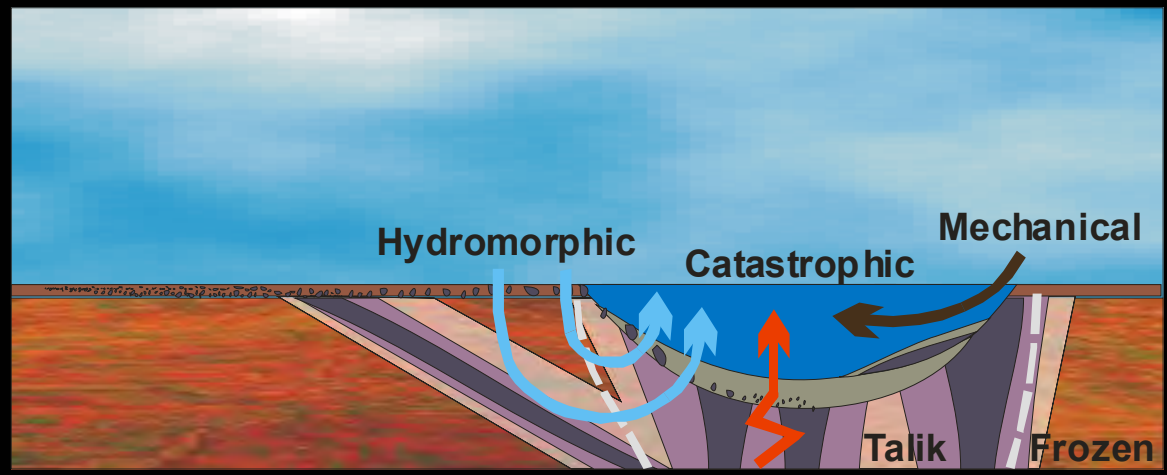
Refined Geochemical Exploration Model

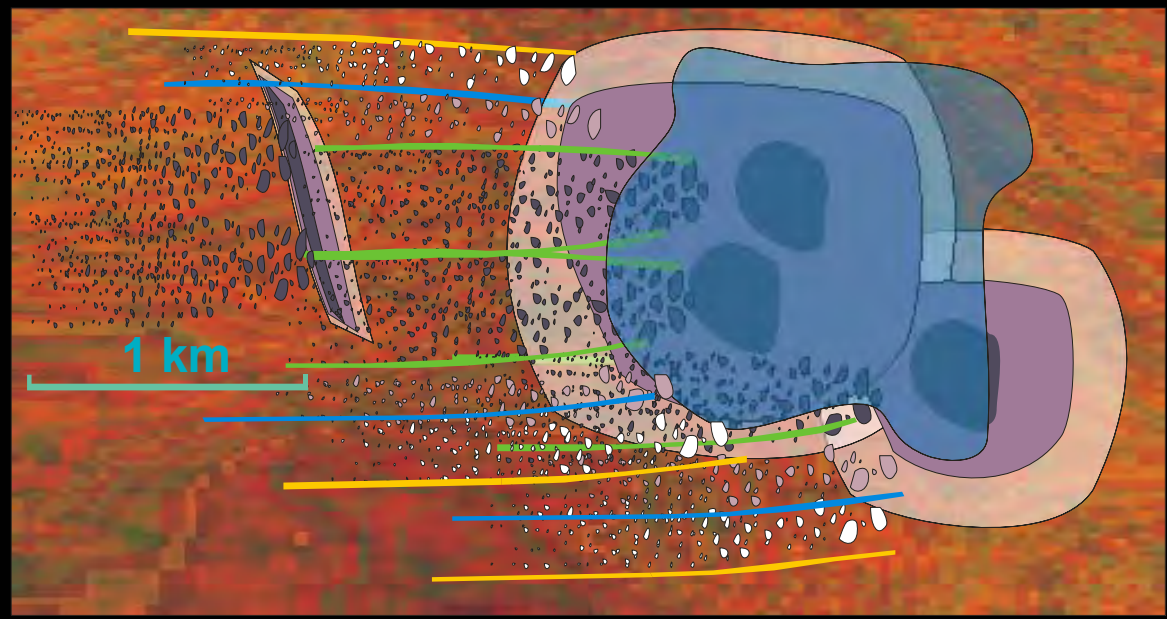
Simple





Complex





Conclusions

Soil Geochemistry

- Is a great adjunct to defining kimberlites whose potential is indicated by other geological disciplines… limited dispersion is an asset not a detriment.
- Depth of overburden, glaciofluvial processes and permafrost may be less of an impediment then believed with anomalies forming directly over their source.
- Geochemical patterns bear a direct relation with erosion products hence a good correlation with kimberlite indicator minerals. Overlapping trains from kimberlite clusters and their associated metasomatised and brecciated halos will add complexity.

Conclusions

Lake Sediment Geochemistry

- Is a highly effective regional exploration tool capable of defining the kimberlite potential within lake basins.
- Dispersion in the sediments may be by mechanical and/or hydromorphic means resulting in decoupling or combining of elements suites associated with the kimberlite and its brecciated and metasomatised halos.
- Lake shore prospecting of boulders and beach deposits may readily detect kimberlite(s) within the lake basin.

ACME ANALYTICAL LABORATORIES LTD.

GCL

Perth, IGES - Sept, 2005