Can remotely piloted aircraft-borne radiometrics and magnetics detect dispersal trains in subglacial tills?

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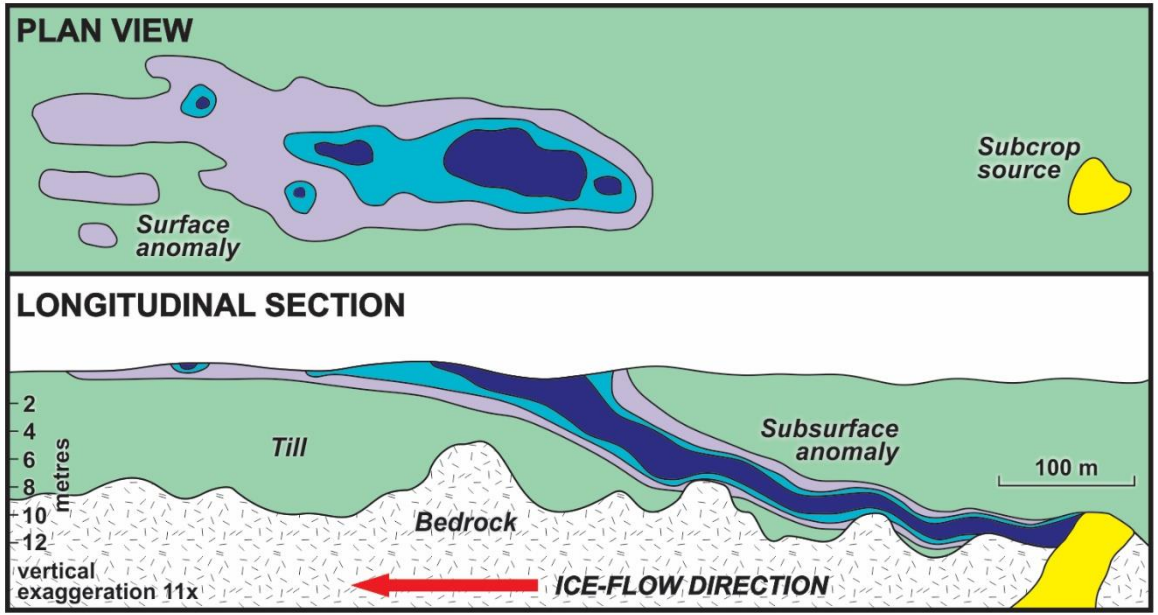
Dispersal in Tills

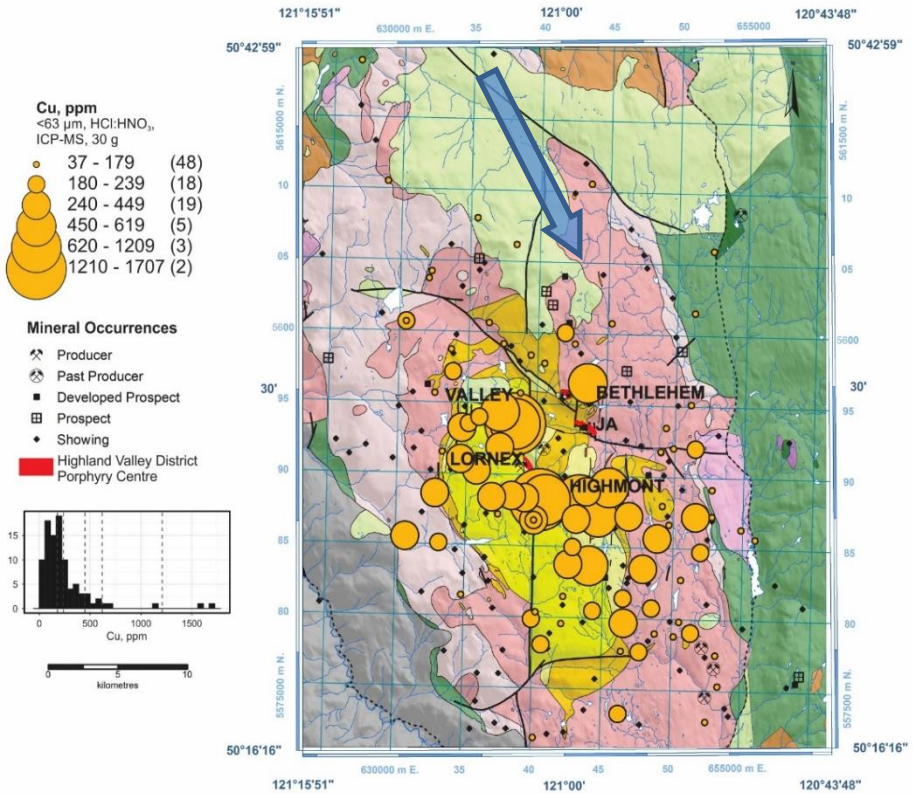


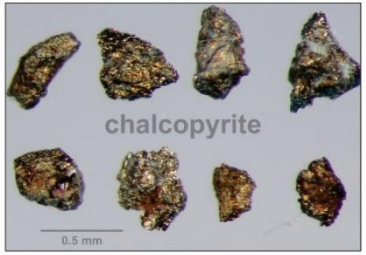
(Miller, 1984)

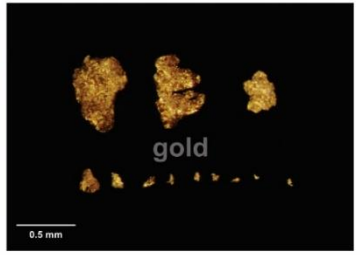
- Subglacial till is target sample medium.
- Predictable transport history, short transport distance, large exploration target.
- Dispersal train defined by contrast.

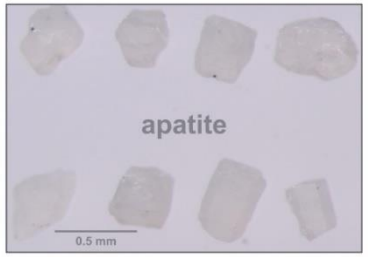
Till Geochemistry and Mineralogy

Can airborne 'surface' geochemistry (K, eU, eTh) define dispersal?

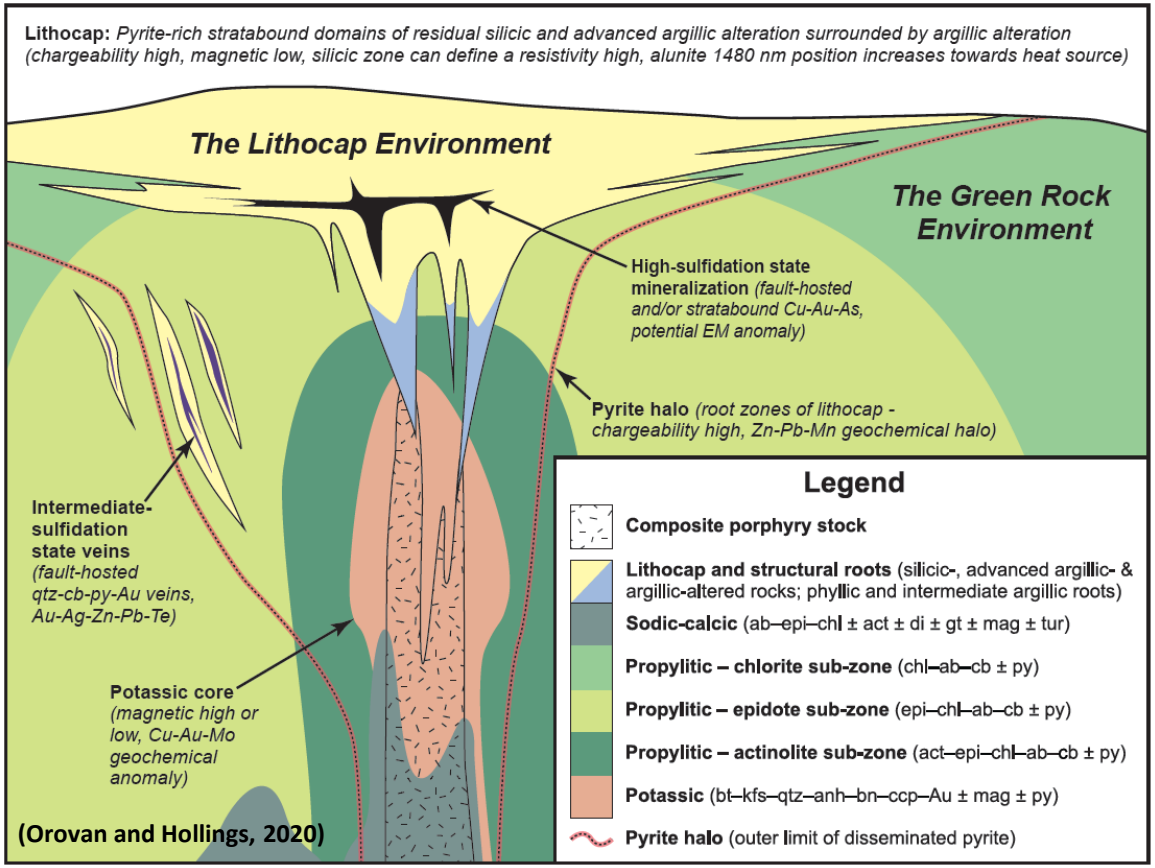








Porphyry Systems



Rock Type	Average K (%)
Syenite	4.11
Monzonite	3.37
Quartz monzonite	3.32
Granodiorite	2.27
Andesite	1.34
Basalt	0.91

Why use an RPAS?

1. **Fast and affordable.**

2. **Fills a scale-gap between traditional airborne and ground surveys.**

3. **Non-invasive.**

4. **Data can be processed in the field and guide exploration programs in near real-time.**

Remotely Piloted Aircraft System (RPAS)

DJI Matrice 600 Pro

- 6 kg payload capacity.
- 20 to 40 minute flights.
- Need to fly low and slow with confidence.
- SPH Engineering radar altimeter integrated with UgCS active terrain following functionality.

Radiation Solutions Inc. RS-530

Radiation Solutions Inc. RS-530

- 3”x3” NaI (Tl) crystal.
- 3.0 kg.
- 5, 7.5, 10 m AGL at 2 m/s.
- Flight line spacing 7.5, 10 m.
- 1 Hz sampling rate, total count collected every 2 m on ground.

GEM Systems DRONEmag

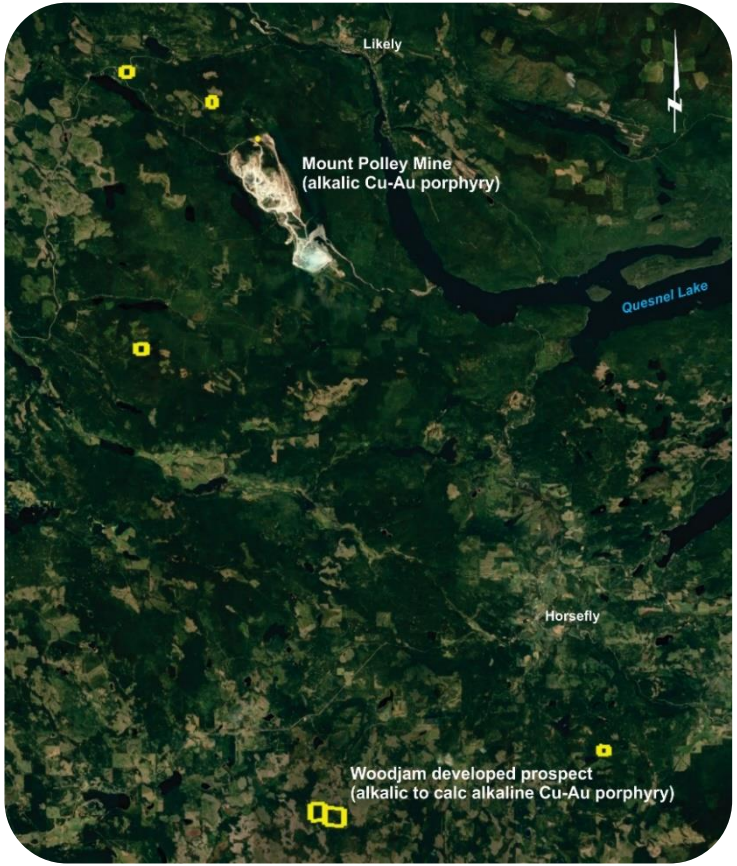
- Potassium magnetometer.
- 2.0 kg.
- Slung 2.5 m below RPAS.
- 5, 7.5, 10 m AGL at 2 m/s.
- Flight line spacing 7.5, 10 m.
- 10 Hz sampling rate, total field measurement every 20 cm on ground.

Cutblock Surveys

- 155 line km of gridded, terrain following, autopilot surveys in 7 survey areas.
- Flown over each survey area:

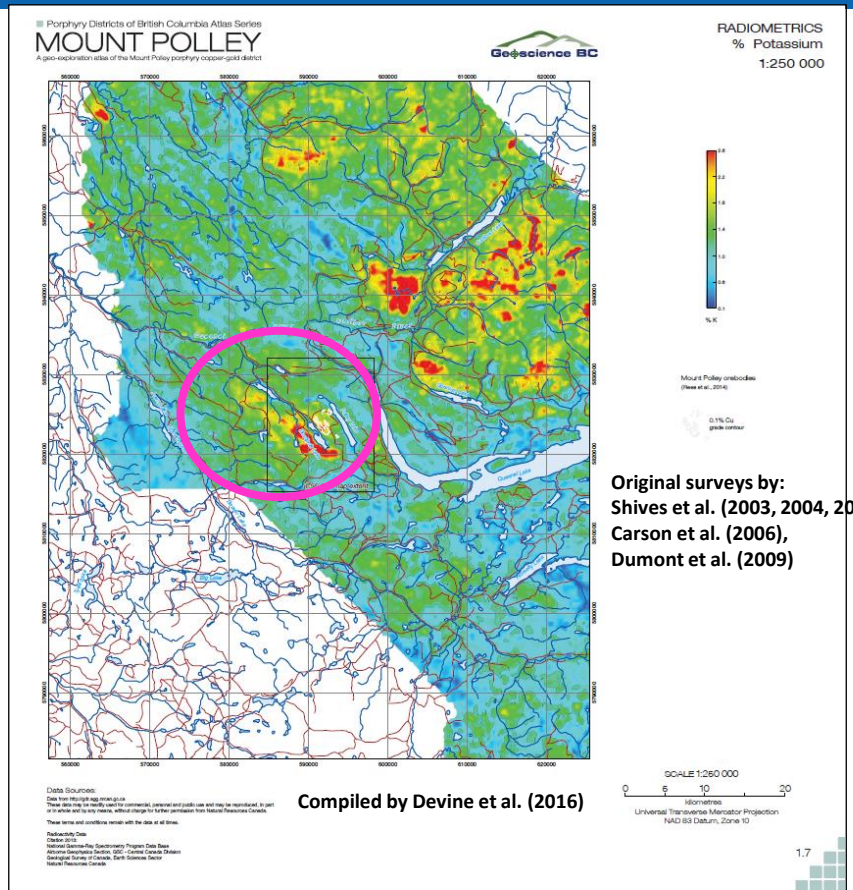
  1) magnetics; 2) radiometrics; 3) lidar; and 4) air photos.
- New till and bedrock samples collected to supplement existing data.

The method development challenge: flyable cutblock with favourable geology.

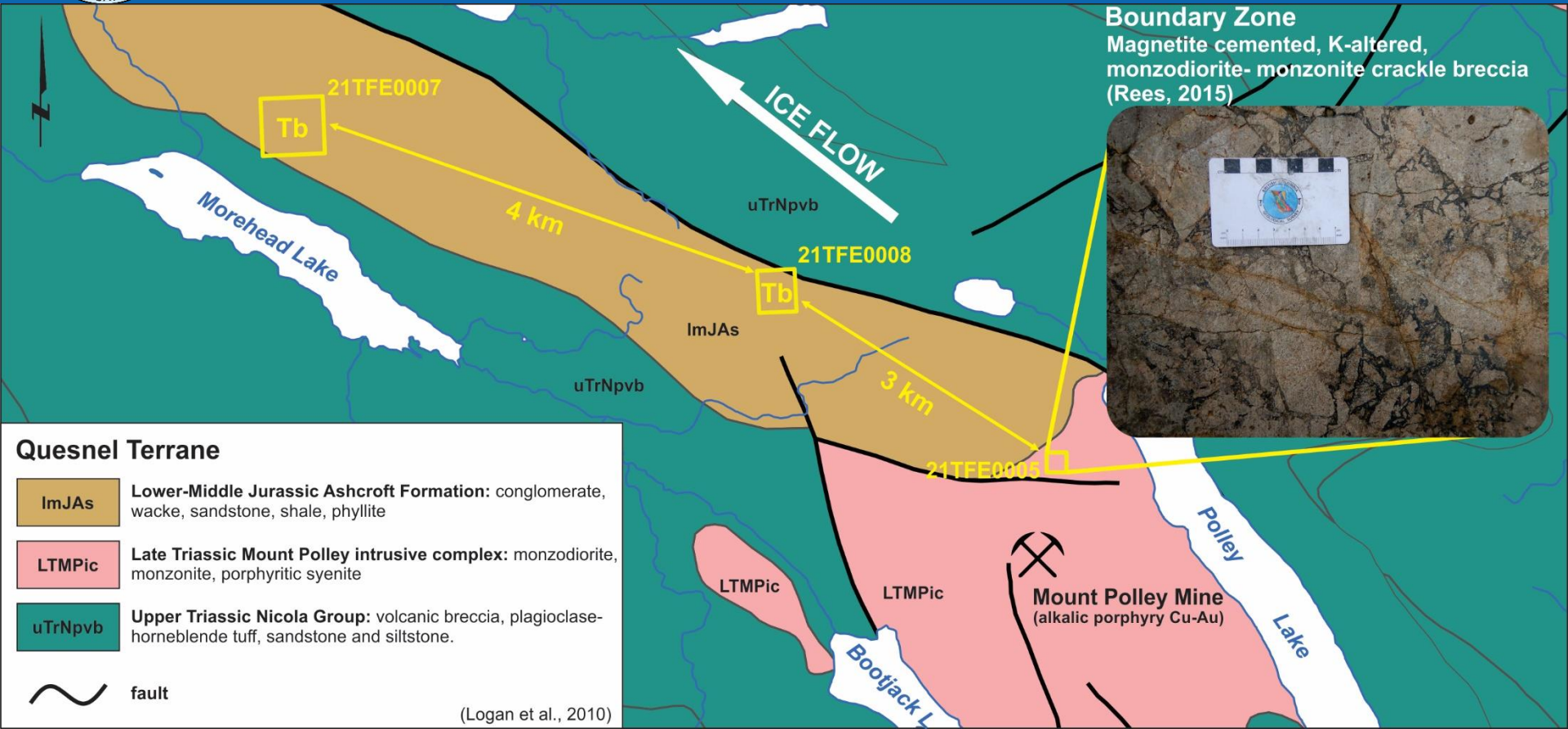


Regional Radiometrics

- Surficial geology predominantly composed of tills; isolated and rare bedrock outcrop.
- Ice-flow (therefore till transport direction) northwest.
- Fixed-wing K radiometrics do detect dispersal from K-rich rocks.
- Can RPAS K radiometrics?



Mount Polley Mine Area Geology



Data Types Used

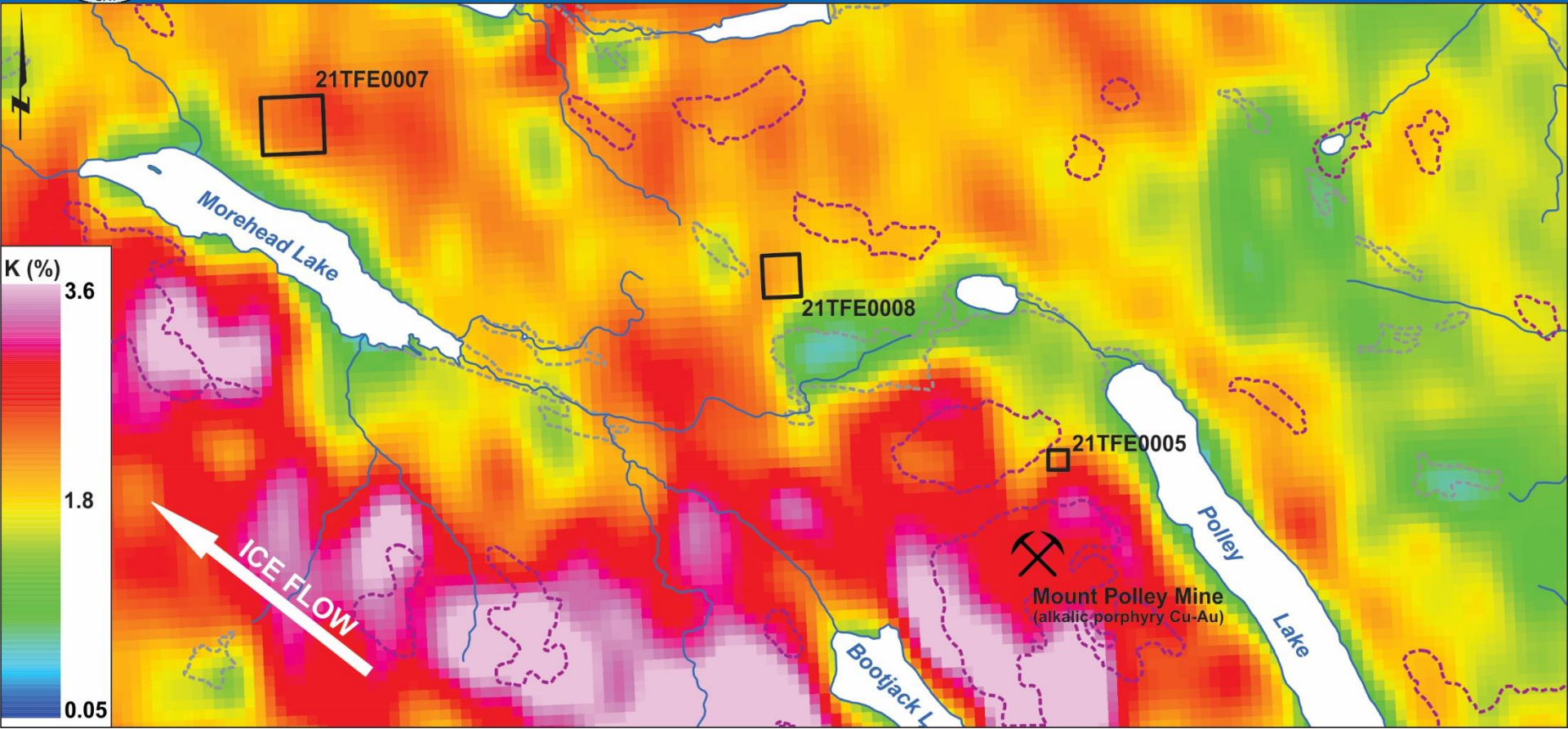
K Radiometrics

	GSC Open File 2802 Shives et al. (1995)	2021 RPAS surveys
Platform	Skyvan	DJI M600 Pro
Instrument	(12) 4" x 4" x 16" NaI(Tl)	RSI RS-530 (1) 3"x3" NaI(Tl)
Instrument weight	~363 kg (~800 lbs)	3 kg (6.61 lbs)
Collection interval	1 Hz	1 Hz
Terrain clearance	125 m	7.5 to 10 m
Aircraft speed	53 m/s (190 km/h)	2 m/s (7 km/h)
Flight line spacing	500 m	7.5 to 10 m
Cell size	100 m	2.5 to 3 m

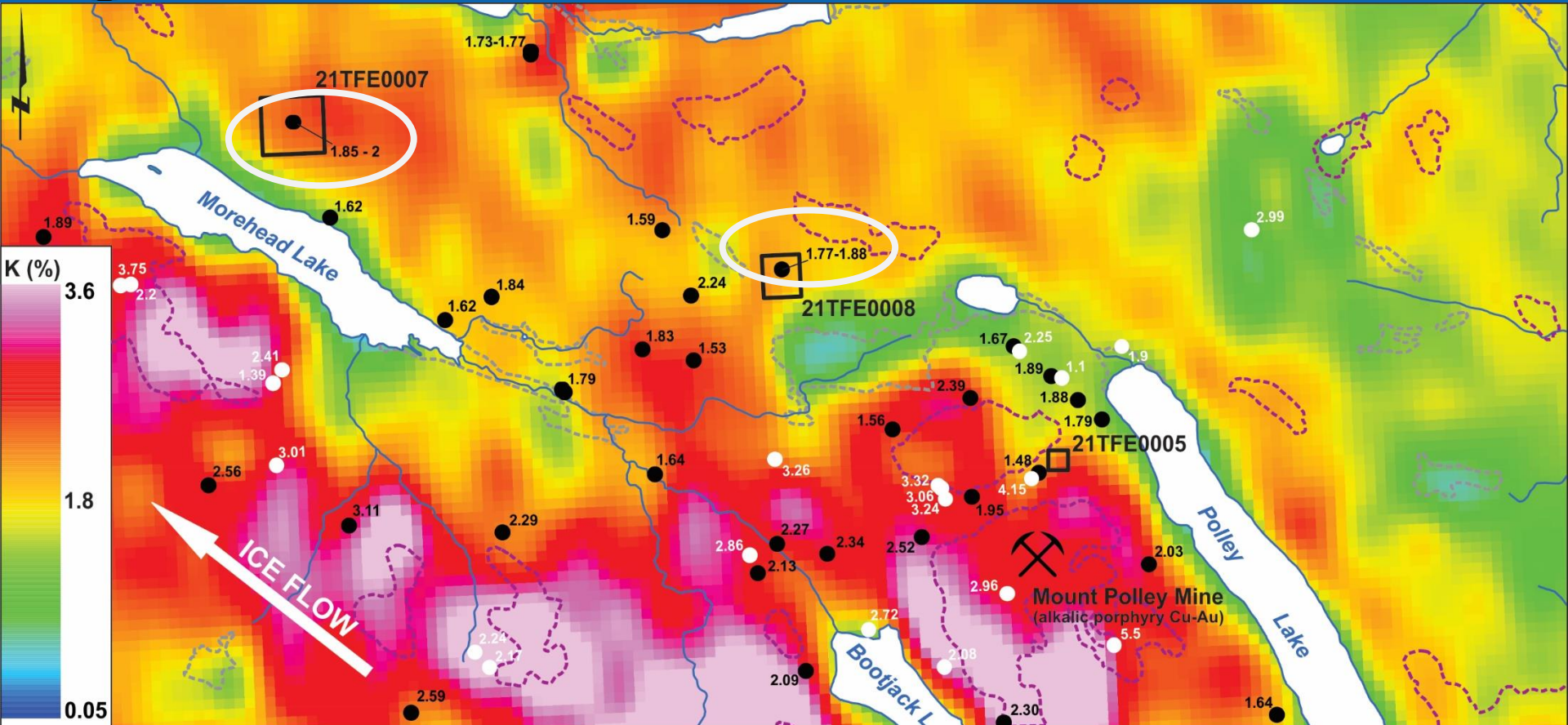
K Geochemistry

	Subglacial till samples Plouffe and Ferbey (2016)	Bedrock samples Logan and Milhalynuk (2005) Bath and Logan (2006)
Method	lithium fusion	x-ray flouresence
Detection limit	0.01 %	0.01 %

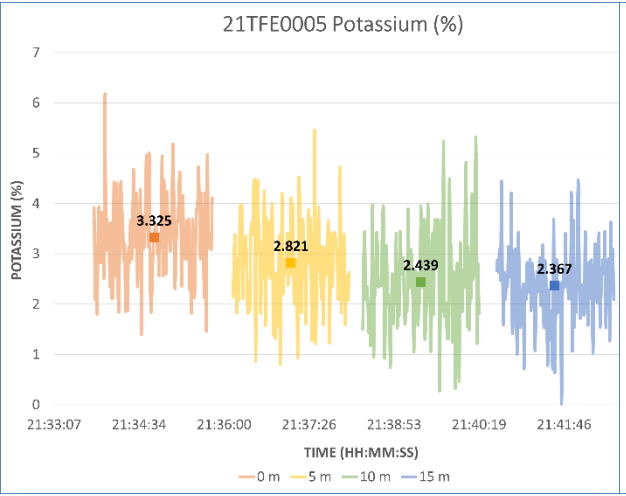
K (%) Shives et al. (1995)

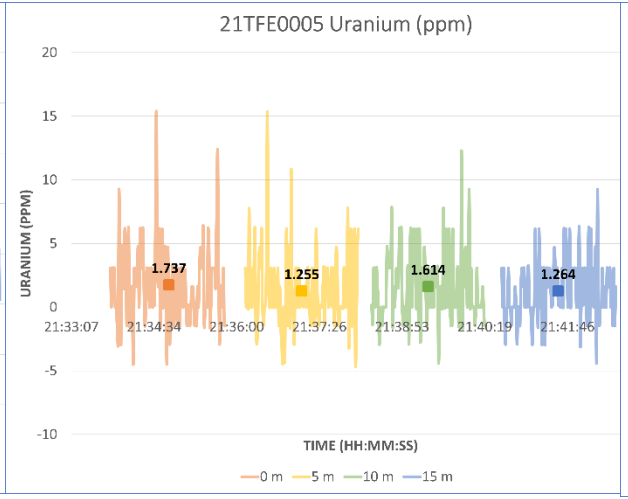


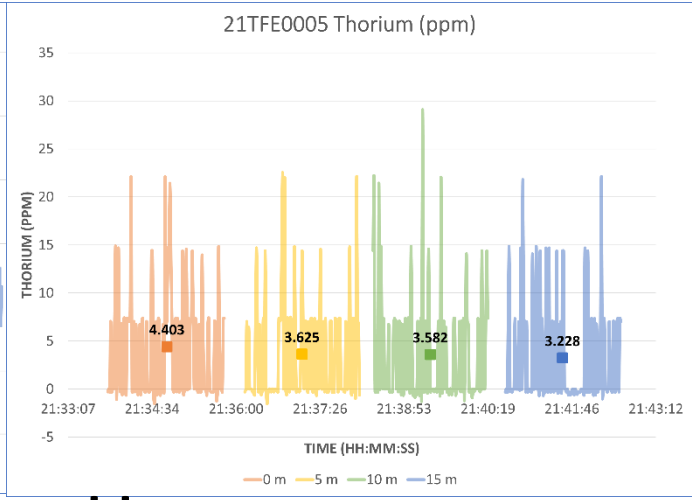
K (%) in Subglacial Tills and Bedrock



Concentration vs. Height Above Ground





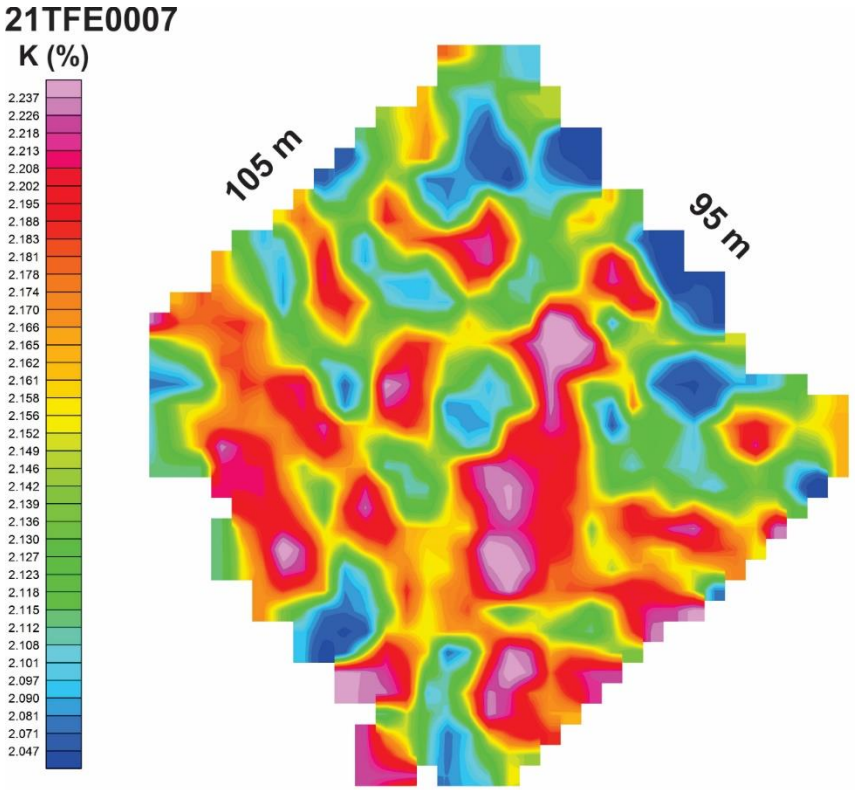


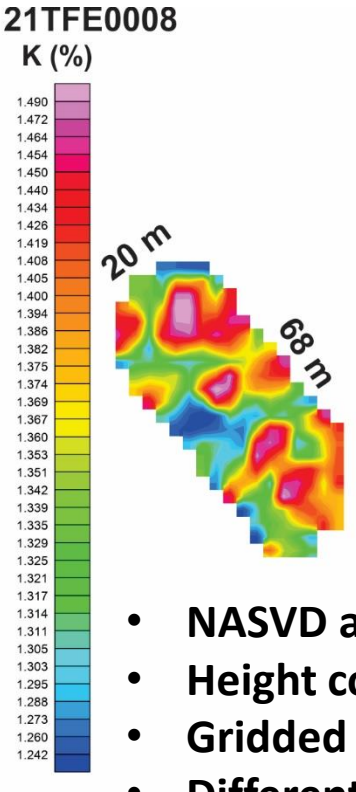
- **Lower energy K-40 gamma-rays attenuate measurably.**
- **eTh (Tl-208) may show slight attenuation as terrain clearance increases.**
- **eU (Bi-214) there is more attenuation at 5m than at 10 m; relationship is lost in the statistical noise.**

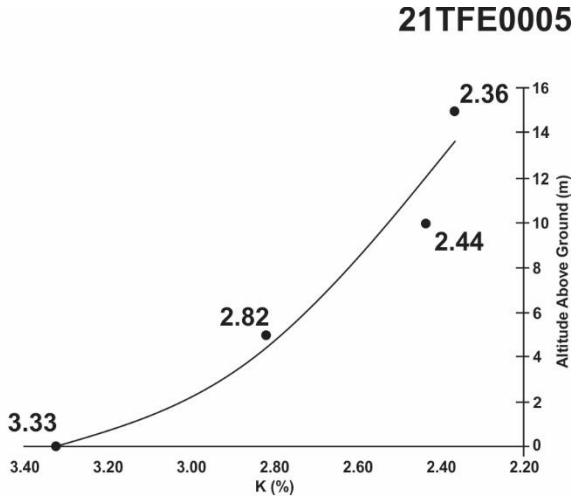
RPAS Survey Summary Values

Survey	Summed count (120 s)	Altitude Above Ground (m)	Average			Height Corrected
			Total c/s	K (c/s)	K (%)	K (%)
21TFE0005	49,837	0.0	415	14	3.33	3.33
21TFE0005	45,322	10.0	384	11	2.44	3.25
21TFE0007	n/a	10.0	262	6	1.34	2.15
21TFE0008	n/a	7.5	196	3	0.68	1.36

K (%) RPAS Data







- NASVD applied
- Height corrected
- Gridded using inverse distant weighting
- Different legends

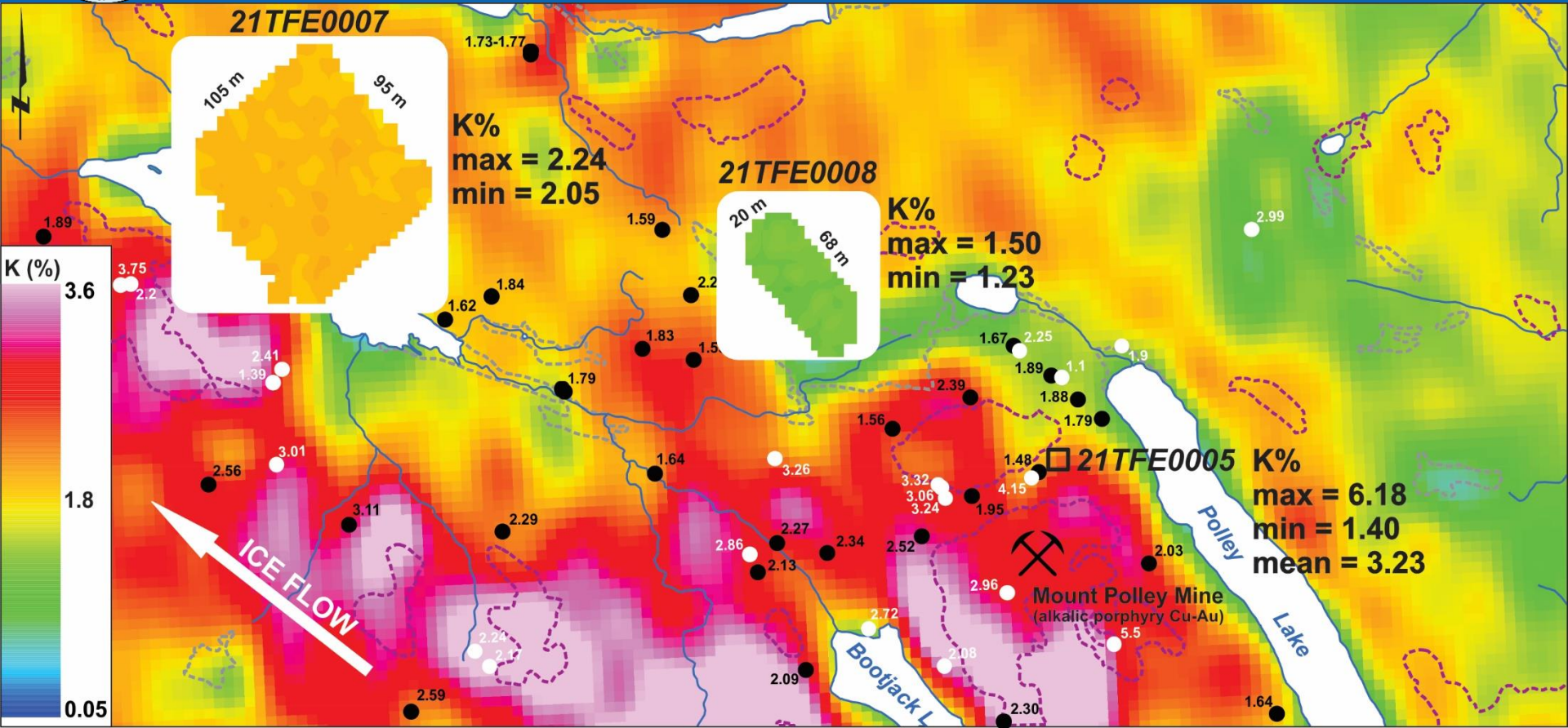
K (%) RPAS Data

What is the top 30 cm composed of?

B (mineral) horizon soil

LFH (organic) horizon soil

K (%) RPAS Data


21TFE0007
105 m
95 m
K%
max = 2.24
min = 2.05
21TFE0008
20 m
68 m
K%
max = 1.50
min = 1.23
21TFE0005
K%
max = 6.18
min = 1.40
mean = 3.23
K (%)
3.6
1.8
0.05
ICE FLOW
Mount Polley Mine
(alkalic porphyry Cu-Au)
Polley Lake
Bootjack L
1.73-1.77
1.89
3.75
2.2
2.41
1.39
1.84
1.62
1.59
1.83
1.79
3.01
2.56
1.64
3.11
2.29
3.26
2.27
2.86
2.13
2.34
2.52
1.56
2.39
1.67
2.25
1.89
1.1
1.9
1.88
1.79
1.48
3.32
3.06
3.24
4.15
1.95
2.03
2.96
2.72
5.5
2.08
2.09
2.30
1.64
2.59
2.99

Summary

- Can RPAS radiometrics detect glacial dispersal? Yes.
- High quality magnetics and radiometrics can be acquired using an RPAS platform.
- RPAS radiometrics compare well with proven traditional airborne methods (with increased resolution) and surface geochemical determinations.
- The biggest challenge to detecting subtle changes in K, in a low elevation and latitude setting, is finding terrain suitable for low and slow data acquisition.
- Above tree-line (alpine and Arctic settings), over stronger K, U, and Th targets, would be ideal survey conditions for RPAS radiometrics.

Acknowledgements