

KEG Conference 2008

BIZ Exploration Strategy Workshop

April 3rd, 2008

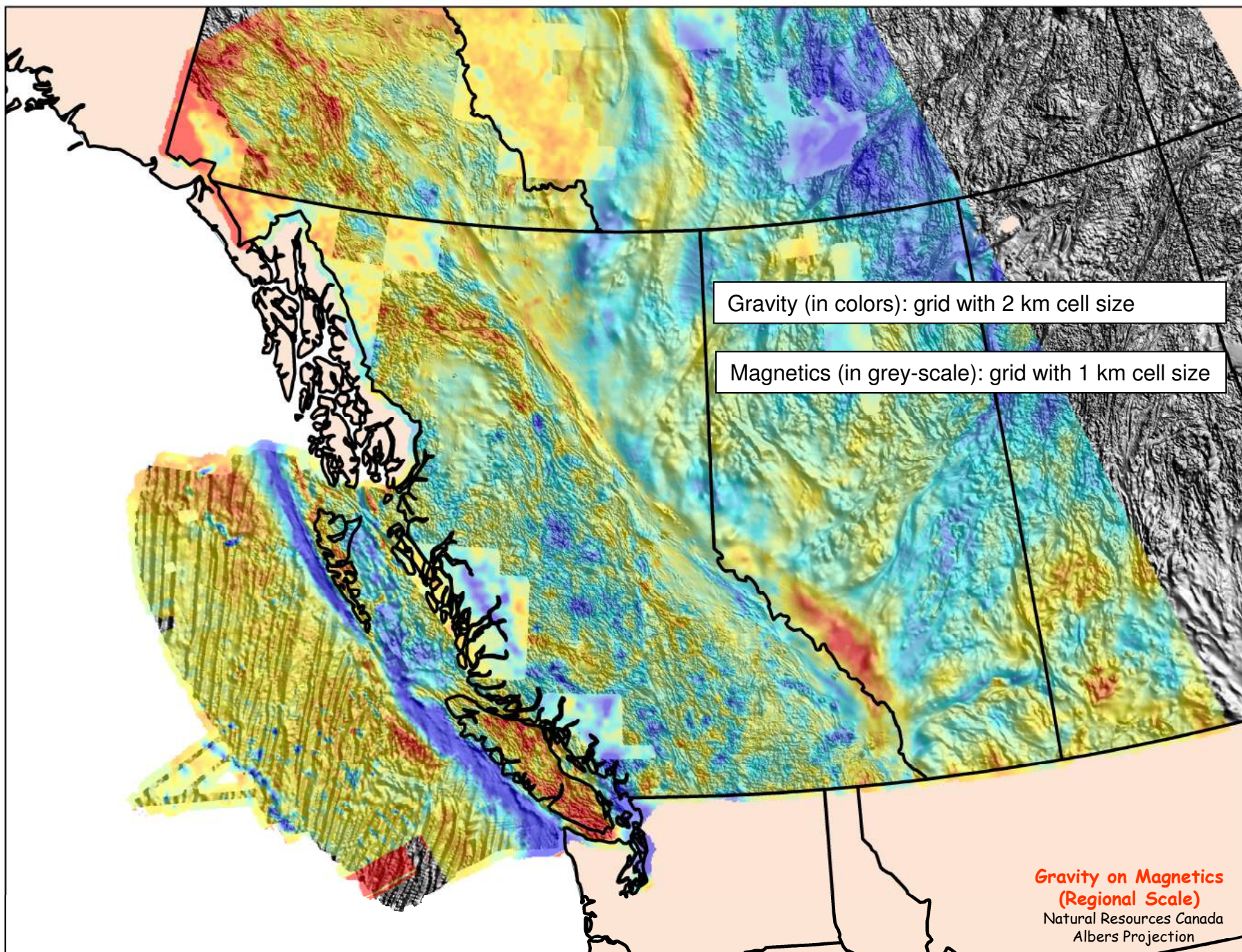
Electromagnetic Exploration in the **Beetle Impacted Zone**

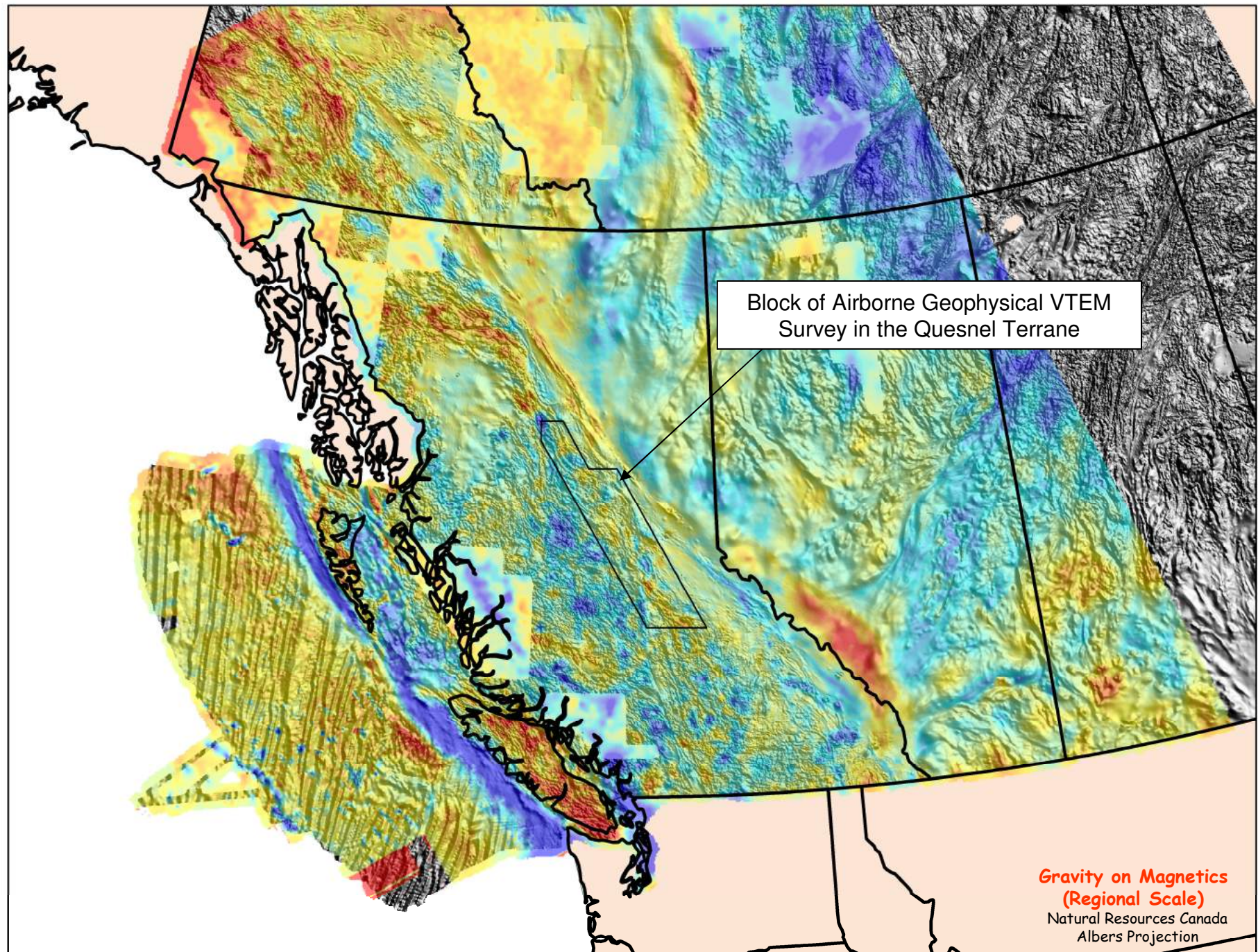
Sergio Espinosa

Geophysics, GIS, and Databases

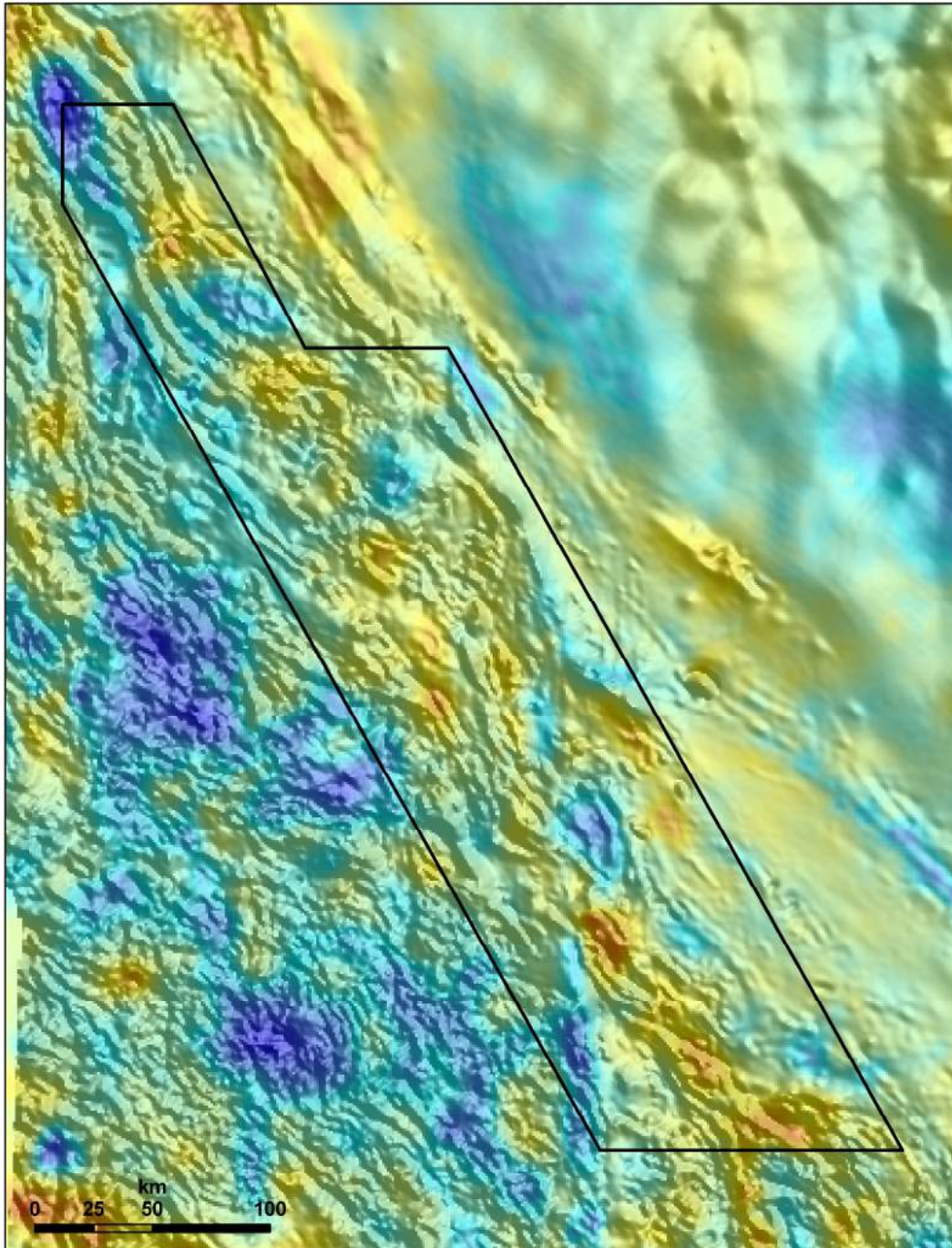
Terrane Metals Corporation

Vancouver, British Columbia





**Block of Airborne Geophysical VTEM
Survey in the Quesnel Terrane**



**Gravity on Magnetics
(Belt Scale)**

Canadian Aeromagnetic Data Base
(Natural Resources Canada)

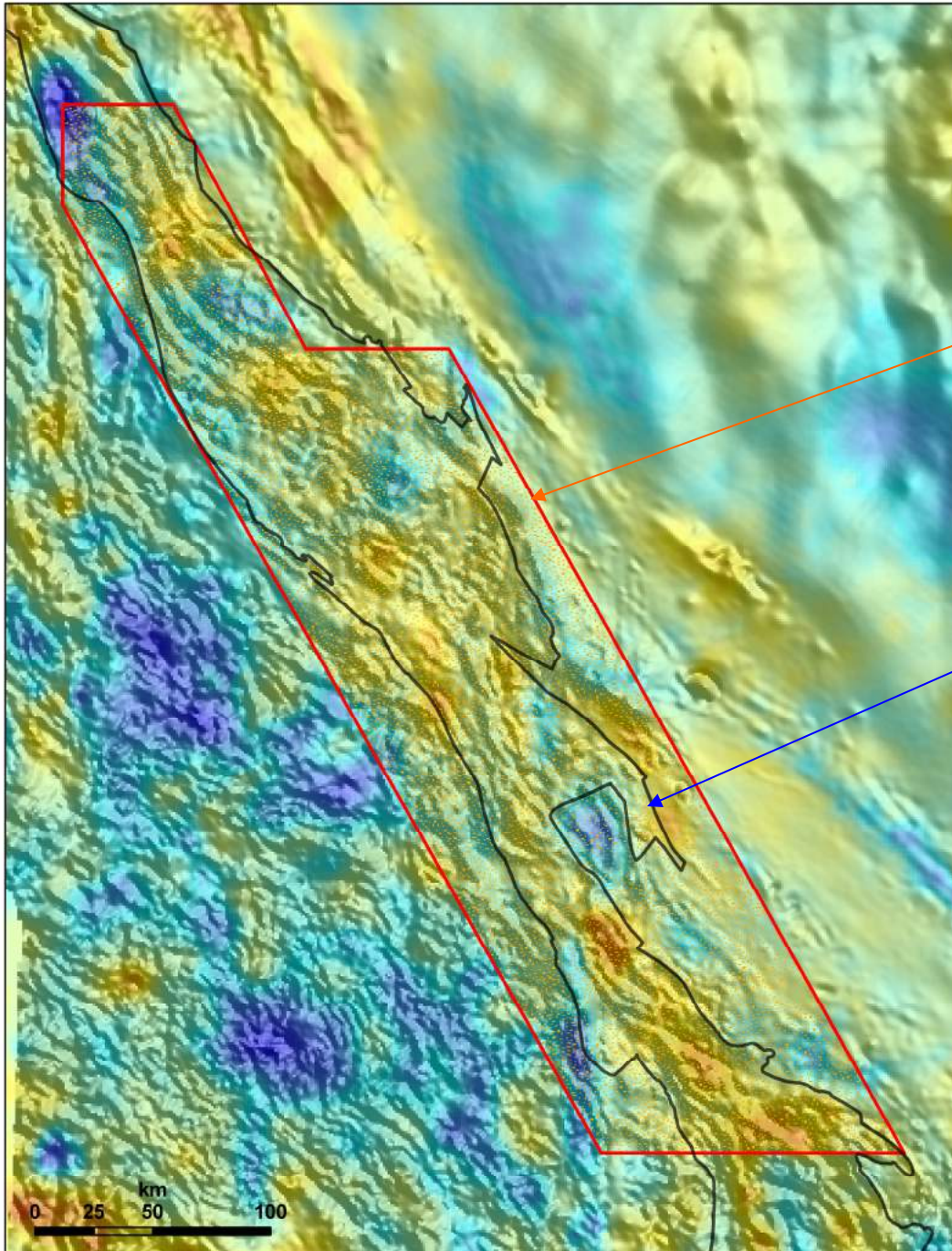
Block of Airborne Geophysical VTEM Survey in the Quesnel Terrane

Block of Airborne Geophysical VTEM Survey in the Quesnel Terrane

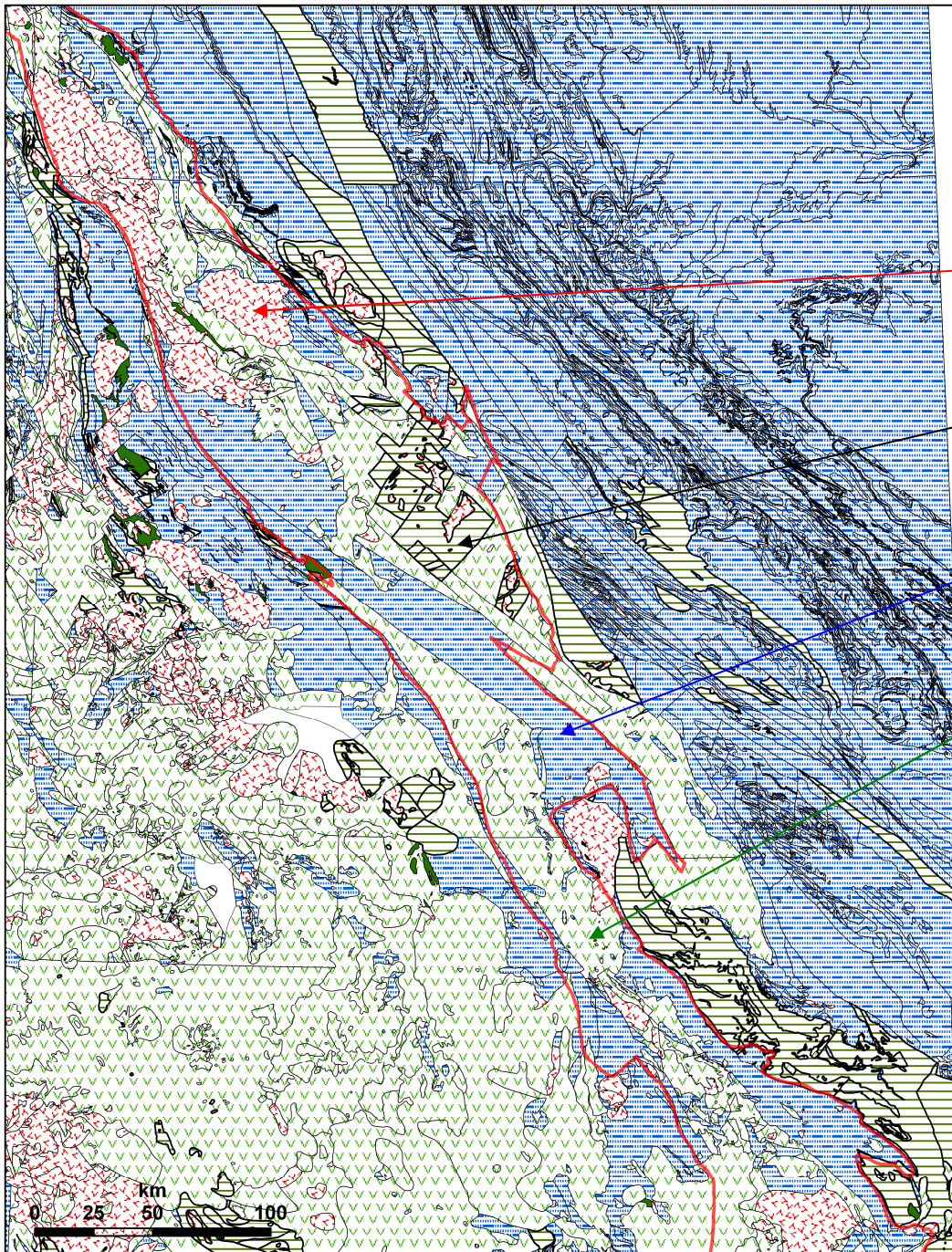
Outline of Quesnel Terrane

Gravity on Magnetics (Belt Scale)

Canadian Aeromagnetic Data Base
(Natural Resources Canada)



Geology of the Quesnel Terrane



Intrusives

Metamorphic Rocks

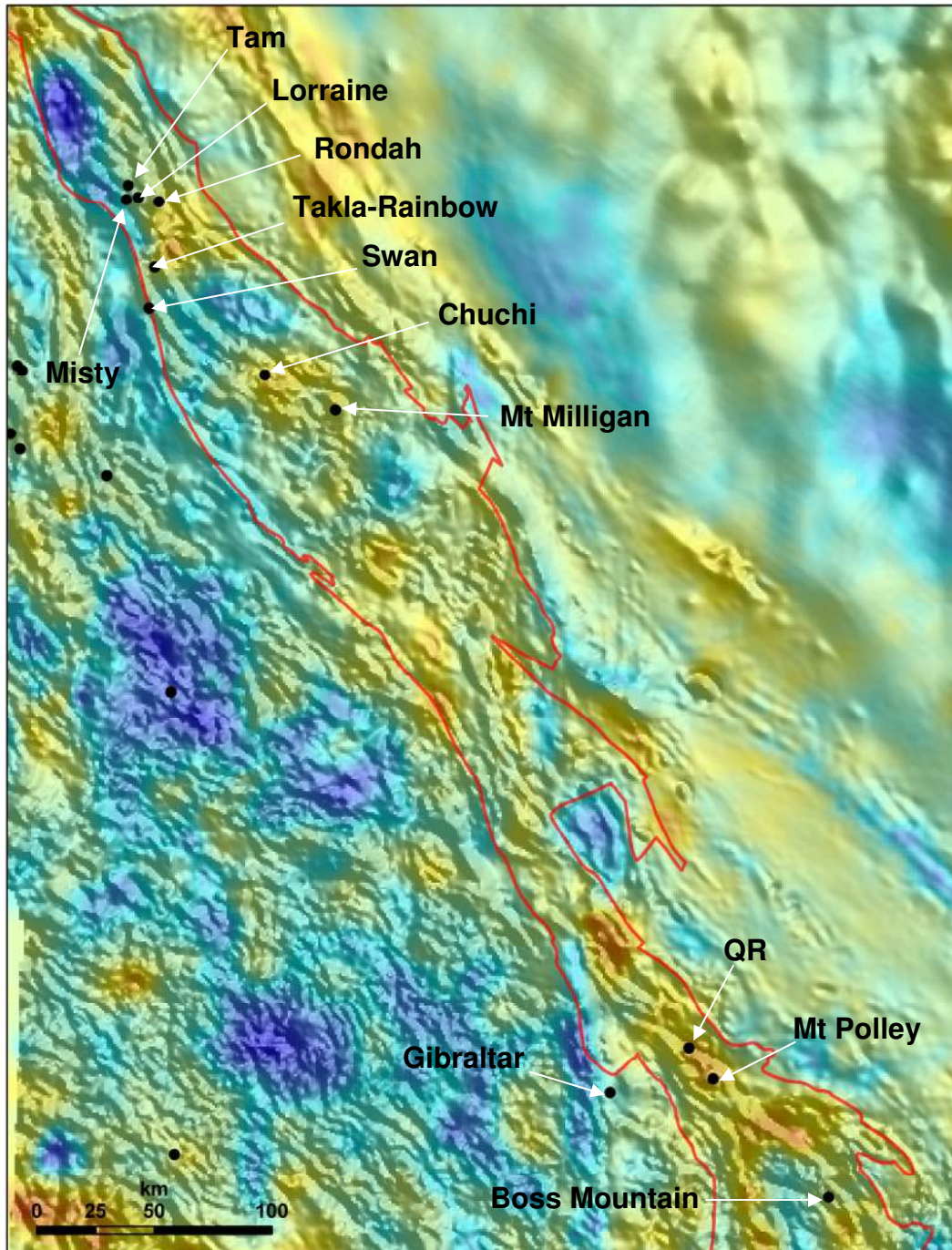
Sediments

Volcanics

**Lithology
(Belt Scale)**

B.C. Geological Survey
(www.mapplace.ca)

Porphyry Occurrences in the Quesnel Terrane



**Gravity on Magnetics
(Belt Scale)**

Canadian Aeromagnetic Data Base
(Natural Resources Canada)

Airborne Geophysical VTEM Survey in the Quesnel Terrane

Metadata

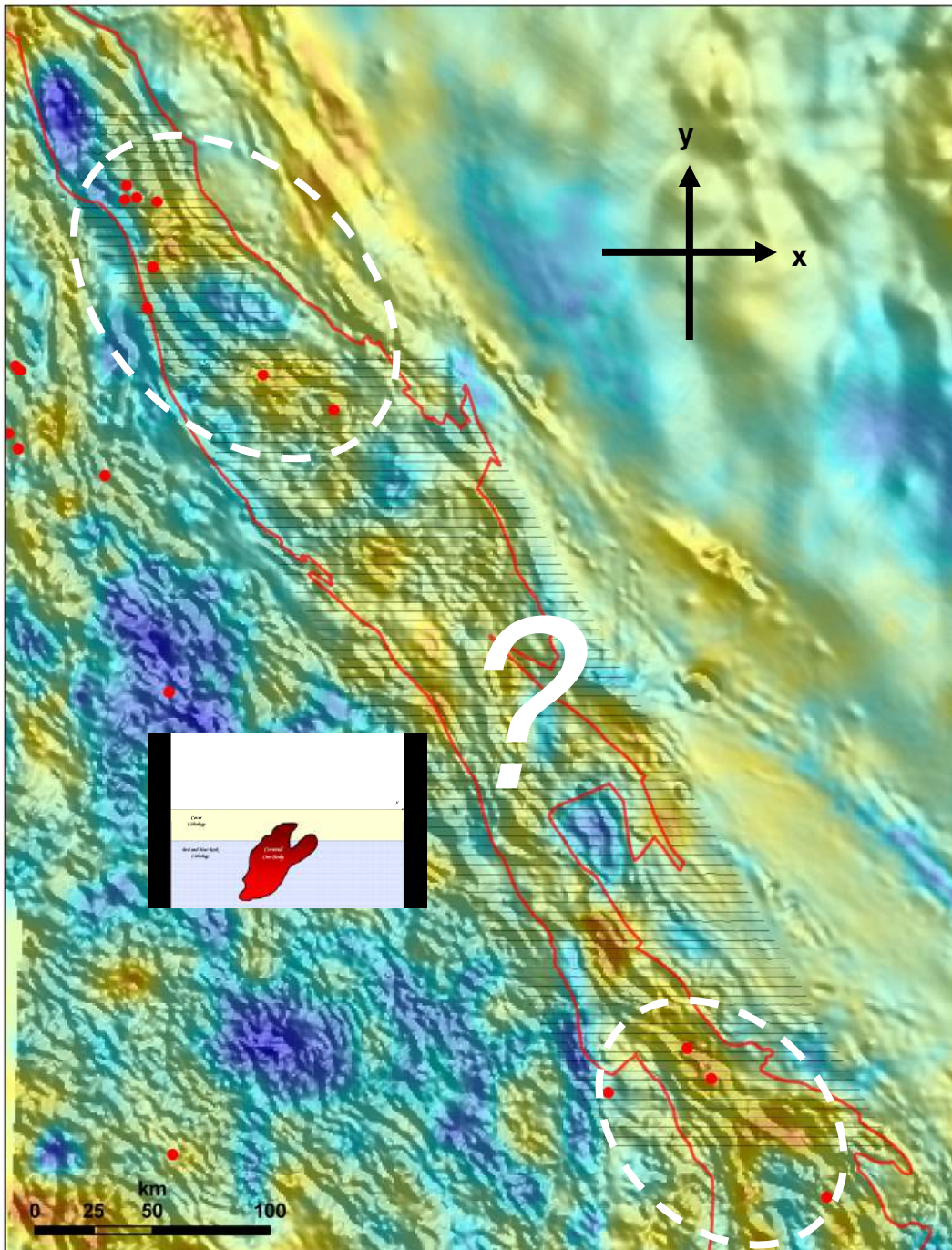
- EW flight lines;
- 4 km line spacing;
- gridding with 800 m cell size.

Remarks

- * Very good spatial resolution along profiles or EW flight lines (X);
- * Very good depth penetration (Z) and spatial resolution along the EM sounding response;
- * Just be careful when extrapolating across flight lines (Y).

Flight Lines (Belt Scale)

Geoscience BC - Quest Project
(www.geosciencebc.com)



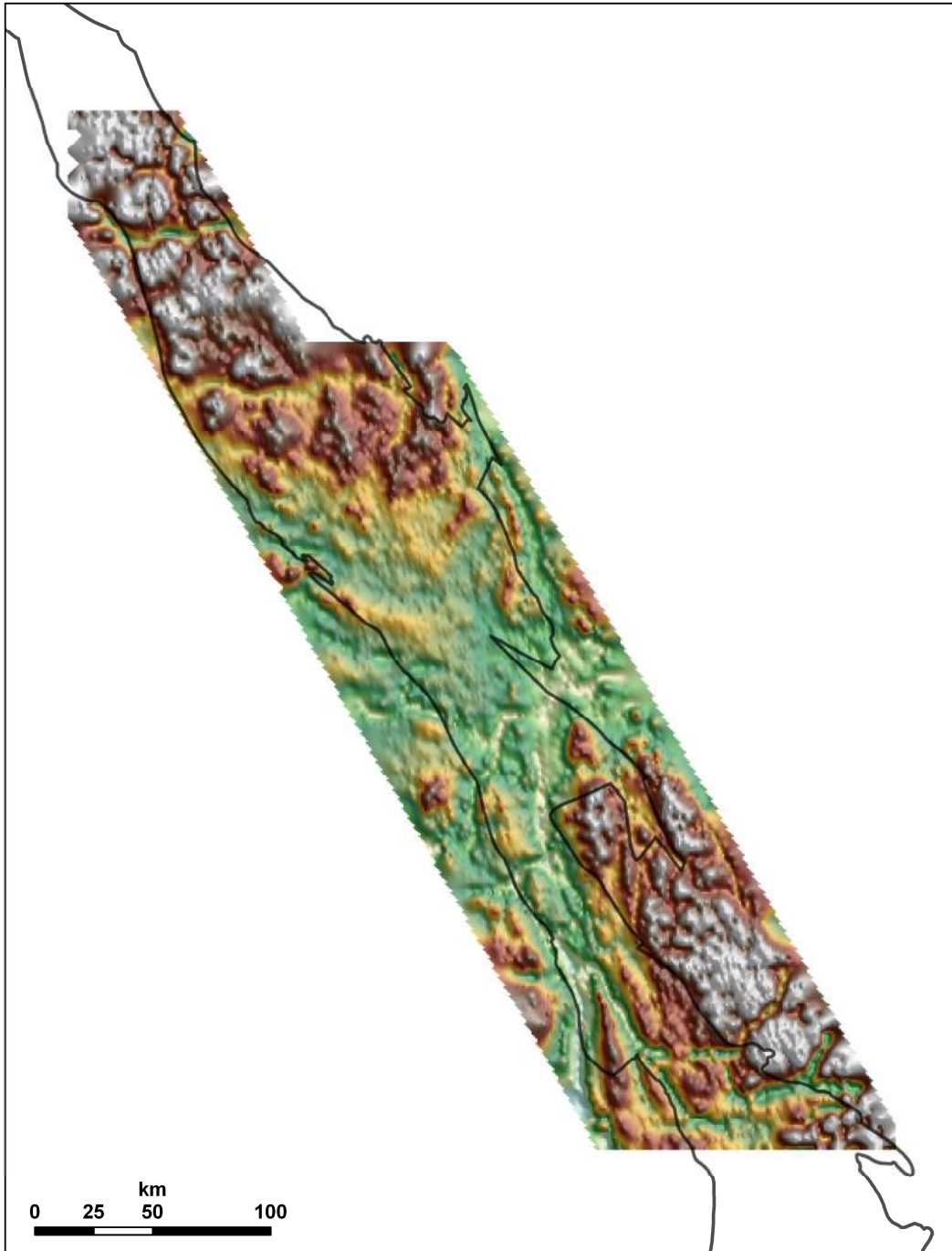
Airborne Geophysical VTEM Survey in the Quesnel Terrane

Remarks

- The DEM grid does not improve the resolution of the already existing TRIM data in the Province.

Extracted Information: Digital Elevation Model

Geoscience BC - Quest Project
(www.geosciencebc.com)



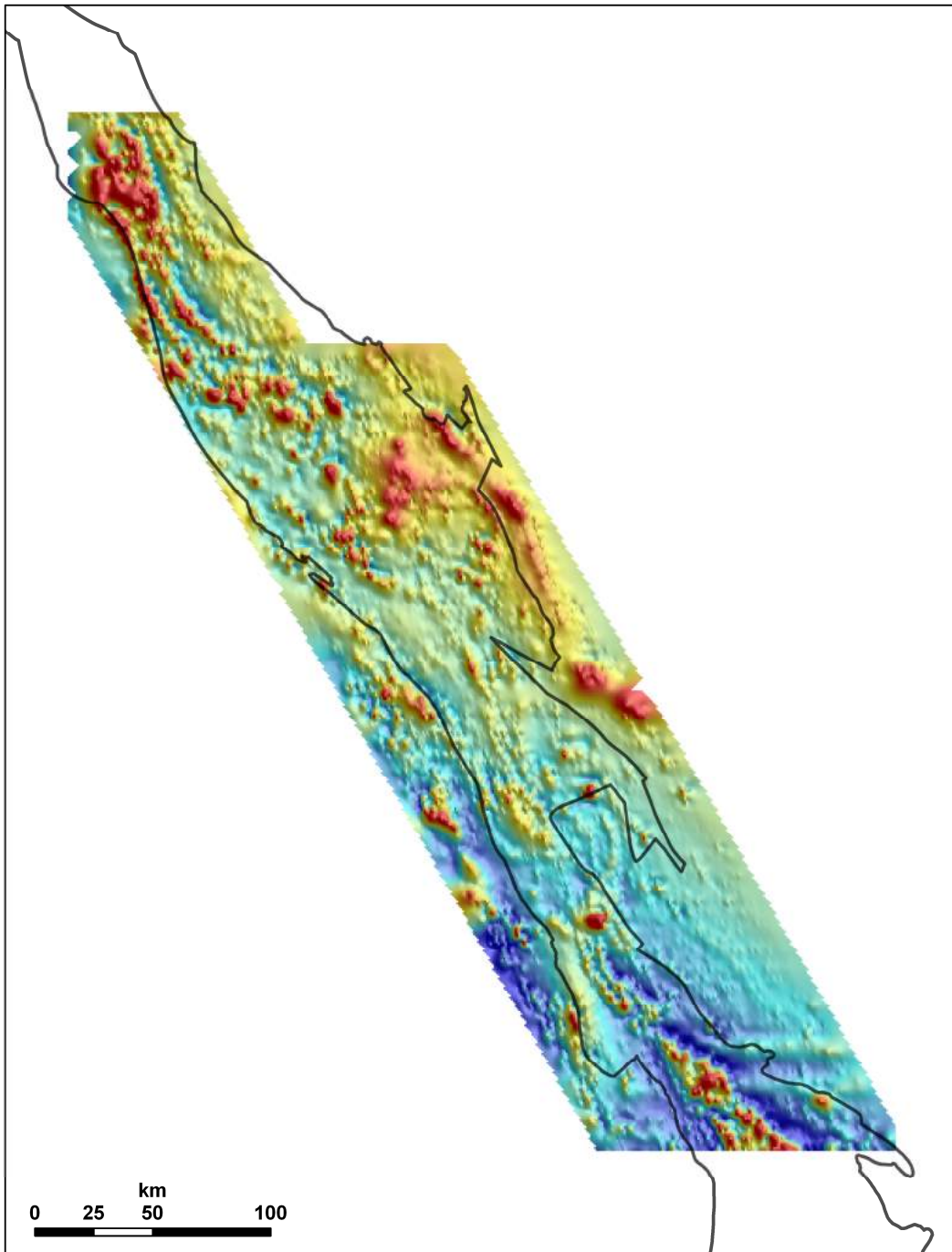
Airborne Geophysical VTEM Survey in the Quesnel Terrane

Remarks

- The information of the magnetic gridded data (line spacing: 4km; cell size 800m) does not improve the existing magnetic grid (line spacing: 800m; cell size 200m) as provided by the Geological Survey of Canada.

Extracted Information: **Total Magnetic Field Intensity**

Geoscience BC - Quest Project
(www.geosciencebc.com)



Airborne Geophysical VTEM Survey in the Quesnel Terrane

Question

So, what is the advantage of flying VTEM?

Answer

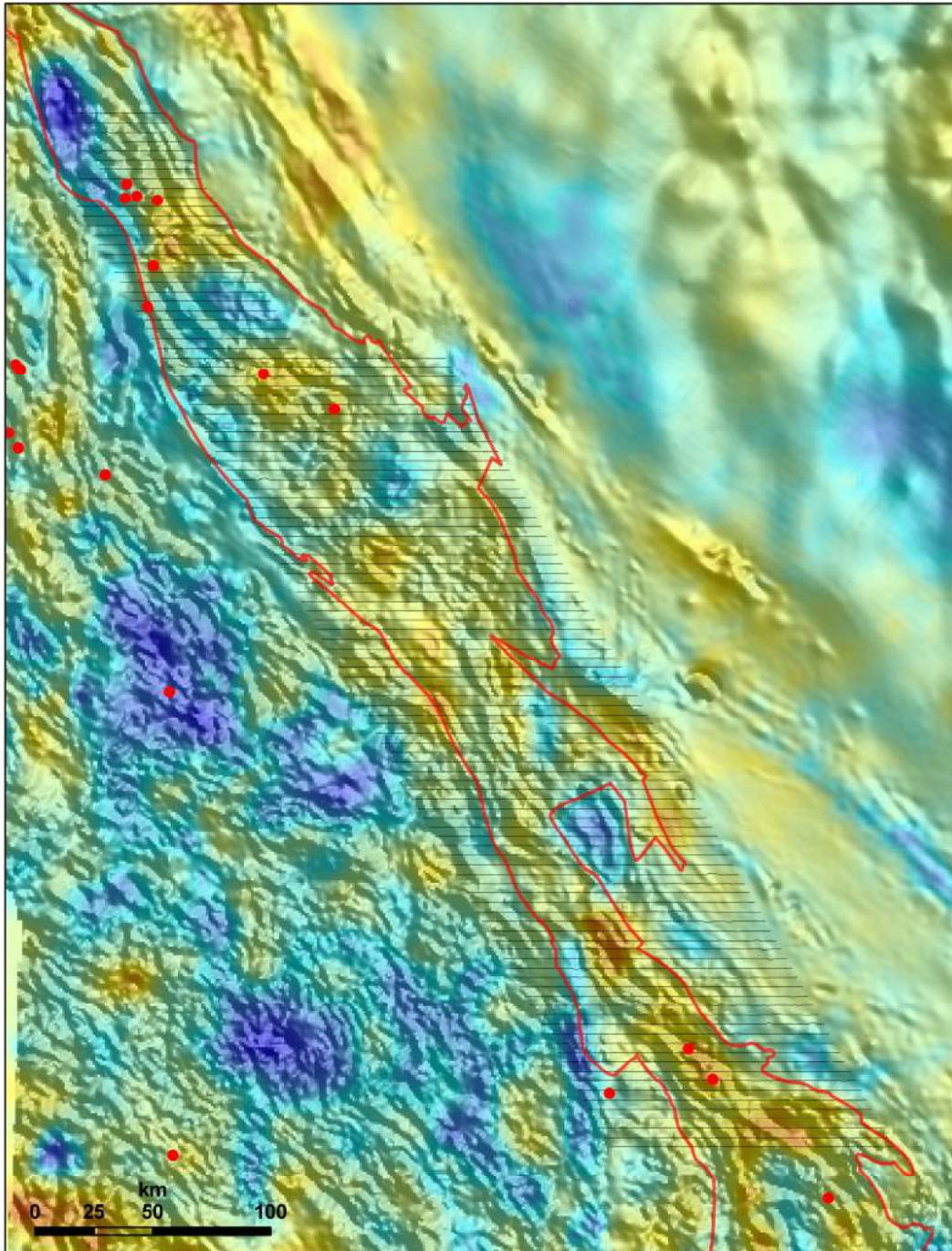
New geophysical information along profiles.

EM responses are associated with conductivity distributions in the underground.

Those conductivity (or resistivity) distributions might be associated with mineralization in the underground or with other geological sources, such as sedimentary covers.

Flight Lines (Belt Scale)

Geoscience BC - Quest Project
(www.geosciencebc.com)



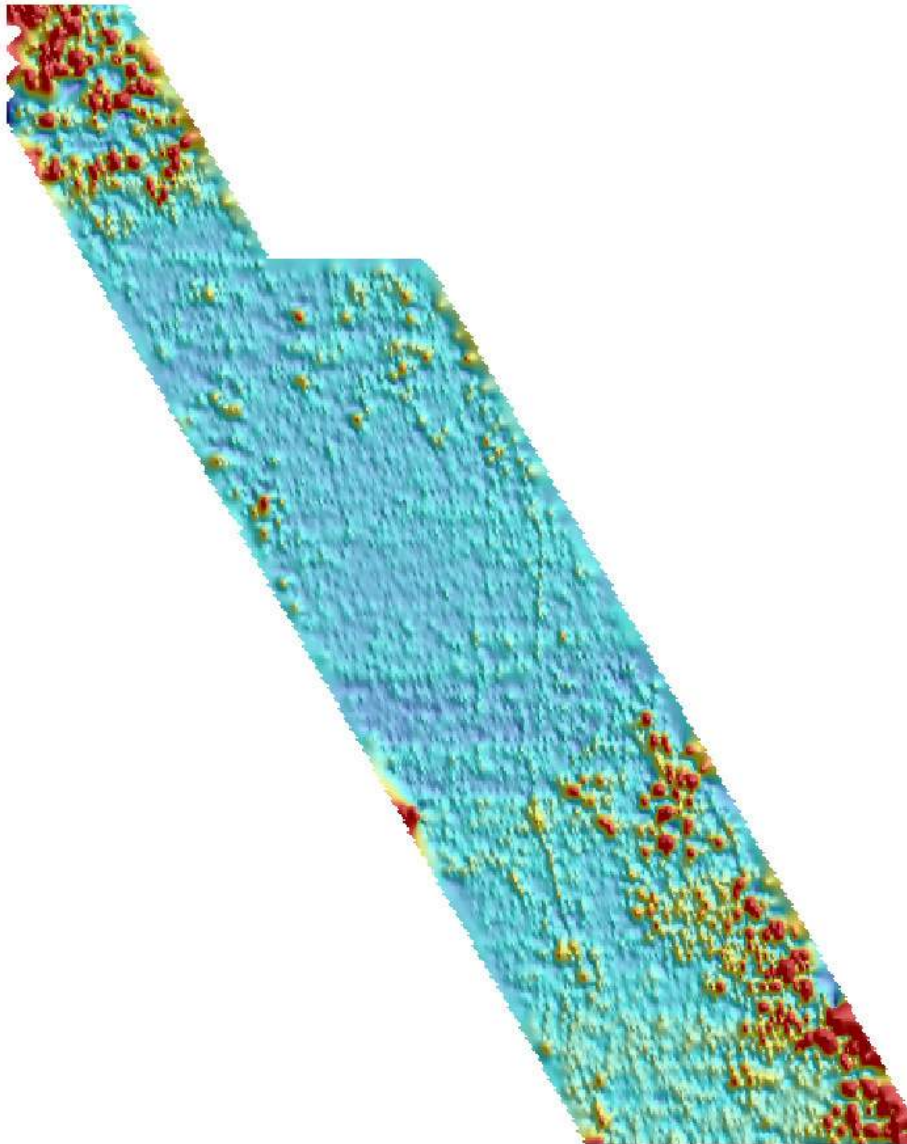
Airborne Geophysical VTEM Survey in the Quesnel Terrane

Remarks

- Electromagnetic amplitude responses depend (1) on the **conductivity** of the geological source, but also (2) on the **distance** from the source to the geophysical instrument.
- This distance might be the depth of the body below surface or the flying altitude of the EM receiver.
- Therefore, areas with high clearance values (red spots) need to be considered carefully because of these topographic effects on the EM responses.

Extracted Information: **Clearance to Ground**

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0 25 50 100
Kilometers

Airborne Geophysical VTEM Survey in the Quesnel Terrane

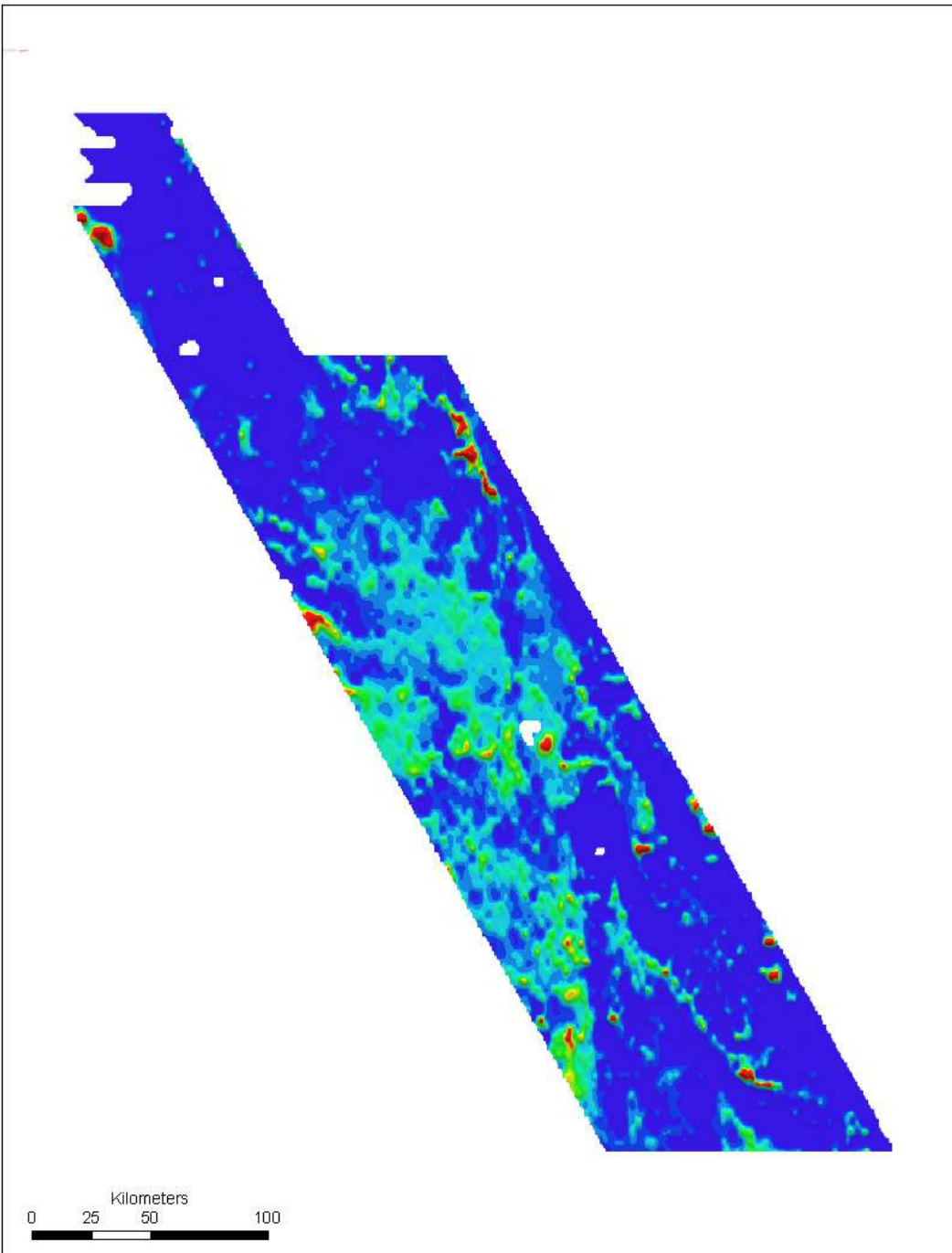
Remarks

- A survey with 4km line spacing means gridding with 800m cell size.
- So, by gridding, resolution along profiles is lost, but a regional overview of the data can be achieved.

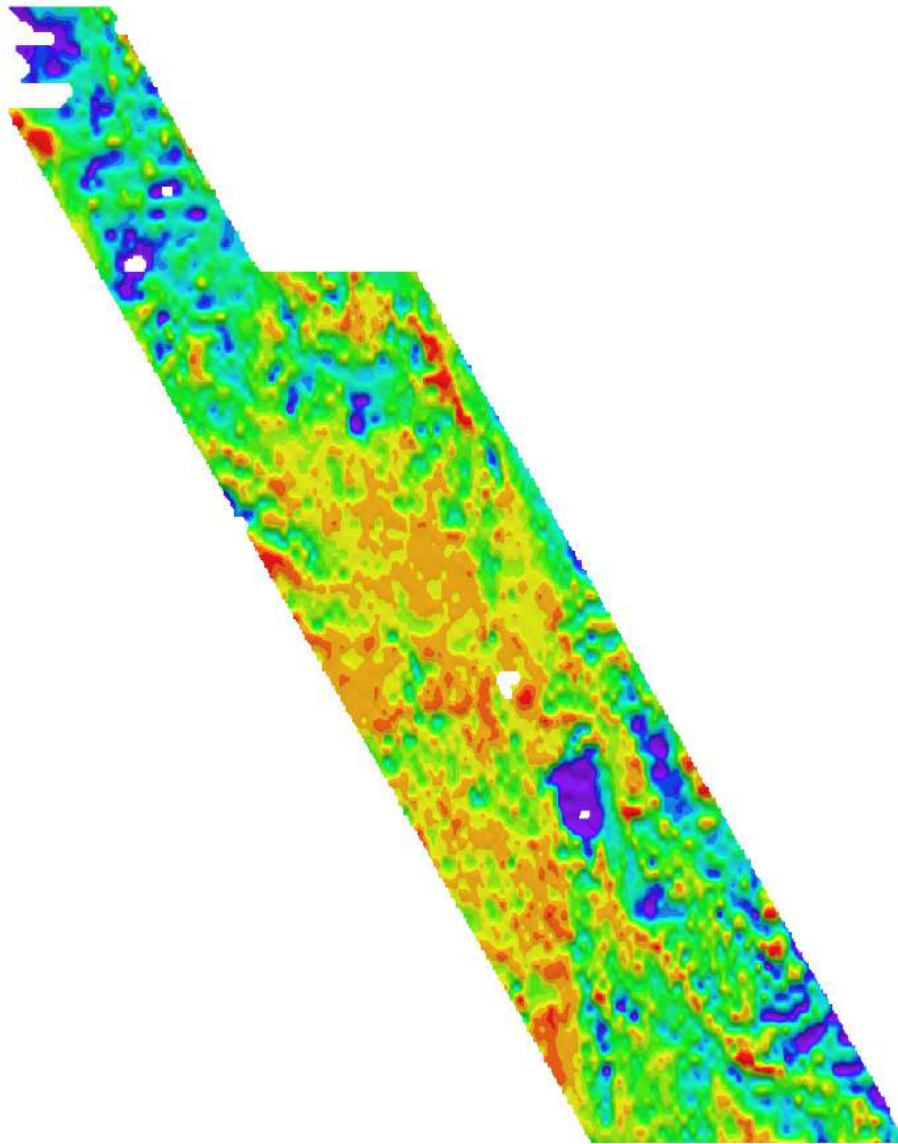
Extracted Information:

Amplitude of 682ms channel

Geoscience BC - Quest Project
(www.geosciencebc.com)



Airborne Geophysical VTEM Survey in the Quesnel Terrane



Remarks

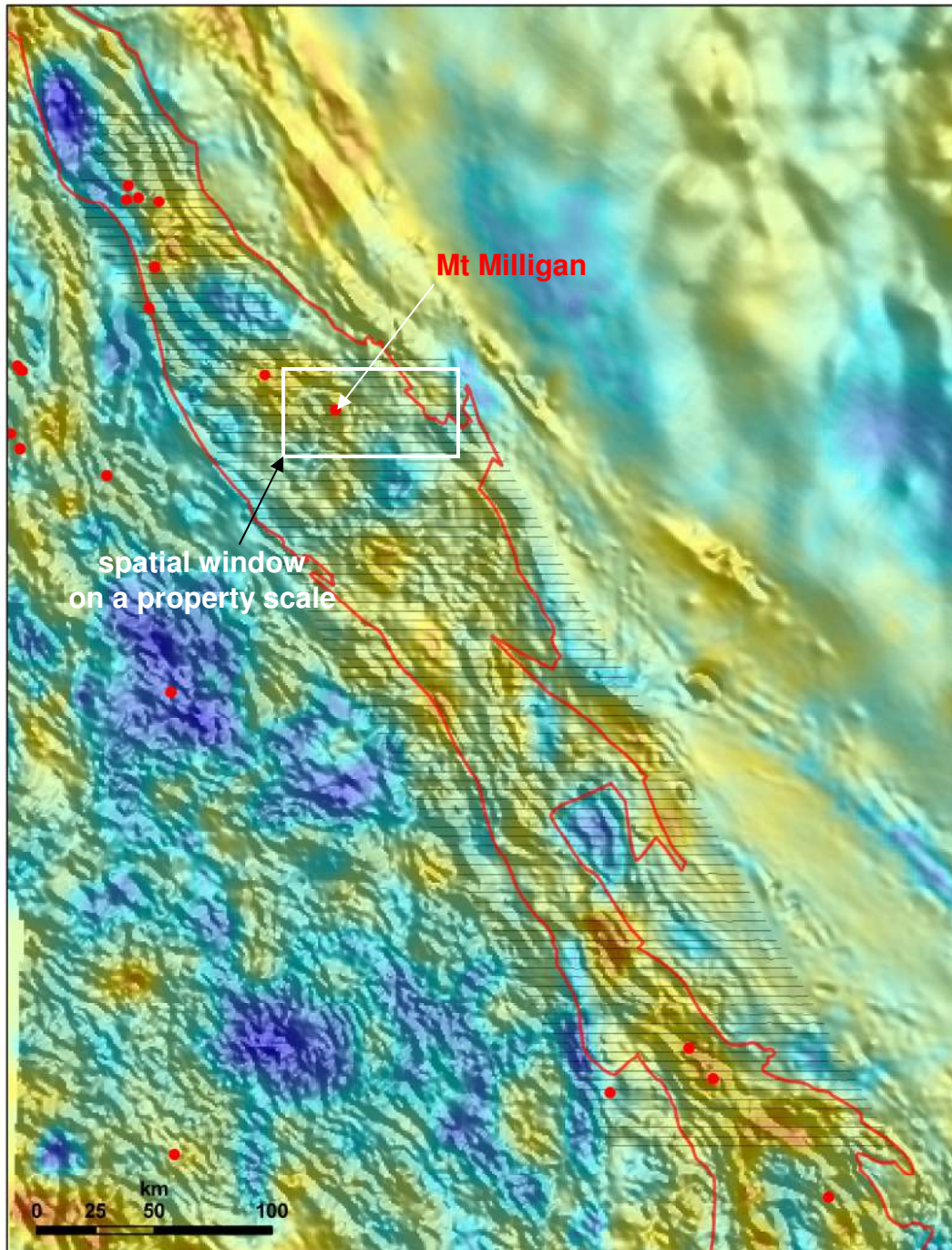
- A survey with 4km line spacing means gridding with 800m cell size.
- So, by gridding, resolution along profiles is lost, but a regional overview of the data can be achieved.

Extracted Information:

Log Amplitude of 682ms channel

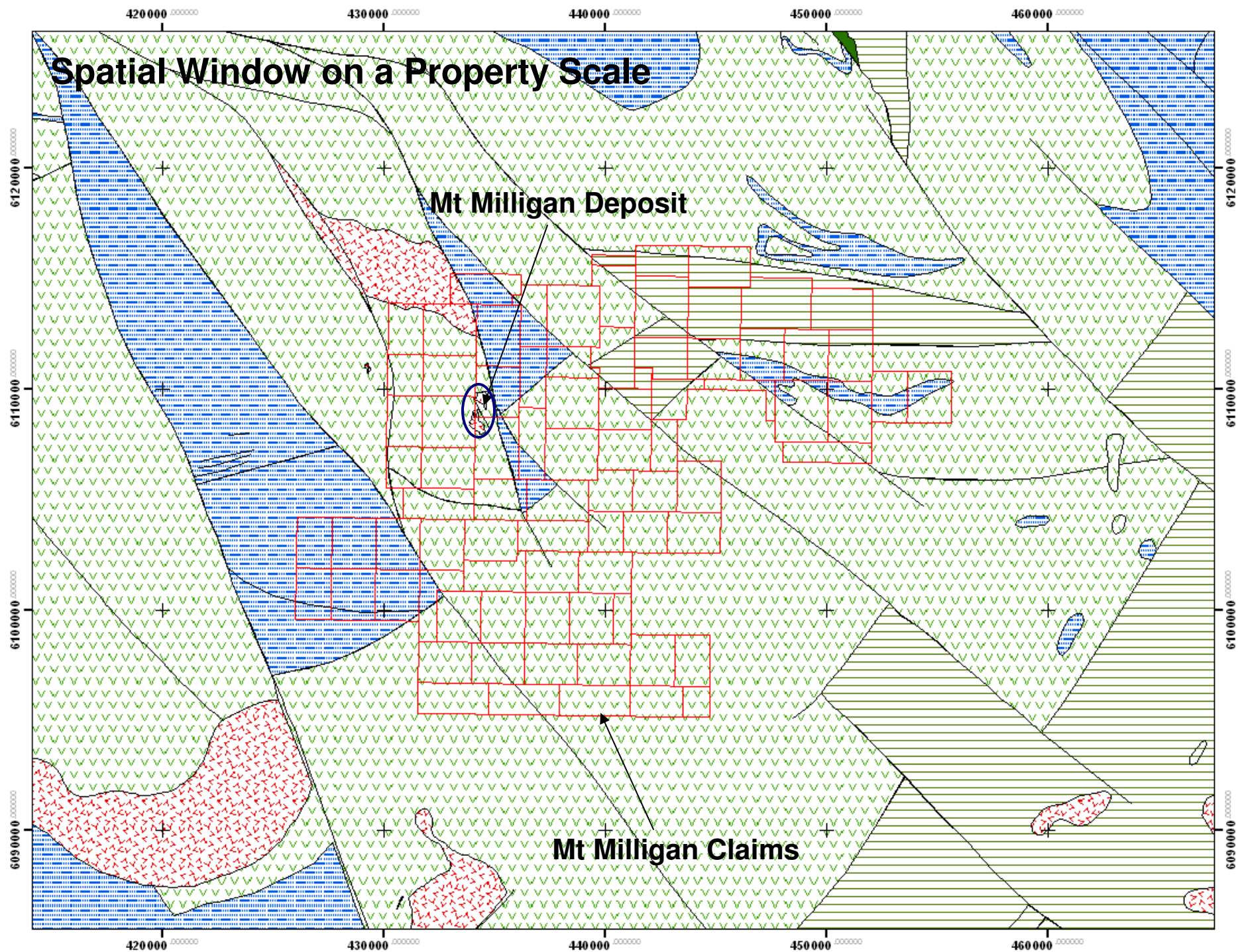
Geoscience BC - Quest Project
(www.geosciencebc.com)

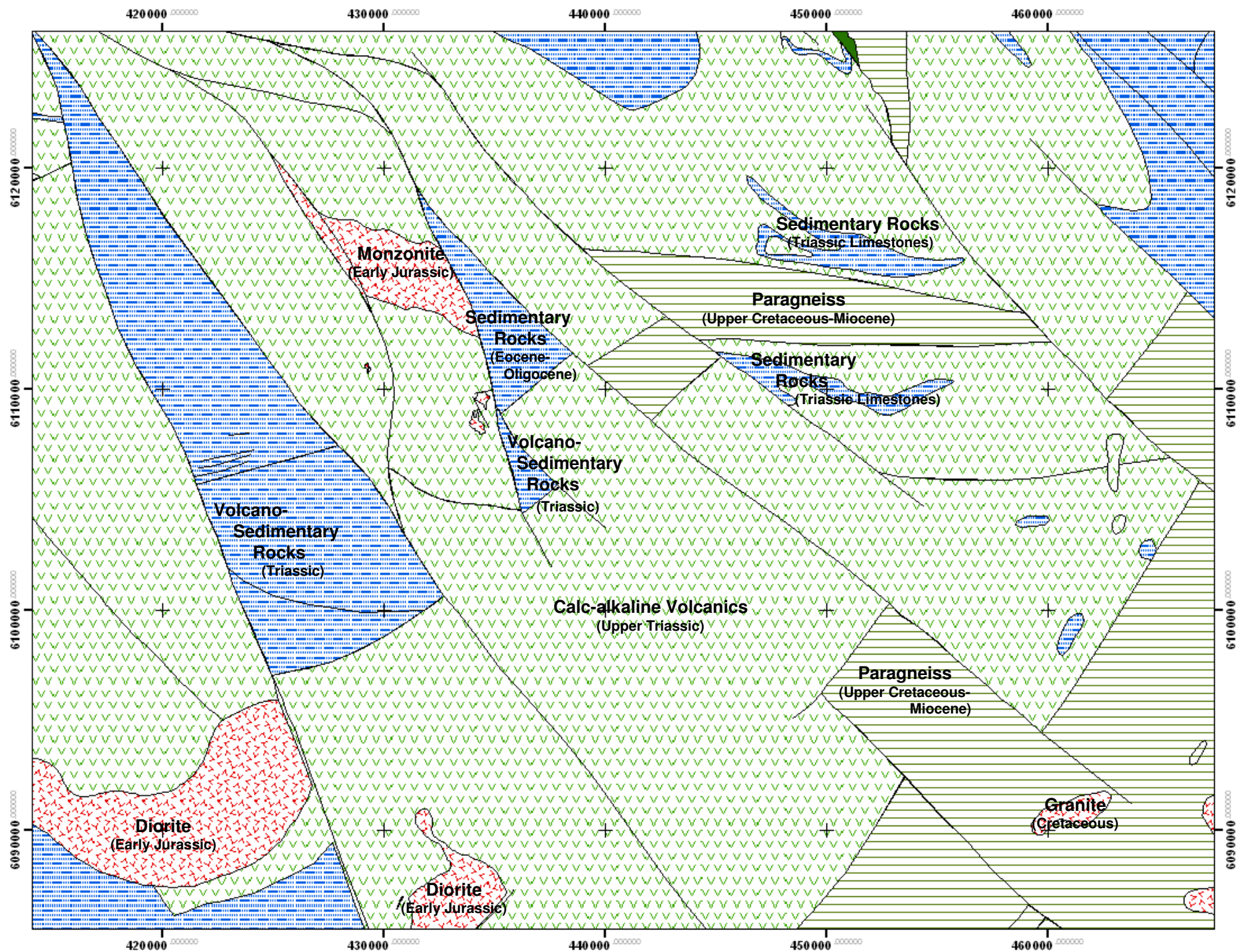
VTEM Response of Mt Milligan

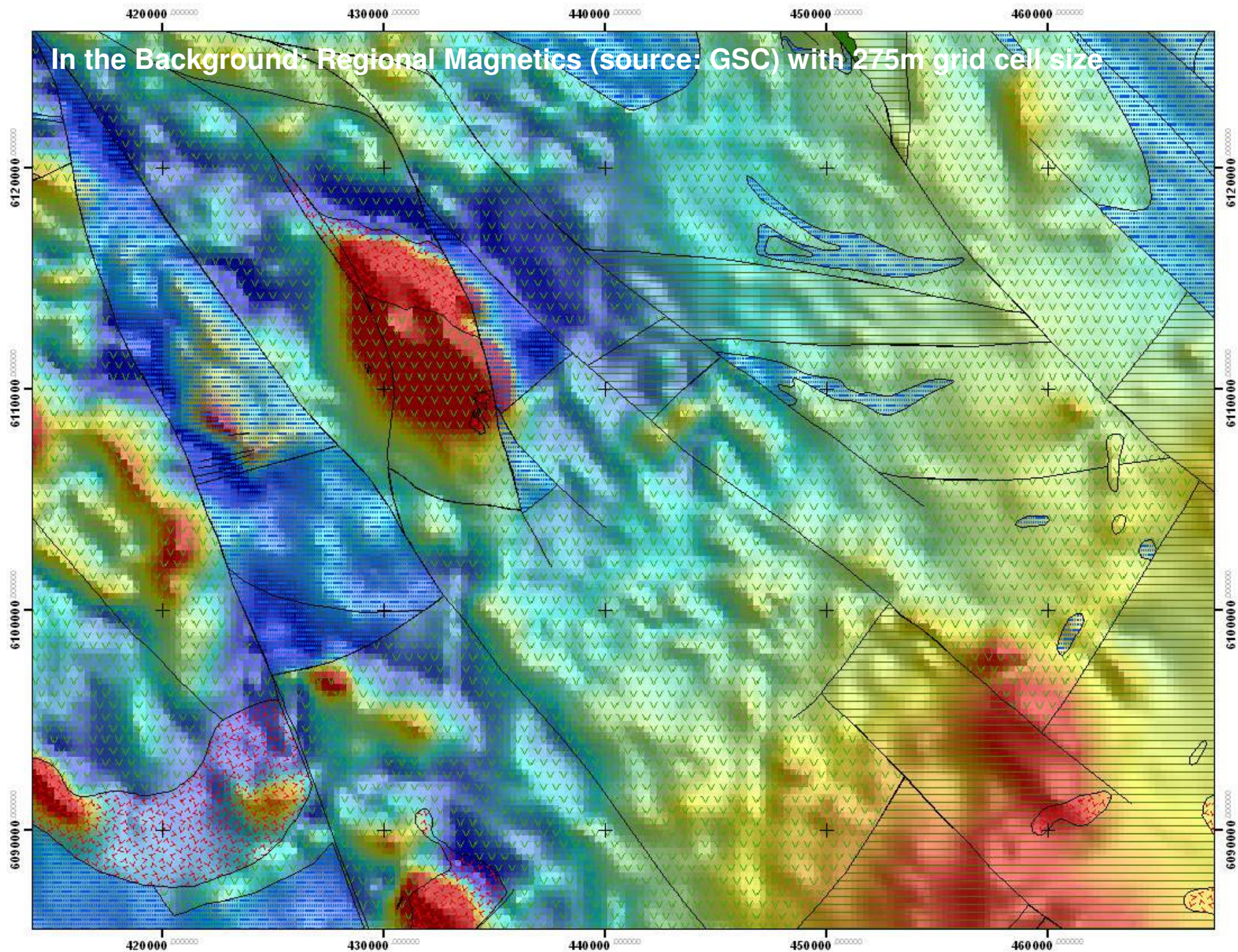


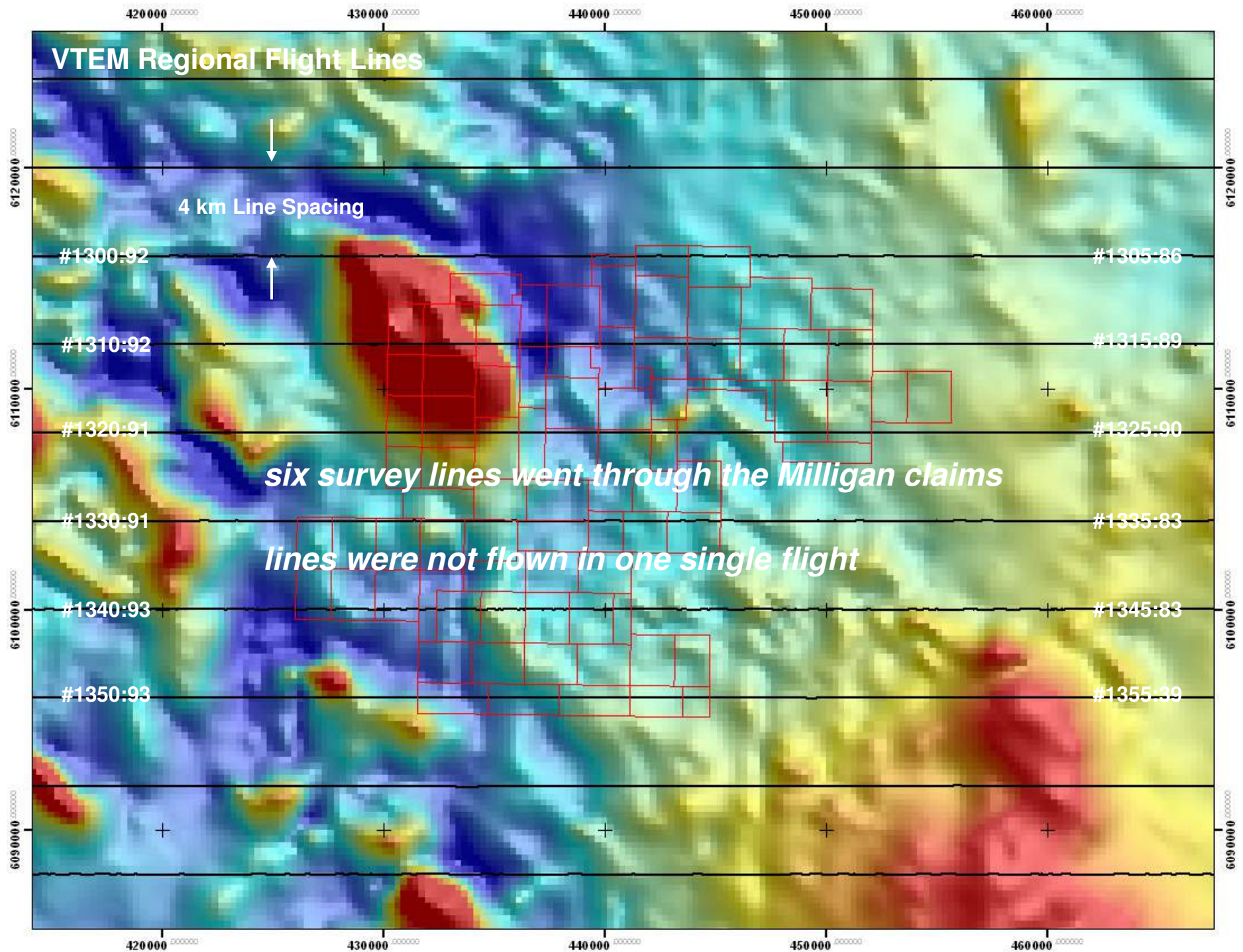
**Flight Lines
(Belt Scale)**

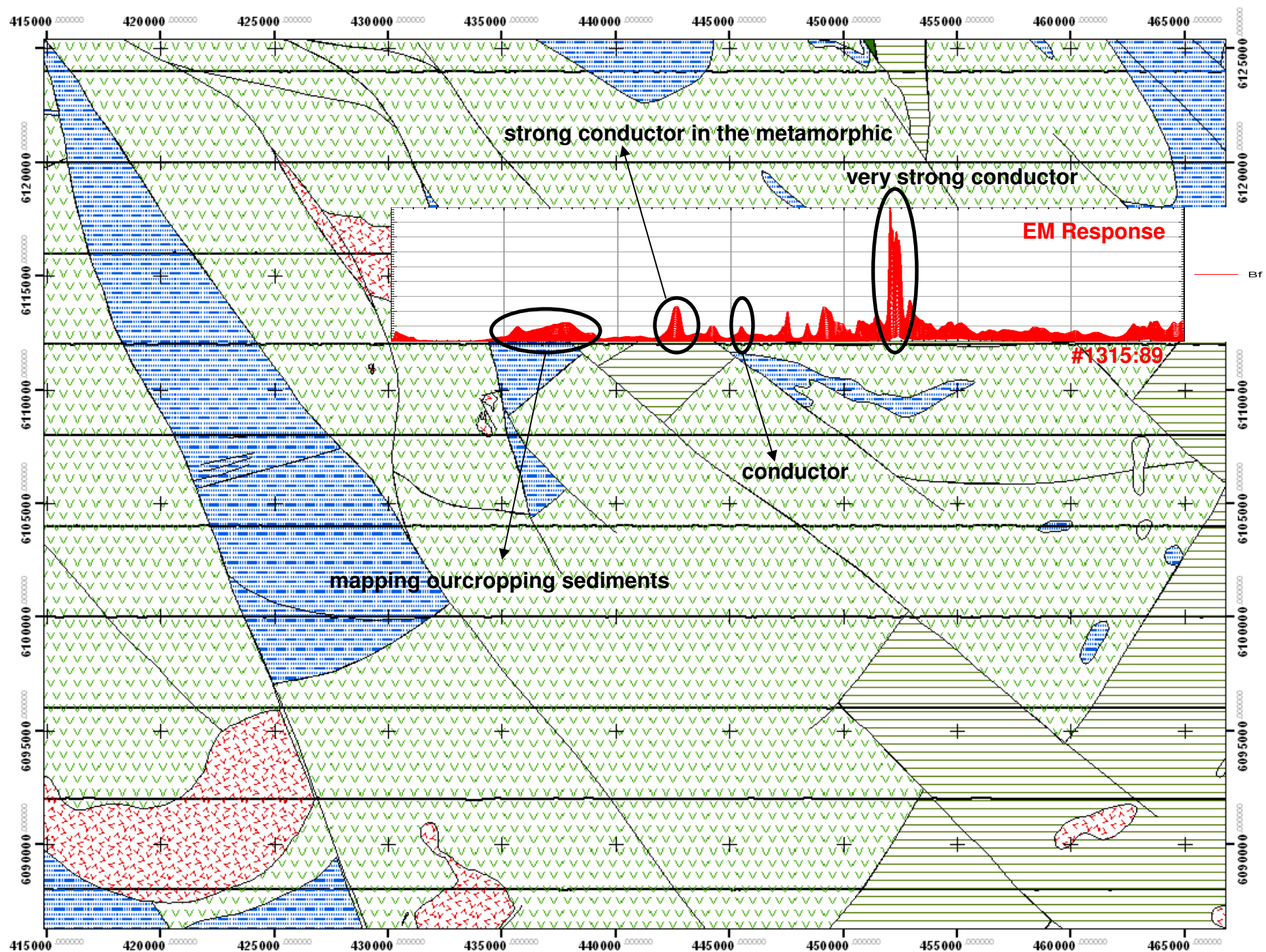
Geoscience BC - Quest Project
(www.geosciencebc.com)

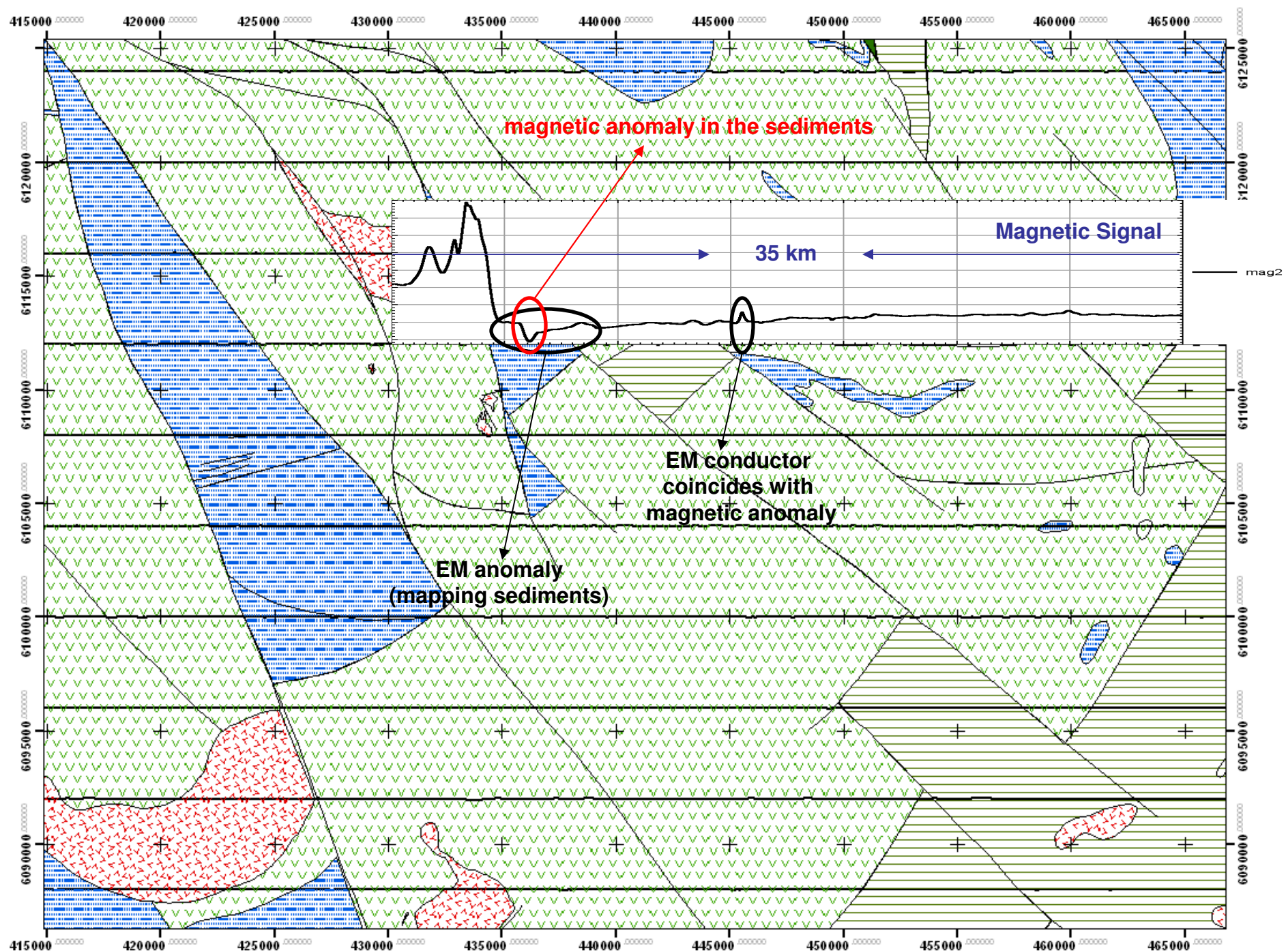


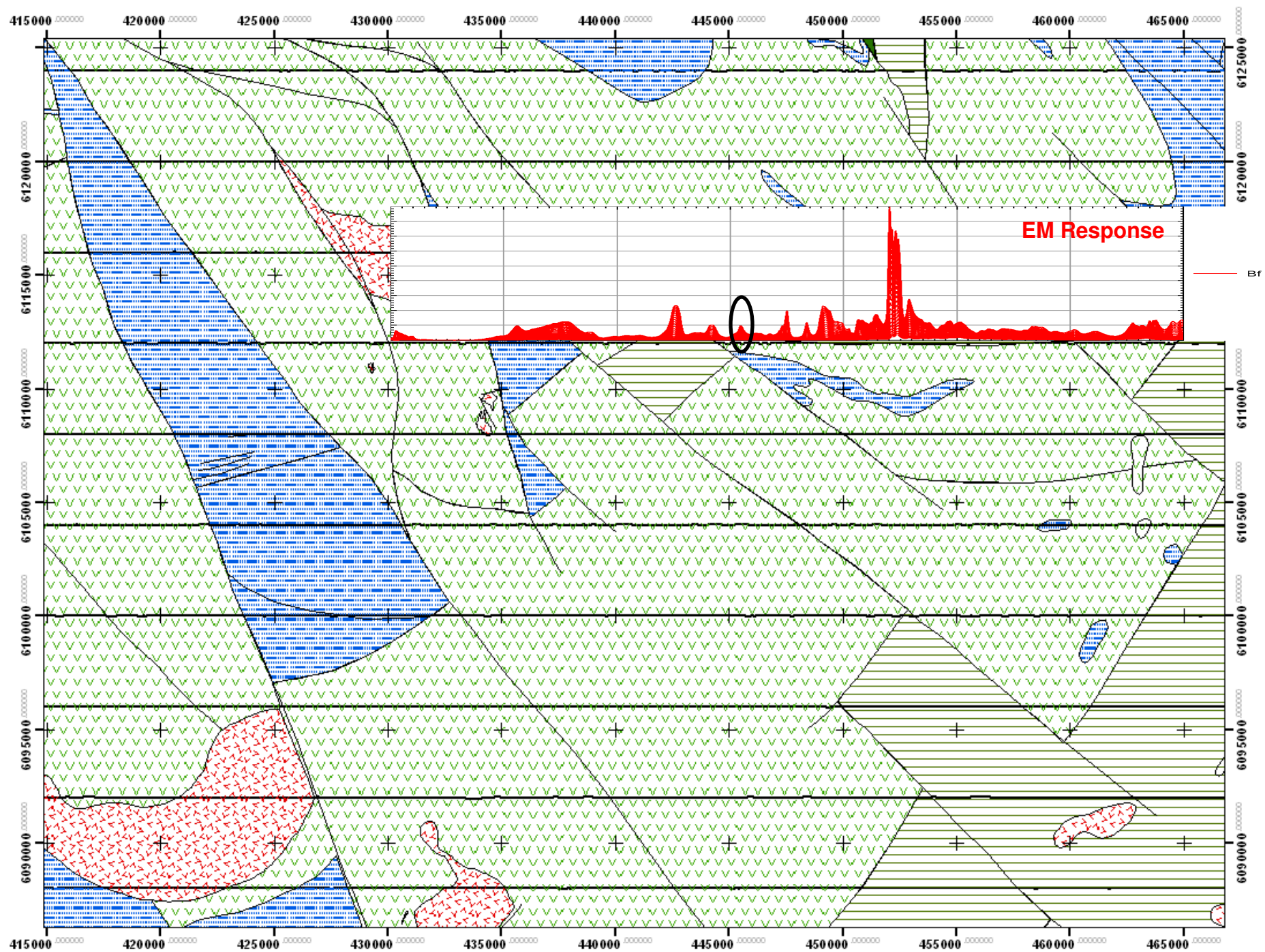












What are EM amplitudes telling us?

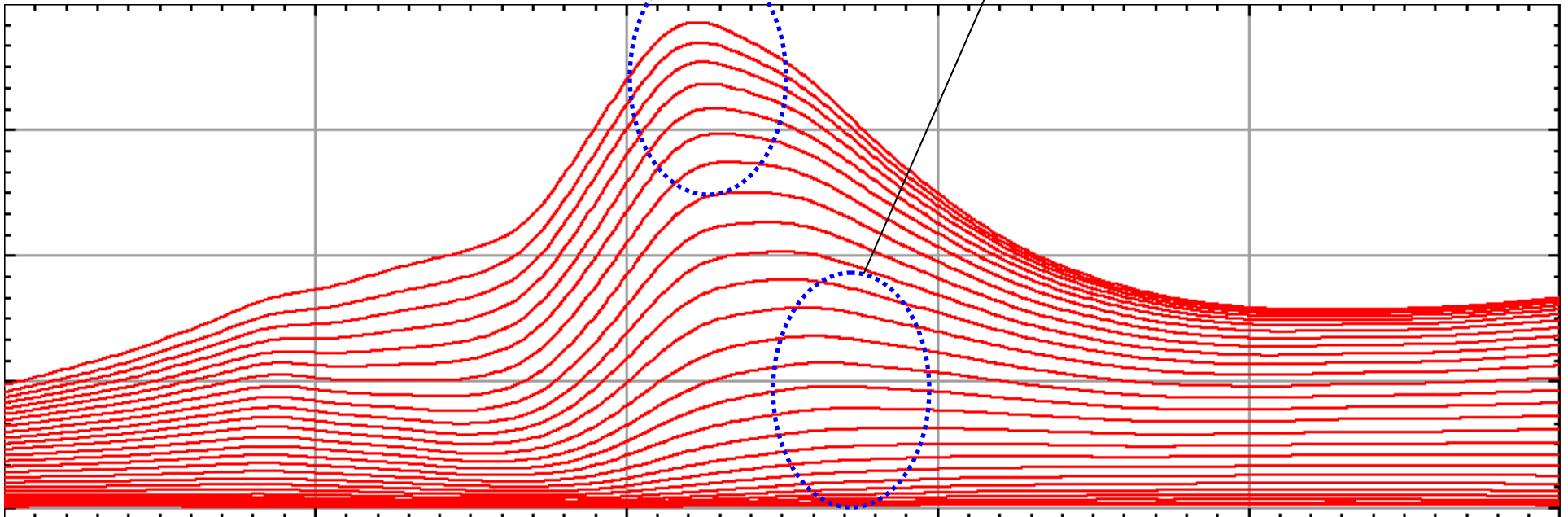
200 m

Early Channels

Mapping shallow geological sources

Late Channels

Mapping deeper geological sources



But, what are **changes of amplitudes in time** telling us?

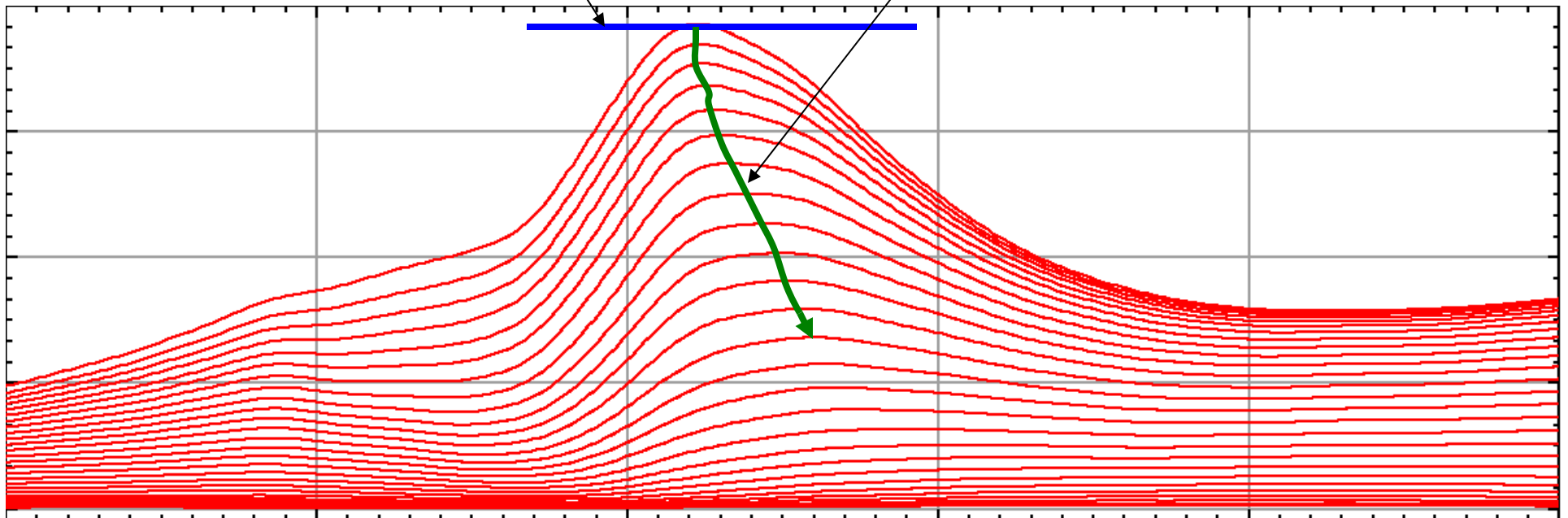
200 m

Amplitude 'A'

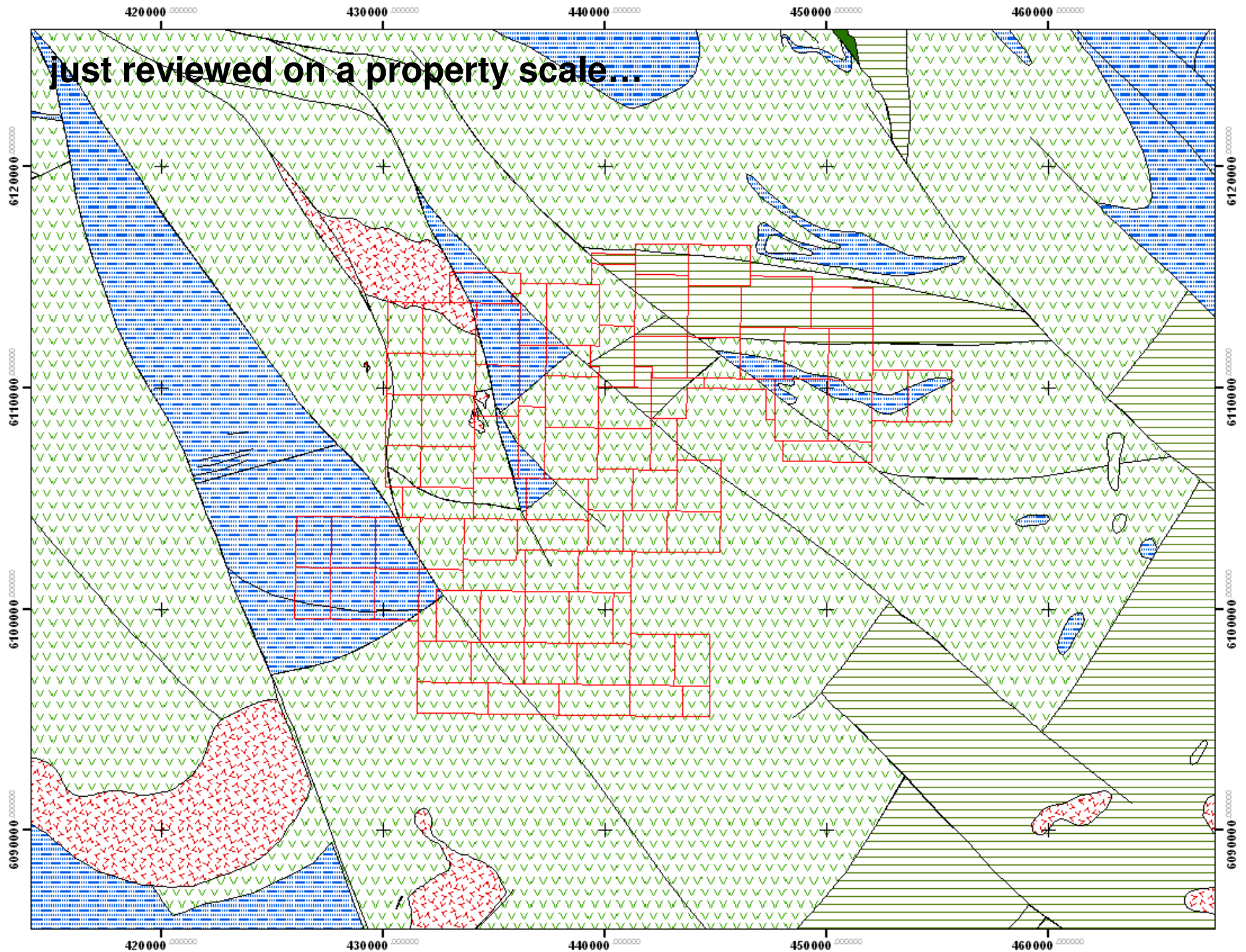
Depends on the **conductivity** of the geological source and on the **distance** from this source to the EM receiver (depth of source below surface, flying altitude of instrument)

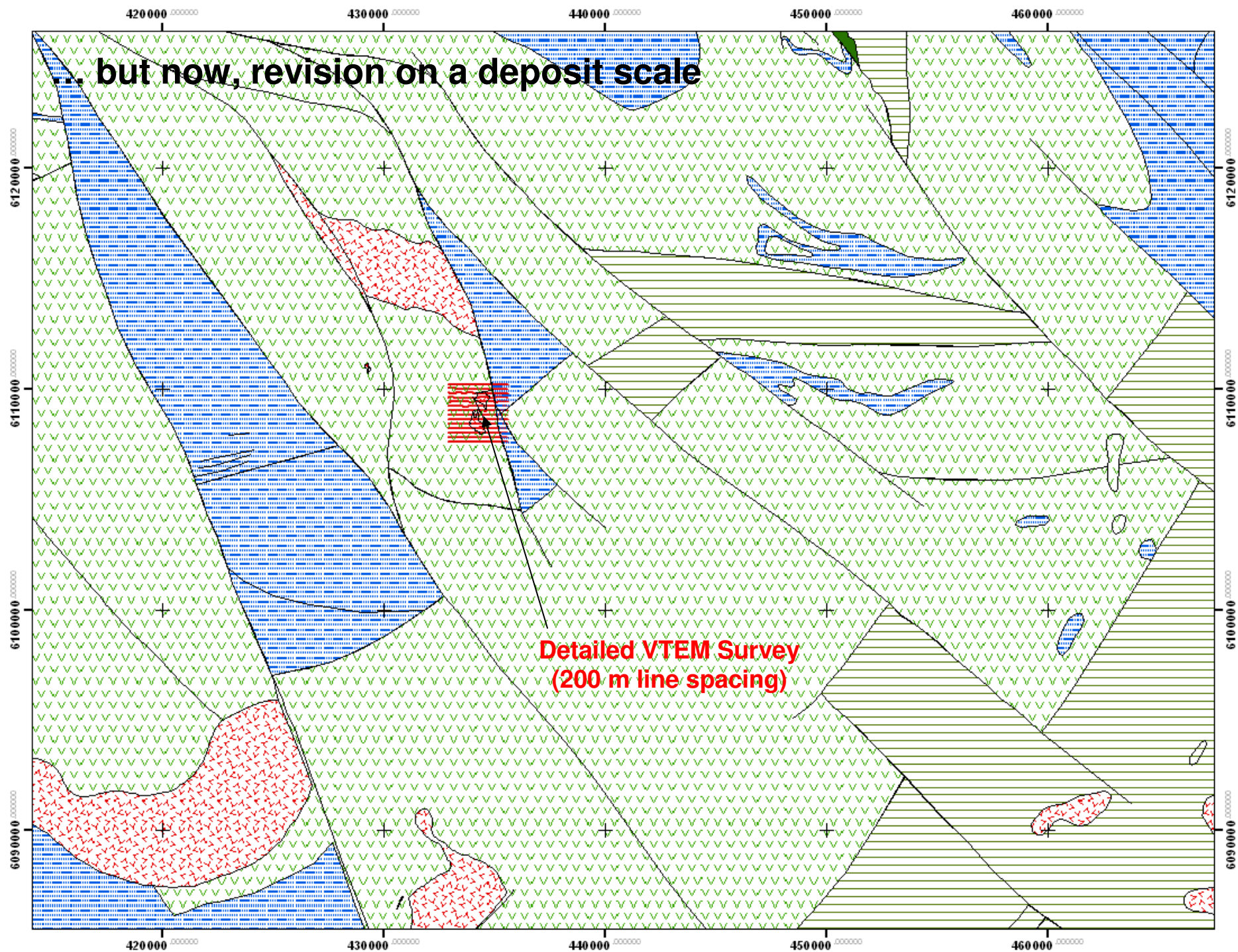
Time Decay 'tau' (dA/dt)

Depends **only on conductivity** of the geological source in depth

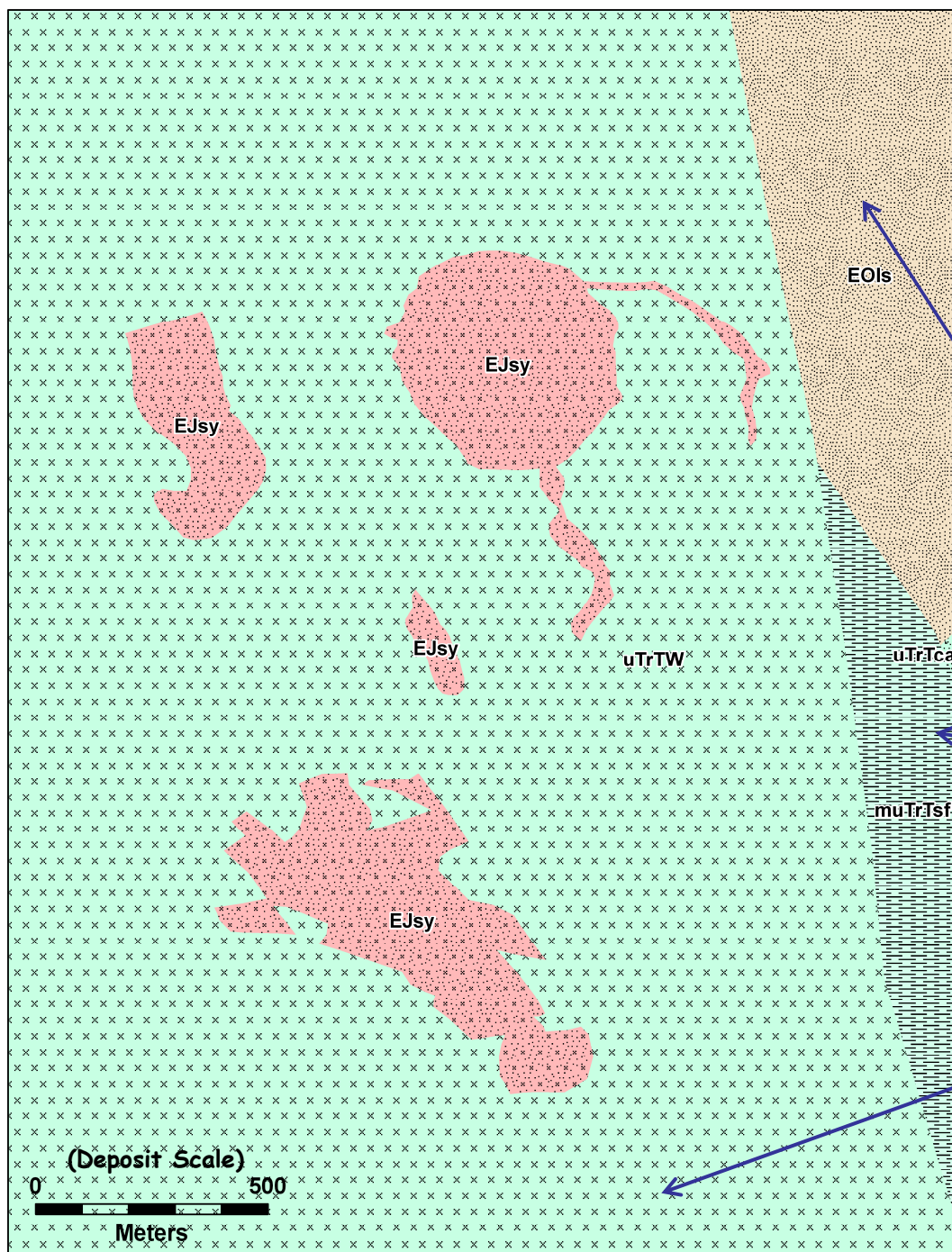


just reviewed on a property scale...





Geology of the "Milligan Cu/Au Porphyry" Detailed Regional Lithology



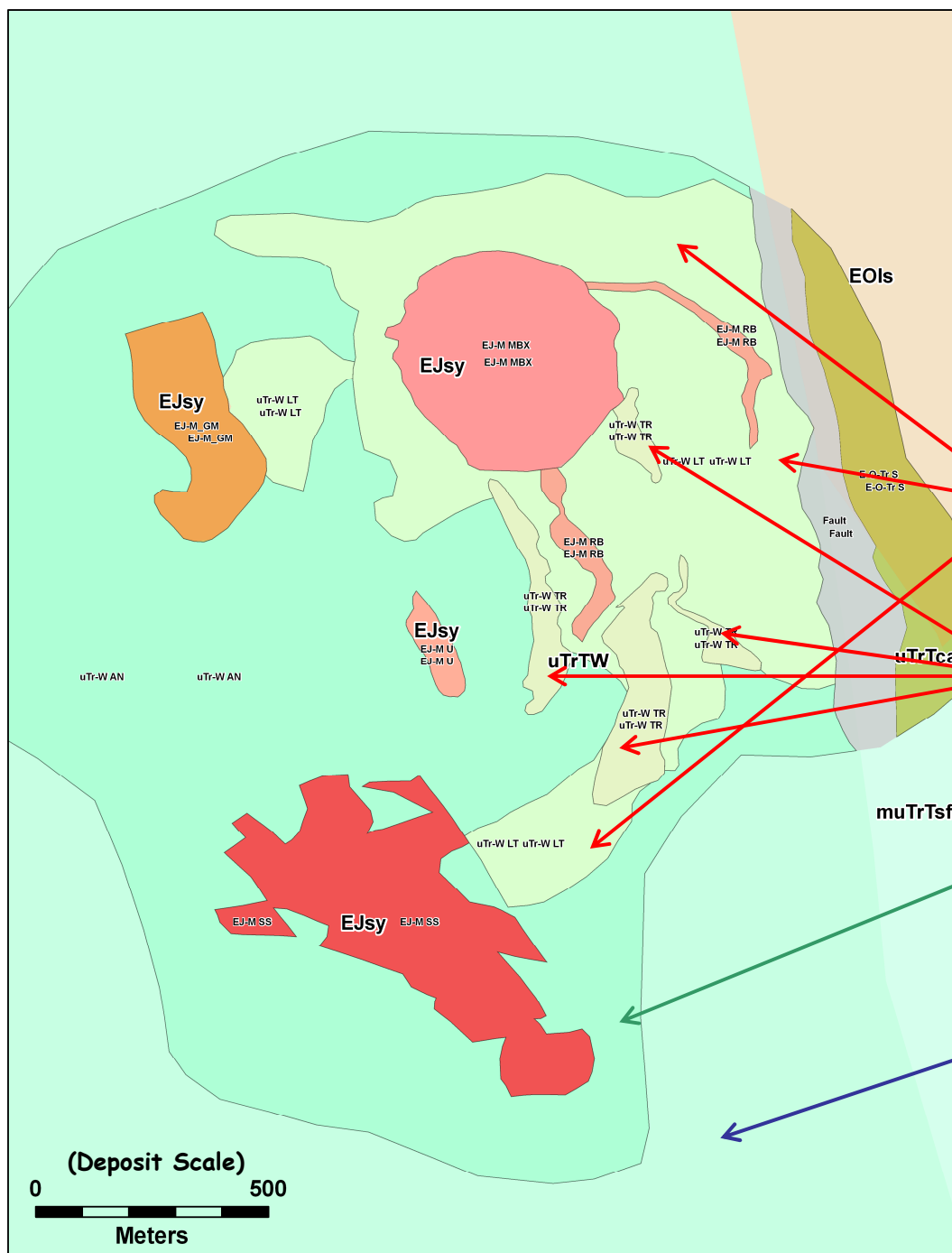
Nechako Plateau
Sediments
(Eocene/Oligocene)

Clastics ...

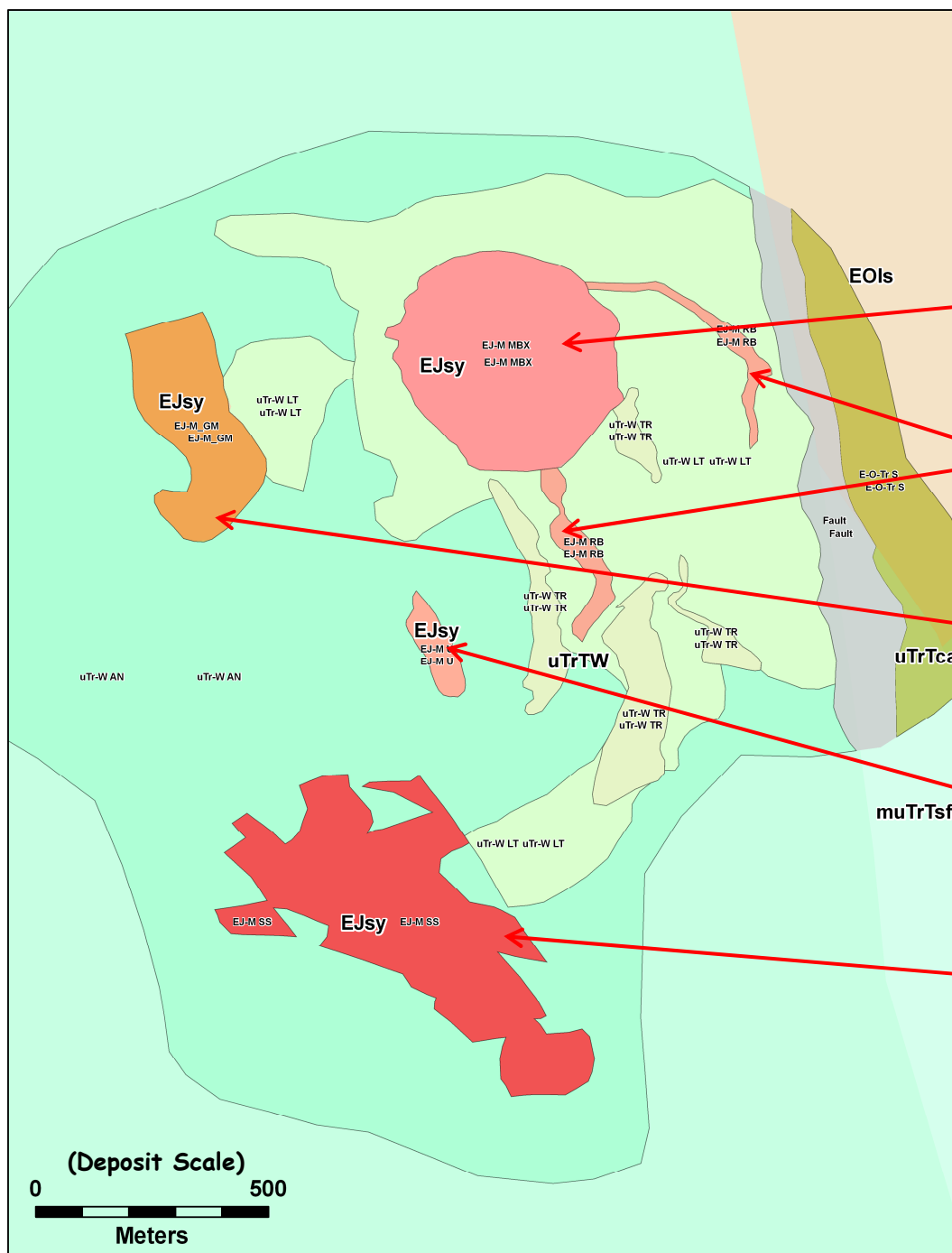
of the Takla Group
(Middle to Upper Triassic)

Volcanoclastics ...

Geology of the "Milligan Cu/Au Porphyry" Detailed Calc-alkalic and Alkalic Volcanics *(Upper Triassic)*



Geology of the "Milligan Cu/Au Porphyry" Detailed Intrusive Centers (Early Jurassic)



MBX Stock

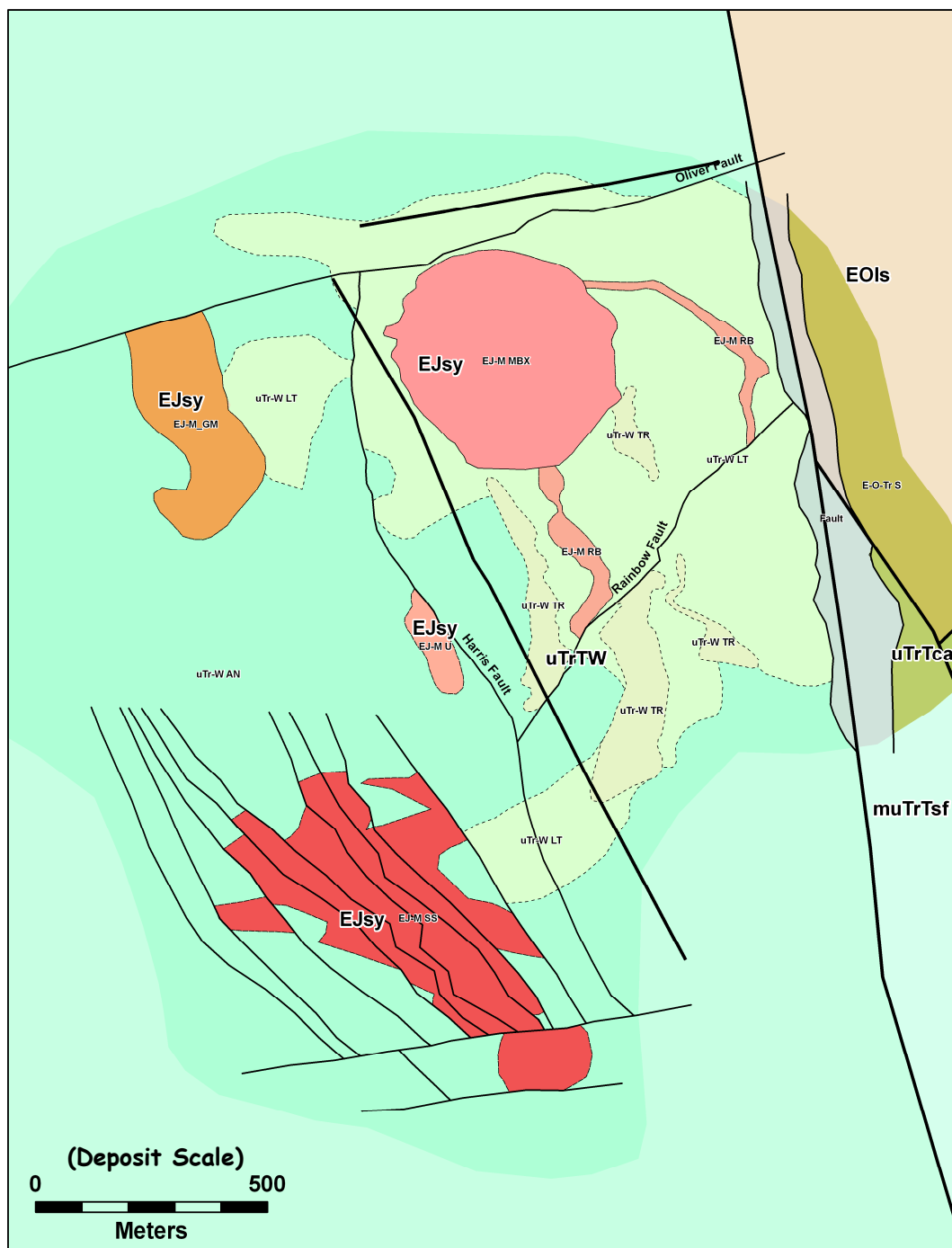
Rainbow Dyke

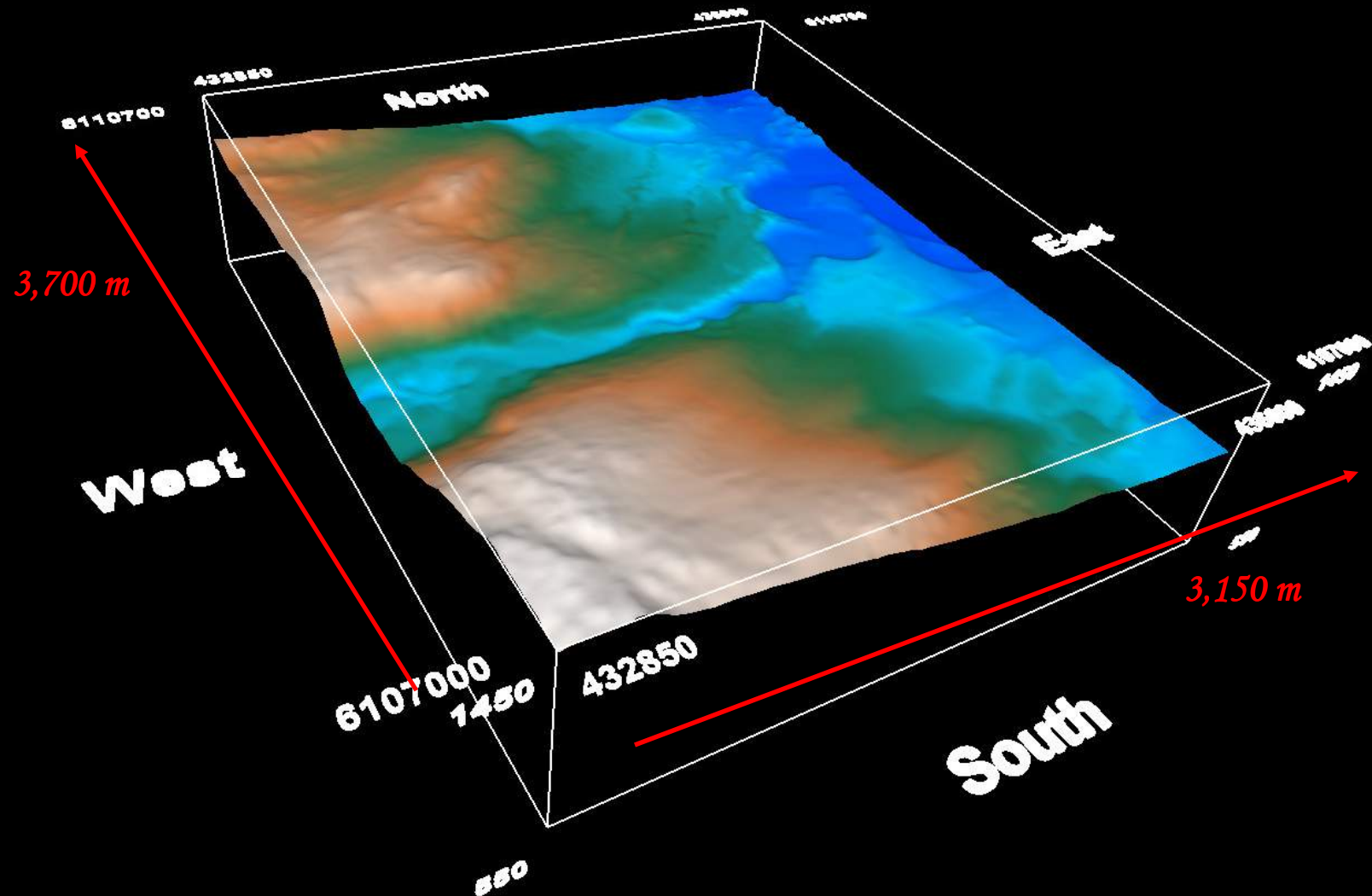
Gold Mark Stock ... being Monzonite
the main petrological
composition

Stock (NN)

Southern Star Stock

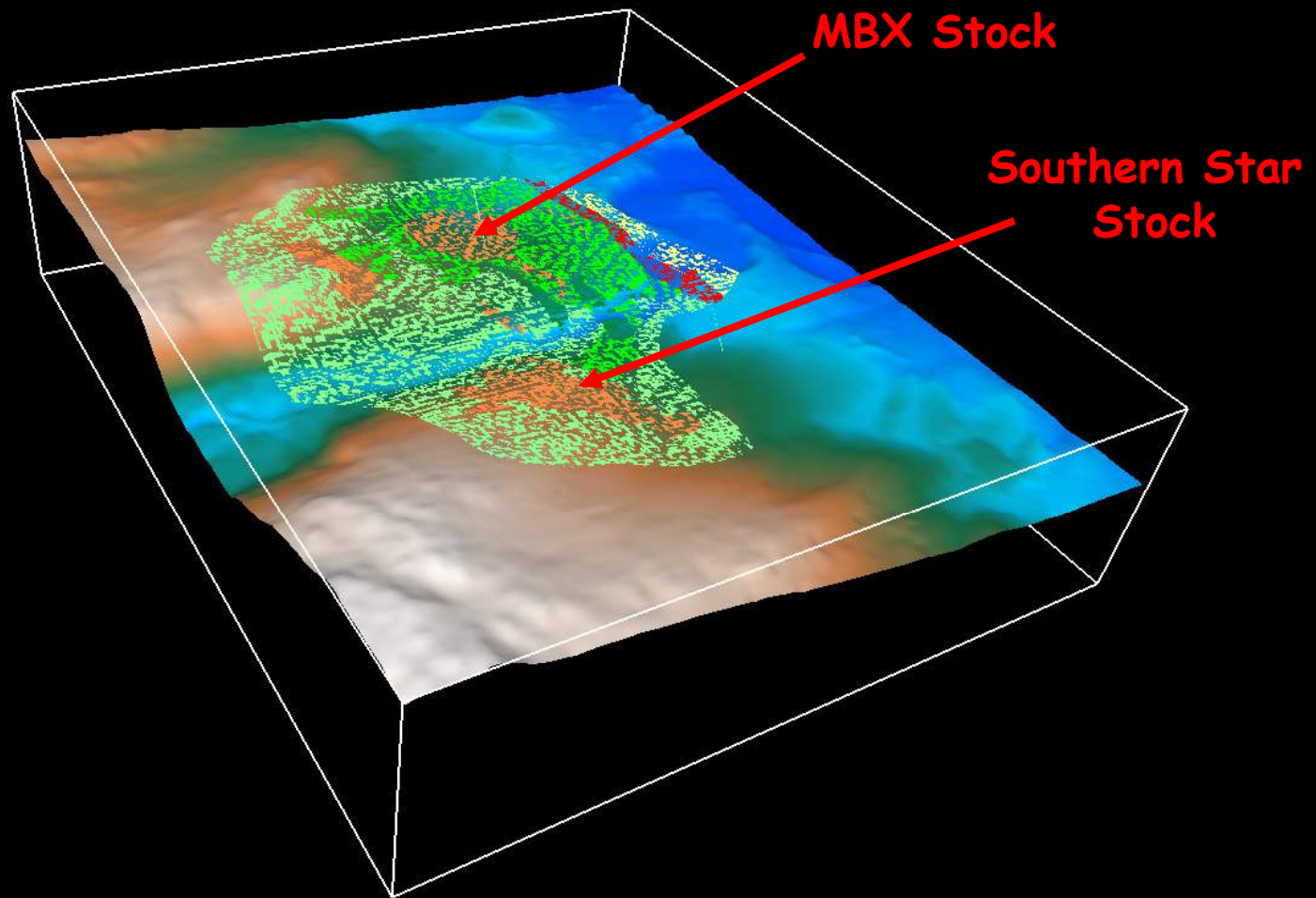
Geology of the "Milligan Cu/Au Porphyry" Detailed Main Structures



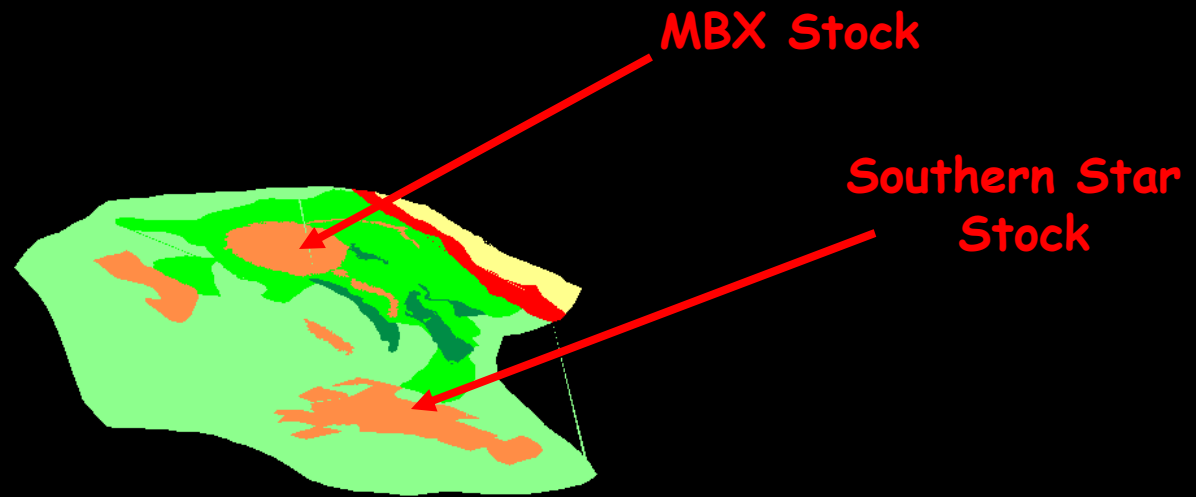


Digital Elevation Model (DEM)

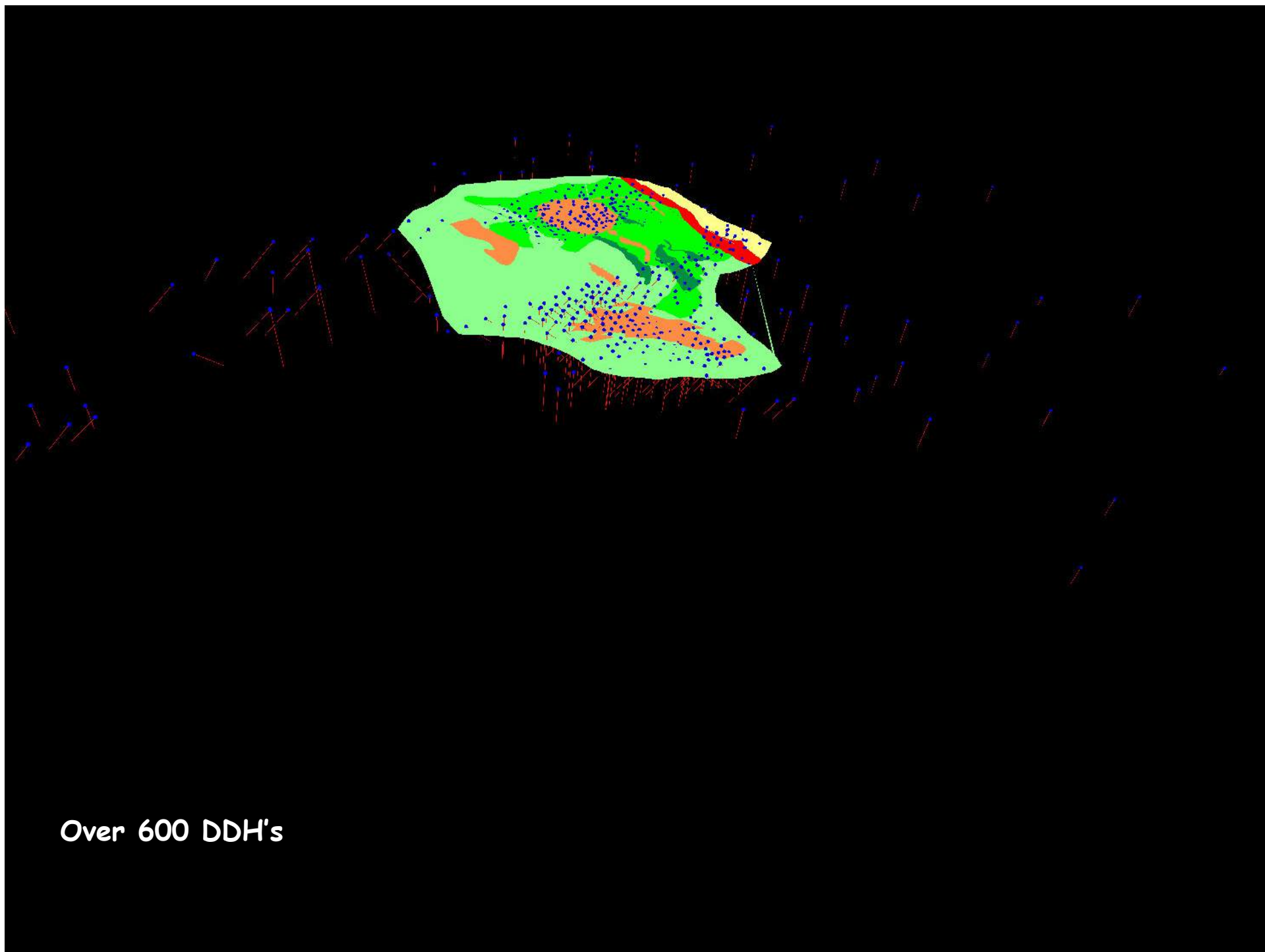
Mt Milligan VTEM Survey



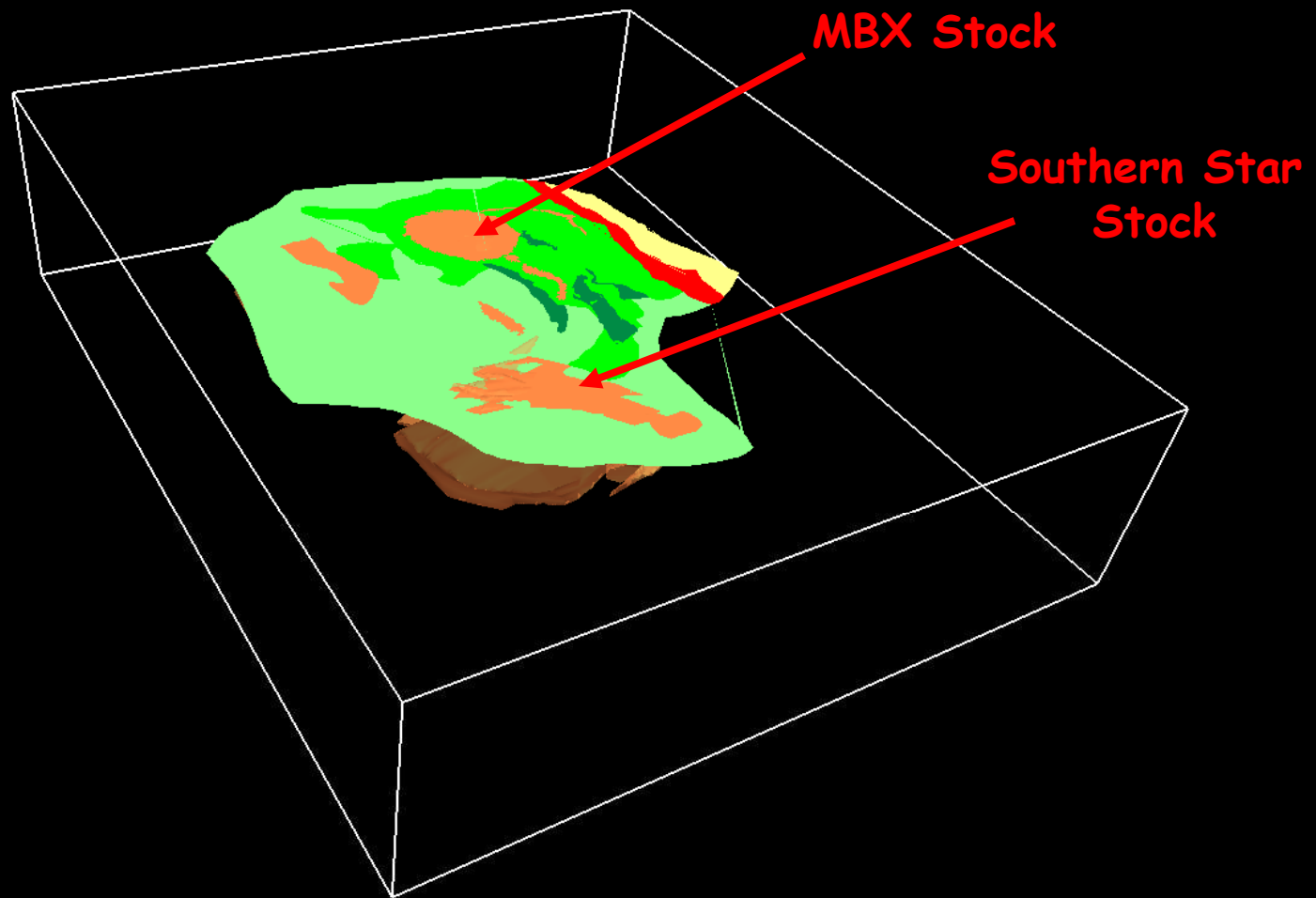
Bedrock Geology on DEM



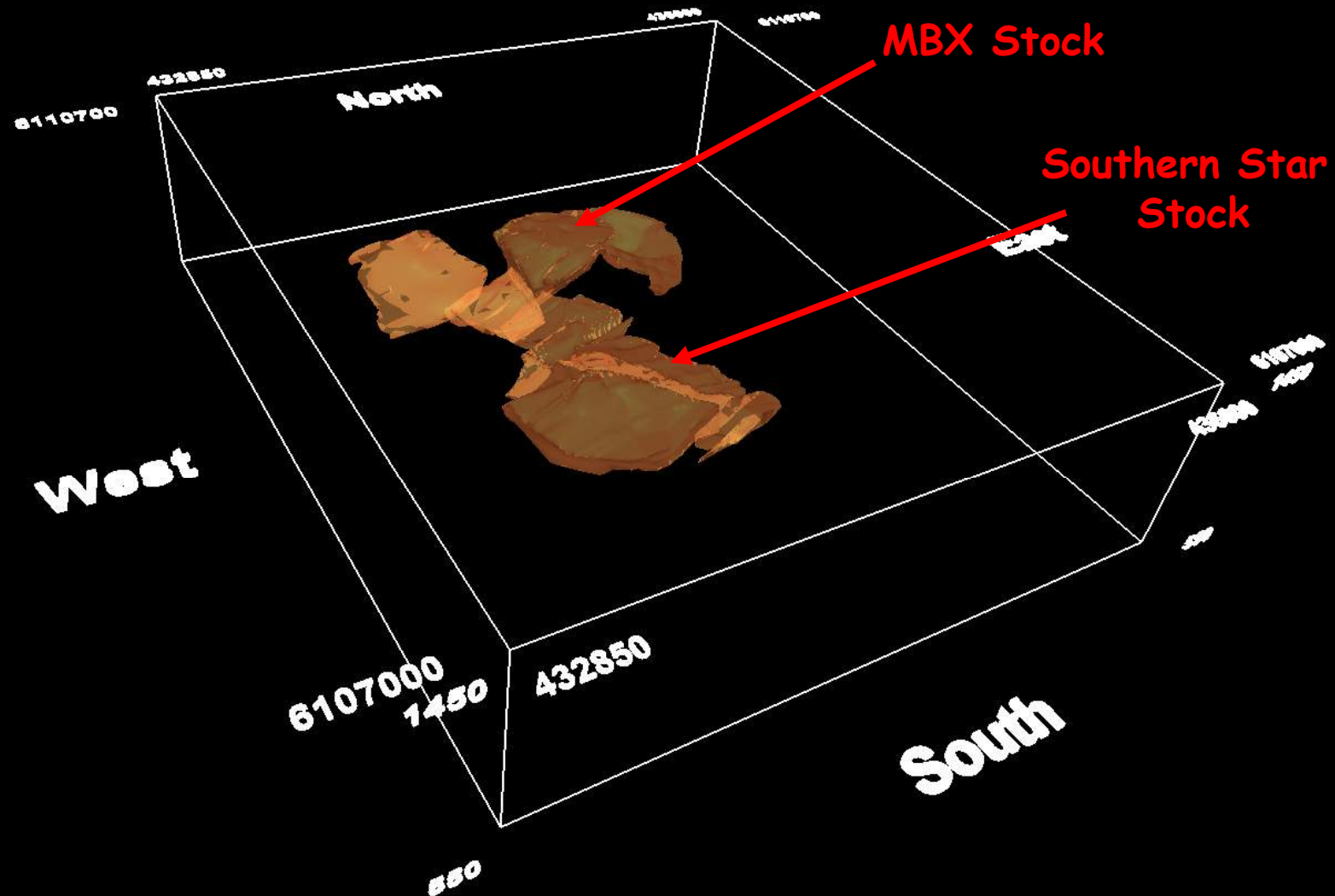
Bedrock Geology



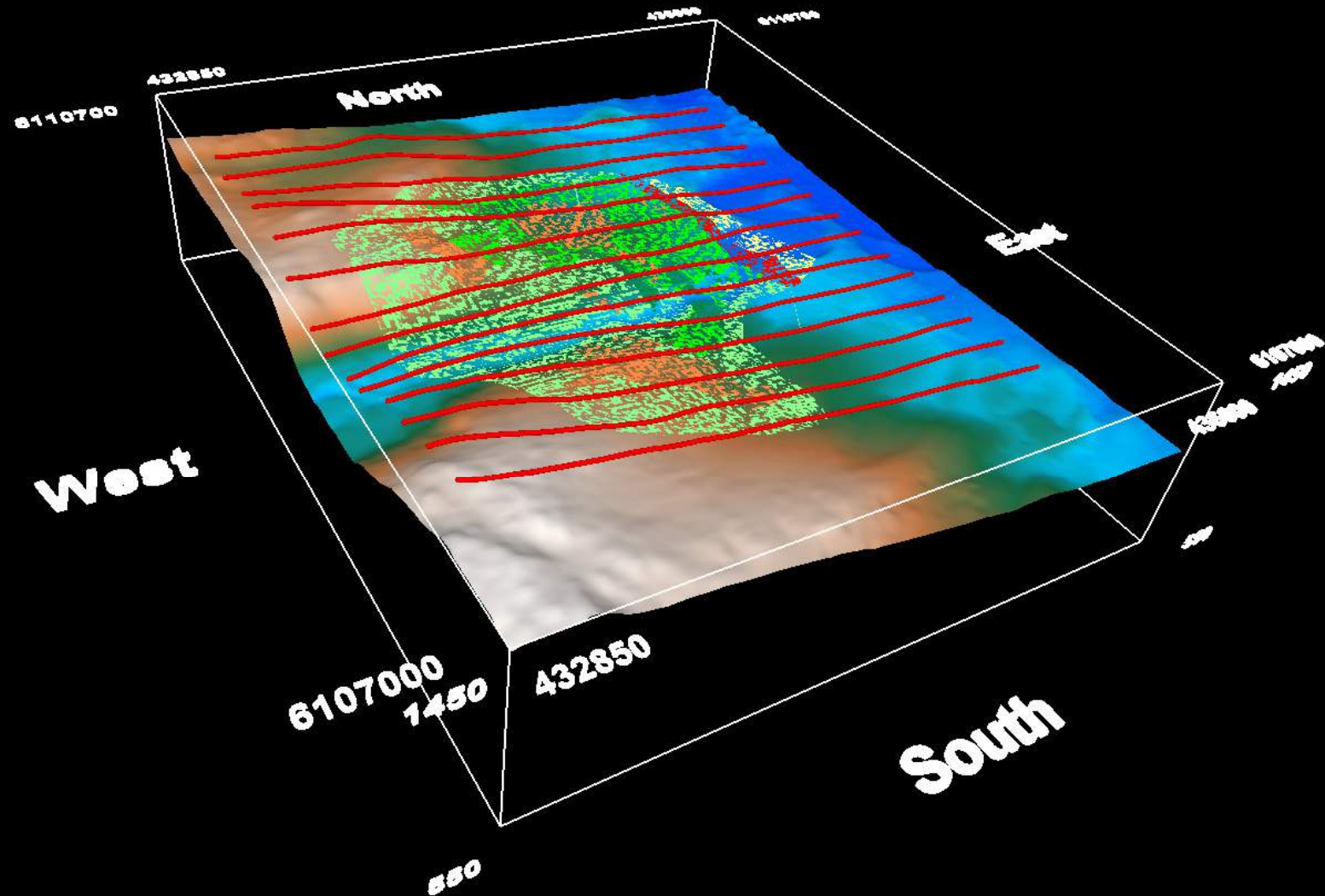
Over 600 DDH's



Bedrock Geology and Stocks in 3D

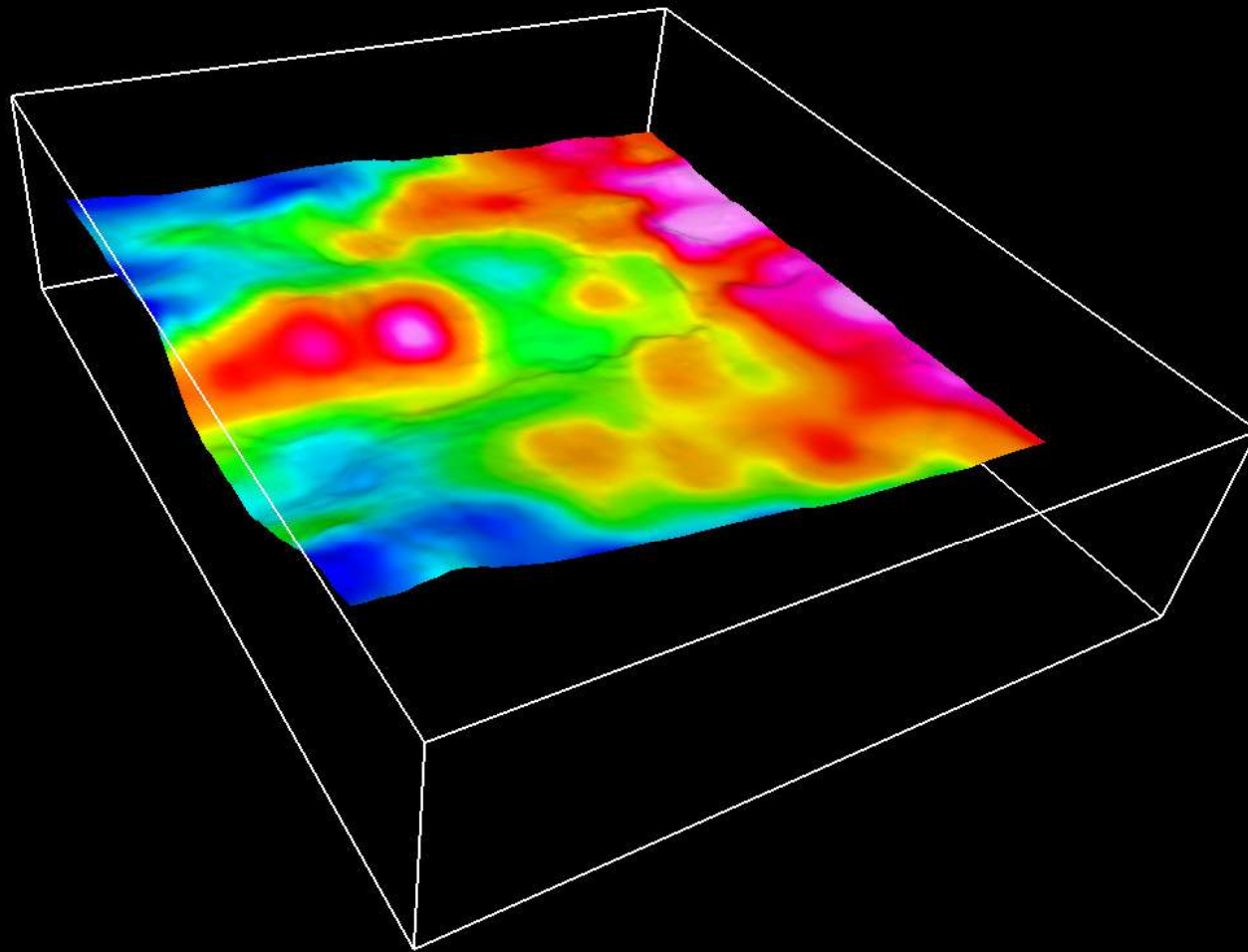


Stocks in 3D (MBX and Southern Star)



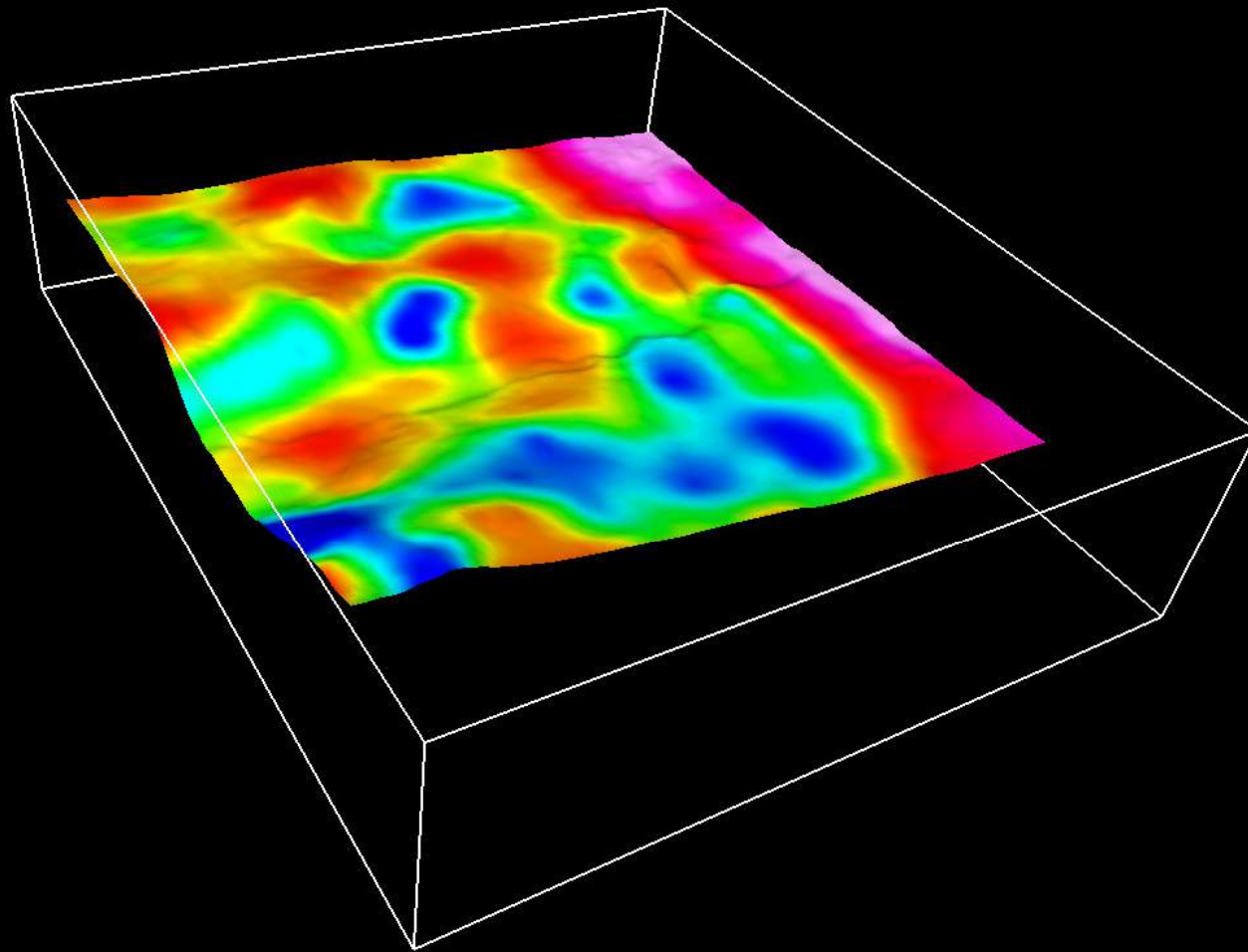
Flight Lines (200m line spacing)

Mt Milligan VTEM Survey



Early Channel Amplitude (99 μ s)

Mt Milligan VTEM Survey



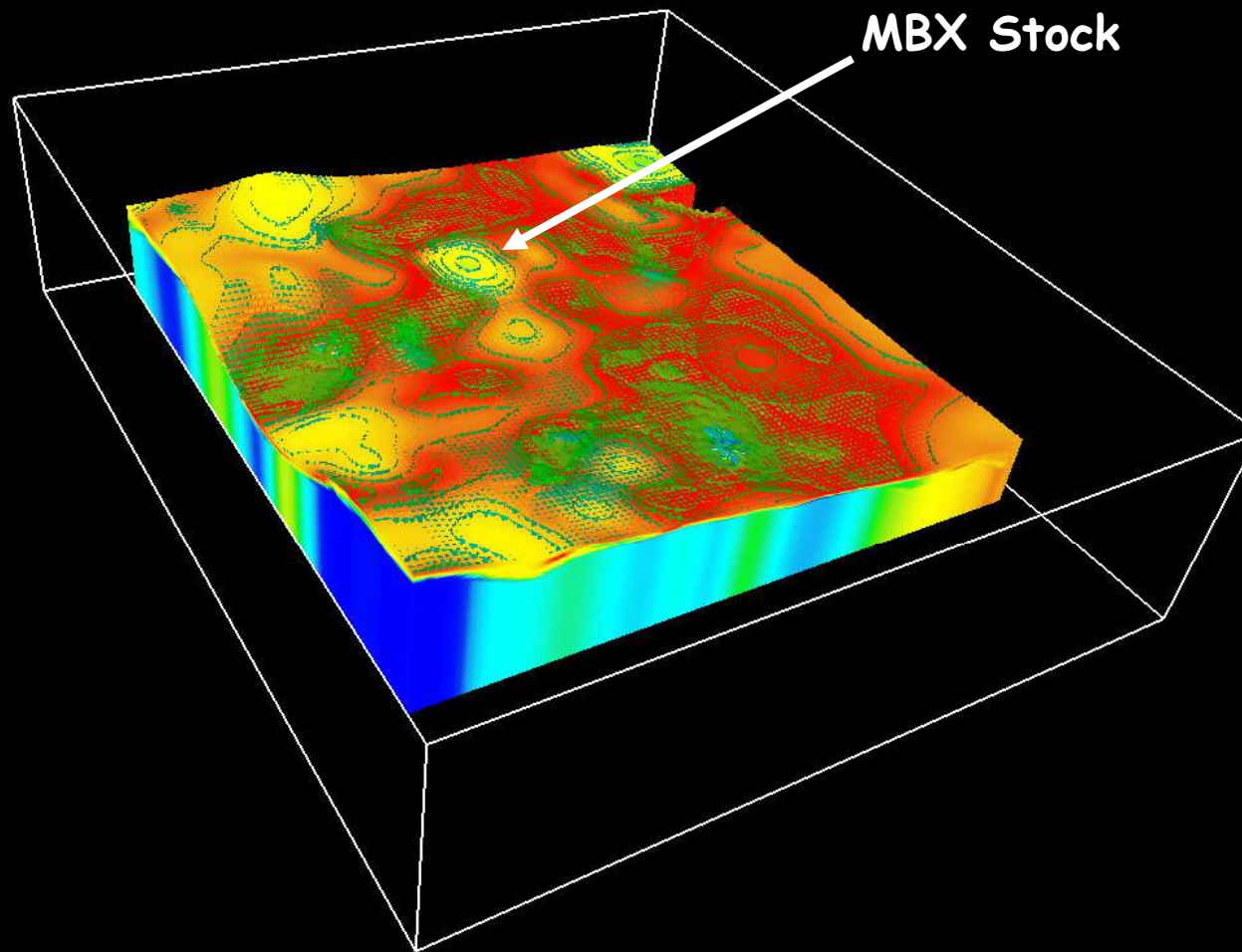
Time Decay (τ)
Mt Milligan VTEM Survey

The concept of 'Data Inversion'

Forward Modeling

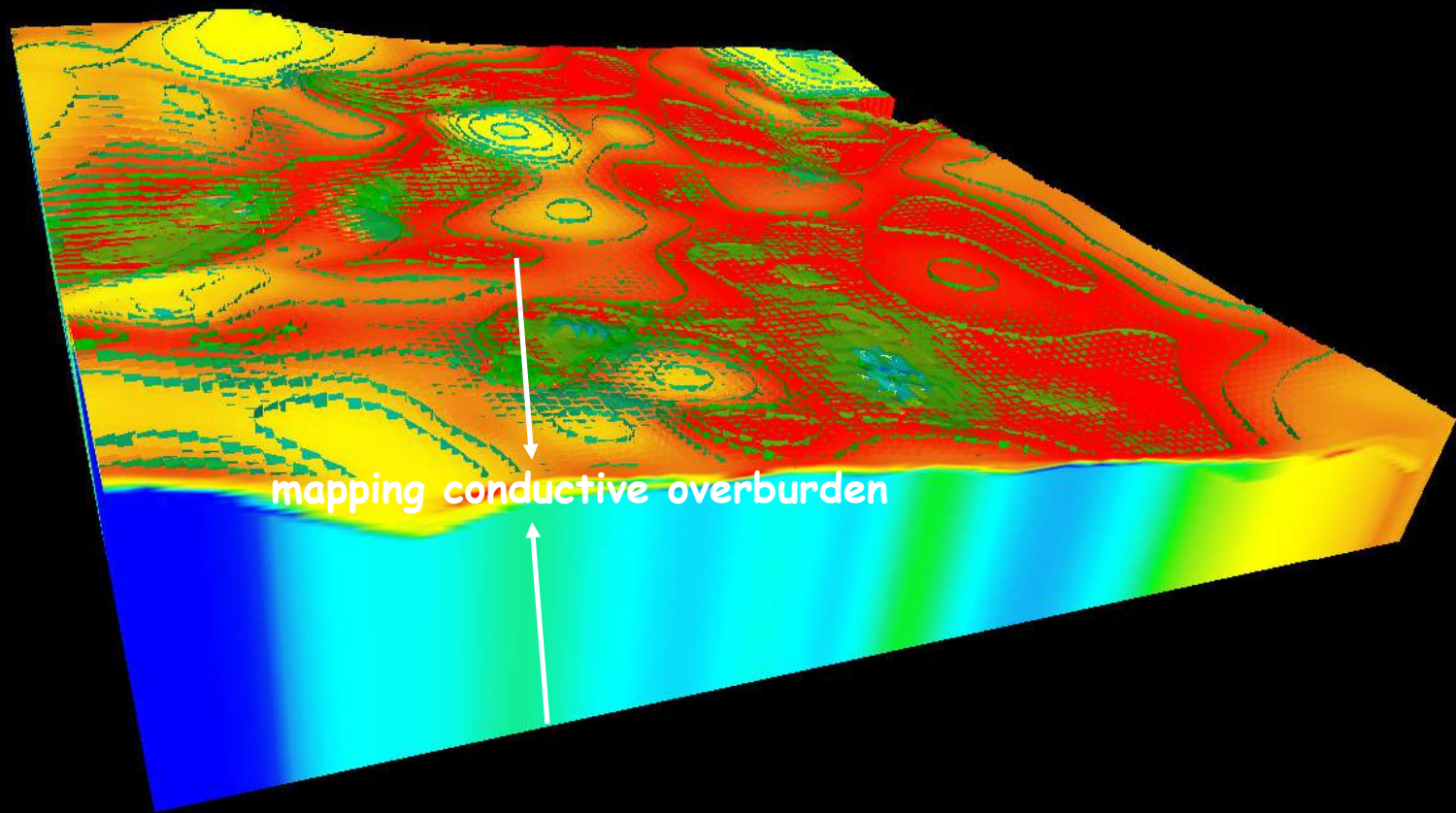
$$D(GV) = \frac{\text{Volume} * D(RPP)}{\text{Depth}^{(1...2...3)}}$$

Inversion



Resistivity 1D Inversions (4 layers)

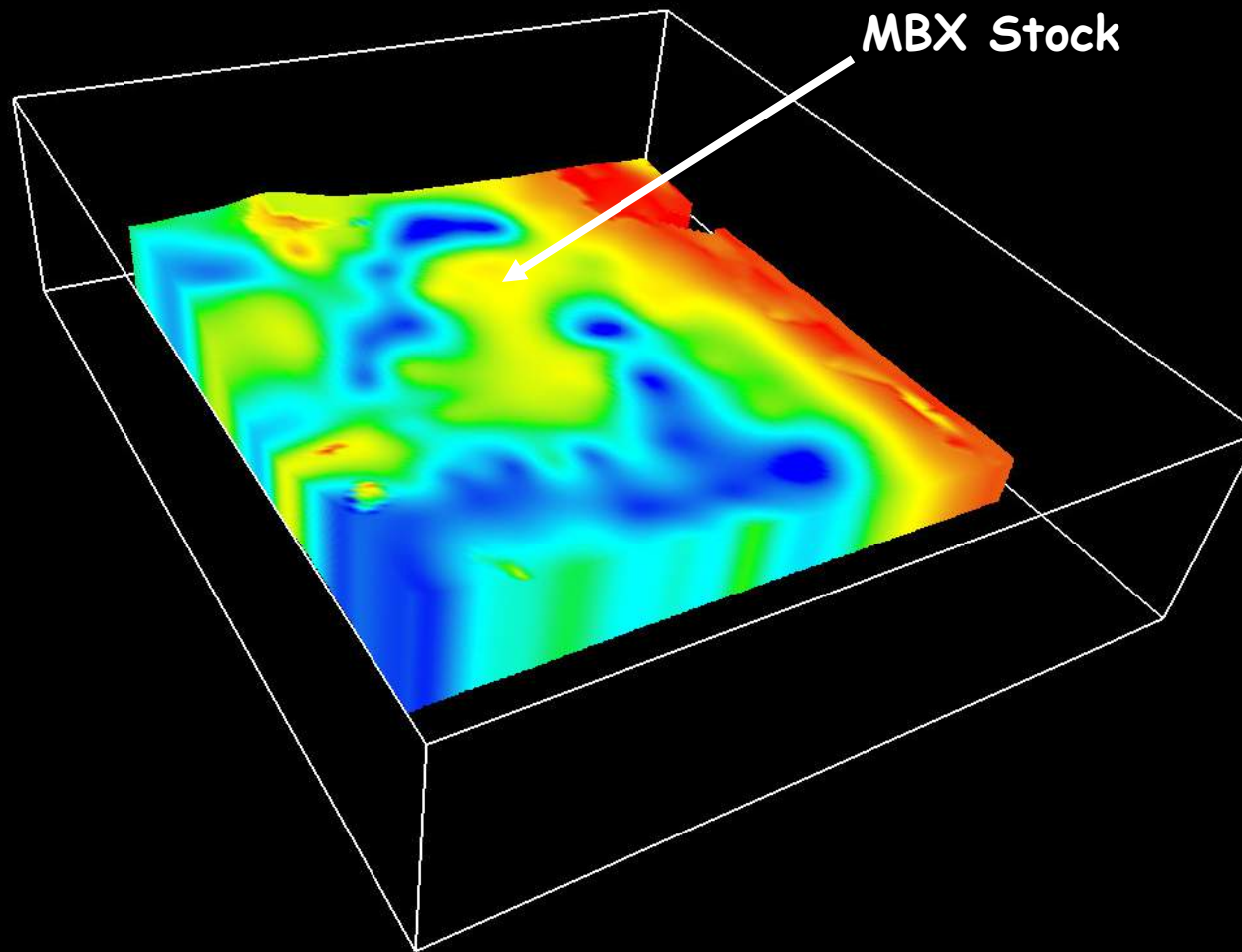
Mt Milligan VTEM Survey



mapping conductive overburden

Resistivity 1D Inversions (4 layers)

Mt Milligan VTEM Survey



Resistivity Distribution 100m below surface

Mt Milligan VTEM Survey

Conclusions

- Early channels are mapping the shallow mineralization in stocks embedded in conductive overburden;
- Late channels are mapping sediments;
- The time decay (*tau*) from the amplitude is mapping the mineralization in depth;
- Simple 1D-inversions (using 4 layers) are mapping in detail the conductive cover;
- However, more complex 1D-inversions (using 60 layers) will be calculated.

Recommendations

- Hire or contract a geophysicist to analyze in detail this publicly available data;
- Data can be downloaded for free from the Geoscience BC website

www.geosciencebc.com

- Data can be viewed with the Oasis Montaj Viewer which can be downloaded for free from the Geosoft website

www.geosoft.com

- Carry out detail surveys:

- **VTEM**

- **AeroTem**

- **HeliGeoTem**

- **SkyTem**