

# Update on GSSA's Paleovalley mapping: Paleovalley characteristics and mineral potential of the northwestern Gawler Craton

B. Hou, C. Krapf, C. Cubitt & A. Petts | 27 November 2025



**GEOLOGICAL  
SURVEY OF**  
South Australia

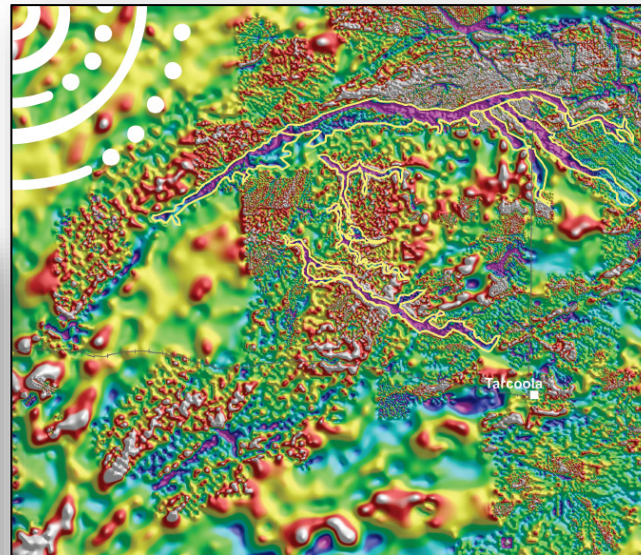
**DISCOVERY DAY**



# GSSA's Paleovalley projects

- **GP2 project (2022-2023)**
- **GP2 Extension project (2024-2025)**
- **SW Gawler Craton project (2026 start)**

DEM RB 2023/00043

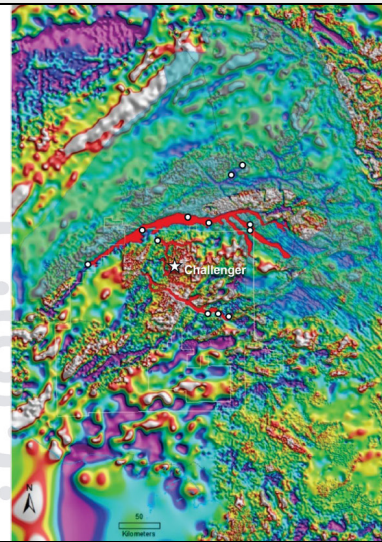


## Remapping the paleovalley systems of the central-western Gawler Craton, South Australia

B Hou, A Petts, C Krapf, J Irvine,  
L Stoian, P Heath, G Reed and C Foss



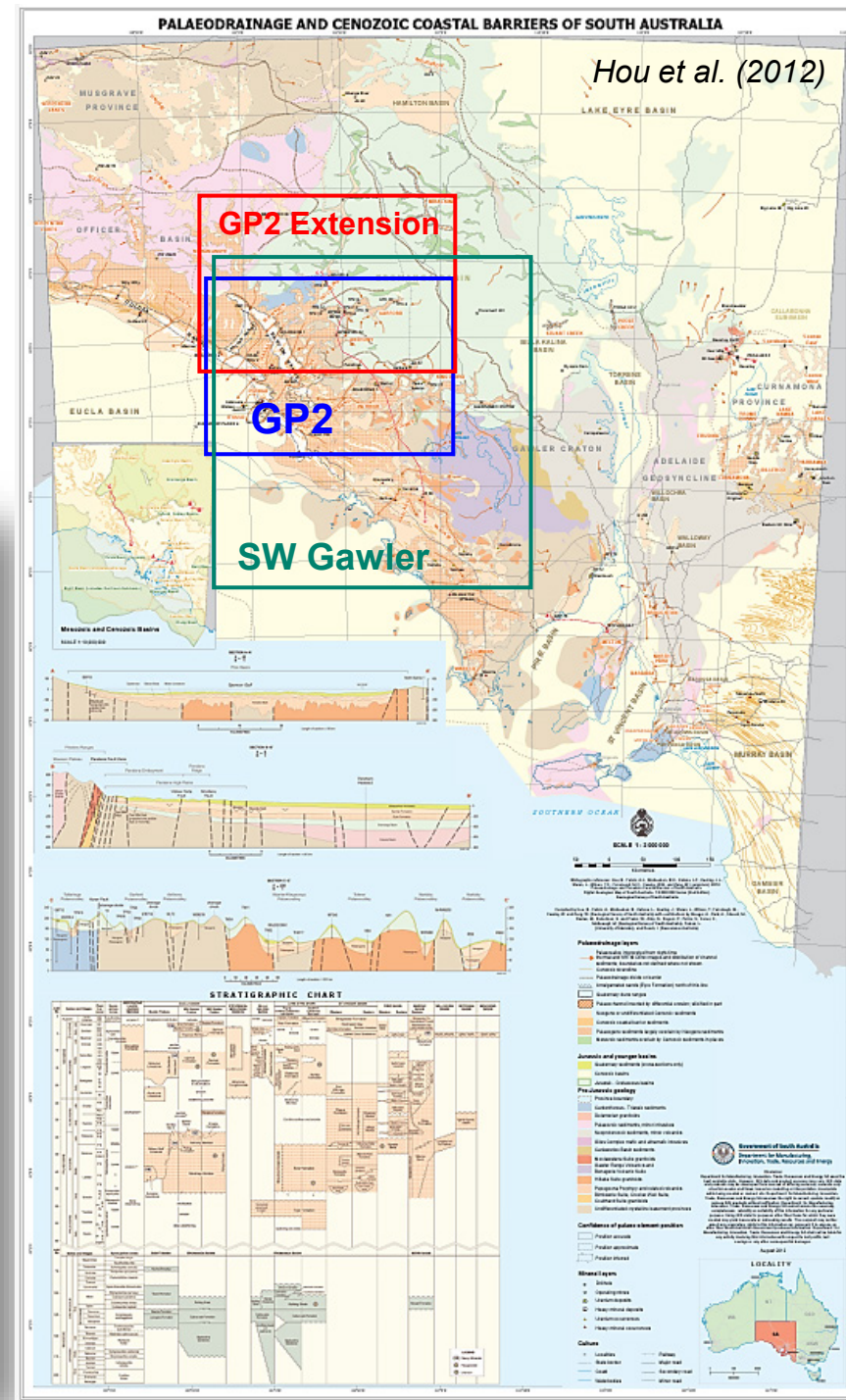
DEM RB 2025/00012



## DRILLHOLES REPORT: PALEOVALLEY MAPPING IN THE NORTHWESTERN GAWLER, SOUTH AUSTRALIA

Gawler Phase 2 (GP2)  
Paleochannel Extension Project

B Hou, C Cubitt, A Petts and C Krapf  
Geological Survey of South Australia  
Department for Energy and Mining

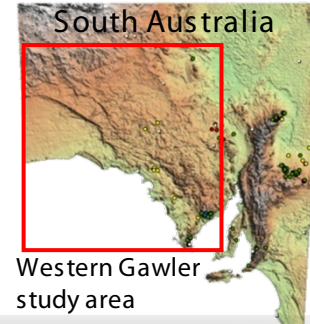
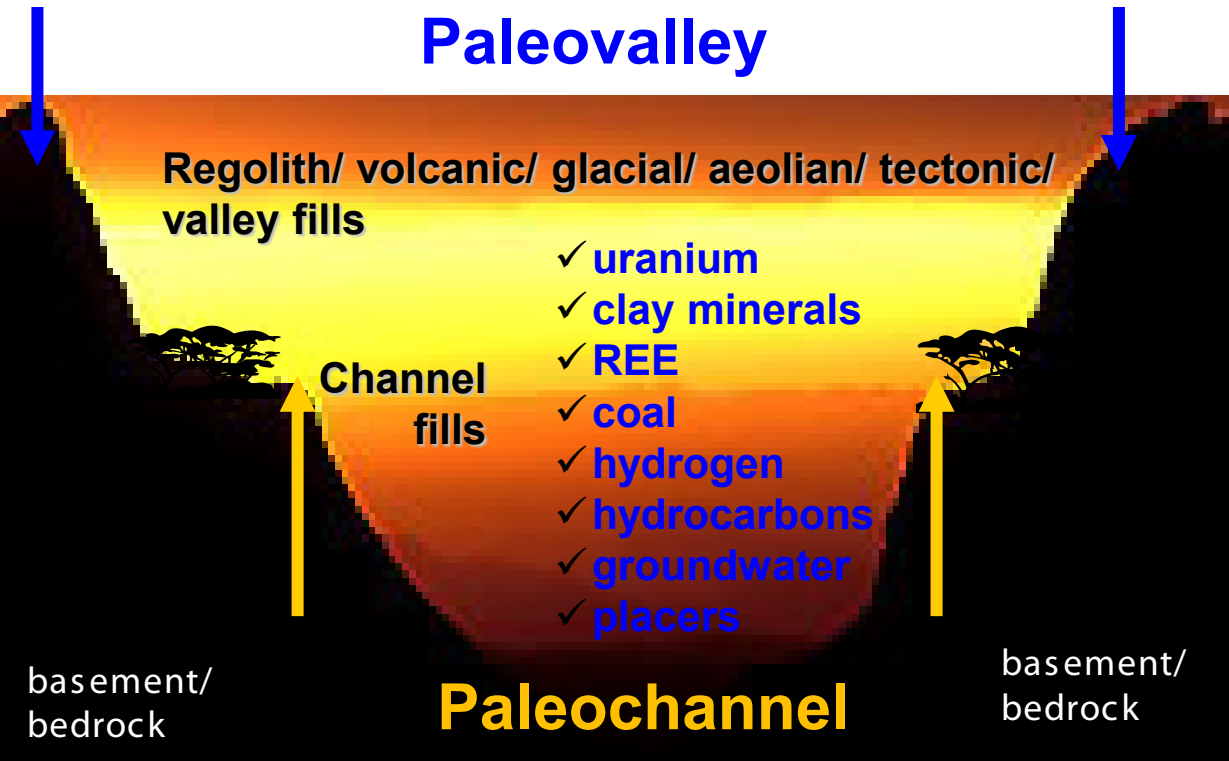


# Time- and spatial-bound geology

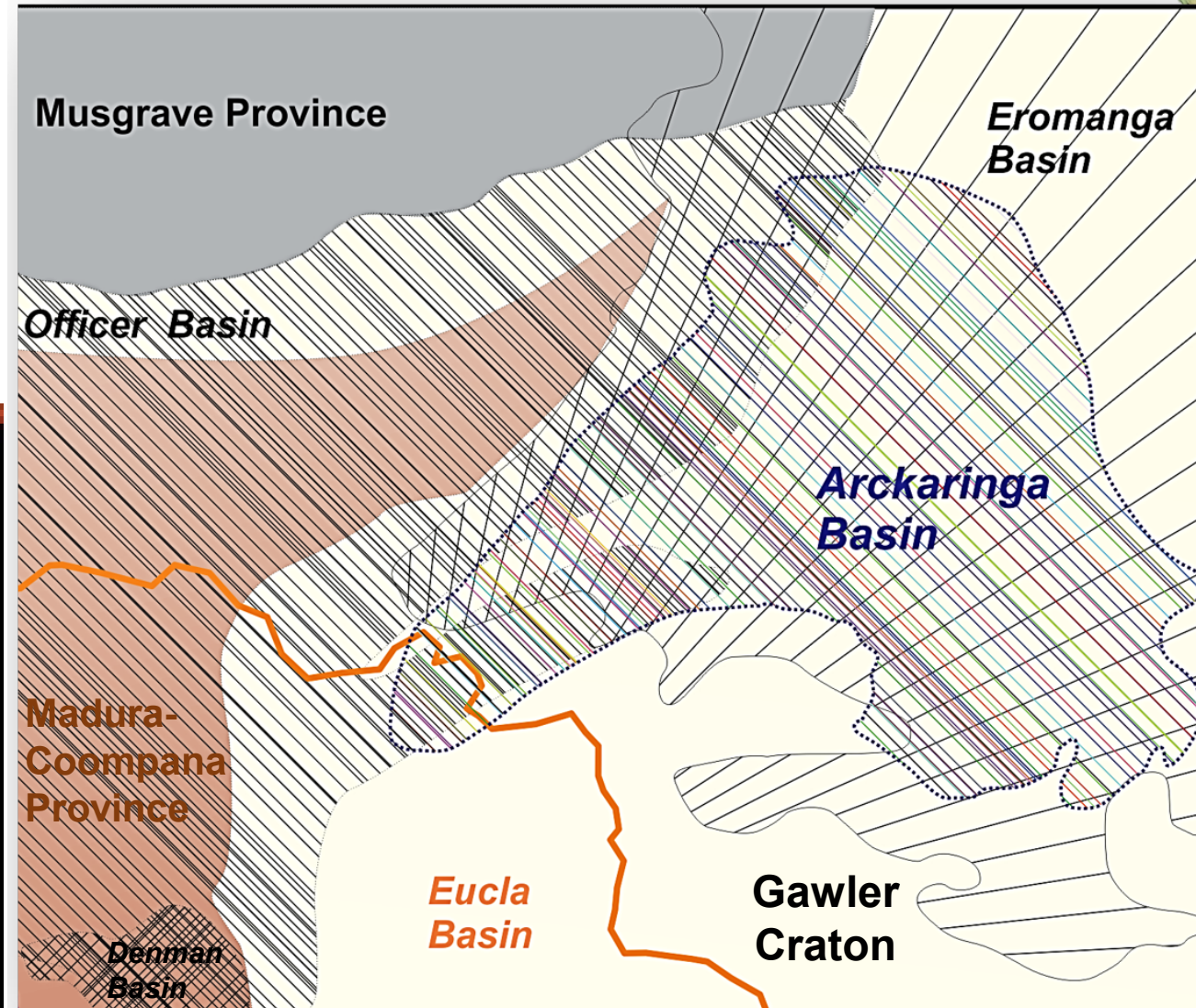
- Cenozoic – E Eucla Basin
- Mesozoic – SW Eromanga Basin
- Late Paleozoic – SW Arckaringa Basin
- Archaean to Early Paleozoic basement

## Paleovalley vs Paleochannel

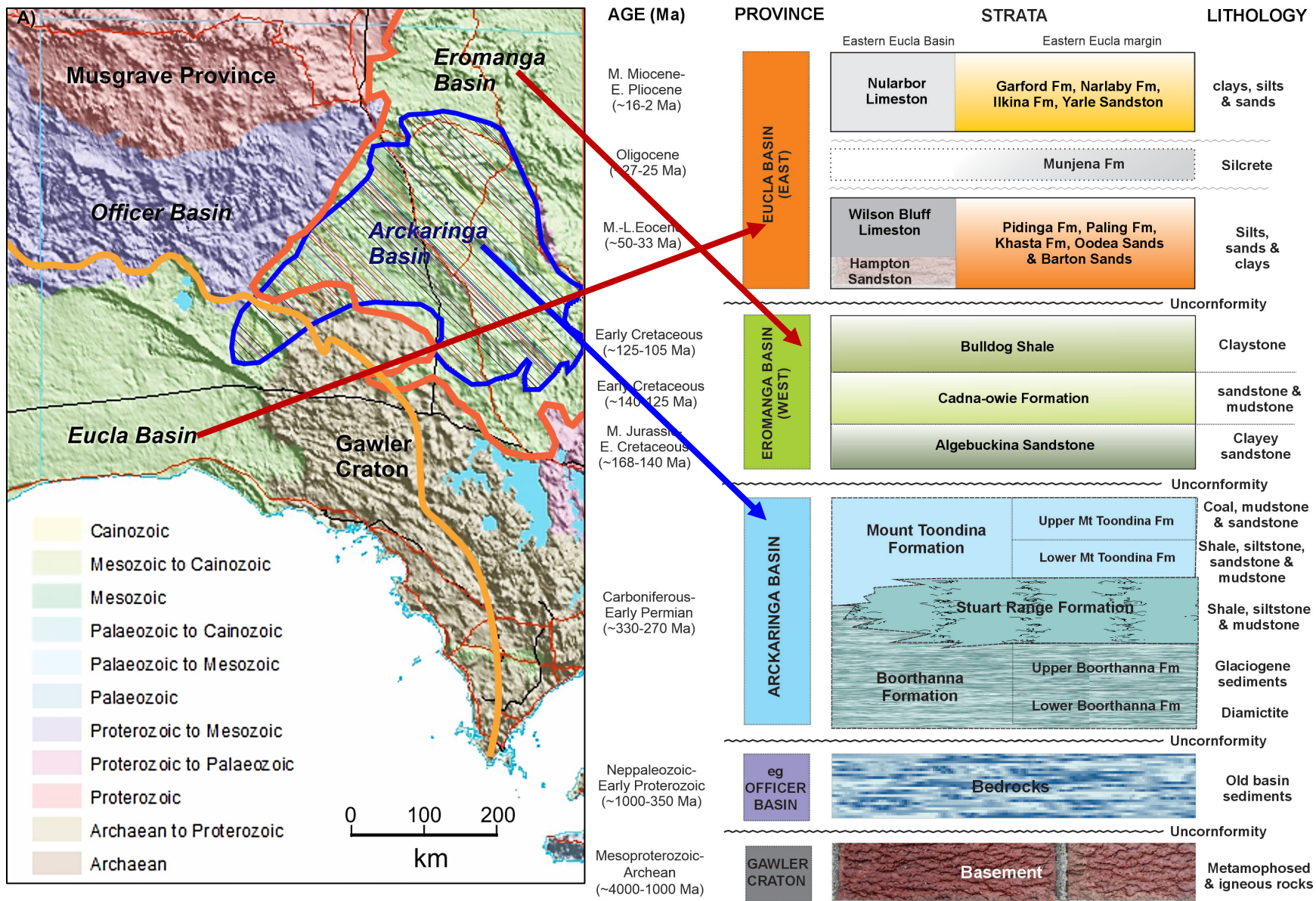
### Paleovalley



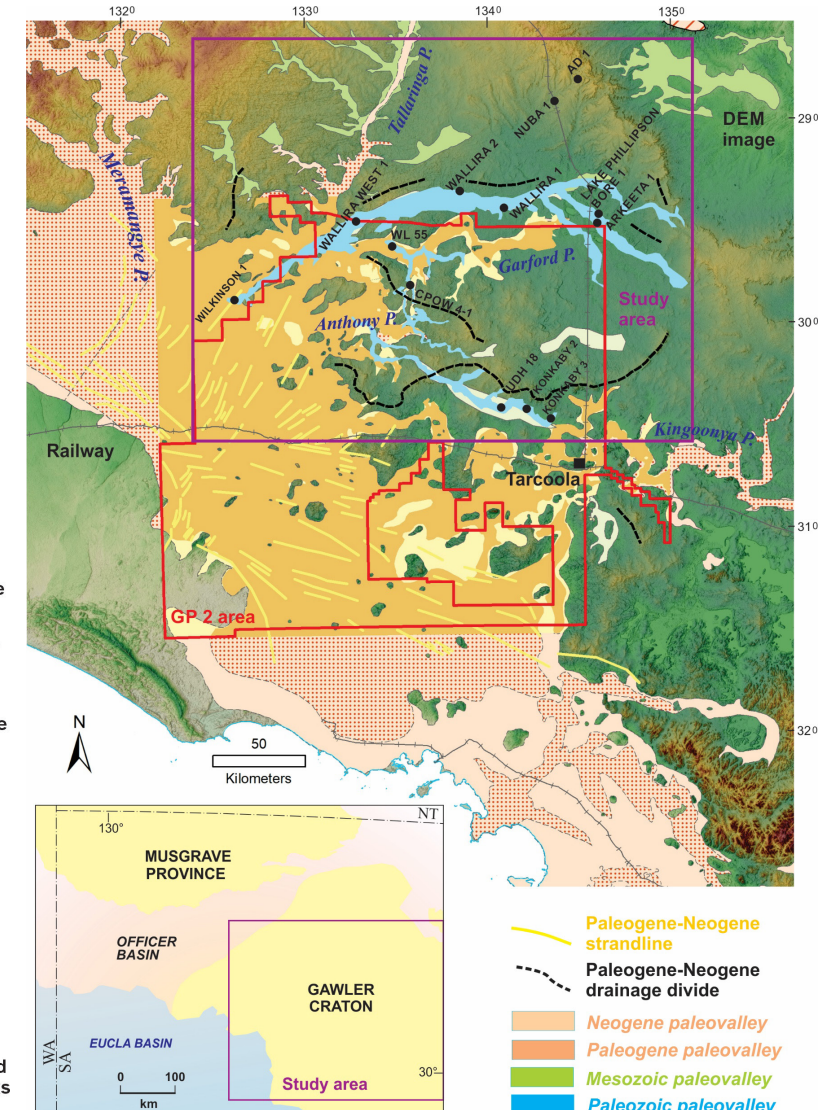
Hou et al. (2024)



# Time- and spatial-bound distribution of paleovalleys



Hou et al. (2022, 2023)



# Paleovalley mapping and exploration

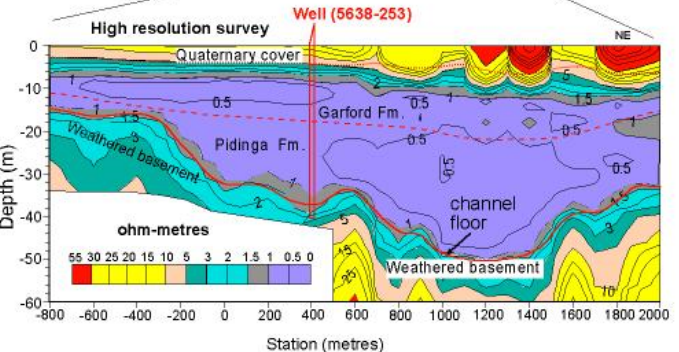
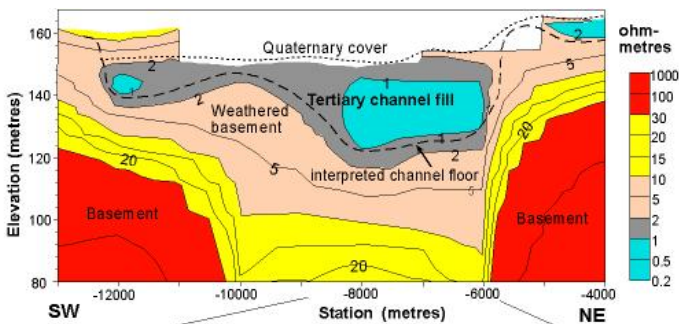
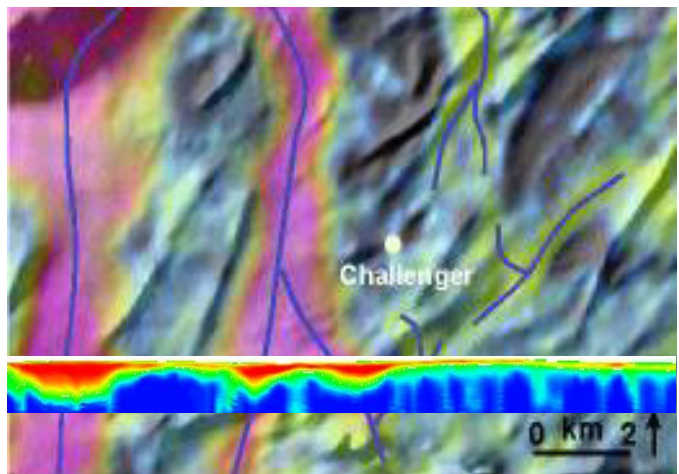
Needs a good understanding of exploration tools :



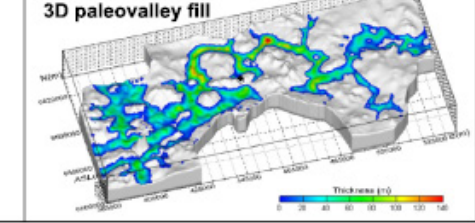
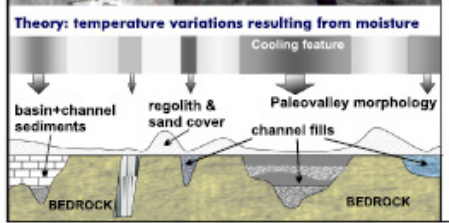
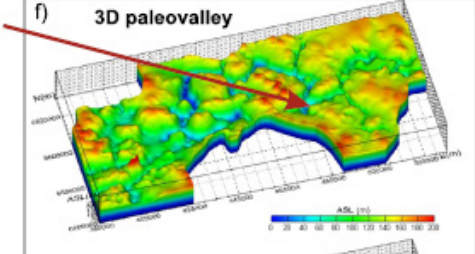
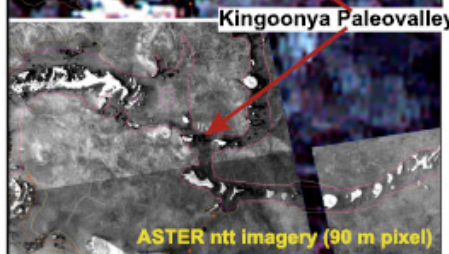
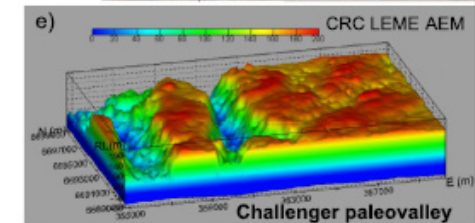
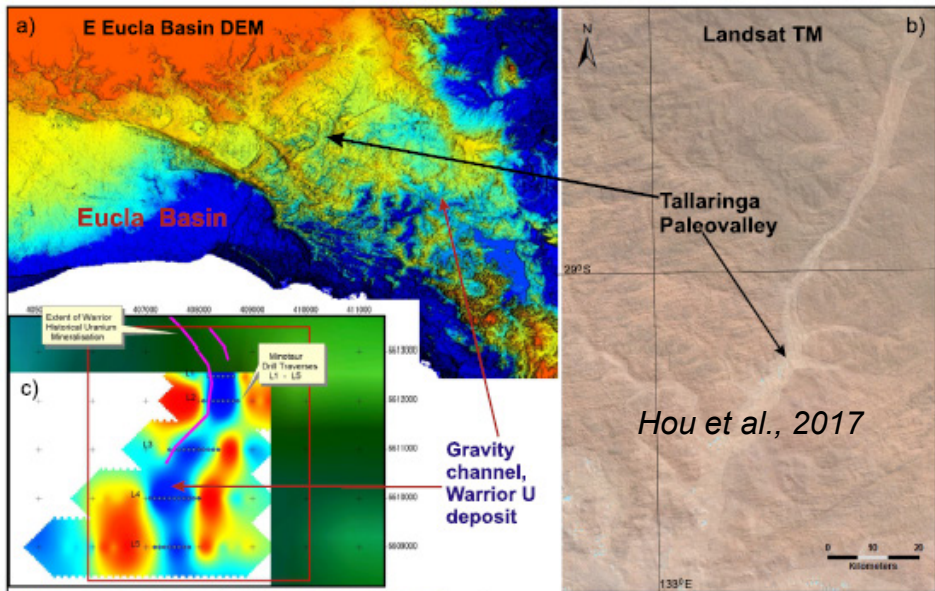
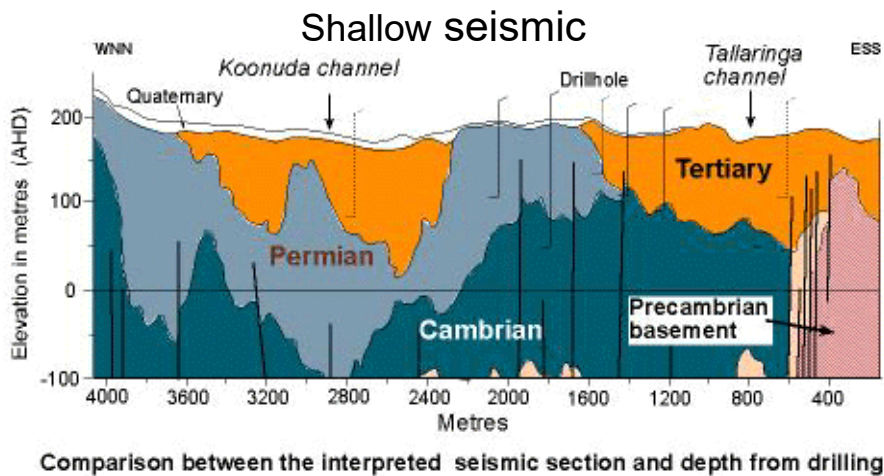
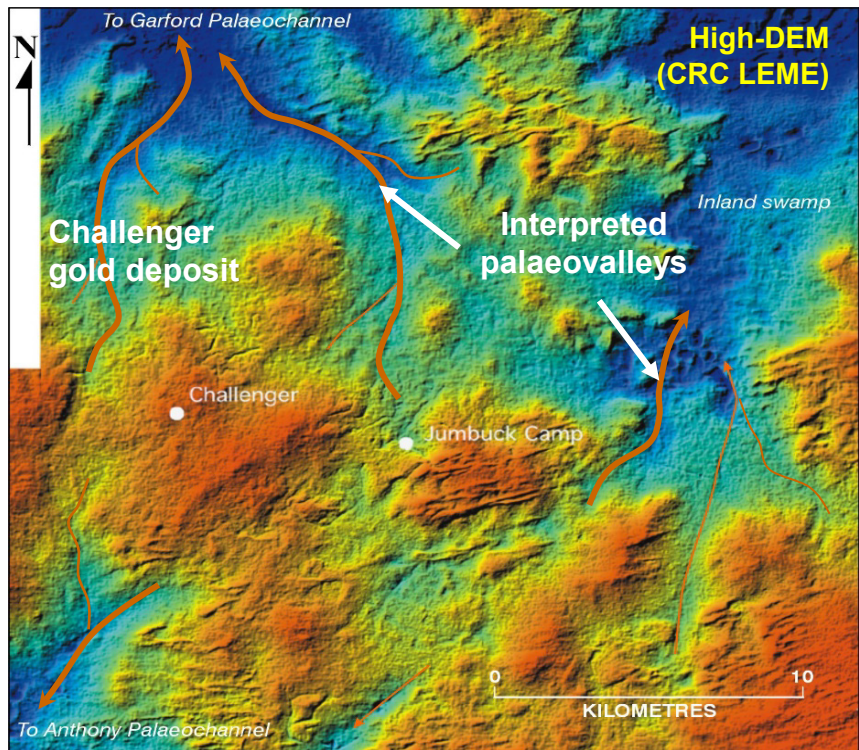
Geological mapping  
DEM & mrVBF  
Remotely sensed images  
*SRTM – DEM*  
*Landsat*  
*Landsat - night-time thermal*  
*NOAA – night-time thermal*  
*Aster - night-time thermal*  
Ground & airborne geophysics  
*Magnetics?*  
*Gravity (micro-)*  
*Radiometric?*  
*EM: AEM & TEM*  
*Shallow /passive seismic*

# Examples of paleovalley exploration techniques

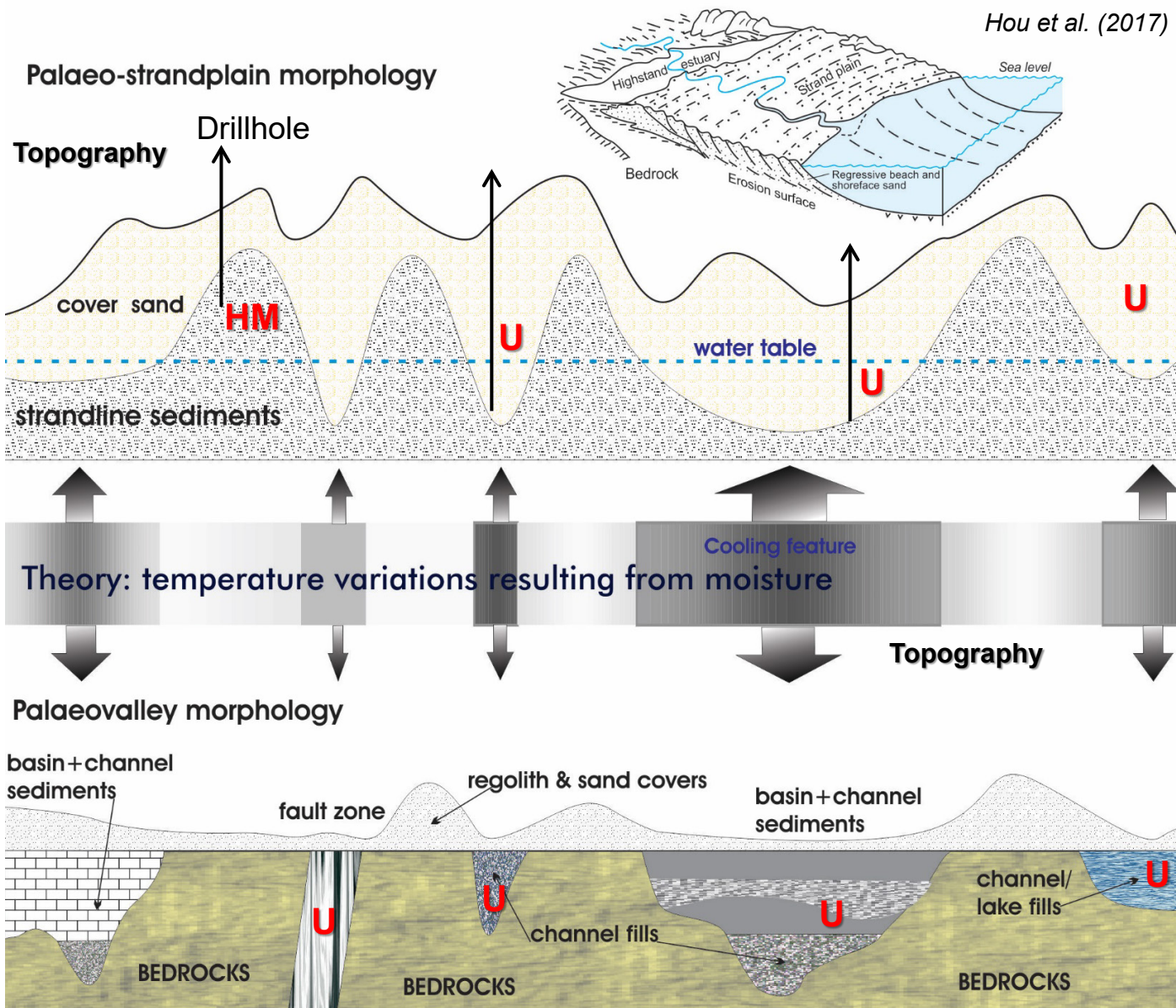
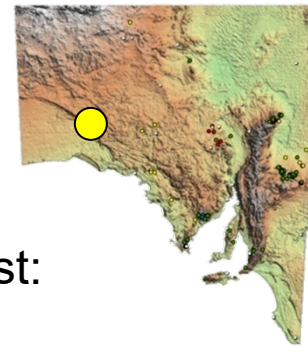
## AEM & TEM – Challenger & Garford Paleovalleys



Hou et al. (2001, 2008, 2017)

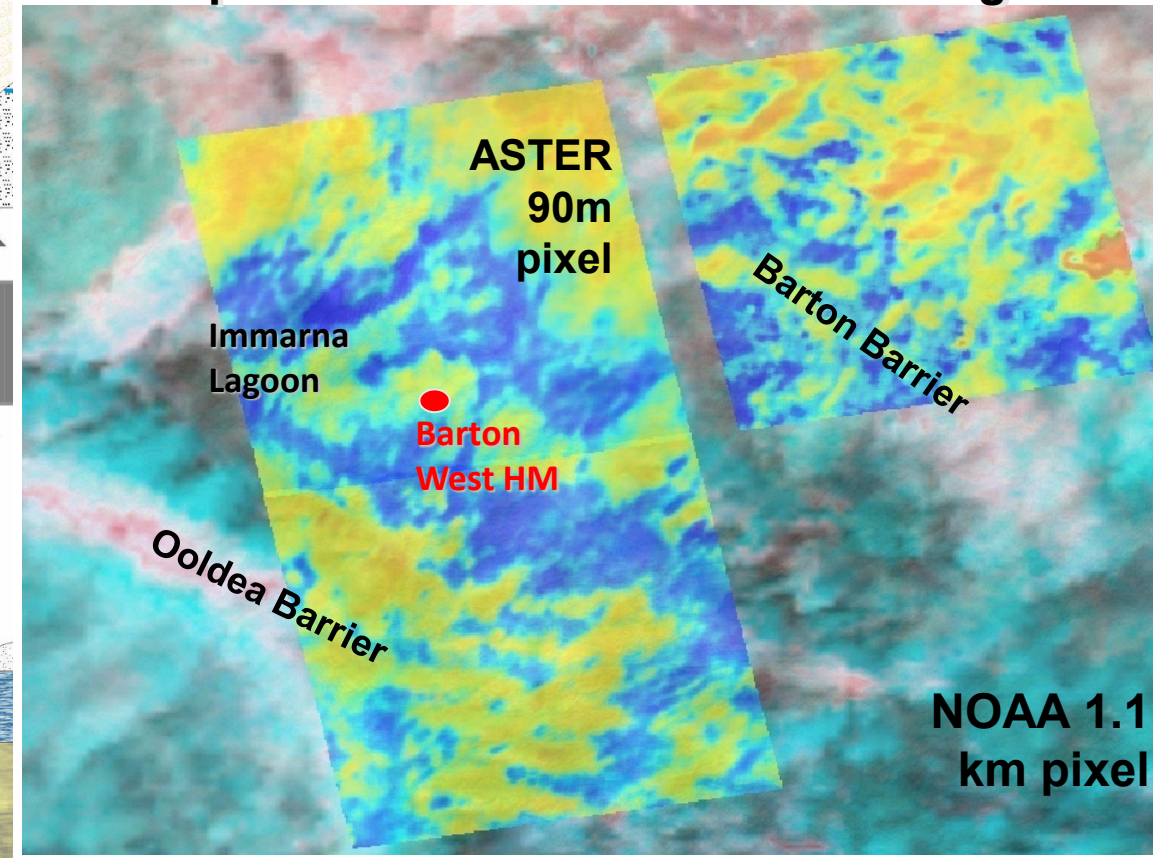


# Night-time Thermal (ntt) paleovalley mapping



- Acquired time – Max thermal contrast: L night – E morning
- Cloud cover & wind-shear affecting the quality
- Frequent overpass of the satellite

## Comparison of NOAA – ASTER ntt images



# Paleovalleys identified in hi-resolution gravity



**Interpreted Paleozoic paleovalleys:**  
originate from erosion by ice and fluvio-glacial meltwaters

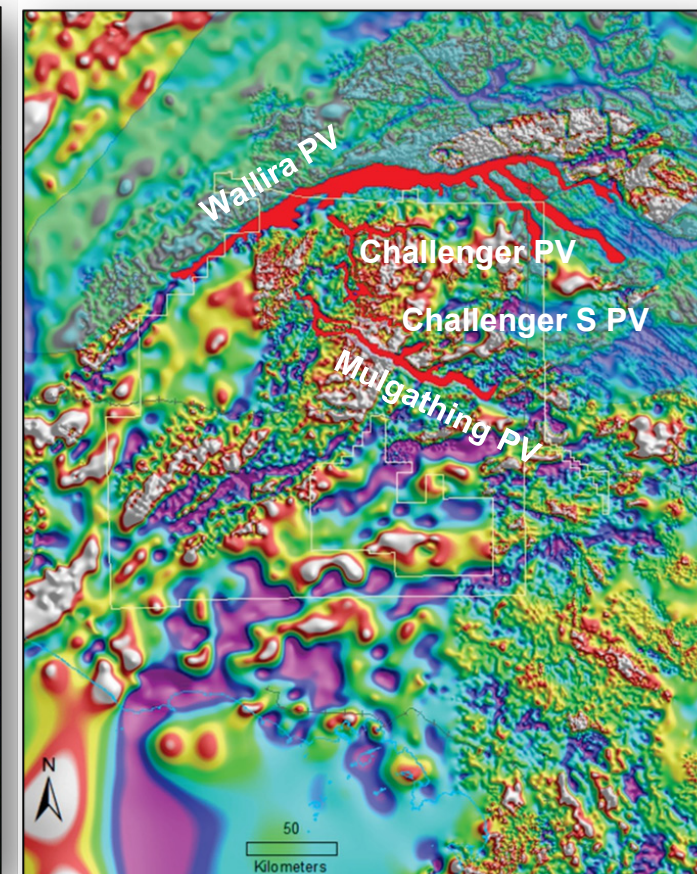
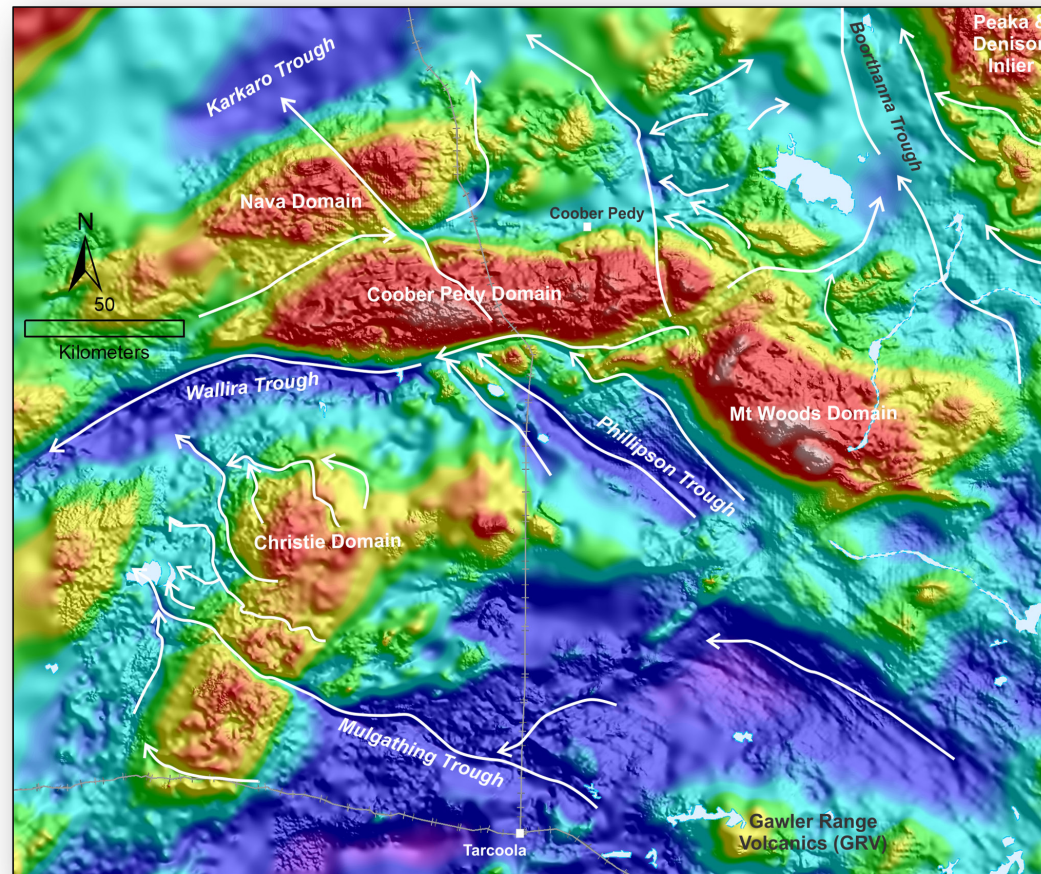
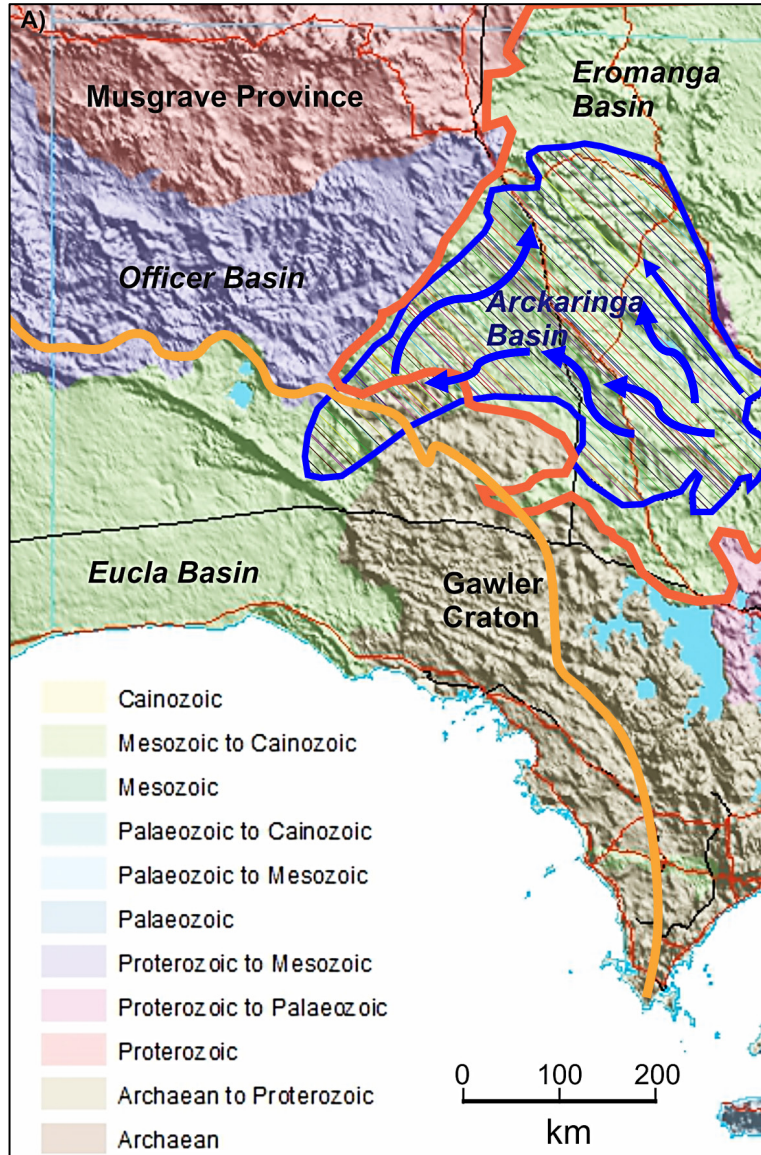
**Paleozoic paleovalleys transport direction in Arckaringa Basin**

*Alley et al. (in press)*

**Paleozoic paleovalleys identified in hi-resolution gravity**

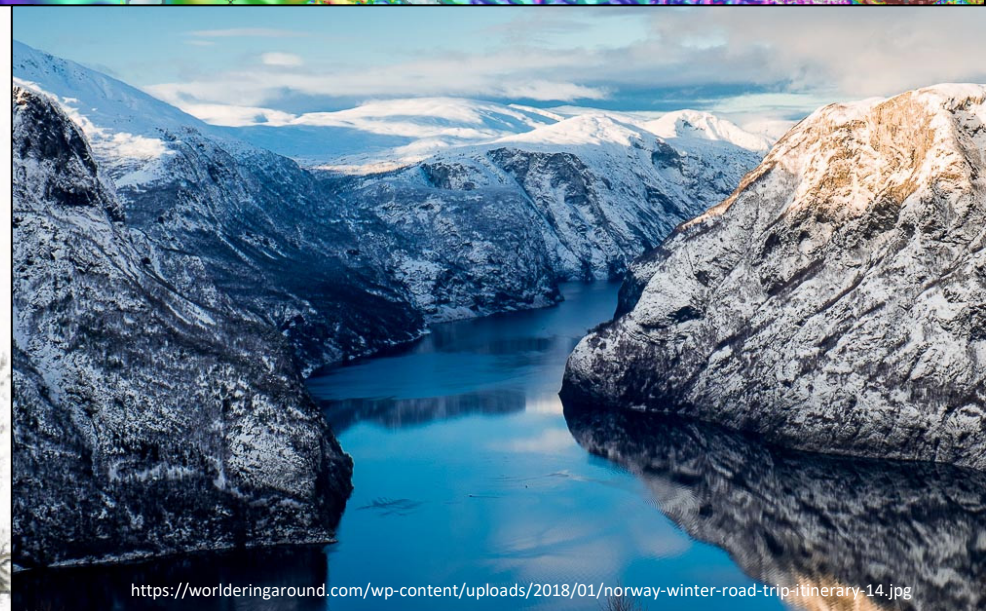
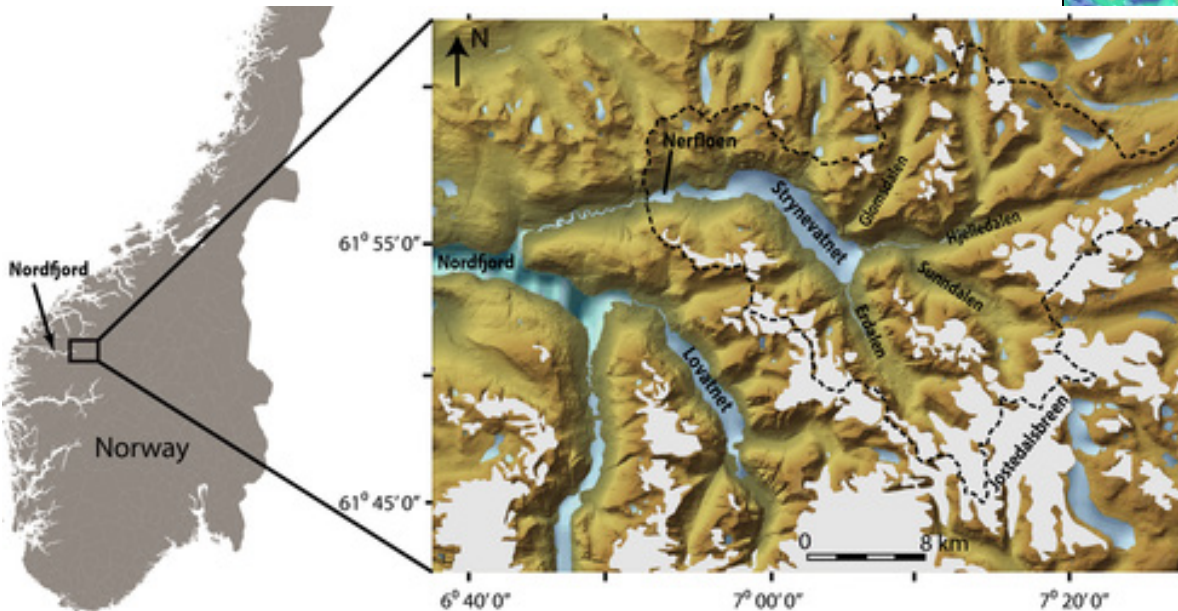
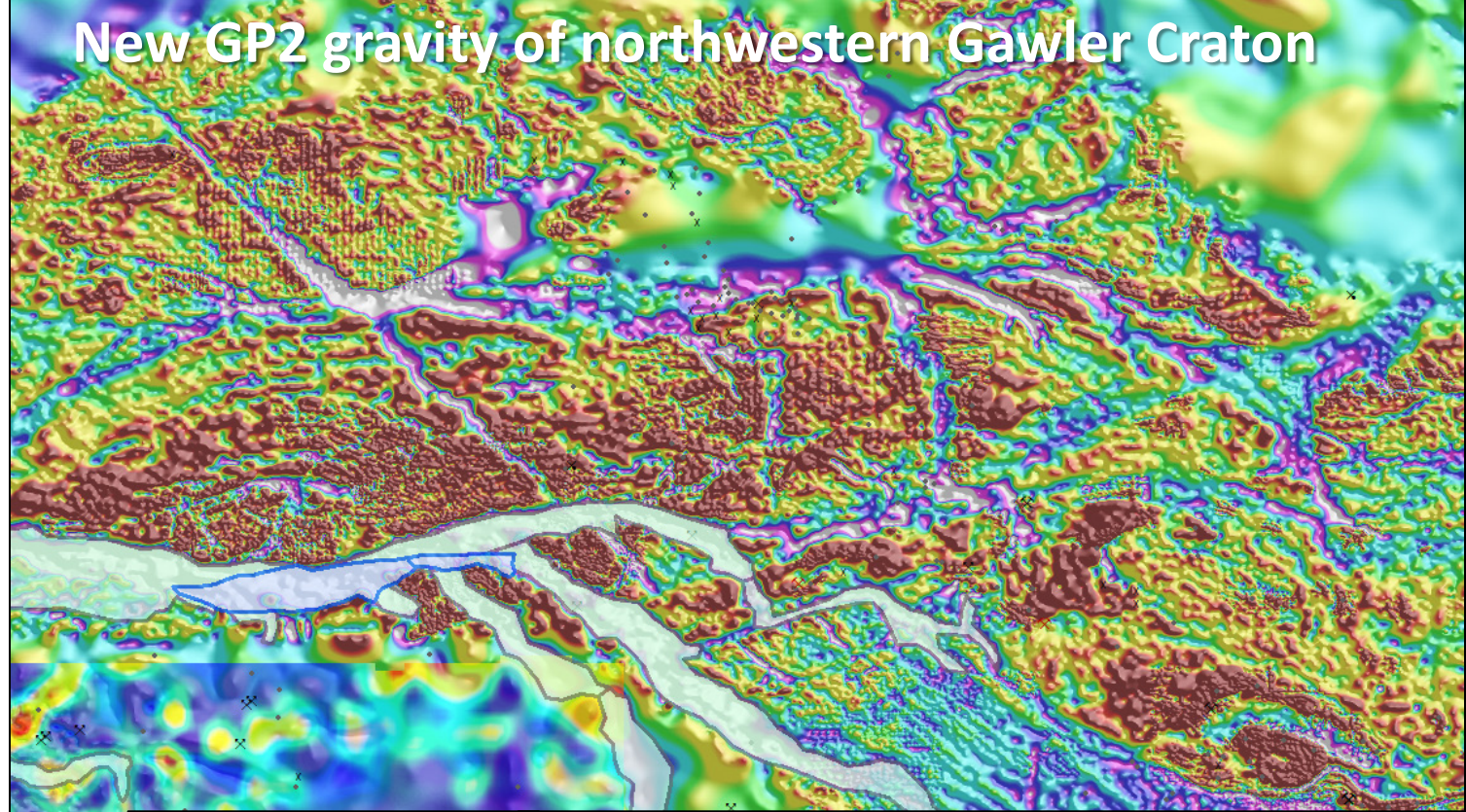
*Hou et al. (2024)*

Hou et al. (2022, 2023)



# Modern analogue of Gawler Paleozoic PVs: Norwegian fjords

Showing what the landscape of study area looked like in the Permian before the valleys were filled-up successively with sediments

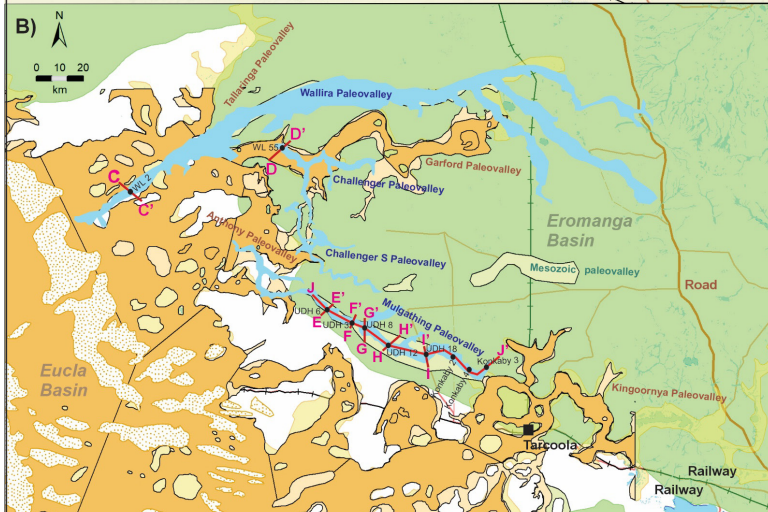


# Characterising palaeovalley sediments

>60s drillholes & cross sections

- handheld downhole gamma & pXRF
- DE and GDE interpretation

- logging lithology & lithofacies
- sequence stratigraphy



## Core Description Wallira 2

Department for Energy and Mining: South Australia

Country (State):	Australia (SA)	Spud Date:	23/08/1969
Main Basin:	Arckaringa	Elevation:	167m
Lat (S) GDA 2020	29° 20' 20.7715"	TD:	335.6m
Long (S) GDA 2020	133° 49' 46.8433"	Depth Shift:	No depth shift applied
Authors:	Description: B. Nix, Interpretation: C. Gault	Scale:	1:1000
Compiled By:	C. Gault - Feb 2025		



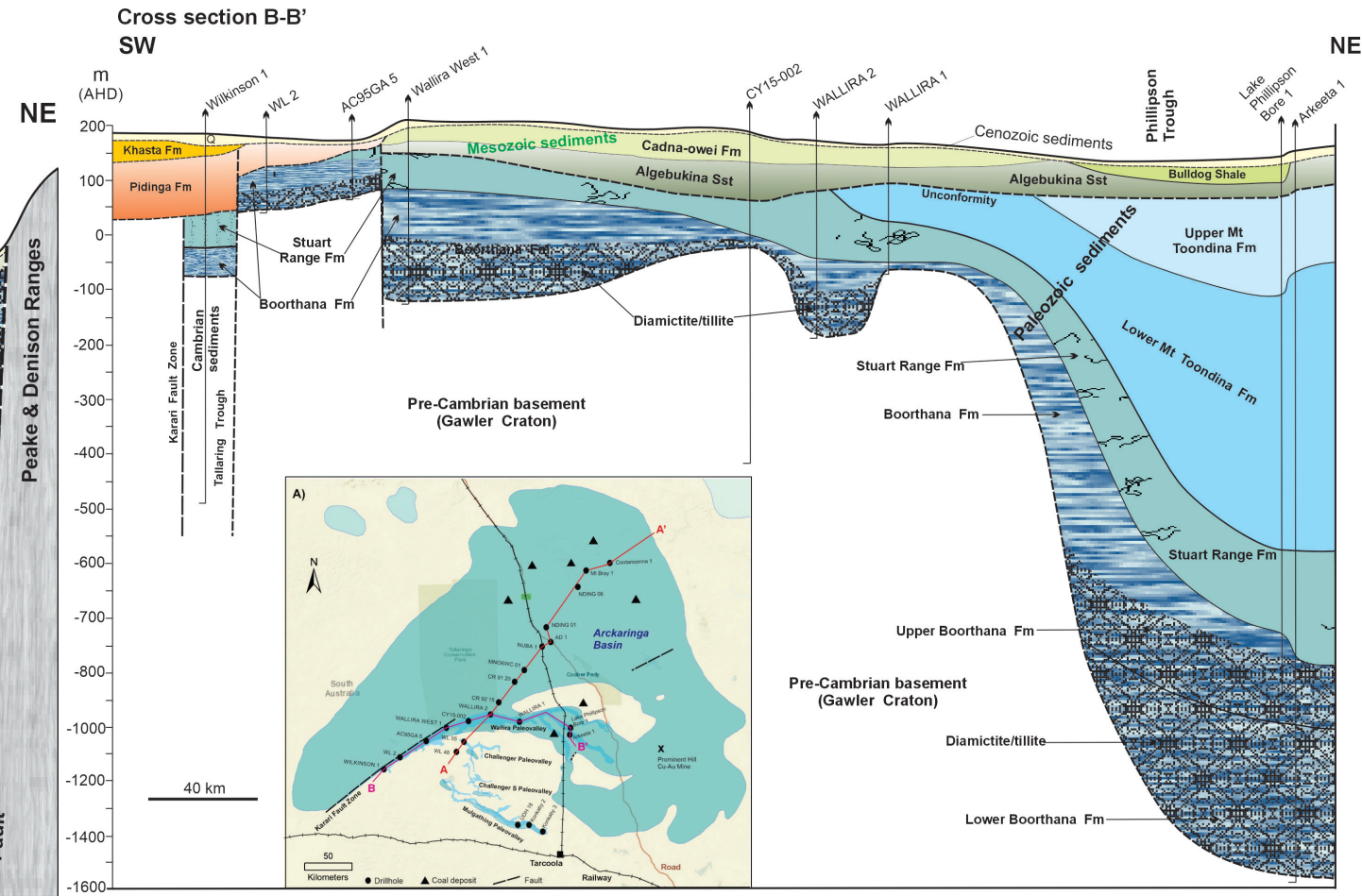
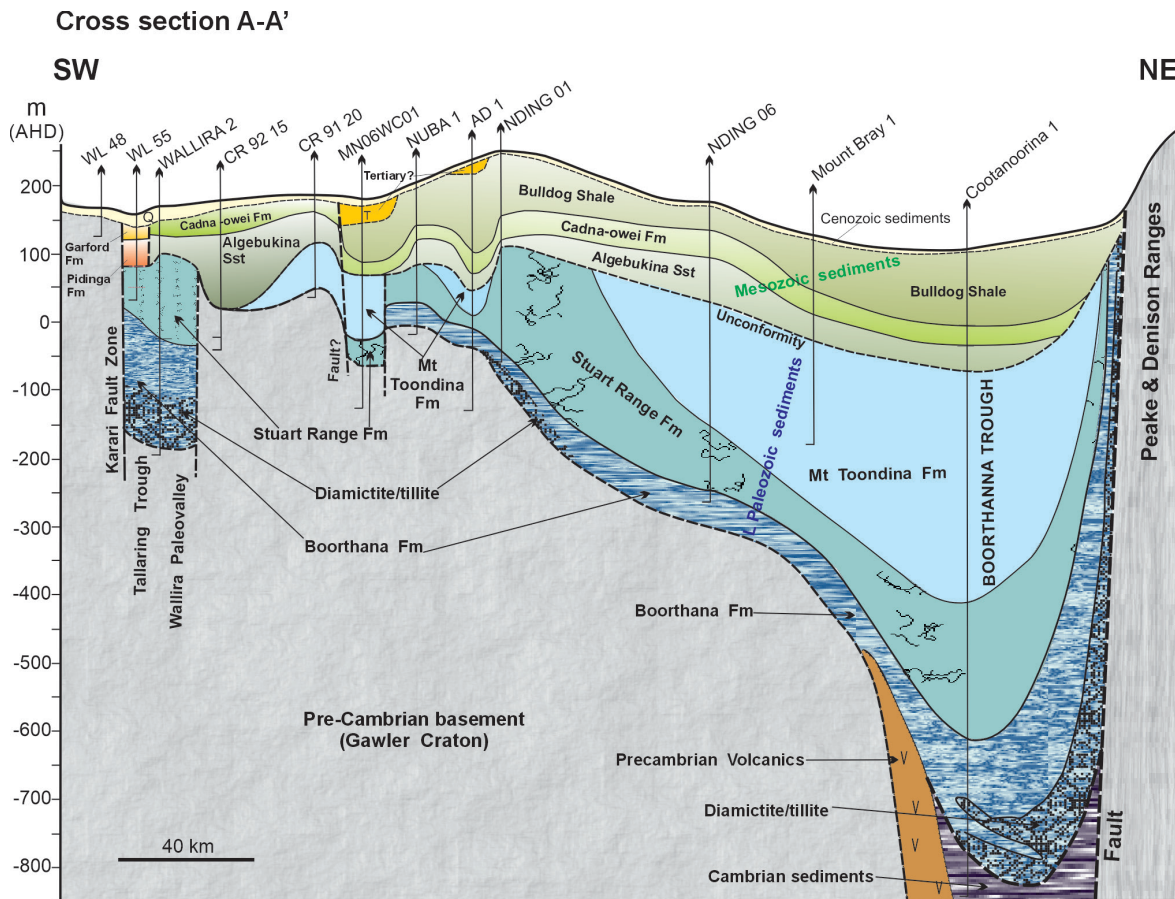
Depth and Stratigraphy		Elements (ppm)										Interpretation		Lithology										Description, Wirelogs and Images																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
Depth (m) (Wellhead)	Depth (m) (Surface)	Si	Al	Fe	Mn	Ca	Mg	K	Na	U	Th	Co	Ni	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li	Rb	K	Na	Ca	Mg	Fe	Mn	Zn	Pb	Cd	Cu	As	Sr	Zr	Hf	Ti	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu	Sc	V	Cr	Mo	Ag	Sn	Sb	Te	Se	Br	I	B	F	Cl	Li

# Time- and spatial-bound distribution of Paleozoic-Mesozoic-Cenozoic sediments

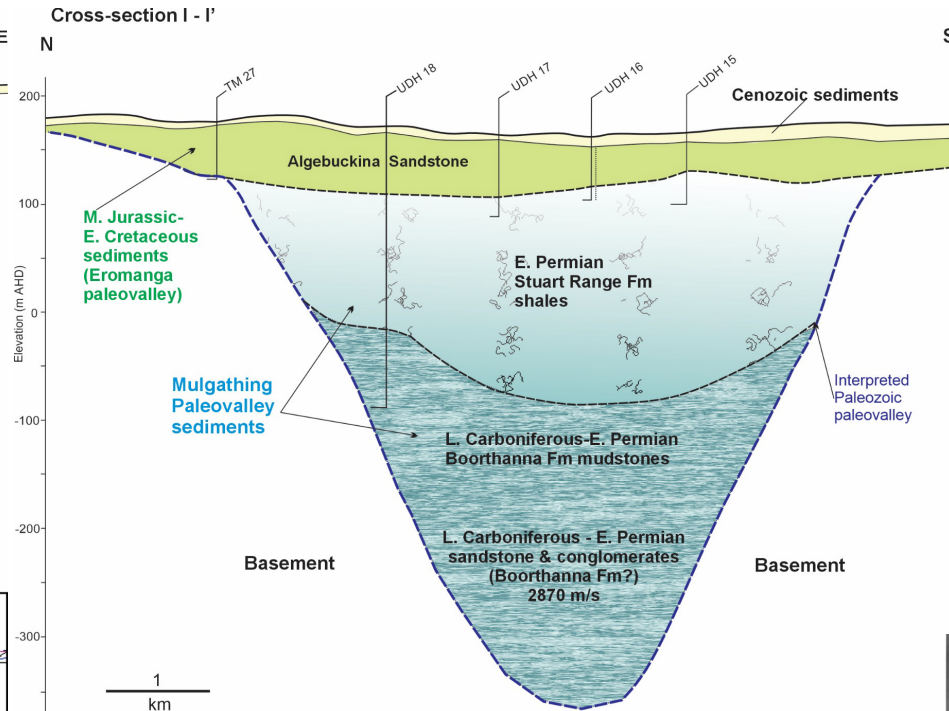
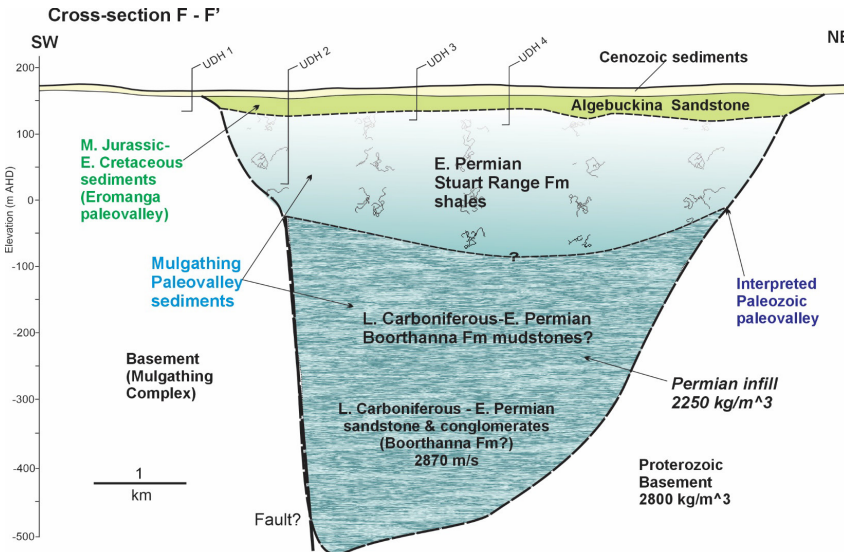


Cross-section A-A' through the overlapping area of the Arckaringa, Eromanga and Eucla basins shows:

- Palaeozoic and Mesozoic paleodrainage direction ~ **SW to NE**
- Paleo/Neogene paleodrainage ~ **NE to SW**

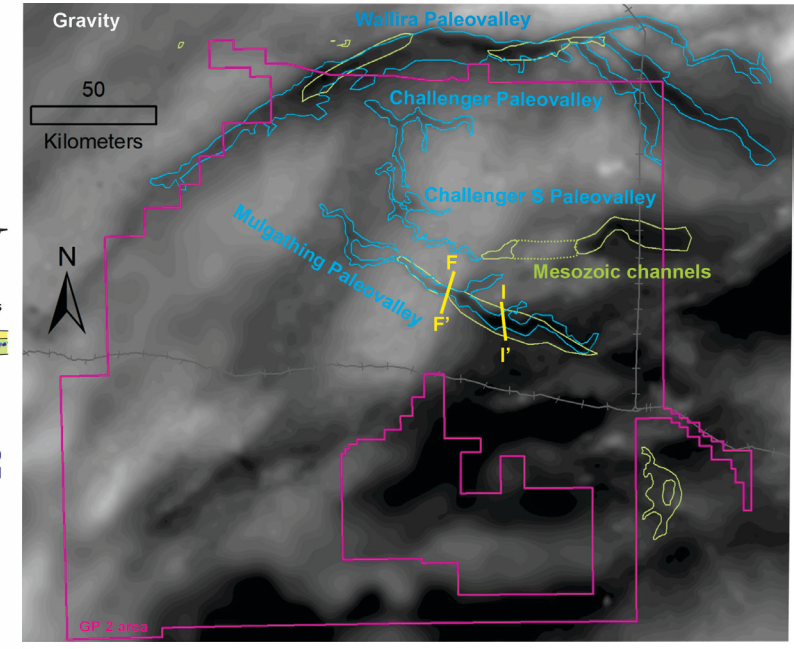
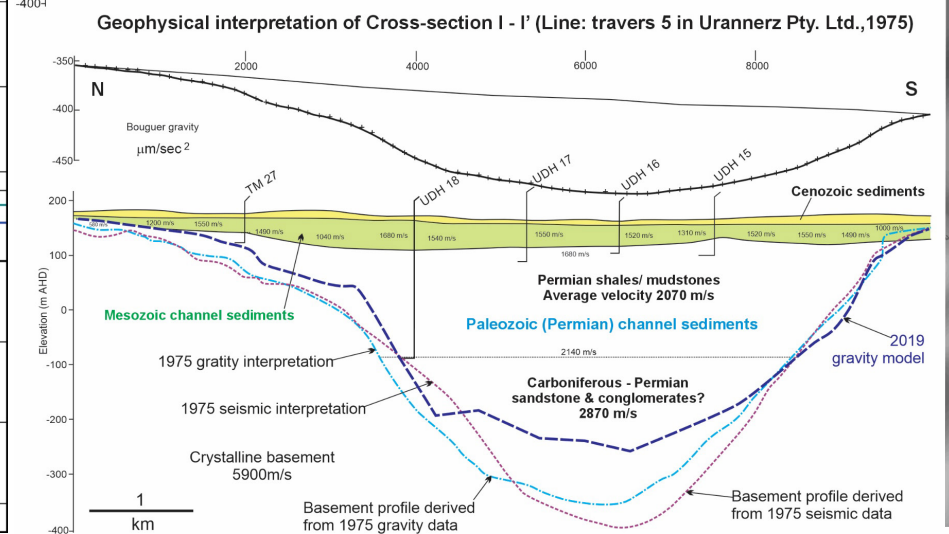
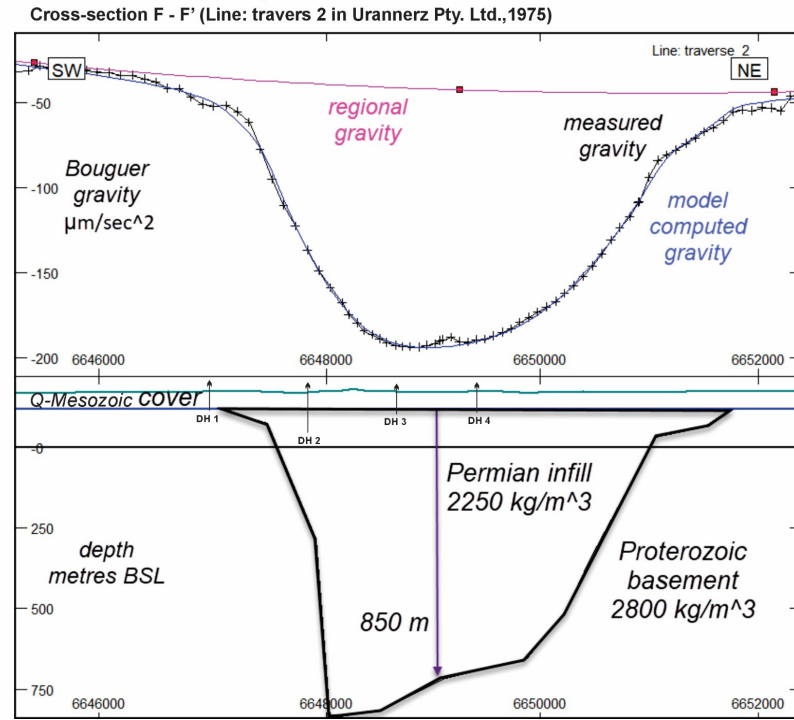


# Paleozoic & Mesozoic paleovalleys imaged in gravity



Cross-sections F-F' and I-I' through Mulgathing Paleovalley and gravity model with mapped Palaeozoic-Mesozoic paleovalleys.

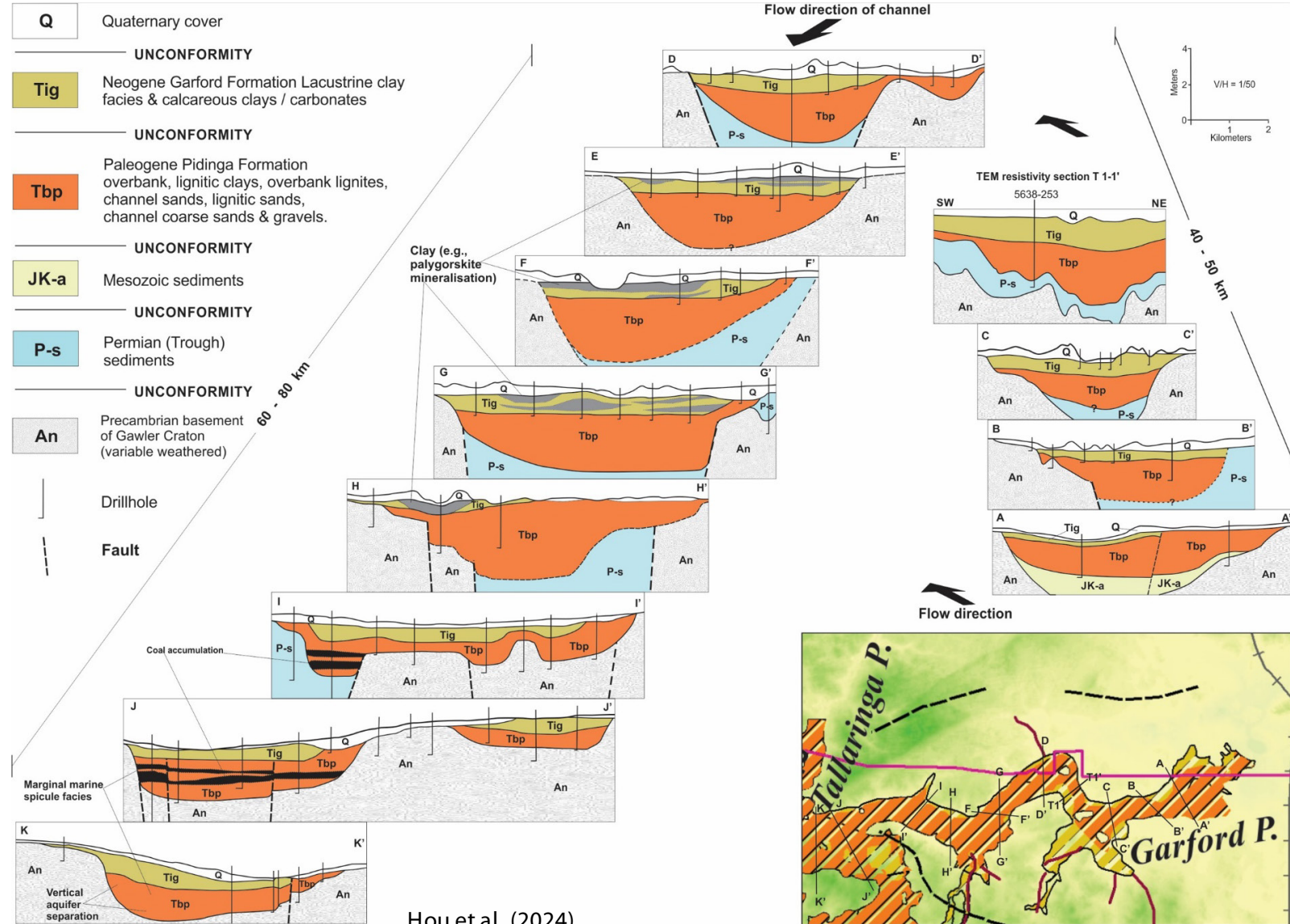
Depths interpreted from gravity modelling (Foss, C., CSIRO; Hou et al., 2023, 2024)



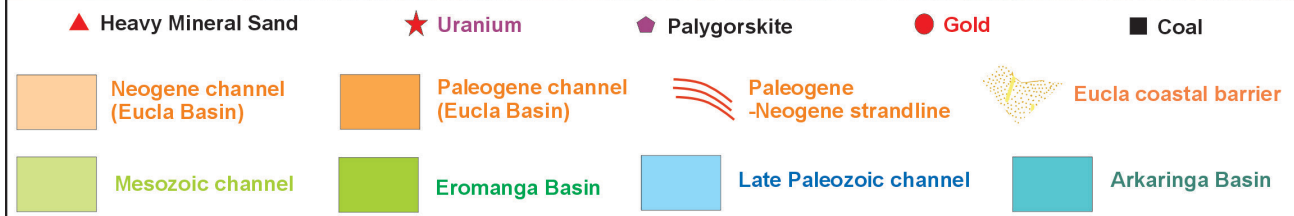
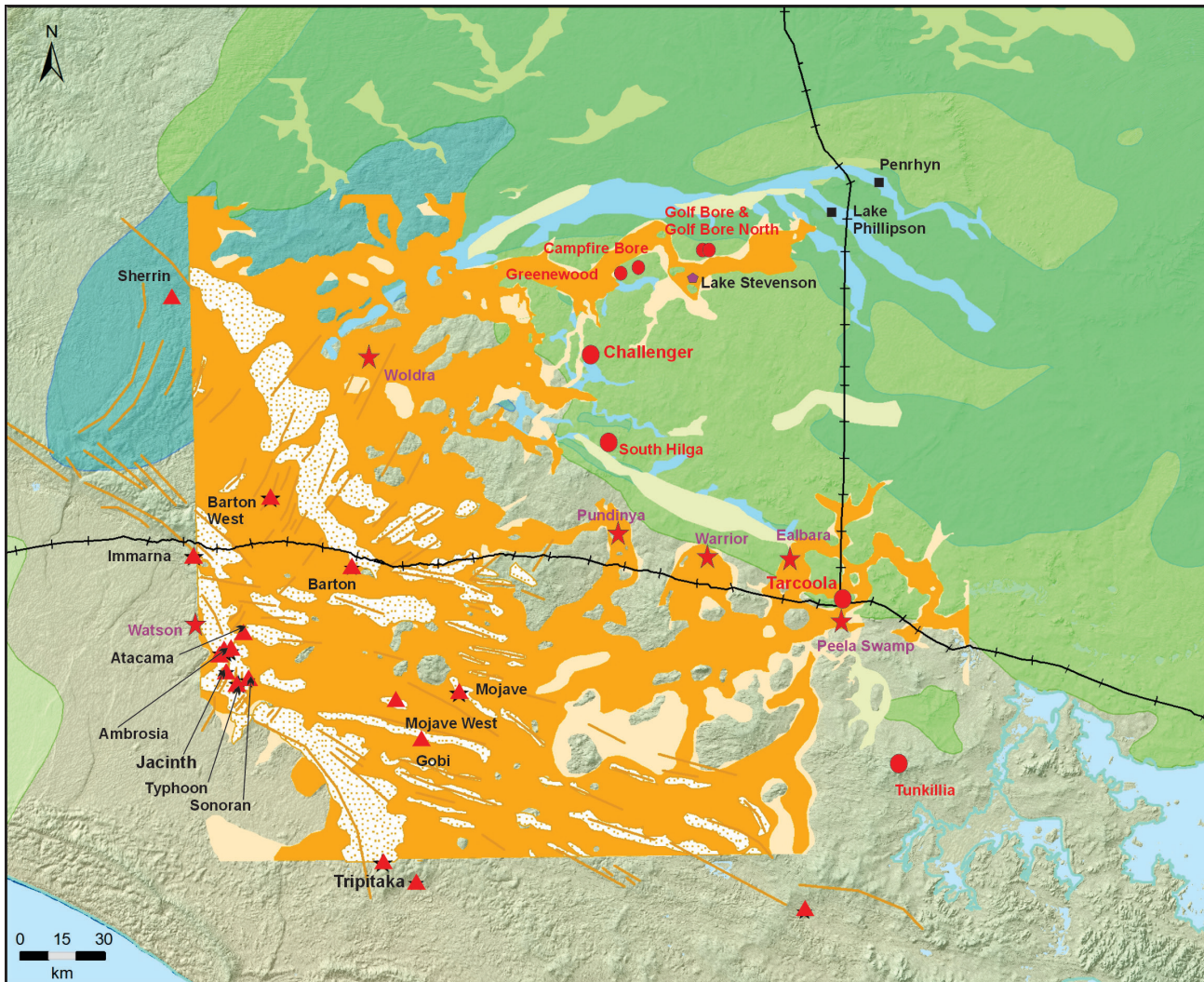
# Time- and spatial-bound distribution of three generations of paleovalleys

- Cenozoic: Garford Paleovalley (Tig – Tbp)**
- Mesozoic paleovalley (JK-a)**
- Paleozoic: Challenger Paleovalley (P-s)**

boundaries between units are interpreted by transient electro-magnetic (TEM) & drilling data

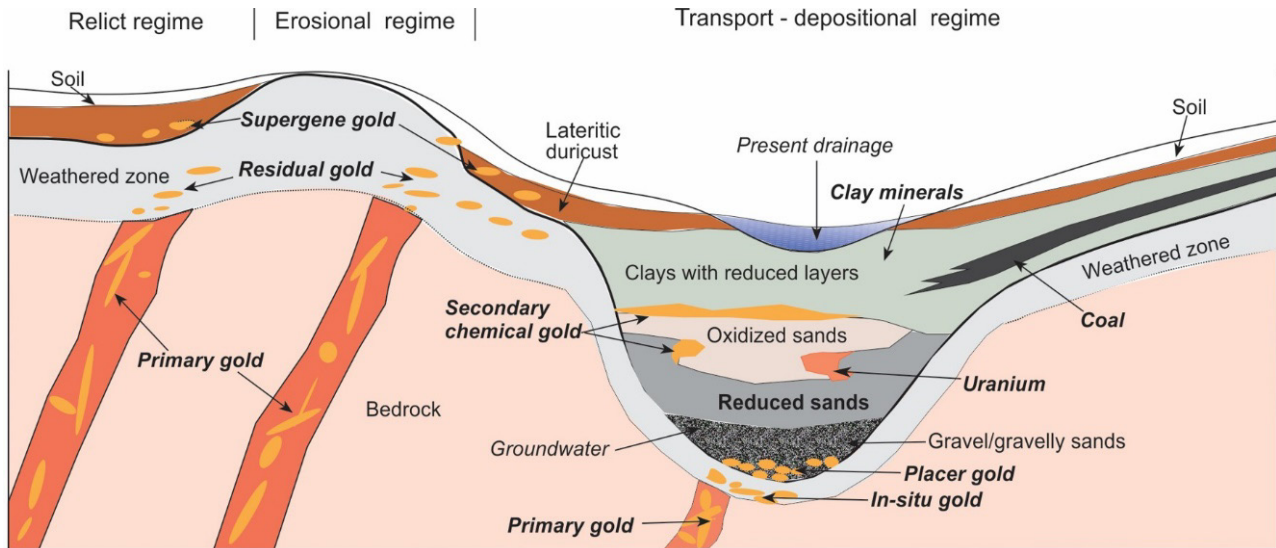
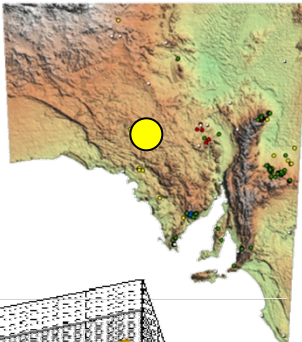


# Implications for paleovalley exploration



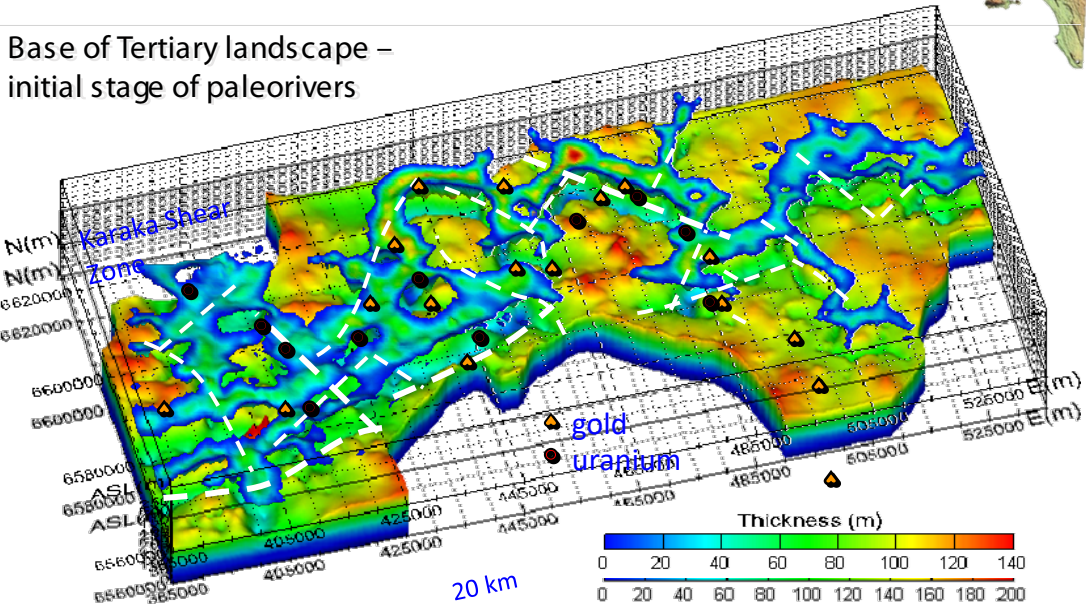
AGE (Ma)	PROVINCE	STRATA	RESOURCES
M. Miocene-E. Pliocene (~16-2 Ma)	EUCLA BASIN (EAST)	Eastern Eucla Basin: Nularbor Limeston	Palygorskite, HMS, Uranium, REE?
		Eastern Eucla margin: Garford Fm, Narlaby Fm, Ilkina Fm, Yarle Sandston	
Oligocene (~27-25 Ma)		Munjena Fm	Silcrete
M.-L. Eocene (~50-33 Ma)	EUCLA BASIN (EAST)	Wilson Bluff Limeston	HMS, Uranium, groundwater placers? REE?
		Hampton Sandston	
		Uncorformity	
Early Cretaceous (~125-105 Ma)	EROMANGA BASIN (WEST)	Bulldog Shale	HMS, Uranium, groundwater placers?
Early Cretaceous (~140-125 Ma)		Cadna-owie Formation	
M. Jurassic-E. Cretaceous (~168-140 Ma)		Algebuckina Sandstone	Placers? Groundwater?
		Uncorformity	
Carboniferous-Early Permian (~330-270 Ma)	ARCKARINGA BASIN	Mount Toondina Formation: Upper Mt Toondina Fm	Coal, Gassification /CSG
		Lower Mt Toondina Fm	
		Stuart Range Formation	Shale Oil, Biogenic Shale, Gas
		Boorthanna Formation: Upper Boorthanna Fm	Placers? Groundwater?
Lower Boorthanna Fm			
		Uncorformity	
Neppaleozoic-Early Proterozoic (~1000-350 Ma)	eg OFFICER BASIN	Bedrock sources	Secondary Au, U, HM, REE
		Uncorformity	
Mesoproterozoic-Archean (~4000-1000 Ma)	GAWLER CRATON	Basement sources	Primary Au, U, HM, REE

# Cenozoic placer-Uranium-clay minerals-REE-groundwater

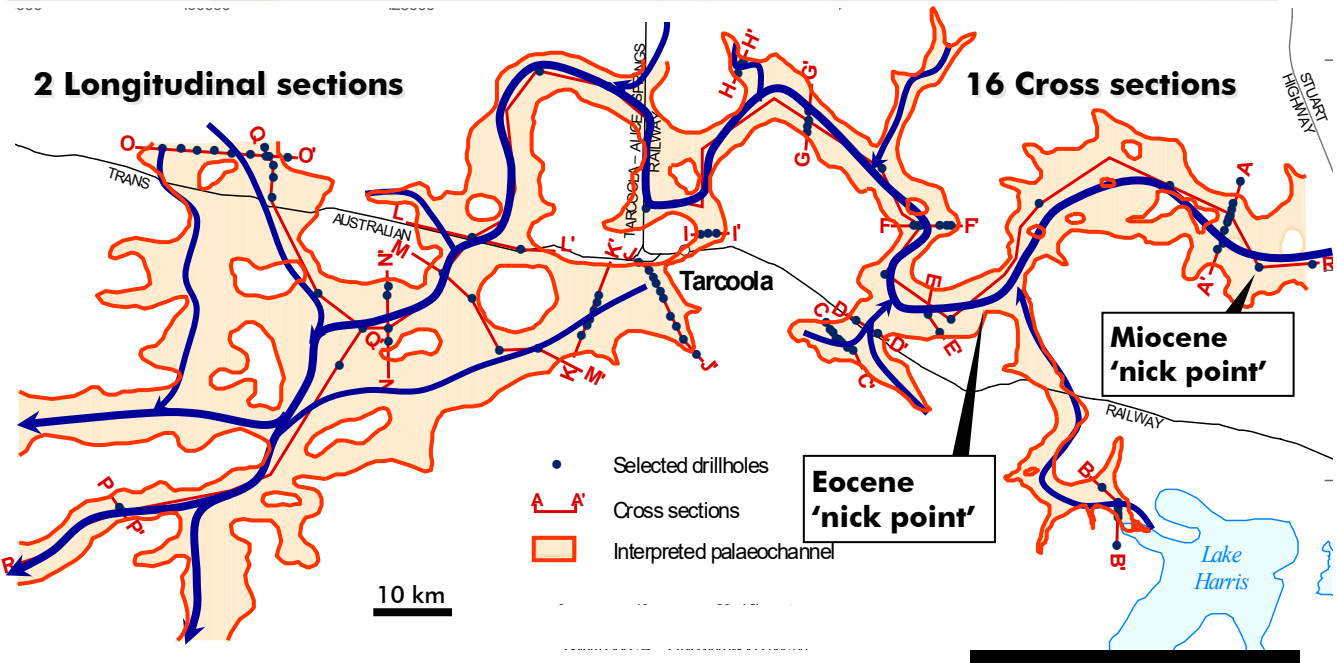


Mineralisation model from a detailed cross-section in the Kingoonya Paleovalley (Hou & Alley 2003)

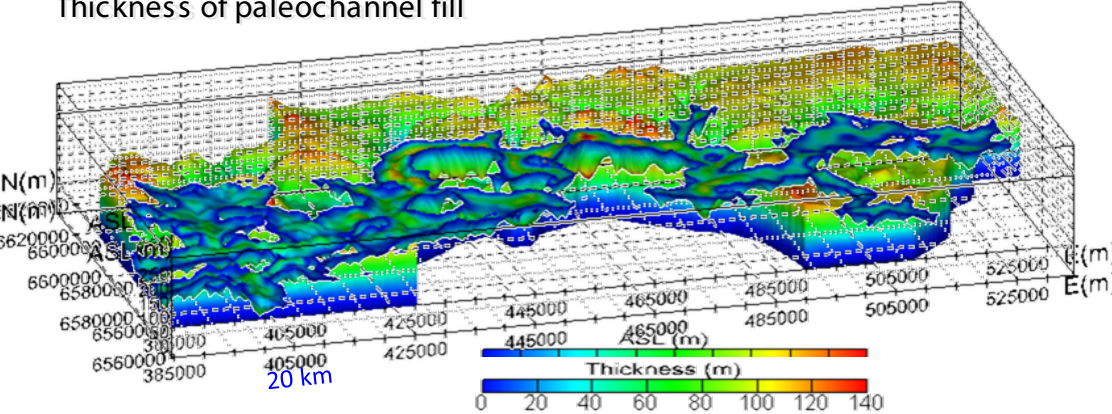
Base of Tertiary landscape – initial stage of paleorivers



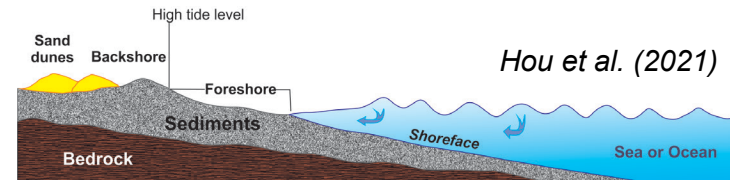
Hou (2008)



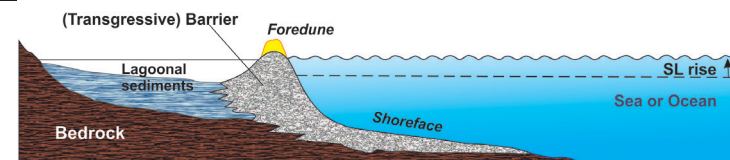
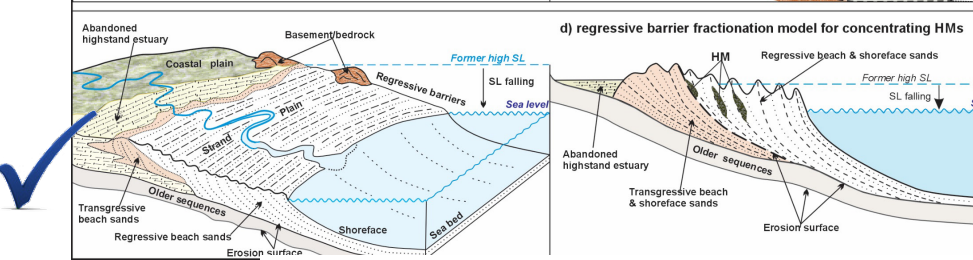
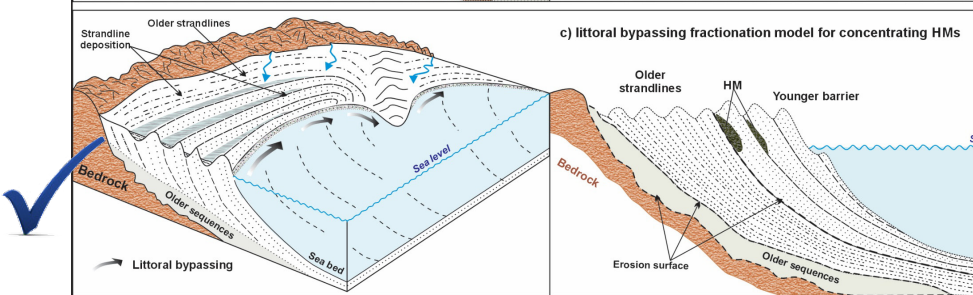
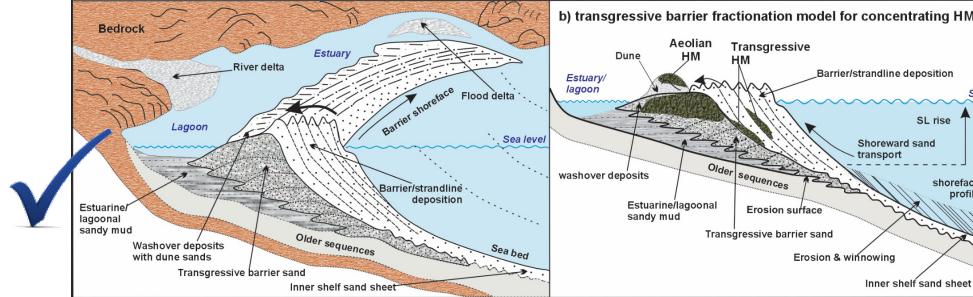
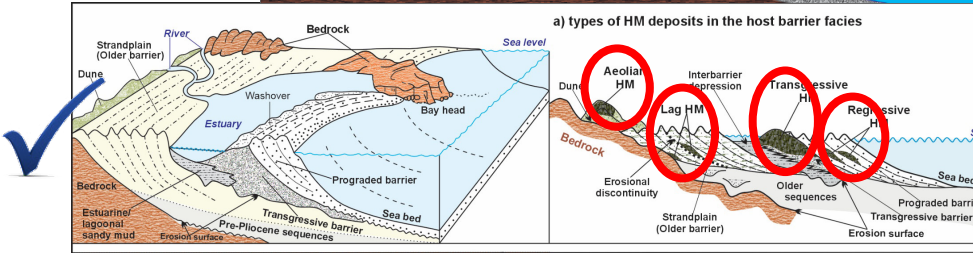
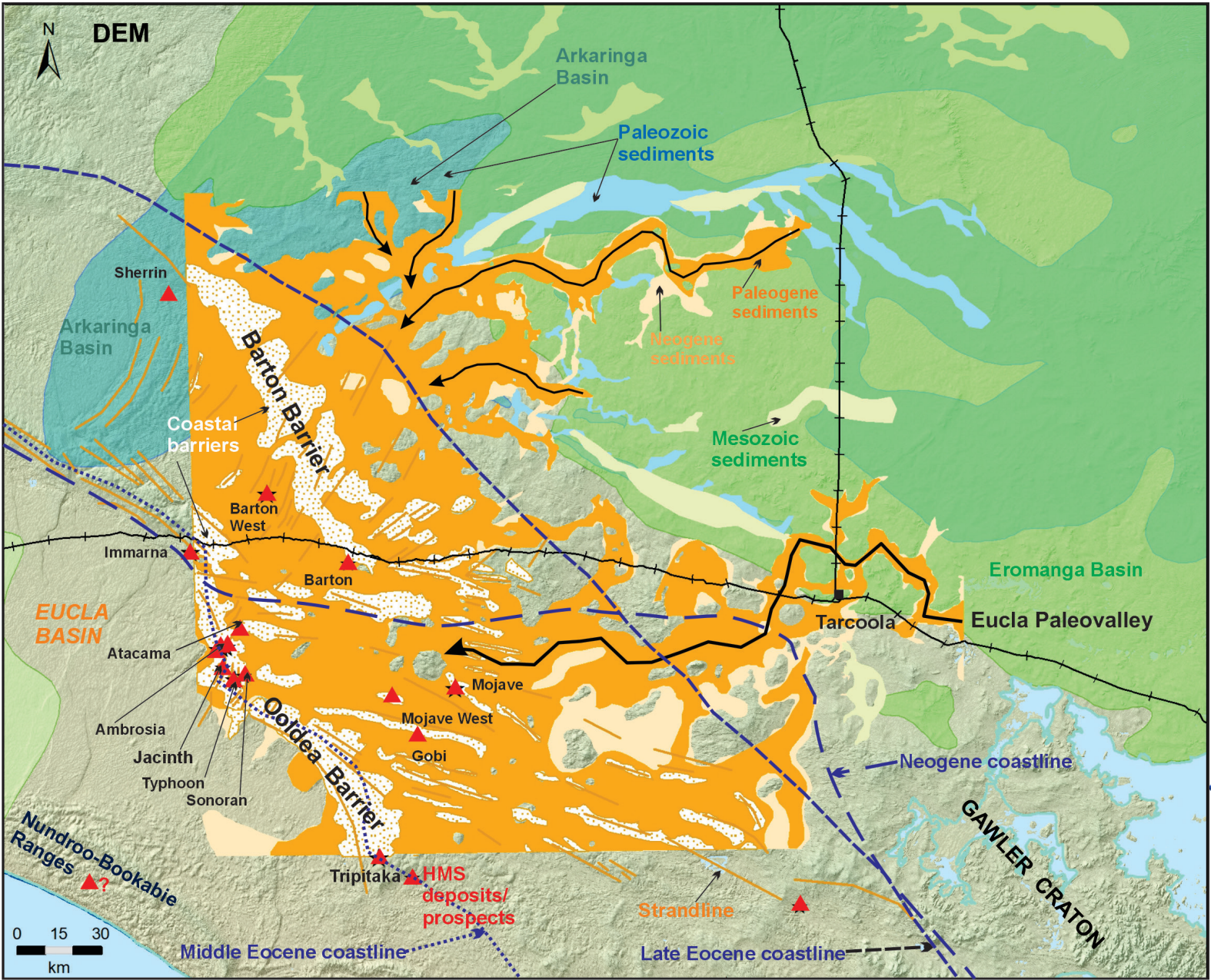
Thickness of paleochannel fill



# Paleogene-Neogene HMS

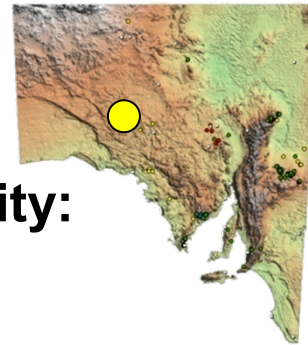


Hou et al. (2021)



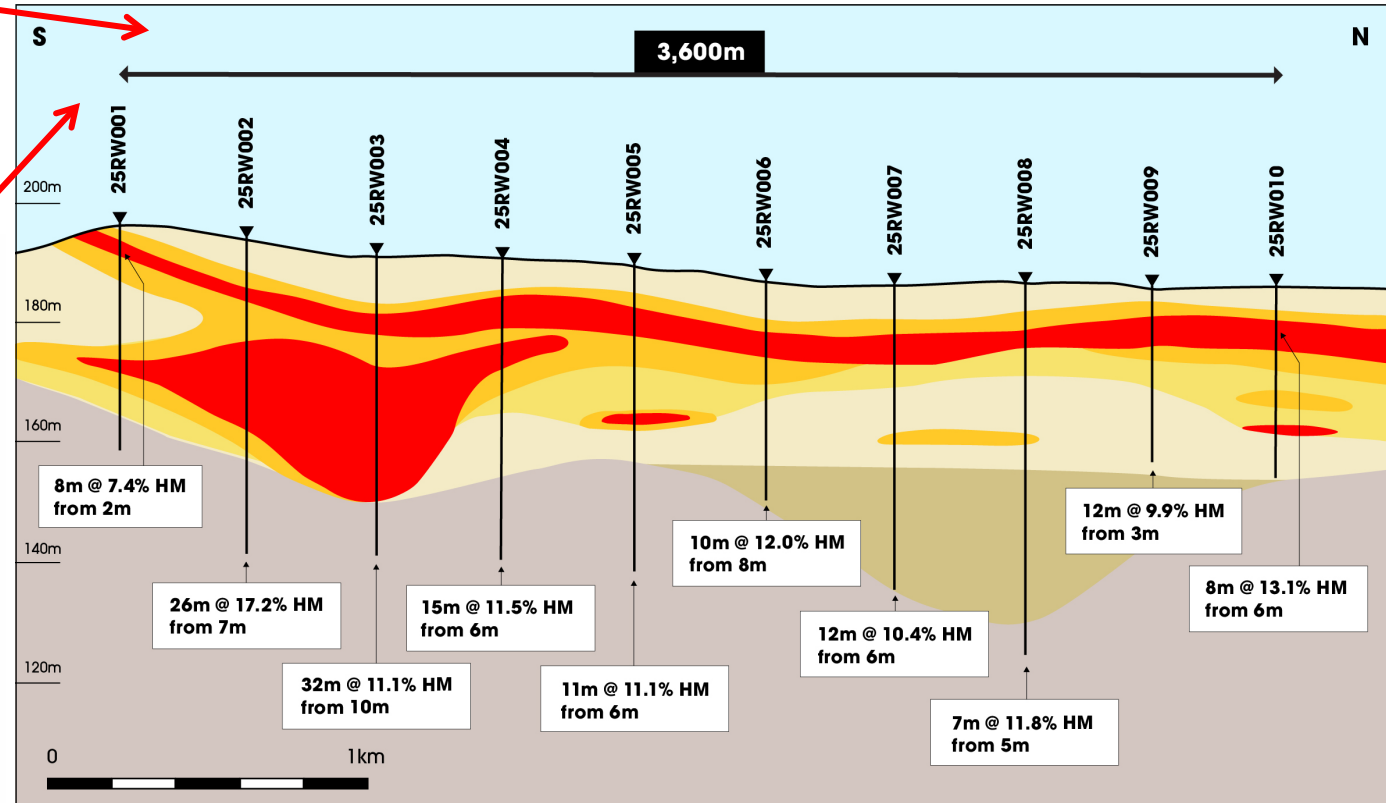
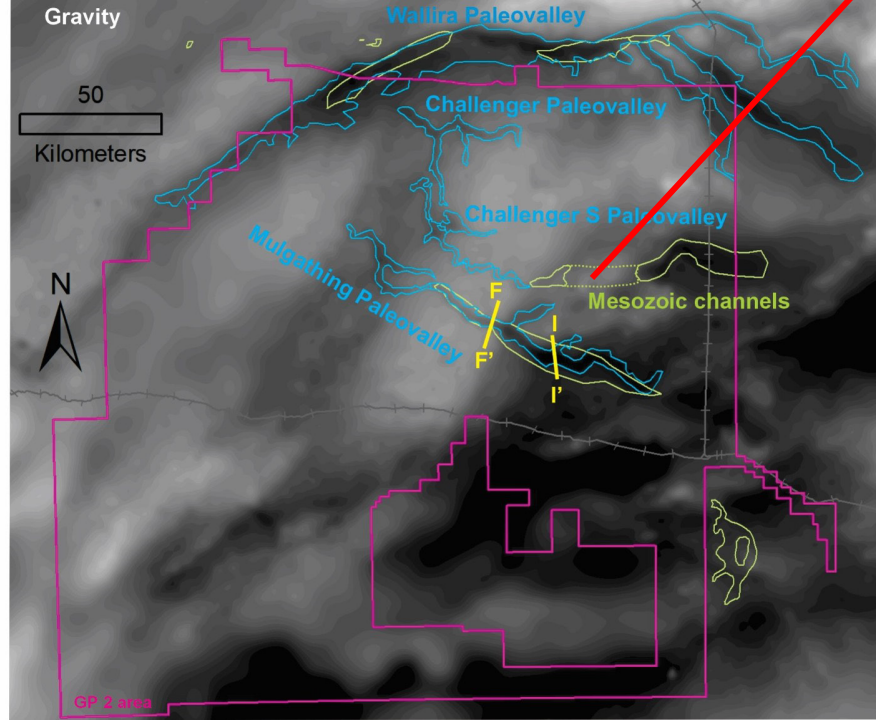
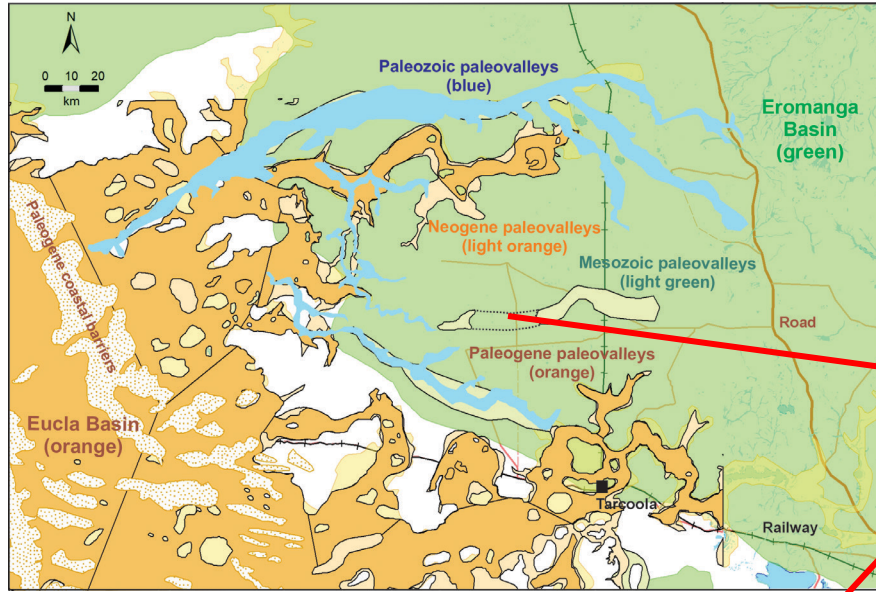


# Mesozoic HMS



## Noise on satellite ntt imagery and hi-resolution gravity:

- absence of moisture at acquired time
- absence of density contrast between thin channel fills and weathered basement rocks
- due to the location of highlands



Thanks for recognition of Mesozoic paleovalleys from Diatreme, Petrathern, Marmota & Iron Road.



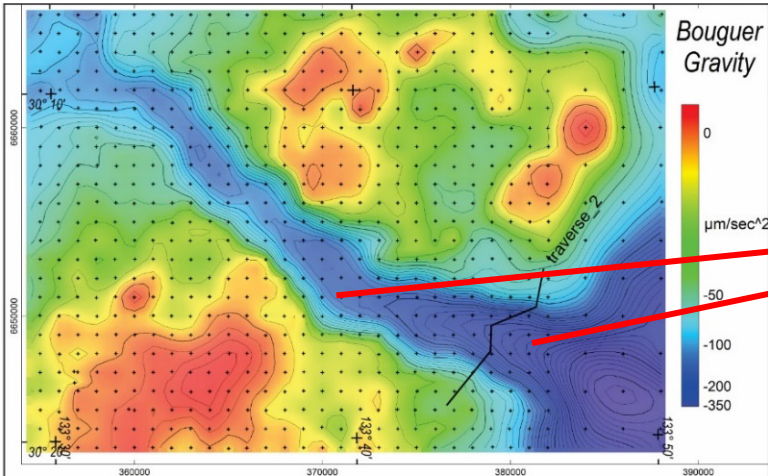
Rosewood Prospect  
Cross Section  
Line 421400E

Sediments  
 Older sediments  
 Weathered Basement

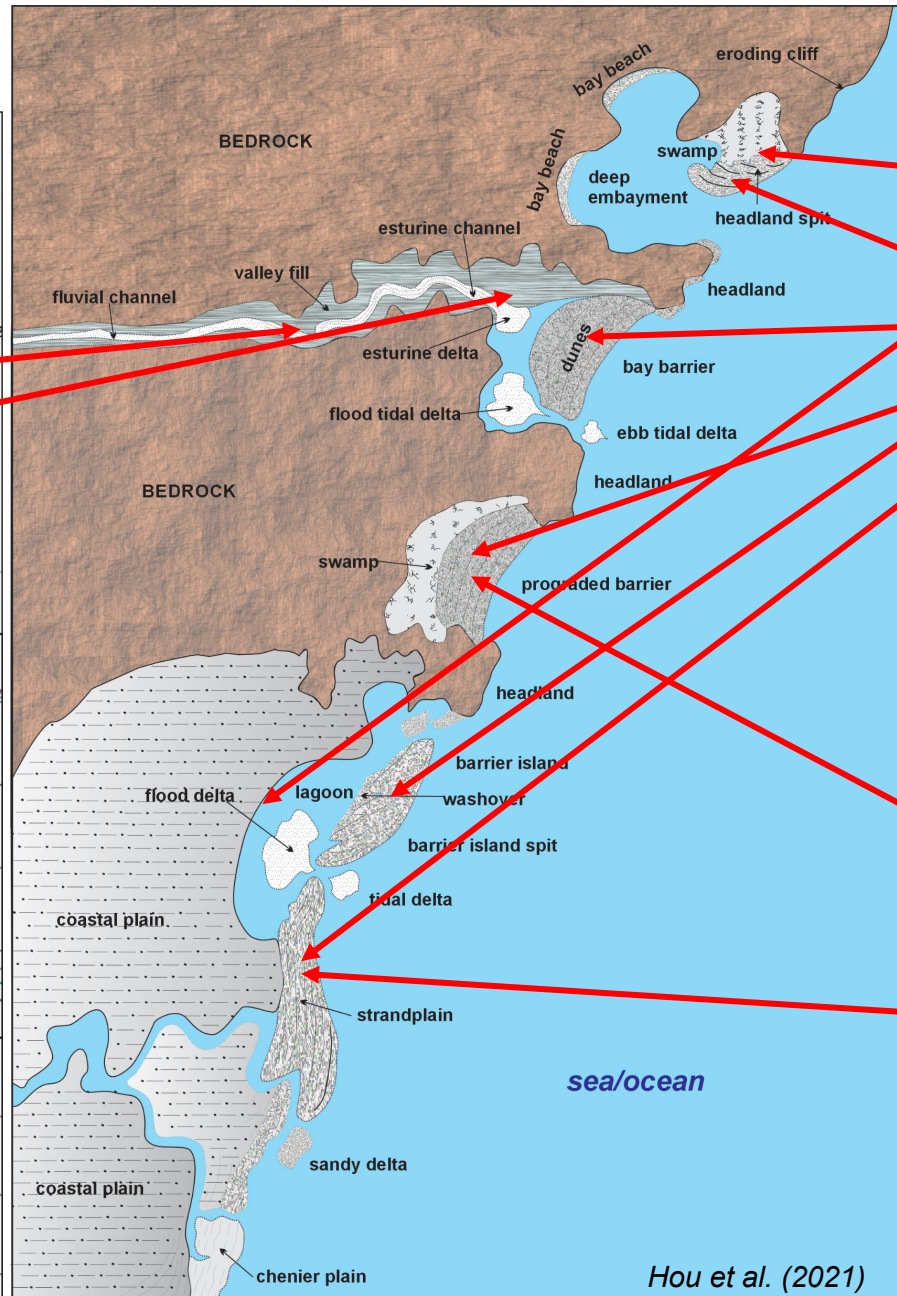
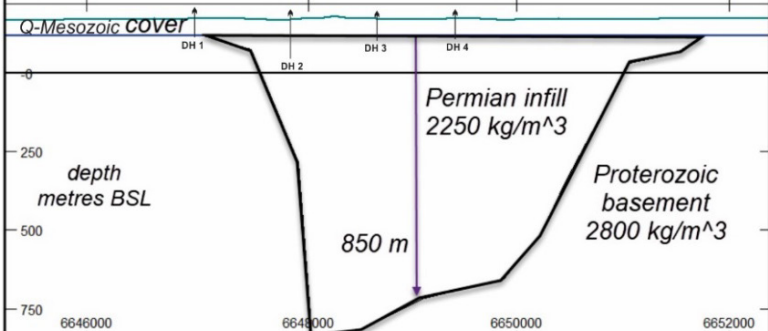
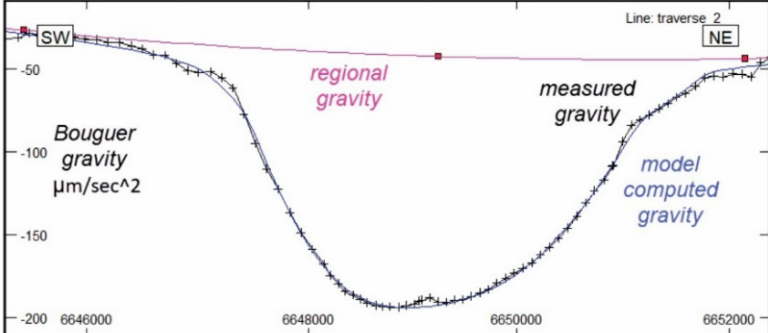
>1% HM  
 >3% HM  
 >12% HM

Drill Hole  
 Vertical Exaggeration = 1 : 20

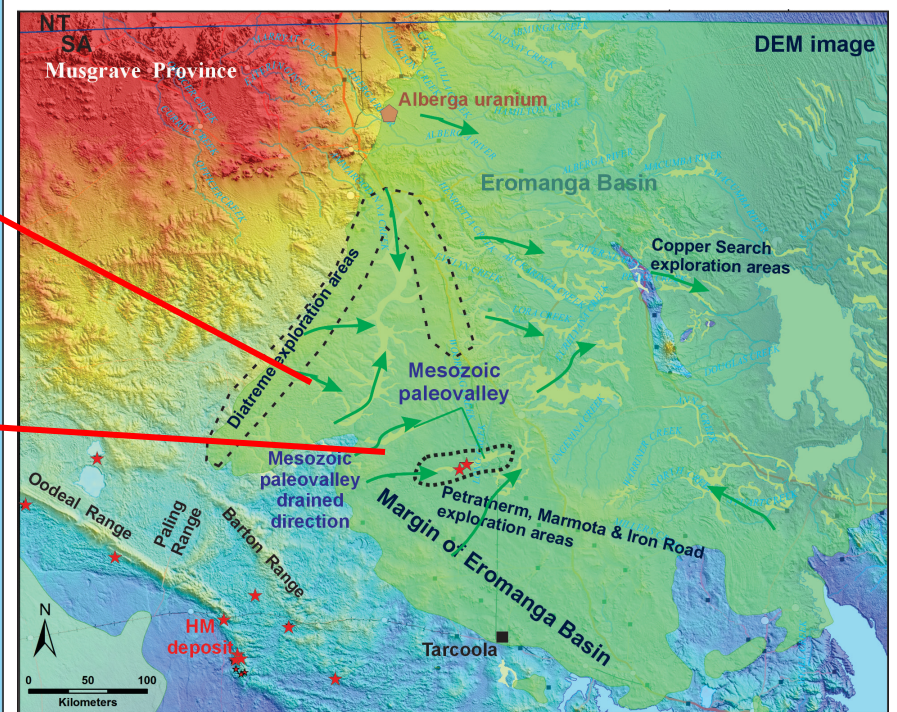
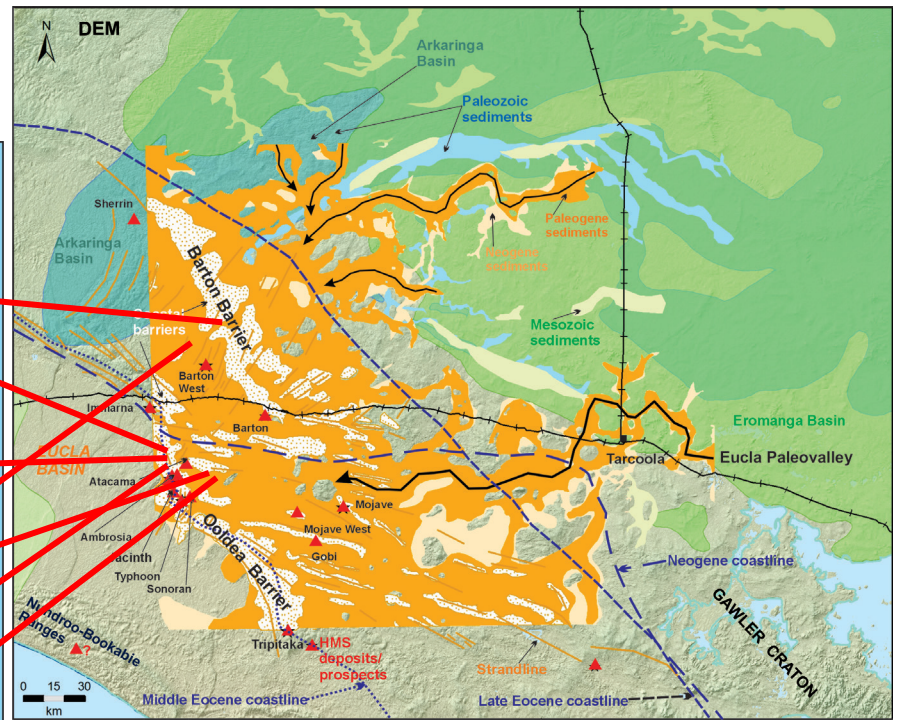
# Arckaringa, Eromanga and Eucla coastal HMS



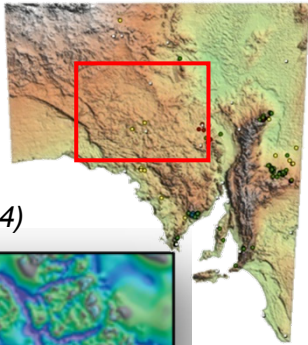
Cross-section B - B' (Line: travers 2 in Uranerz Pty. Ltd., 1975)



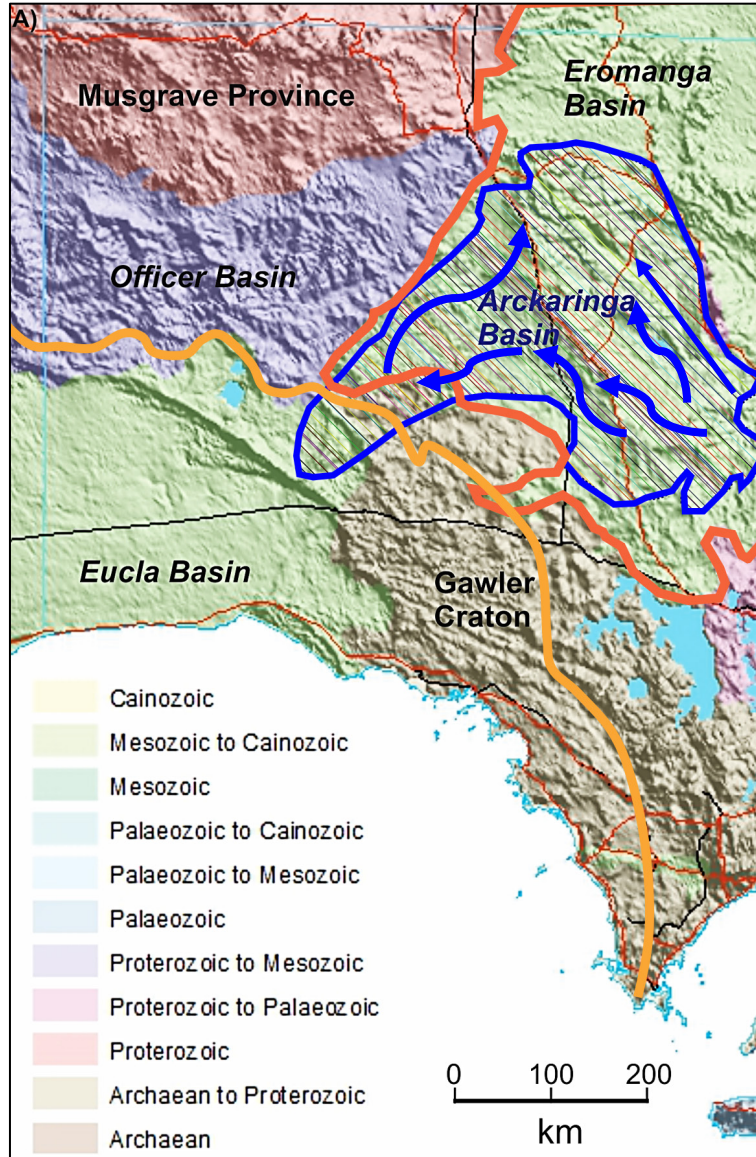
Hou et al. (2021)



# Paleozoic paleovalley resources



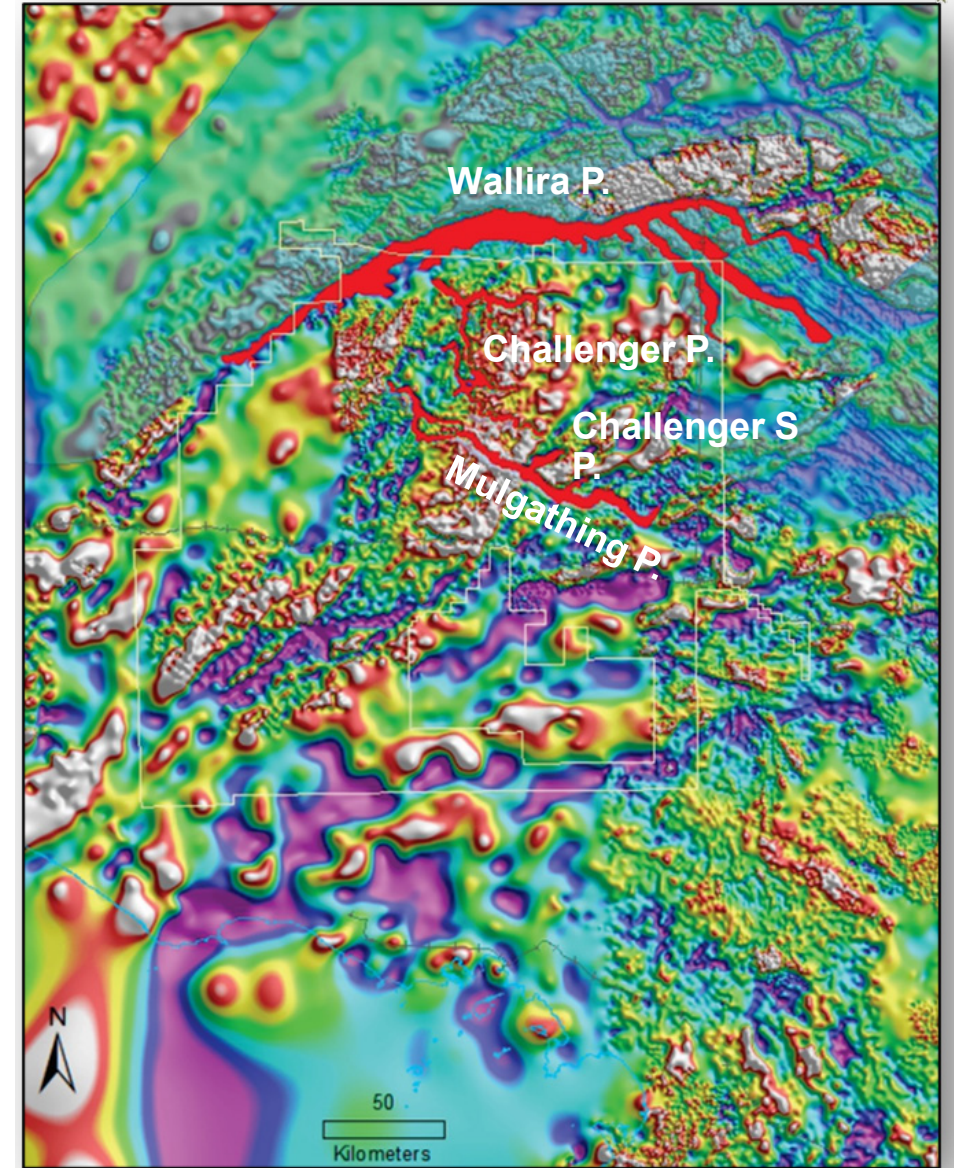
Hou et al. (2022, 2023)



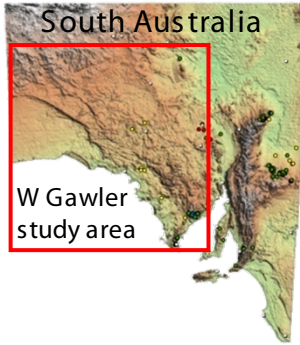
## Resource potential:

- coal
- hydrogen
- hydrocarbons
- groundwater
- .....

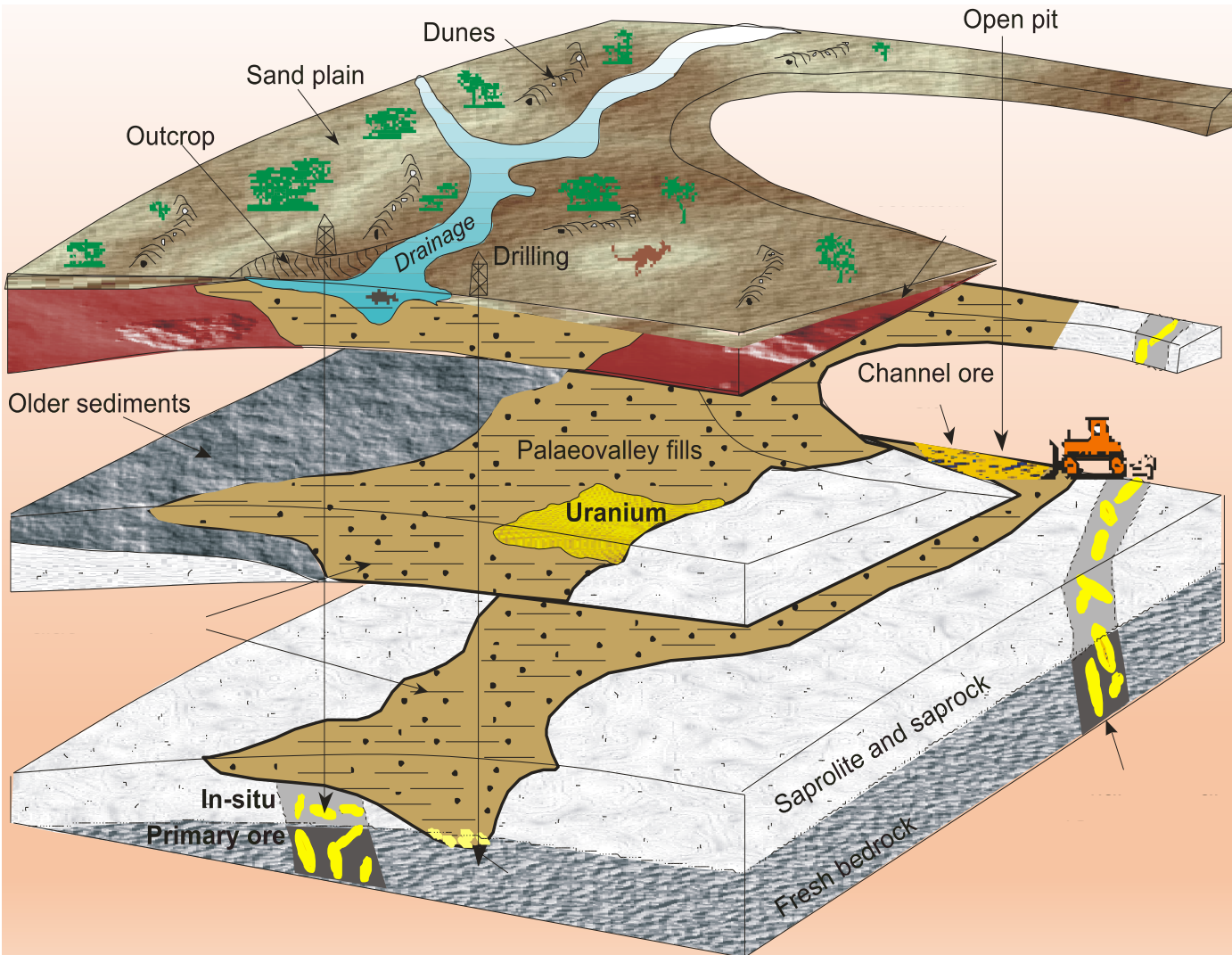
Hou et al. (2024)



# Summary: Paleovalley exploration



Paleovalleys present numerous exploration problems and opportunities, and challenging exploration techniques



## The best methods:

- Hi-resolution DEM + NTT imager
- EM (AEM/TEM)
- Hi-resolution gravity
- Shallow seismic/ passive seismic
- Drilling with geophysical logs

## The cheapest & best methods:

- DEM
- NTT imagery
- Passive seismic
- Test drilling with geophysical logs

## The potential resources:

- Placers/HMS
- Uranium
- Clay minerals
- REE
- Groundwater
- Hydrogen/hydrocarbons
- Coal

# Disclaimer

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# Acknowledgement of Country

As guests here on Kurna land, the Department for Energy and Mining (DEM) acknowledges everything this department does impacts on Aboriginal country, the sea, the sky, its people, and the spiritual and cultural connections which have existed since the first sunrise. Our responsibility is to share our collective knowledge, recognise a difficult history, respect the relationships made over time, and create a stronger future. We are ready to walk, learn and work together.



**DISCOVERY DAY**

