

# Petrophysics of porphyry deposits at local and regional scales in British Columbia

---

Dianne Mitchinson, PhD, PGeo  
Mineral Deposit Research Unit, UBC

Xploration Tech Symposium 2023  
January 20, 2023



**BARRICK**



**Newmont**



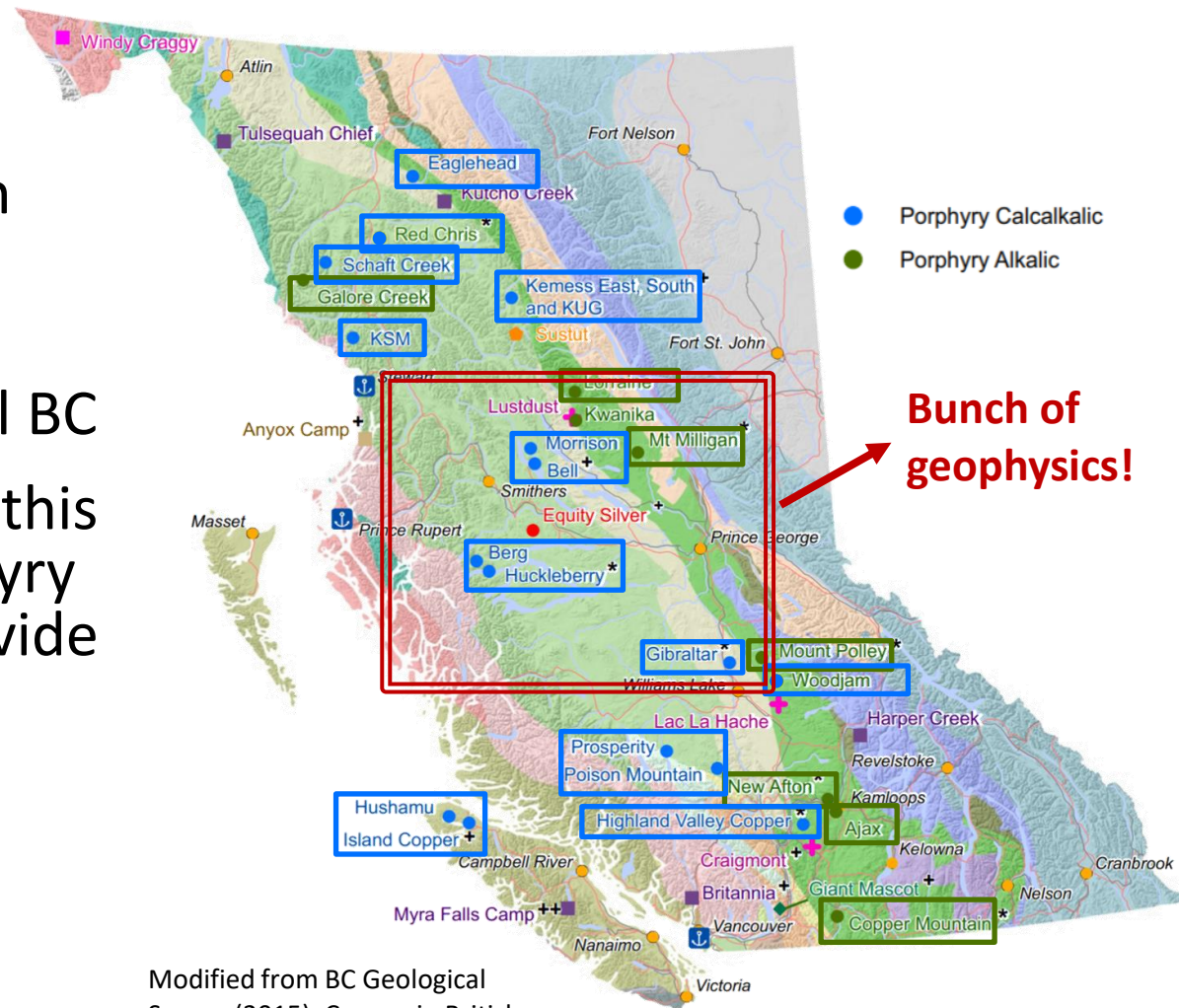
**Teck**

# Preamble

- **What's tech about this talk?**
  - Tech was taken advantage of
  - Observations can be fed into tech
  - Physical properties are still innovative!
- **What's in this for you?**
  - Copper (Au, Mo) stuff
  - Porphyry stuff
  - BC stuff
  - Geophysics for exploration
  - Physical properties for exploration

# Porphyry Cu and Au in BC and under cover potential

- Lots of potential for **porphyry Cu+/-Au** in British Columbia
- Areas of **extensive cover**, esp. in central BC
- Can we see through this to locate new porphyry targets in BC, or provide new information on existing targets?



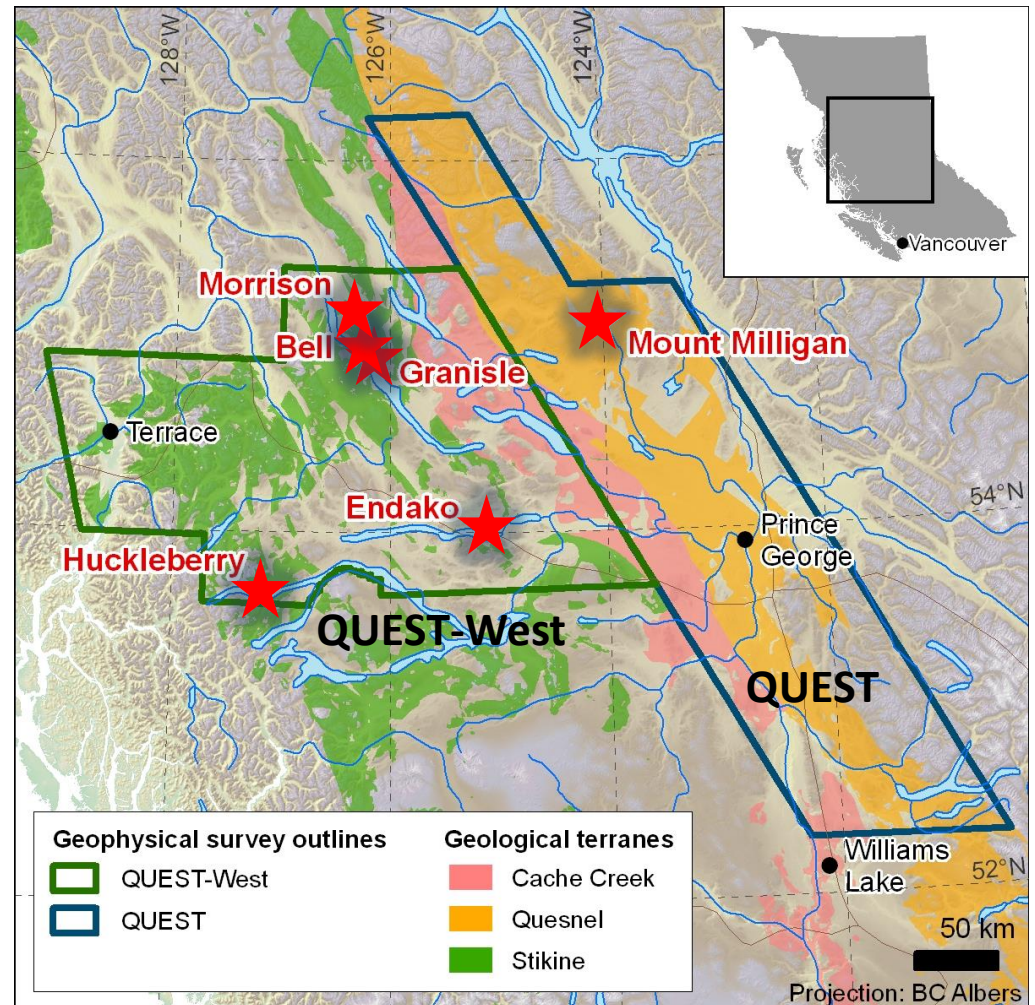
Modified from BC Geological Survey (2015), Copper in British Columbia, information circular



# Geoscience BC QUEST and QUEST-West projects



- 2007 and 2008 - new **regional gravity and electromagnetic** (VTEM, AeroTEM) data collected over a large part of central BC
- **Infill EM and magnetic surveys** over suite of known porphyry deposits

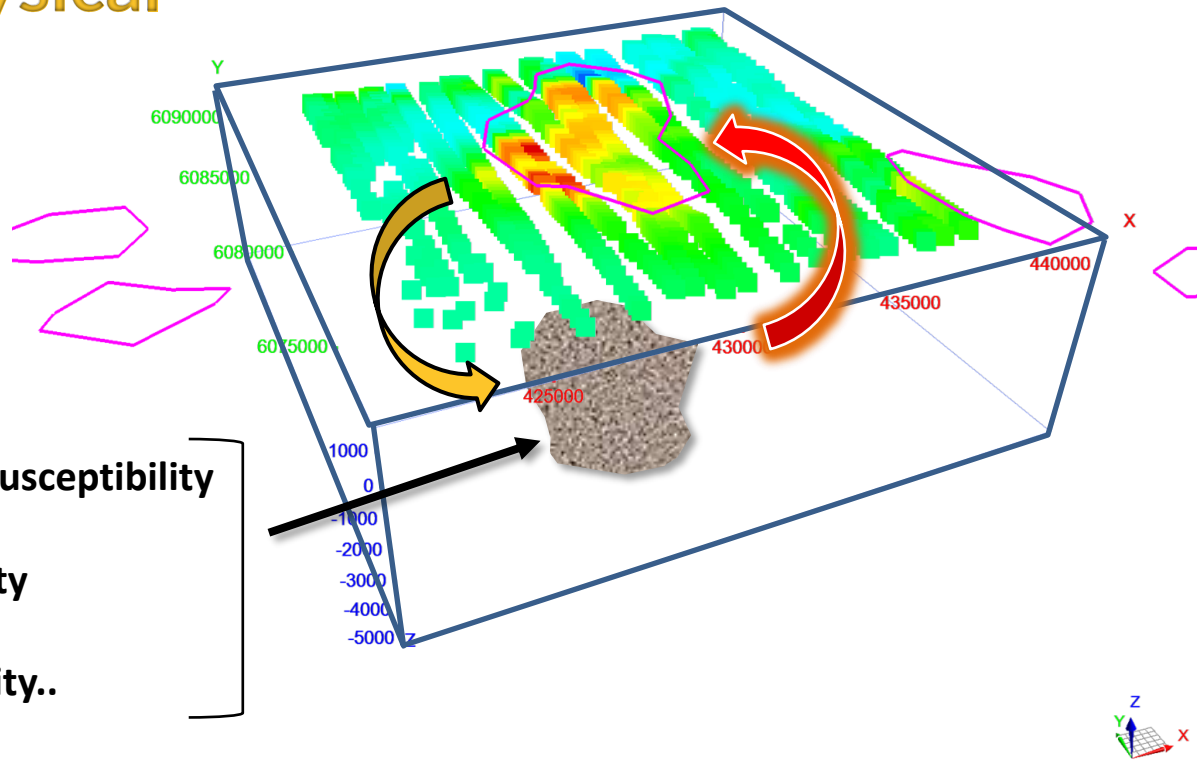


# How can we use these incredible geophysical data resources to help find new porphyry deposits?

## Knowledge of physical rock properties



Magnetic susceptibility  
Density  
Conductivity  
Porosity  
Chargeability..



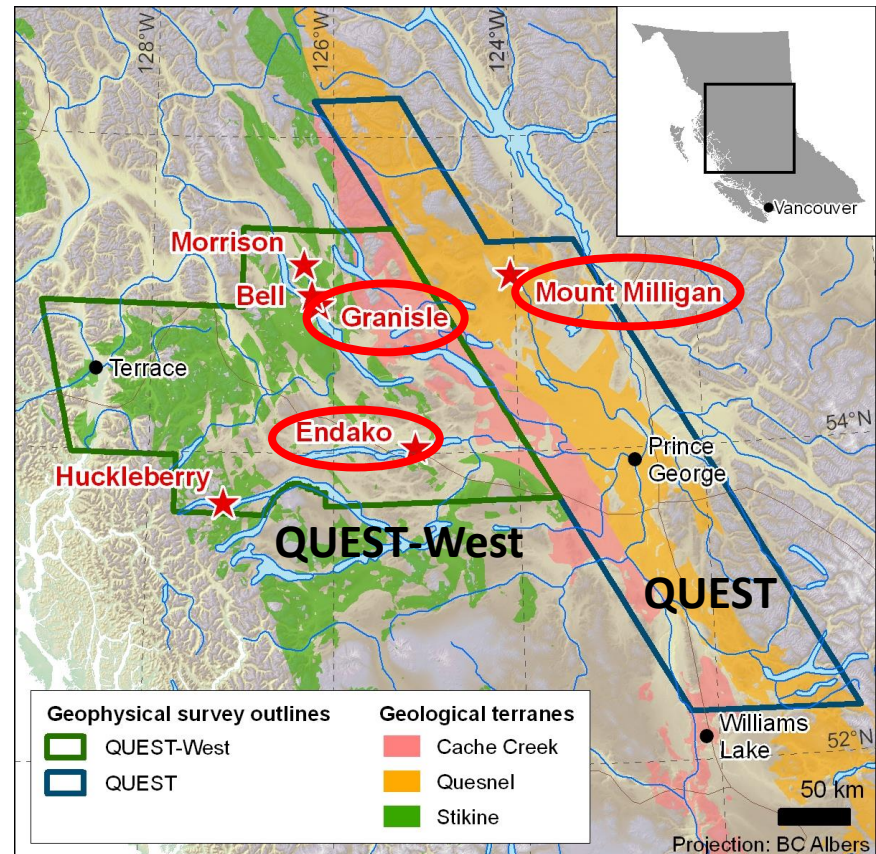
# Physical rock property trends for BC porphyry deposits

- **Property**-scale petrophysical trends of porphyries in BC
  - Physical property trends influenced by alteration
- **Regional**-scale petrophysical trends of porphyries in BC
  - Physical property trends influenced by bulk host rock composition



# Property-scale petrophysical trends of porphyries in BC

- **2013 MDRU/Geoscience BC study** of physical properties at **6 porphyry deposits** in BC's Stikine and Quesnel terranes
- Range of calc-alkalic to alkalic type porphyry deposits
- Examples, this talk:
  - **Endako** (calc-alkalic Mo)
  - **Granisle** (low K calc-alkalic Cu-Au)
  - **Mount Milligan** (alkalic Cu-Au)



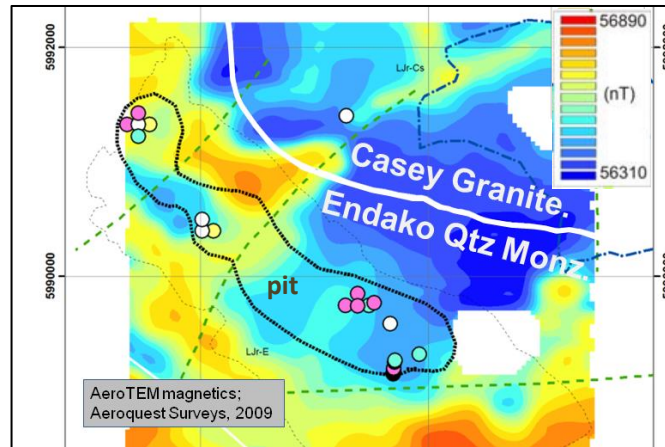


# Magnetic susceptibility

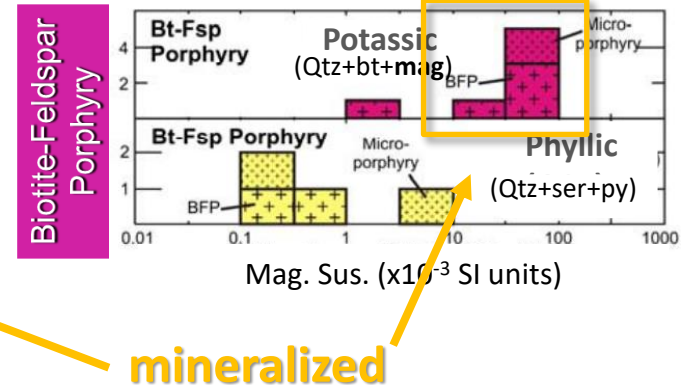
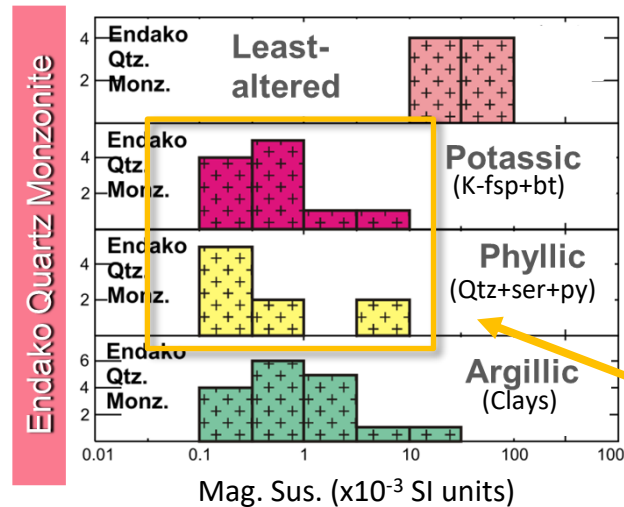
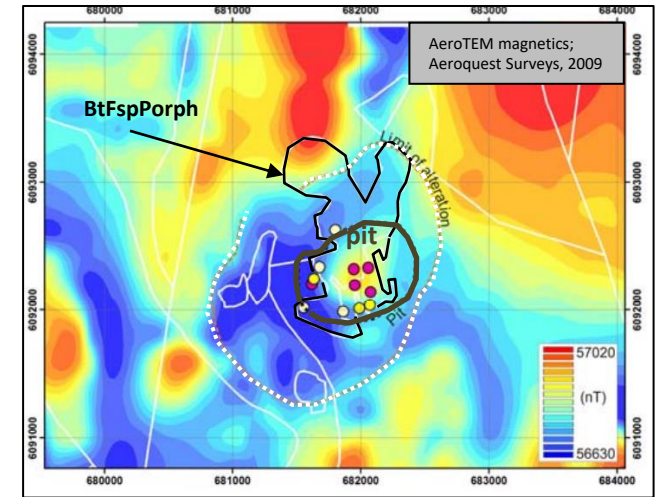
Mineralization can be associated with low or high magnetic susceptibilities

Potassic alteration for one porphyry  
 $\neq$   
 Potassic alteration for another porphyry

**Endako (calc-alkalic Mo)**



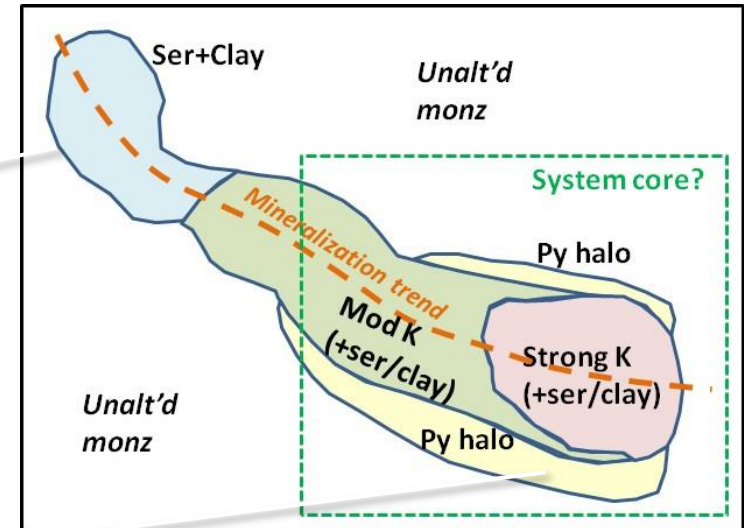
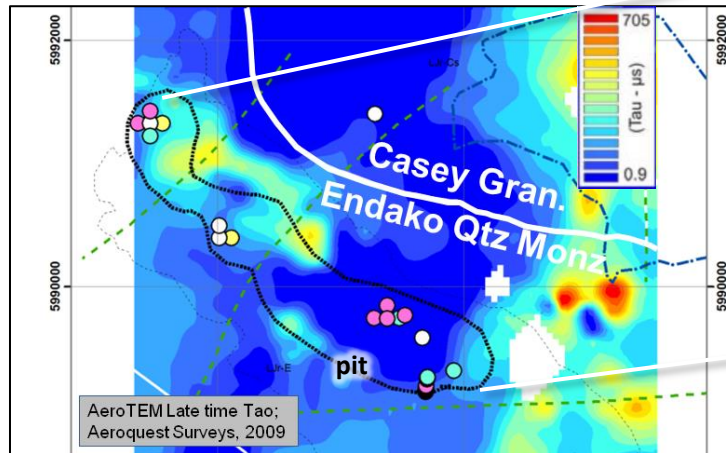
**Granisle (low K calc-alkalic Cu-Au)**



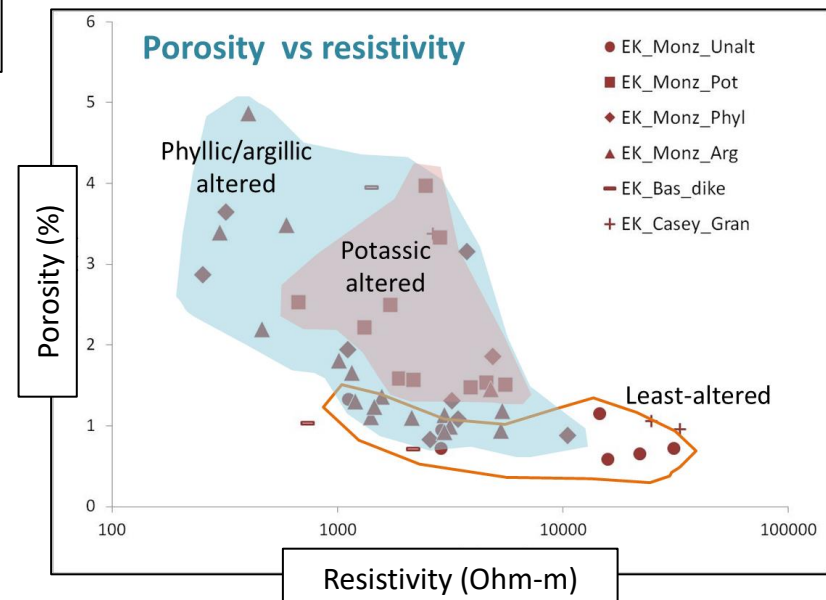
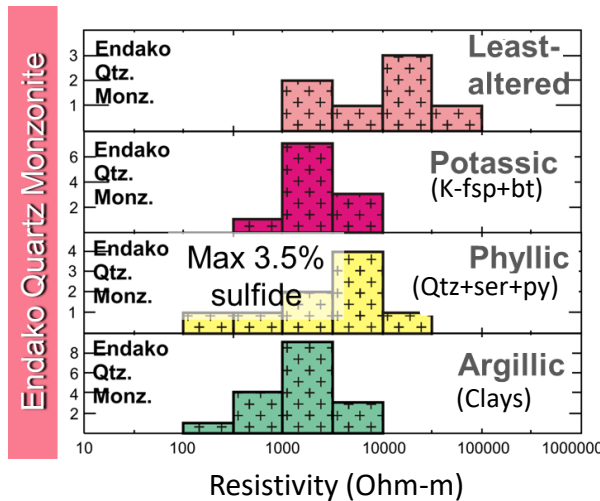


# Resistivity/conductivity

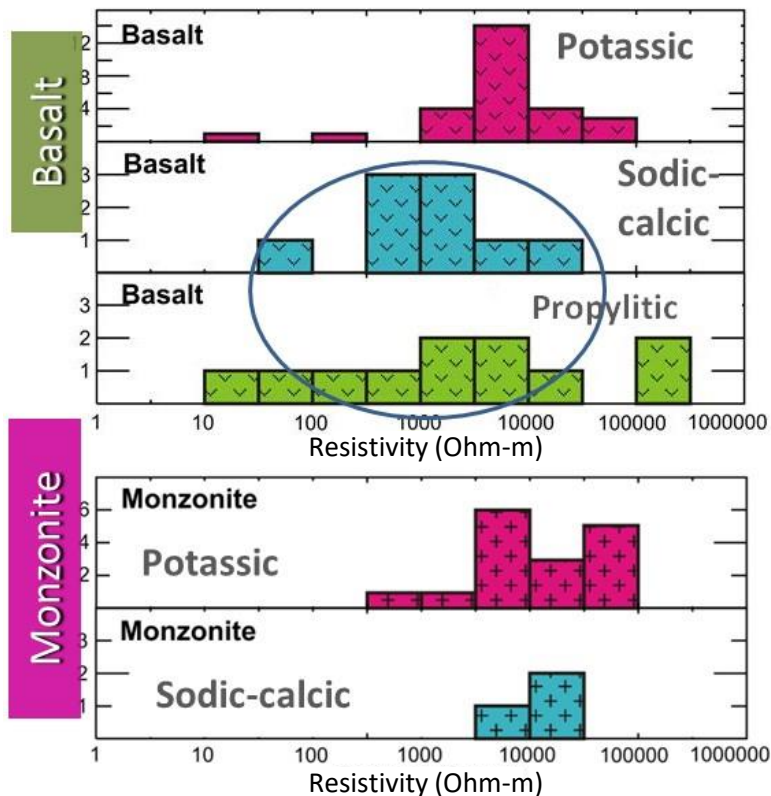
## Endako (calc-alkalic Mo)



Phyllic/argillic alteration consistently increases porosity and decreases resistivity

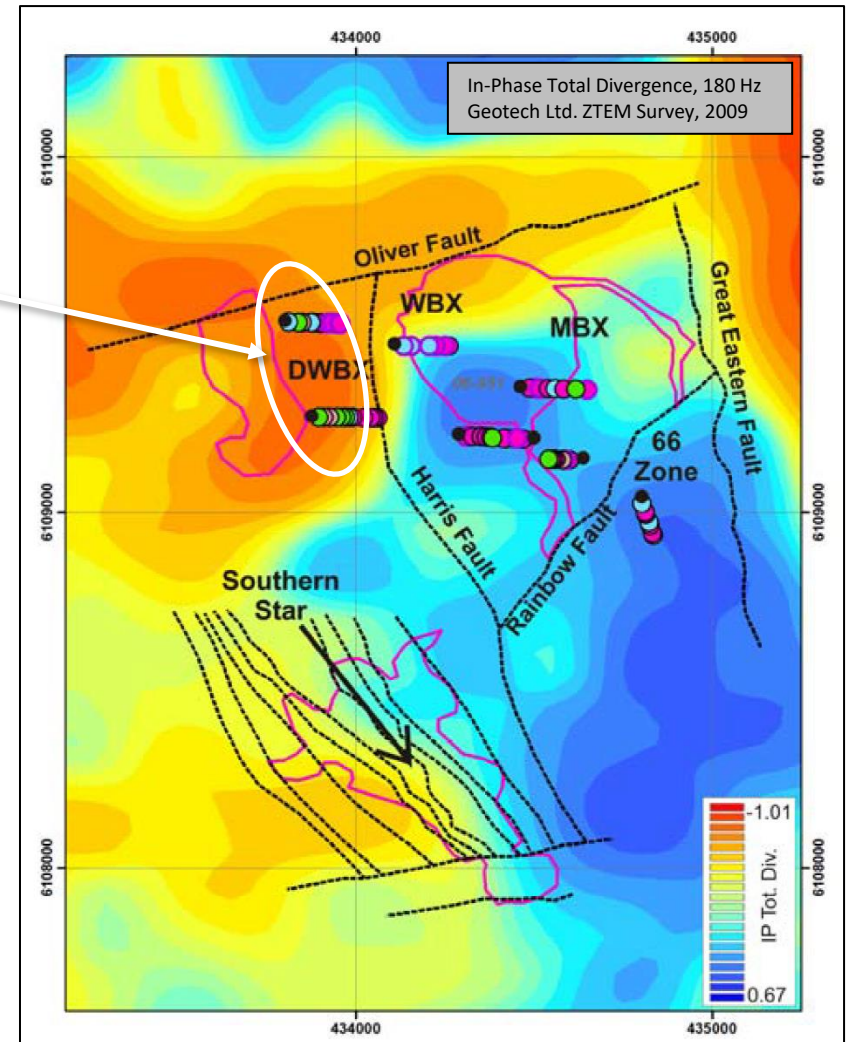


# Resistivity/conductivity – Mount Milligan same but different



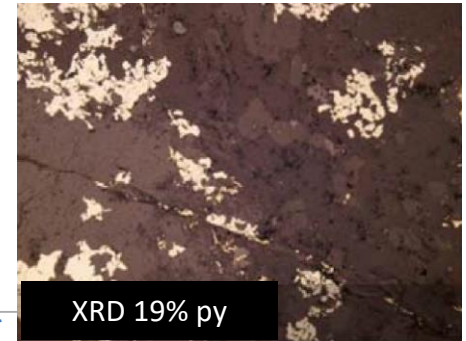
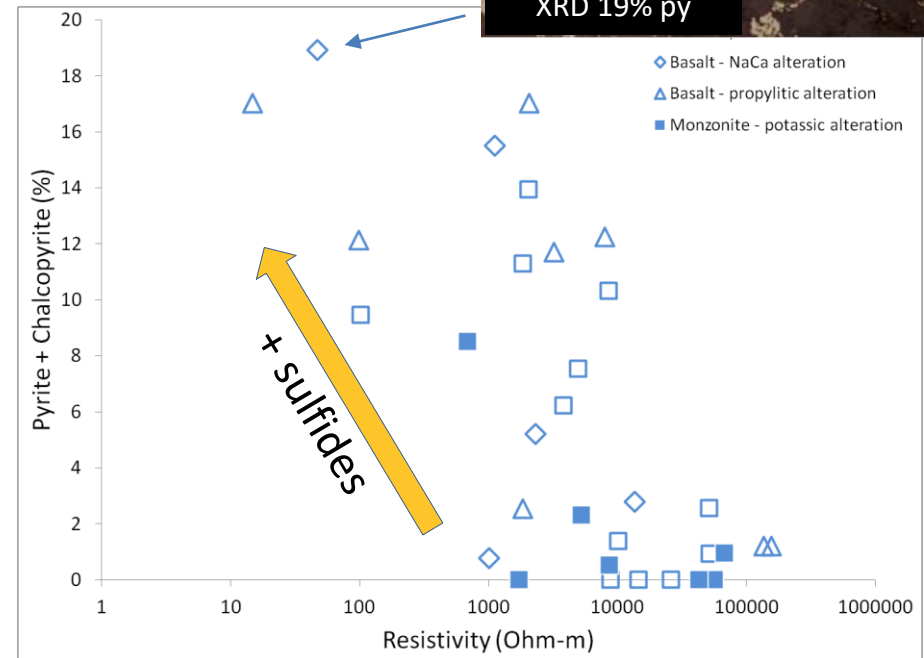
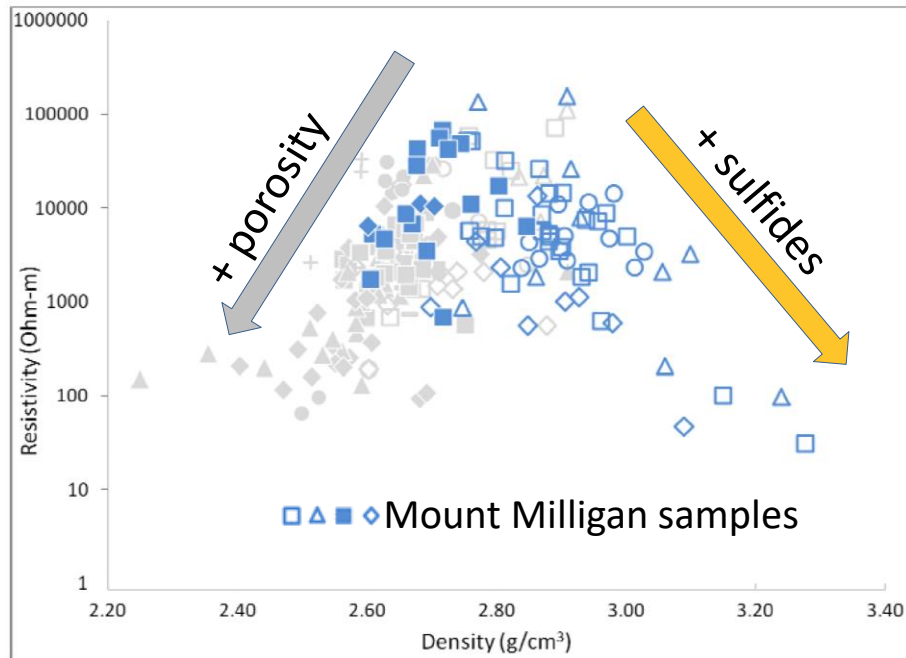
Propylitic/Na-Ca altered rocks are most conductive of Mt Milligan porphyry suite due to sulfides.

ZTEM survey detects structure, but possibly also sulfides, where abundant



Mount Milligan (alkalic Cu-Au)

# Resistivity – Mount Milligan – role of sulfides



# Physical rock property trends for BC porphyry deposits

- **Property**-scale petrophysical trends of porphyries in BC
  - Physical property trends influenced by alteration
- **Regional**-scale petrophysical trends of porphyries in BC
  - Physical property trends influenced by bulk host rock composition

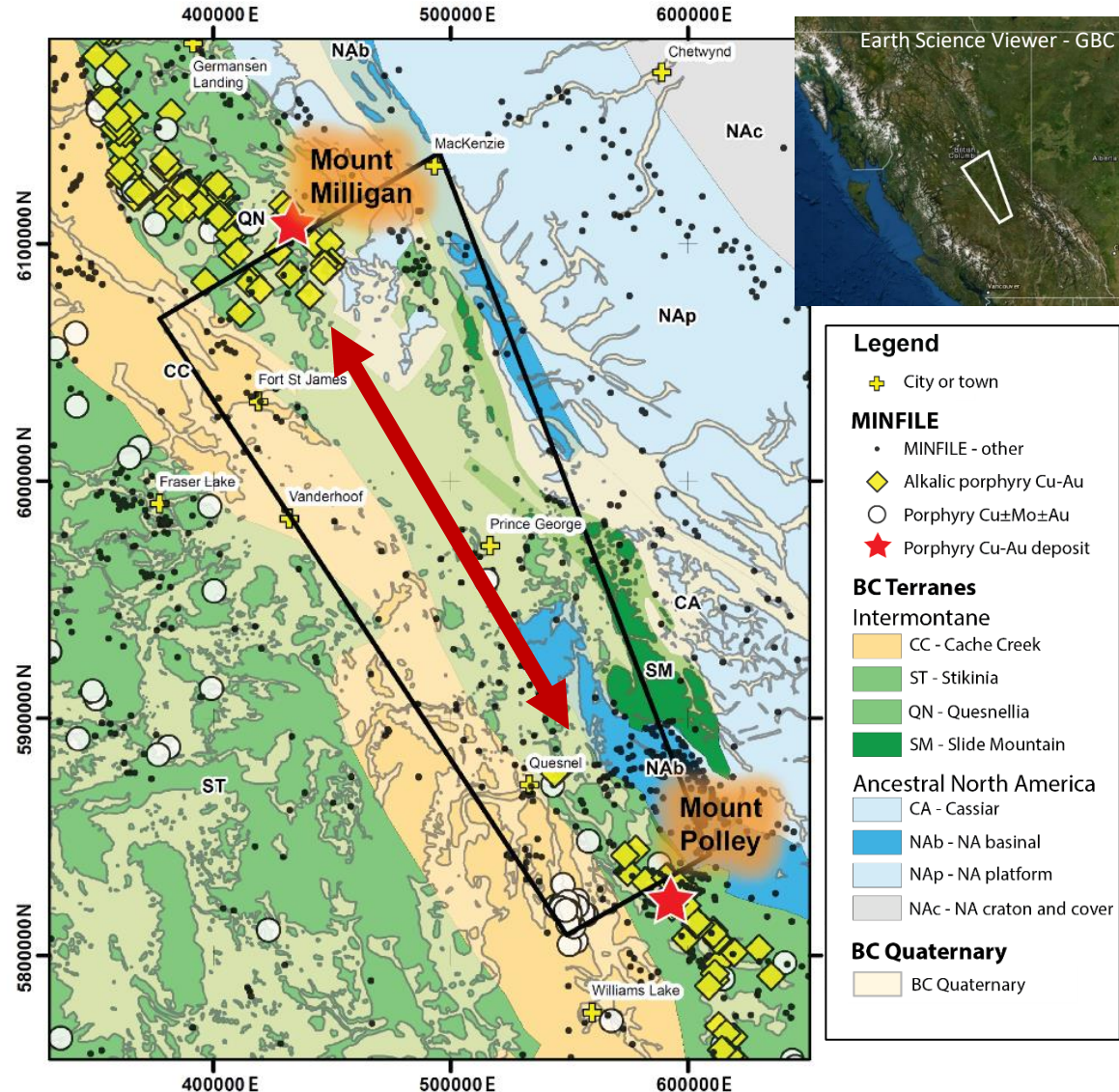




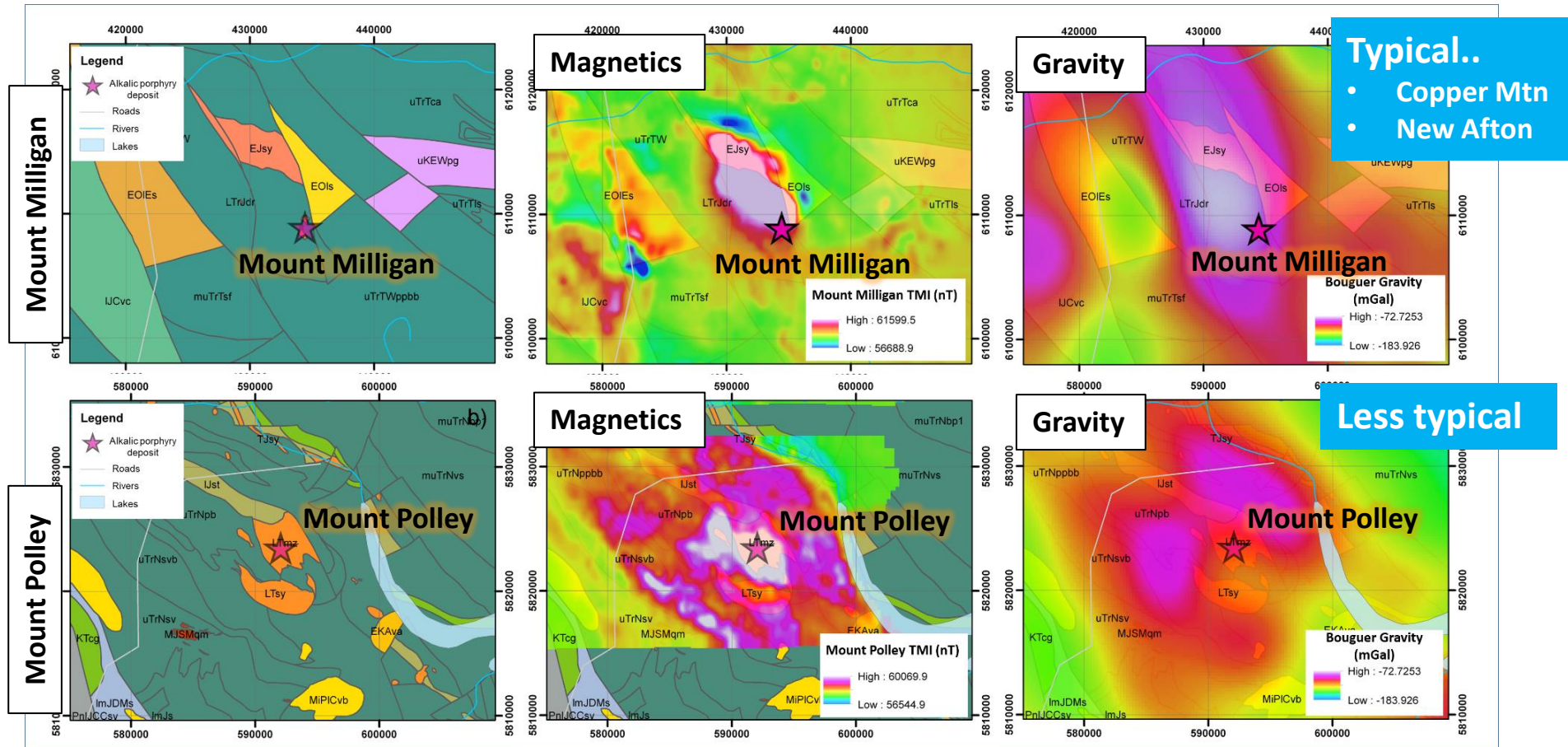
# Regional scale petrophysical trends of porphyries in BC

- **2022 MDRU/Geoscience BC study to explore for porphyry host rocks undercover using geophysics**
- Quesnel terrane has a large **250 km gap in mineral occurrences** - underexplored
- This terrane is known for its **alkalic porphyry Cu-Au deposits**
- (Most of) These deposits have a **common geophysical footprint** at the regional scale

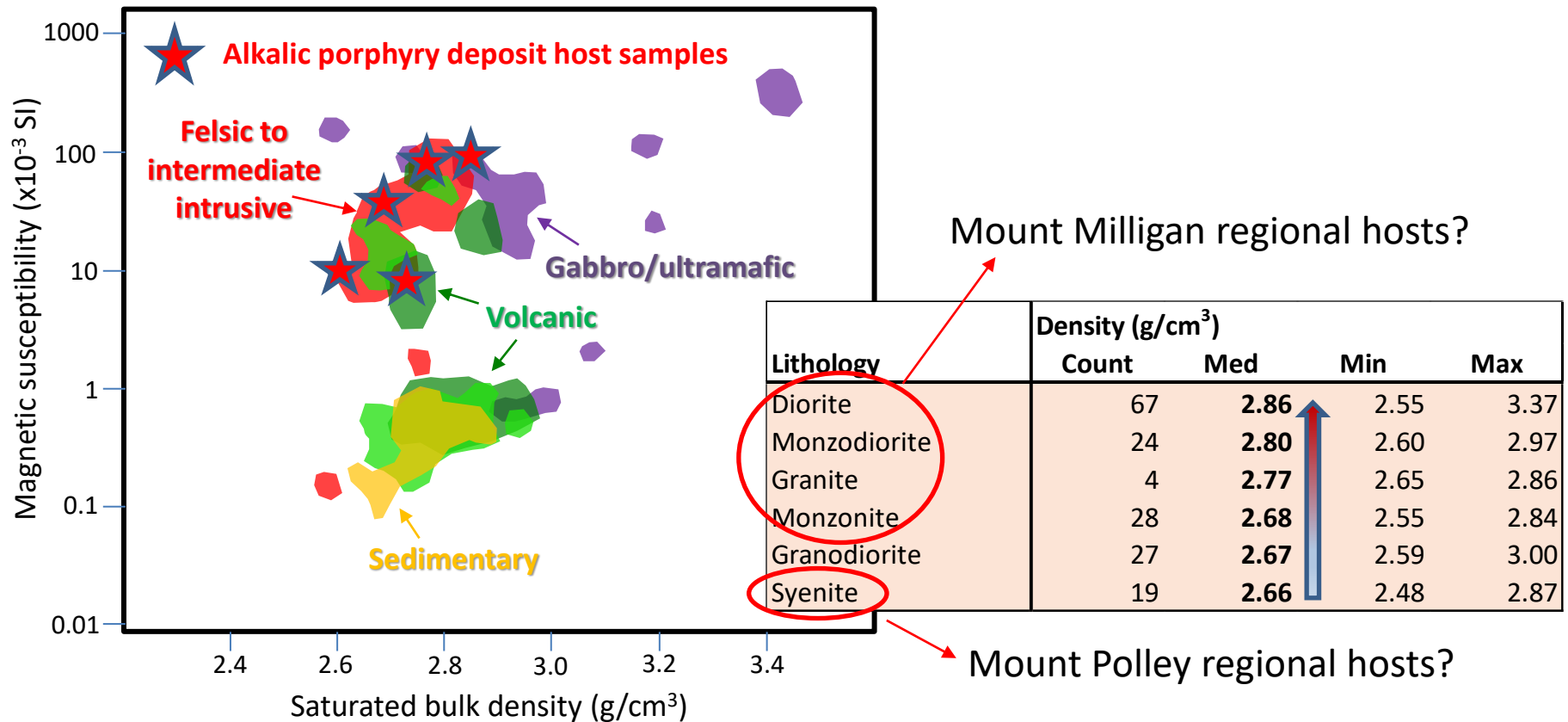
Terrane map: Colpron and Nelson, 2011;  
Quaternary overburden: Cui et al., 2017



# What is the geophysical footprint of alkalic porphyry host rocks?



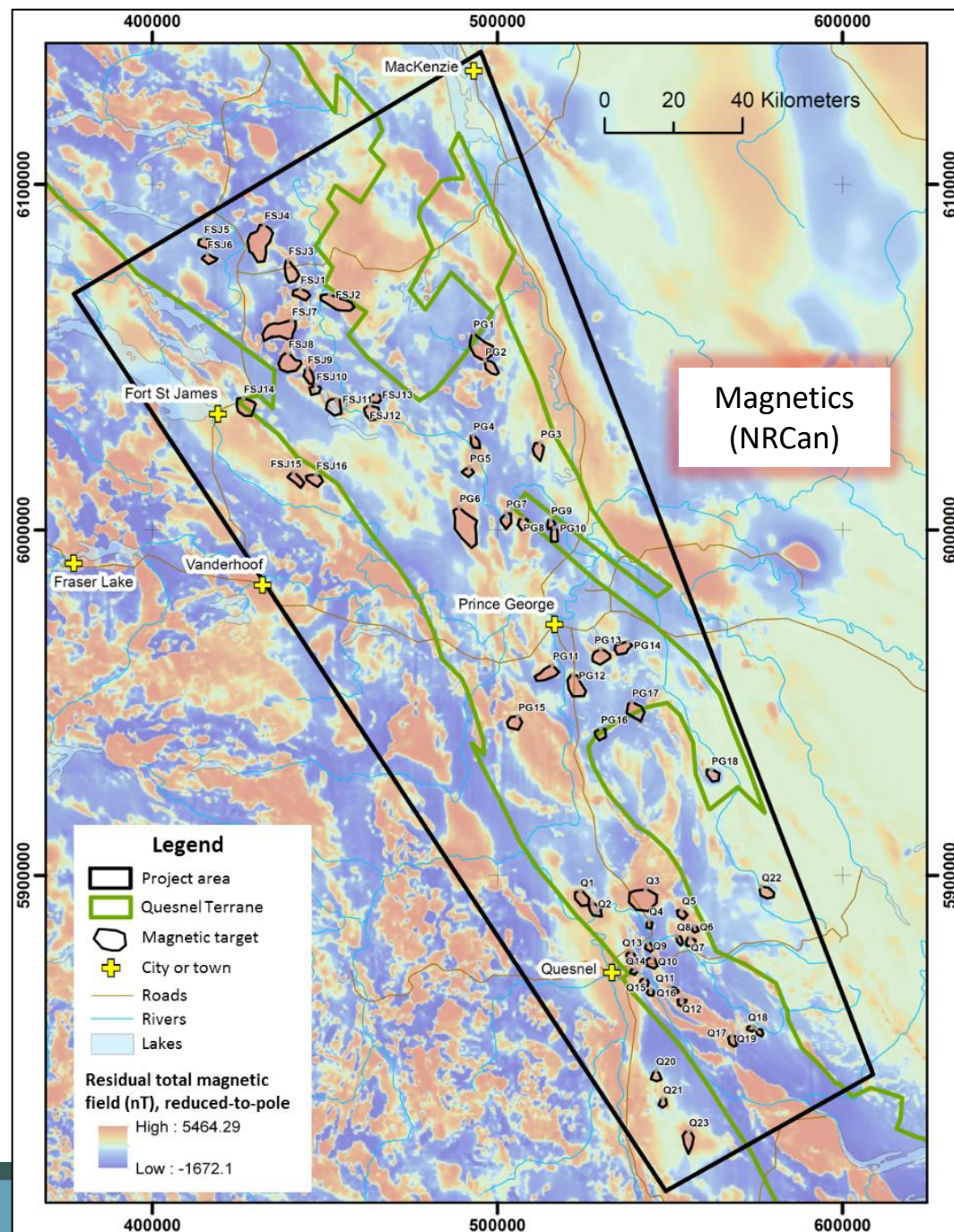
# What is the petrophysical footprint of alkalic porphyry host rocks?



Sample data from Canadian Rock Physical Property Database (Enkin, 2018), and Mitchinson et al., (2022)



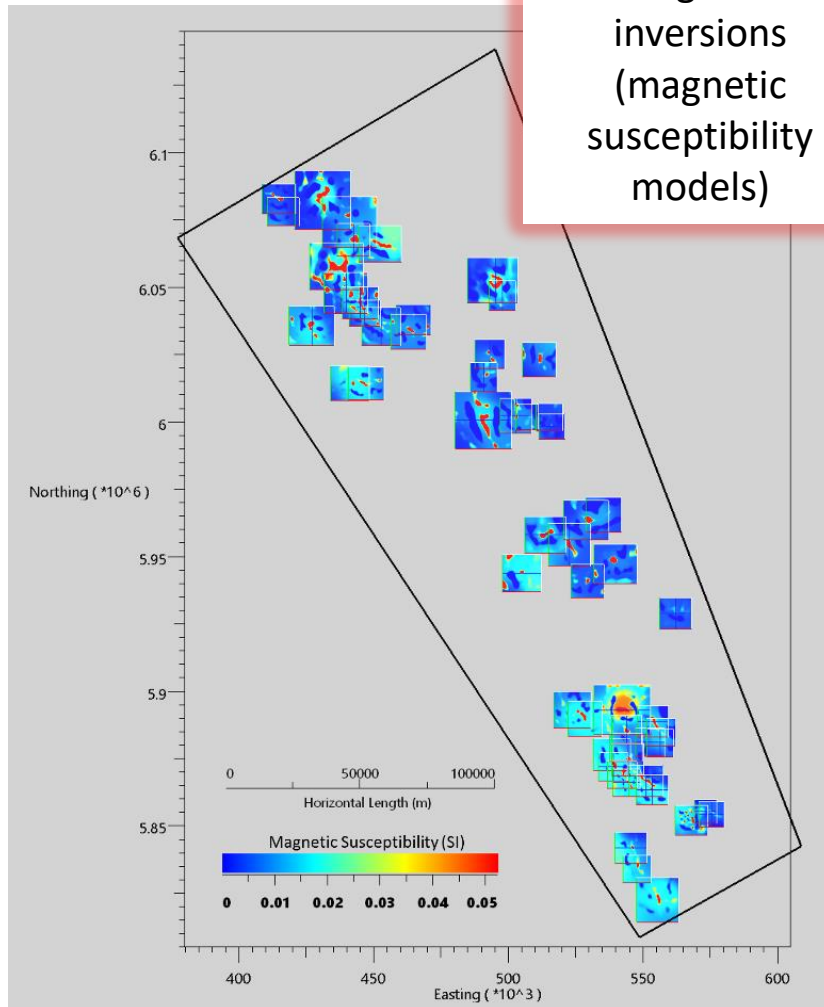
# Picking some porphyry host targets using magnetics



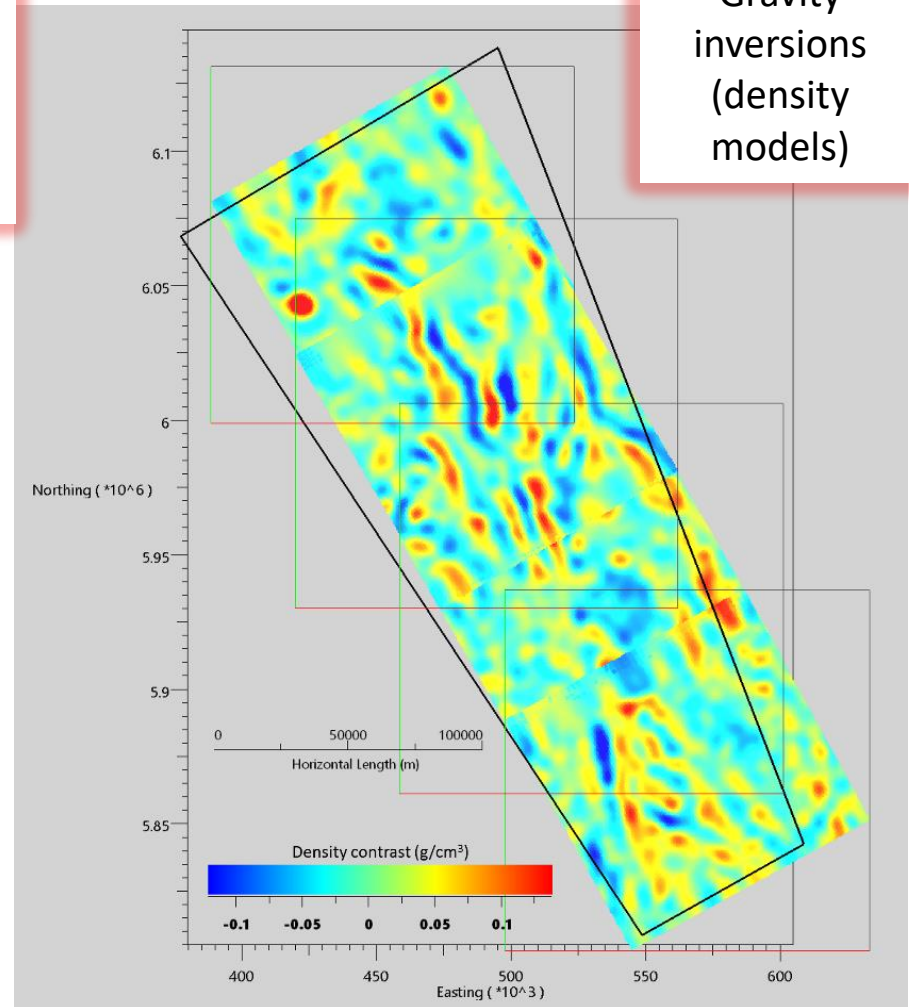


# 3D modelling of targets for susceptibility and density

Magnetic  
inversions  
(magnetic  
susceptibility  
models)



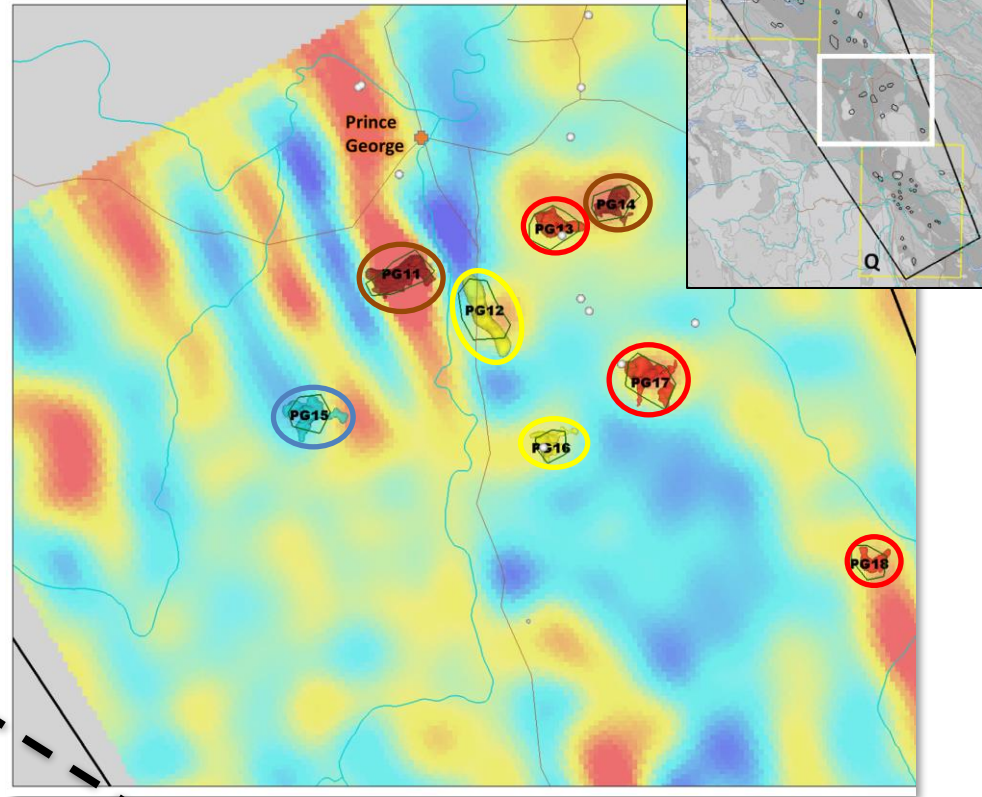
Gravity  
inversions  
(density  
models)



# Classifying regional porphyry targets using petrophysics - central BC

**High magnetic susceptibility bodies from magnetic inversion classified by average density from gravity inversion**

Target ID	Magnetic susceptibility ( $10^{-3}$ SI)	Density ( $\text{g/cm}^3$ )	Density class
PG11	41.56	2.85	v. high
PG14	46.57	2.75	v. high
PG17	61.19	2.74	high
PG18	36.96	2.74	high
PG13	46.37	2.73	high
PG16	34.46	2.70	med
PG12	49.16	2.68	med
PG15	29.05	2.63	low



Typical of alkalic porphyry hosts in the Quesnel terrane

Less typical of alkalic porphyry hosts in the Quesnel terrane

# Physical properties of BC porphyry deposits - summary

- **Locally** - some consistencies in petrophysical/geophysical patterns for porphyries, but the 'anomaly of interest' will depend on:
  - what alteration phase the mineralization is dominantly hosted in
  - what the associated alteration may be introducing or taking away (minerals, textures)
  - Sulfide abundance and distribution
- **Regionally** - need to have an awareness of the range of compositional variations that exist for porphyry host rocks, since regionally, petrophysical/geophysical patterns will depend on bulk host rock composition

# Physical properties in mineral exploration

- Sample and measure for physical properties and **integrate petrographic, mineral, and geochemical analysis to determine the ‘why’** of the petrophysical/geophysical response for best informed interpretations
- Low cost (\$ and time) to make big impact on interpretations





# THANK YOU!

- **Acknowledgements**

- Geoscience BC
- Craig Hart, Shaun Barker, MDRU
- Dominique Fournier
- Devin Cowan, Thibaut Astic, UBC-Geophysical Inversion Facility
- Randy Enkin, GSC