MOOMBARRIGA GEOSCIENCE

Deeper understanding of the Duketon Gold project through integration of district scale resistivity data

Thomas Hoskin & Celia Guergouz

Moombarriga Geoscience & Regis Resources

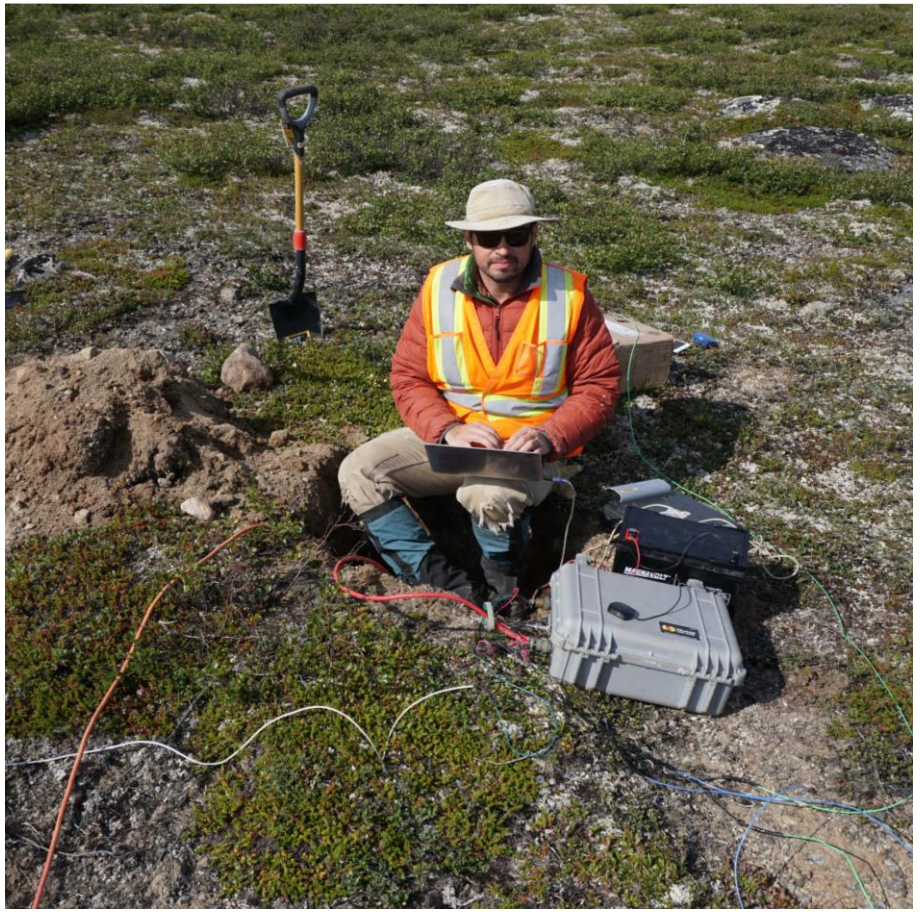
MOOMBARRIGA GEOSCIENCE

Introduction: What's the thesis?

- That MT is an essential/complementary tool for exploration
  - Efficient mapping tool – both lateral and vertical search space
  - Bridges a targeting gap between government and commercial geophysical datasets
- MT has value as a multiscale tool
  - Bring you into the right area and onto the right structures
  - Sensitive to essential elements of the mineral system at various depths
- Case Study: Review the Duketon Belt MT survey to support this hypothesis



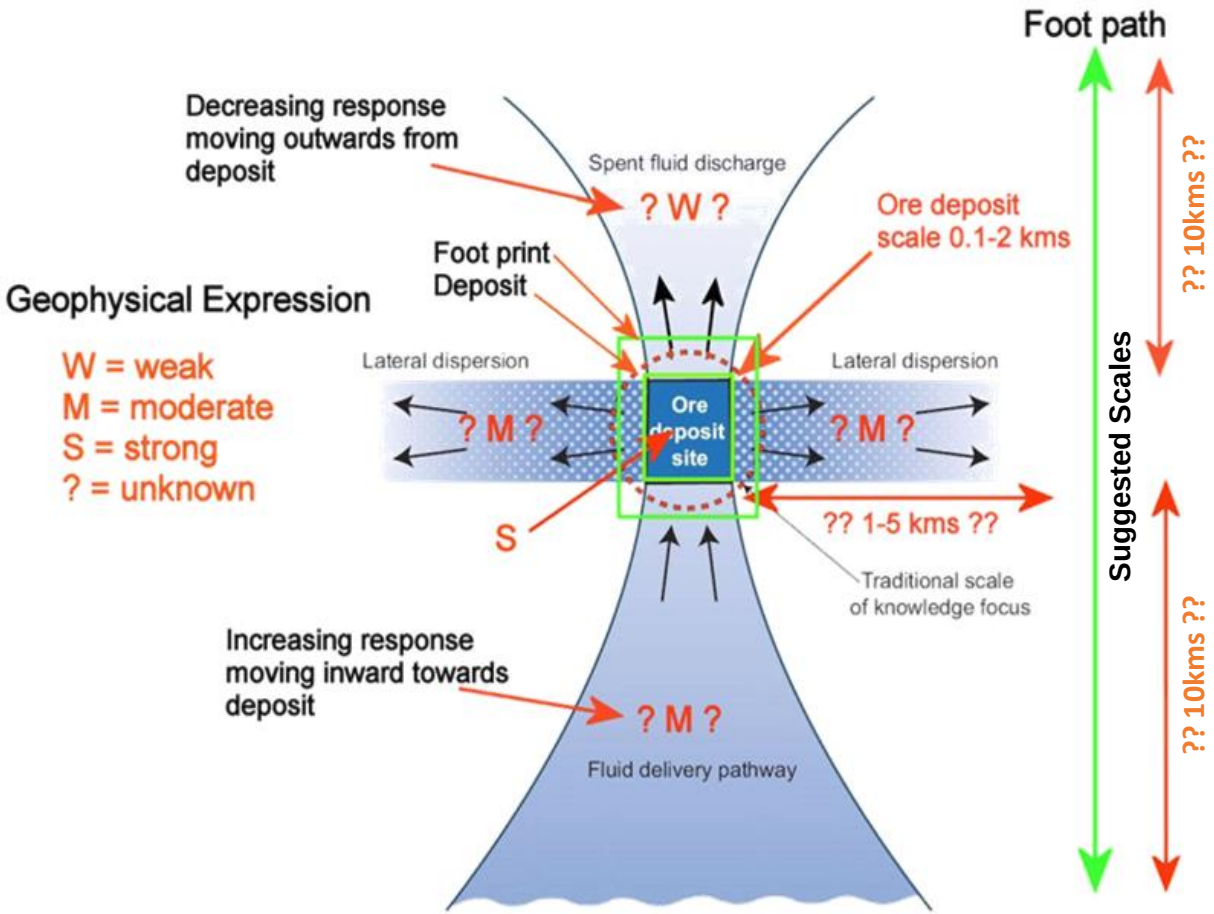


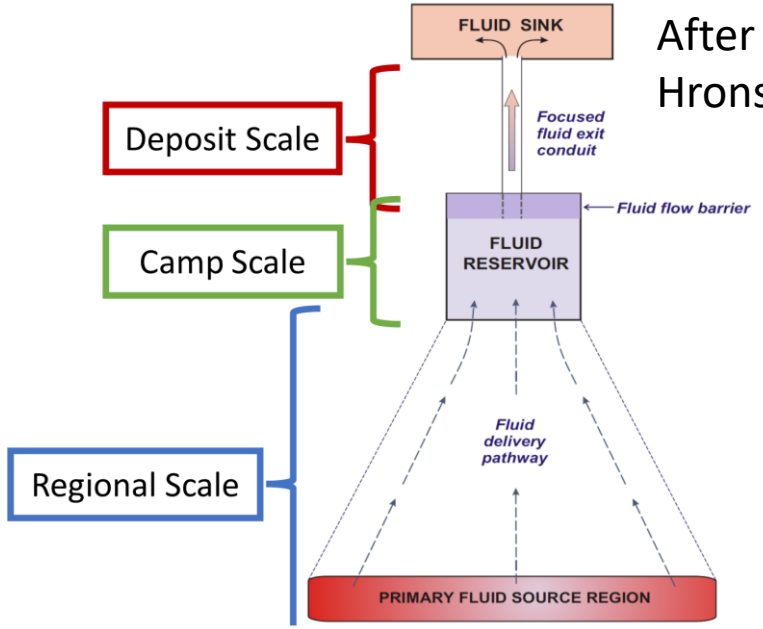
Rationale for MT

- Cost effective mapping tool
- MT is logistically simple
  - more readily deployed to greenfield exploration
  - (environmental/cultural sensitivity)
- MT has very deep penetration
  - Deeper targets/mineralisation
  - Mineral system mapping
- As with all EM methods, it maps a fundamentally different physical property
- Complementary to EM

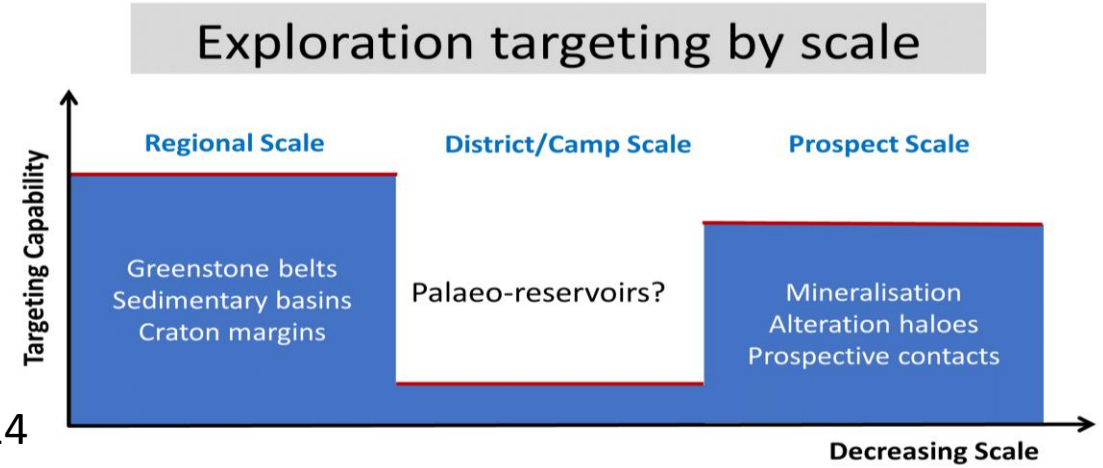
Rationale for MT – Mineral System Model



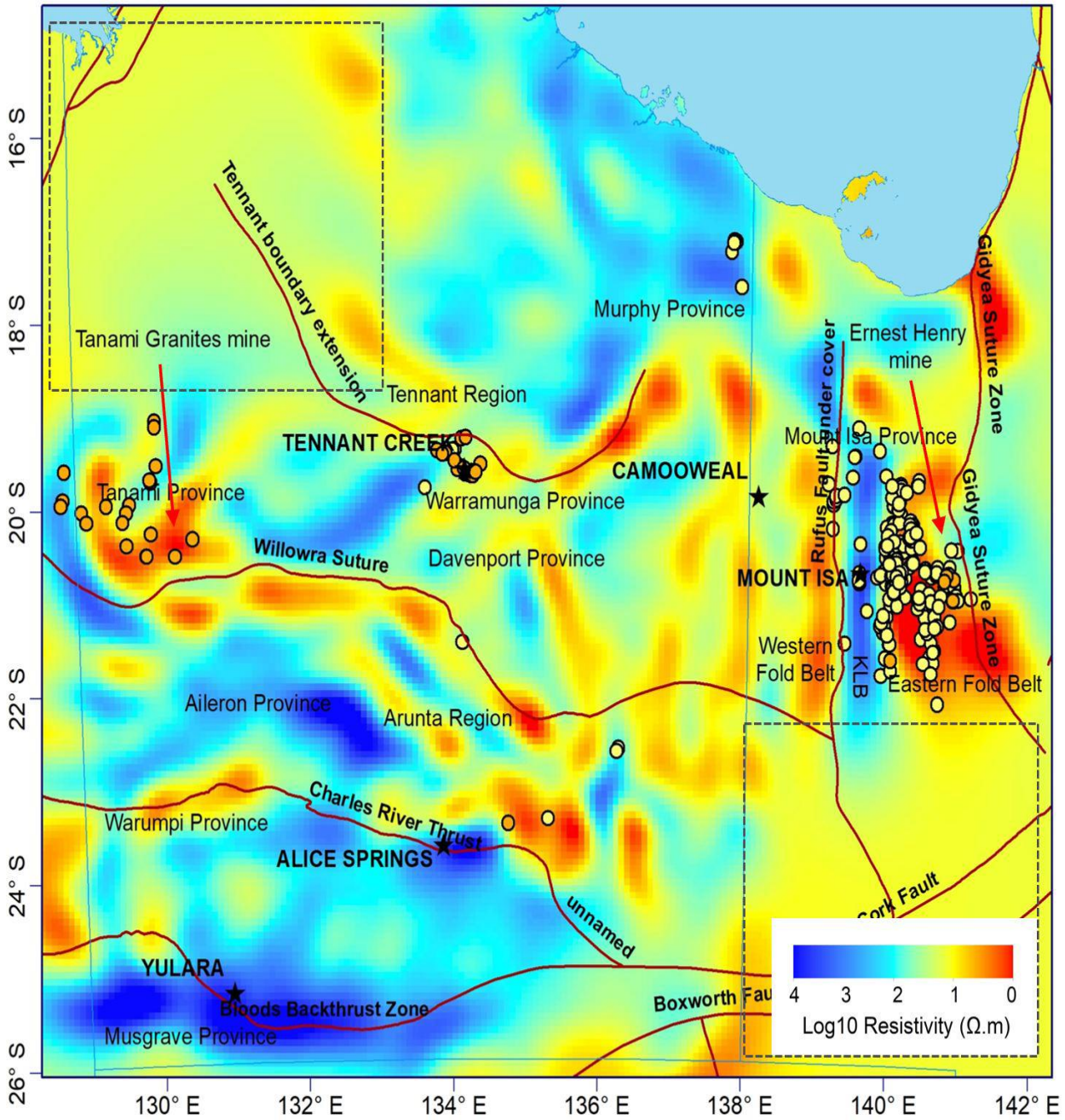
Witherly. 2015



After McCuaig and Hronsky. 2014



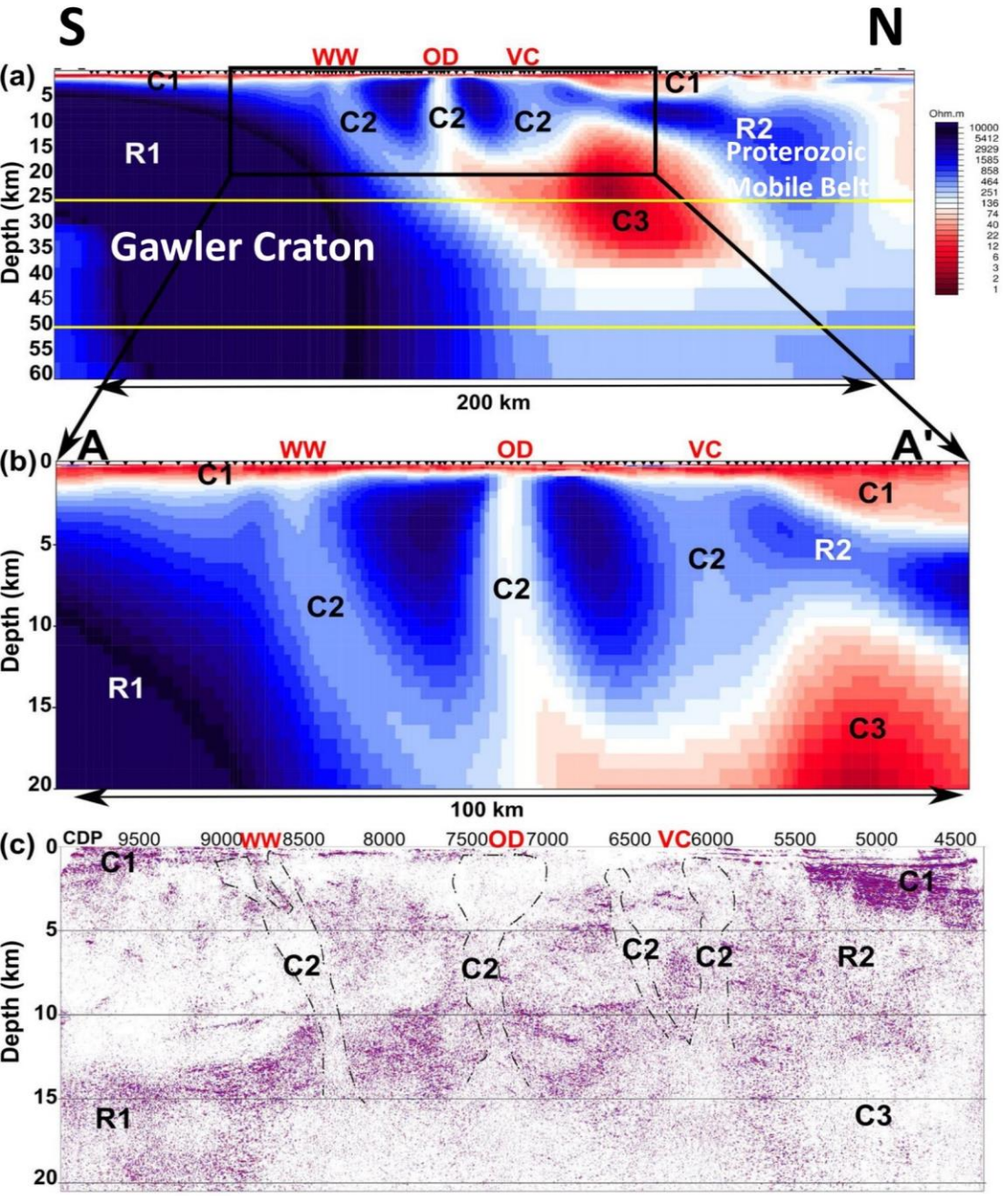
After Dentith. 2014



Duan and Jiang. 2021

Large scale - crustal architecture studies

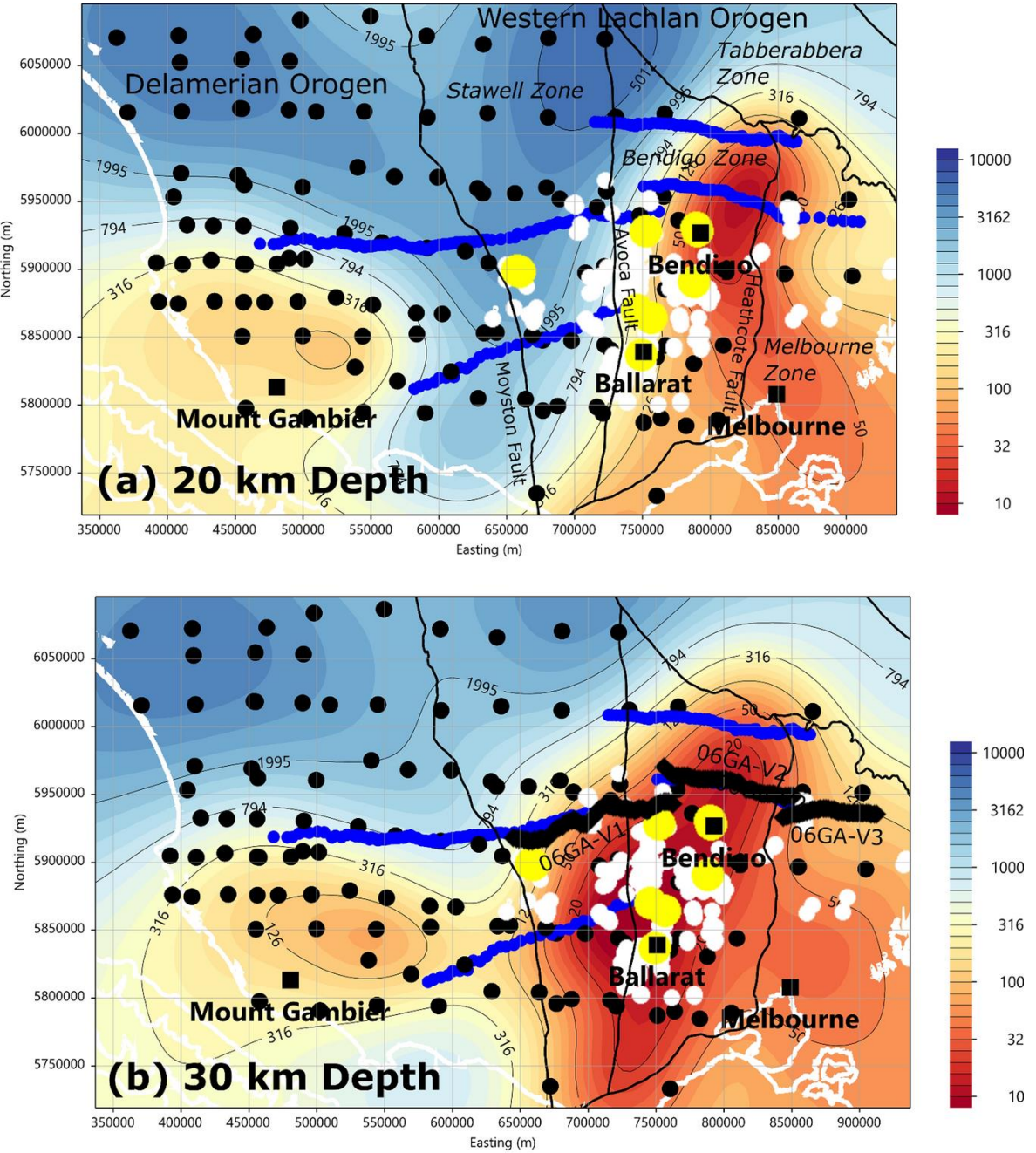
- AusLAMP
- Reflects regional geological features
  - Terrane boundaries
  - Lithological domains
  - Sedimentary basins
  - Greenstone belts
  - Major faults/shear zones
- Correlation between deep conductive anomalies and mineral provinces



Heinson et al. 2018

Mineral system studies – Olympic Dam

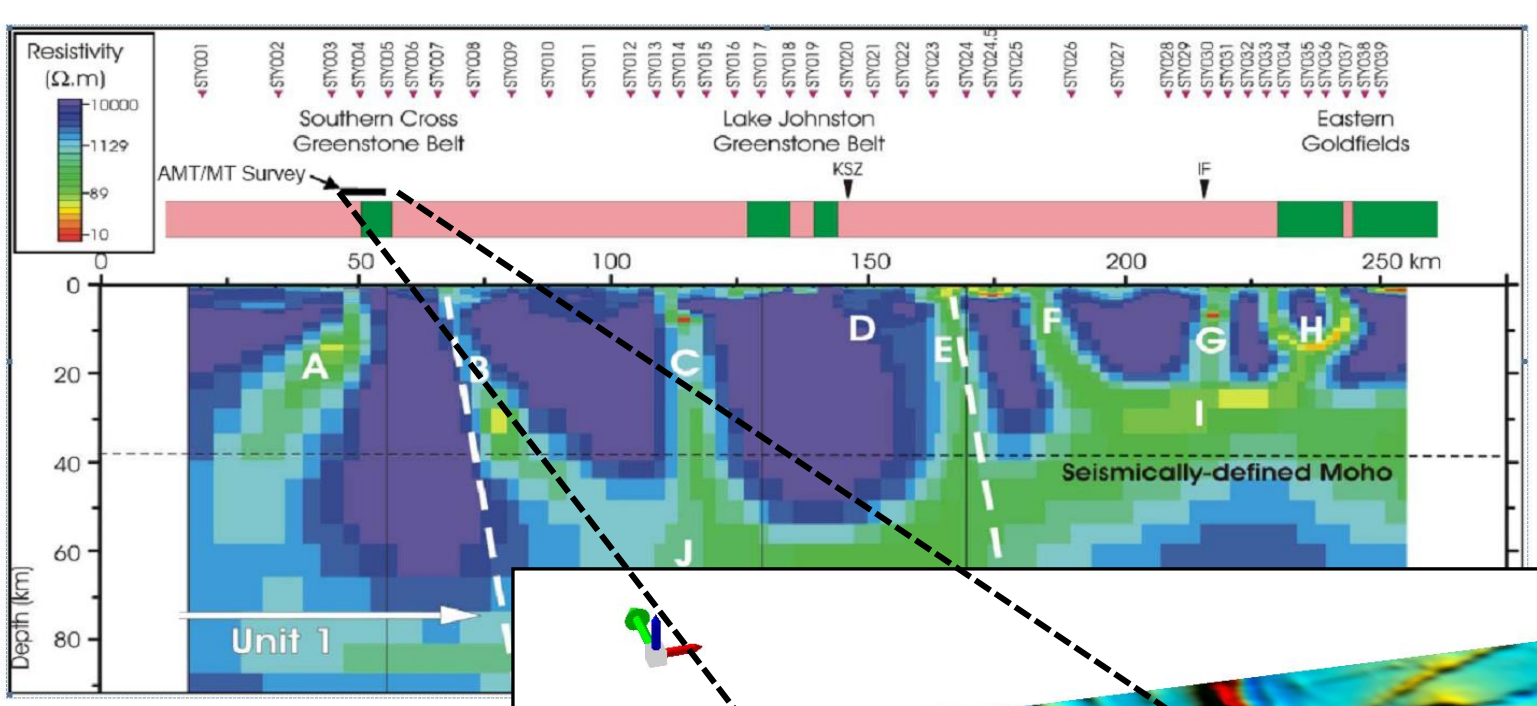
- "Hand of God"
- Deep (10-15km) conductor observed at the margins of the Gawler Craton
  - Mineral system reservoir/source
- Pathways into the crust (C2) relating to mineralization (WW, OD and VC)
- Scale: not looking at the deposit scale
- Anomalous responses of fluid pathways (C2) to multiple geophysical techniques

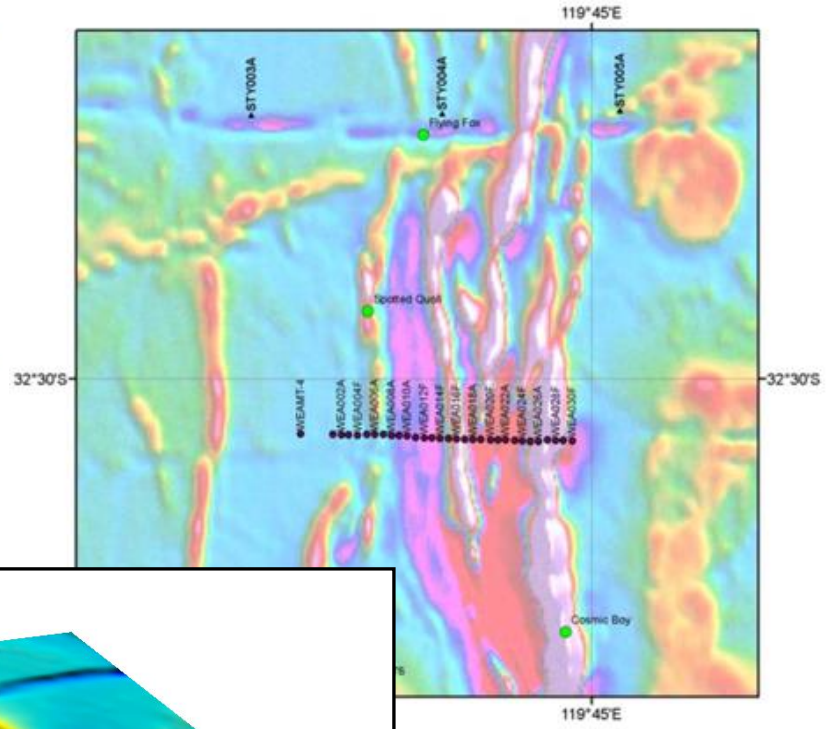


Mineral system studies – Ballarat/Bendigo

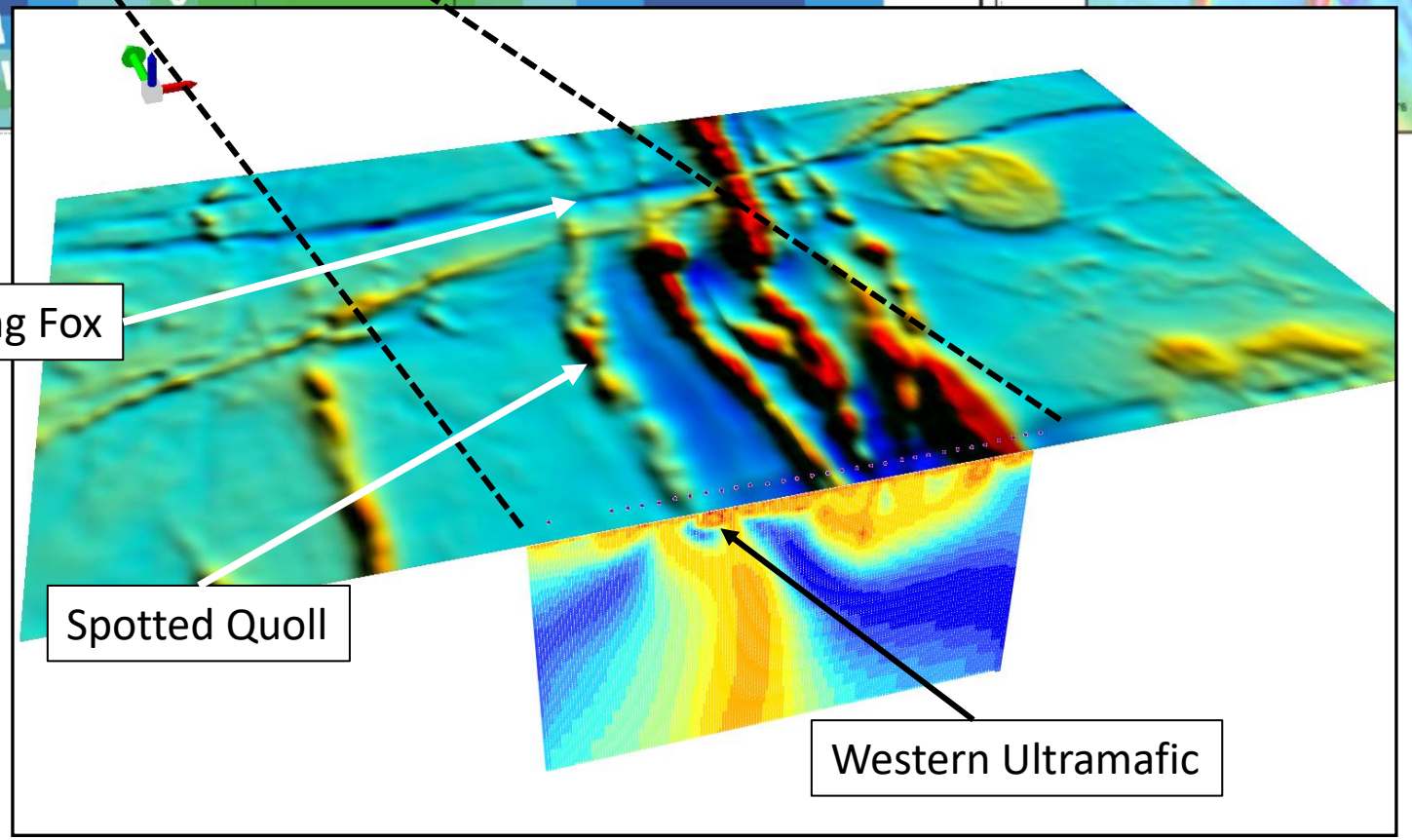
- Spatial correlation between deep conductors and mineralization in western Victoria
- Correlation between deep conductors and mineralisation type
  - Orogenic gold occurs OVER deep conductors
  - Porphyritic and intrusion-related gold occurs at the EDGE of deep conductive anomalies

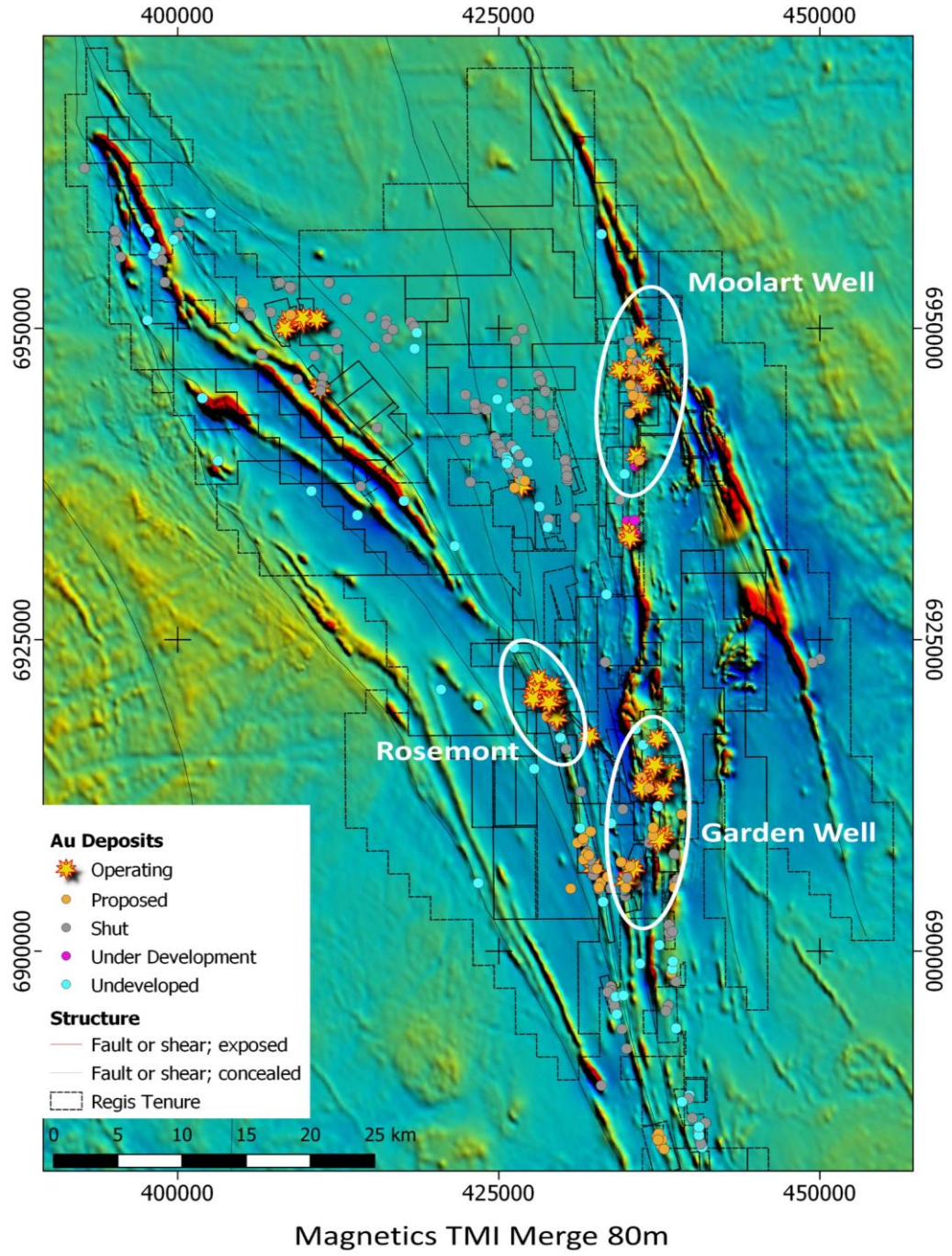
Heinson et al. 2021





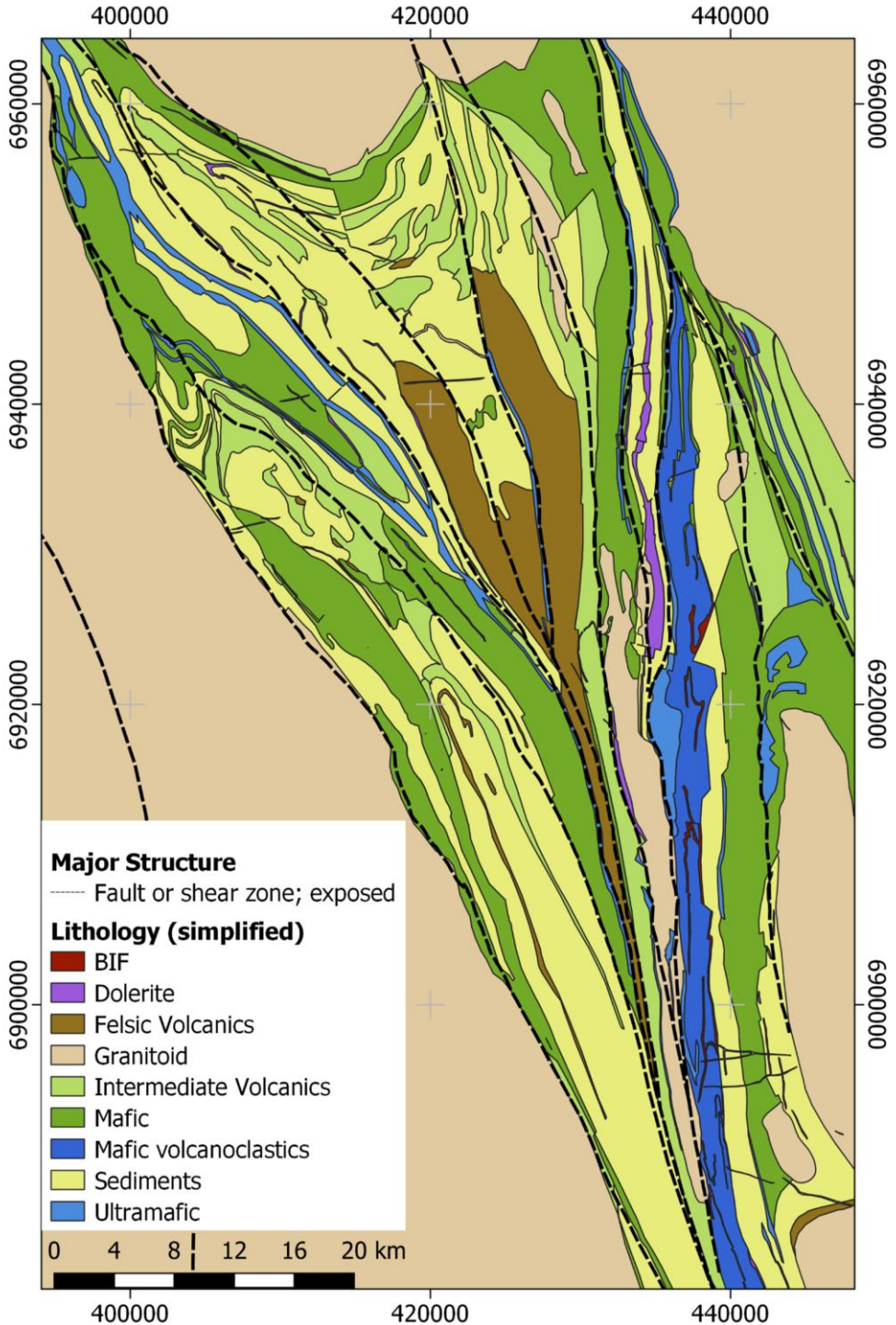
Dentith et al. 2013





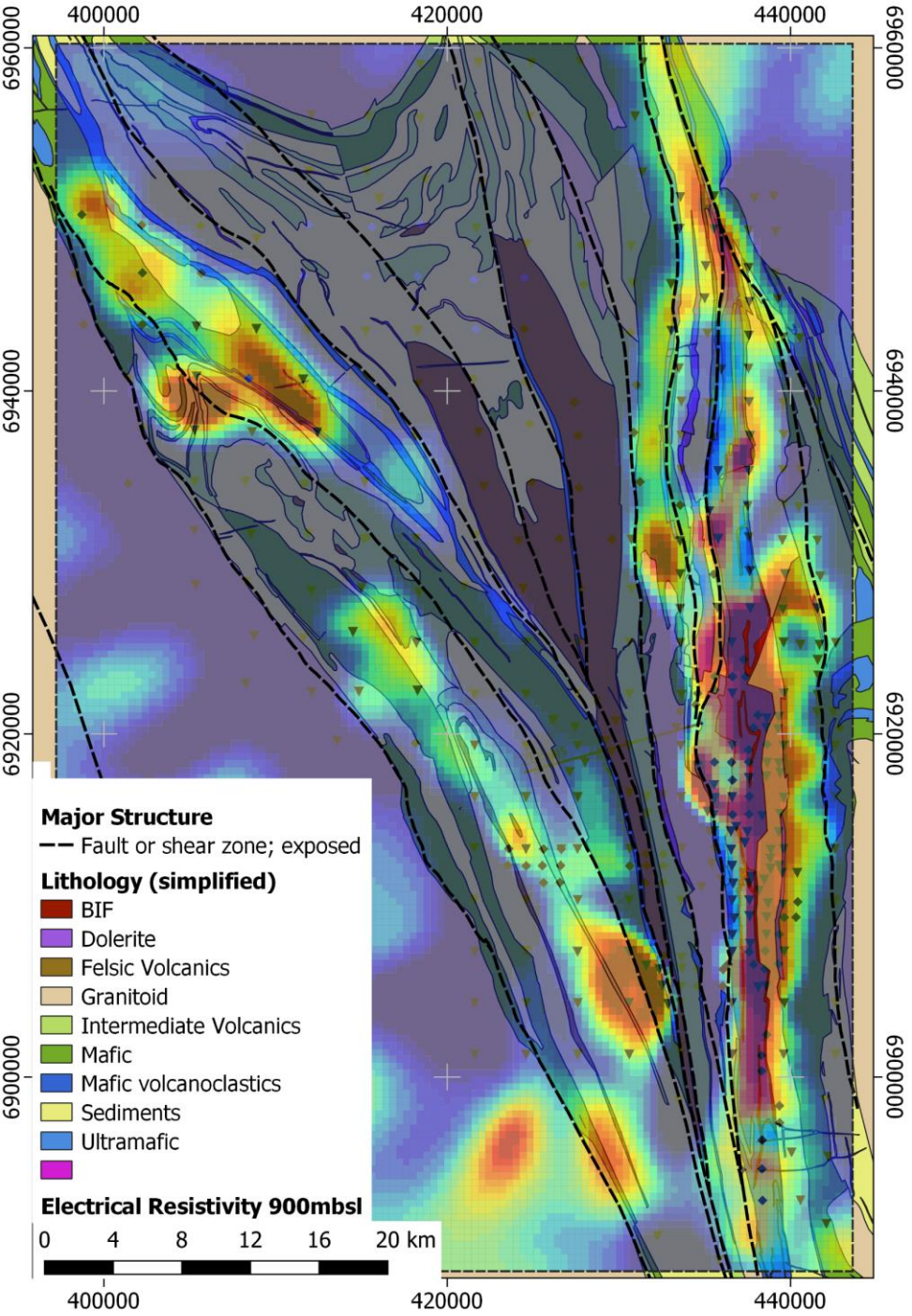
The Duketon Gold Project

- Duketon Greenstone belt eastern Goldfields
- Several key deposits
  - Garden Well
  - Rosemont
  - Moolart Well
  - Numerous satellite pits
- The challenge: efficiently identify prospective parts of this large tenement holding



Regional Geology Summary

- Duketon greenstone belt is located on the contact between the eastern goldfields superterrane and the Burtville terrane
- Inferred contact is between Rosemont and Garden Well mines
- Different lithologies and geophysical responses

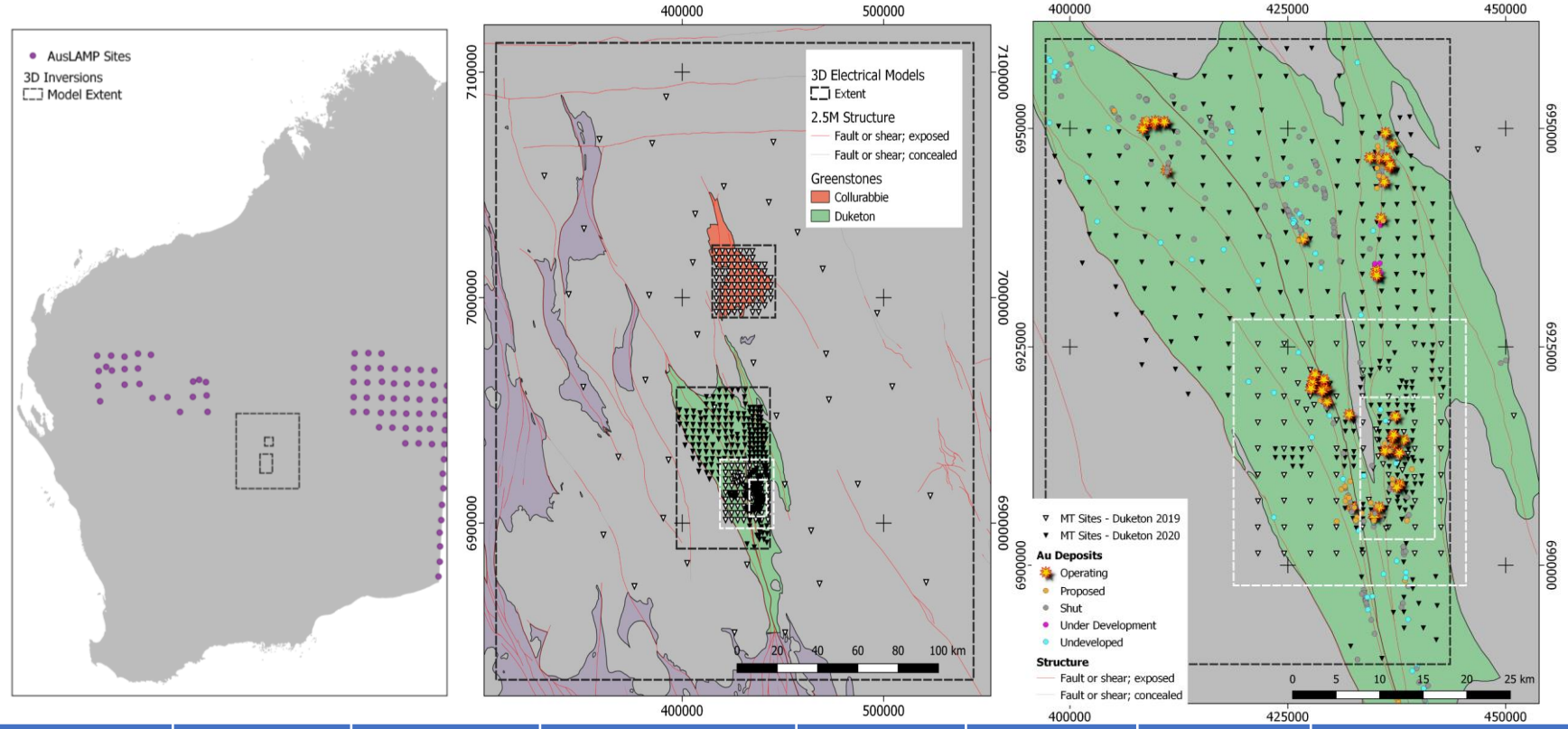


Regional Geology Summary

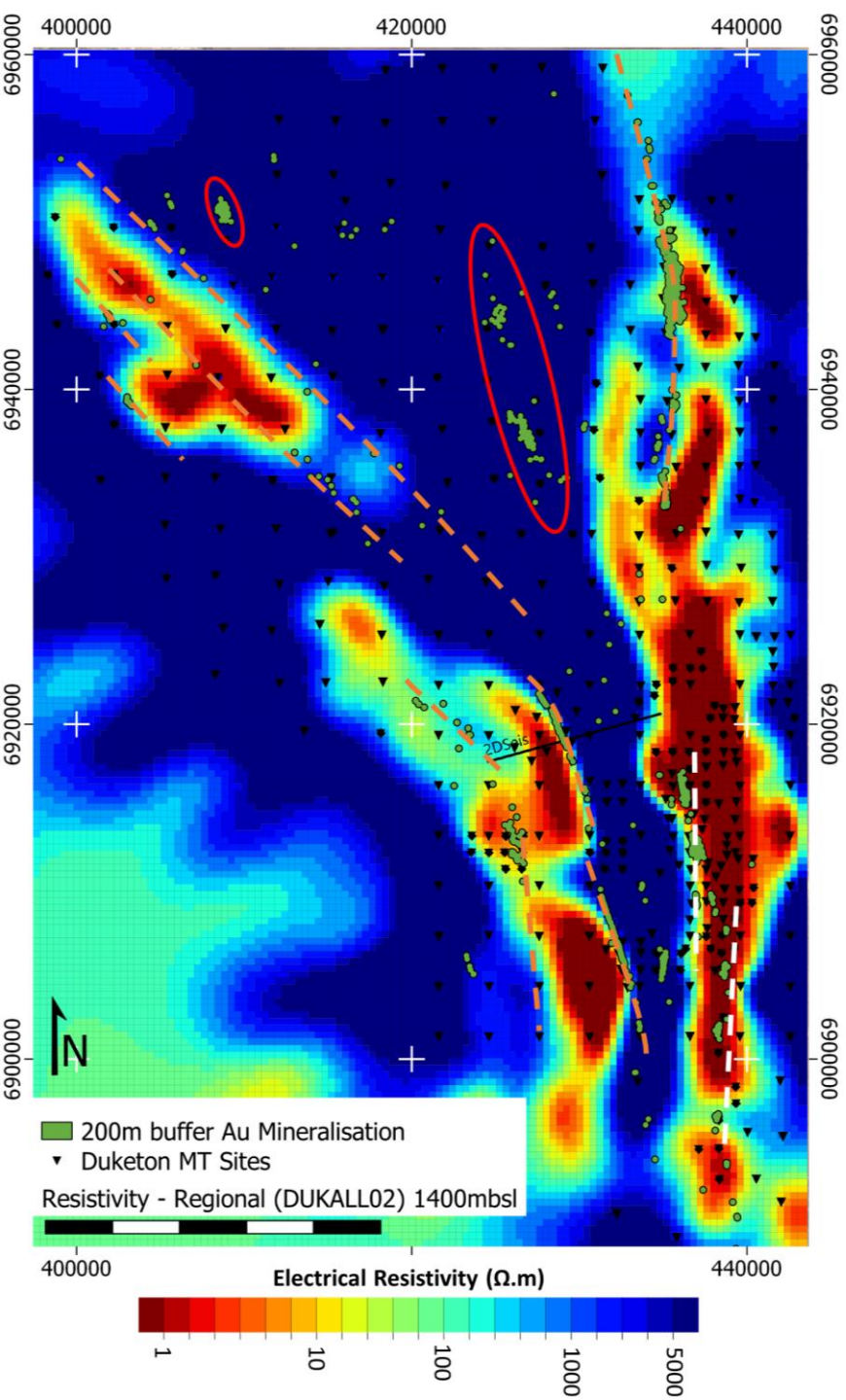
- Duketon greenstone belt is located on the contact between the eastern goldfields superterrane and the Burtville terrane
- Inferred contact is between Rosemont and Garden Well mines
- Different lithologies and geophysical responses

MOOMBARRIGA GEOSCIENCE

MT Surveys at the Duketon Belt

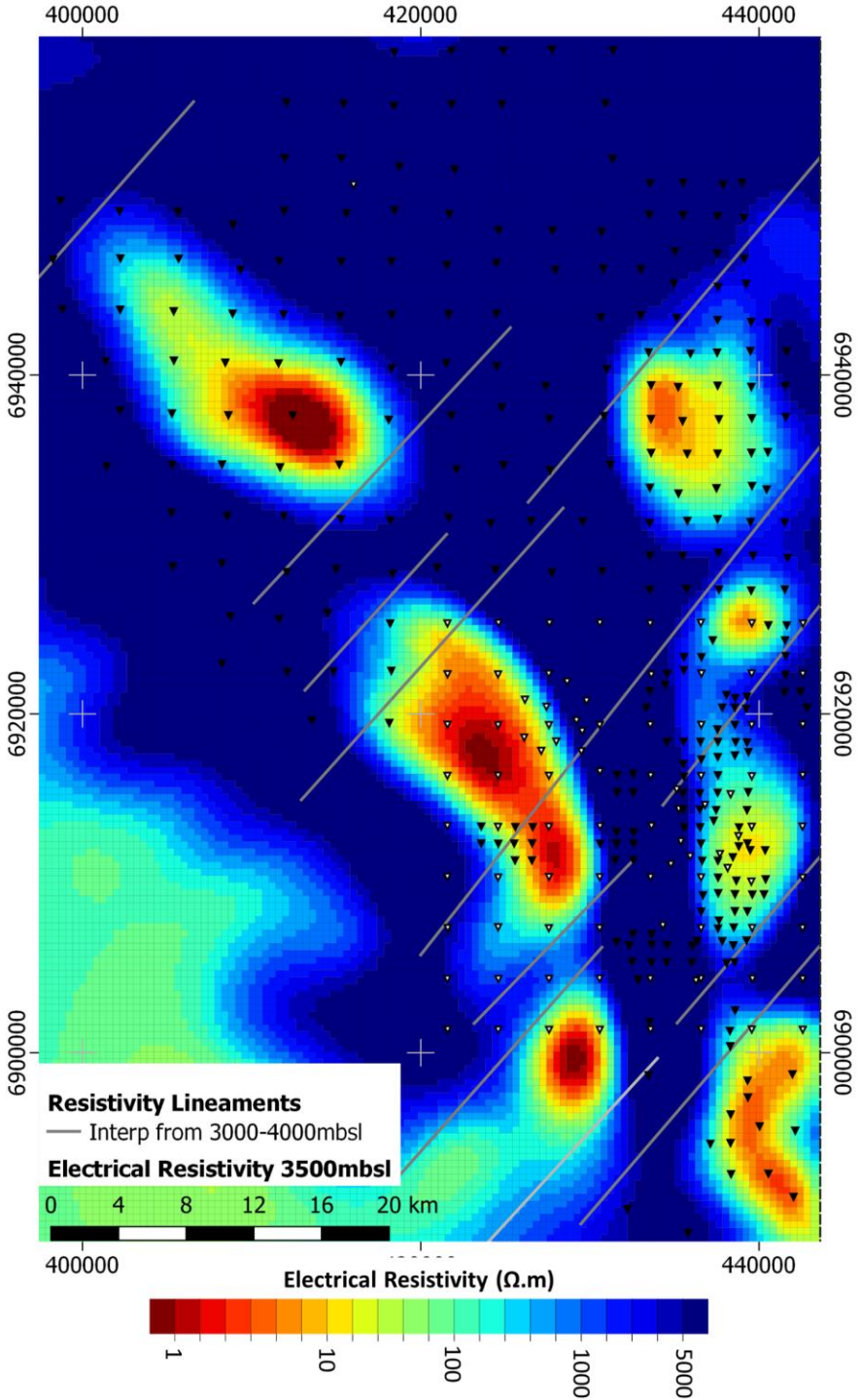


	Sites	Cell size	Freq Range	X Cells	Y Cells	Z Cells	Total Cells
Hi-Res	202	200 m	10k-0.01	143	162	106	2,455,596
Regional	384	400 m	500-0.01	143	206	81	2,386,098



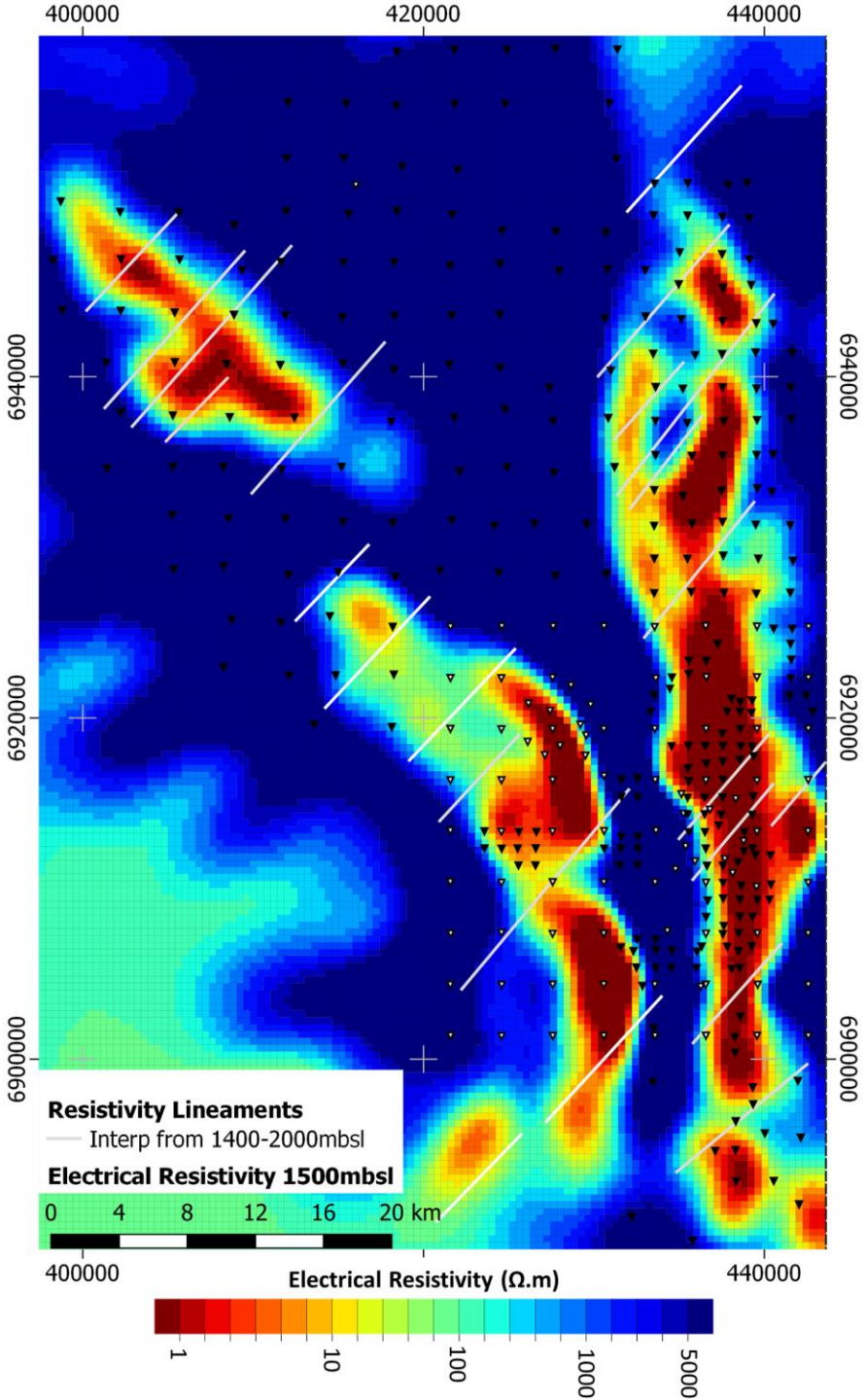
Resistivity anomalies (<4km)

- Highly conductive feature (<10 Ω.m)
- North and north-west orientation – following broad greenstone trend
- Mineralisation generally correlates with the edges of conductive anomalies
- Little mineralisation over conductive anomalies
- Some mineralization exists away from these conductors



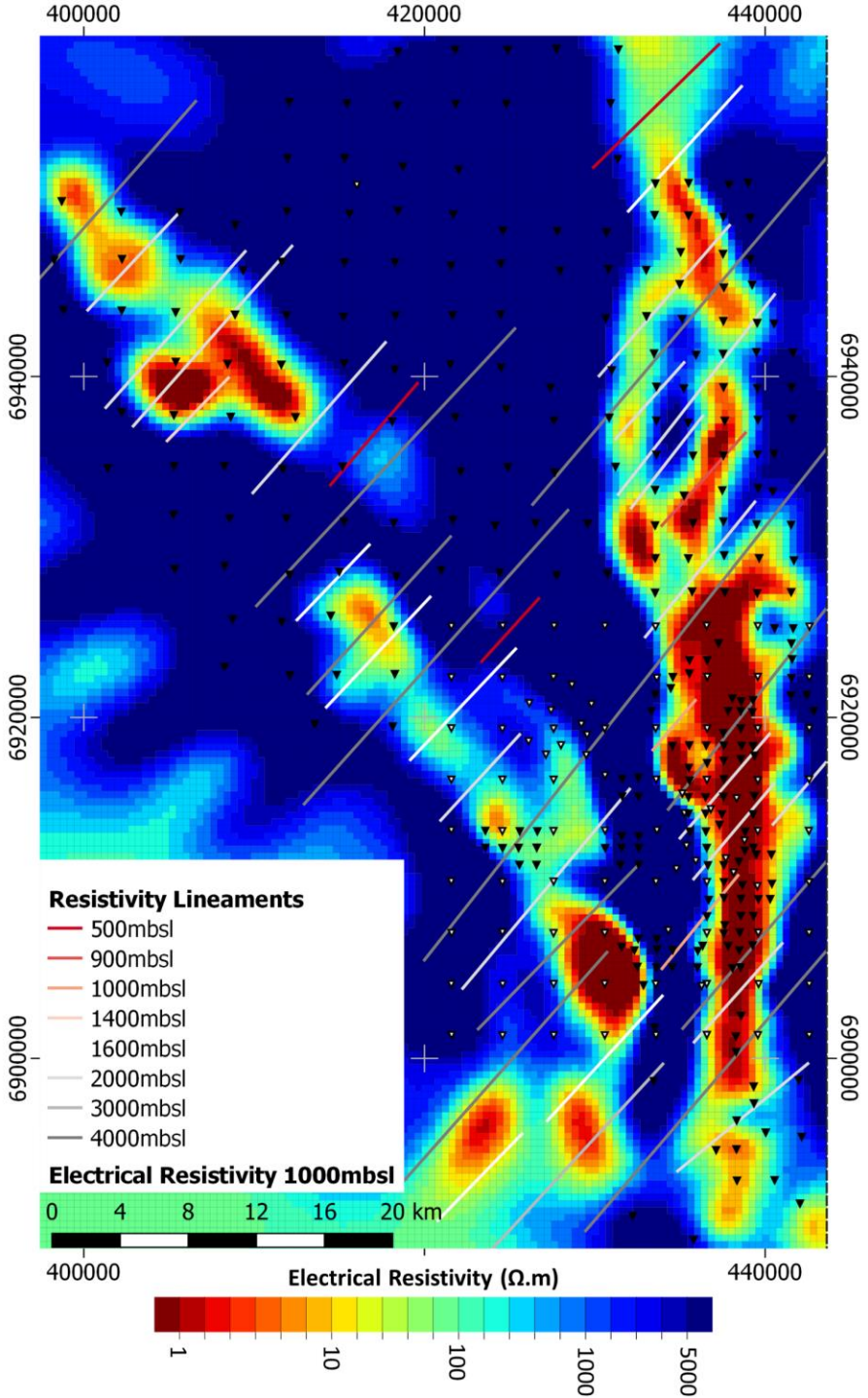
Resistivity Lineaments

- Resistivity controlled, to some extent, by lithology and major structures
- Resistivity is not uniform for mapped geological units
- No clear control from geological maps
- Map lineaments at various depths of electrical models
  - termination
  - deflection
  - magnitude change



Resistivity Lineaments

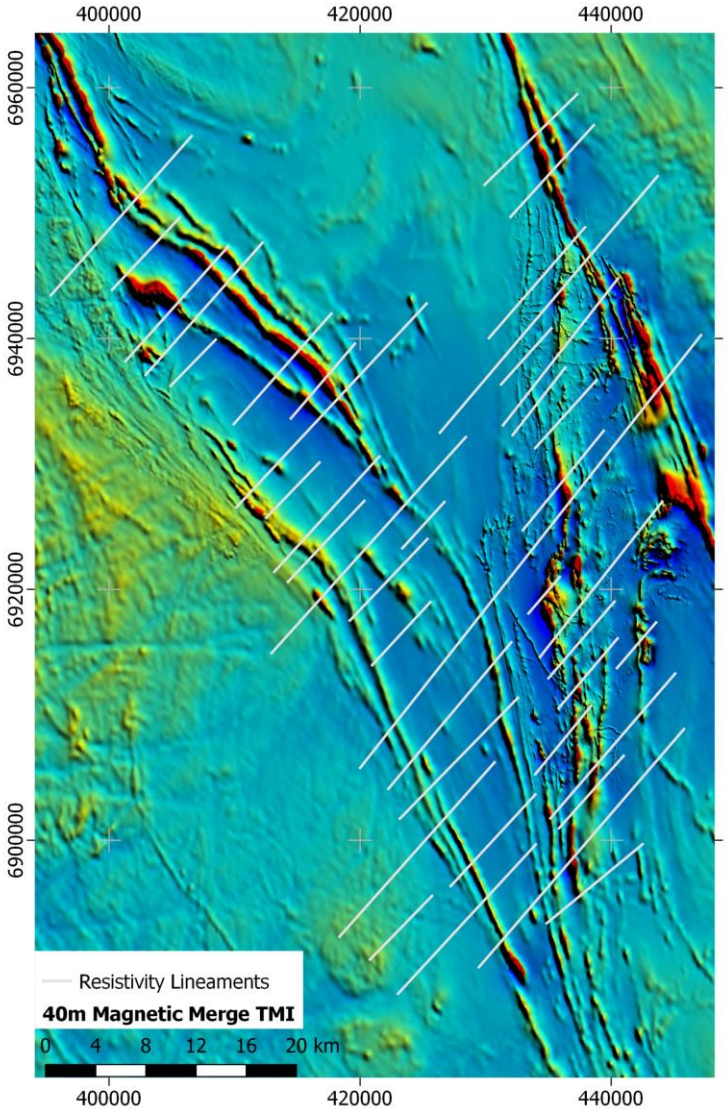
- Resistivity controlled, to some extent, by lithology and major structures
- Resistivity is not uniform for mapped geological units
- No clear control from geological maps
- Map lineaments at various depths of electrical models
  - termination
  - deflection
  - magnitude change

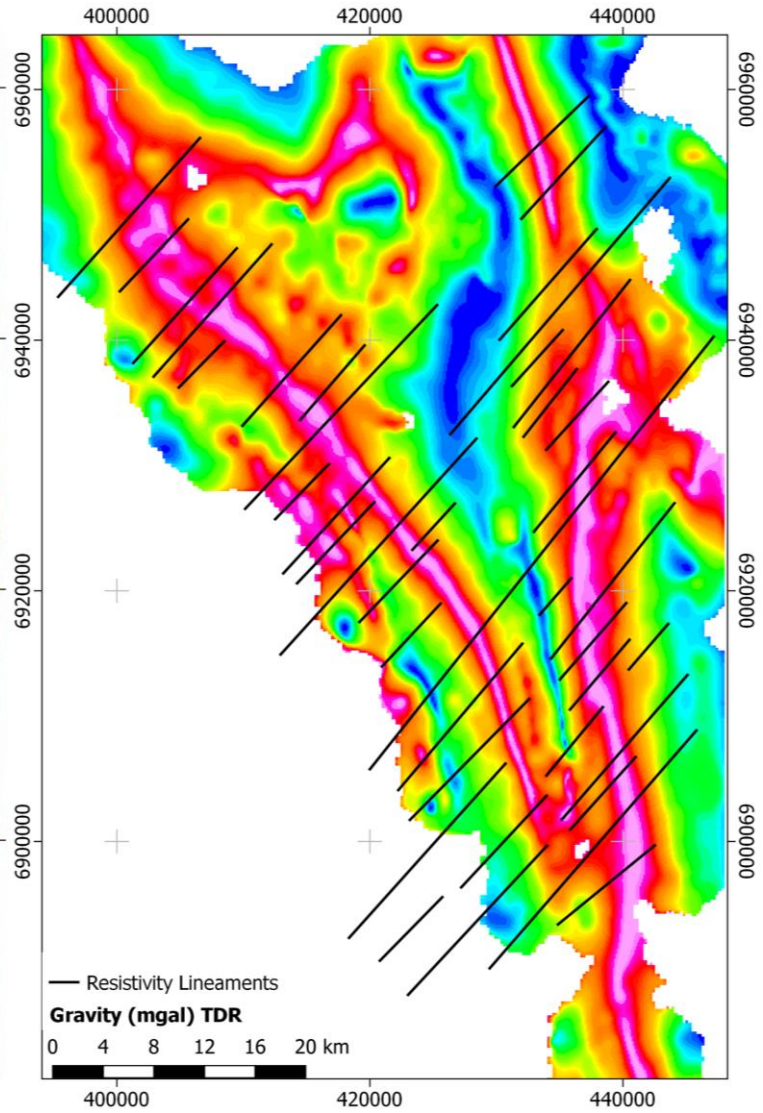


Resistivity Lineaments

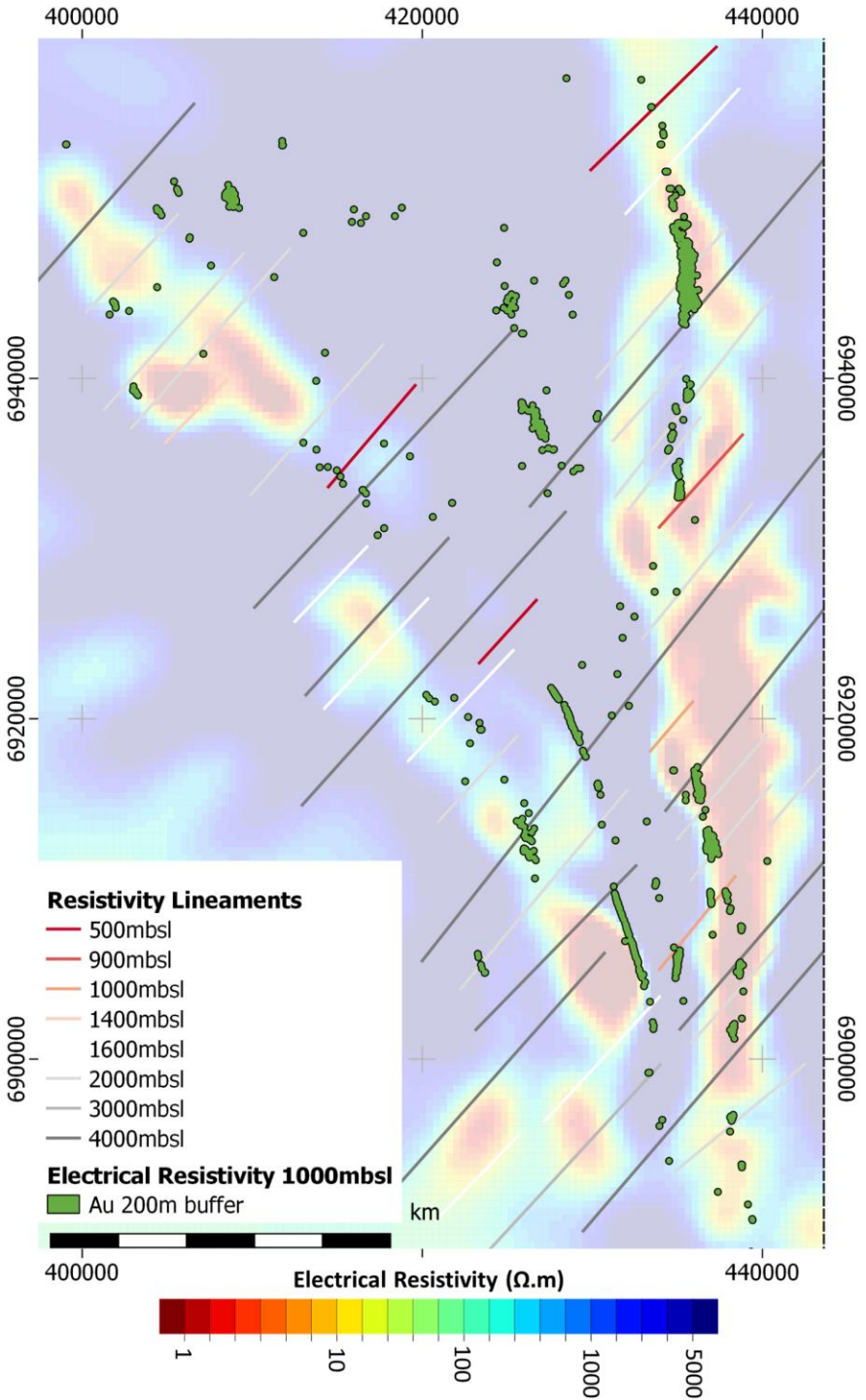
- Resistivity controlled, to some extent, by lithology and major structures
- Resistivity is not uniform for mapped geological units
- No clear control from geological maps
- Map lineaments at various depths of electrical models
  - termination
  - deflection
  - magnitude change

Correlation with potential field data



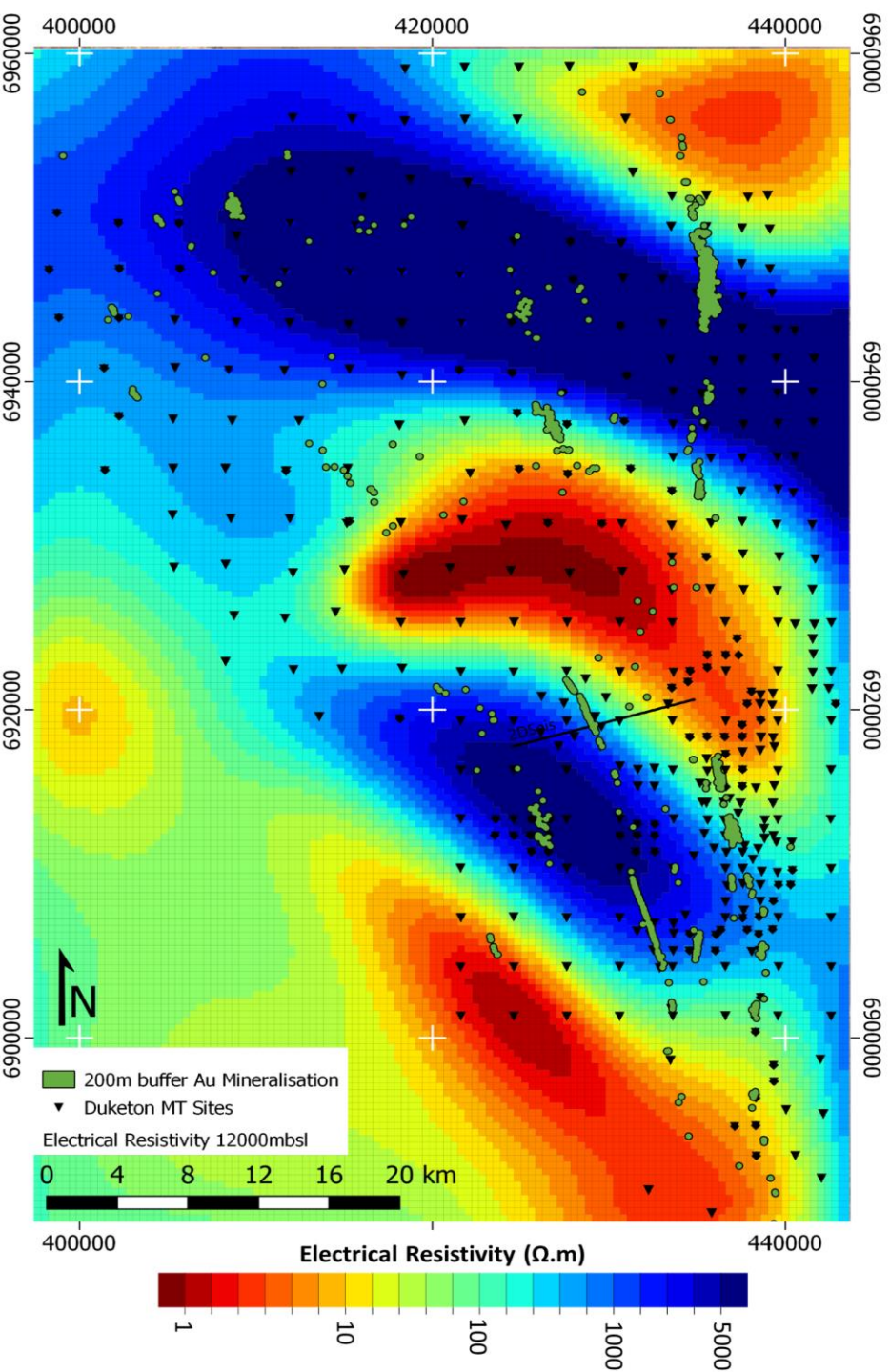


- Some correlation with gravity and magnetics
  - Strike and magnitude changes
- Best correlation observed in gravity in the northwestern part of the belt



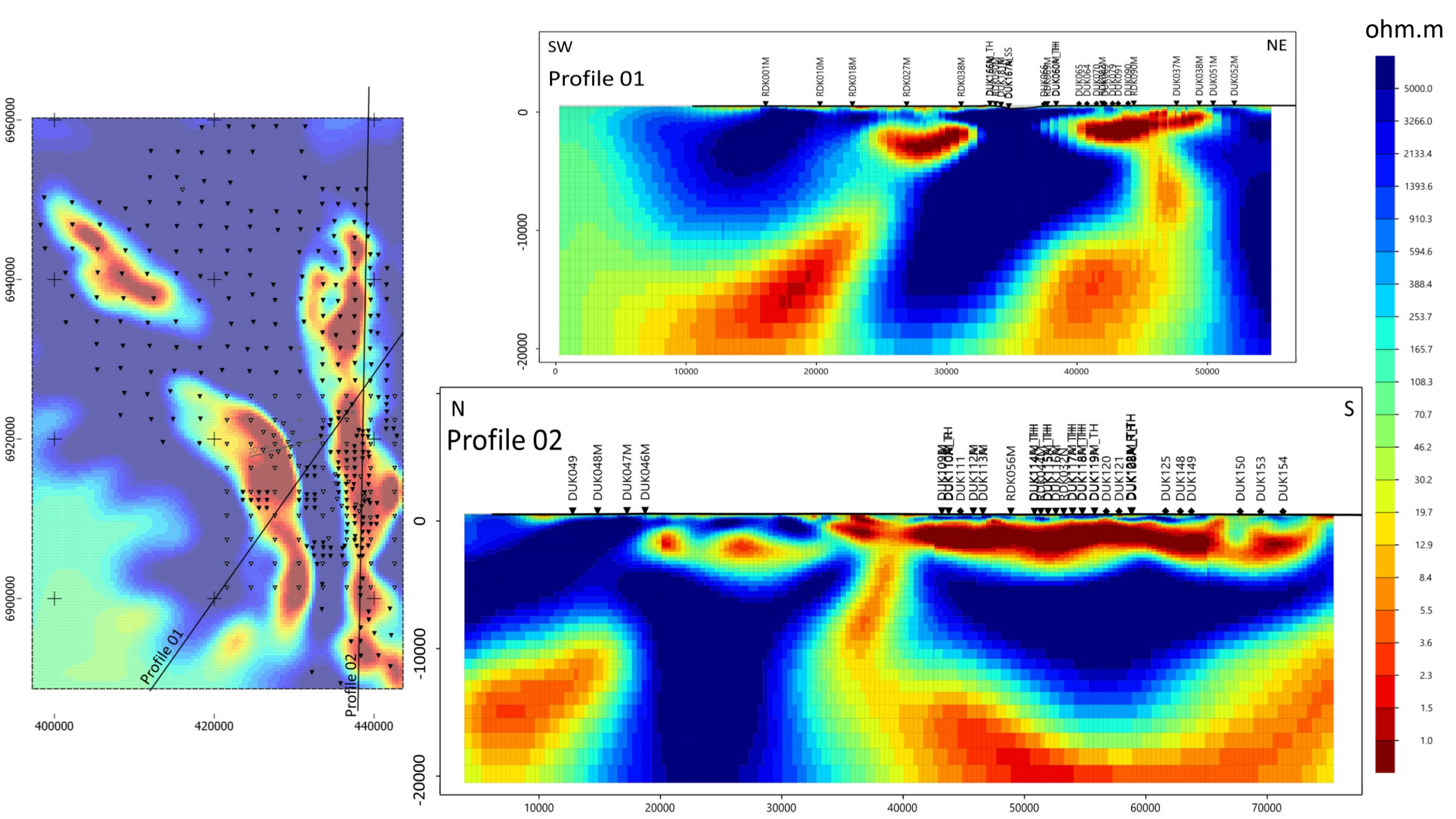
Resistivity lineaments and mineralisation

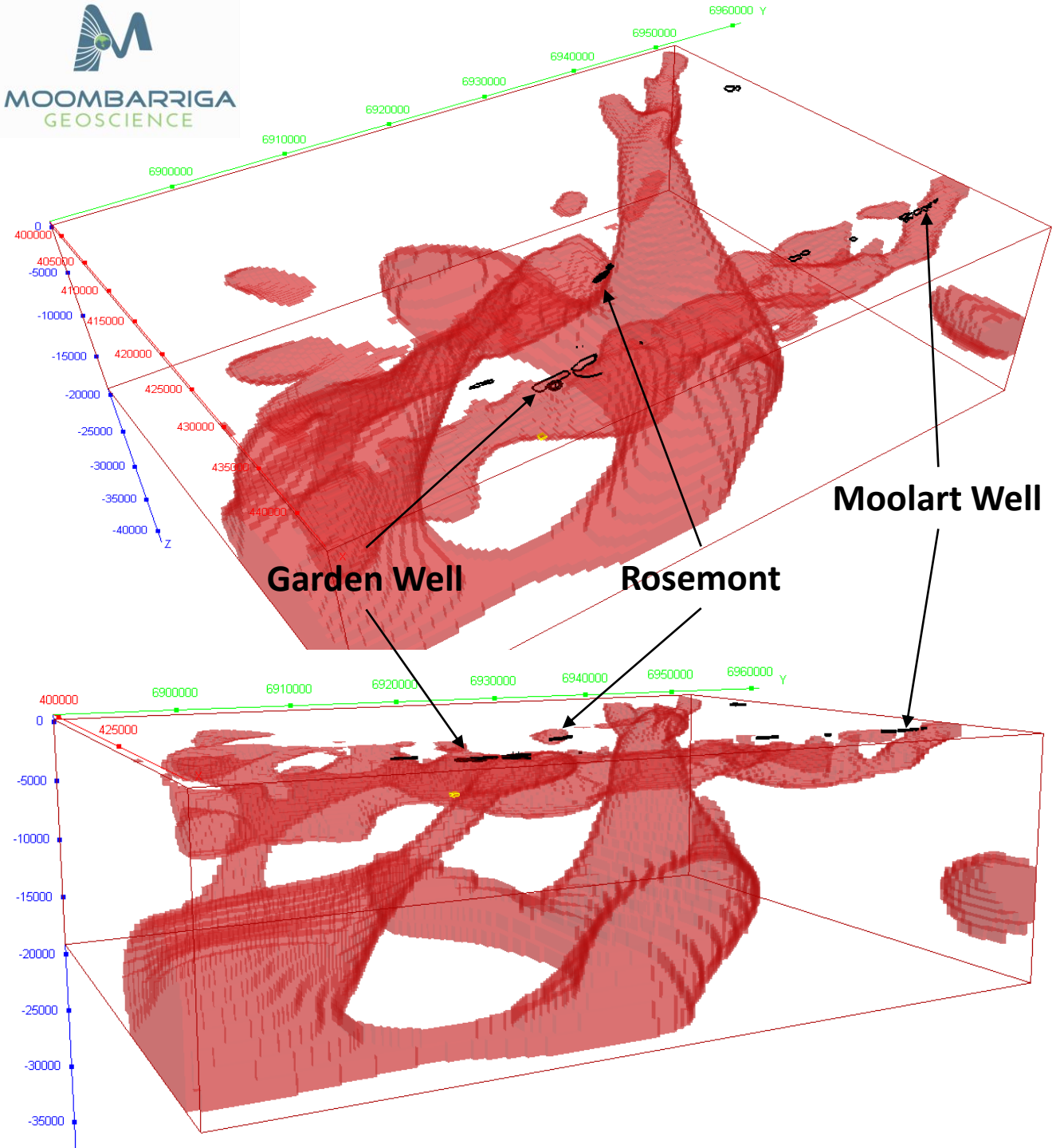
- Some correlation between the location of resistivity lineaments and the location of mineralization
- Mineralisation appears to terminate of some of these structures
- Known mineralisation seems to be controlled to some extent by these NE striking lineaments



Deep Resistivity (>10km)

- Series of conductive anomalies
  - Highly conductive <20 Ω.m
  - Orientated north-west
- Some evidence of lower resistivity at depth to the west (i.e., the Eastern Goldfield Terrane)
- Is it related to the highs, lows or gradients?

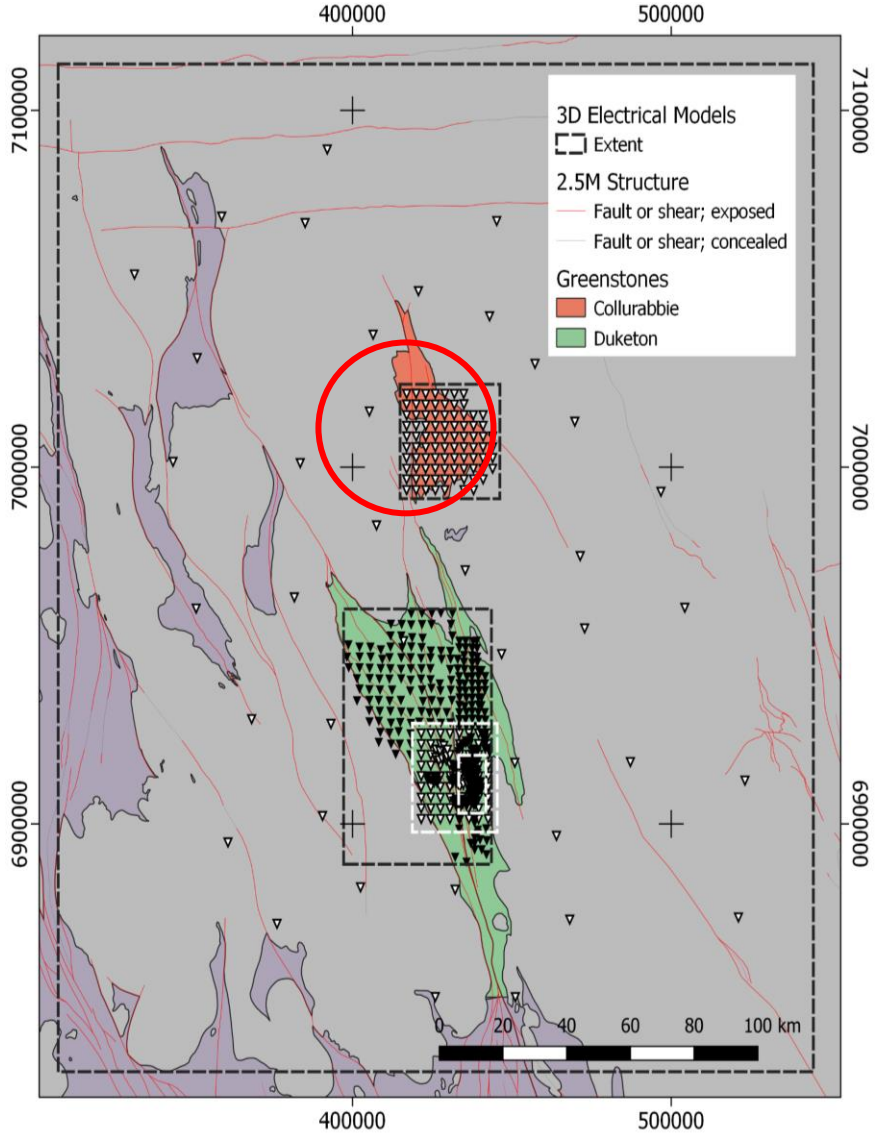

ohm.m
5000.0
3266.0
2133.4
1393.6
910.3
594.6
388.4
253.7
165.7
108.3
70.7
46.2
30.2
19.7
12.9
8.4
5.5
3.6
2.3
1.5
1.0
SW
NE
Profile 01
RDK001M
RDK010M
RDK018M
RDK027M
RDK038M
DUK037M
DUK038M
DUK051M
DUK052M
0
-10000
-20000
0
10000
20000
30000
40000
50000
N
S
Profile 02
DUK049
DUK048M
DUK047M
DUK046M
RDK056M
DUK111
DUK120
DUK121
DUK125
DUK148
DUK149
DUK150
DUK153
DUK154
0
-10000
-20000
10000
20000
30000
40000
50000
60000
70000
6960000
6940000
6920000
6900000
400000
420000
440000
Profile 01
Profile 02



Communication to depth

- 20 Ω.m shell
  - Deep <20 Ω.m conductor linked to shallow <20 Ω.m conductors
- Why 20 Ω.m?
  - High temperature hydrous minerals don't explain resistivity this low
  - Another mechanism usually expected
    - graphite films, magnetite, sulfides or free fluids
- Is this the next step, mapping paleo-reservoirs and fluid pathways of the mineral system?

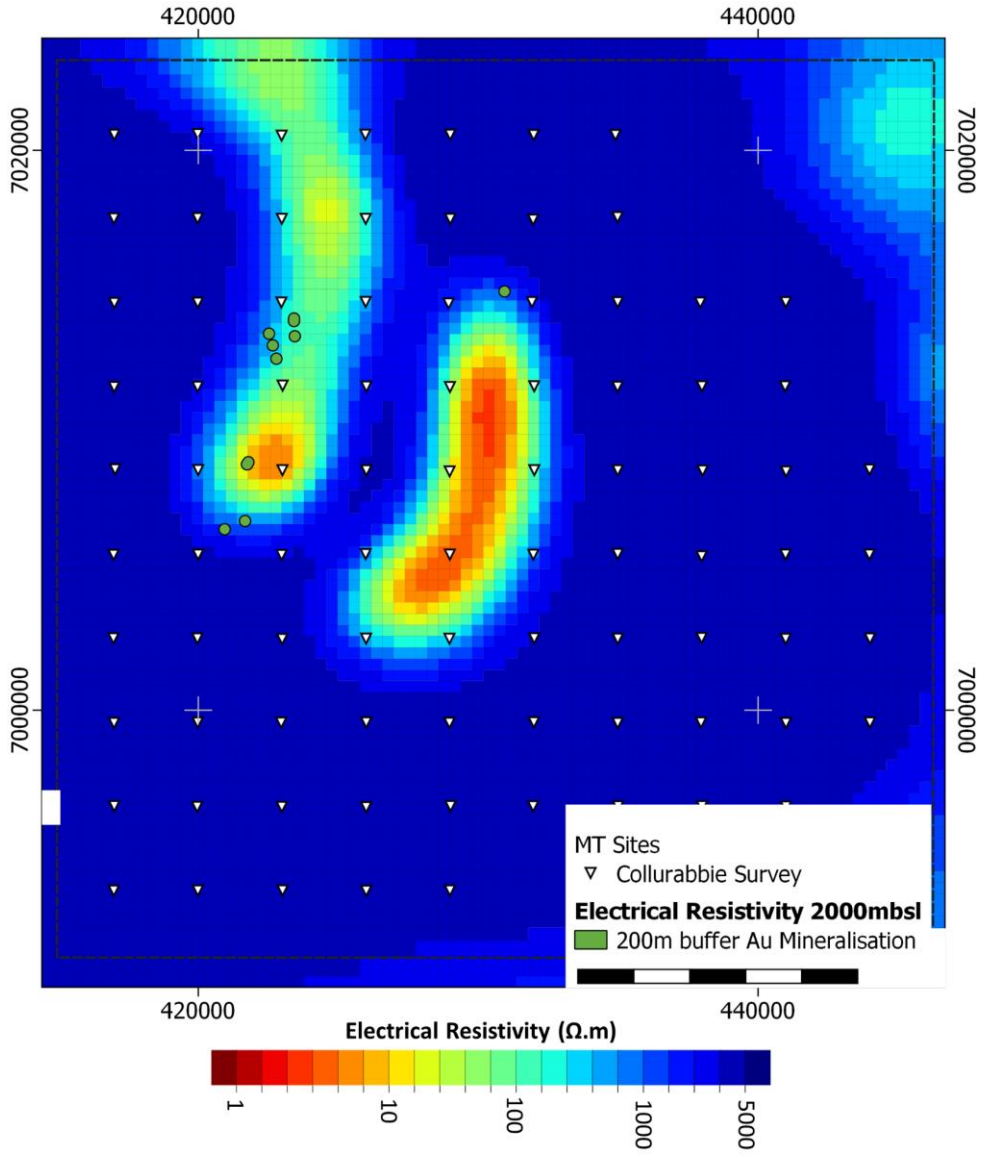
Collurabbie – hypothesis for mineralisation



- Greenstone belt to the north of the Duketon belt
- Little known mineralisation

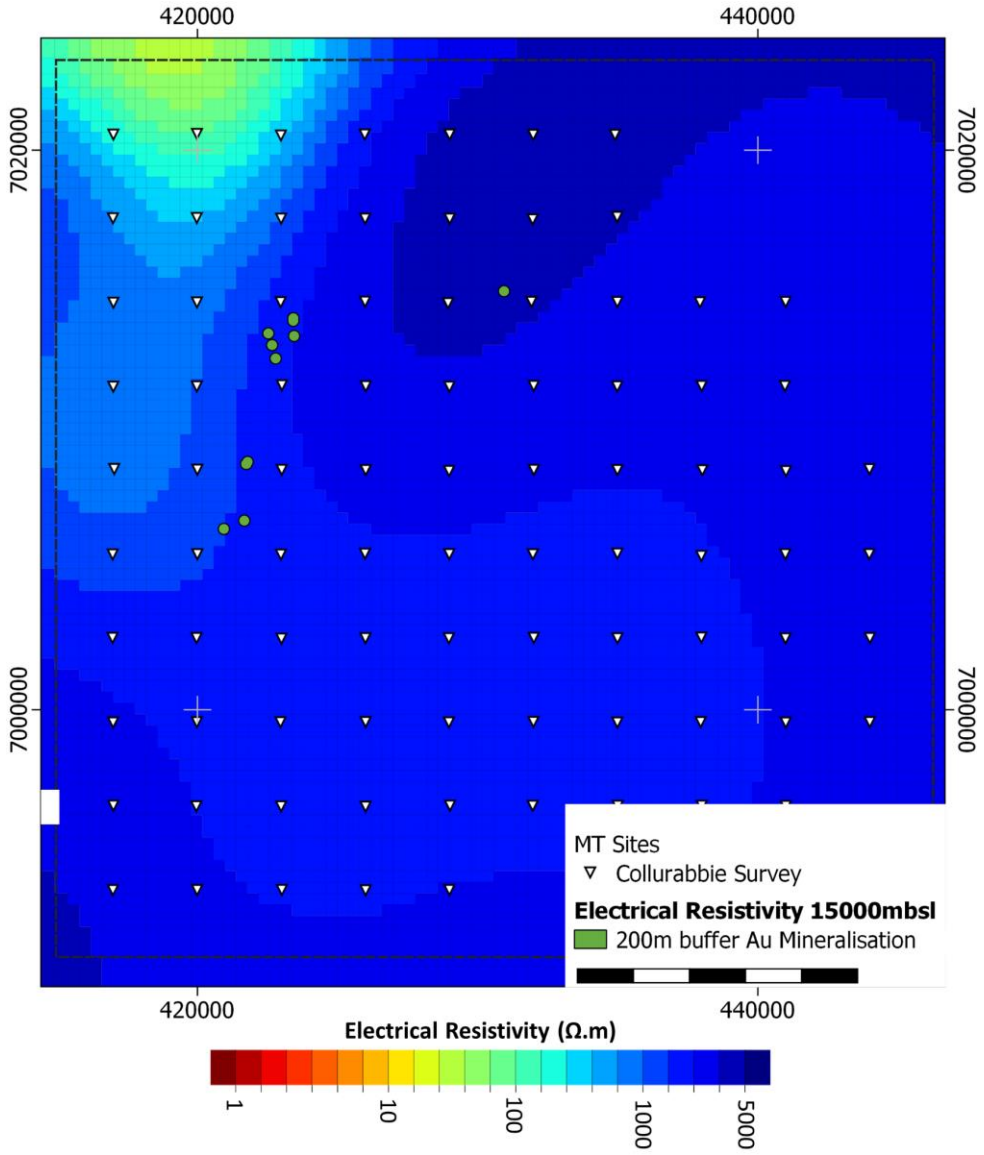
- MT survey 2019
  - 500-0.01Hz data inverted in 3D
  - RLM3D code

Collurabbie – hypothesis for mineralisation



- Near surface (<4km) conductor
- Known mineralisation correlates with shallow conductor

Collurabbie – hypothesis for mineralisation



- Near surface (<4km) conductor
- Known mineralisation correlates with shallow conductor
- Near surface conductor is narrow and dips to the north and out of the survey area
- **Key difference -** No deep (20-30km) conductor is imaged

MOOMBARRIGA GEOSCIENCE

Conclusion

- MT is a multiscale tool that provides information about the deep crust
- MT may be sensitive to source, reservoir and fluid pathways of mineral system in the crust
- The Duketon resistivity data appears to show the next step in mapping a mineral system
  - Deep conductors
  - Shallow conductors
  - Pathways between
- Timing? When would the MT data products be MOST helpful in exploration?

References

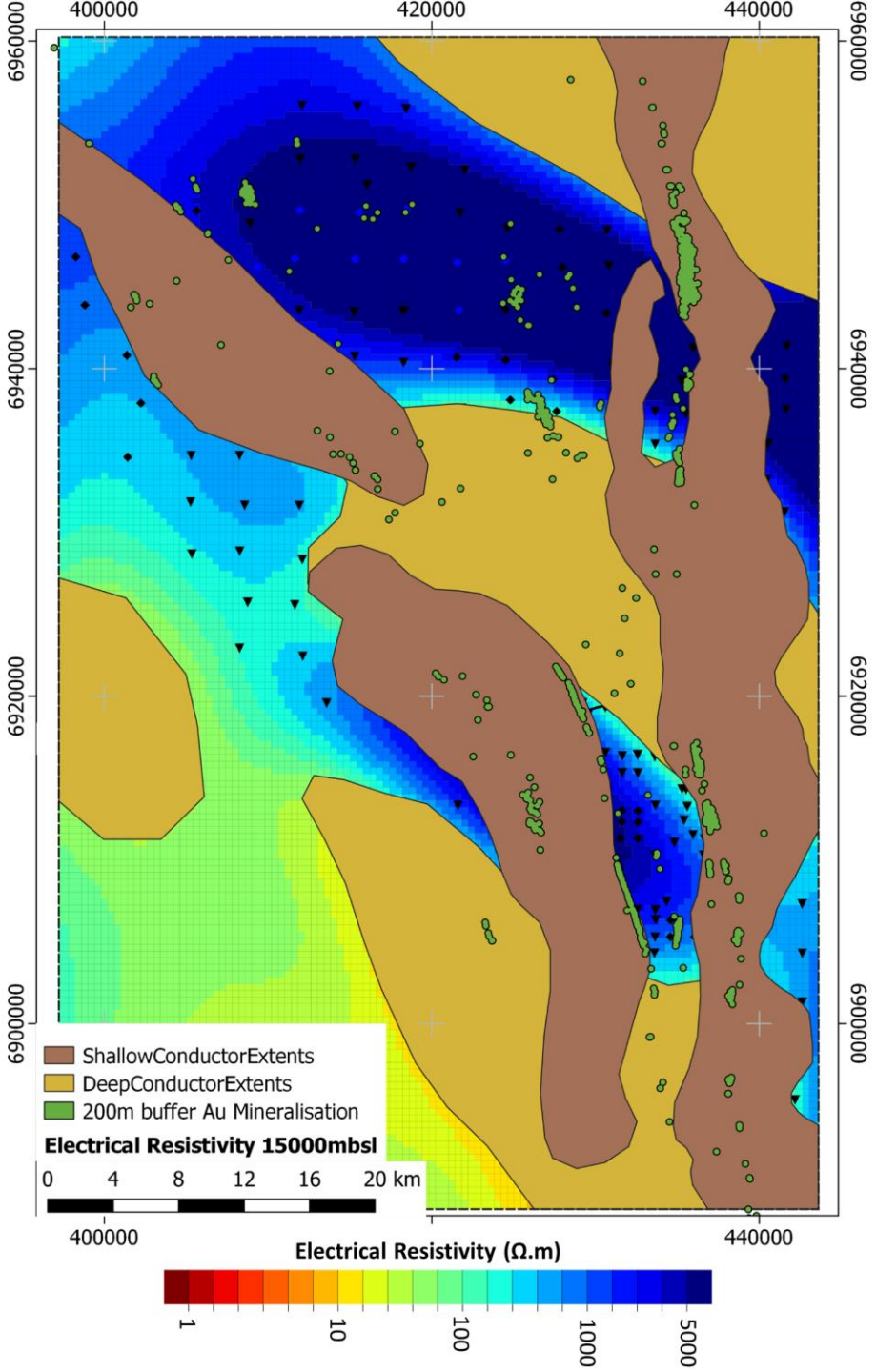
- Dentith, M., Evans, S., Thiel, S., Gallardo, L., Joly, A., Romano, S.S. 2013. A magnetotelluric traverse across the southern Yilgarn Craton. Report 121. Geological Survey of Western Australia, pp. 44.
- Duan, J. and Jiang, W. 2021. *Electrical resistivity structures and mineral prospectivity from Exploring for the Future AusLAMP data in northern Australia*. Record 2021/21. Geoscience Australia. Canberra. http://dx.doi.org/10.11636/Record.2021.021
- Groves, D., Santosh, M., Deng, J., Wang, Q., Yang, L. and Zhang, L. 2019. A holistic model for the origin of orogenic gold deposits and its implications for exploration. Mineralium Deposita. Vol. 55 pp 275-292.
- Heinson, G., Yohannes, D., Soeffky, P., Thiel, S. and Wise, T. 2018. *The crustal geophysical signature of a world-class magmatic mineral system.* Scientific Reports Vol. 8 Article number: 10608.
- Heinson, G., Duan, J., Kirkby, A., Robertson, K., Thiel, S., Aivazpourporgou, S., and Soyer, W. 2021. Lower crustal resistivity signature of an orogenic gold system. Scientific Reports Vol. 11 Article number: 15807.
- Witherly, K. 2015. Building effective mineral system models – the importance of merging geophysical observation with geological inference. ASEG Extended Abstracts, 2015: 1, 1-4.

MOOMBARRIGA GEOSCIENCE

Inversion details

ModelID	Sites	Cell size	Freq Range	X Cells	Y Cells	Z Cells	Total Cells	RMS
Hi-Res	202	200 m	10k-0.01	143	162	106	2,455,596	3.29
Regional	384	400 m	500-0.01	143	206	81	2,386,098	3.44

- Why?
- Areas of the model with relatively poor fit – these bias RMS value
- Which areas?



Deep and Shallow Anomalies vs Mineralisation