Australian Government
Geoscience Australia

Geological interpretations from the Paterson AEM survey

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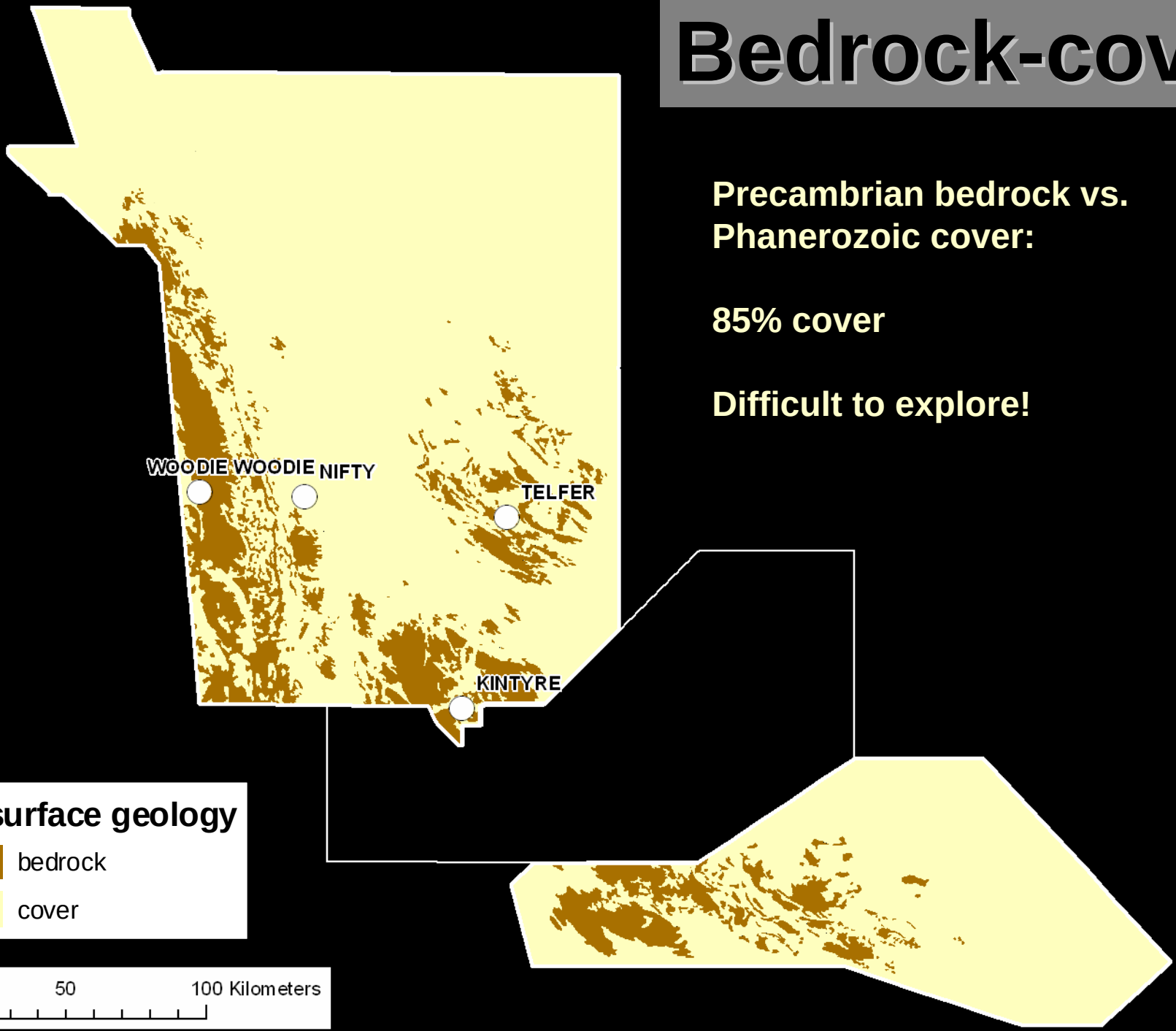
Introduction

1. Surface geomorphology and geology:
    1. Topography-relief-palaeodrainage;
    2. Geological provinces, cover geology;
    3. Bedrock/cover relationship.
2. Airborne geophysics:
    1. Gravity;
    2. Aeromagnetics.
3. AEM data validation:
    1. Geological and Geophysical data compilation.
4. AEM: the big-picture:
    1. Surface conductivity;
    2. Depth slices;
    3. Detail of large objects – Anketell & Throssell shelfs, Rudall Complex, palaeodrainage systems;
    4. Depth-to map.
5. Mineral Deposits.

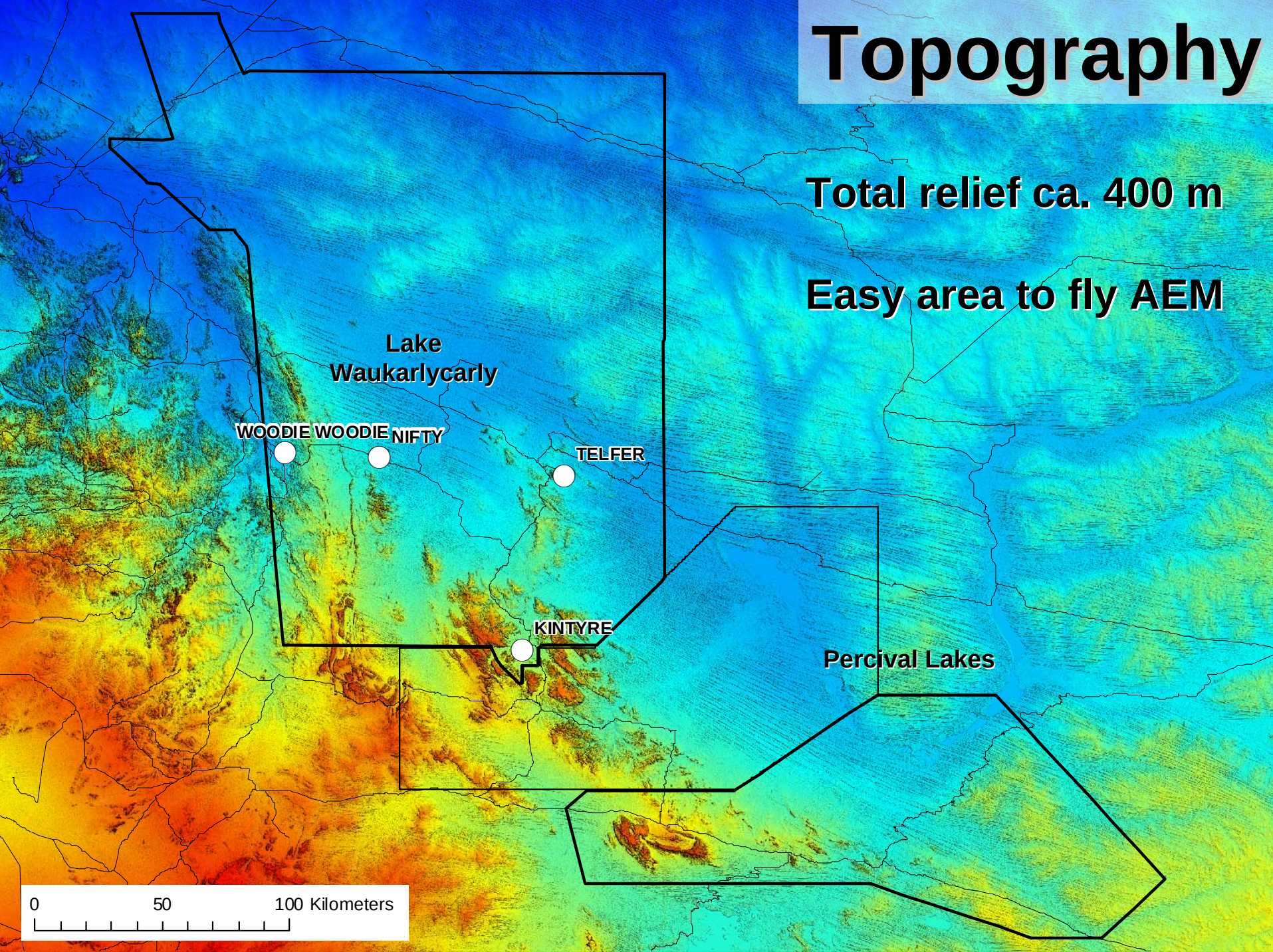
Bedrock-cover

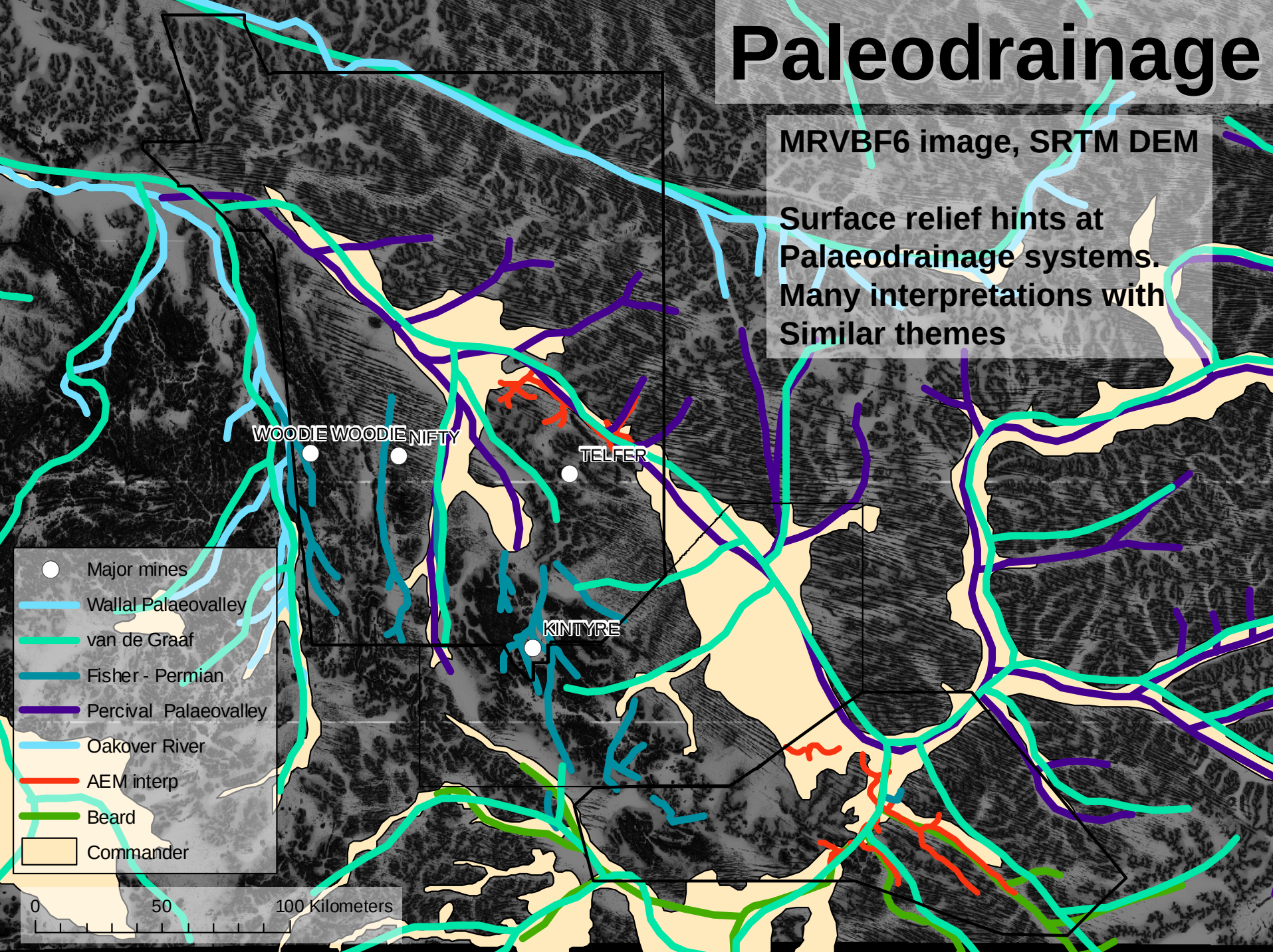


Precambrian bedrock vs. Phanerozoic cover:

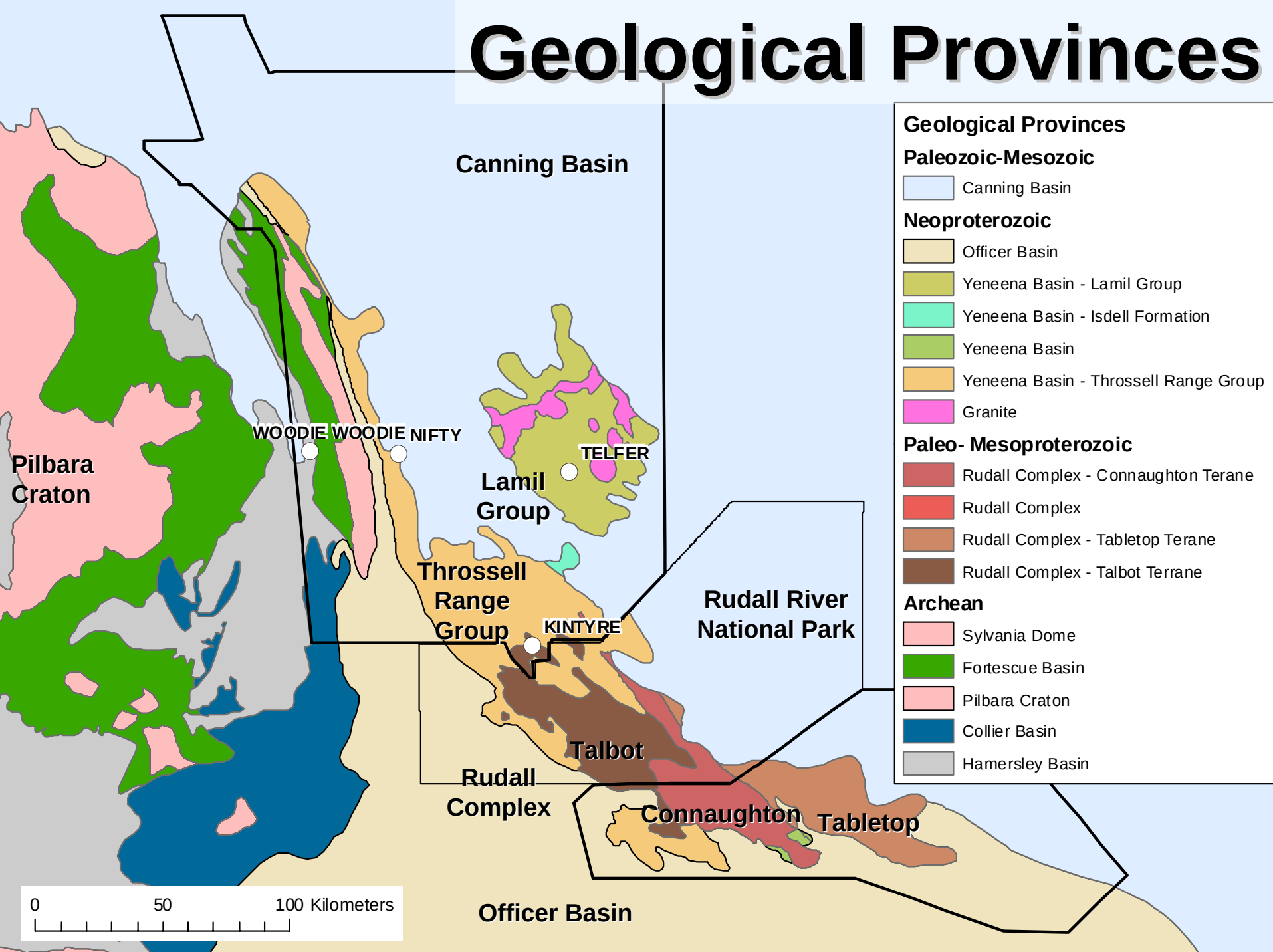
85% cover

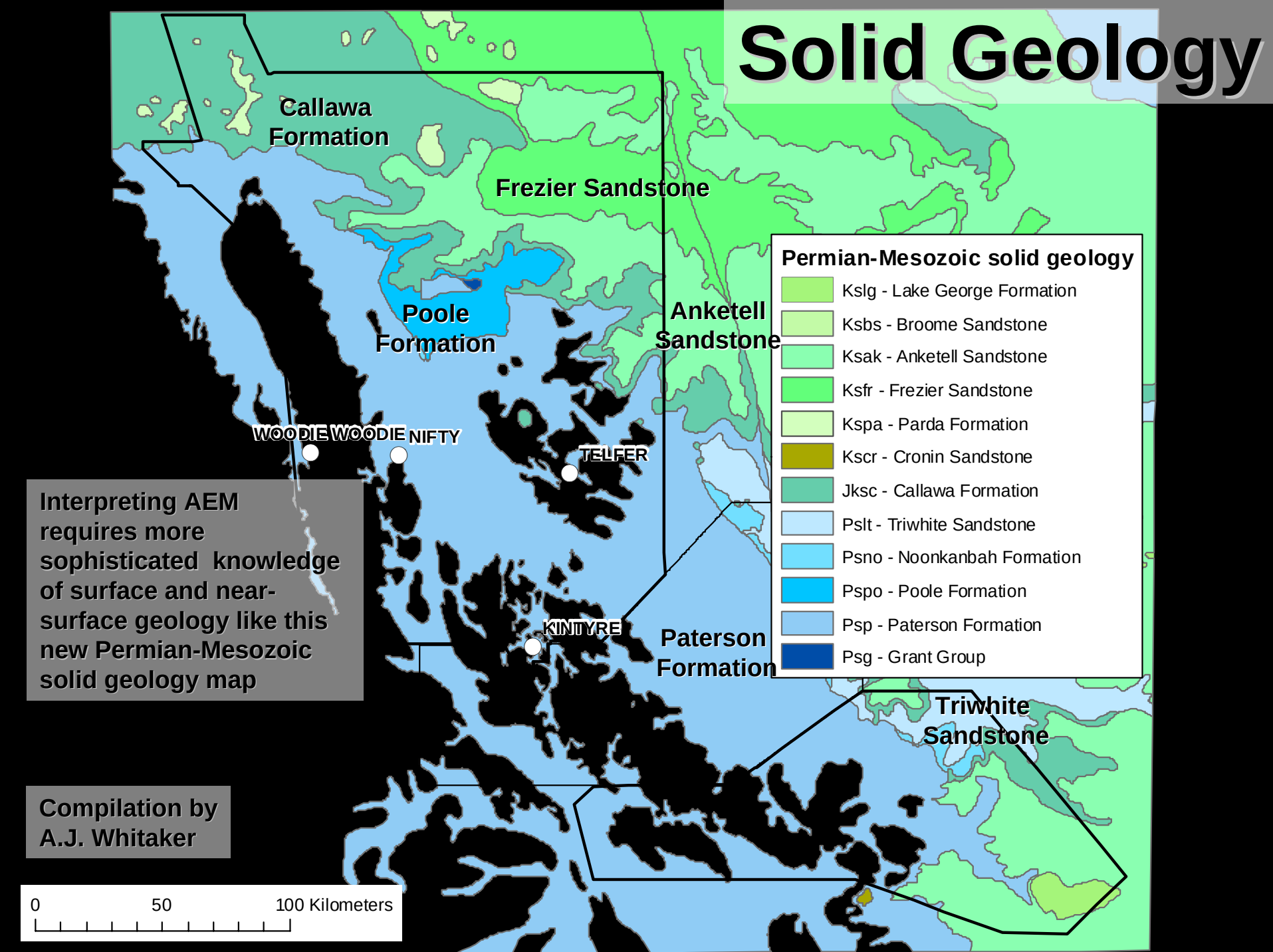
Difficult to explore!


Topography
Total relief ca. 400 m
Easy area to fly AEM
Lake
Waukarlycarly
WOODIE WOODIE
NIFTY
TELFER
KINTYRE
Percival Lakes
0
50
100 Kilometers


Paleodrainage
MRVBF6 image, SRTM DEM
Surface relief hints at Palaeodrainage systems. Many interpretations with Similar themes
WOODIE WOODIE
NIFTY
TELFER
KINTYRE
Major mines
Wallal Palaeovalley
van de Graaf
Fisher - Permian
Percival Palaeovalley
Oakover River
AEM interp
Beard
Commander
0
50
100 Kilometers

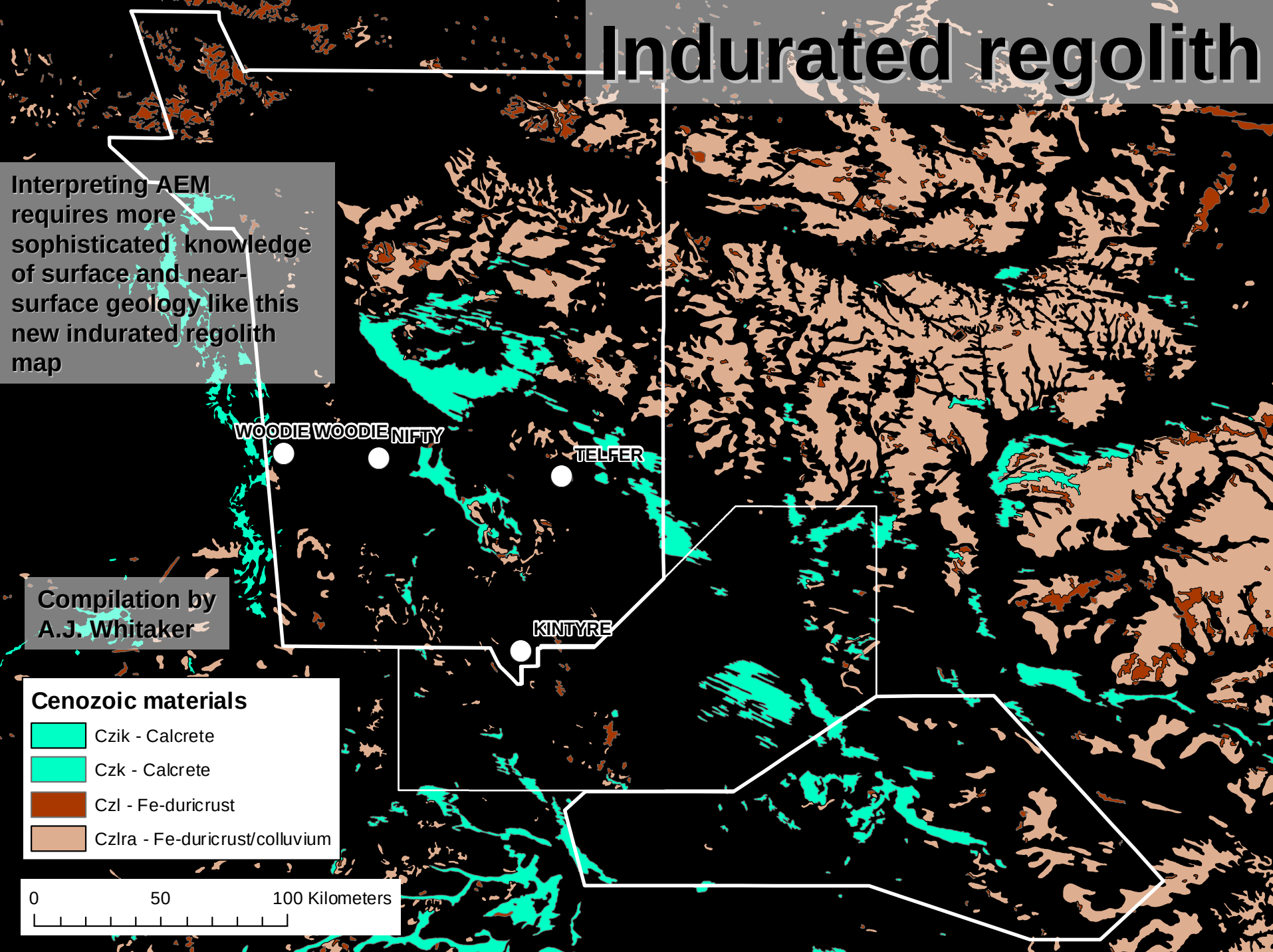
Geological Provinces




Solid Geology
Callawa Formation
Frezier Sandstone
Poole Formation
Anketell Sandstone
WOODIE WOODIE
NIFTY
TELFER
KINTYRE
Paterson Formation
Triwhite Sandstone
Permian-Mesozoic solid geology
Kslg - Lake George Formation
Ksbs - Broome Sandstone
Ksak - Anketell Sandstone
Ksfr - Frezier Sandstone
Kspa - Parda Formation
Kscr - Cronin Sandstone
Jksc - Callawa Formation
Pslt - Triwhite Sandstone
Psno - Noonkanbah Formation
Pspo - Poole Formation
Psp - Paterson Formation
Psg - Grant Group
Interpreting AEM requires more sophisticated knowledge of surface and near-surface geology like this new Permian-Mesozoic solid geology map
Compilation by A.J. Whitaker
0
50
100 Kilometers

Indurated regolith

Interpreting AEM requires more sophisticated knowledge of surface and near-surface geology like this new indurated regolith map

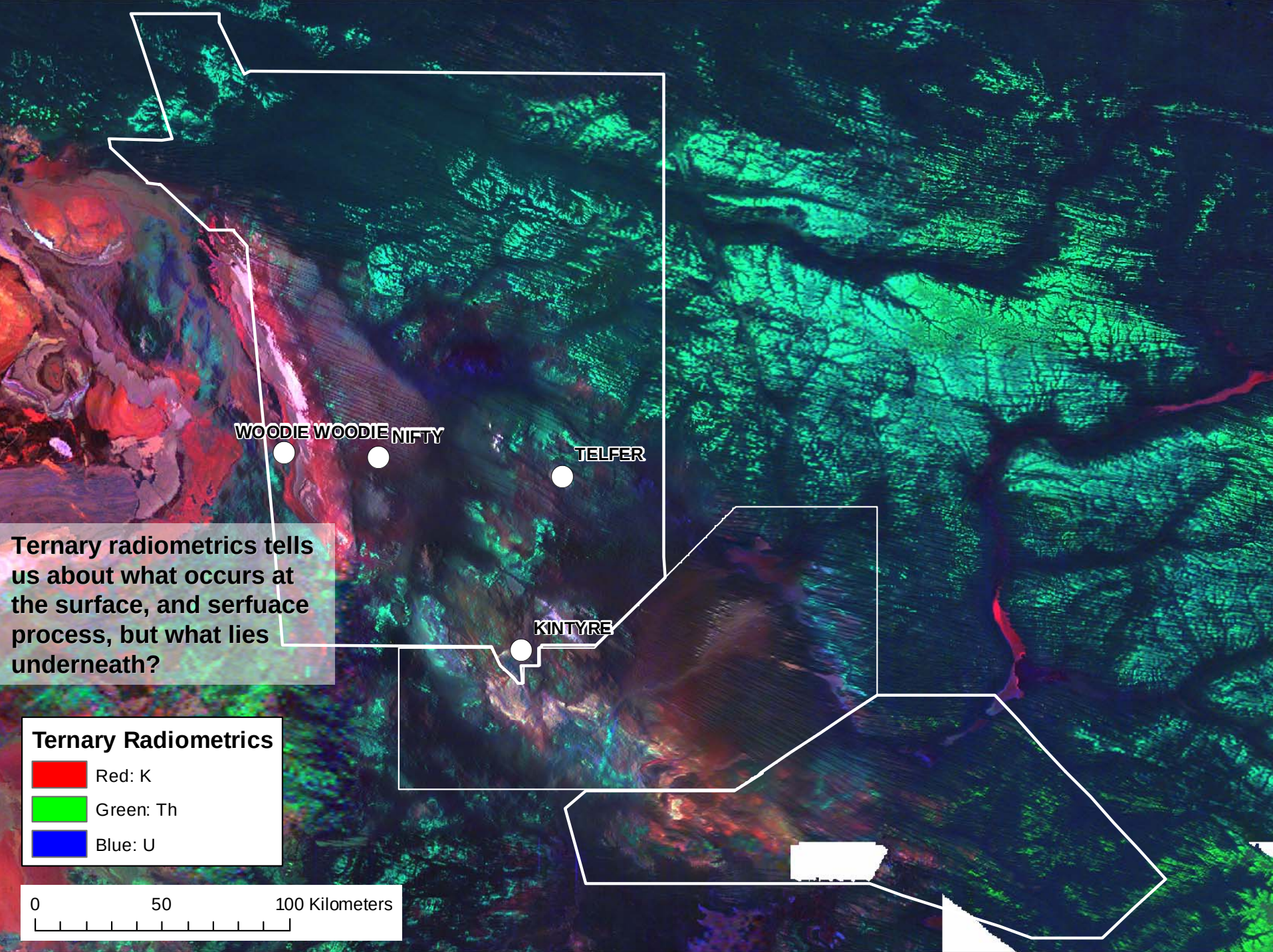


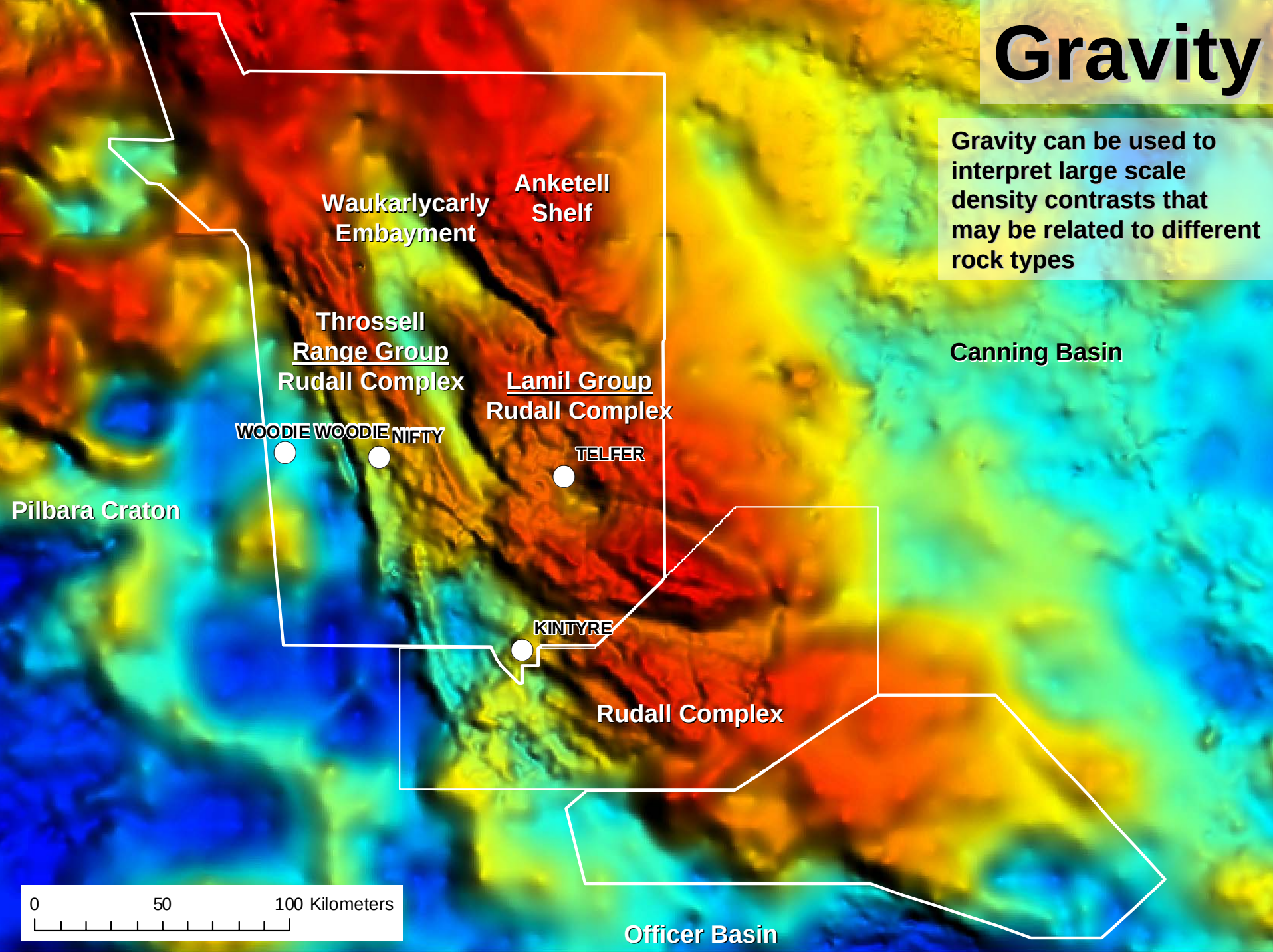
Compilation by A.J. Whitaker

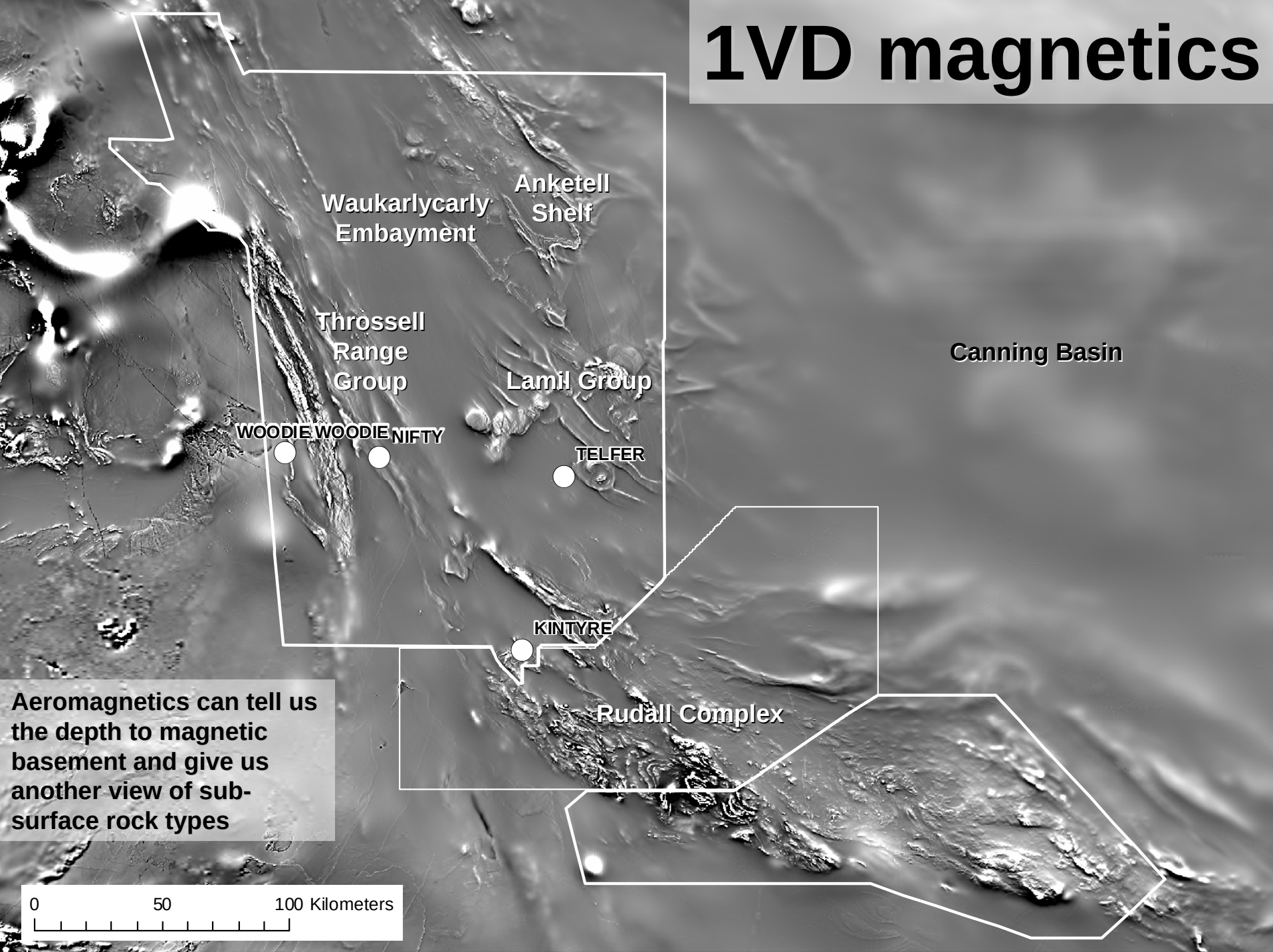
Cenozoic materials

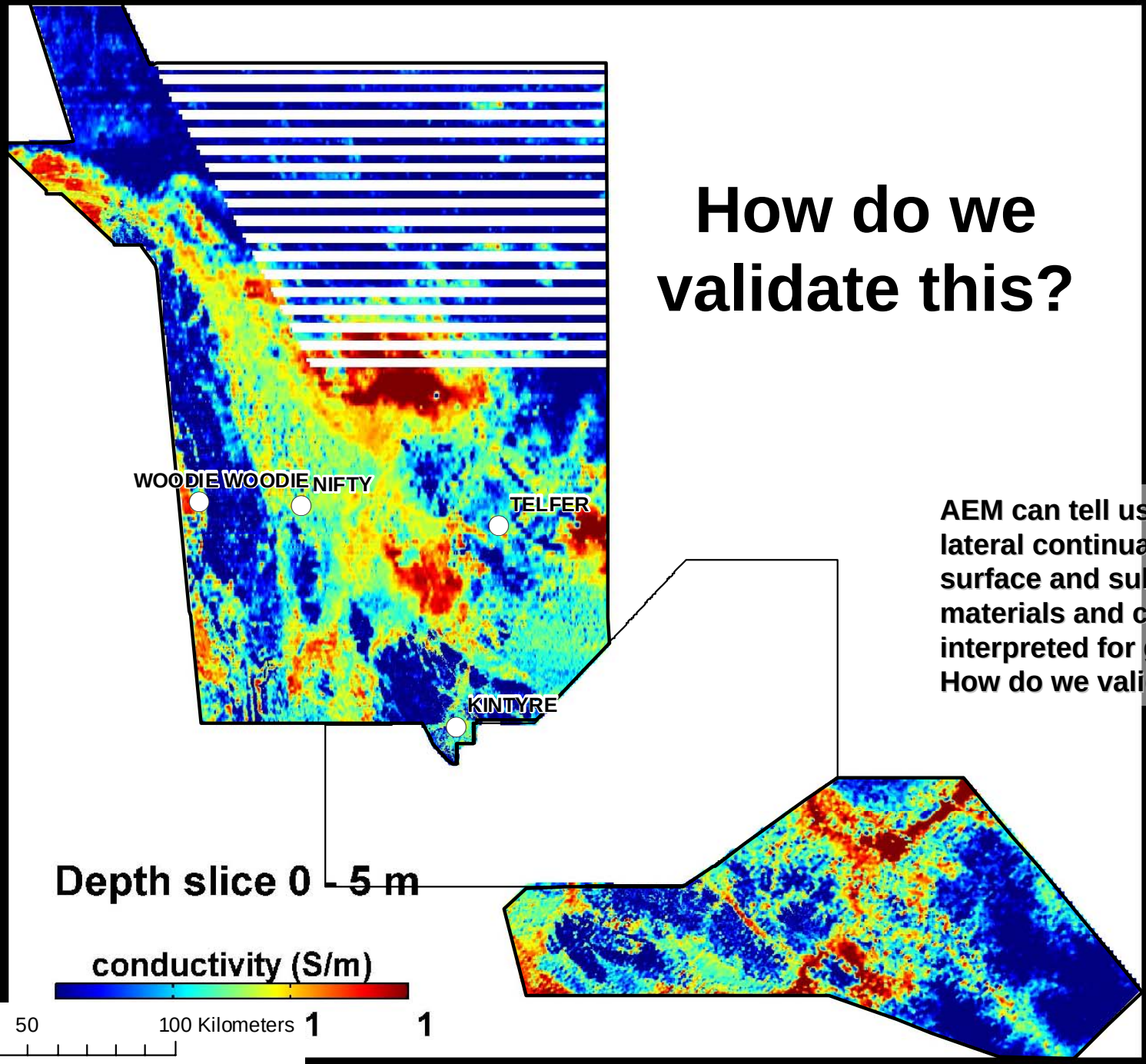
- Czik - Calcrete
- Czk - Calcrete
- Czl - Fe-duricrust
- Czlra - Fe-duricrust/colluvium

0 50 100 Kilometers


WOODIE WOODIE
NIFTY
TELFER
KINTYRE
Ternary radiometrics tells us about what occurs at the surface, and serfuace process, but what lies underneath?
Ternary Radiometrics
Red: K
Green: Th
Blue: U
0
50
100 Kilometers


Gravity
Gravity can be used to interpret large scale density contrasts that may be related to different rock types
Waukarlycarly Embayment
Anketell Shelf
Throssell Range Group
Rudall Complex
Lamil Group
Rudall Complex
Canning Basin
WOODIE WOODIE
NIFTY
TELFER
Pilbara Craton
KINTYRE
Rudall Complex
0
50
100 Kilometers
Officer Basin


1VD magnetics
Waukarlycarly Embayment
Anketell Shelf
Throssell Range Group
Lamil Group
Canning Basin
WOODIE WOODIE
NIFTY
TELFER
KINTYRE
Rudall Complex
Aeromagnetics can tell us the depth to magnetic basement and give us another view of sub-surface rock types
0
50
100 Kilometers


How do we validate this?
WOODIE WOODIE
NIFTY
TELFER
KINTYRE
AEM can tell us about the lateral continuation of surface and sub-surface materials and can be interpreted for geology. How do we validate this?
Depth slice 0 - 5 m
conductivity (S/m)
1
1
0
50
100 Kilometers

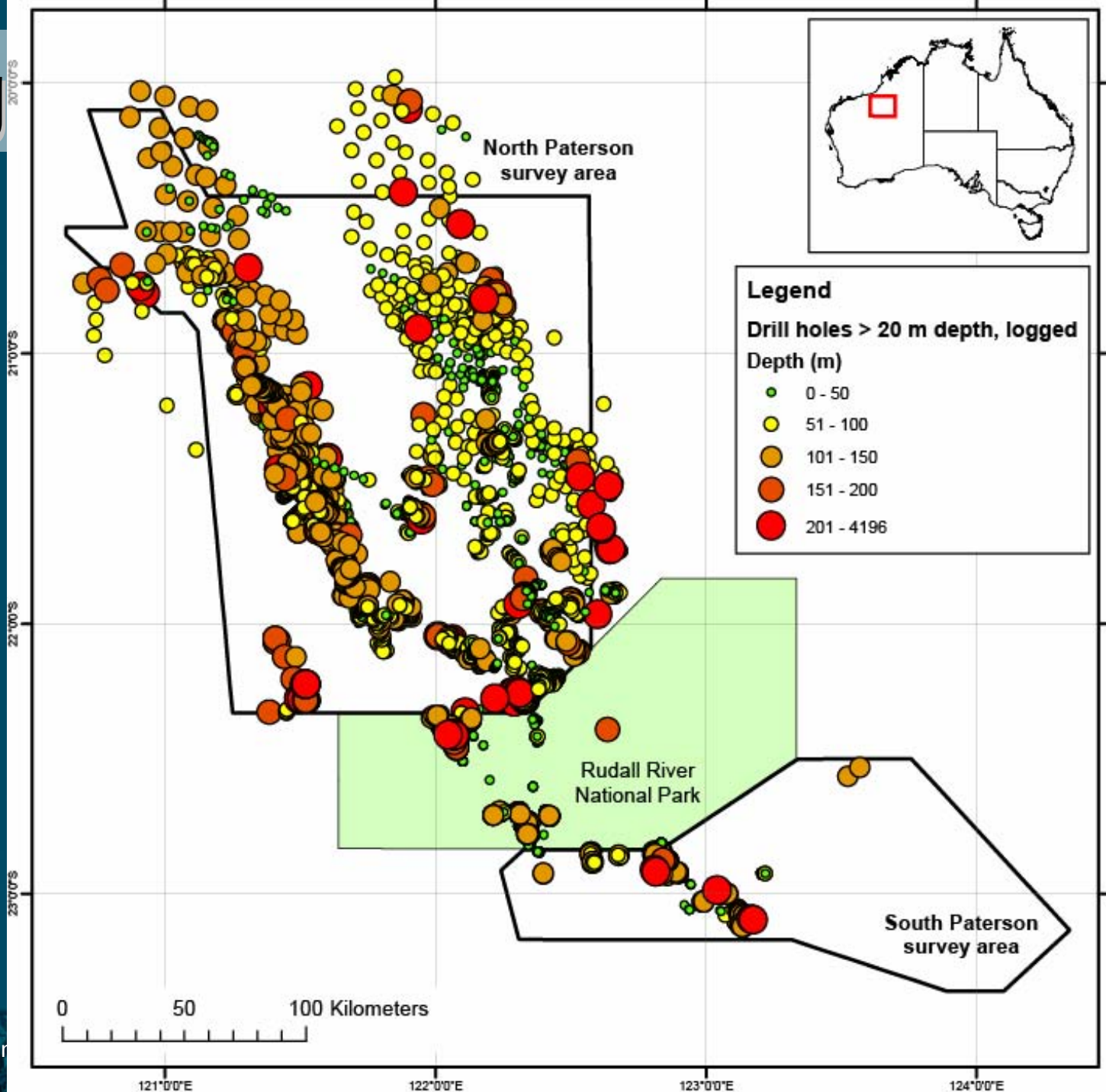
Geological validation

- Drill holes: a publicly-available drill hole compilation (Roach, 2009);
- Solid geology: a compilation by Czarnota *et al.* (2009);
- Surface geology: the 1:1 000 000 scale Surface Geology of Western Australia (Stewart, 2008);
- 1:250 000 and 1:100 000 geological maps;
- Magnetics: GA Magnetic Map of Australia;
- Gravity: GA Gravity map of Australia;
- Radiometrics: GA Radiometric Map of Australia (Minty *et al.*, 2009);
- Conductivity logs

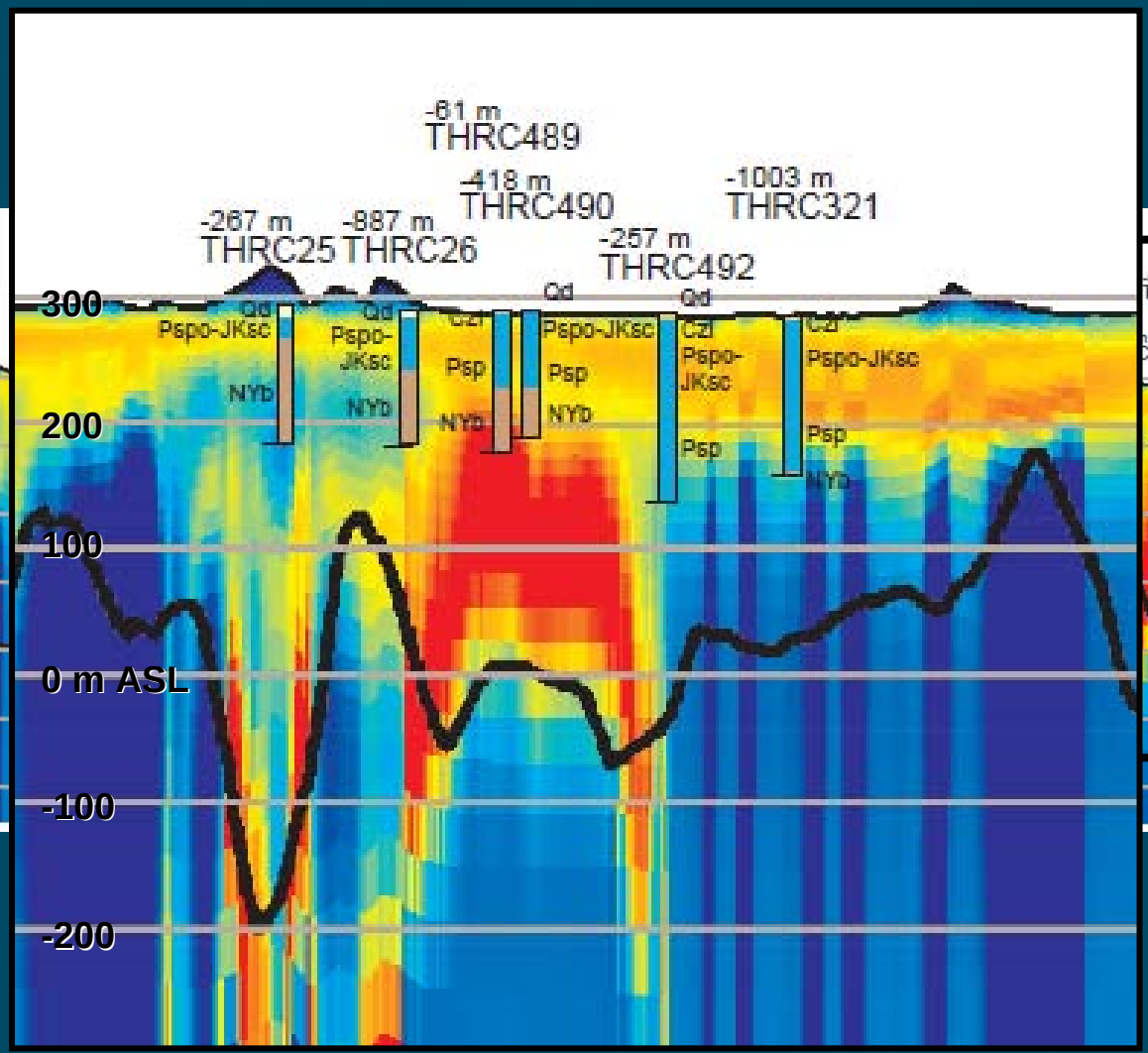
All GA data are available on-line at: www.ga.gov.au/minerals

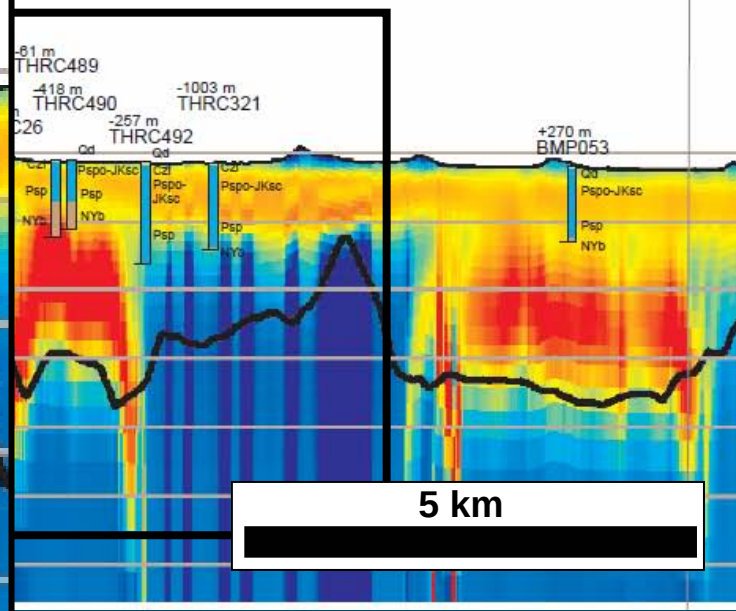
Drilling

- 4,300+ logged drill holes.
- Released as GA Record and database Roach (2009).



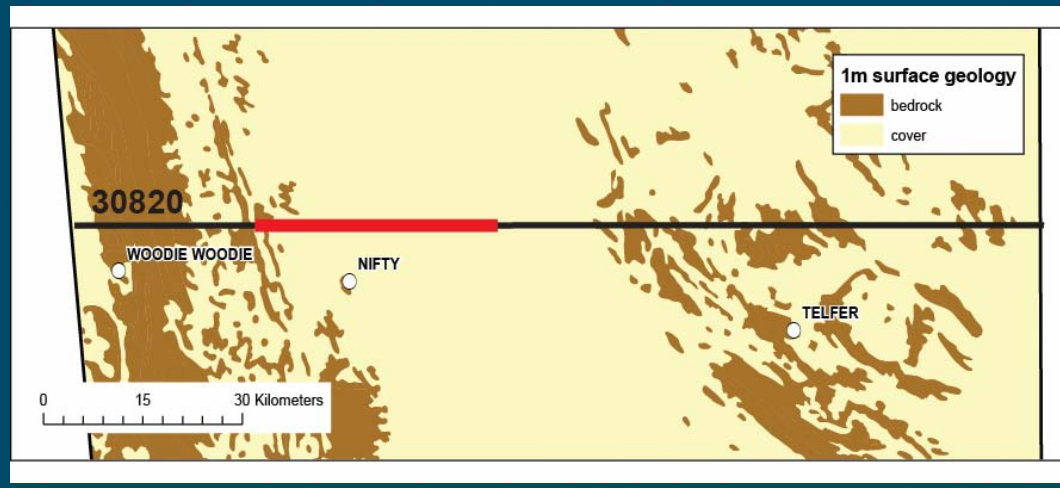
Drill holes vs AEM conductivity sections

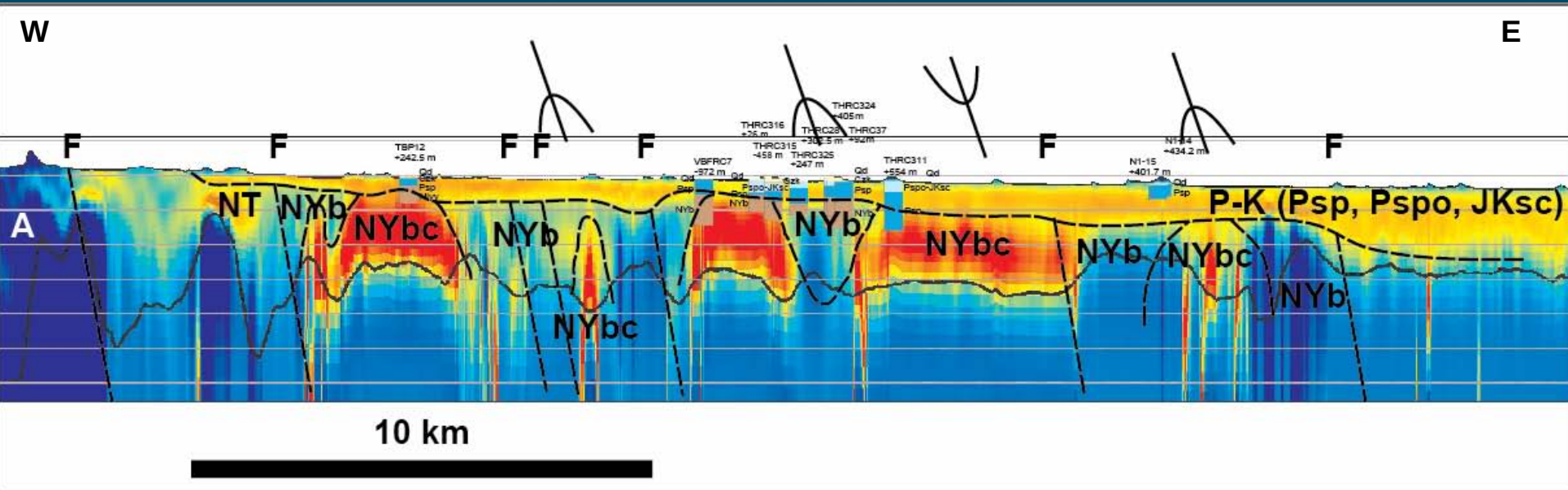




GA LEI section geological interpretation

- Line 30820, ca. 8 km north of Nifty Cu mine.
- Interpretation after Bagas (2002), Lamil 1:100,000 geology sheet.





Large-scale geological interpretations

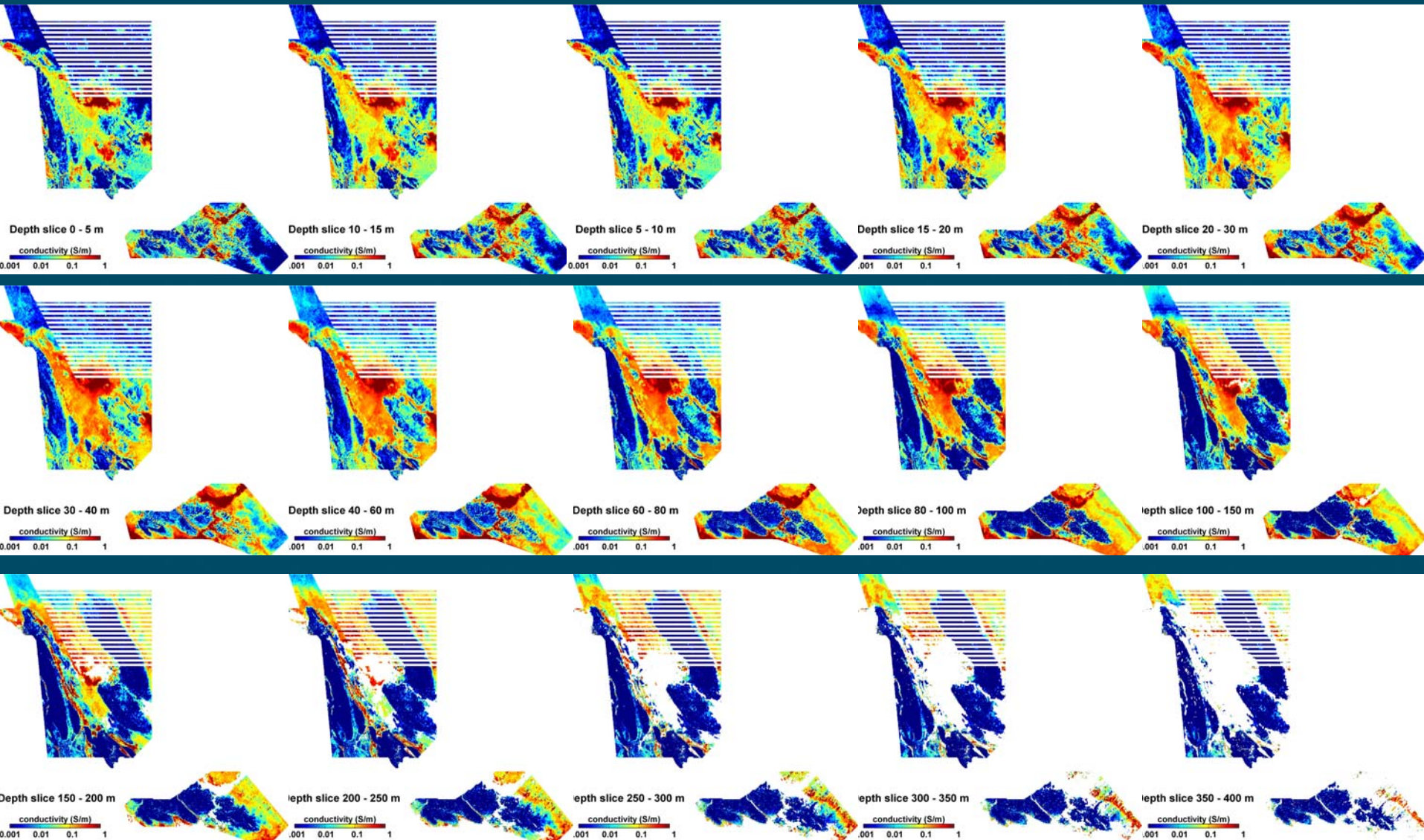
- Interpretations mostly from gridded data:
  - GA LEI Depth Slices:
    - Created by draping gridded inversion conductivity values over an elevation model;
    - Represent a conductivity ‘skin’ at a certain depth from topographic surface.
  - GA LEI Elevation Slices:
    - Removes terrain;
    - Represent a conductivity ‘level’ from datum.
- Grids have data under the DOI removed.

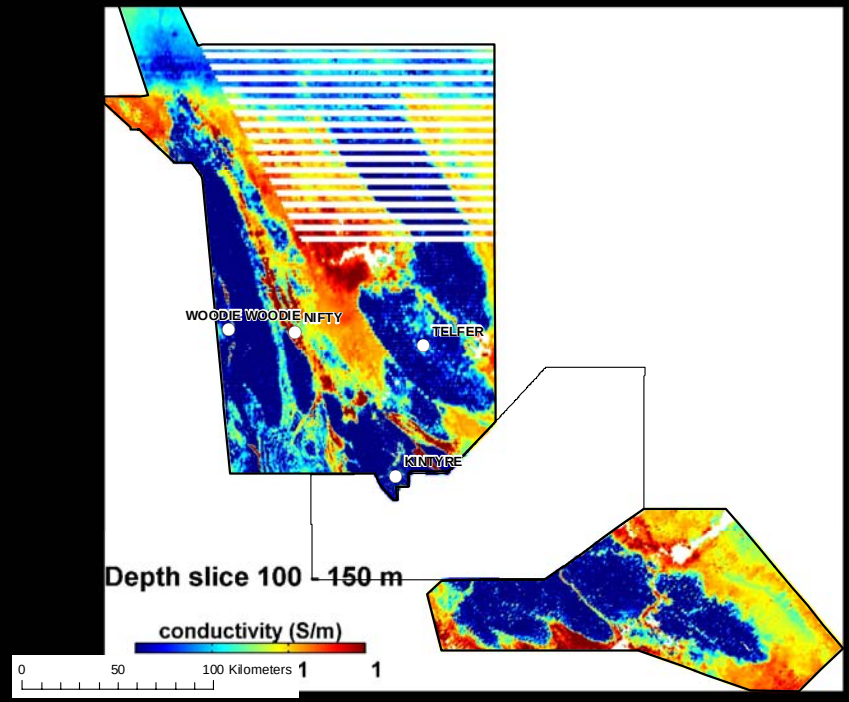
Mapping palaeosurfaces- Conductivity anomaly contours

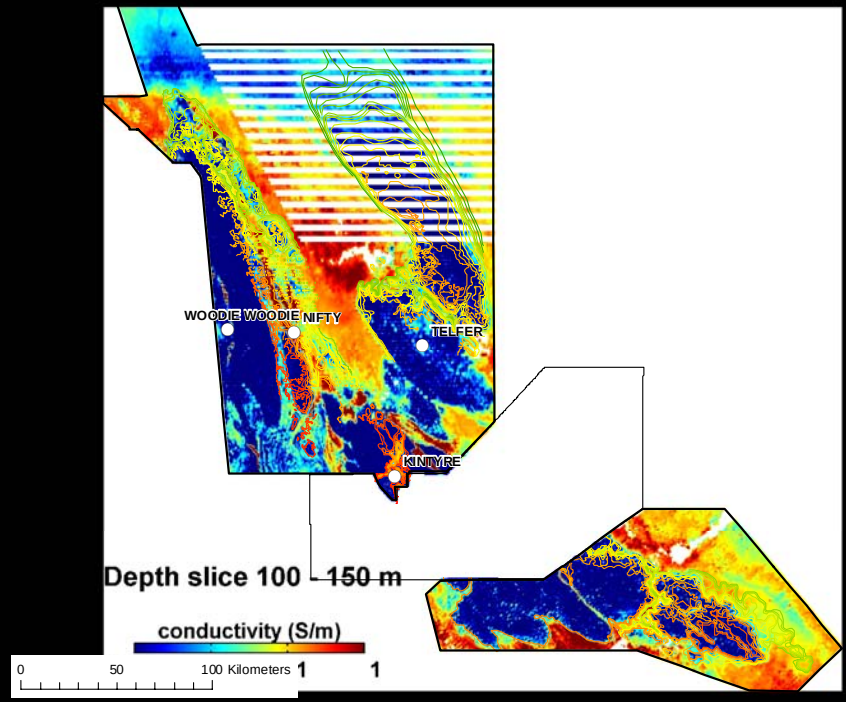
- Created using gridded GA LEI data and drill holes.
- Assumes conductivity anomaly follows broad sub-Permian unconformity – DOI permitting:
    - Only drawn in areas where Permian and younger fill is conductive.
- Able to visualise large palaeotopographic features and some unconformities.

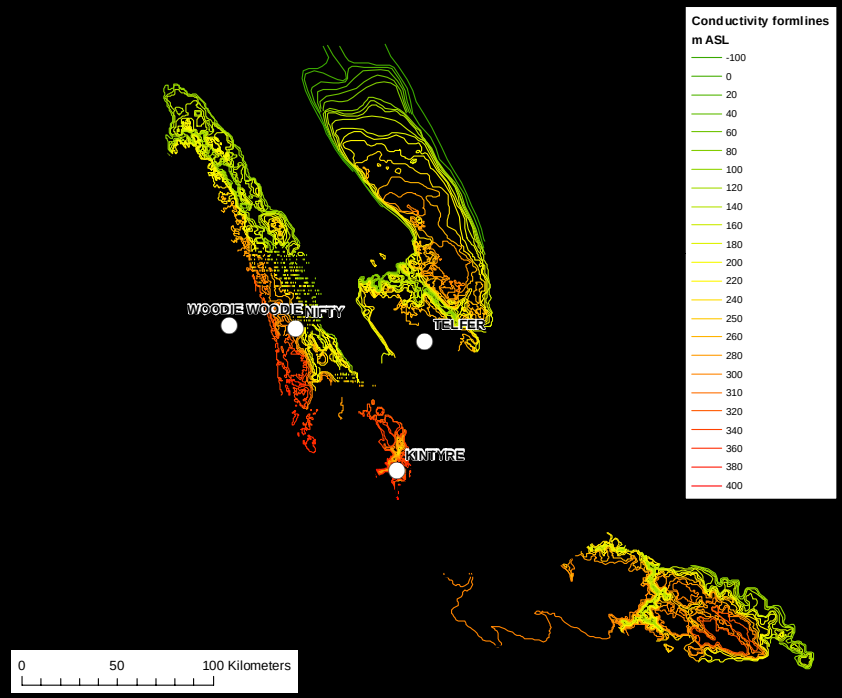
GA LEI Depth slices

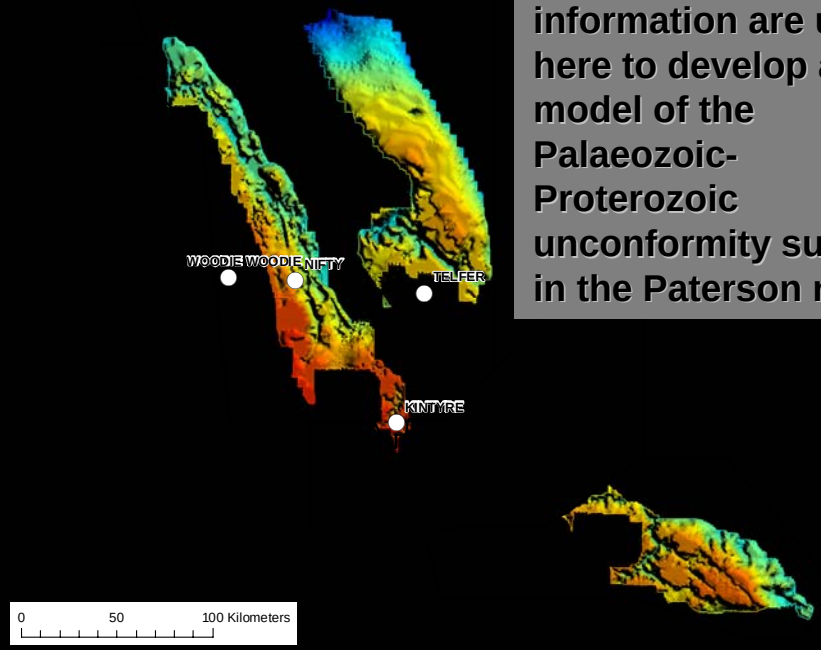
Depth slices show subsurface conductivity features, Can these be used to map conductivity surfaces?



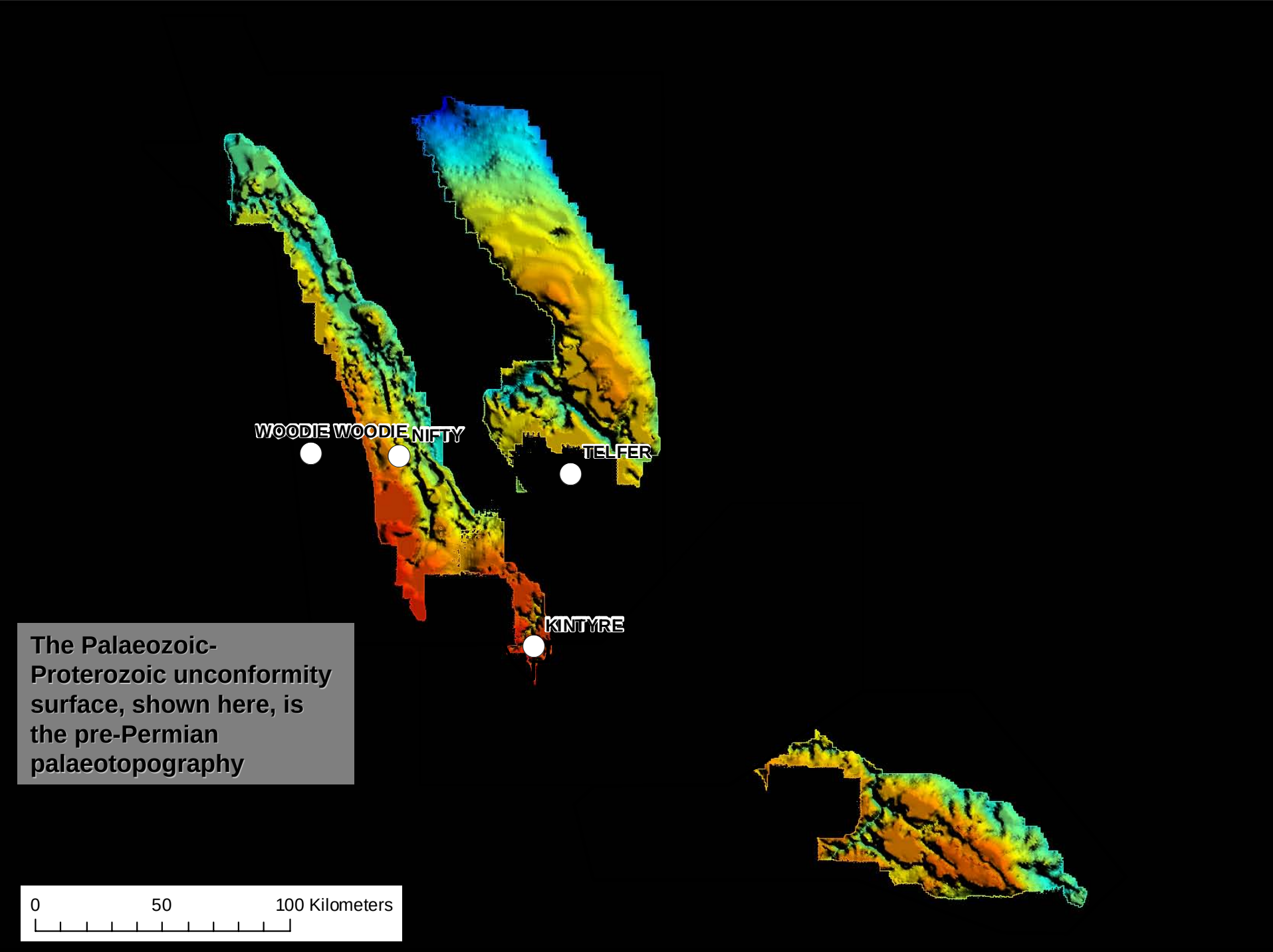


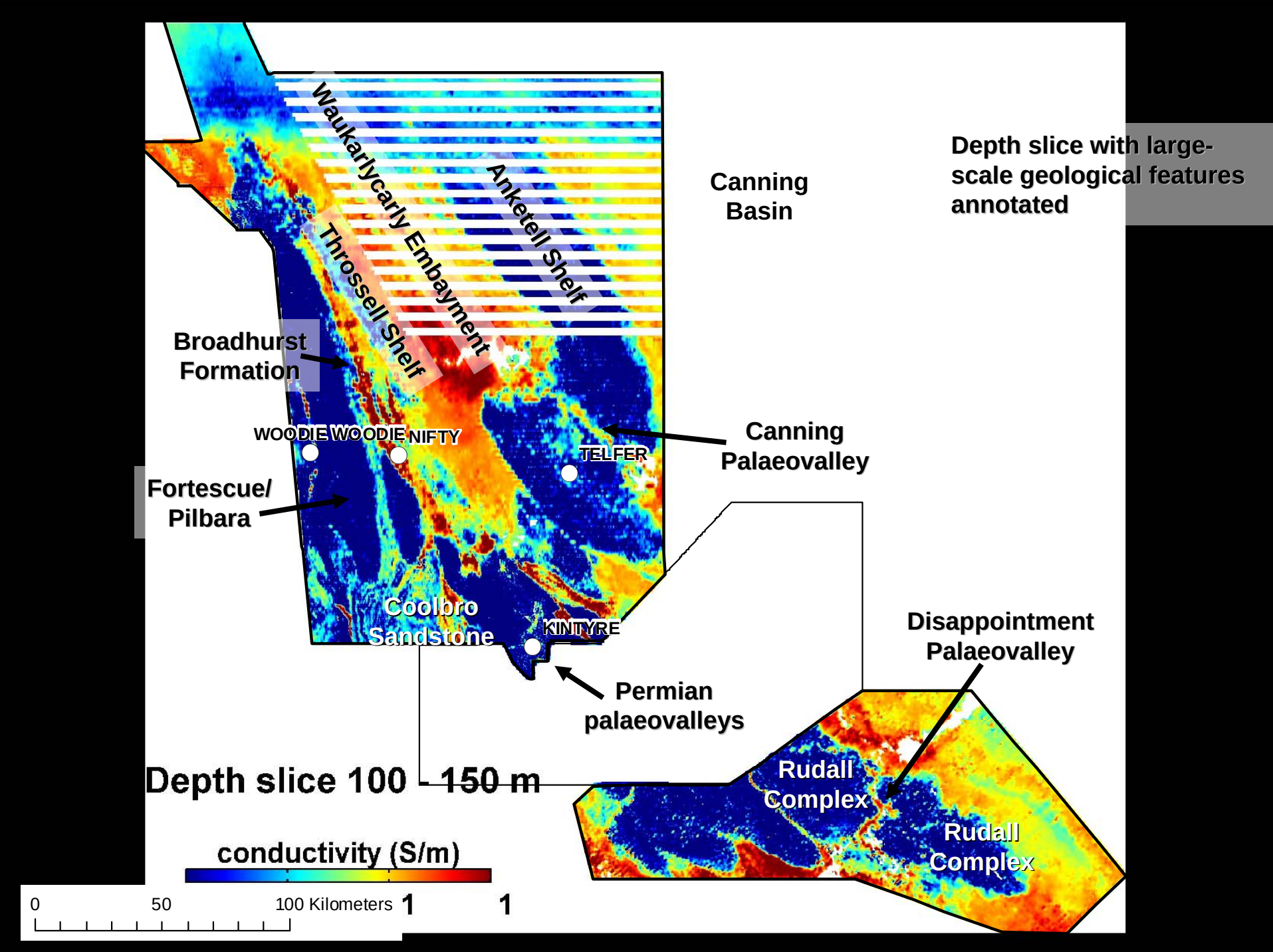


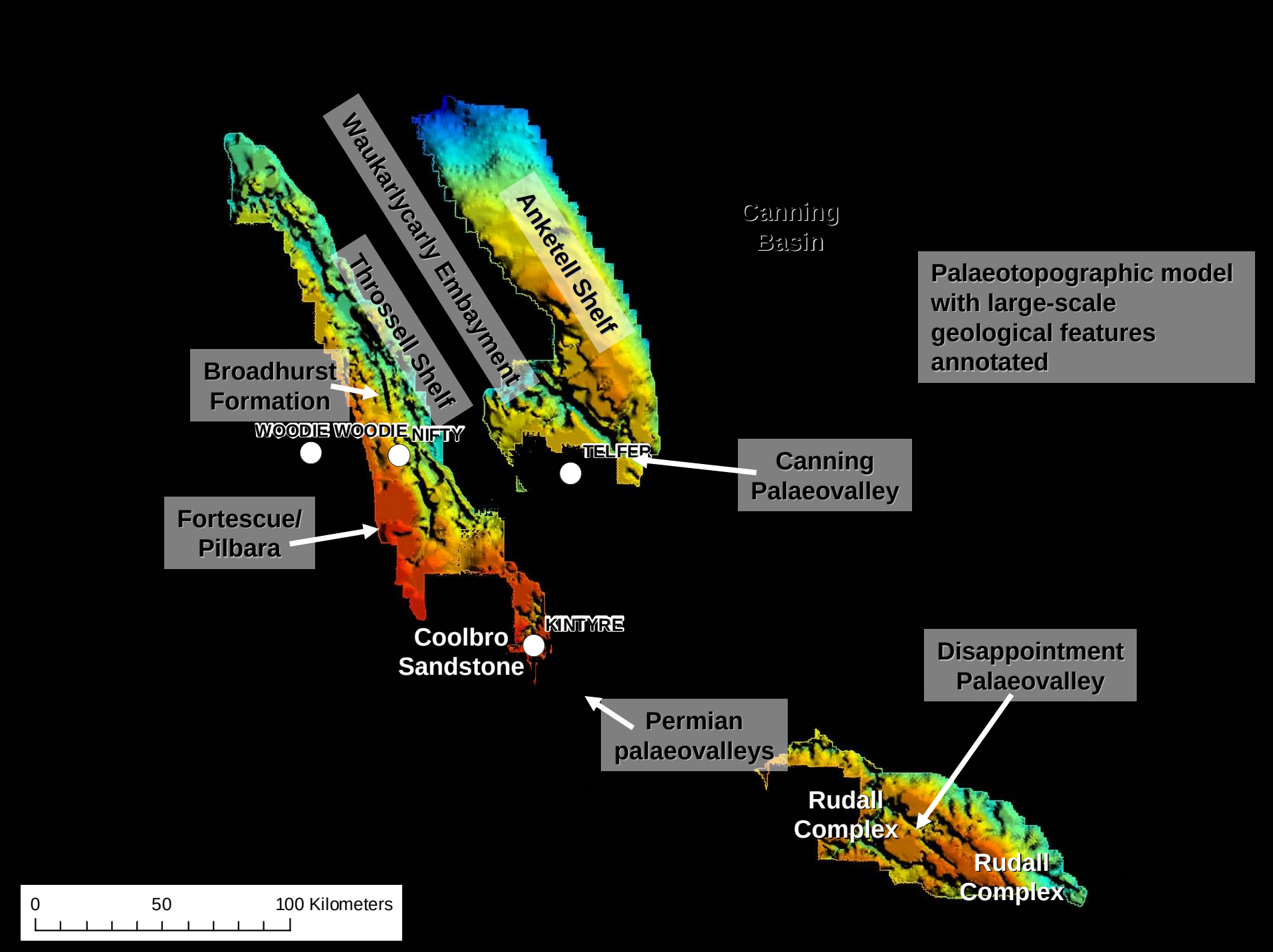




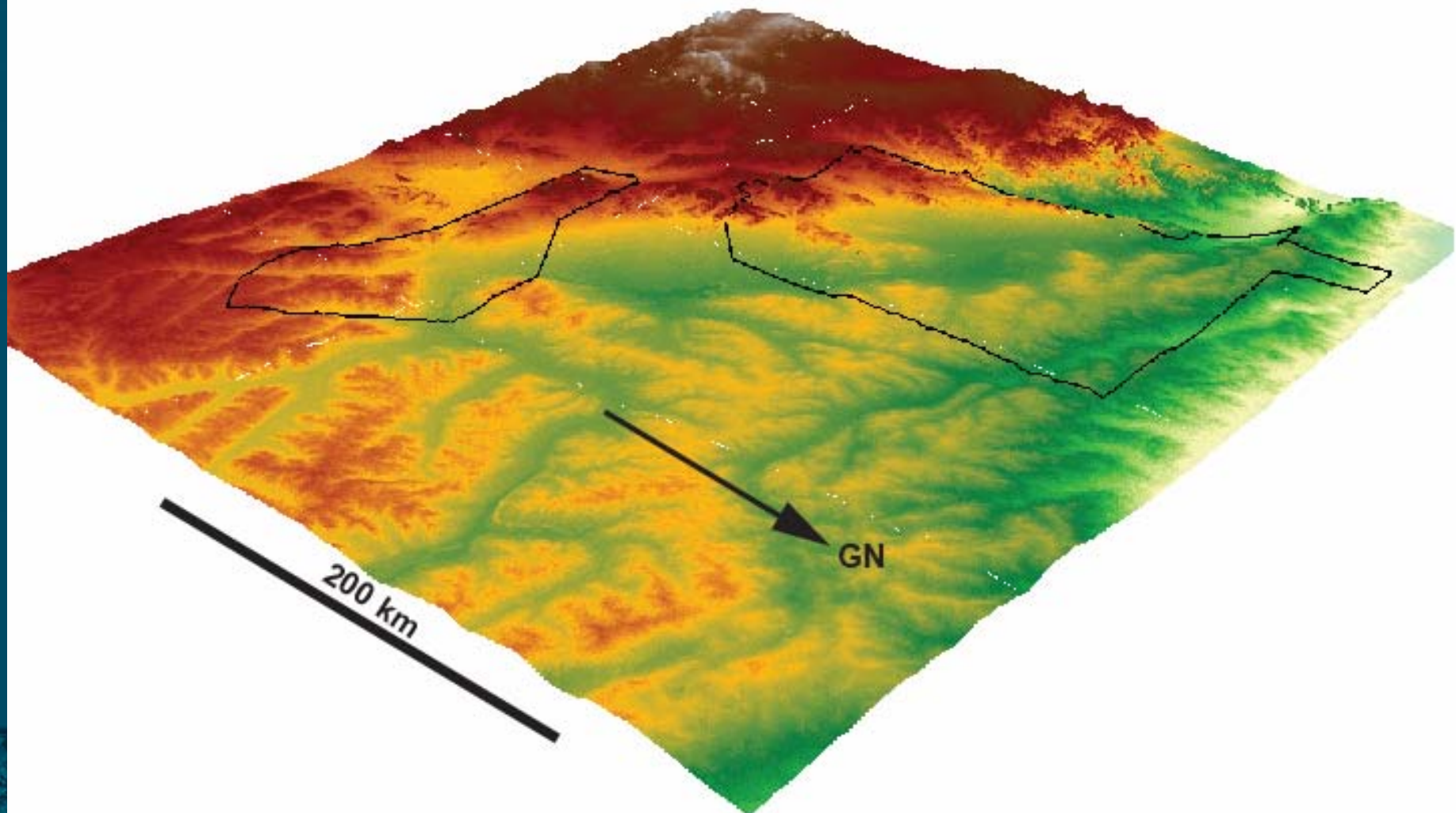
Depth slice information are used here to develop a model of the Palaeozoic-Proterozoic unconformity surface in the Paterson region


WOODIE WOODIE
NIFTY
TELFER
KINTYRE
The Palaeozoic-Proterozoic unconformity surface, shown here, is the pre-Permian palaeotopography
0
50
100 Kilometers

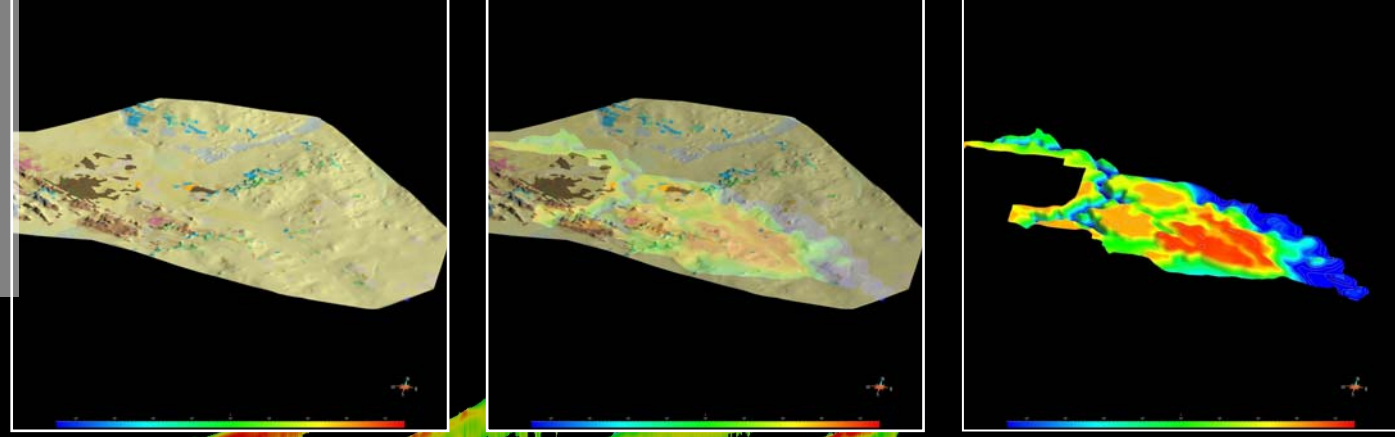

Depth slice with large-scale geological features annotated
Canning Basin
Waukarlycarly Embayment
Throssell Shelf
Anketell Shelf
Broadhurst Formation
WOODIE WOODIE
NIFTY
TELFER
Canning Palaeovalley
Fortescue/ Pilbara
Coolbro Sandstone
KINTYRE
Permian palaeovalleys
Disappointment Palaeovalley
Rudall Complex
Rudall Complex
Depth slice 100 - 150 m
conductivity (S/m)
0
50
100 Kilometers
1
1

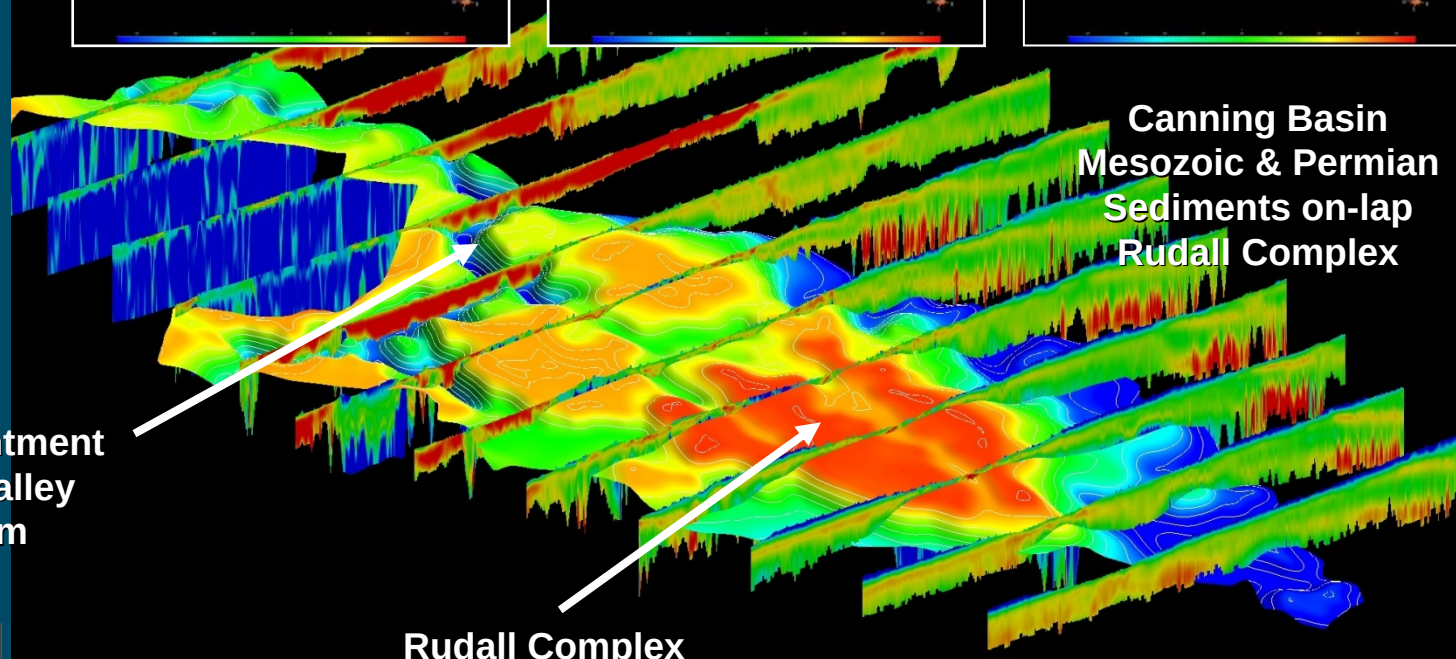

Waukarlycarly Embayment
Anketell Shelf
Throssell Shelf
Canning Basin
Palaeotopographic model with large-scale geological features annotated
Broadhurst Formation
WOODIE WOODIE
NIFTY
TELFER
Canning Palaeovalley
Fortescue/ Pilbara
KINTYRE
Coolbro Sandstone
Disappointment Palaeovalley
Permian palaeovalleys
Rudall Complex
Rudall Complex
0
50
100 Kilometers

3D perspective views



Paterson South



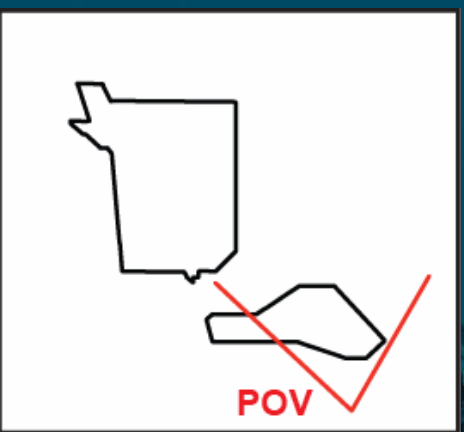


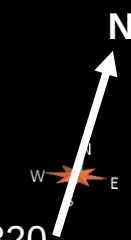
Rudall Complex outcrop

Disappointment Palaeovalley system

Rudall Complex Under cover

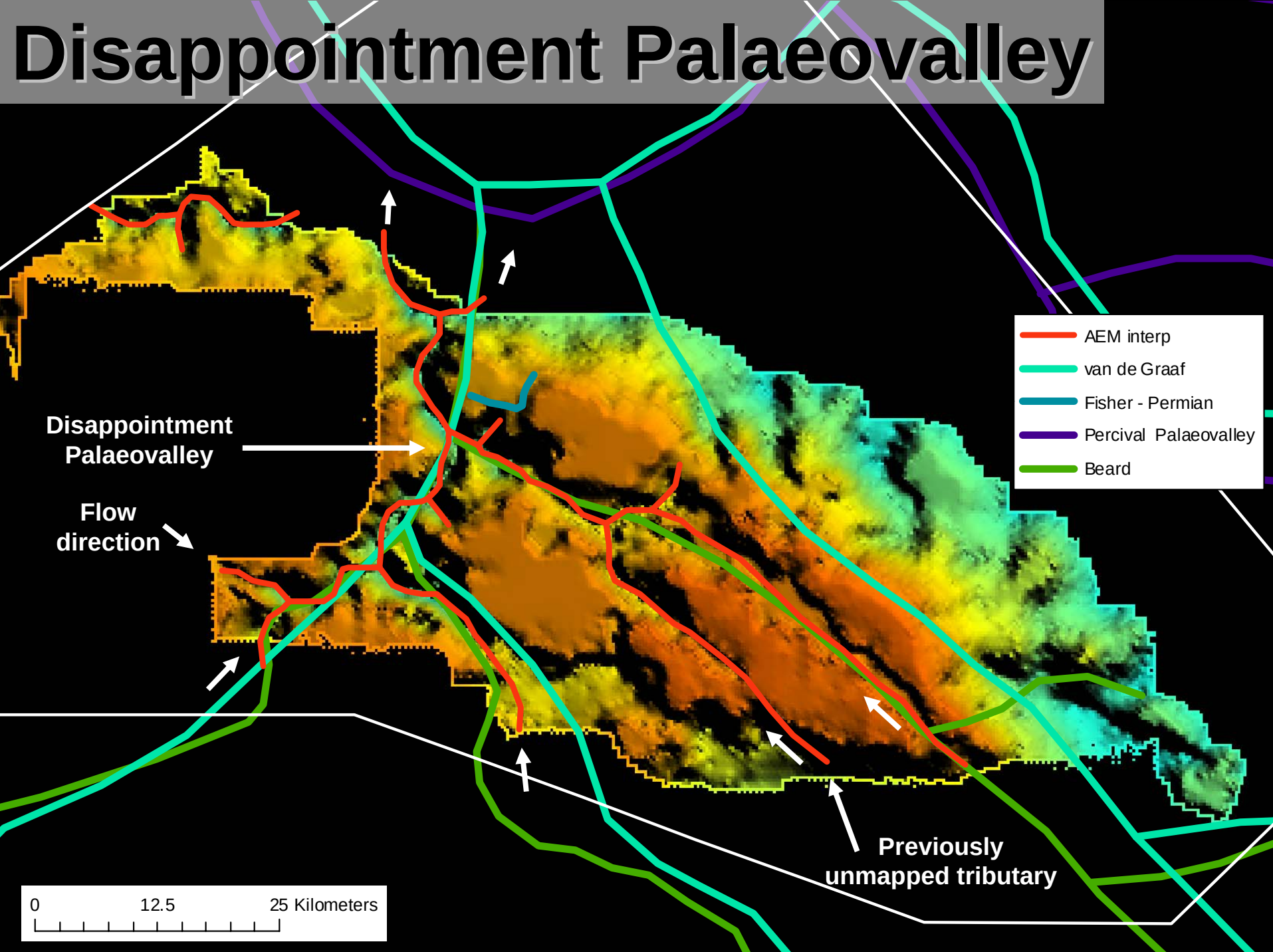
Canning Basin Mesozoic & Permian Sediments on-lap Rudall Complex



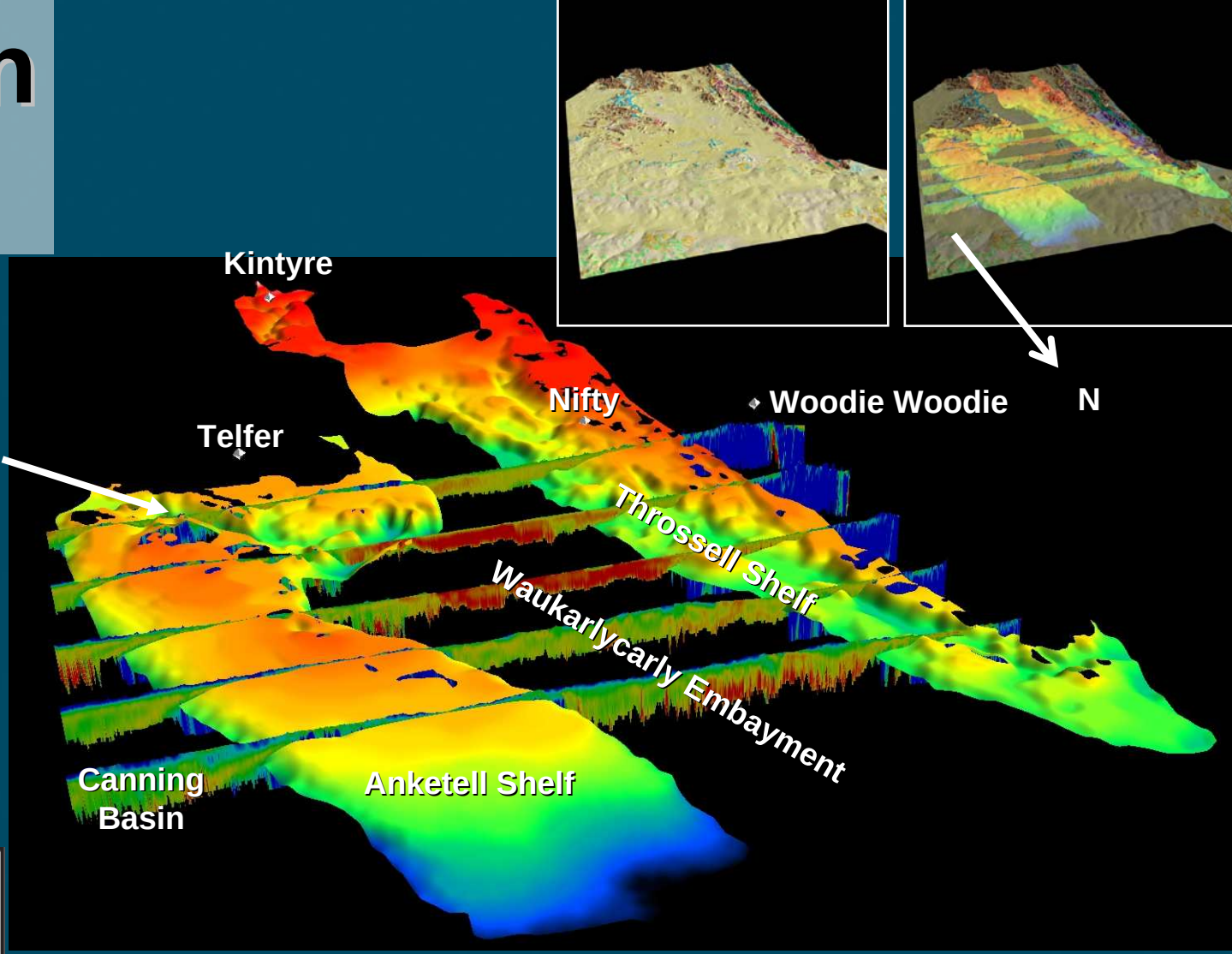


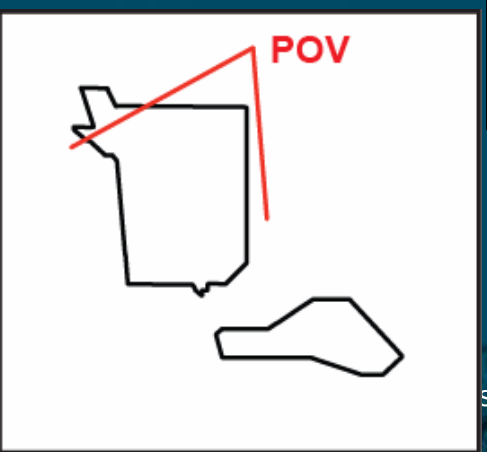
m ASL 160 200 240 280 320

Disappointment Palaeovalley

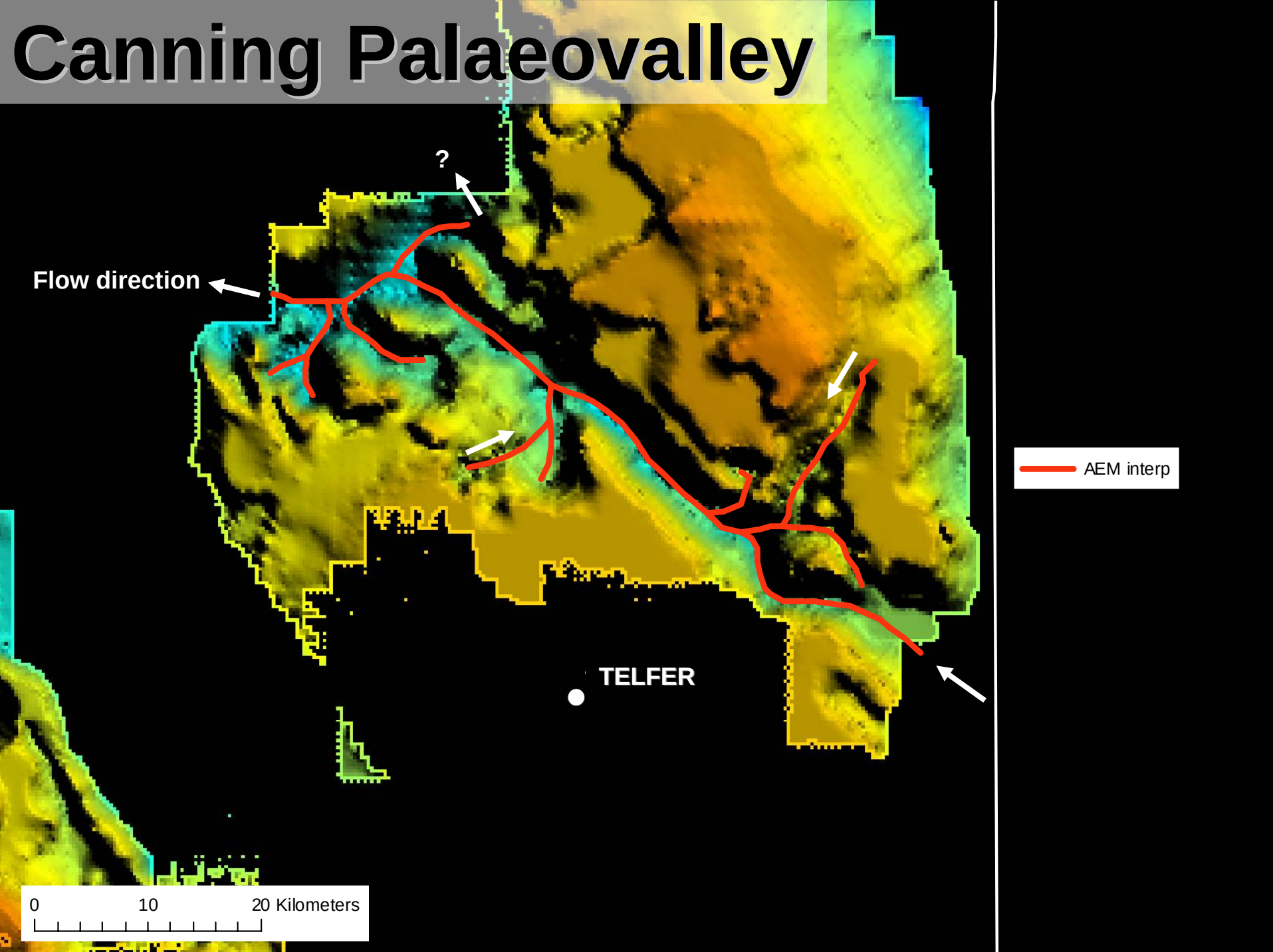


Paterson North

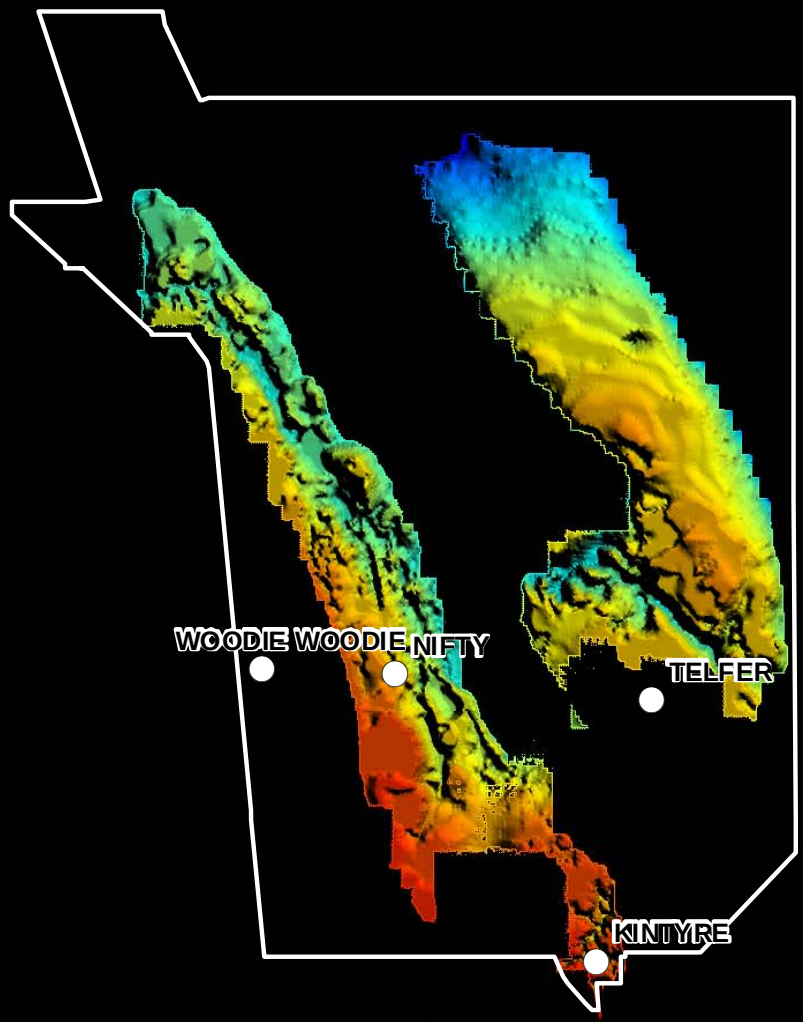




s from the Paterson AEM survey

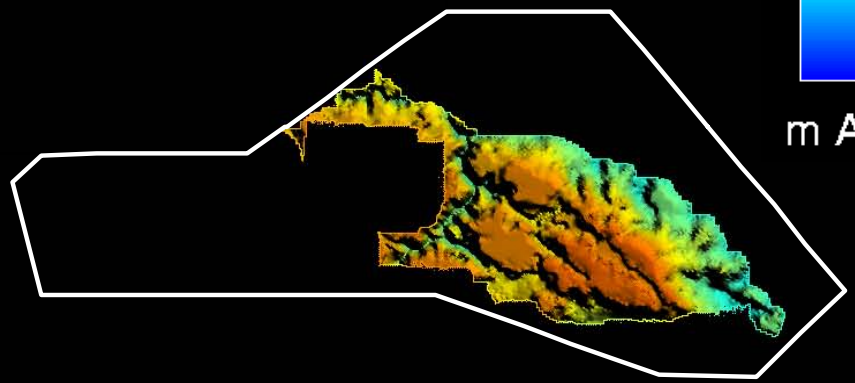

Canning Palaeovalley
?
Flow direction
TELFER
AEM interp
0
10
20 Kilometers

Interpreted Paleozoic-Proterozoic unconformity



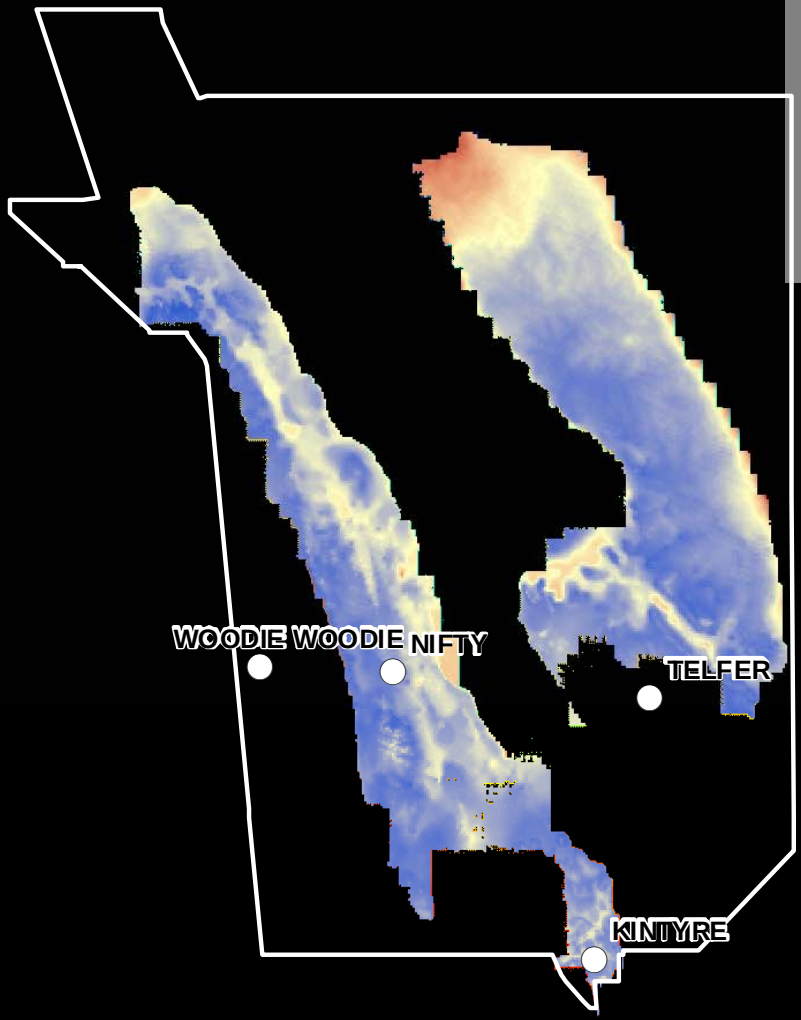
Height of unconformity above sea level

382
293
205
116
27
-61
m ASL



0 50 100 Kilometers

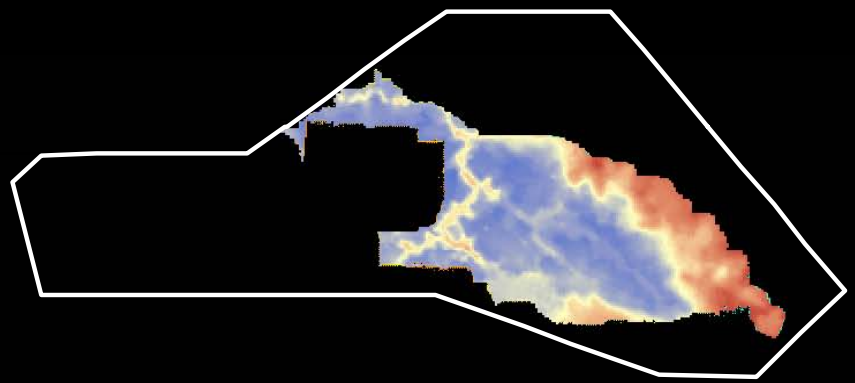
Interpreted cover thickness



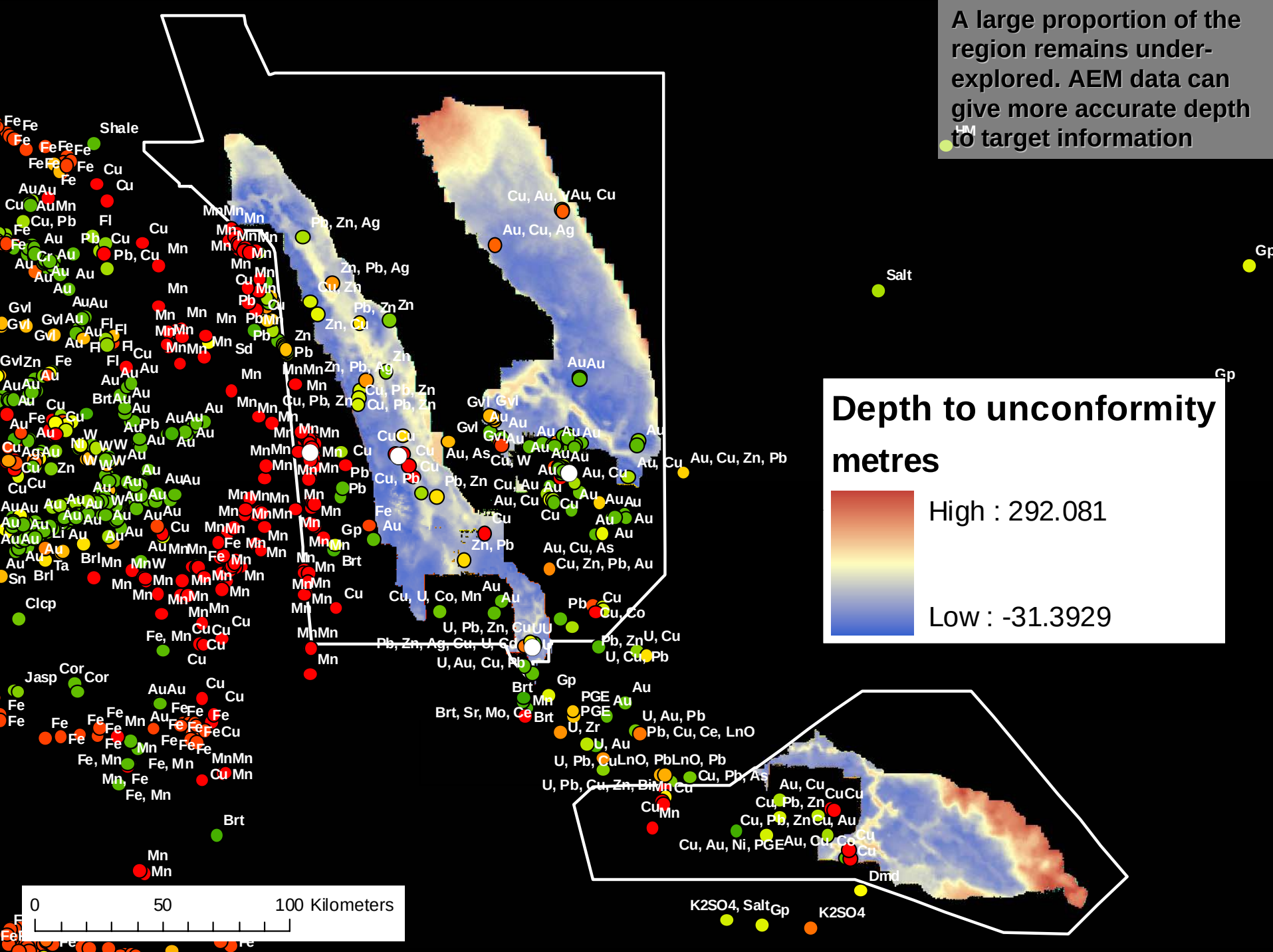
Depth to unconformity metres

High : 292.081

Low : -31.3929



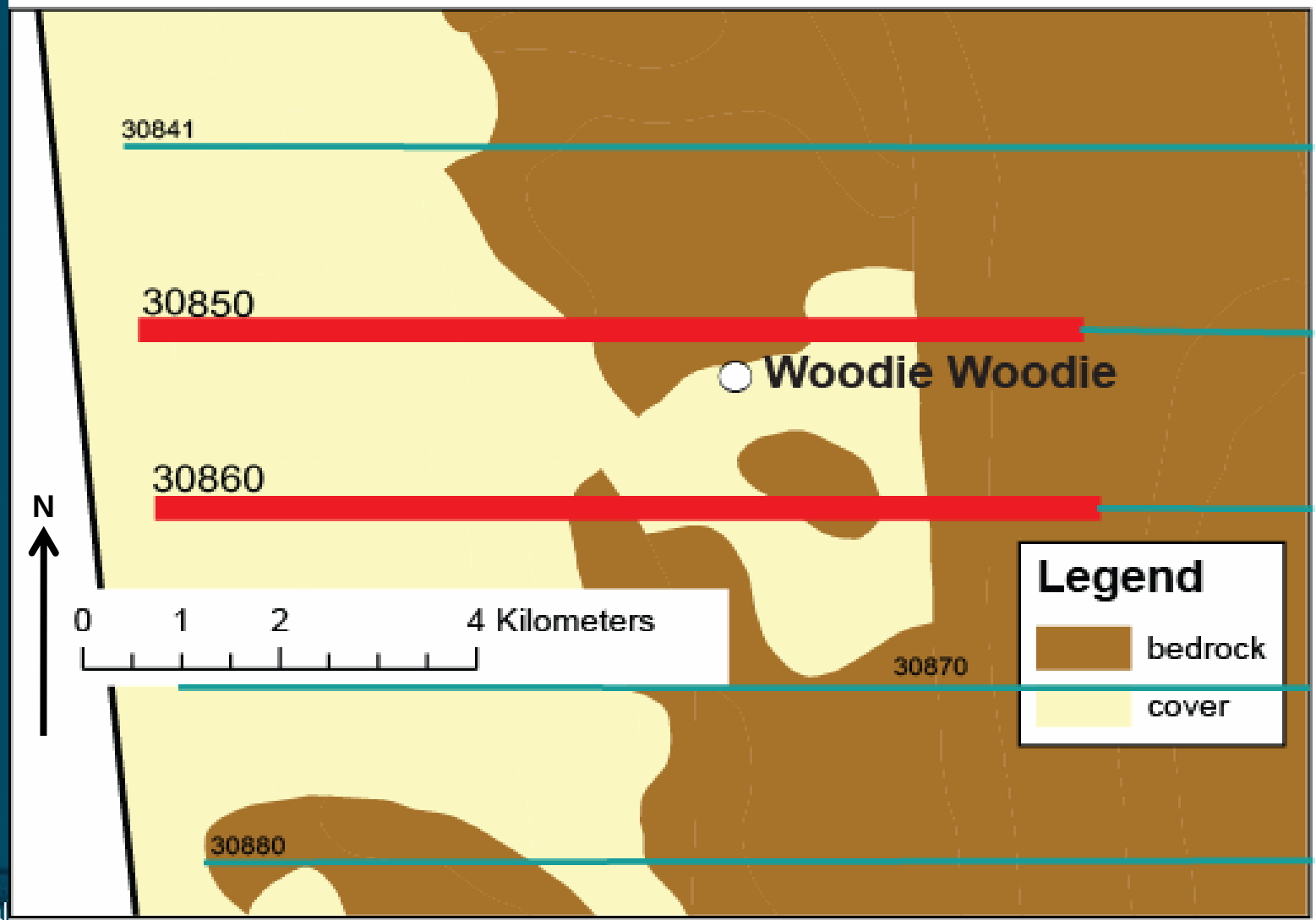
0 50 100 Kilometers


A large proportion of the region remains under-explored. AEM data can give more accurate depth to target information
Depth to unconformity
metres
High : 292.081
Low : -31.3929
0
50
100 Kilometers

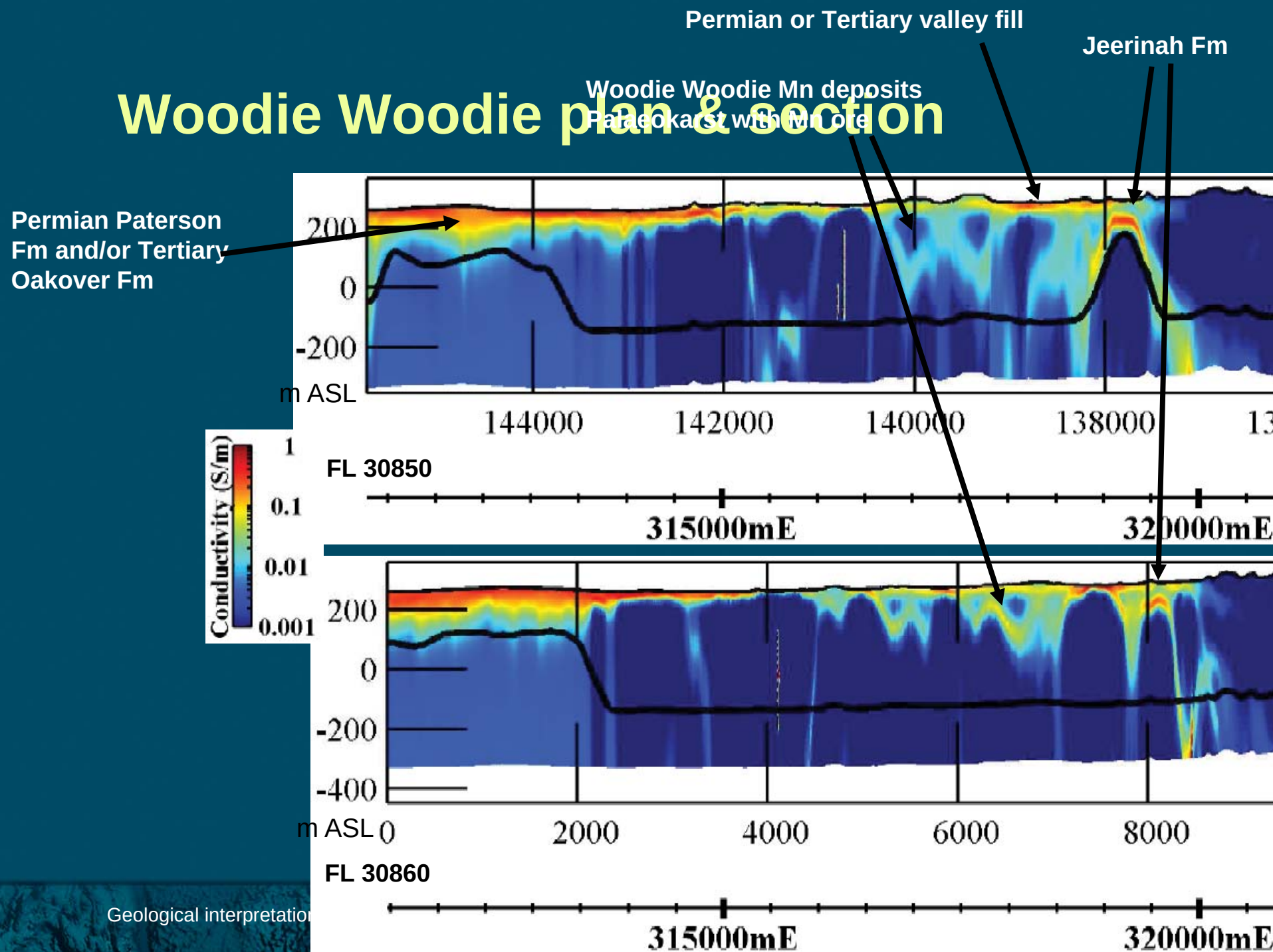
AEM Signatures of Mineral Deposits

- Finally, a quick look at how the AEM performed over some of the mineral deposits in the area.

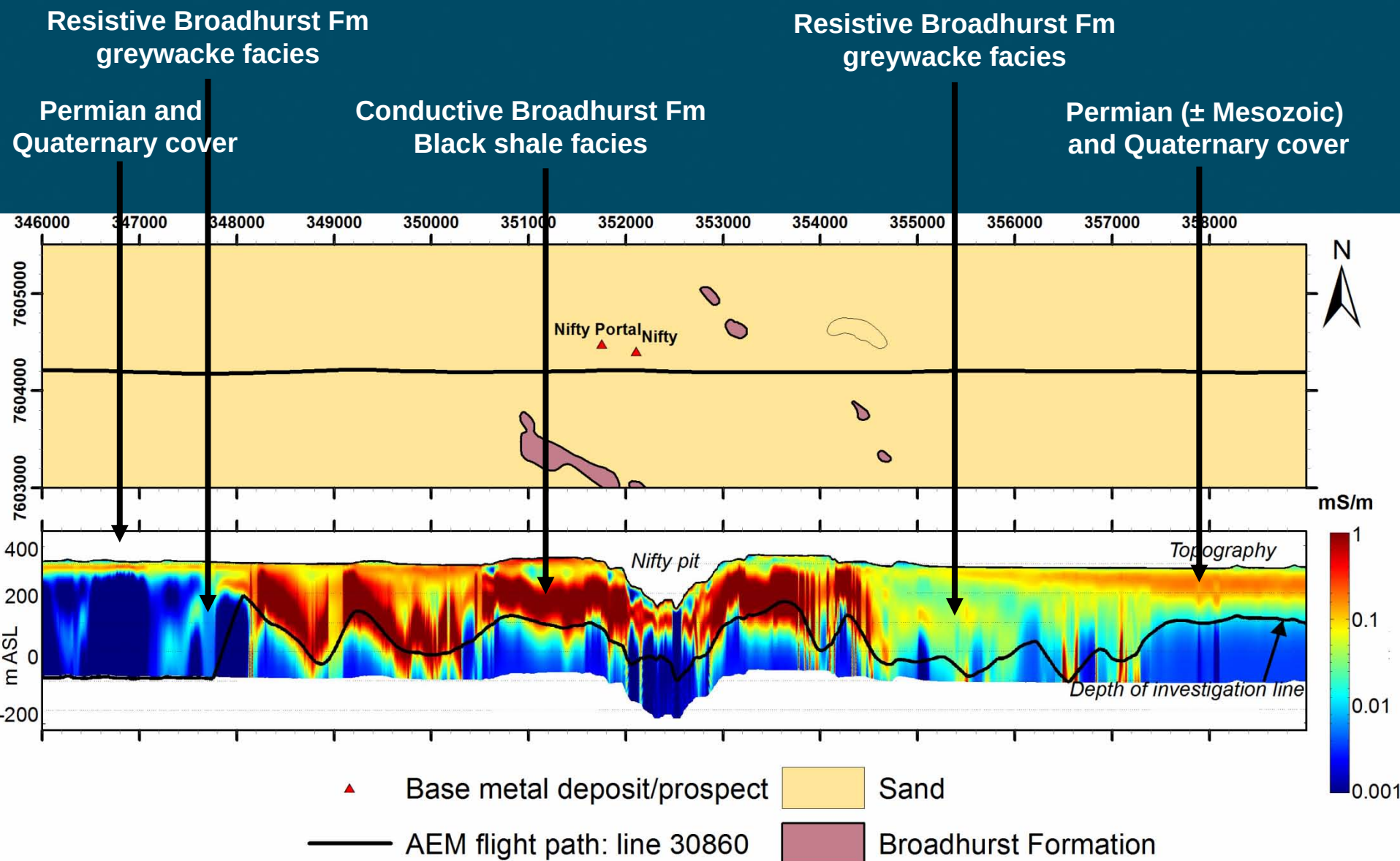
Woodie Woodie plan & section



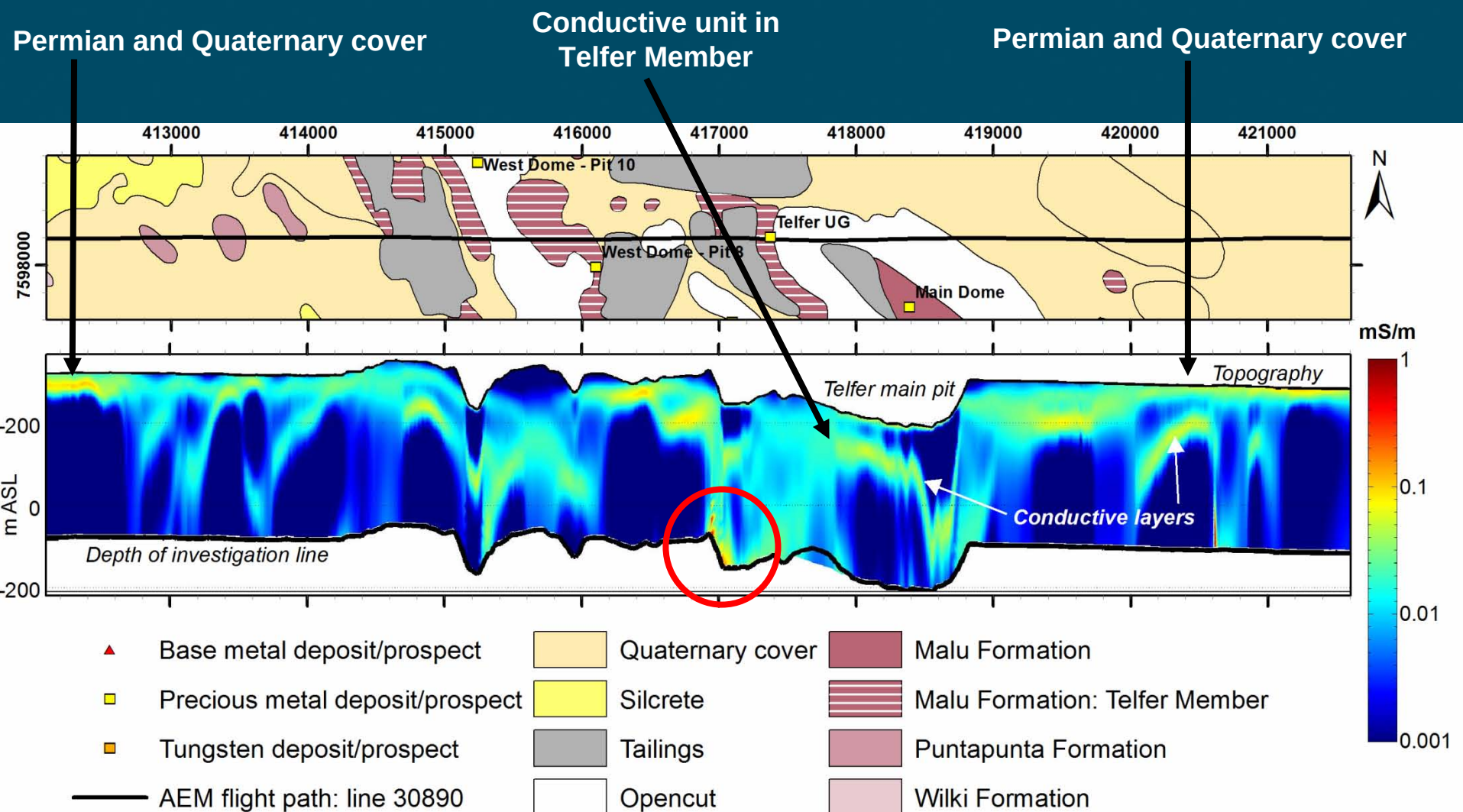
Woodie Woodie plan & section



Nifty plan & section



Telfer plan & section



Conclusion

- Regional AEM data give us:
  - A better understanding of paleotopography;
  - A better information on under-cover extent of mineralised rocks including 3-D disposition;
  - Reduced risk by providing more accurate depth to target information;
  - Much more information on landscape evolution for exploration models.