Building geophysical data in the Northern Territory, Australia: an industry and government collaboration

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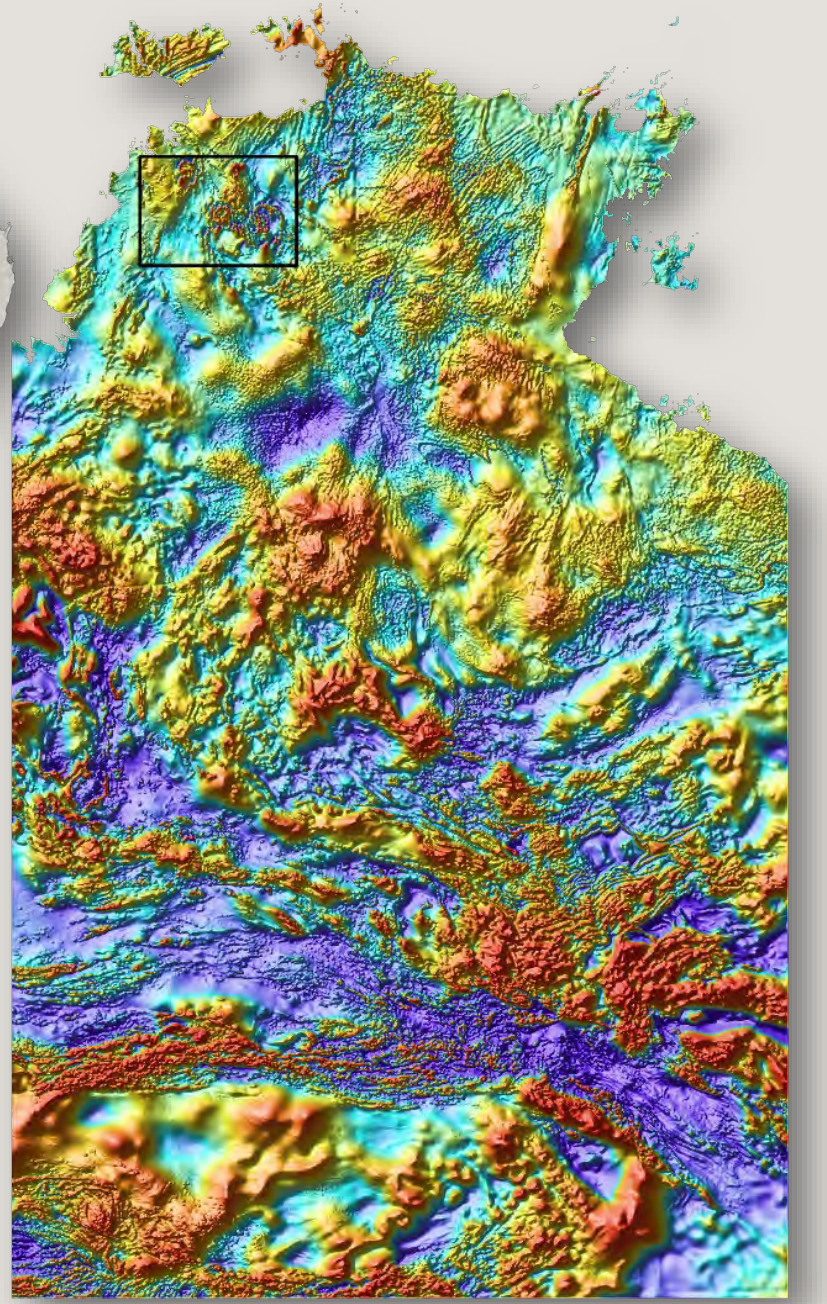
Introduction

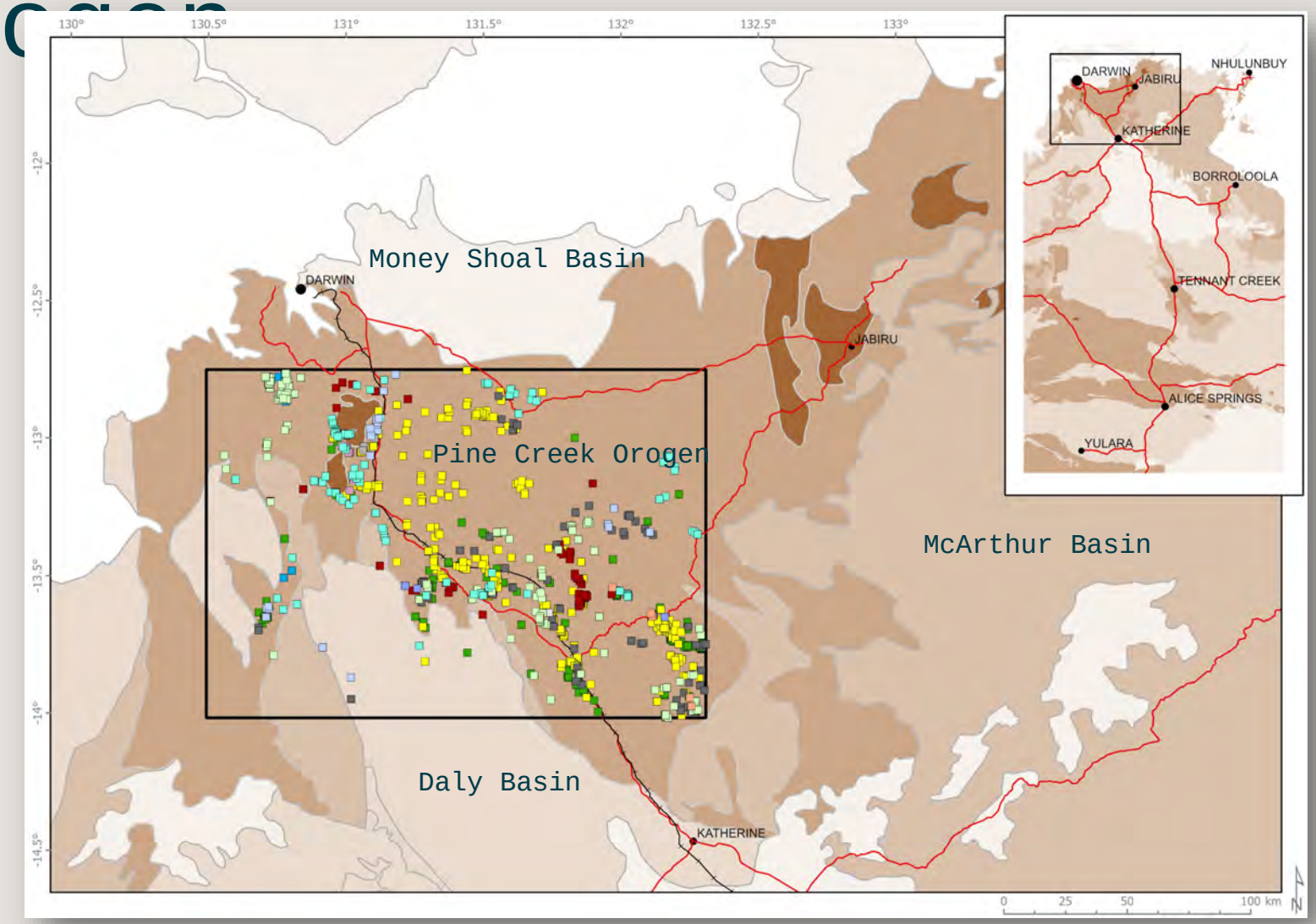
Geophysical data in the NT sources:

- Northern Territory Government led by Northern Territory Geological Survey (NTGS)
- Commonwealth Government led by Geoscience Australia (GA)
- Northern Territory Government – exploration industry collaborations supported by NTGS Geophysics and Drilling Collaborations (GDC) program
- Exploration industry data submitted to Northern Territory Government to meet legislative requirements

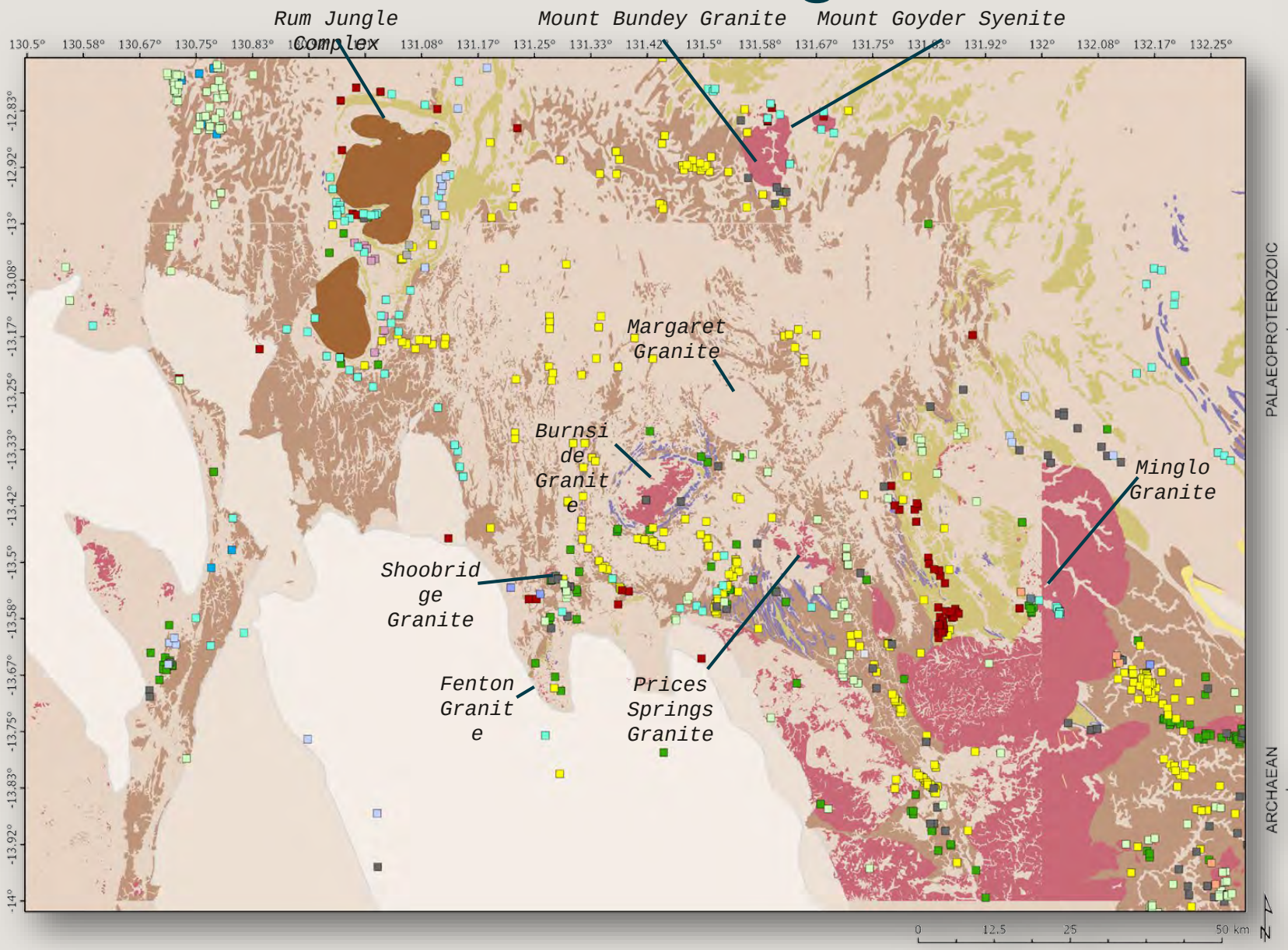


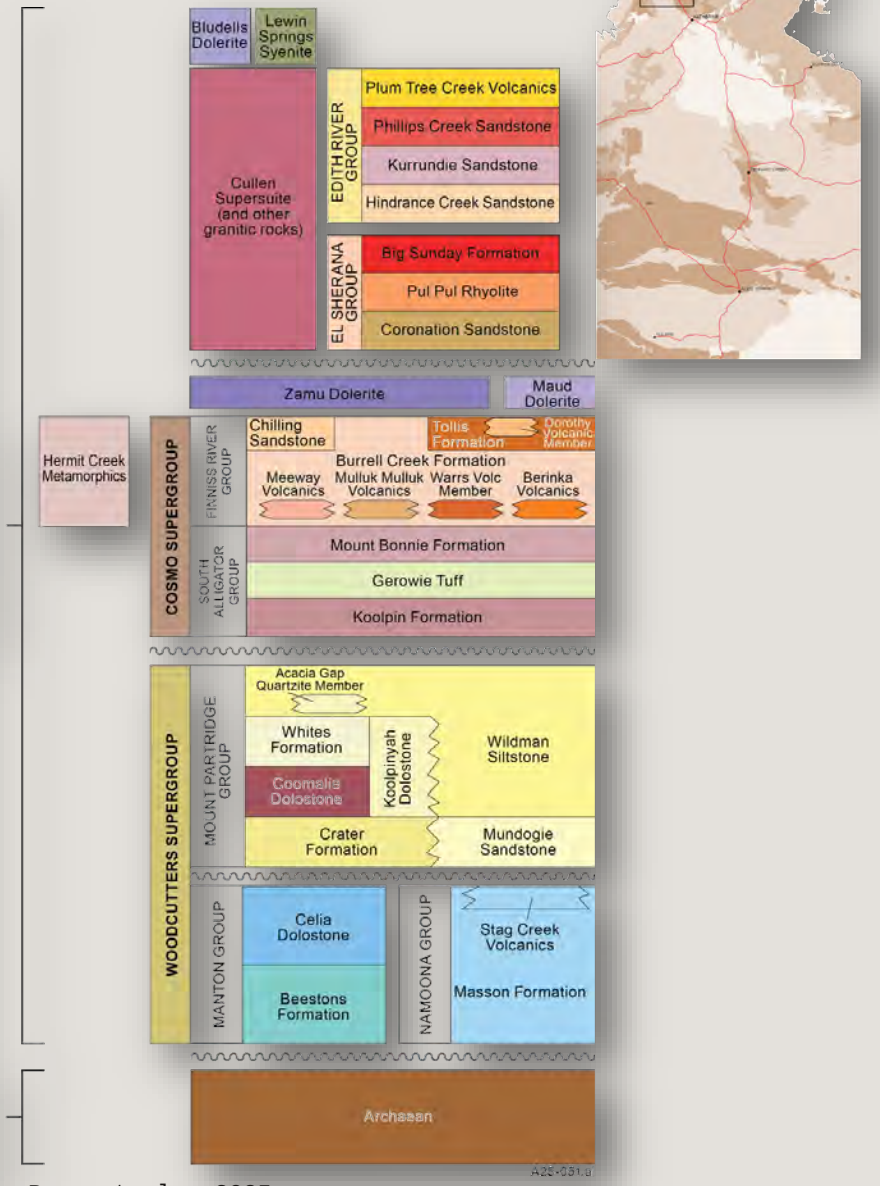
Pine Creek Orogen

- Focus of exploration since the late 1800's and is prospective for gold, uranium, base metals and critical minerals
- Palaeoproterozoic meta-sediments and volcaniclastic rocks unconformably overlying Neoarchean basement and intruded by voluminous mafic and felsic igneous rocks



Pine Creek Orogen

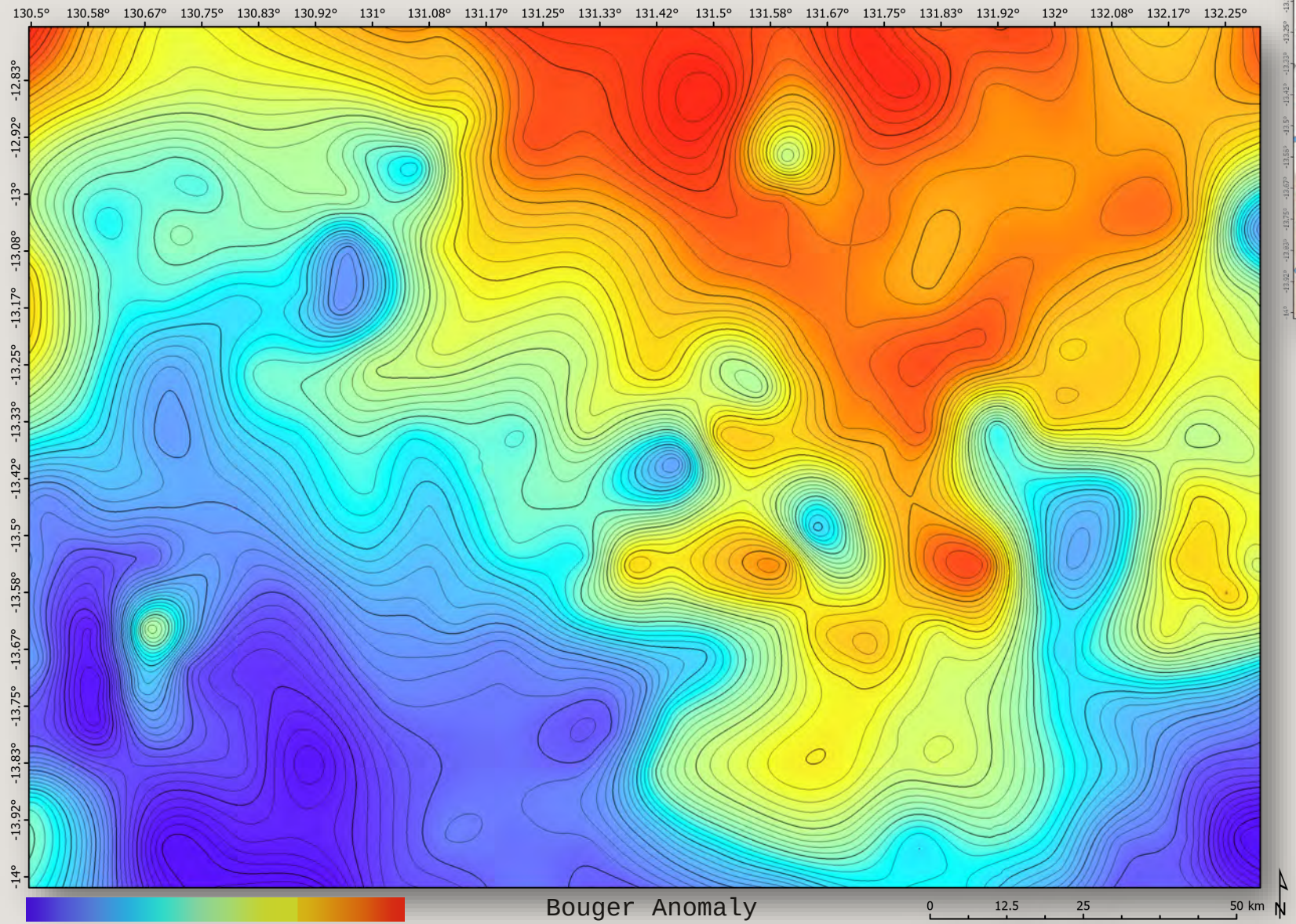


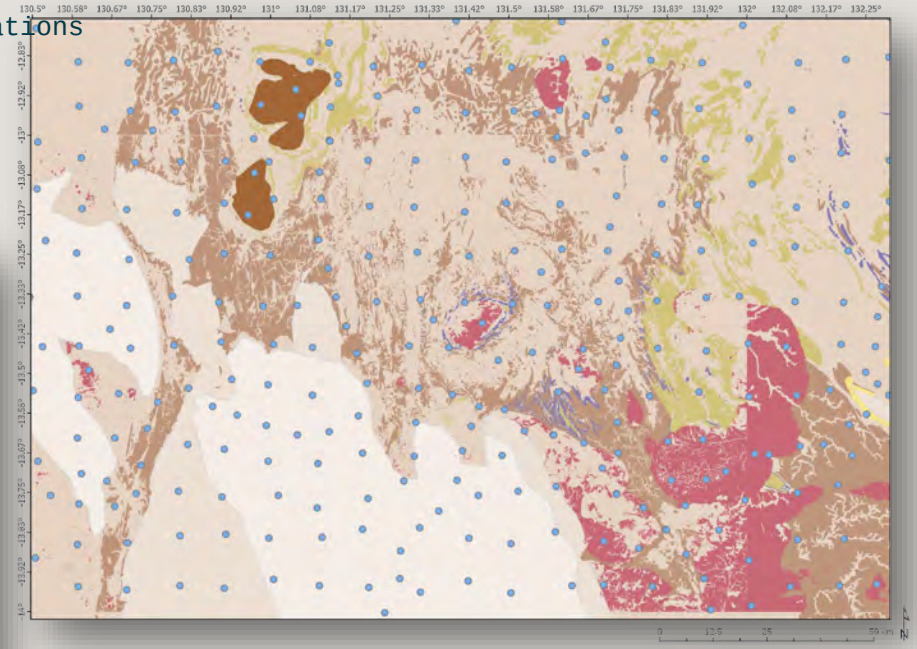


Reno et al., 2025

RESOURCING THE TERRITORY

Ground Gravity





- Acquired 1960's
- Bureau of Mineral Resources (BMR) now GA
- Broad ~11 km spaced grid
- Around 300 stations

RESOURCING THE TERRITORY

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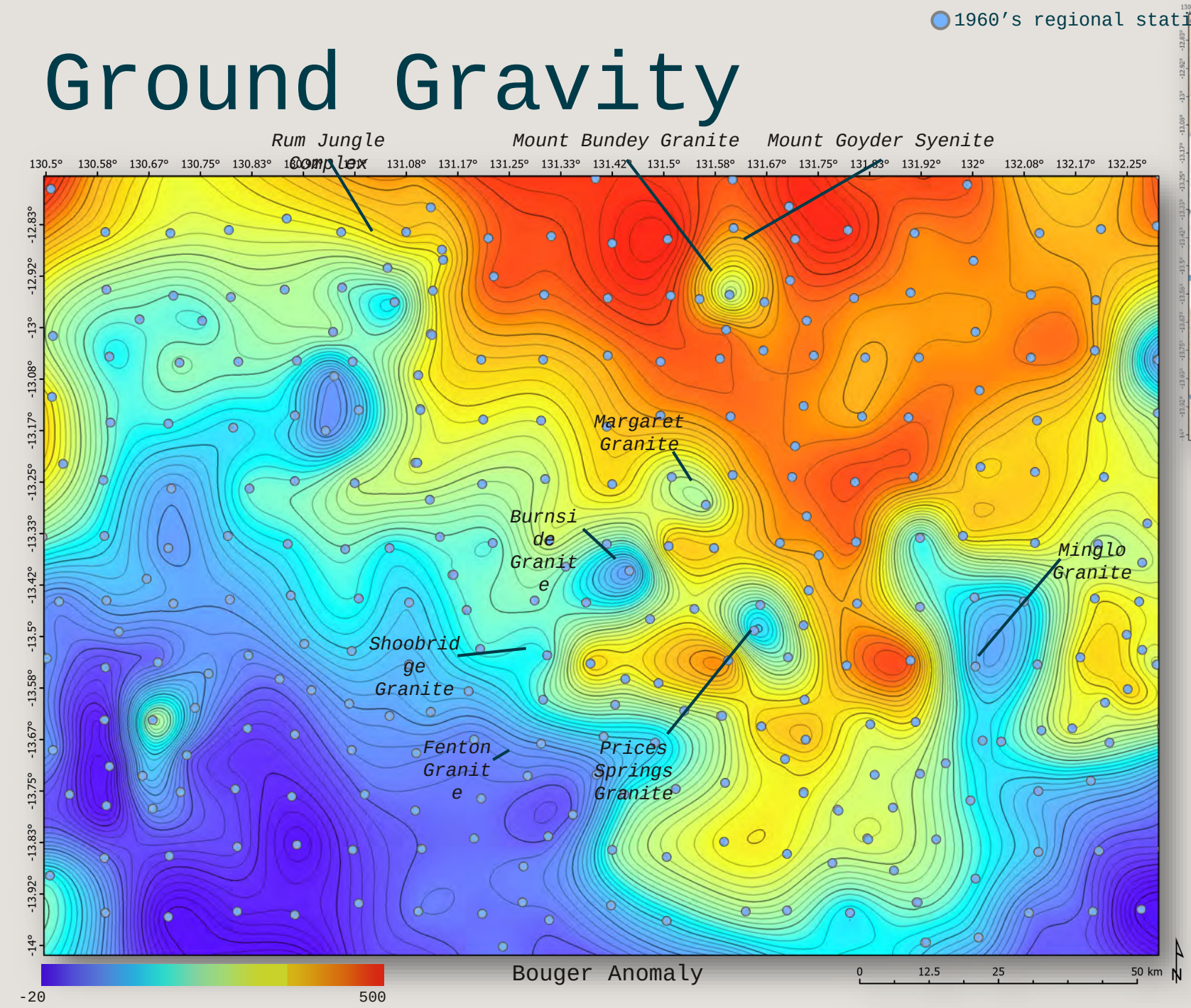

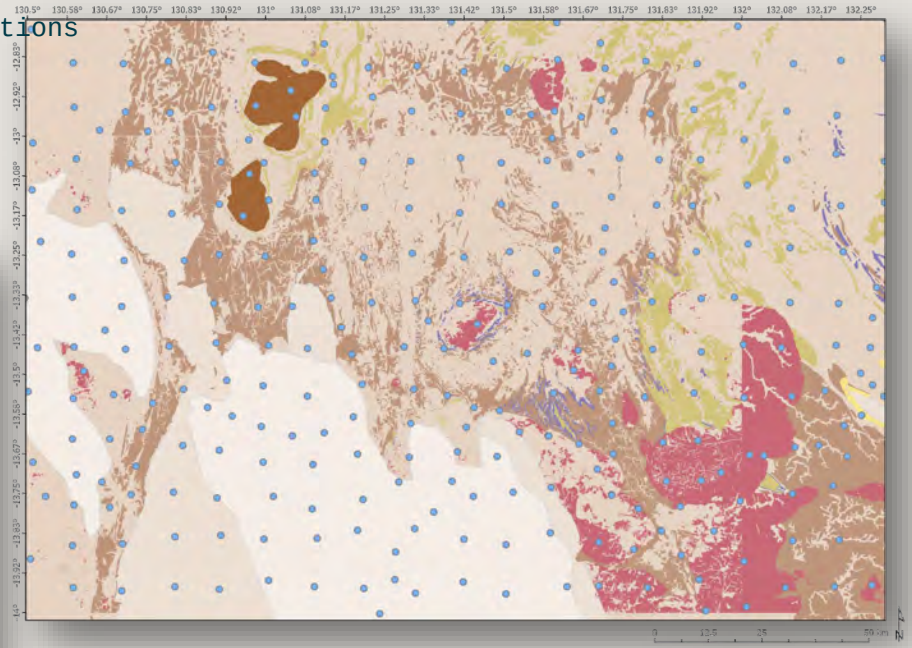

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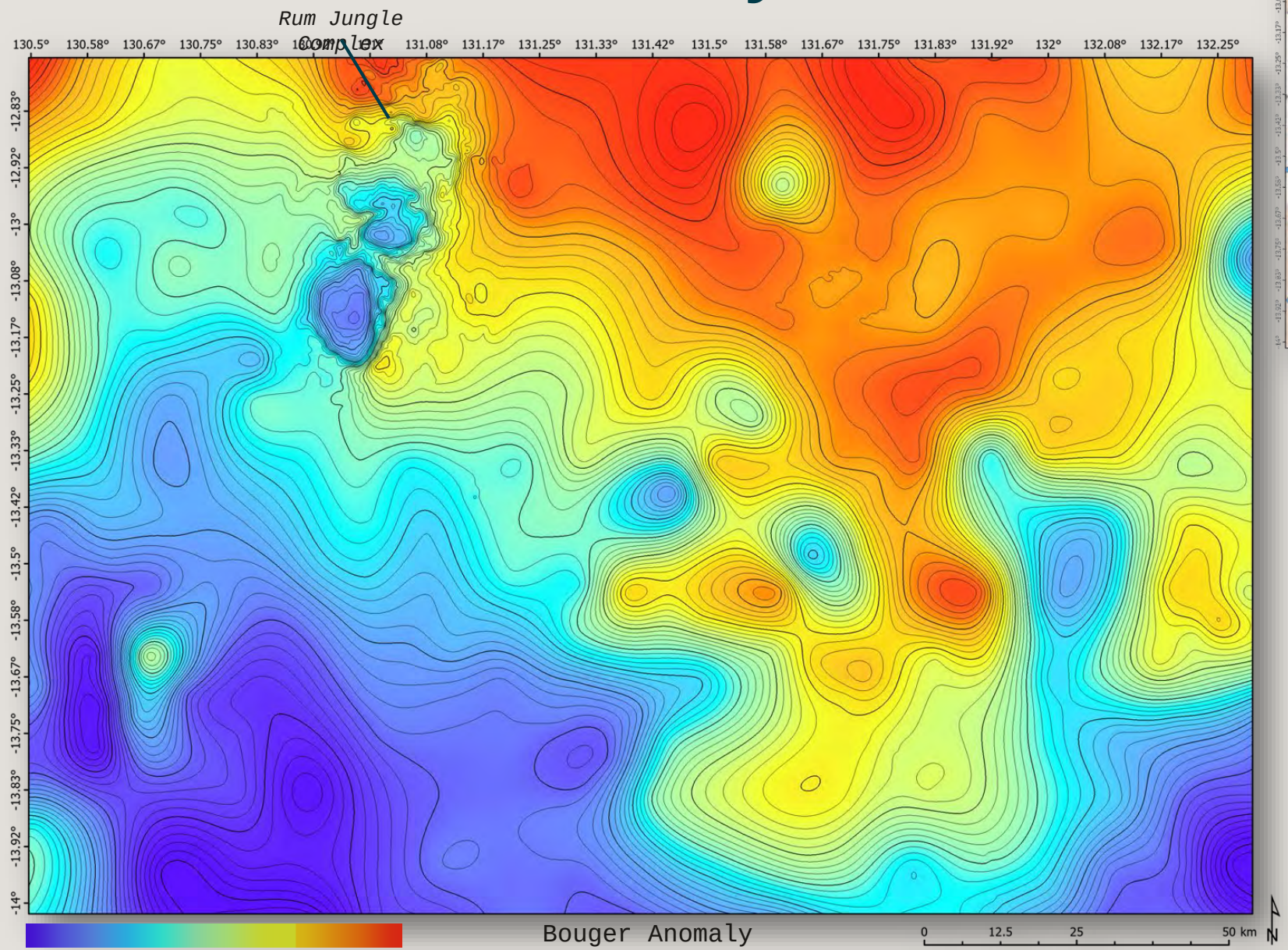
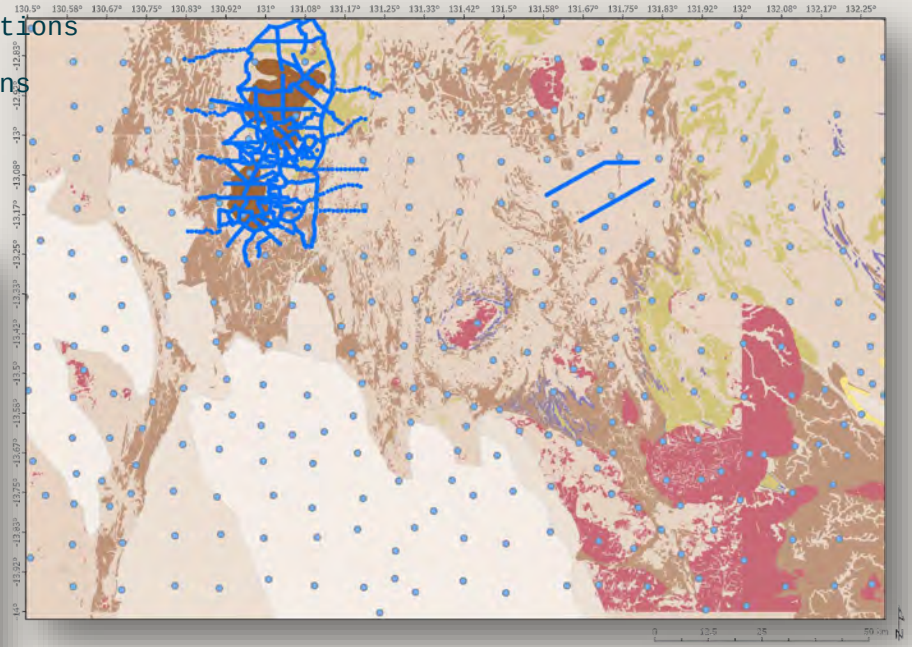


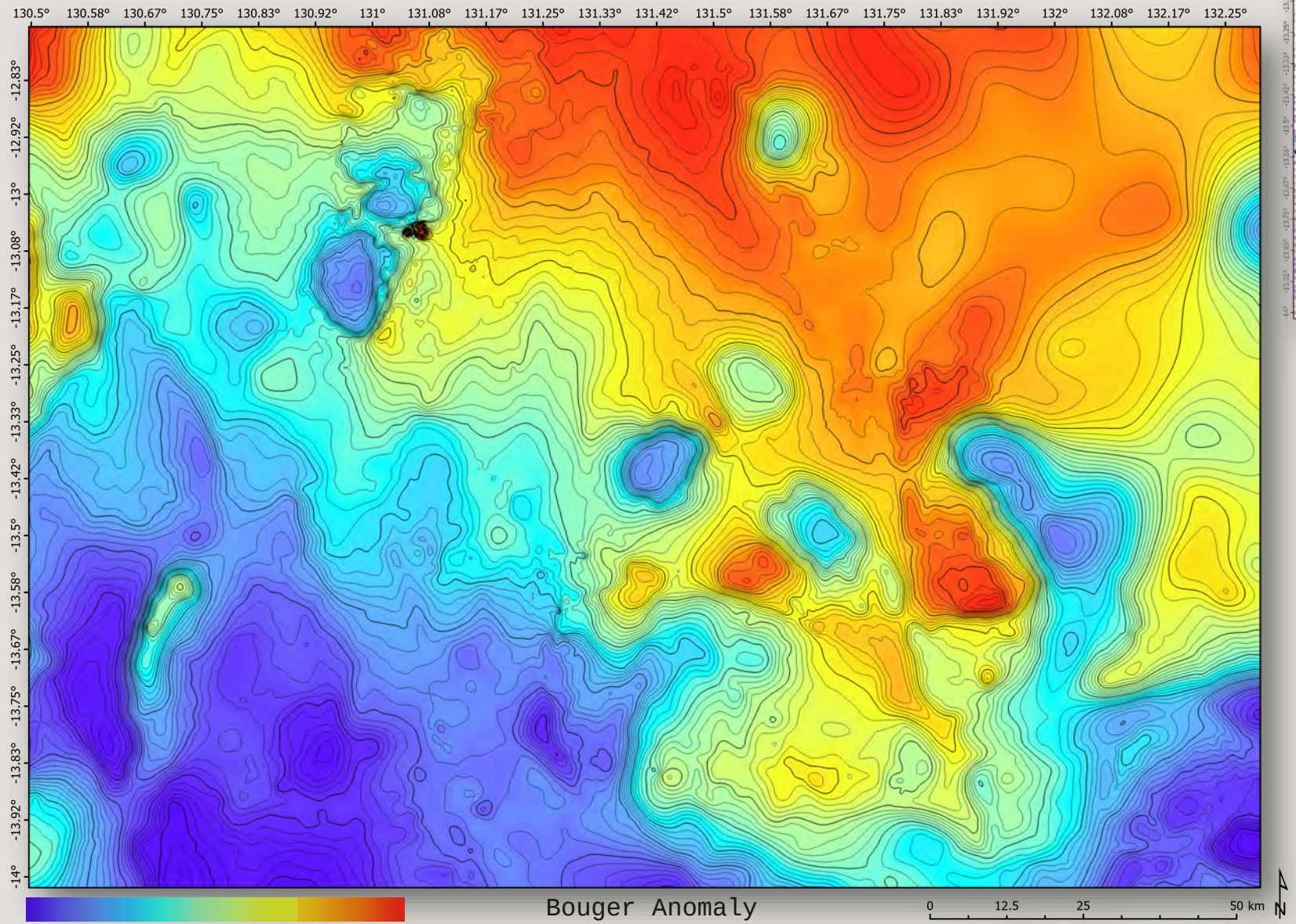


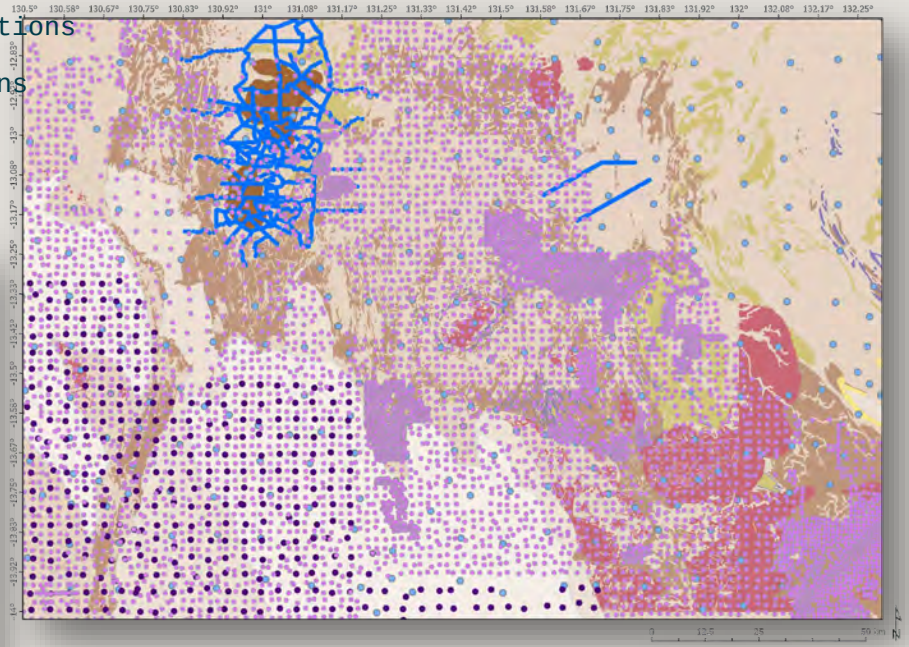
- Detailed road traverses (1970's) focussed on Rum Jungle Complex by BMR
- 1560 stations at ~500 m spacing
- McKinlay River gravity traverses (1996) by BMR for NTGS
- 213 stations at 200 m spacing

RESOURCING THE TERRITORY

Ground Gravity

NTGS Daly Basin Ground Gravity Survey
NTGS Pine Creek Ground Gravity Survey
1960's regional stations
BMR traverse stations



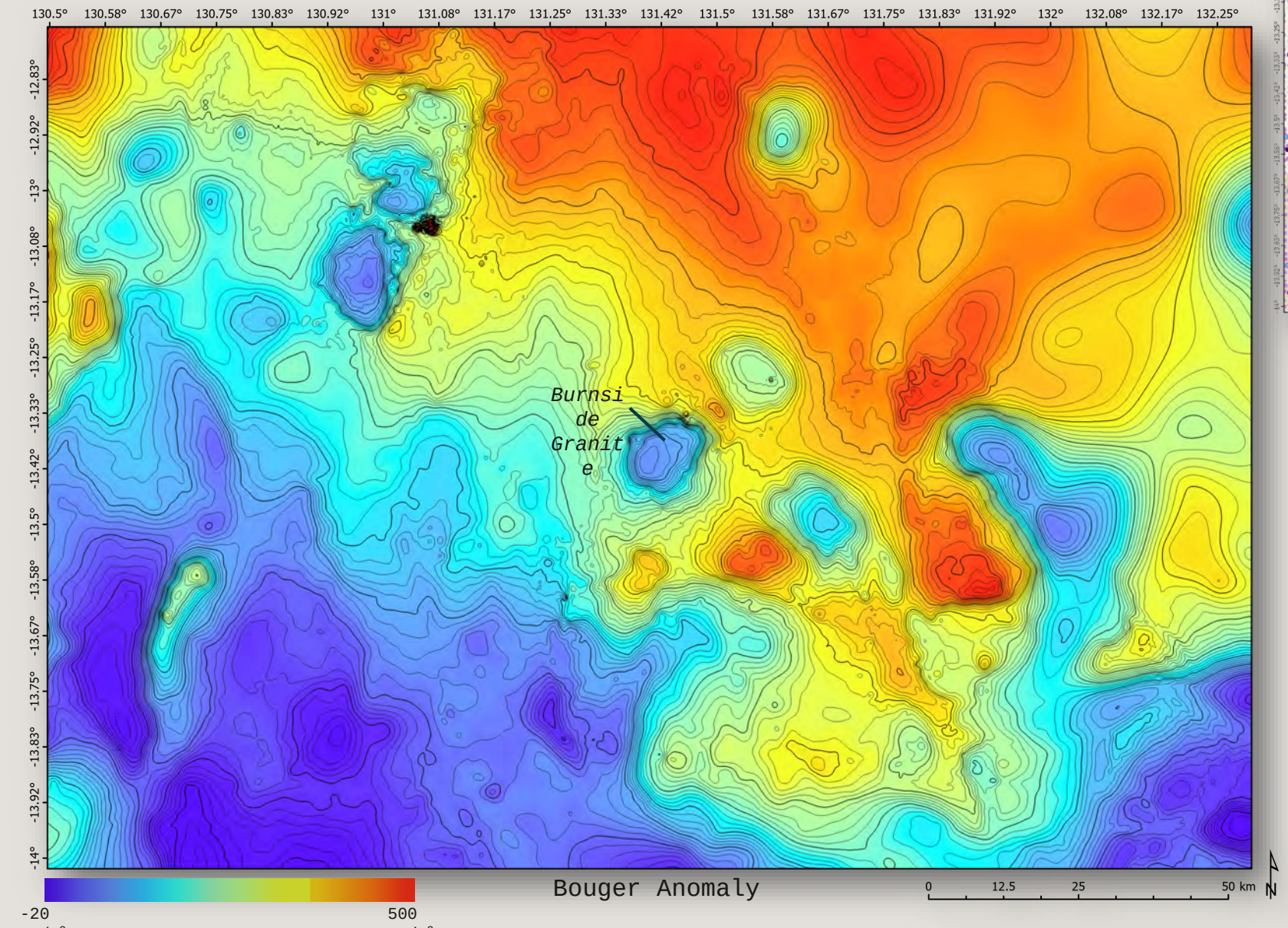


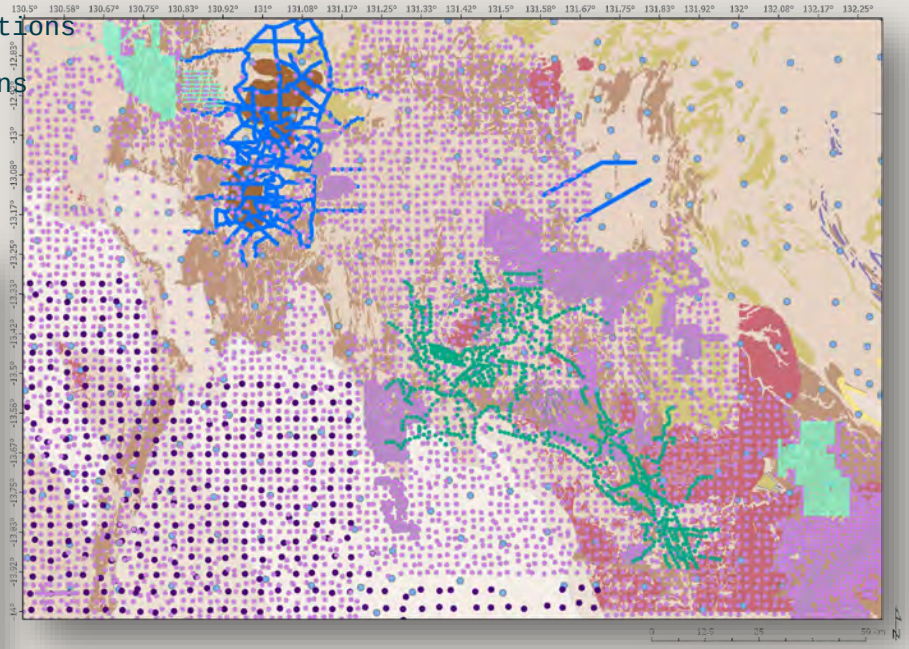
- NTGS Daly Basin survey (2016)
- 338 stations @ 4 km spacing
- NTGS Pine Creek survey (24/25)
- 7613 stations
- Primarily 2 km spacing with infill to 1 km and 500 m supported by industry

RESOURCING THE TERRITORY

Ground Gravity

NTGS Daly Basin Ground Gravity Survey
NTGS Pine Creek Ground Gravity Survey
GDO stations
1960's regional stations
BMR traverse stations
Industry stations



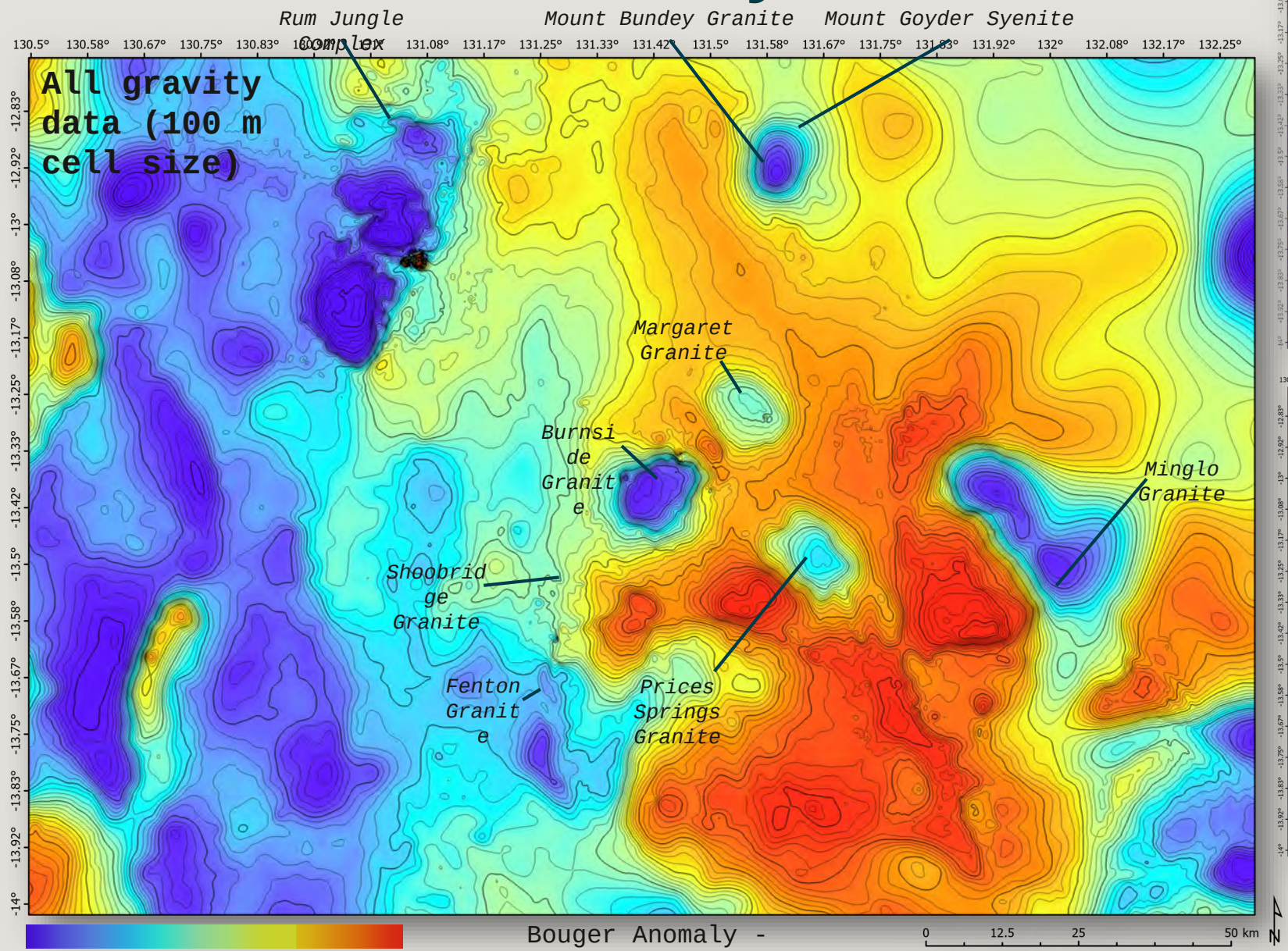


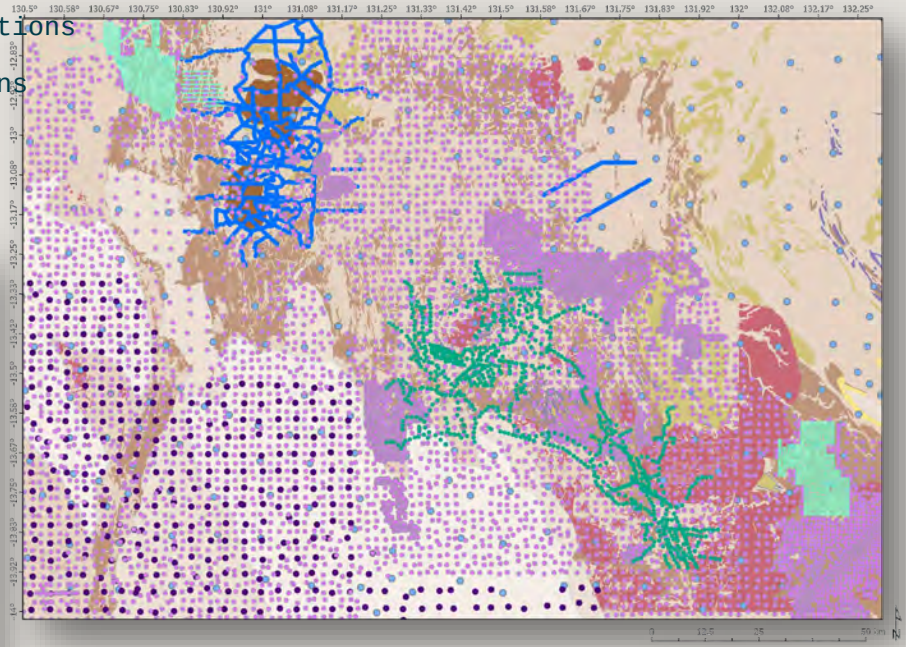
- Two geophysics and drilling collaborations surveys:
  - Core Lithium Ltd CR2020-0372 (NW)
  - PNX Metals Ltd CR2024-0089 (SE)
  - Almost 2000 stations @ 500 m spacing
- One industry survey
  - Acacia Resources in collaboration with University of Tasmania CR2001-0197
  - Over 900 stations along traverses at 500 m to 1500 m spacing

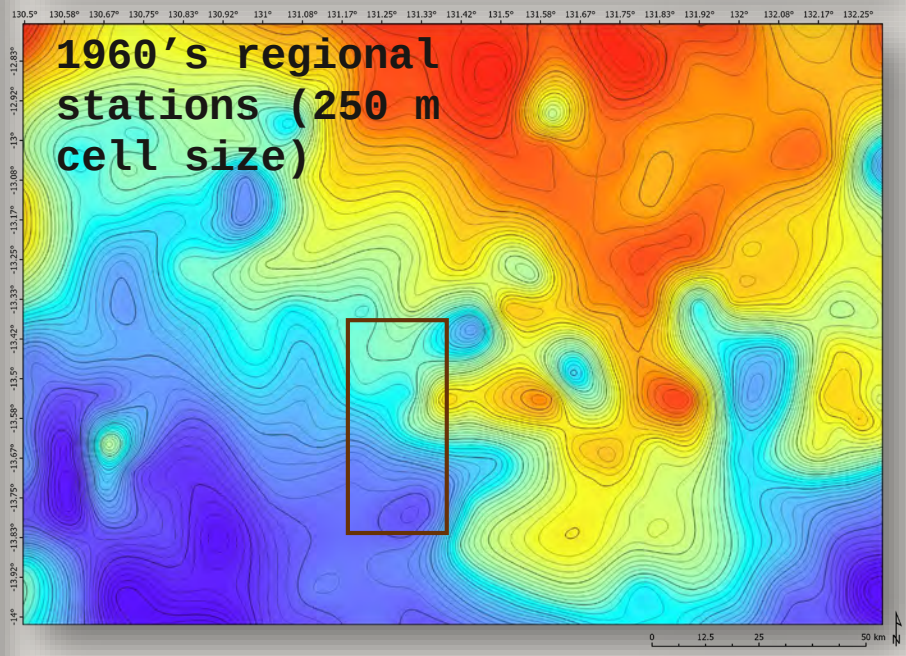
RESOURCING THE TERRITORY

Ground Gravity

NTGS Daly Basin Ground Gravity Survey
NTGS Pine Creek Ground Gravity Survey
GDD stations
1960's regional stations
BMR traverse stations
Industry stations

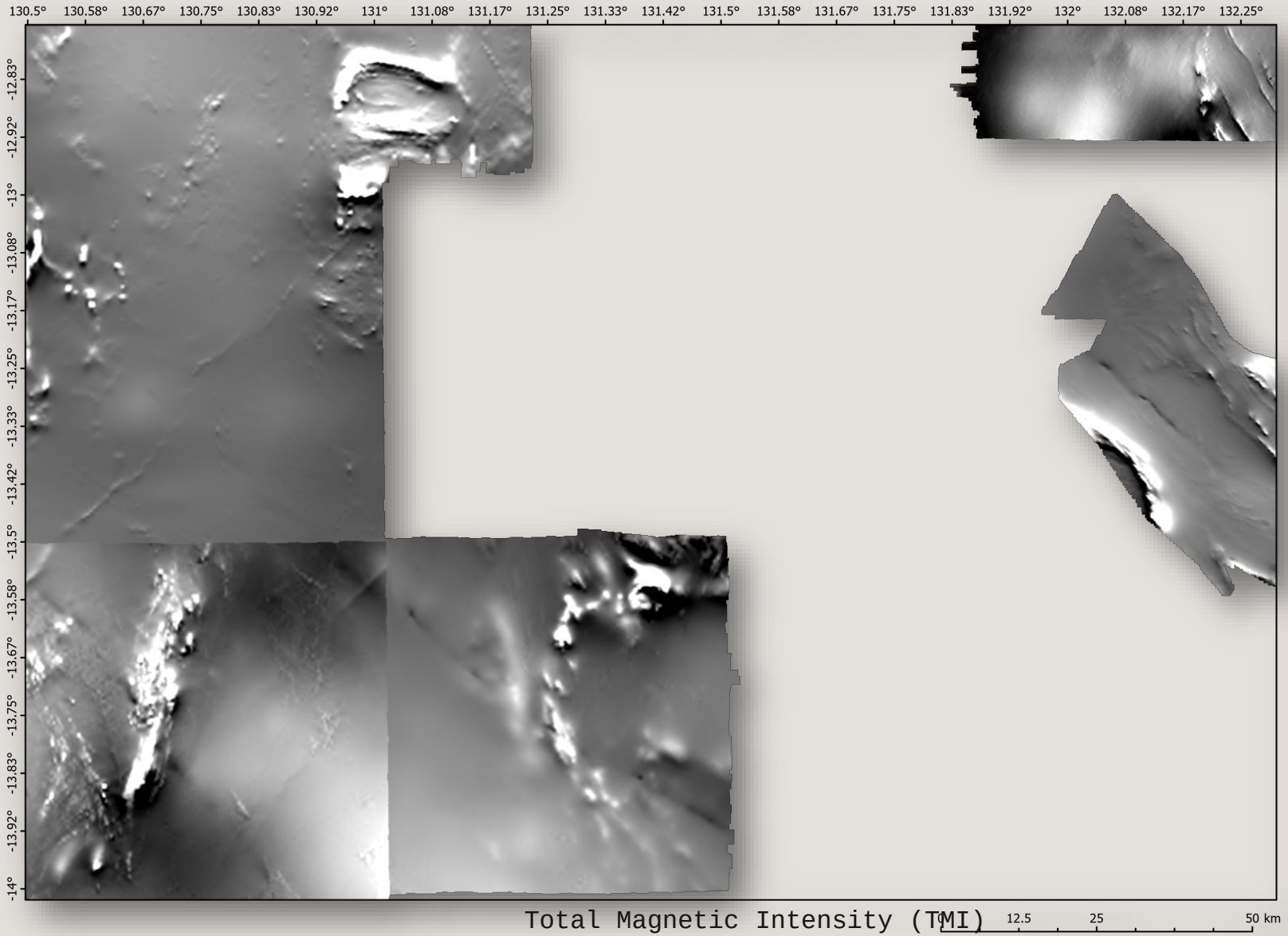


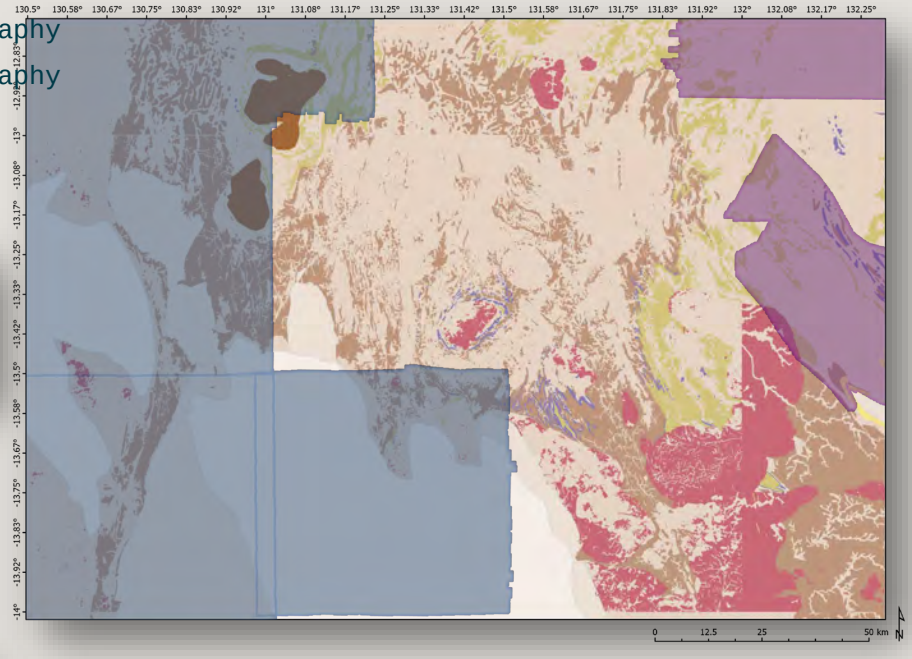




RESOURCING THE TERRITORY

Airborne Magnetics



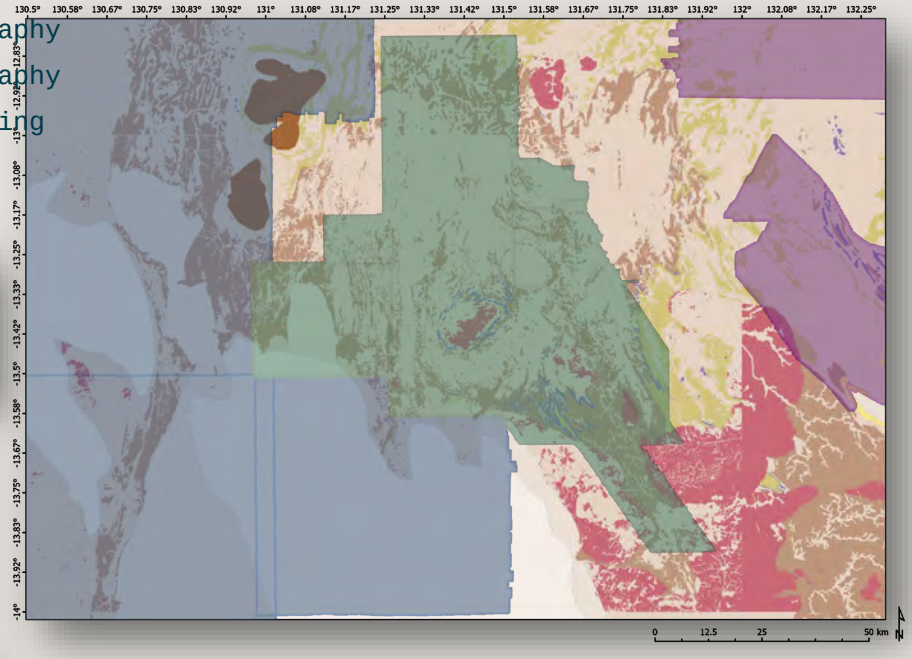


Navigation by aerial photography / unknown:

- Commenced in the 1980's
- 3 surveys at 500 m line spacing
- 2 surveys at 250 m line spacing

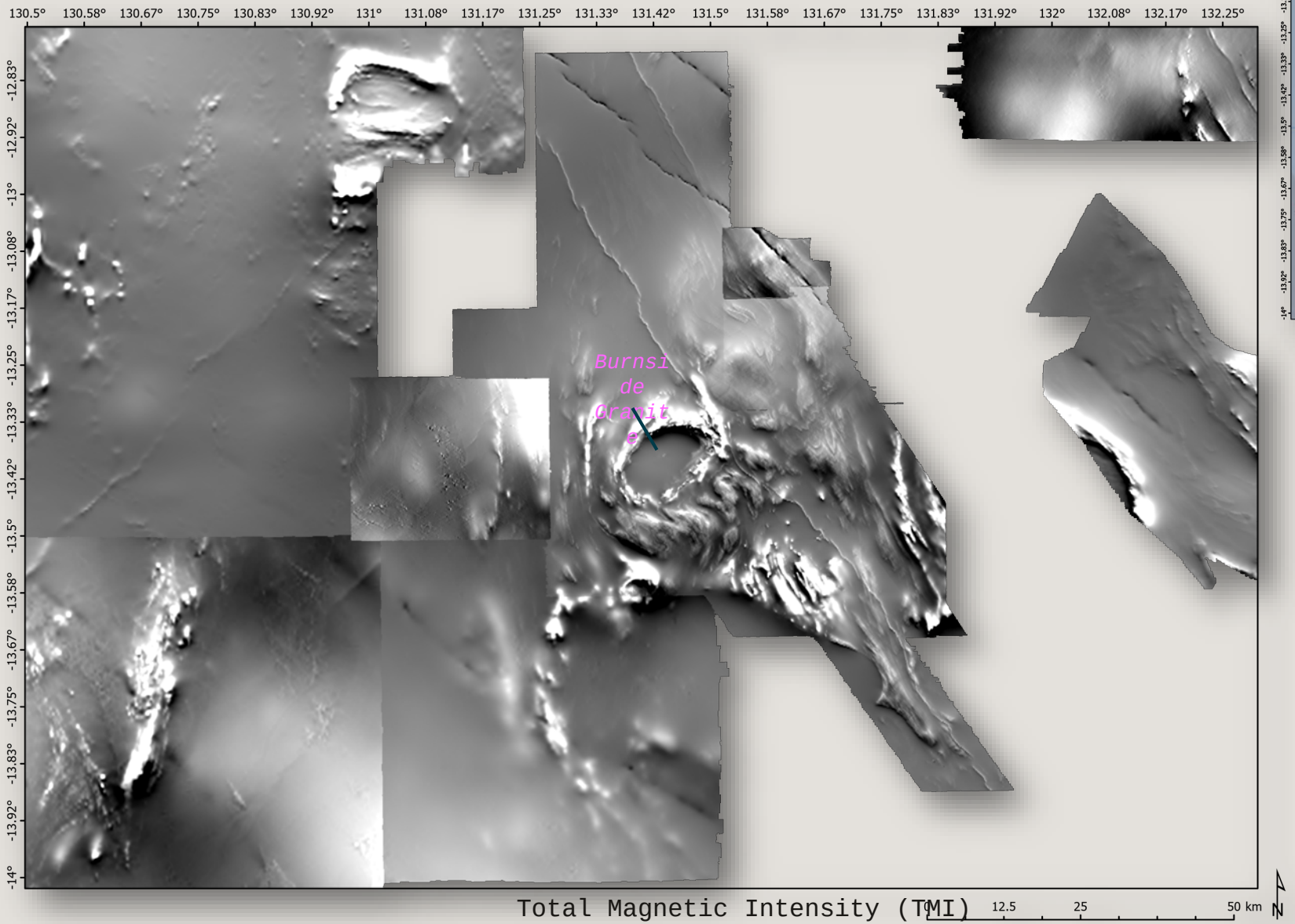
Airborne Magnetics

250 m aerial photography
500 m aerial photography
200 m radio positioning



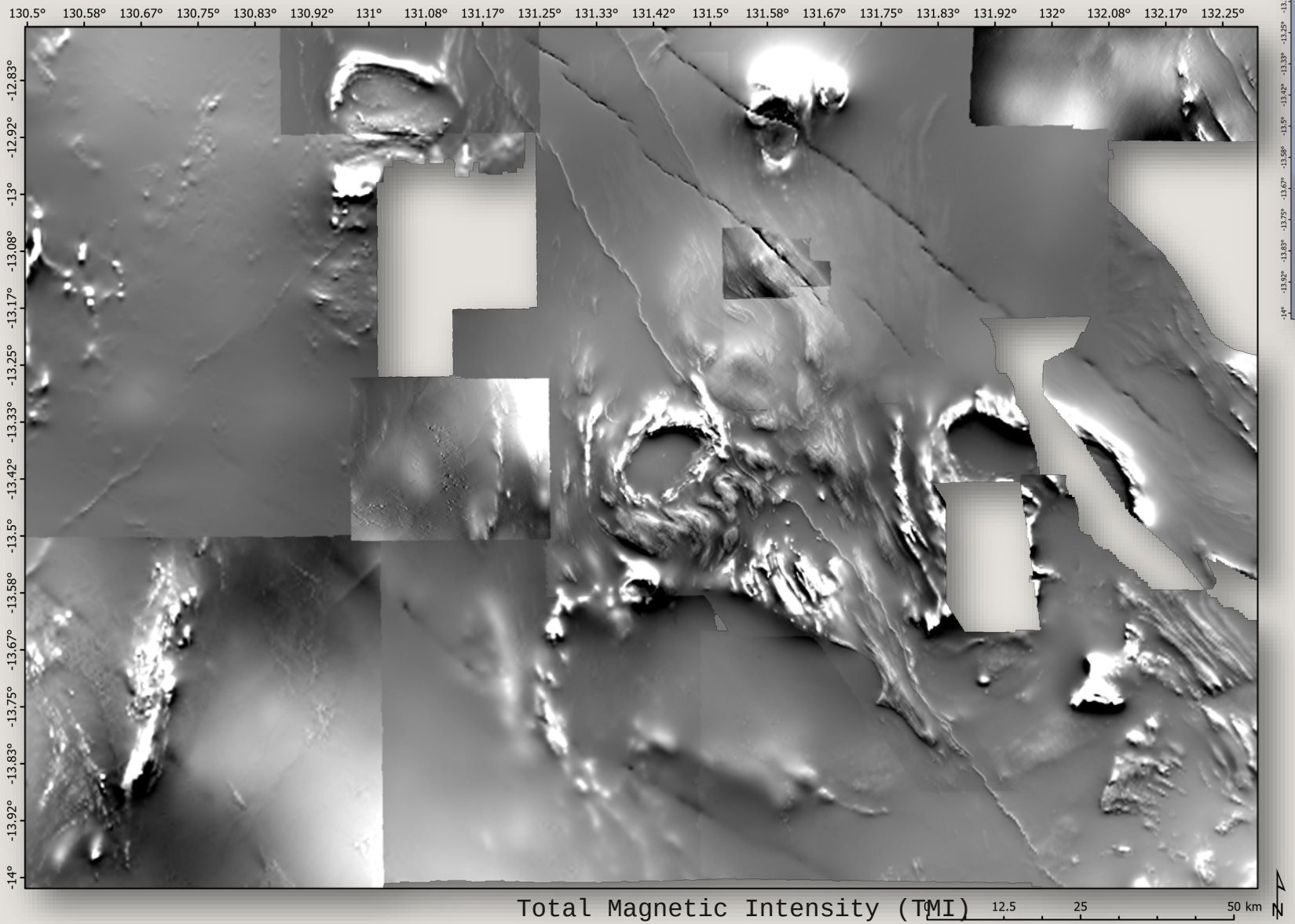
Navigation by radio positioning:

- 4 surveys at 200 m line spacing

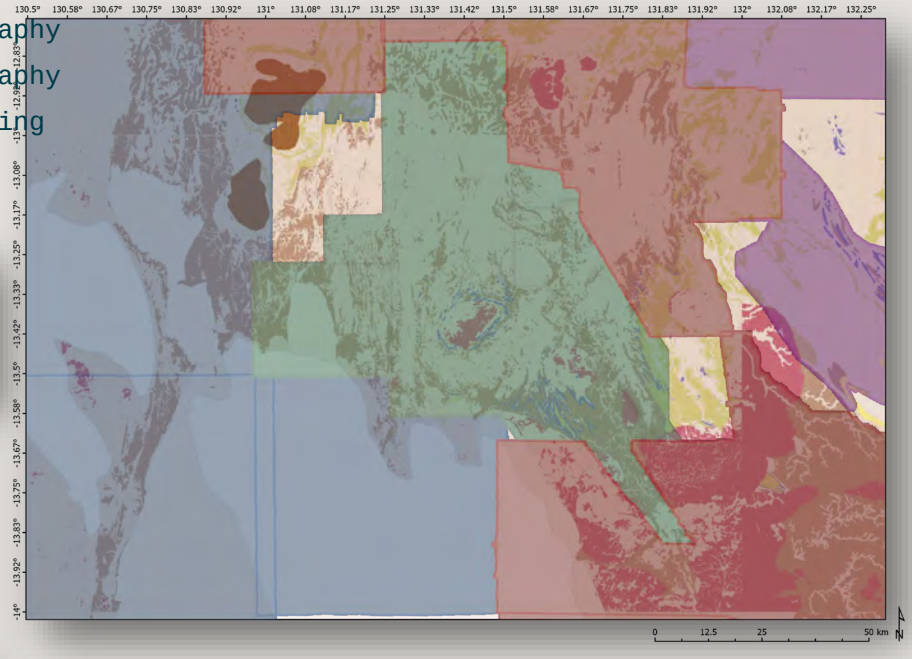


RESOURCING THE TERRITORY

Airborne Magnetics



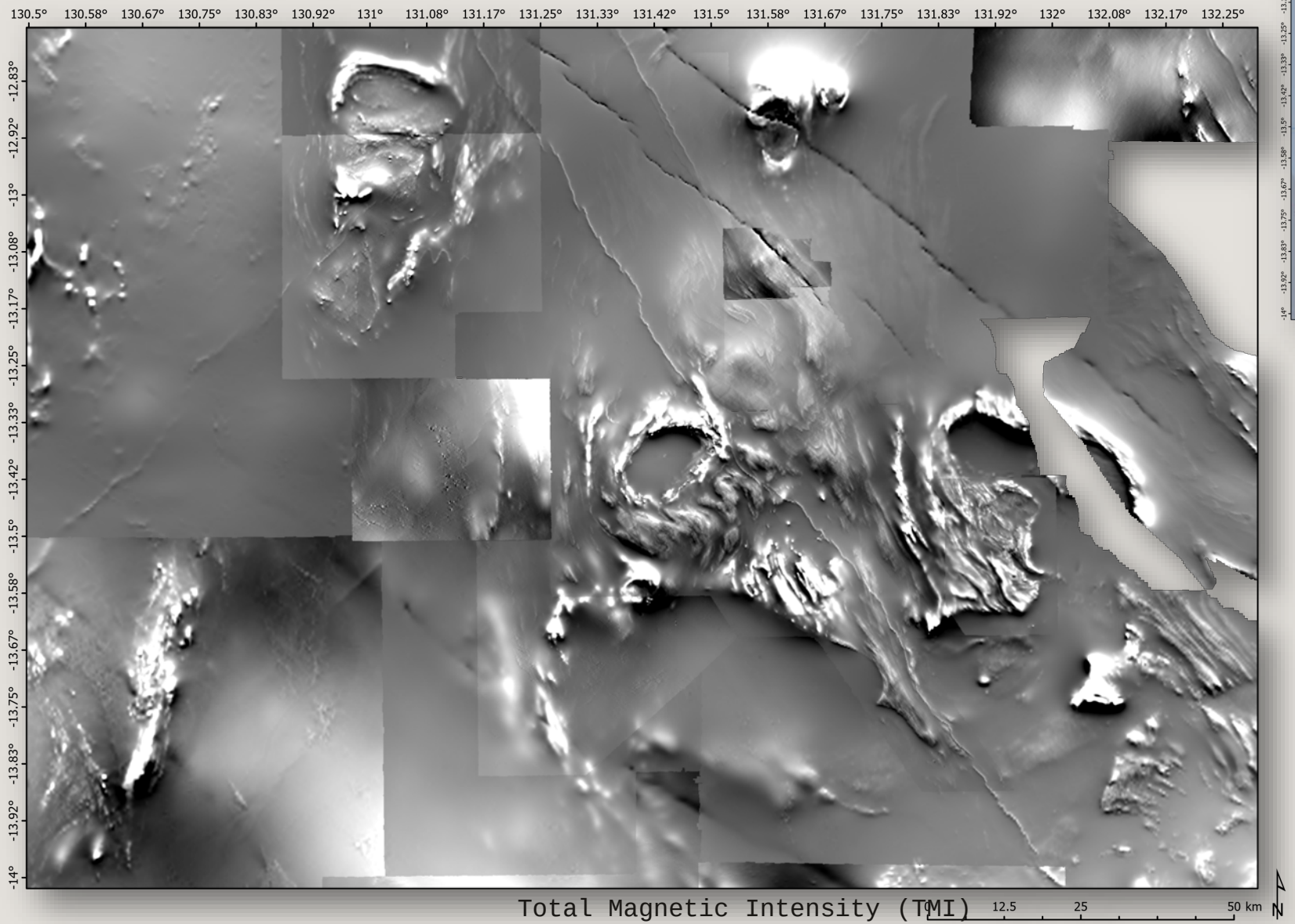
250 m aerial photography
500 m aerial photography
200 m radio positioning
400 m GPS

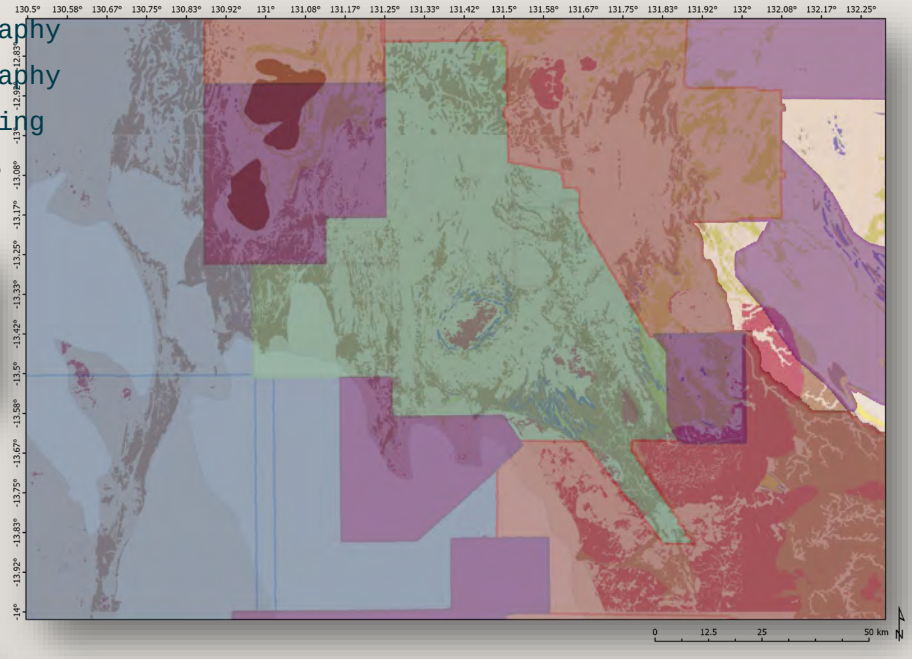


Navigation by GPS:

- 3 surveys at 400 m line spacing

Airborne Magnetics

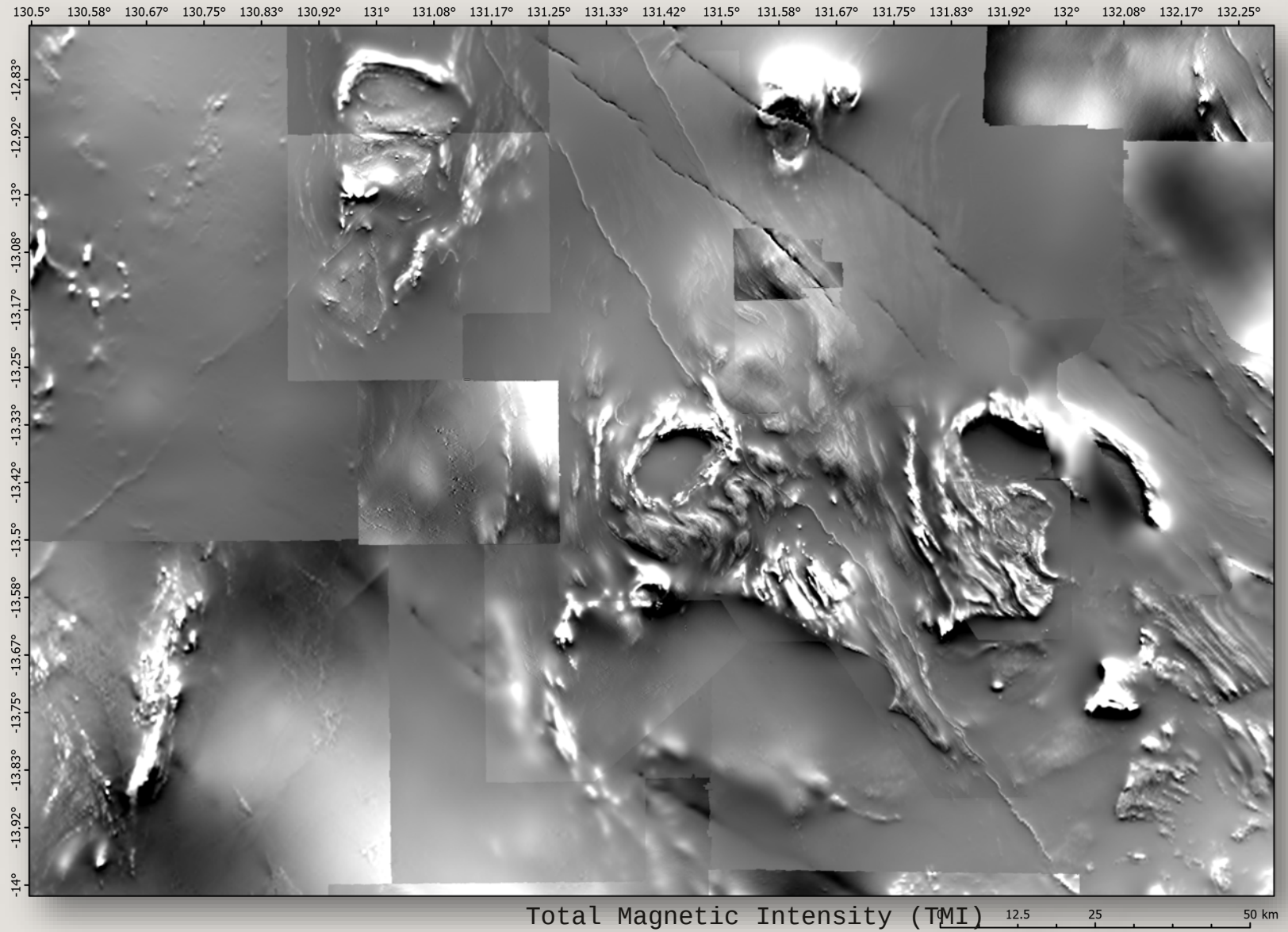


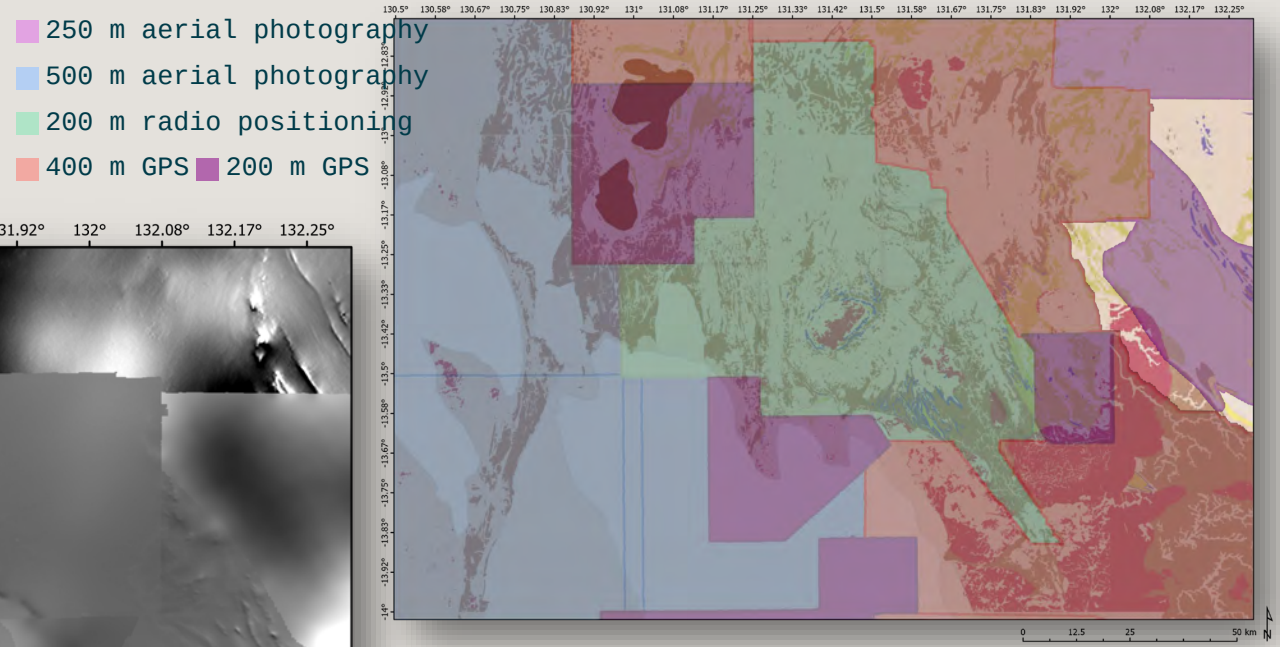


Navigation by GPS:

- 3 surveys at 400 m line spacing
- 4 surveys at 200 m line spacing

Airborne Magnetics



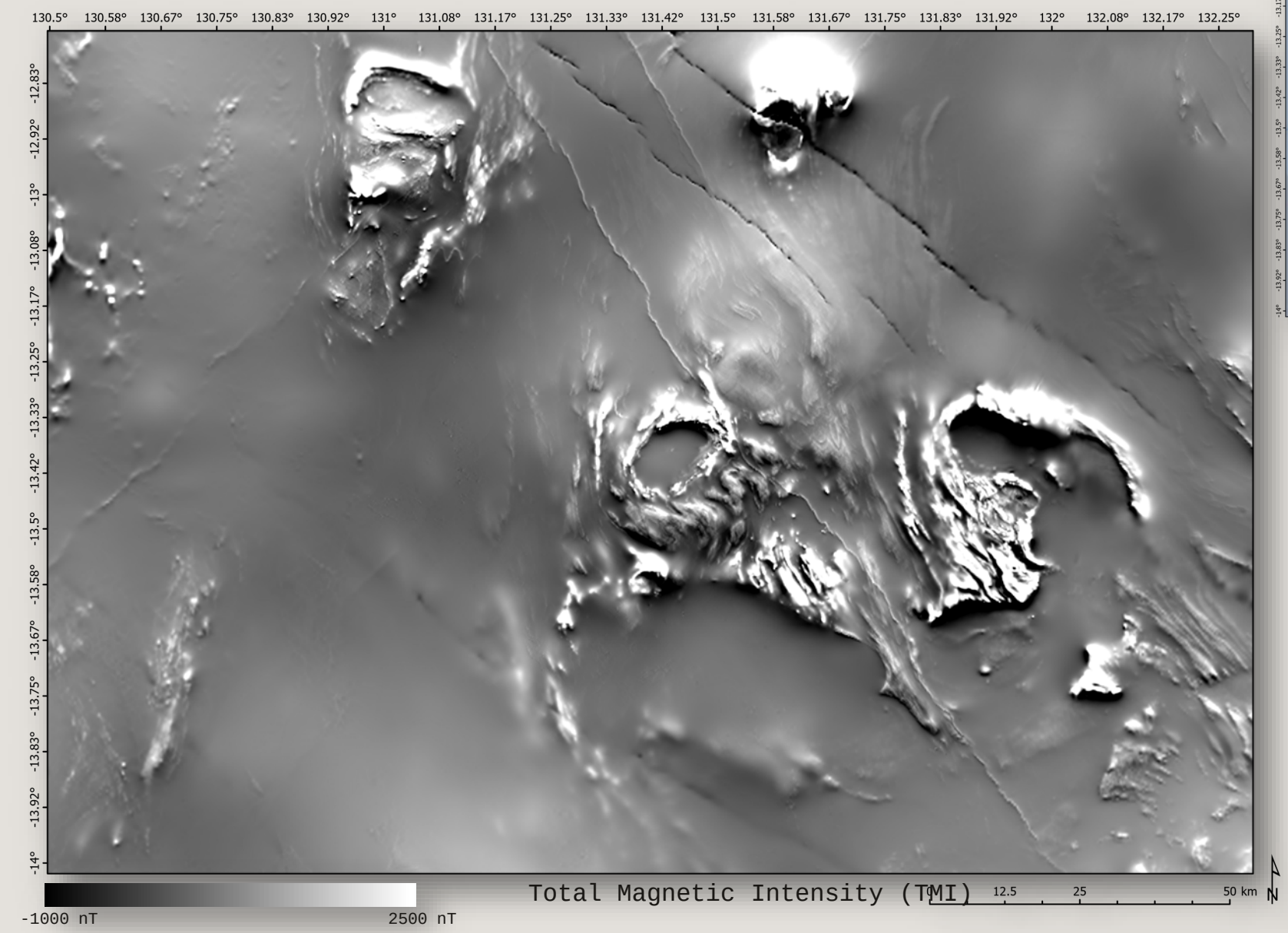


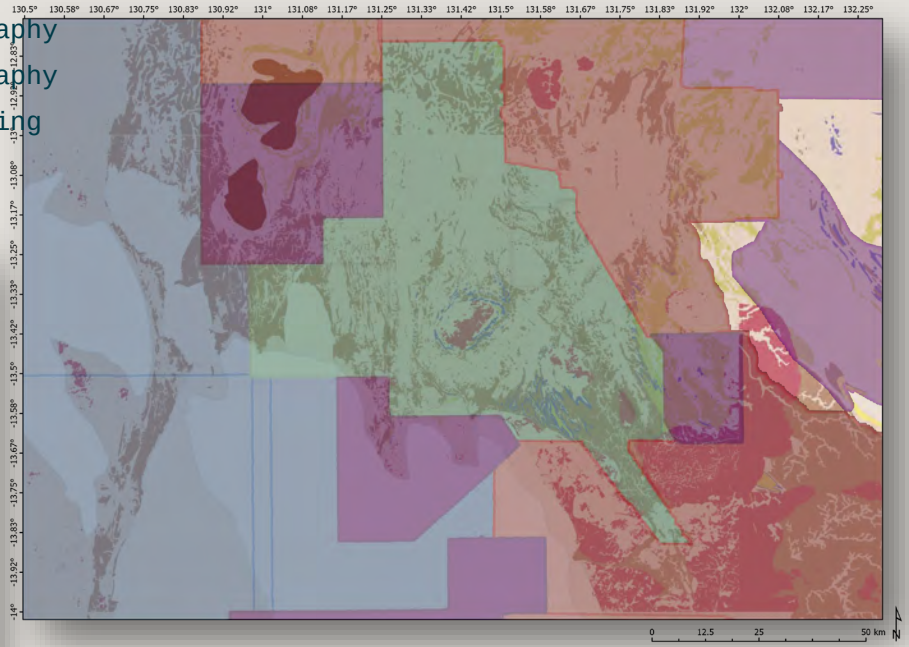
Navigation by GPS:

- 3 surveys at 400 m line spacing
- 4 surveys at 200 m line spacing

A couple of old grids with unknown provenance fill the gaps

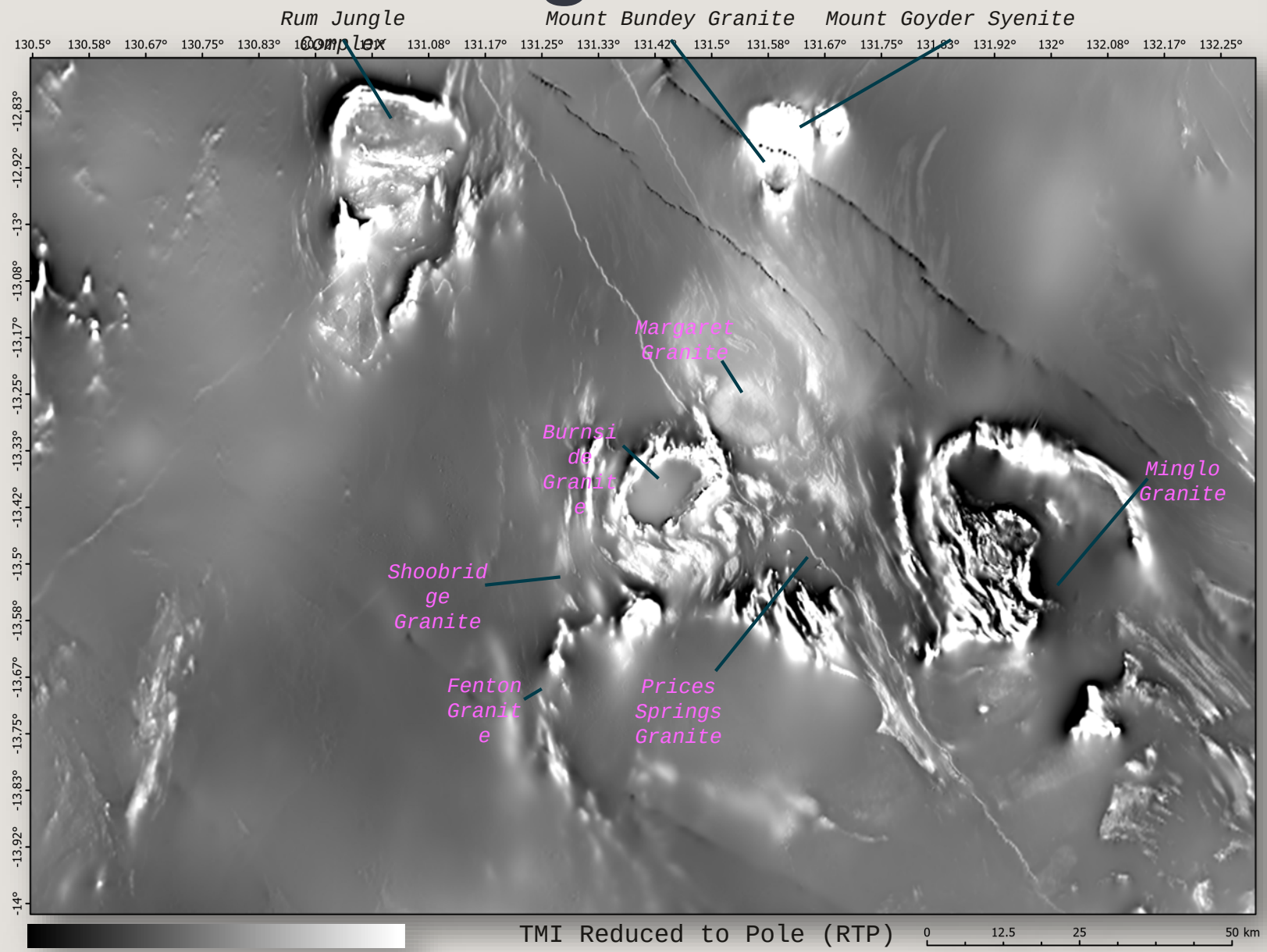
Airborne Magnetics

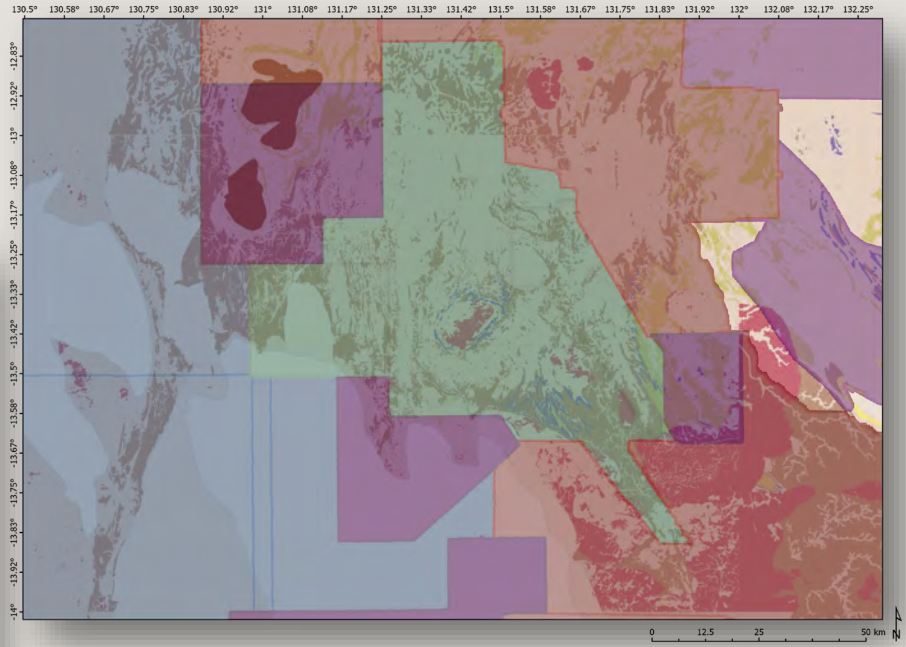


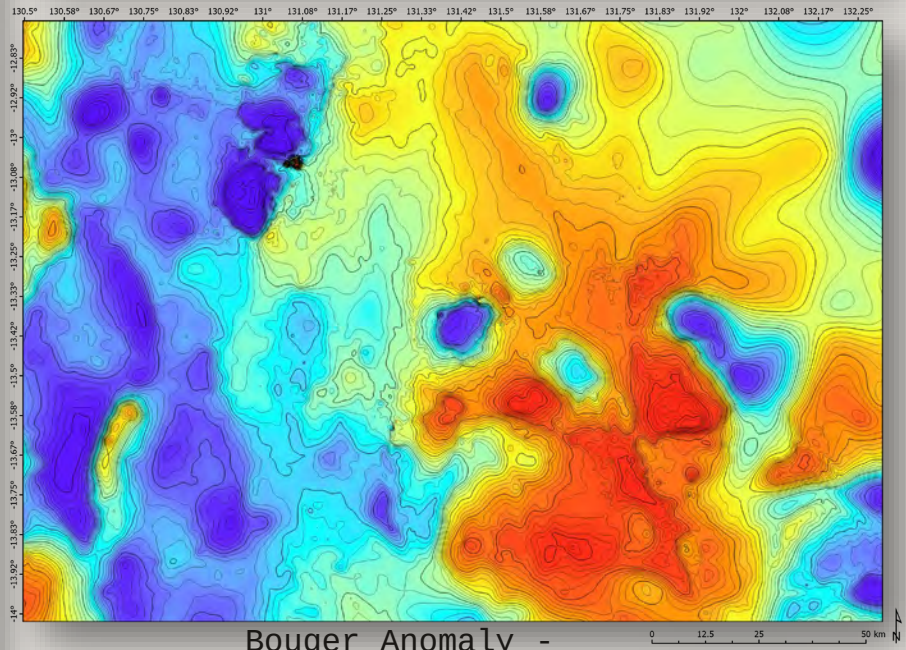


- Grids merged together using Intrepid Geophysics gridmerge
- 80 m cell size
- GA AWAGS levelled Magnetic Map of Australia 2019 edition used as a base grid

Airborne Magnetics



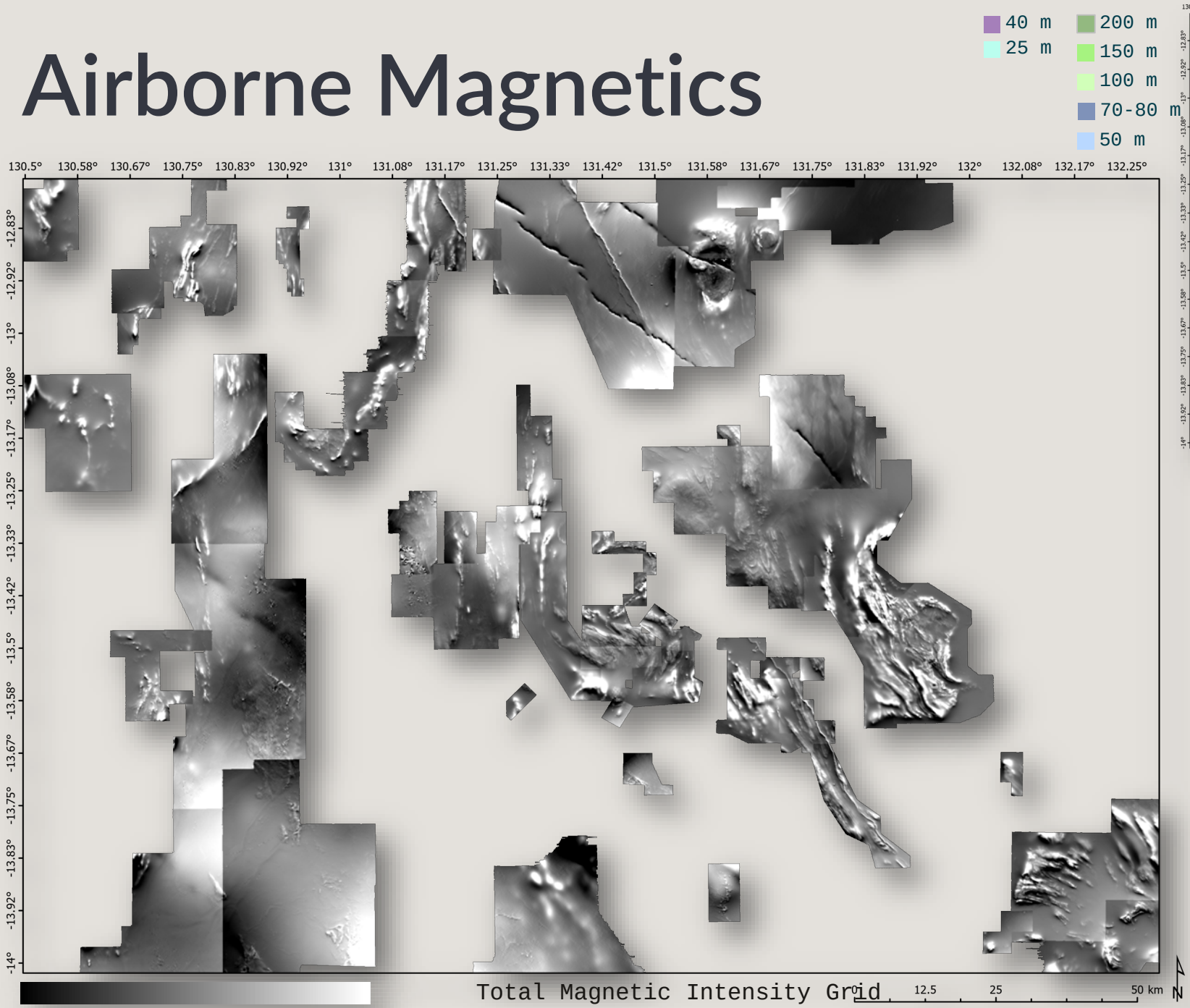


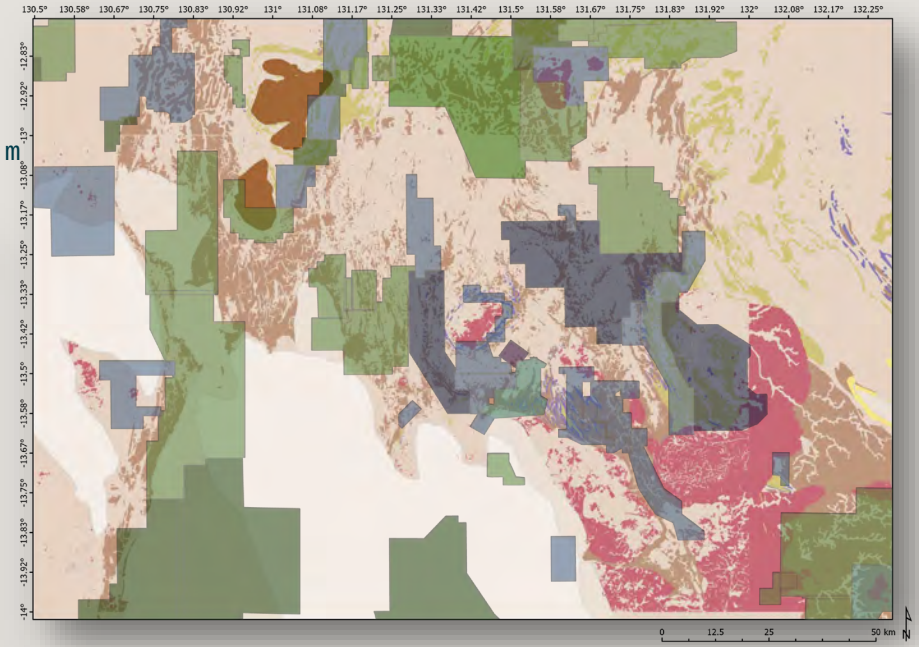


Bouger Anomaly - Detrended

RESOURCING THE TERRITORY

Airborne Magnetics



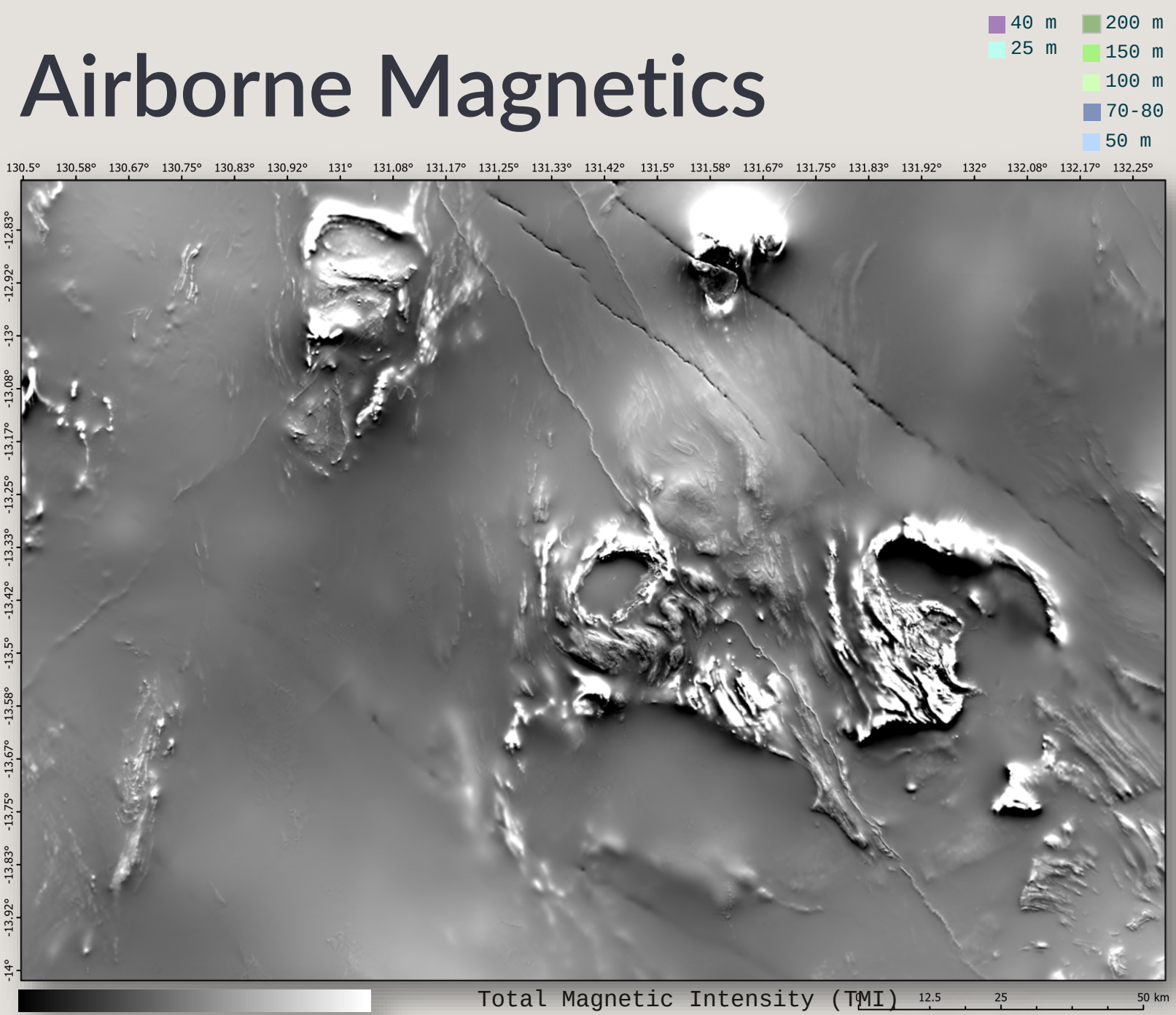


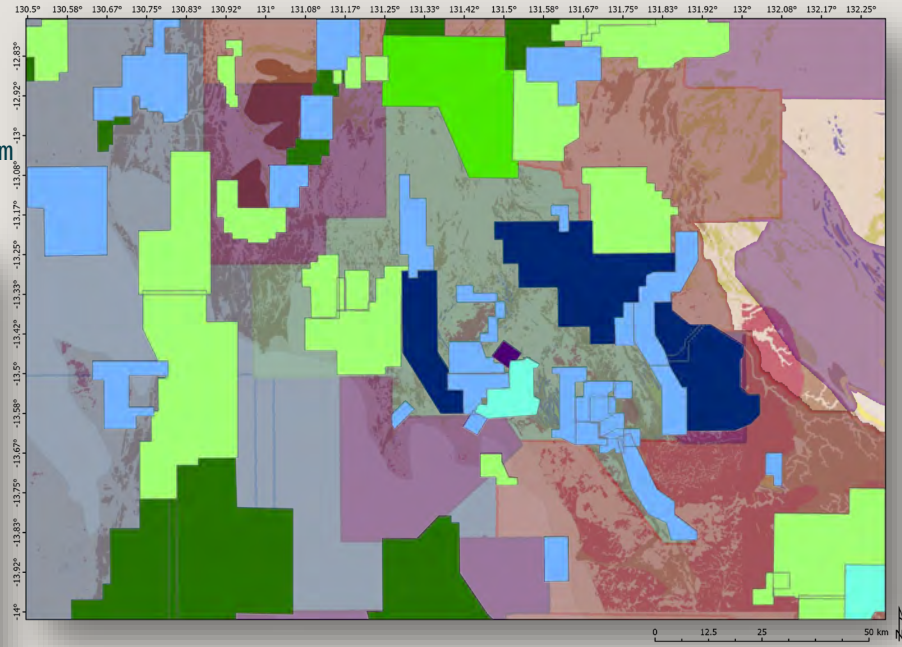
Industry datasets ~70 individual survey parts, ~180,000 line km

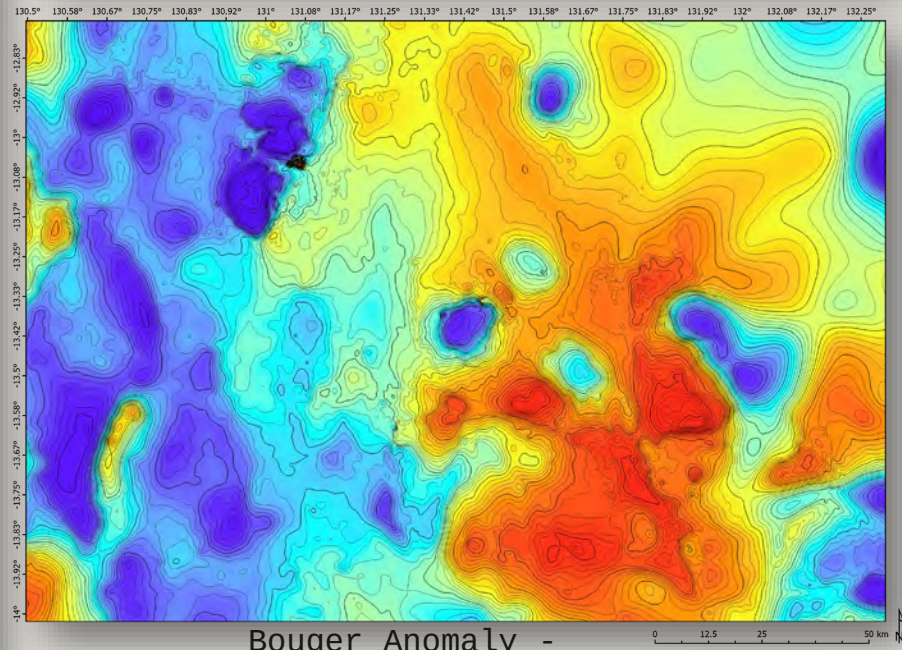
- 200 m line spacing: 11 areas > 26,500 line km
- 150 m line spacing: 1 area > 5,380 line km
- 100 m line spacing: 23 areas > 53,000 line km
- 70 & 80 m line spacing: 3 areas > 21,500 line km
- 50 m line spacing: 28 areas > 59,000 line km
- 40 m line spacing: 2 areas (drone) > 1200 line km
- 25 m line spacing: 2 areas > 13,000 line km
- Quality and completeness of datasets varies widely

RESOURCING THE TERRITORY

Airborne Magnetics







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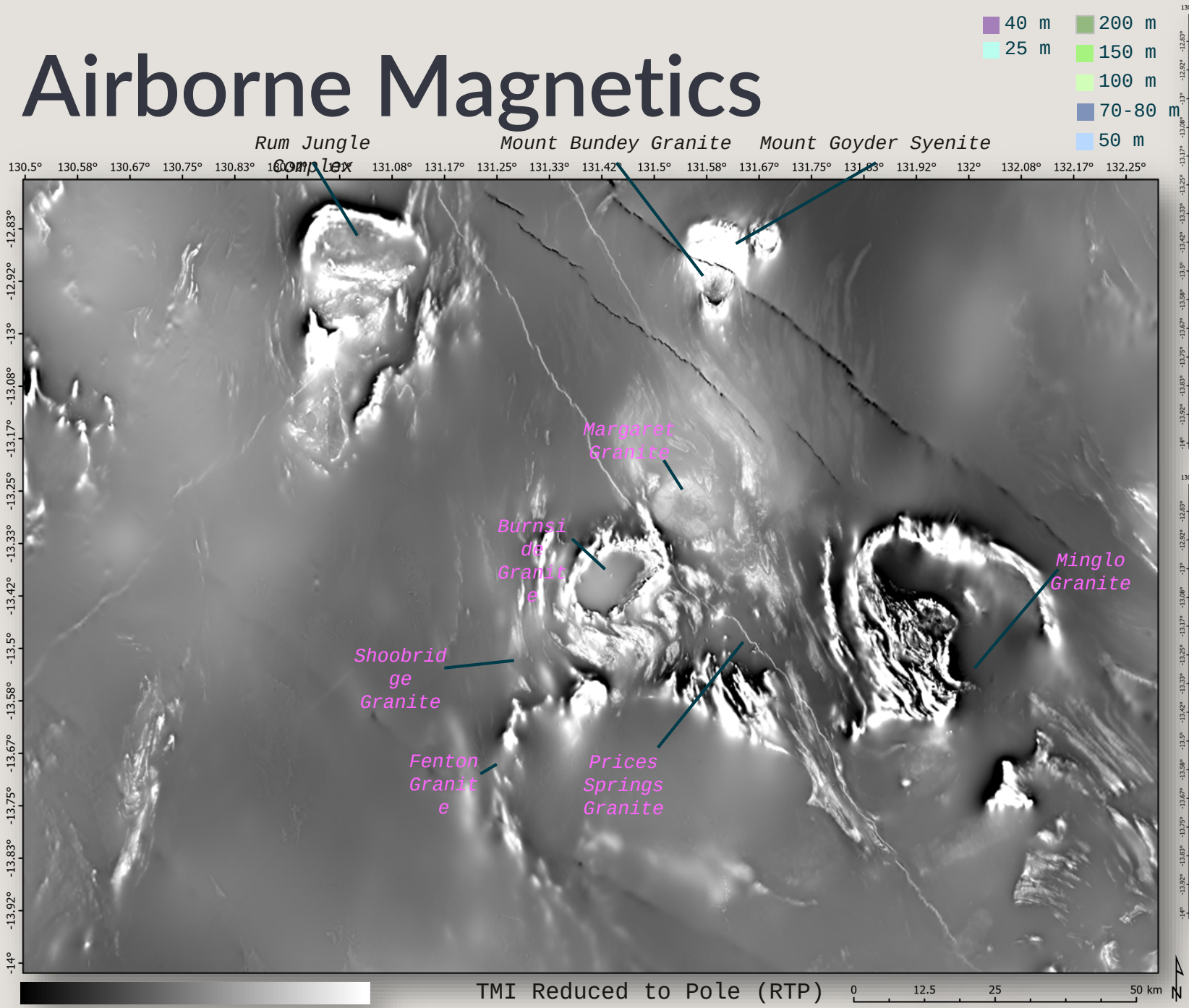

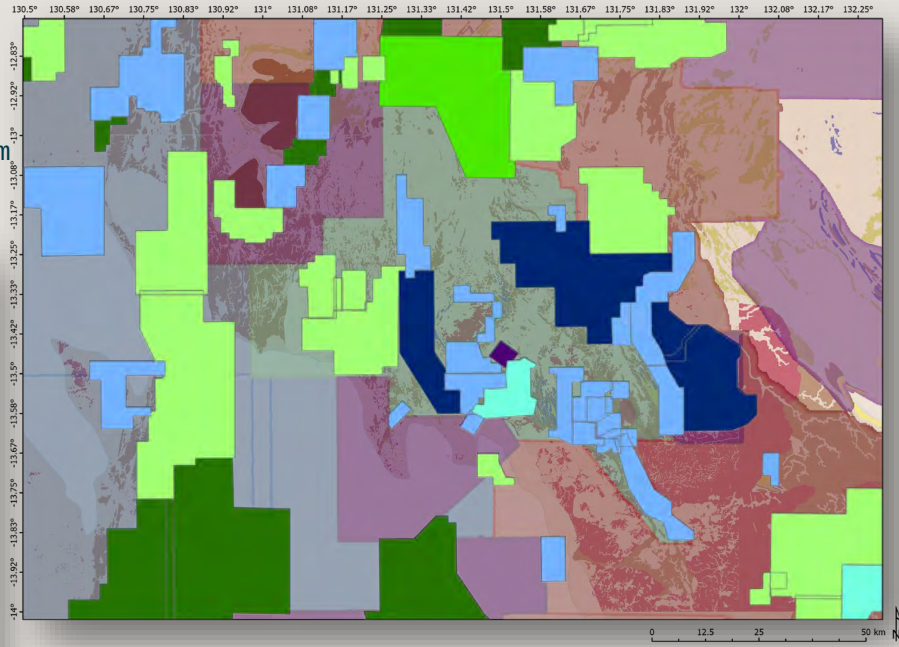

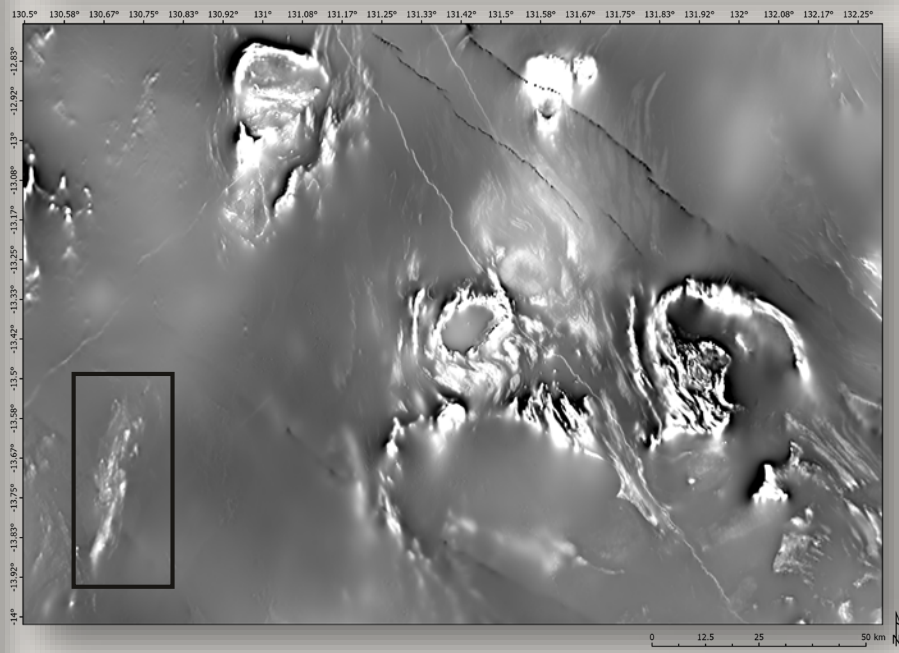

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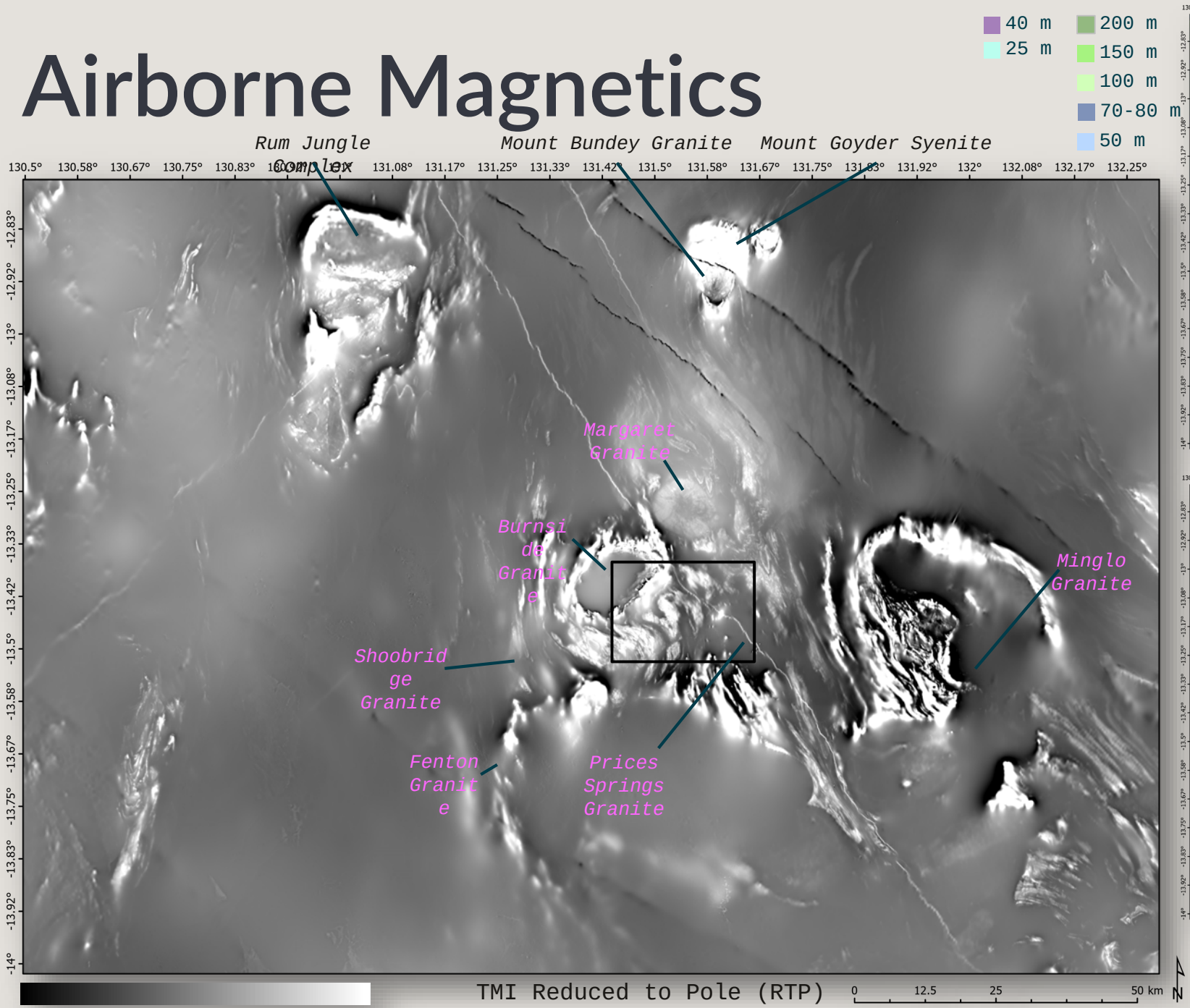
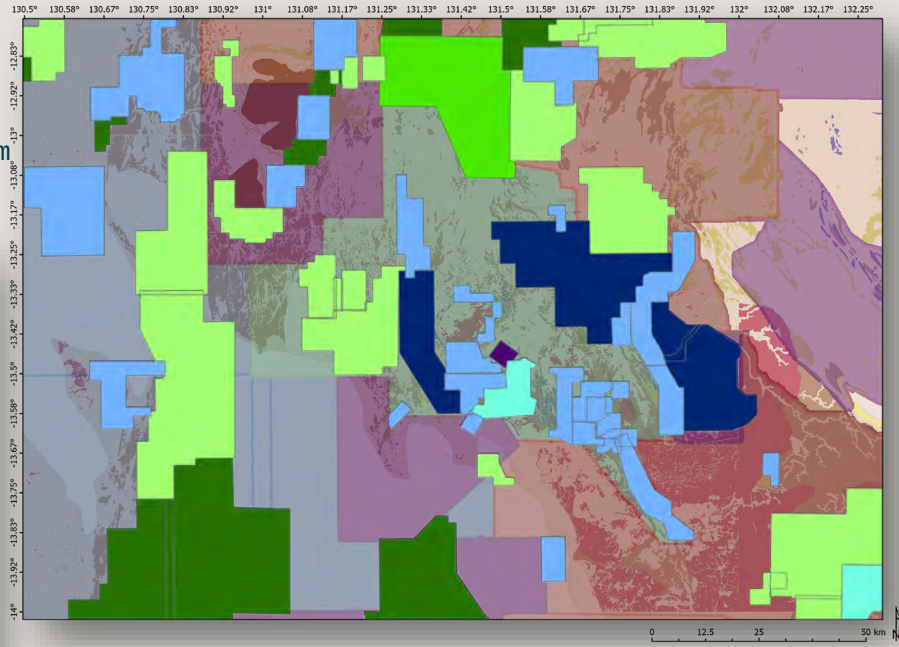
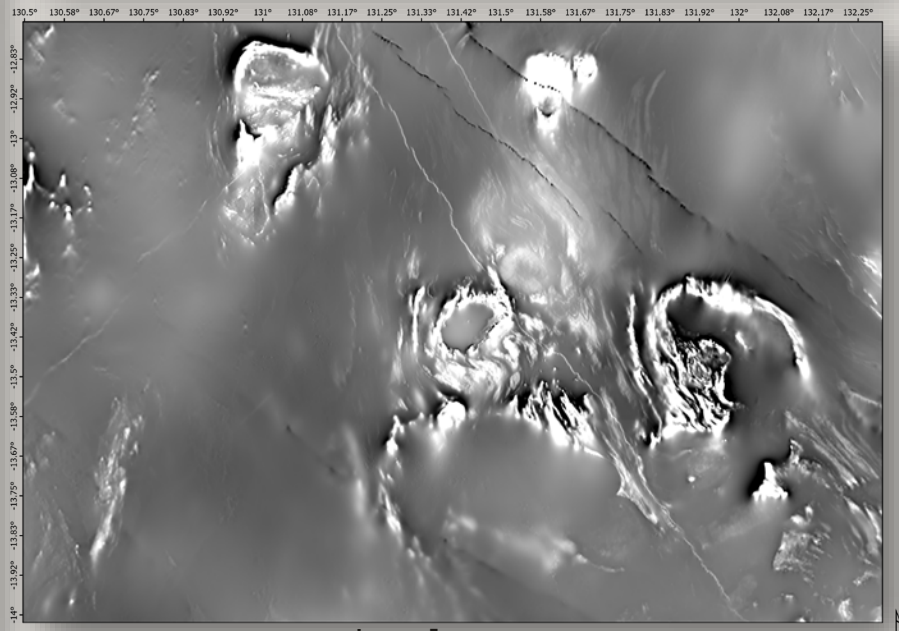


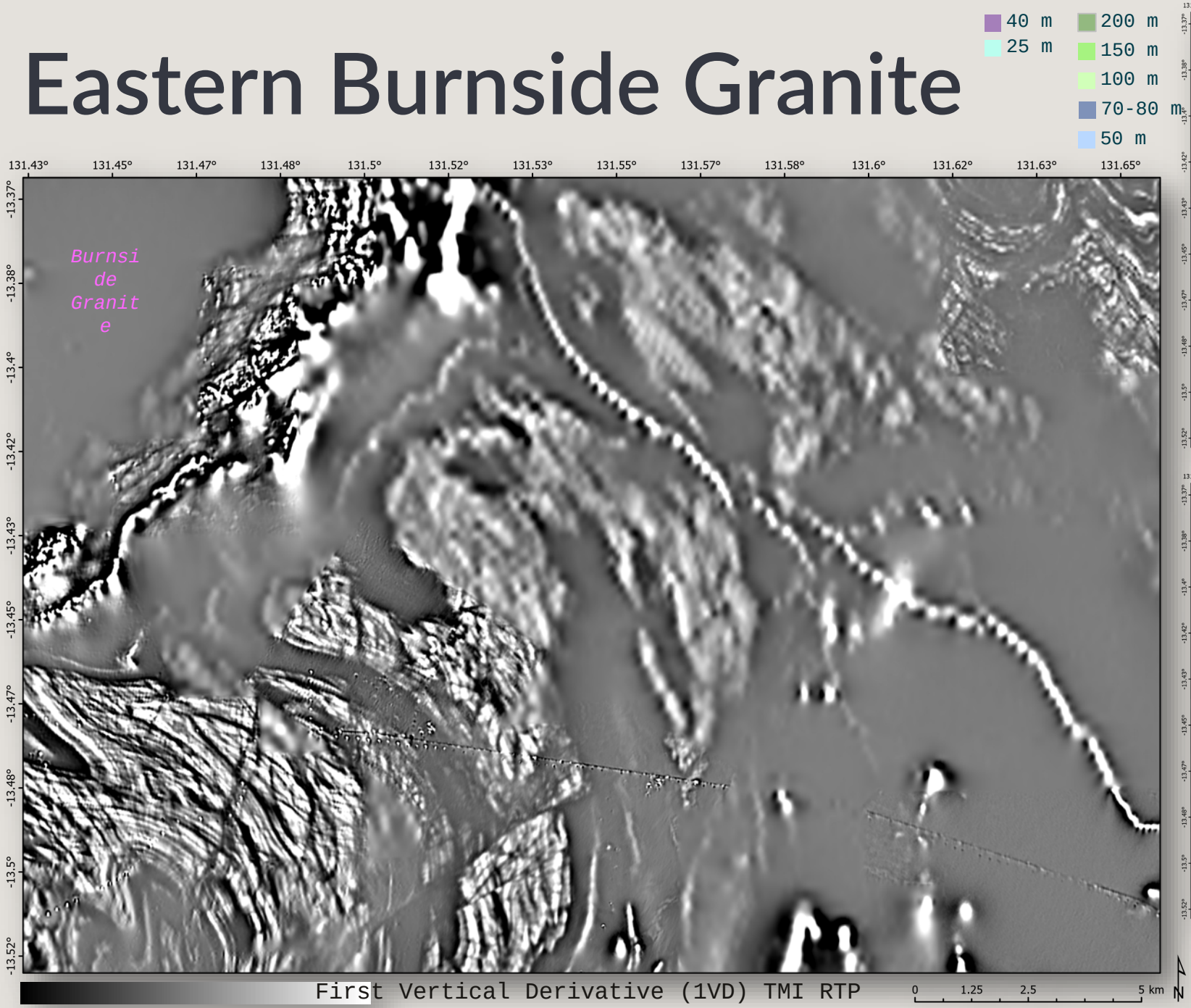


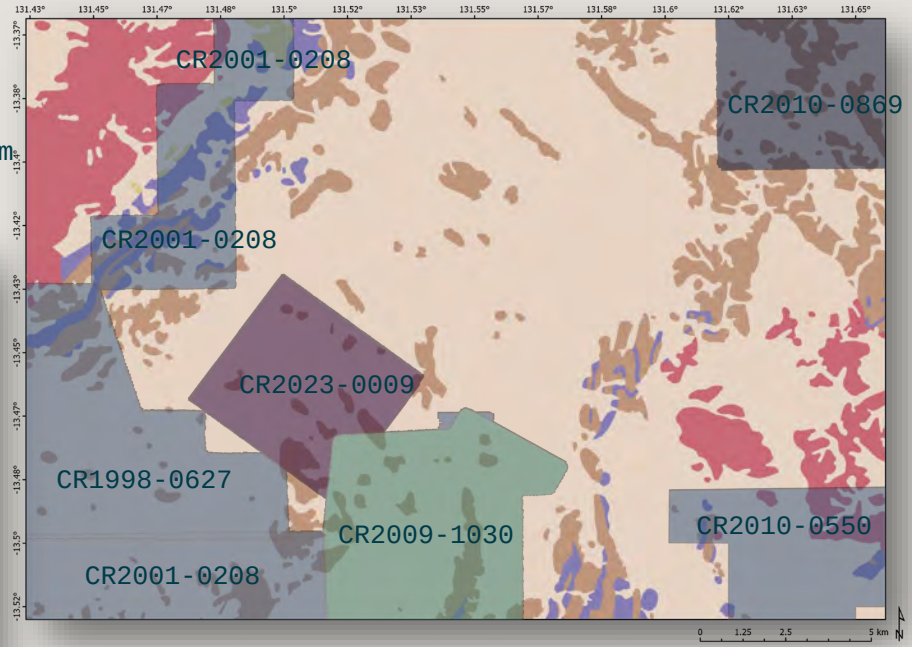


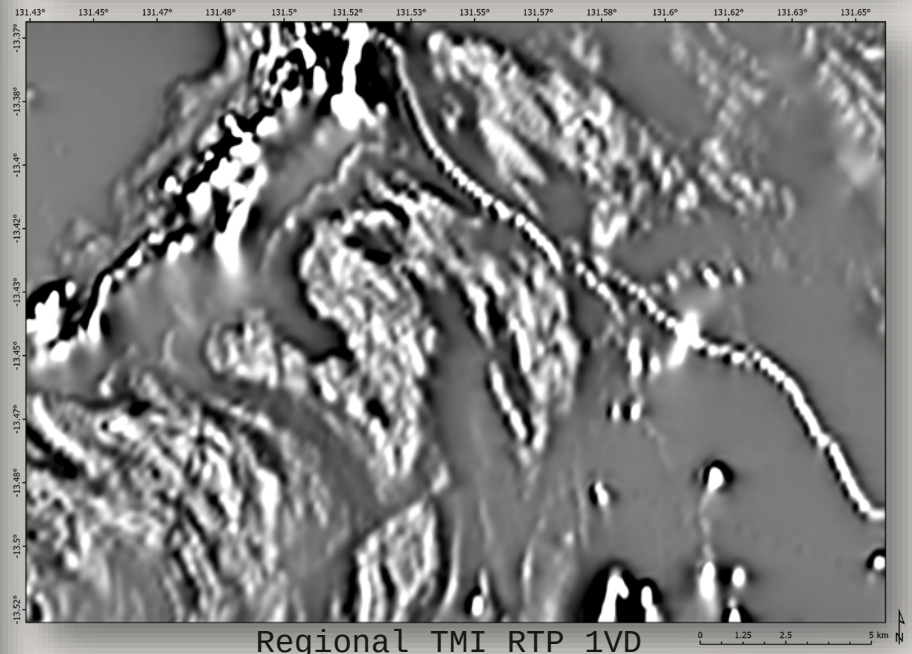
Regional TMI RTP

RESOURCING THE TERRITORY

Eastern Burnside Granite







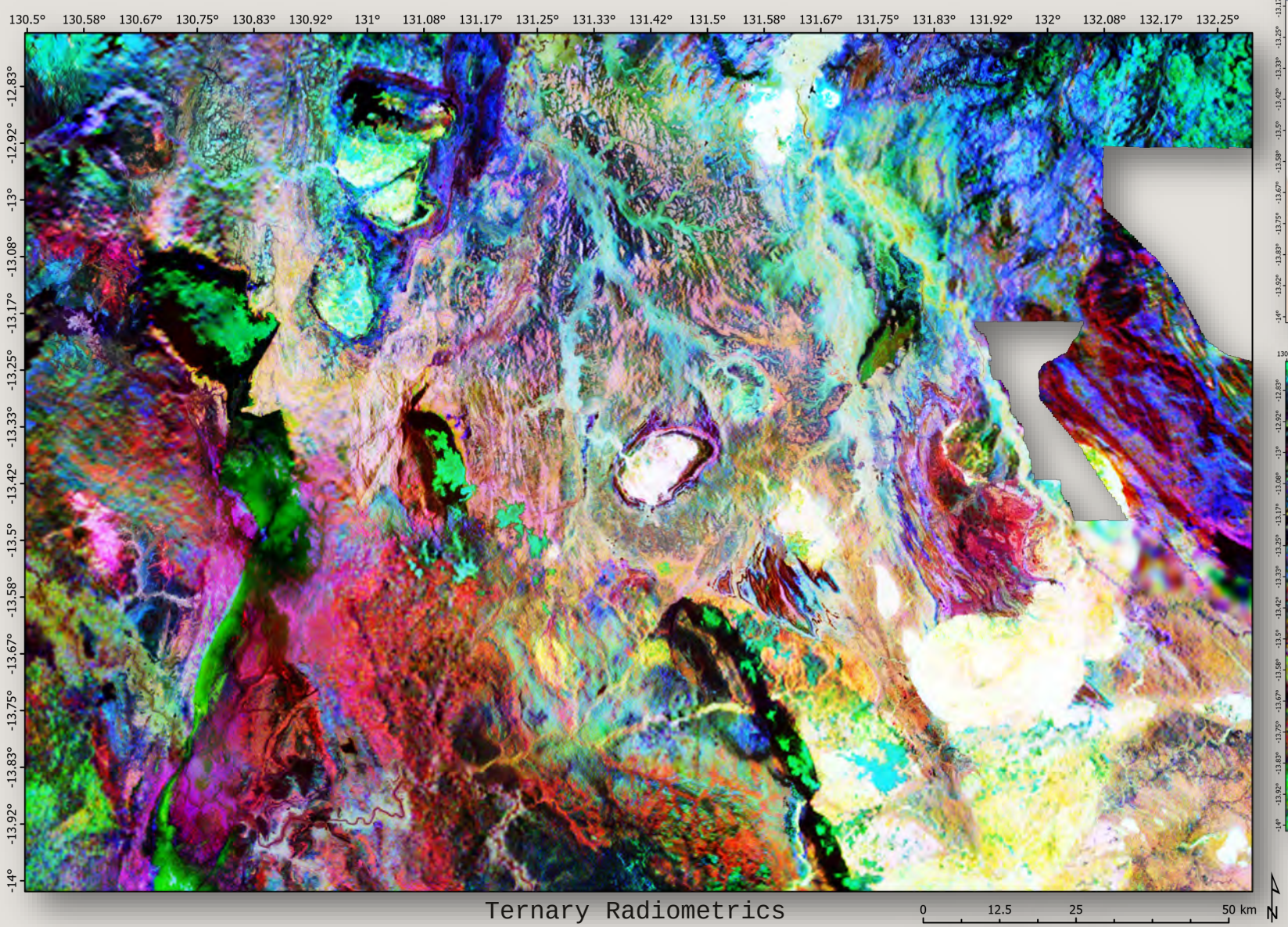
Regional TMI RTP 1VD

RESOURCING THE TERRITORY

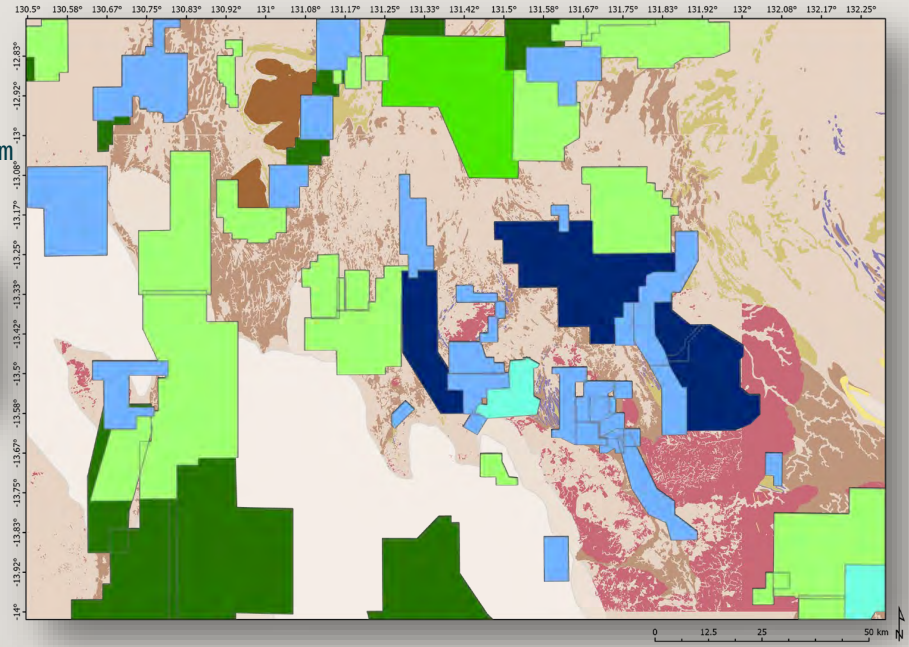
Airborne Radiometrics

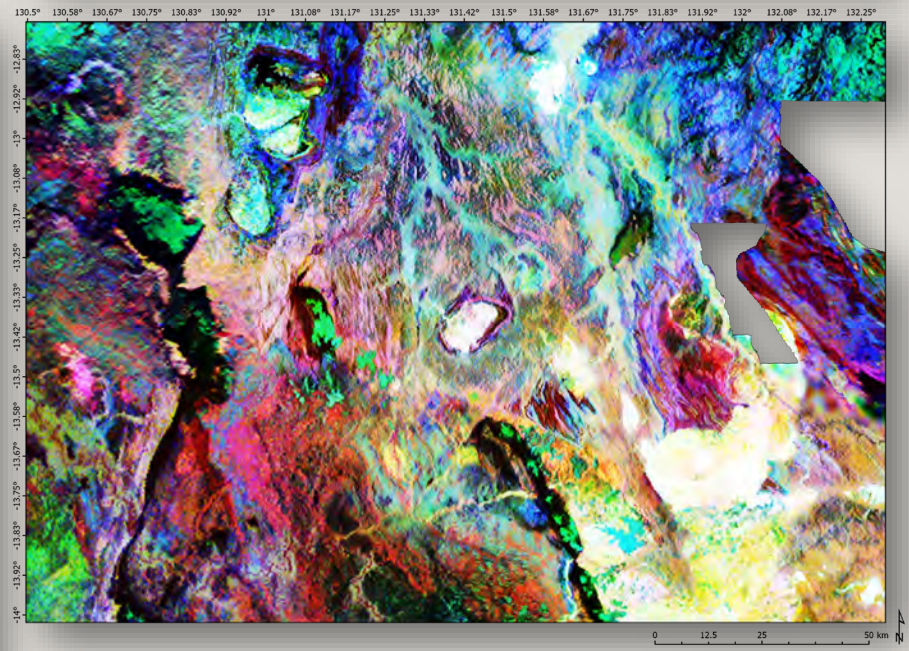
40 m
25 m

200 m
150 m
100 m
70-80 m
50 m



Ternary Radiometrics





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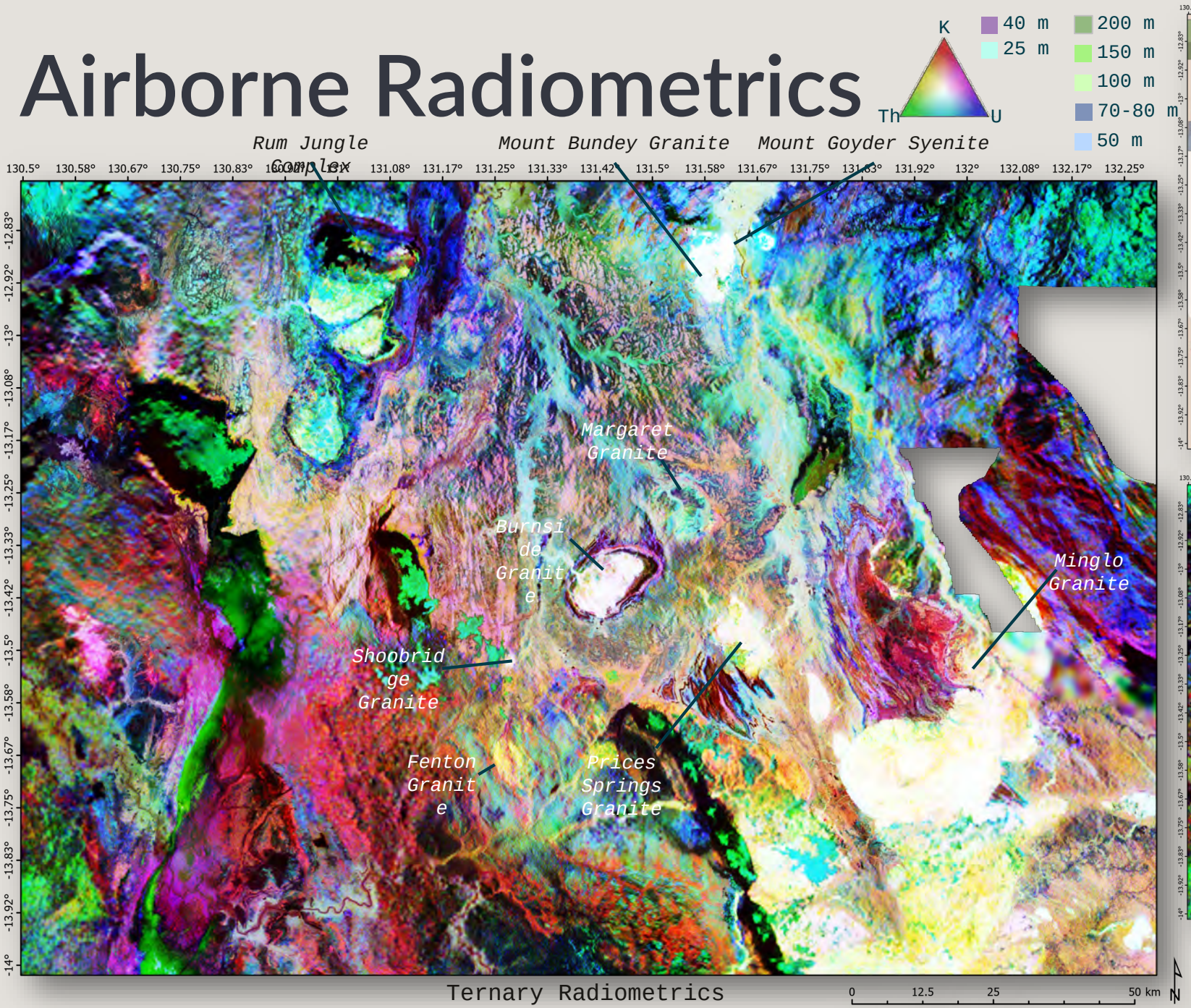
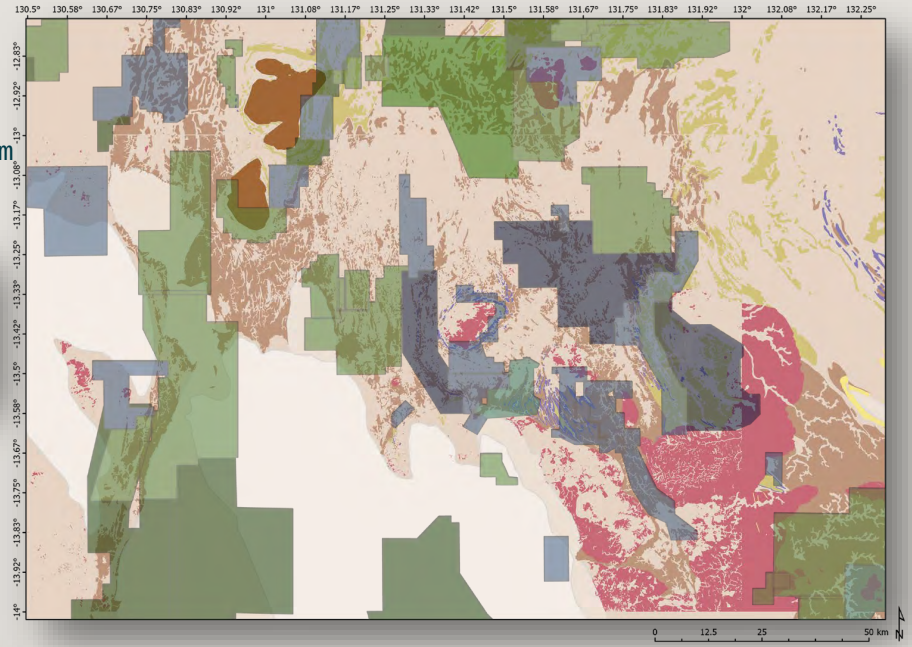
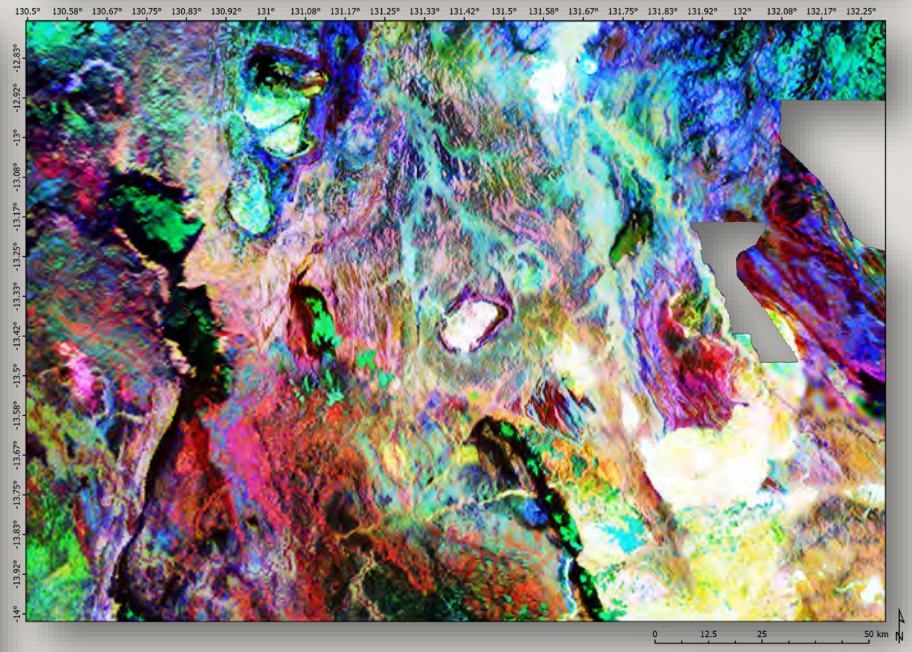
Airborne Radiometrics

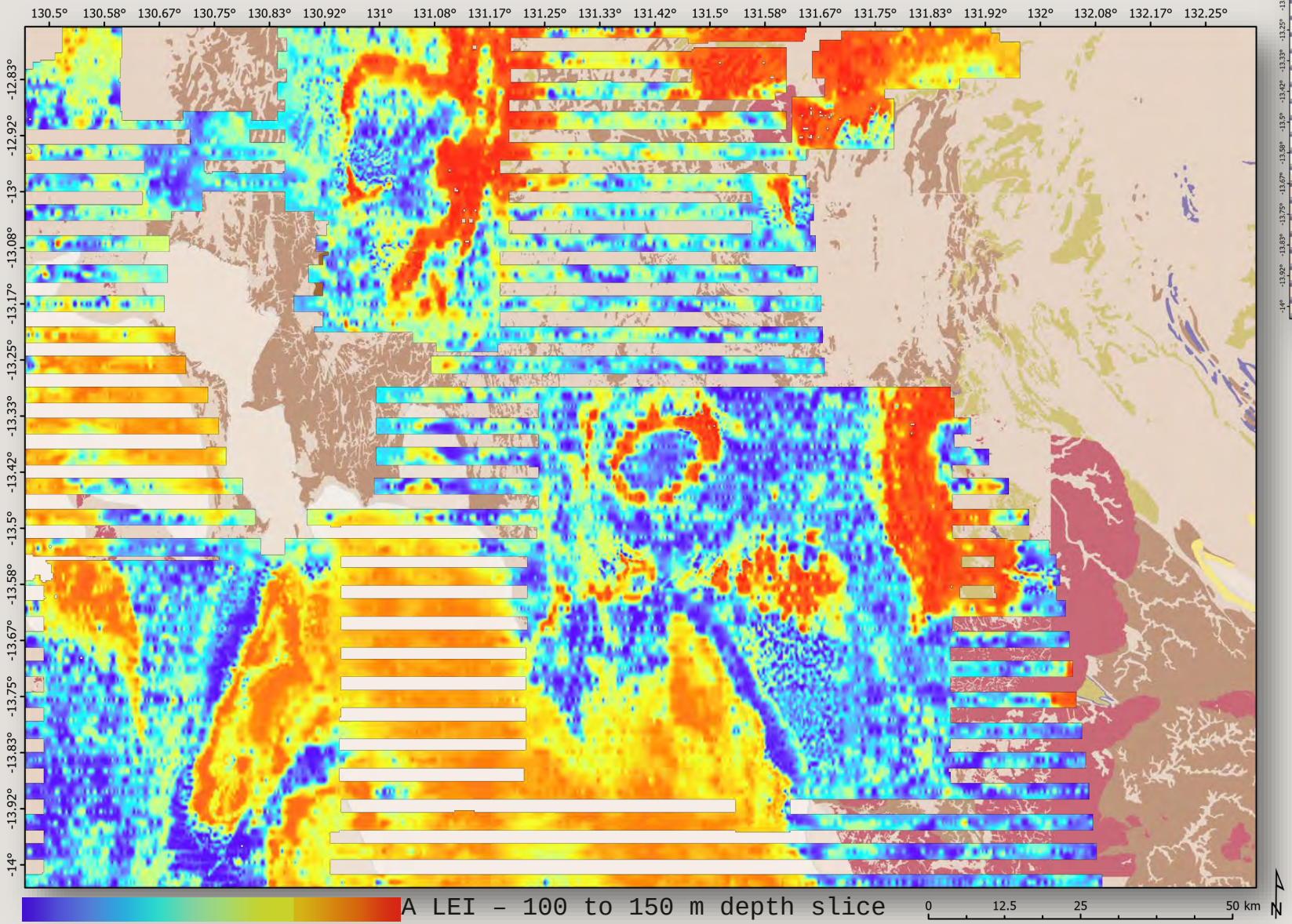




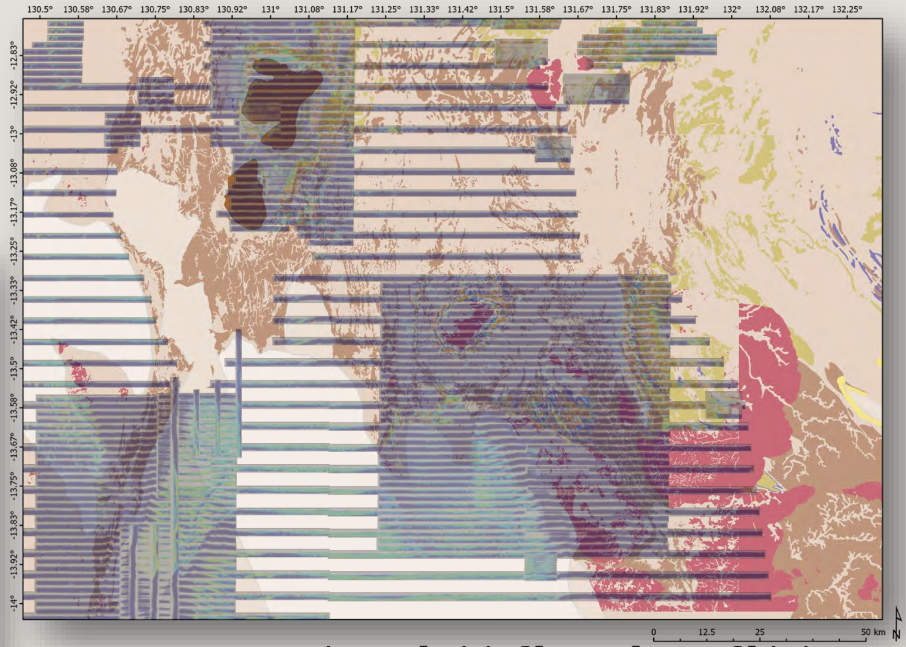


RESOURCING THE TERRITORY

Airborne Electromagnetics



GA LEI – 100 to 150 m depth slice



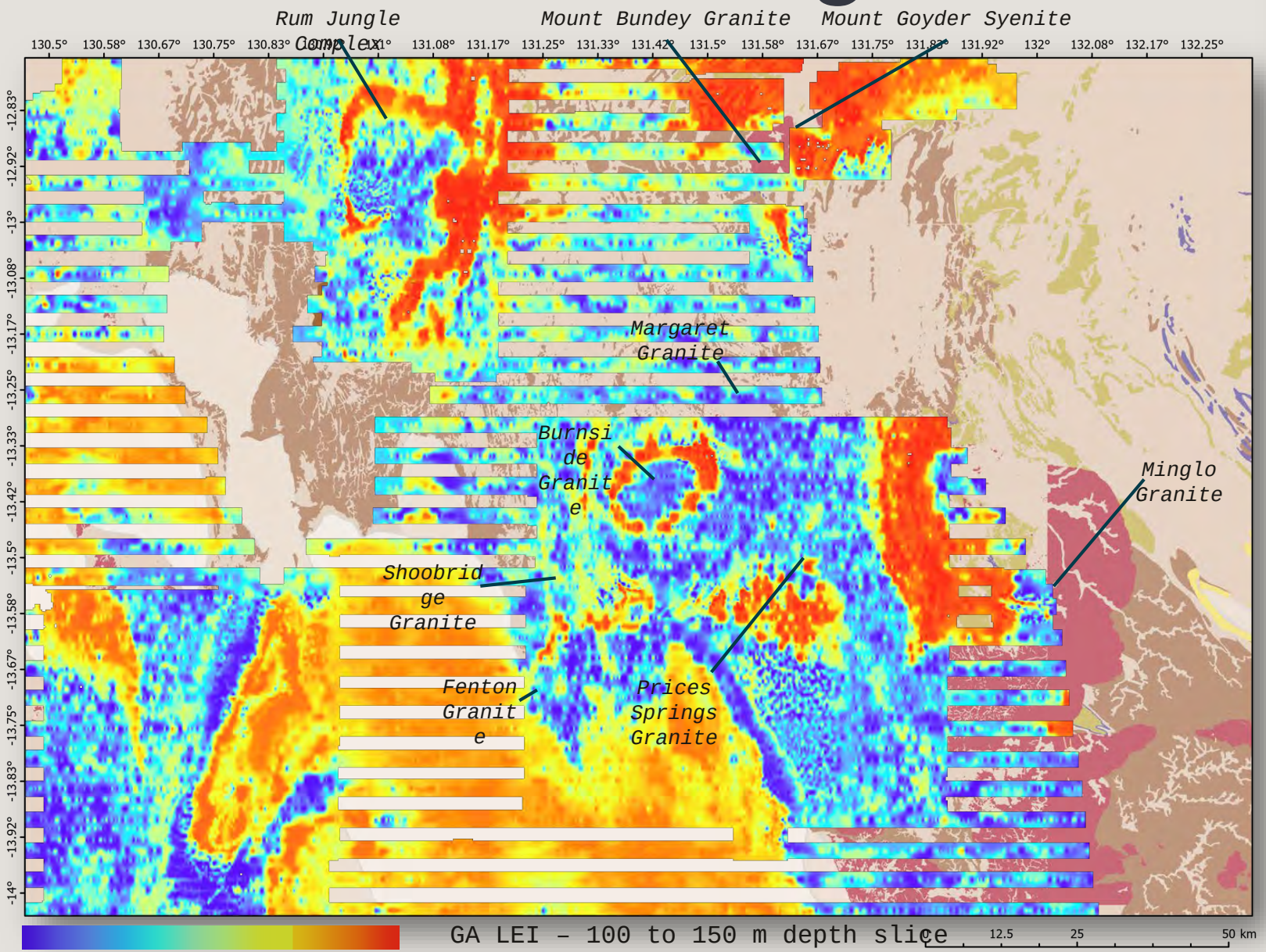
GA LEI – Sections laid flat along flight lines

Geoscience Australia Onshore Energy Security Program:

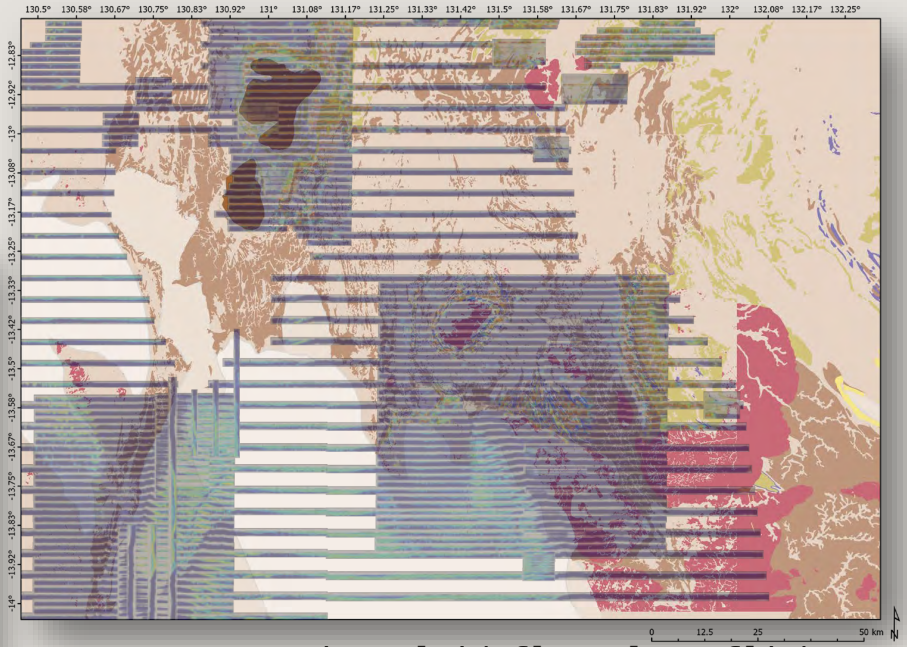
- Woolner and Rum Jungle Tempest AEM surveys
- Line spacing 6000 m to ~250 m
- 19 infill areas funded by industry (not all within the study area)

RESOURCING THE TERRITORY

Airborne Electromagnetics



GA LEI – 100 to 150 m depth slice



GA LEI – Sections laid flat along flight lines

Geoscience Australia Onshore Energy Security Program:

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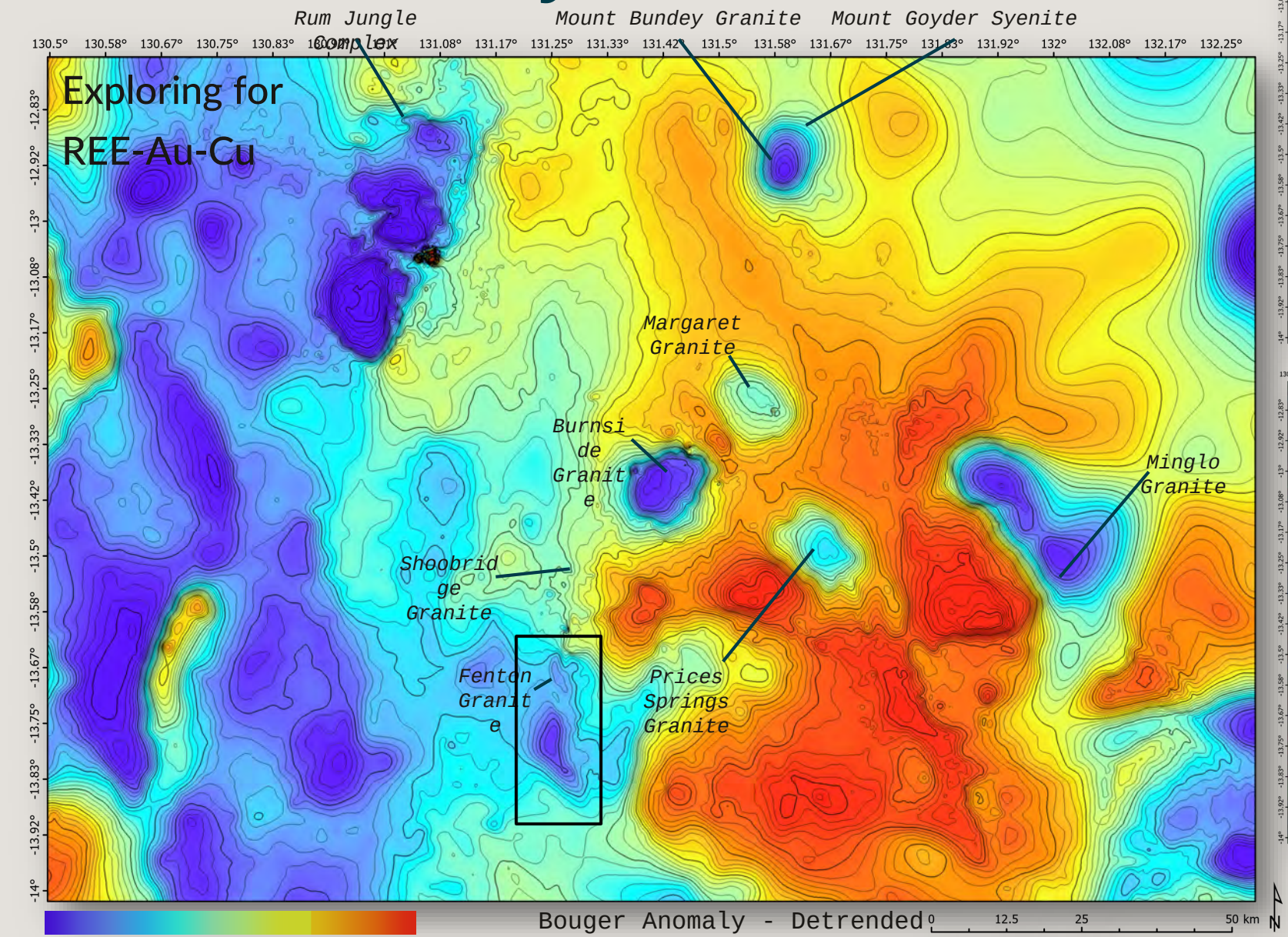
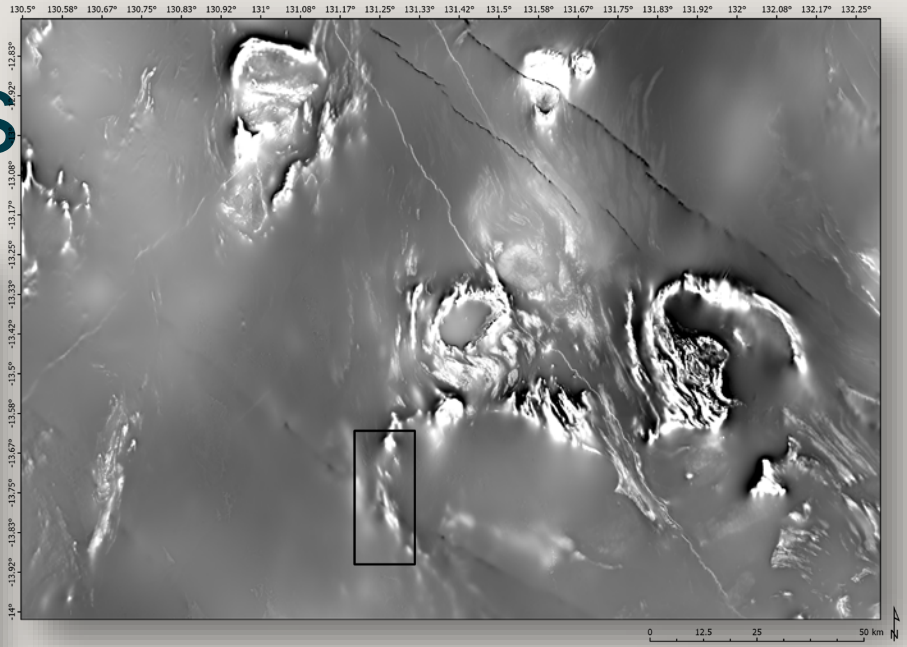
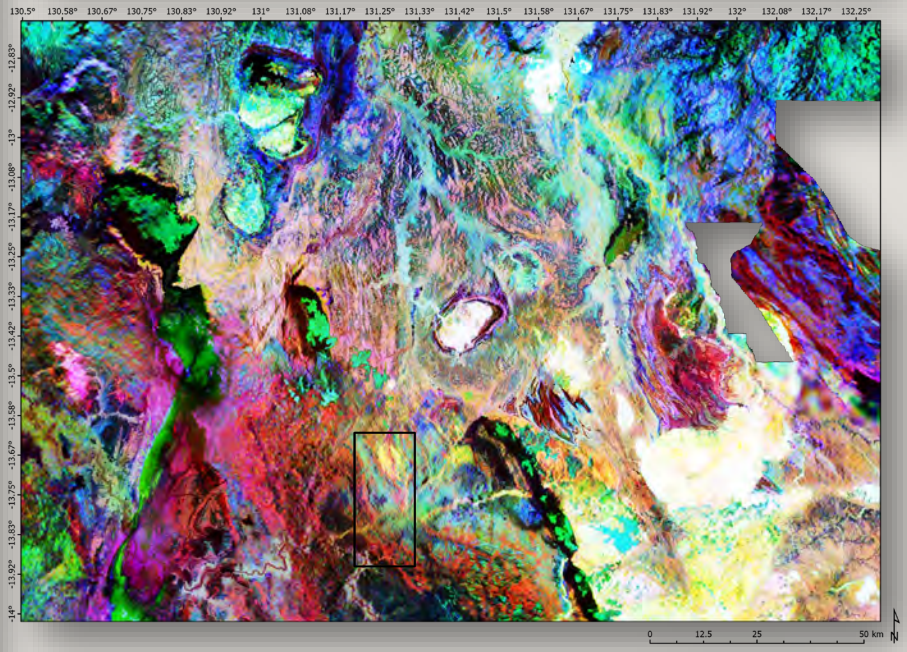
RESOURCING THE TERRITORY

Case Study – DeSoto Res

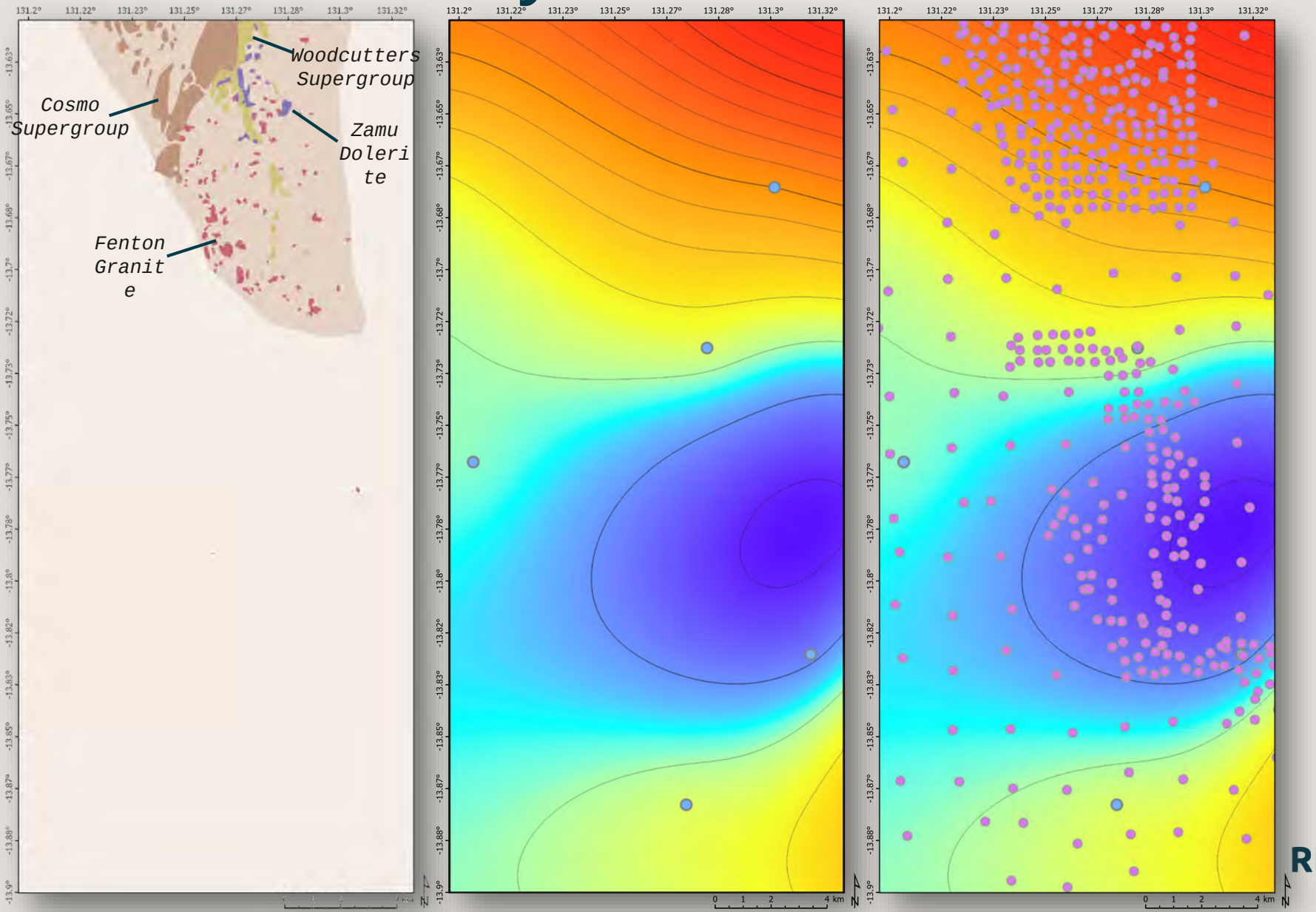






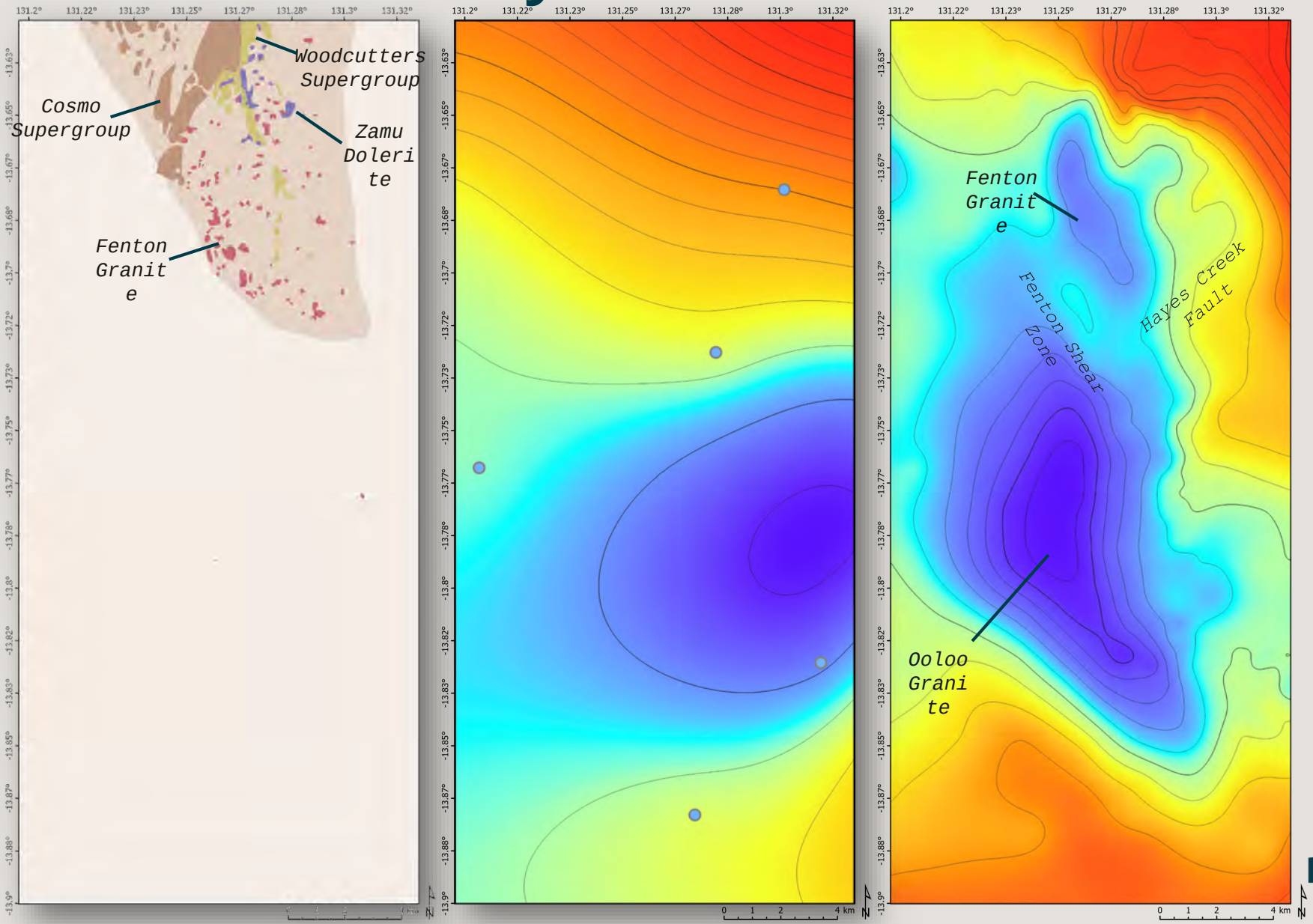
RESOURCING THE TERRITORY

Case Study – DeSoto Resources



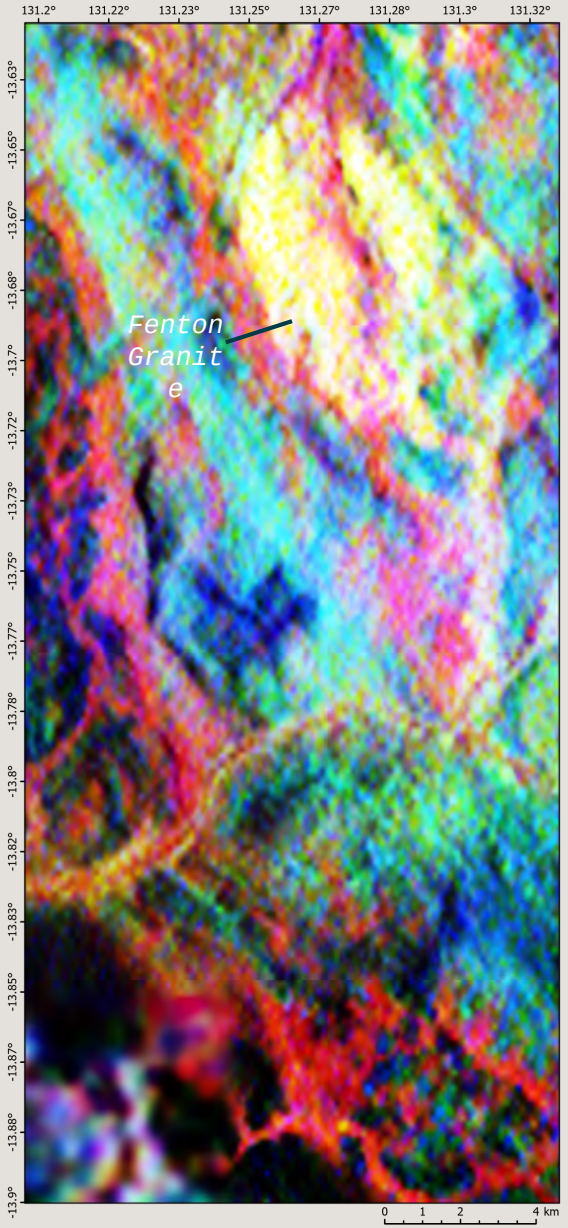
- Very little outcrop in the area
- Five stations of existing ground gravity data in area
- NTGS Pine Creek Ground Gravity survey upgraded to 2 km spacing
- DeSoto Resources contributions upgraded AOI to 500 m spacing
- ~420 new stations in case study area

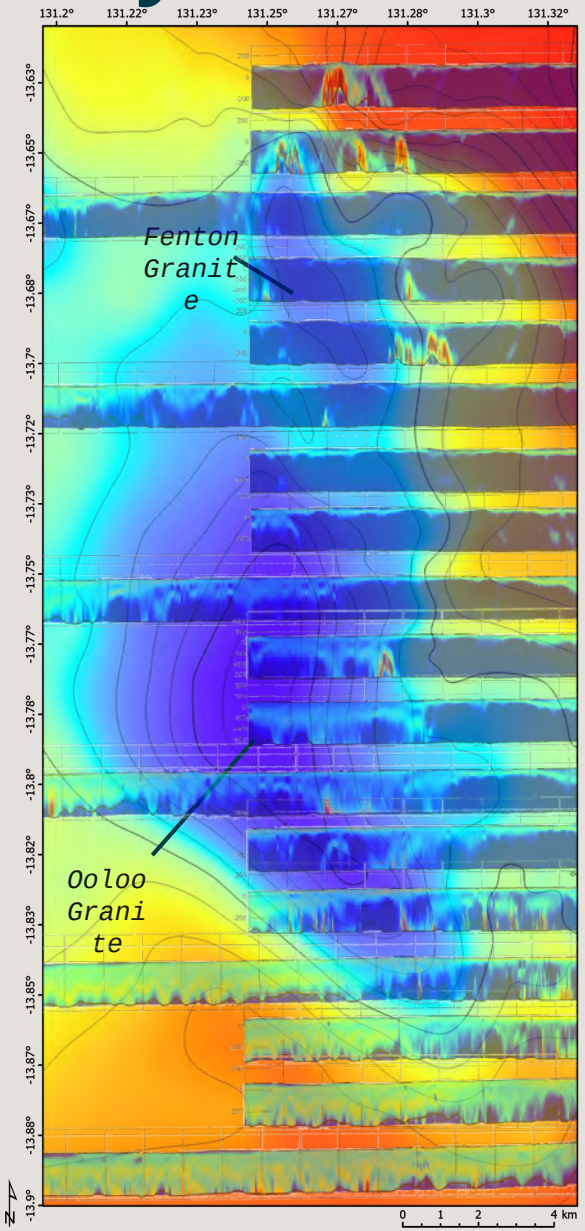
Case Study – DeSoto Resources

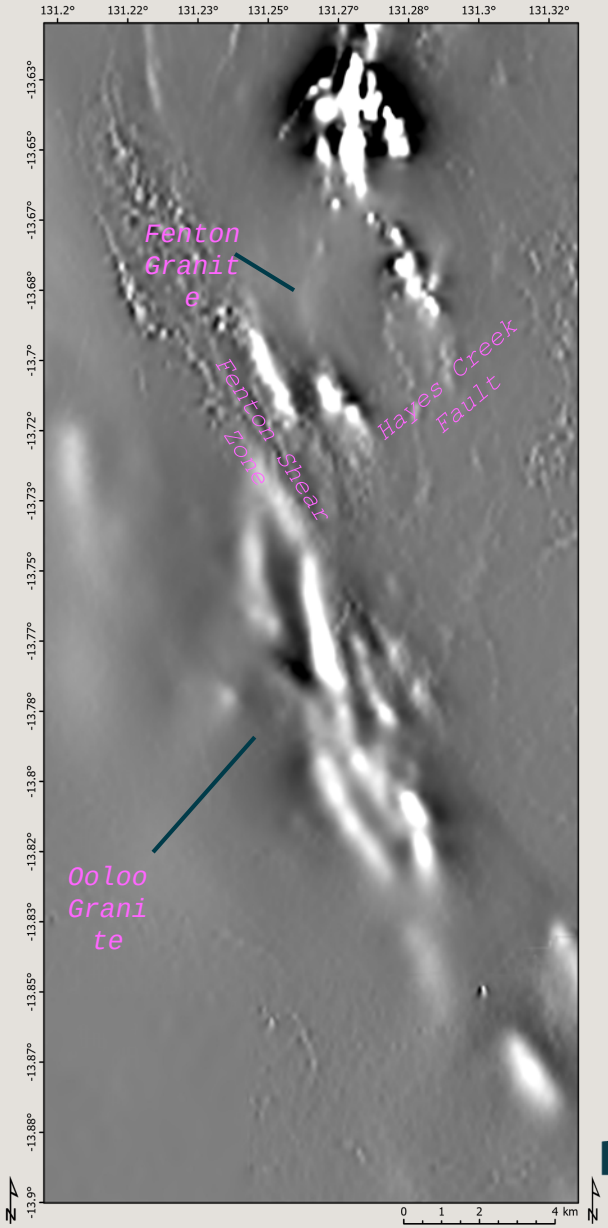


- New gravity better defines the Fenton Granite
- New granite identified – Ooloo Granite
- Located near intersection of Fenton Shear Zone and Hayes Creek Fault
- Supported by drilling results

Case Study – DeSoto Resources

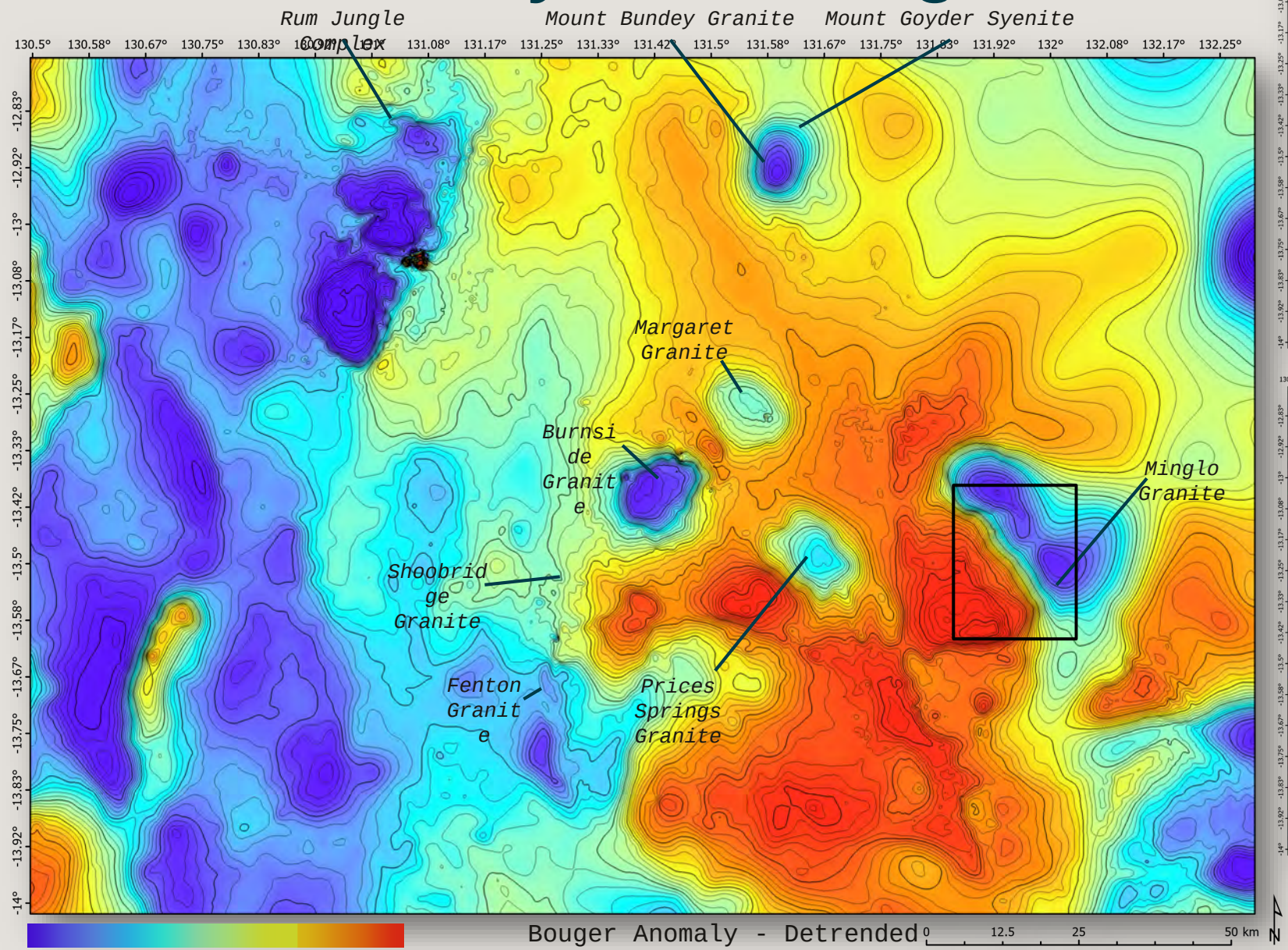


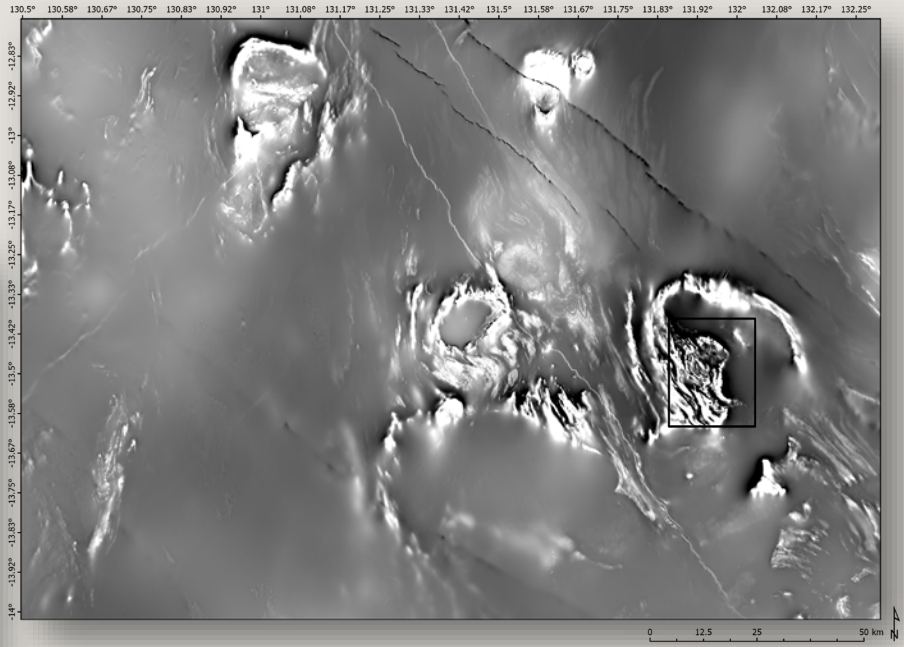


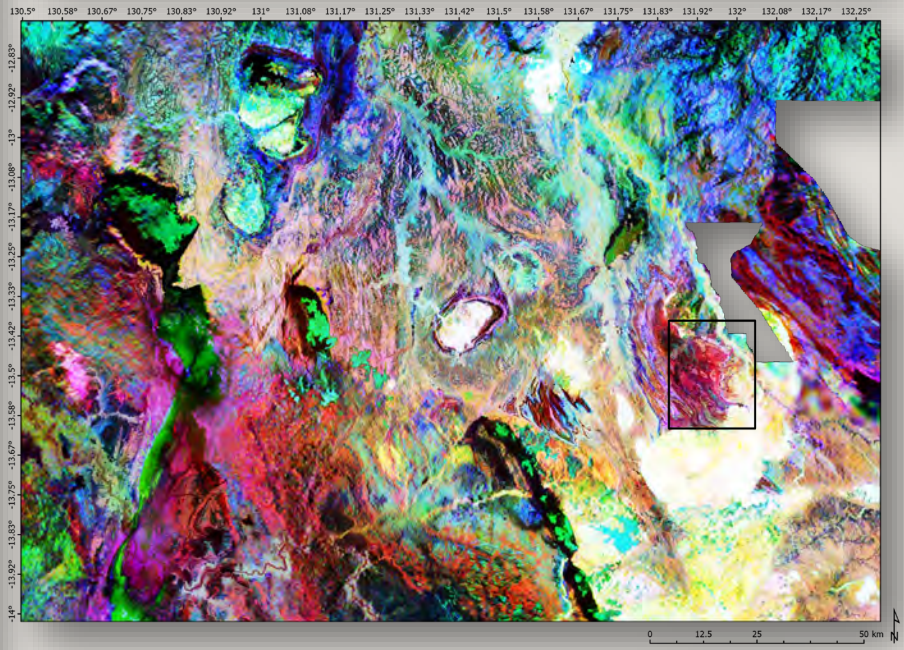


- Primarily 200 m spaced magnetic and radiometric data in area
- AEM data at ~1500 m line spacing
- Magnetic and conductive responses on the eastern boundary of the Fenton and Ooloo granites
- Radiometric response of the Fenton granite

Case Study – Kingsland

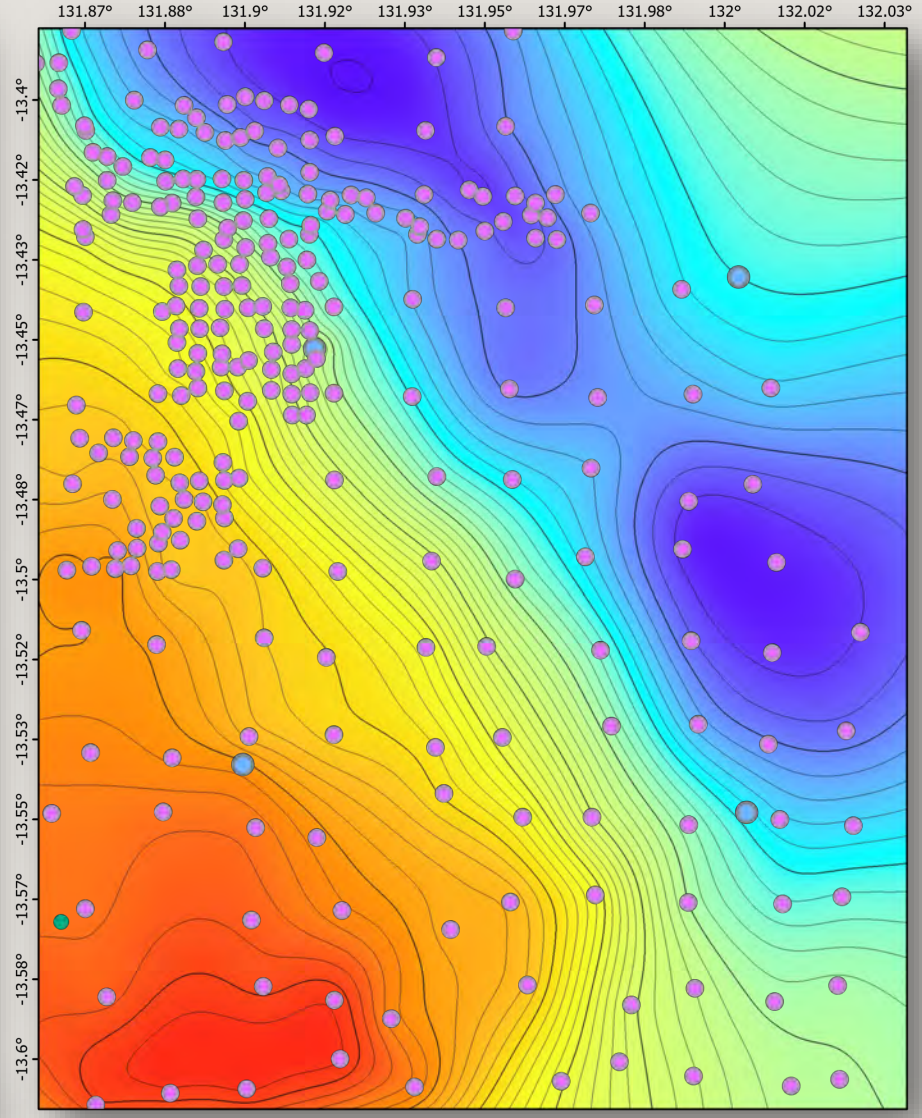






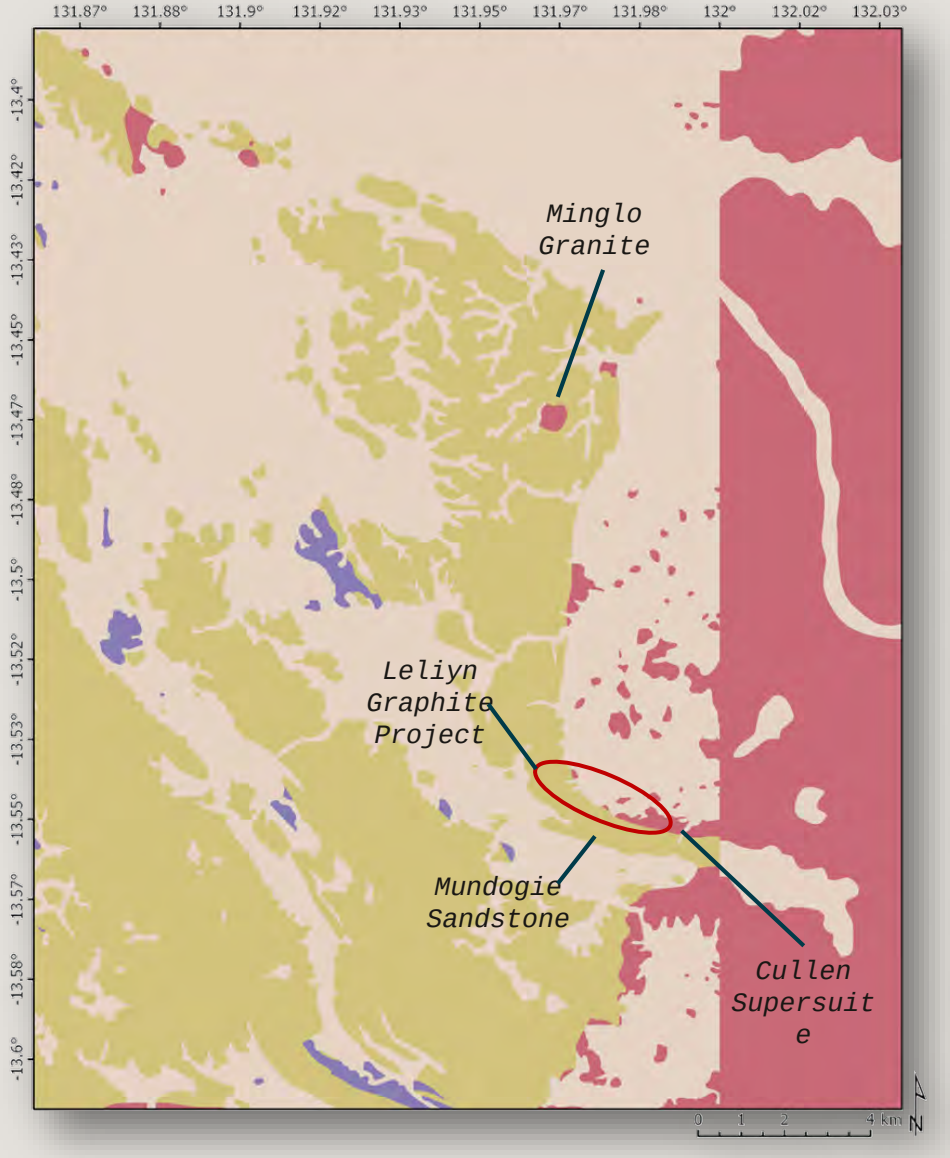
RESOURCING THE TERRITORY

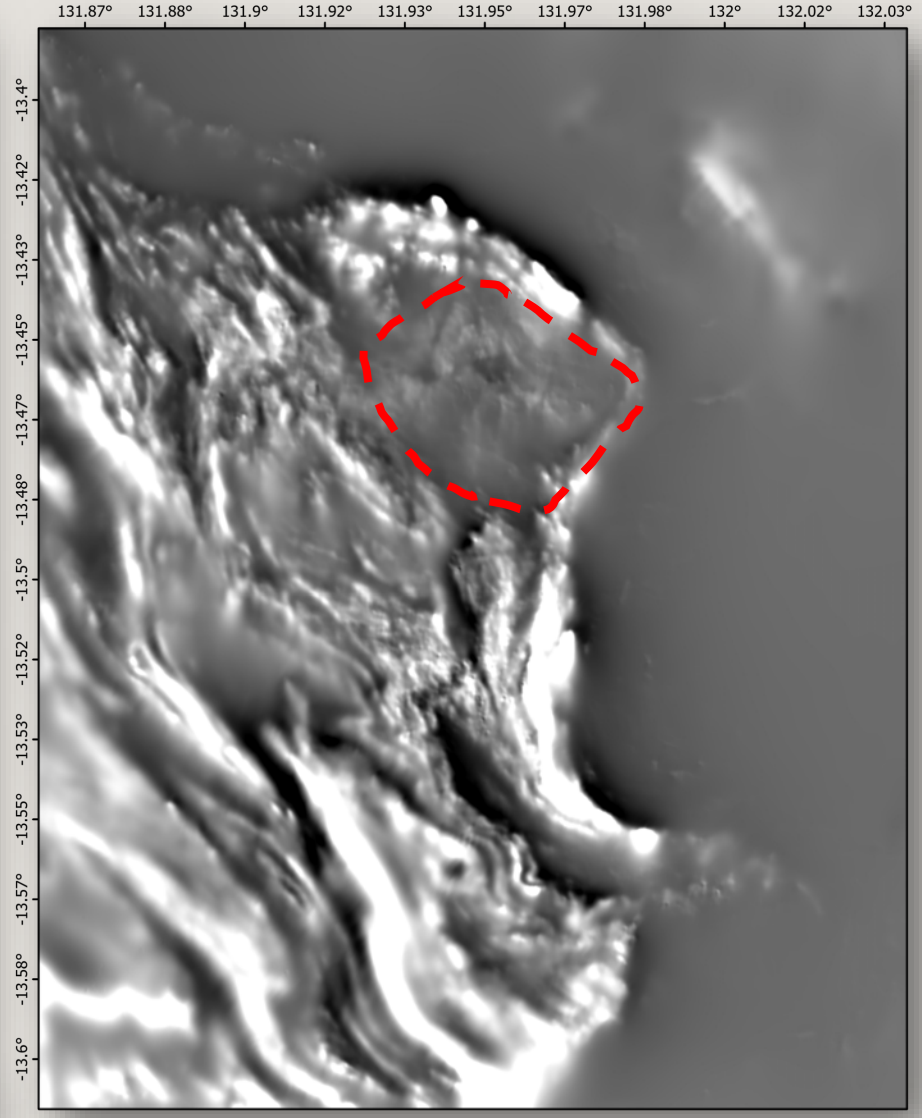
Case Study – Kingsland Minerals



- Australia's largest graphite deposit identified – Leliyn Graphite project (Maddocks & Revell, 2025)
- Mineralsation within graphitic schist along the contact of the Mundogie Sandstone in the Woodcutters Supergroup (tan) and the Cullen Supersuite (pink)
- The entire length of this boundary is prospective

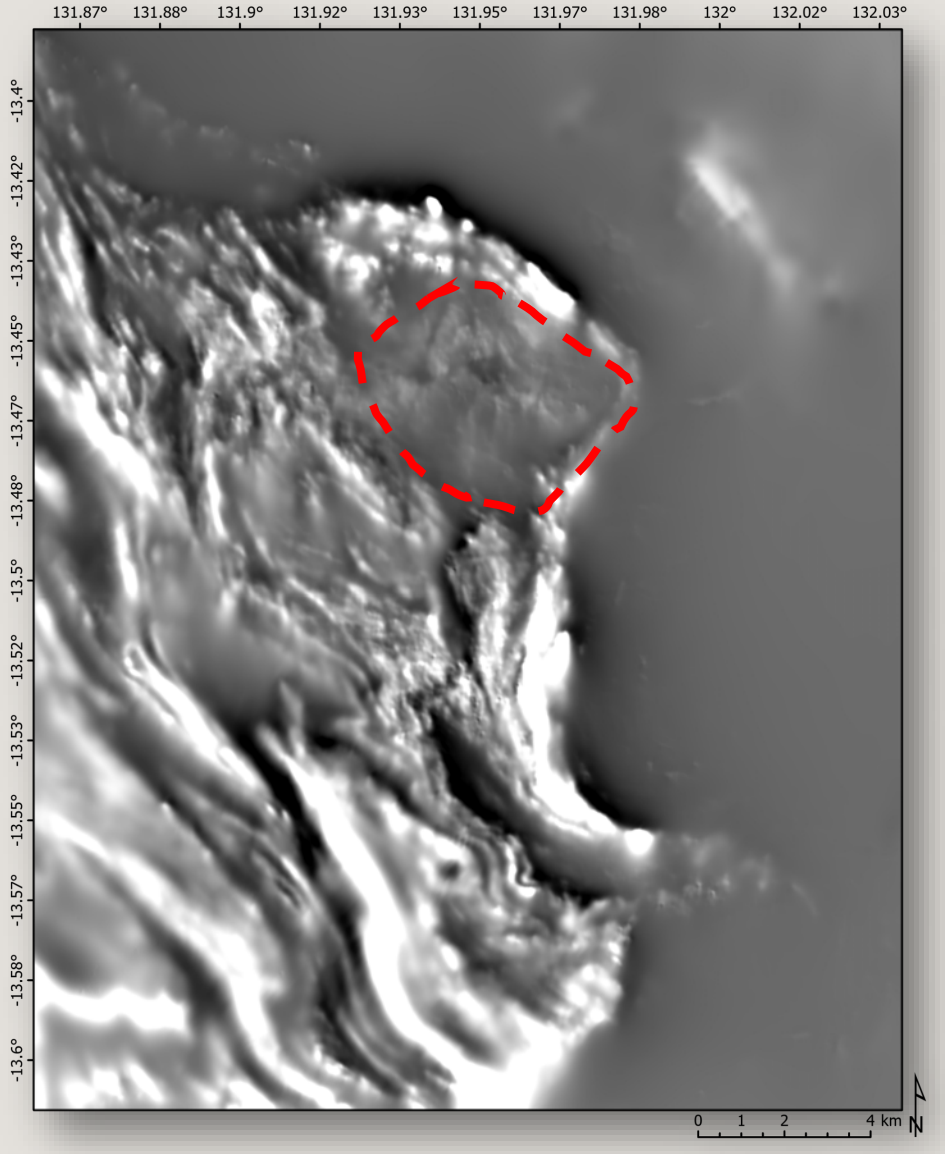
Case Study – Kingsland Minerals

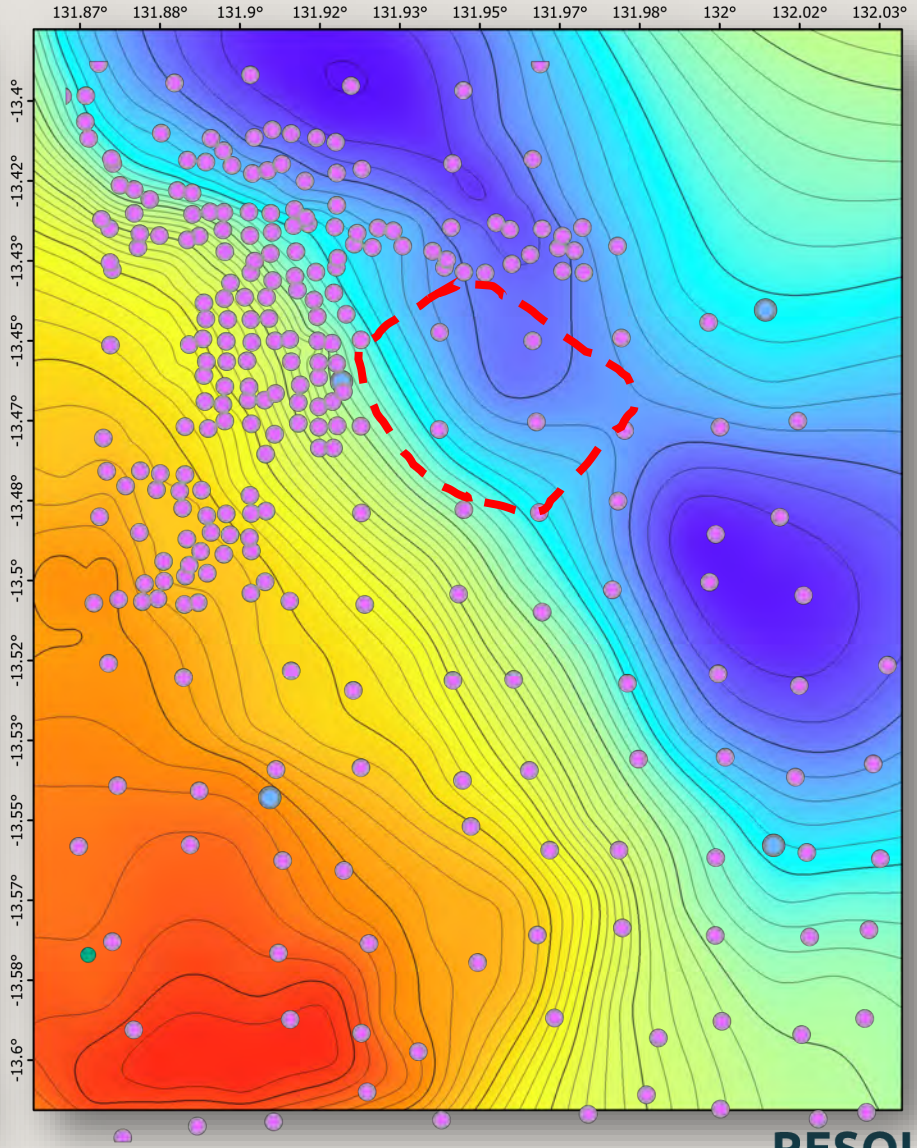




- The majority of the area covered by 70-80 m line spaced magnetic and radiometric data
- Magnetic low possibly associated with undercover extent of the Minglo Granite

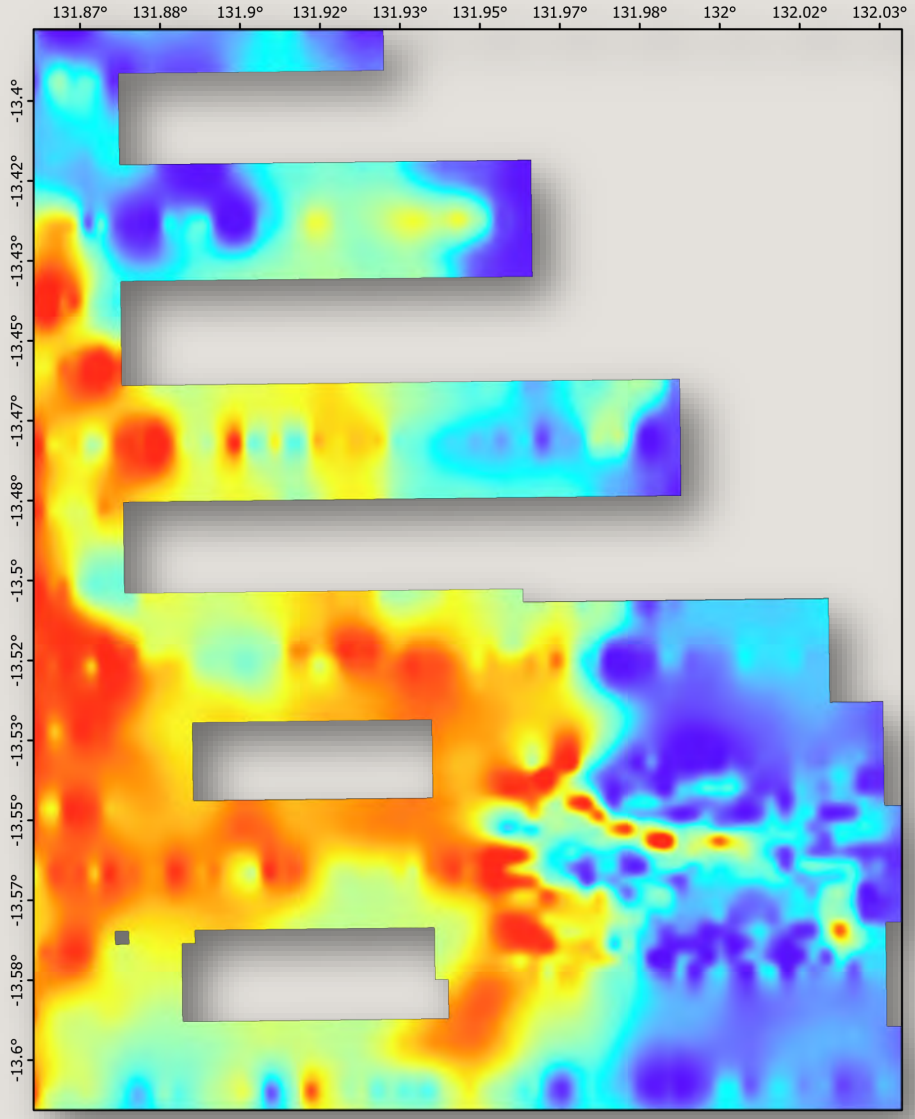
Case Study – Kingsland Minerals





- Less clear in the gravity data, possibly due to the resolution

Case Study – Kingsland Minerals



- The boundary between the Mundogie Sandstone and Cullen Supersuite is clearly visible in the radiometrics
- Sparse AEM data reveals an associated conductive anomaly

Thanks

References

- Reno BL, Farias P, Burton-Johnson A and Whelan J, 2025. Towards a revised understanding of the Central Domain of the Pine Creek Orogen: in *Annual Geoscience Exploration Seminar (AGES) Proceedings, Alice Springs, Northern Territory, 8-9 April 2025. Northern Territory Geological Survey, Darwin.*
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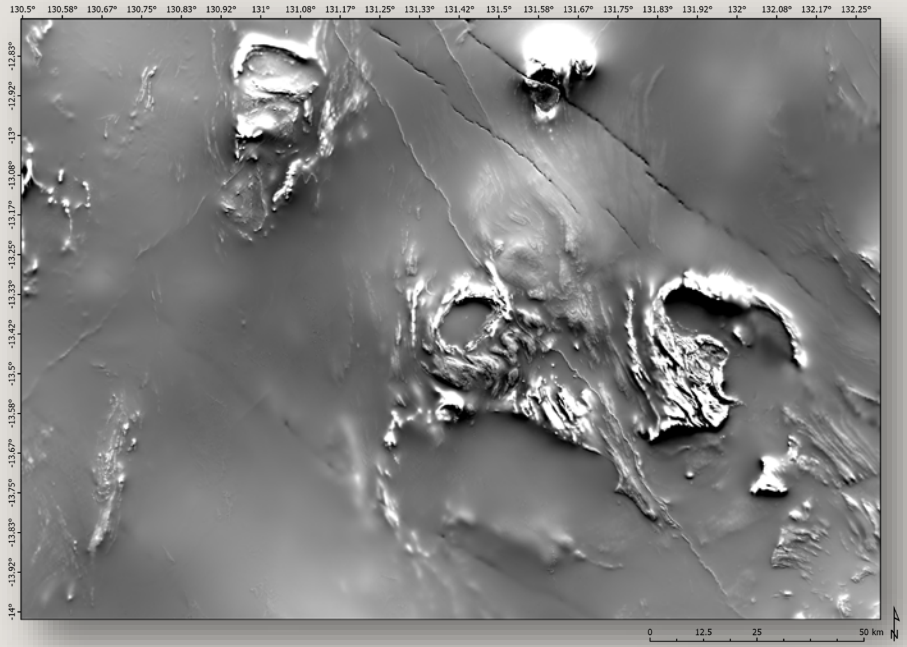

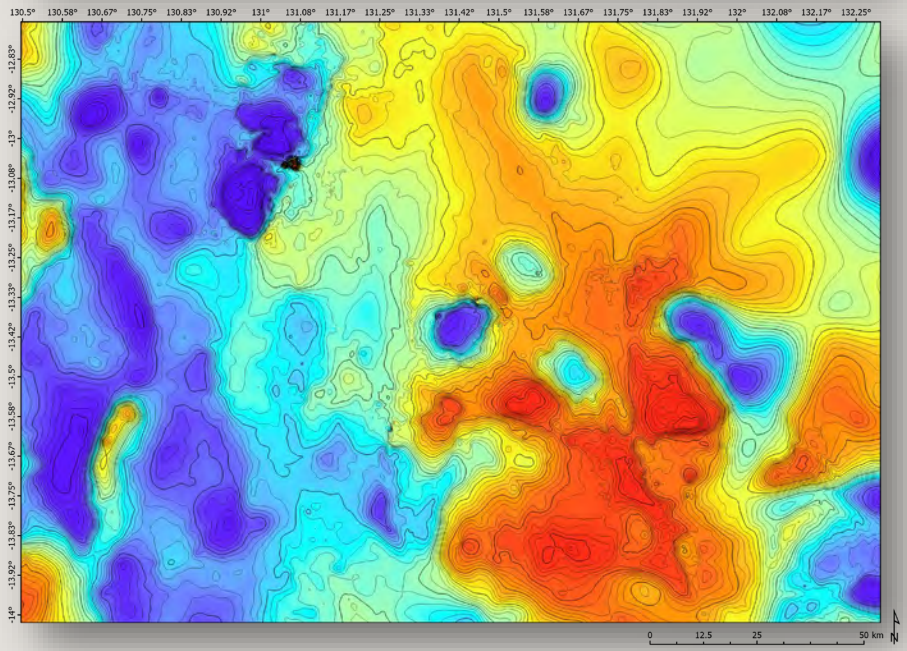

RESOURCING THE TERRITORY