


# Murray Basin baseline environmental geochemistry, including critical minerals

A Campbell, A Martin, N Reid, C Riley, C Cairns, S Herley, S Travers, C O'Neill, R Thorne, B Mahon





We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

Resources Victoria is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

# Northwest Victoria



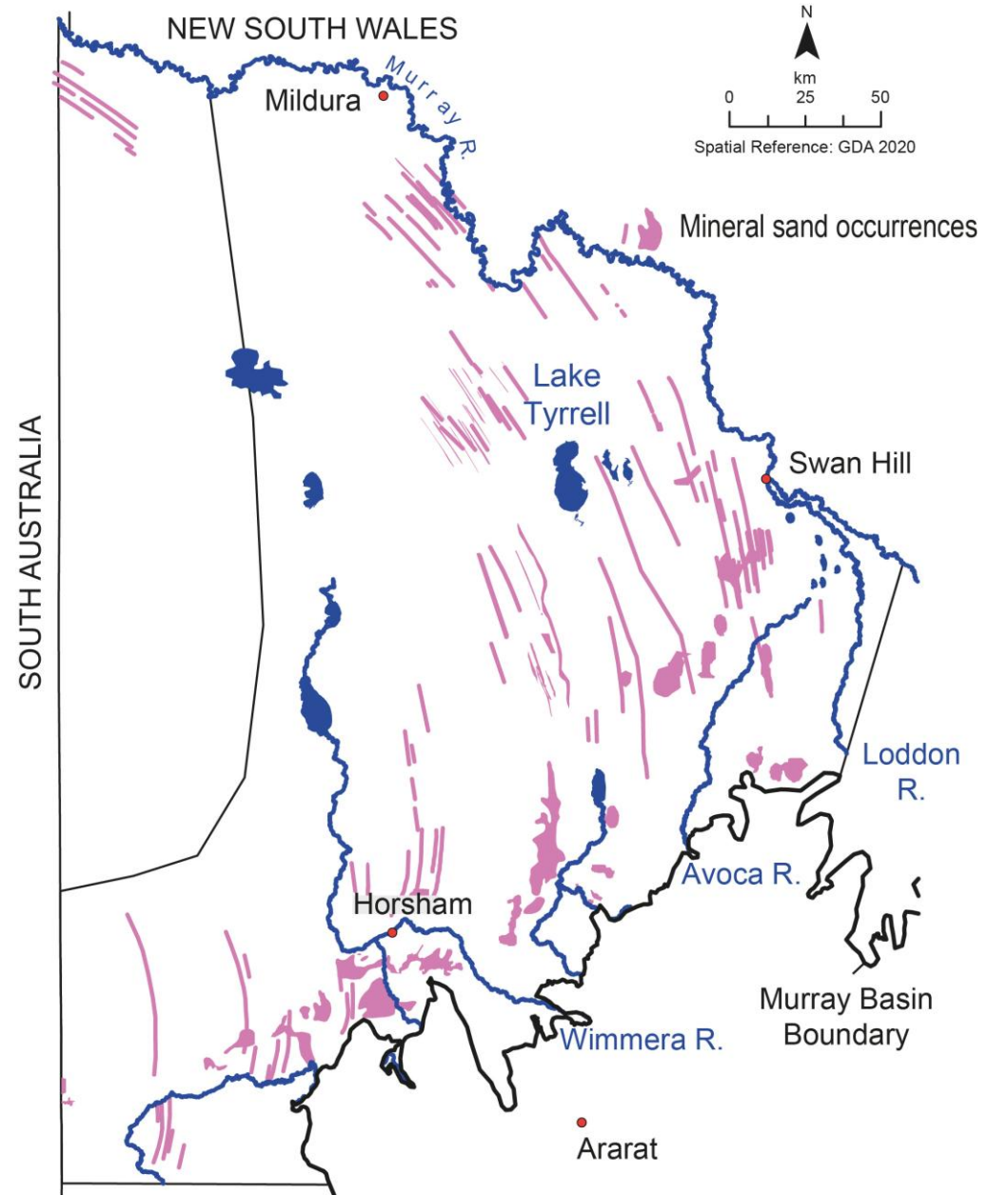
Murray Sunset NP, First People of the Millewa-Mallee



Agricultural land, Barengi Gadjin



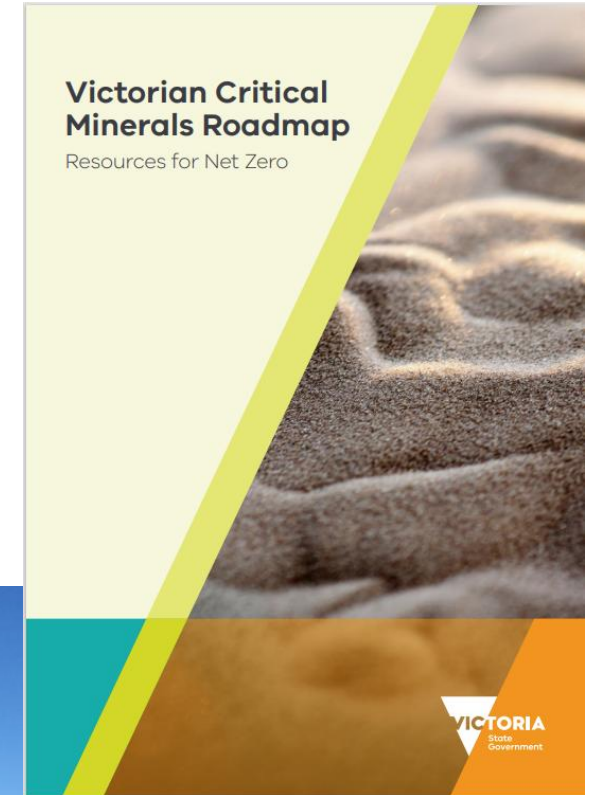
Lake Wahpool, Wamba Wamba



# Project Aims

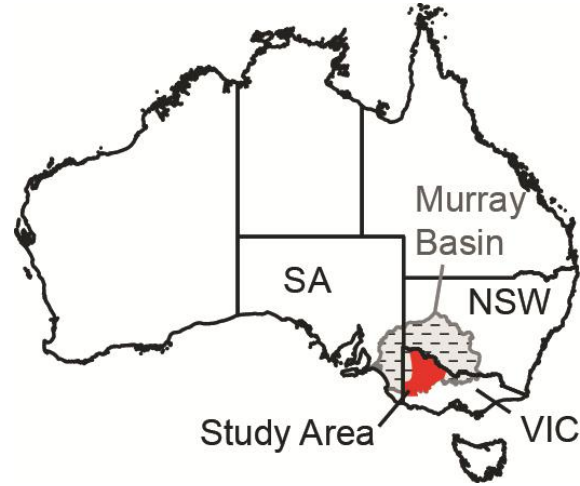
## *Establish an environmental geochemical baseline across northwest Victoria*

- Victorian Critical Minerals Roadmap (2024)
- A **snapshot** of environmental chemistry for future monitoring and evaluation
- Understand how critical minerals & strategic materials occur in the landscape
- Reconnaissance sampling of soil, groundwater, vegetation and lake sediments

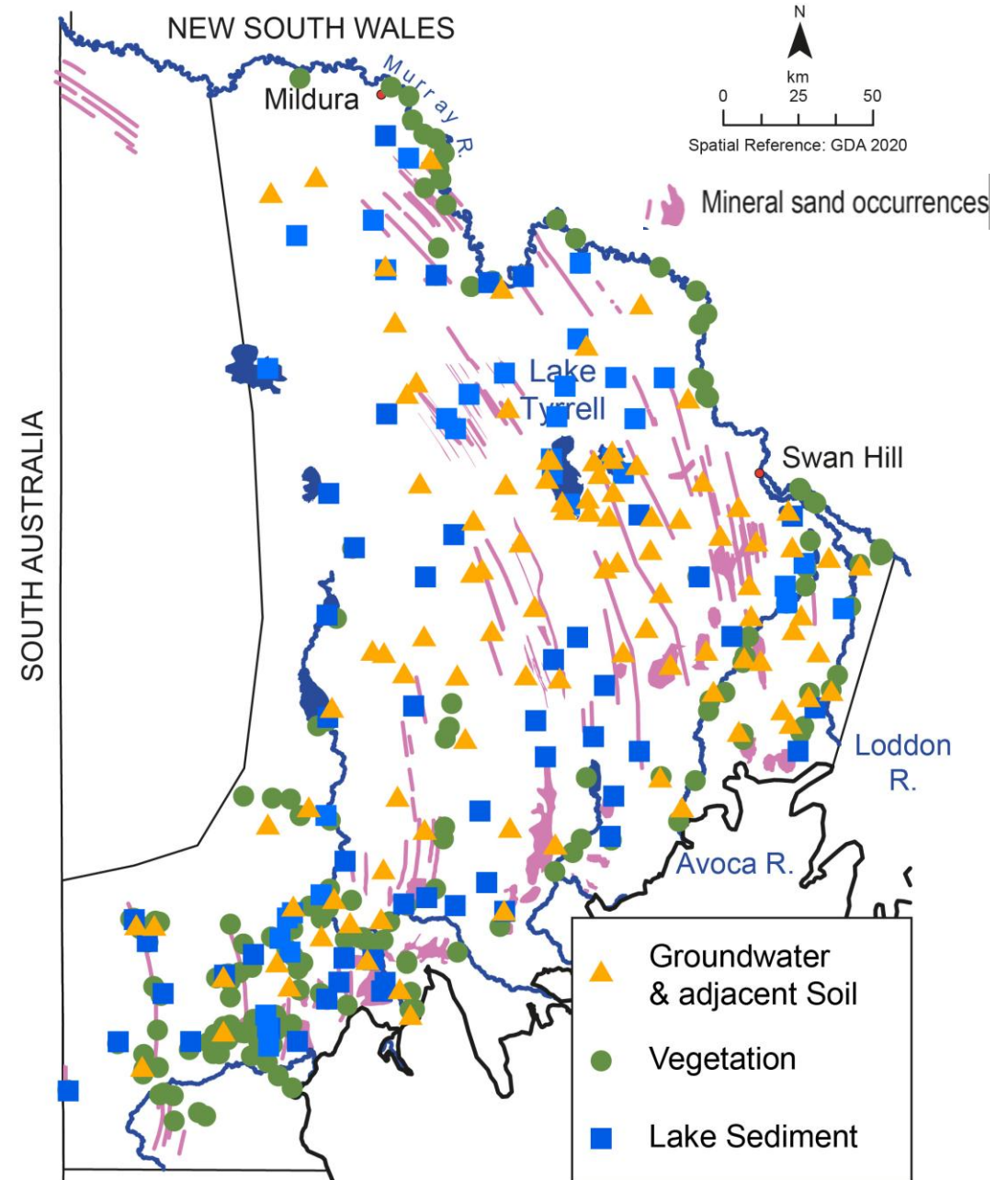


Sampling site, Barengi Gadjin

# Location

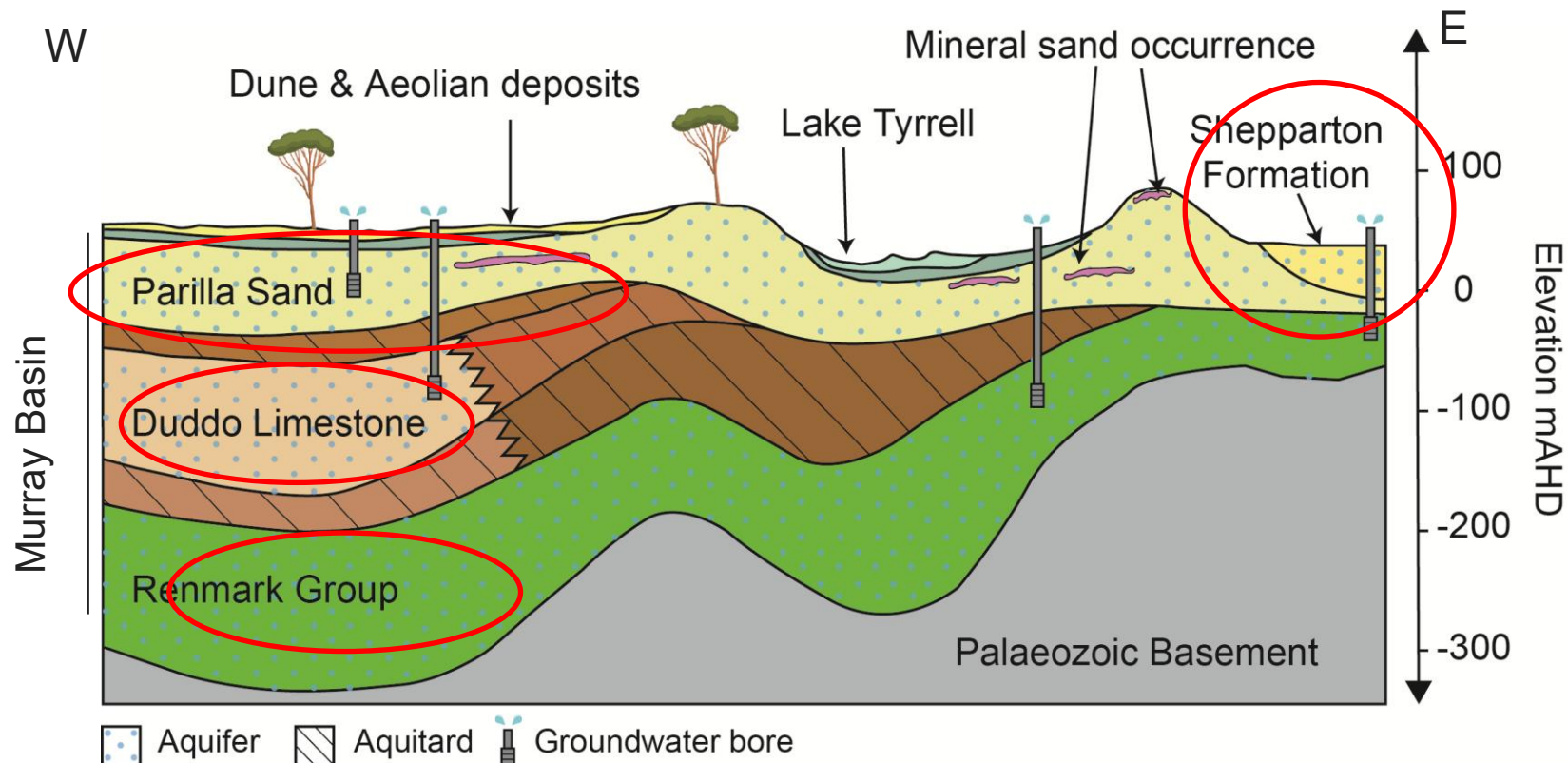
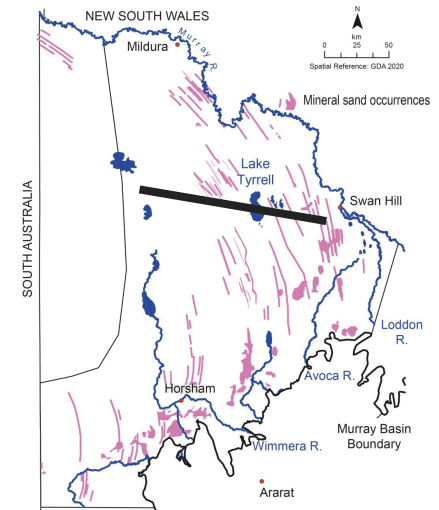


- Study area of 57,000 km<sup>2</sup> = 1/5 of Victoria
- Mineral sand occurrences containing **Ti, Zr and REE**
- 560 samples of **Soil, groundwater, vegetation** and **lake sediment** between 2025-2026



# Geology and hydrogeology

- 4 main aquifers: Shepparton Formation, Parilla Sand, Duddo Limestone, Renmark Group
- Mineral sands within the marine Miocene-Pliocene Parilla Sands
- Groundwater mostly saline > 10,000 mg/L



# Soil



Soil surface, Barengi Gadjin



Topsoil profile, Barengi Gadjin

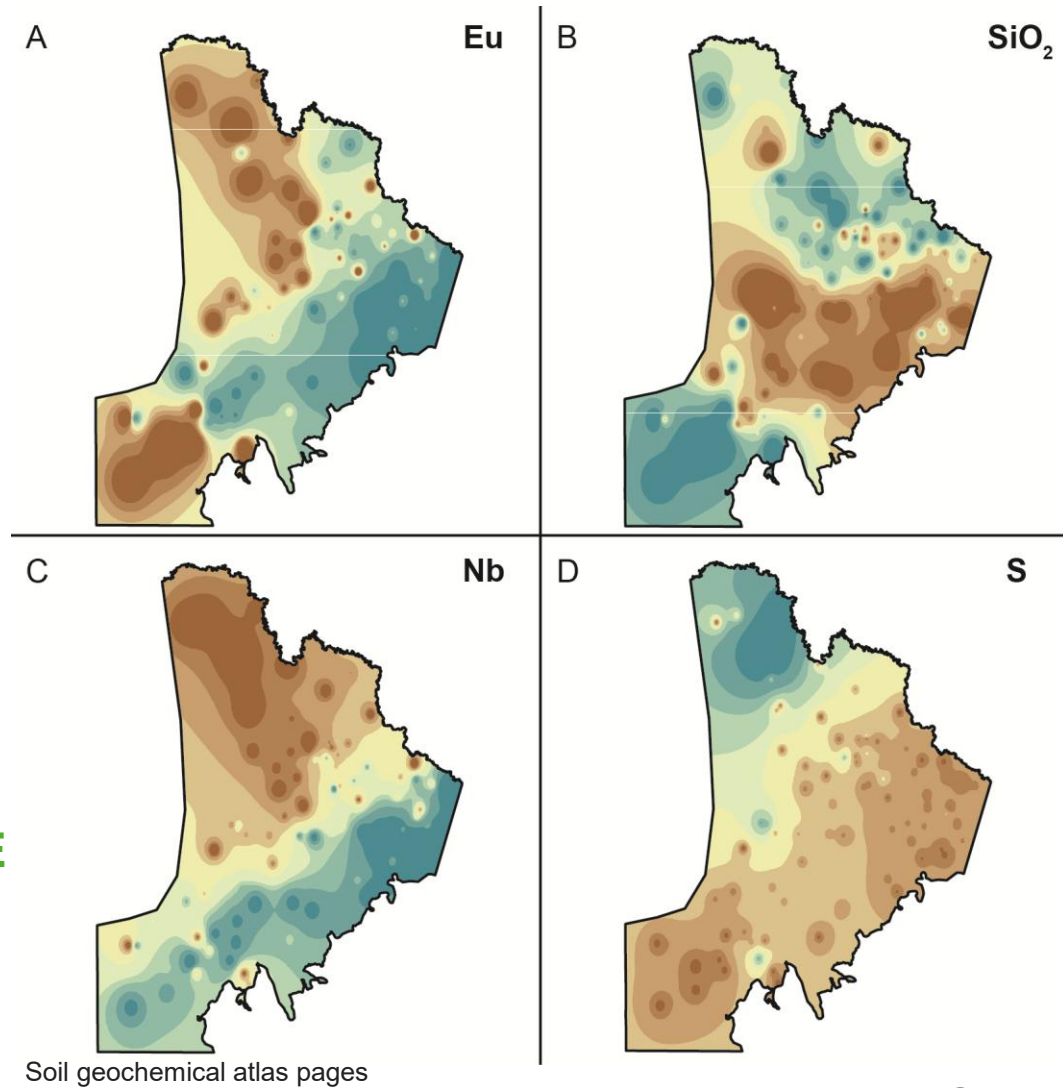
# Methods

- 104 near surface soil samples 10 – 20 cm
- Partial digest and total digest on < 2 mm fraction
- **~14,000 data points**
- 137-page baseline soil geochemical atlas

H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra																	
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

  CRITICAL MINERALS & MATERIALS    
   STRATEGIC MINERALS & MATERIALS    
   NON-CRITICAL MINERALS & MATERIALS    
 Ti ANALYSED ELEMENT (THIS STUDY)

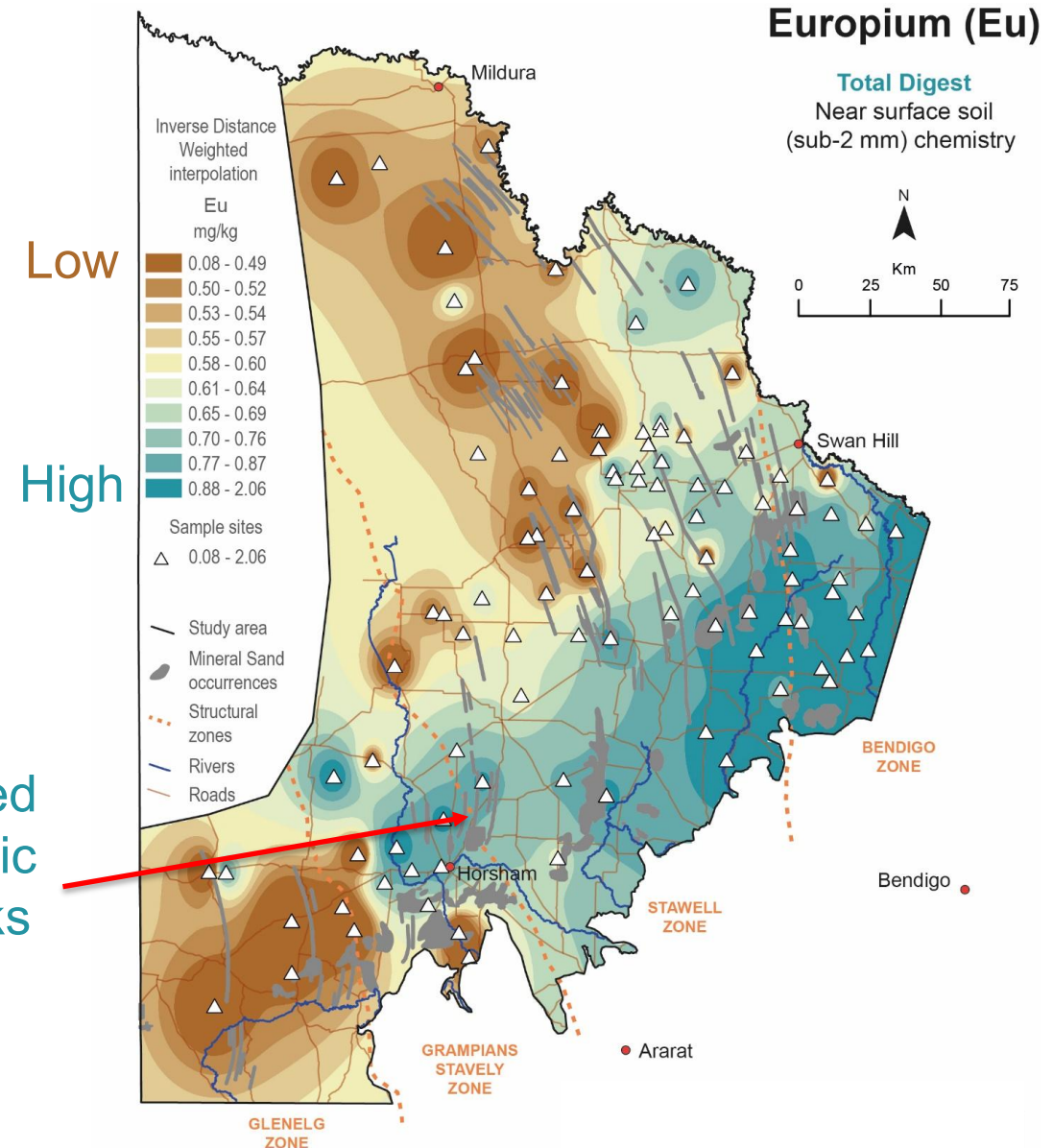
OFFICIAL



# Factors influencing soil geochemistry

- Geological – mineralogy of parent material
- Physiographic – presence of rivers
- Anthropogenic – land-use changes (minor)

Fluvially derived from Palaeozoic basement rocks (e.g. the Grampians)



# Factors influencing soil geochemistry

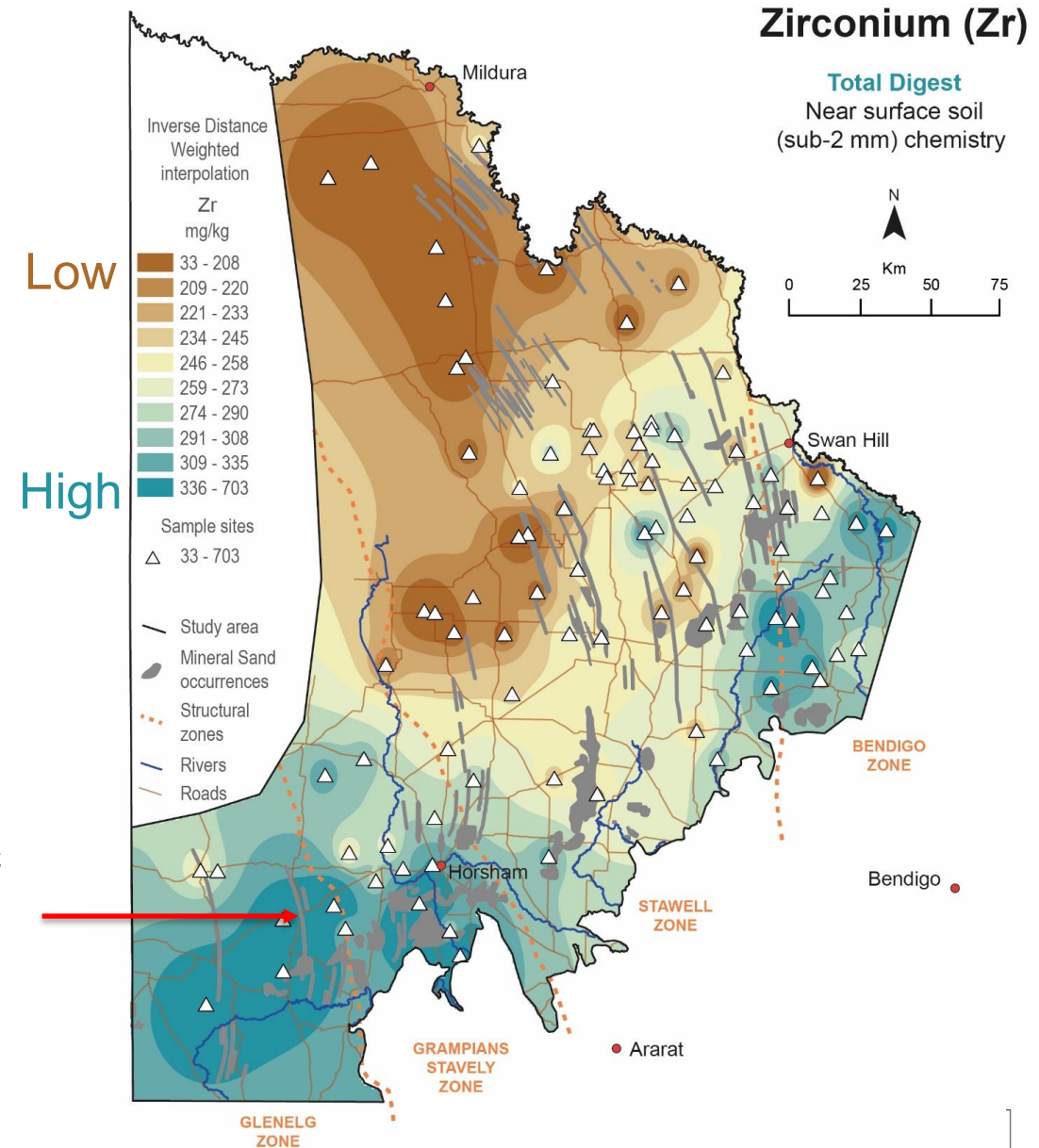
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Mineral sands and local geology not reflected in soil geochemistry

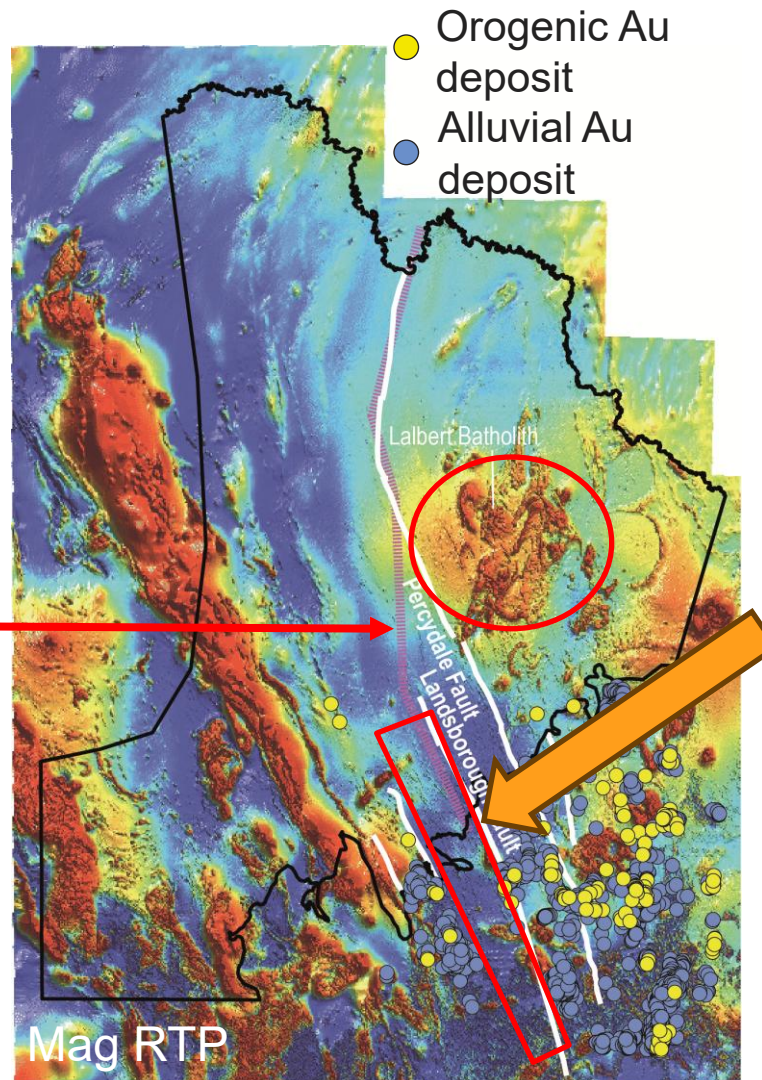
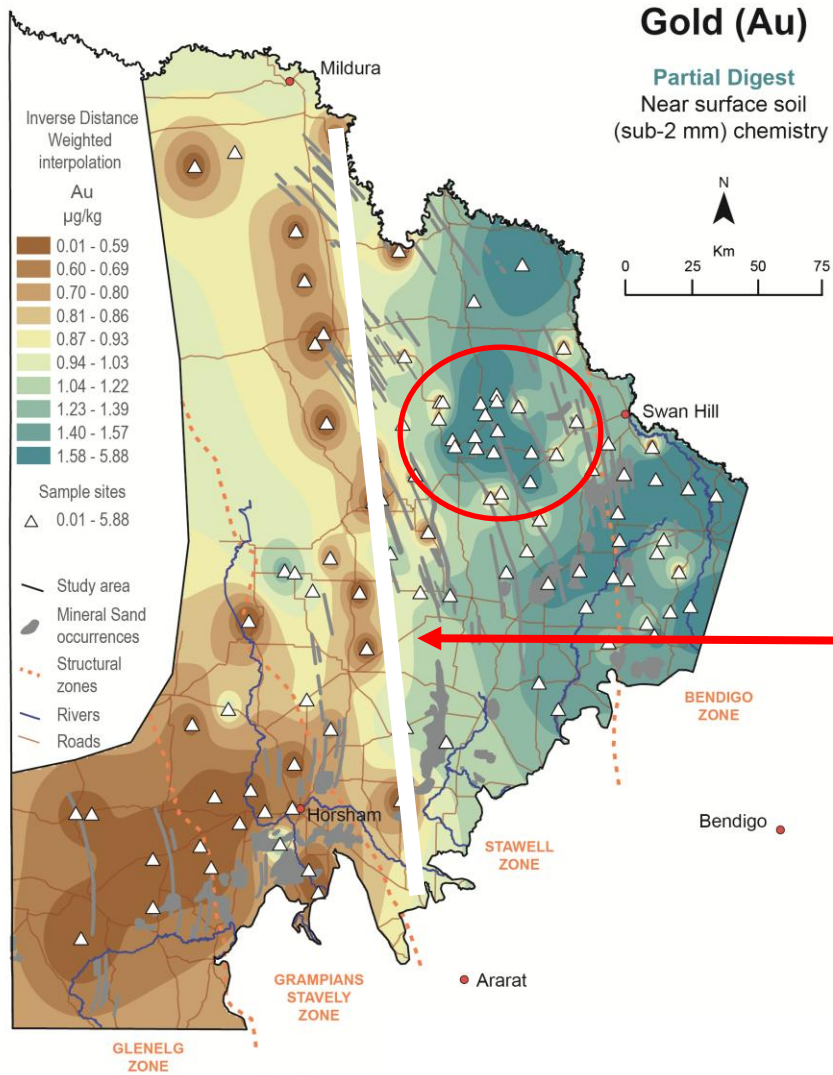


Other sampling or analysis types required for mineral sand exploration

Fluvially derived from Palaeozoic basement rocks (e.g. the Grampians)



# Gold concentrations in soil



- Regional geological features coincident with high vs low gold in soil boundary
- Same boundary observed south between gold bearing & gold barren rocks
- Anomalous concentrations coincident with A type Granite

# Groundwater



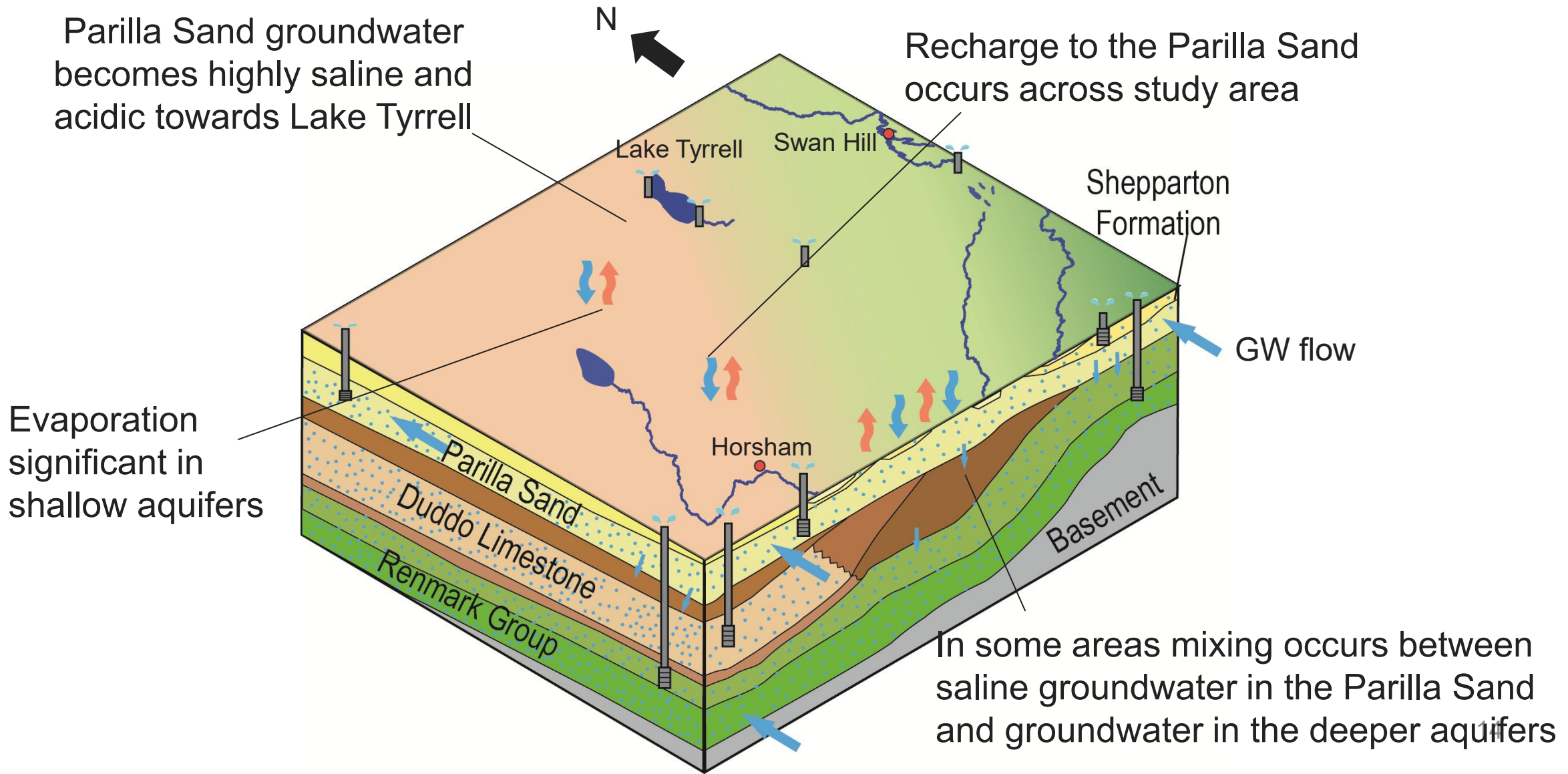
Observation bore, Barengi Gadjin

# Methods

- Groundwater samples from 161 state observation bores
- Bailer sampling to enable rapid regional reconnaissance sampling
- Detailed geochemistry analysis, including:
  - 80 different major, minor and trace elements (including Ti, Zr and REE)
  - Stable isotope ratios
  - Age-dating isotope tracers (tritium and radiocarbon)
  - Natural radioactivity (including uranium, thorium and radium isotopes)

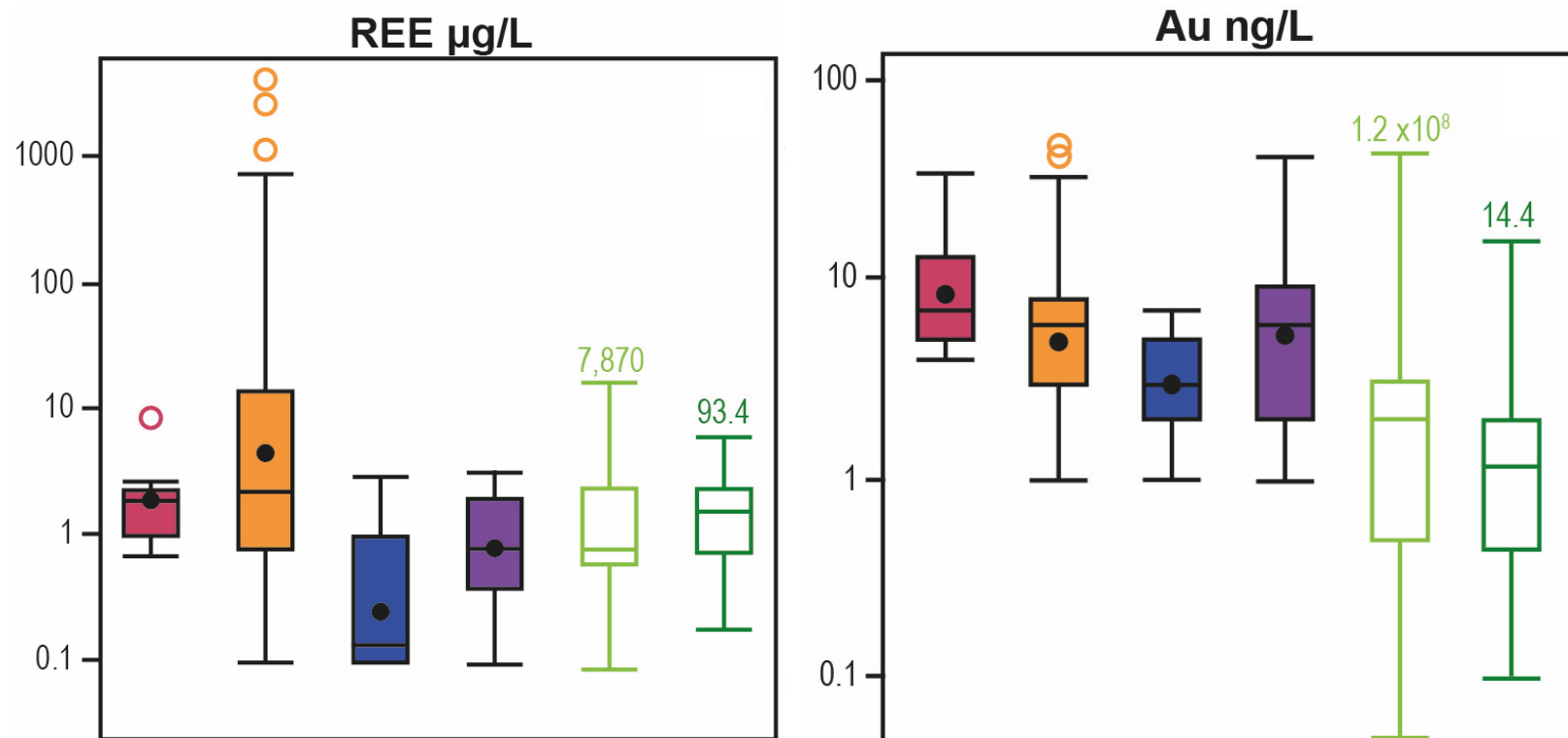


# Hydro-chemical and geological conceptual model



# Elevated metal concentrations in groundwater

- Concentrations of several metals above Australian and Victorian medians
- **REE, Au, Co, Li, Ni, Se among others**
- Ti and Zr mostly below detection



## Legend

- |                   |                         |
|-------------------|-------------------------|
| ■ Shepparton Fm   | ■ Renmark Group         |
| ■ Parilla Sand    | □ Australia-wide values |
| ■ Duddo Limestone | □ Victoria-wide values  |

# Metal concentrations in acidic groundwater

- Concentrations of most metals **highest in acid-saline groundwater in the Parilla Sand**

Groundwater pH decreases

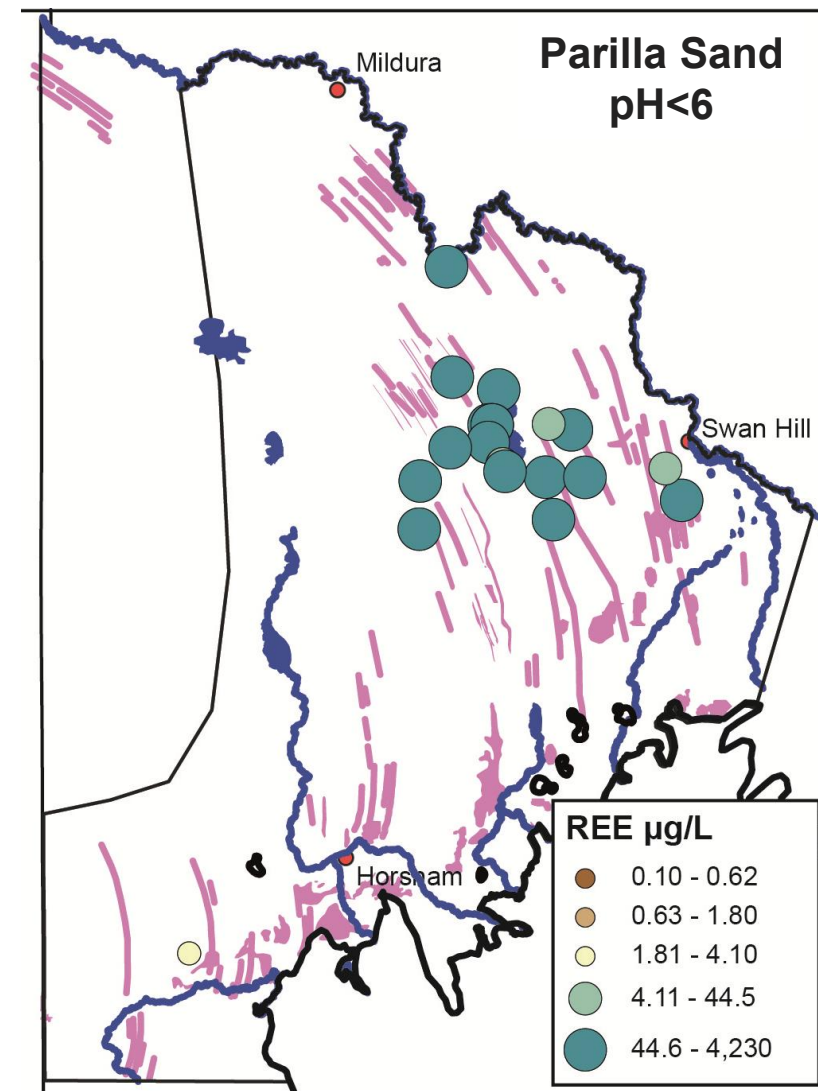
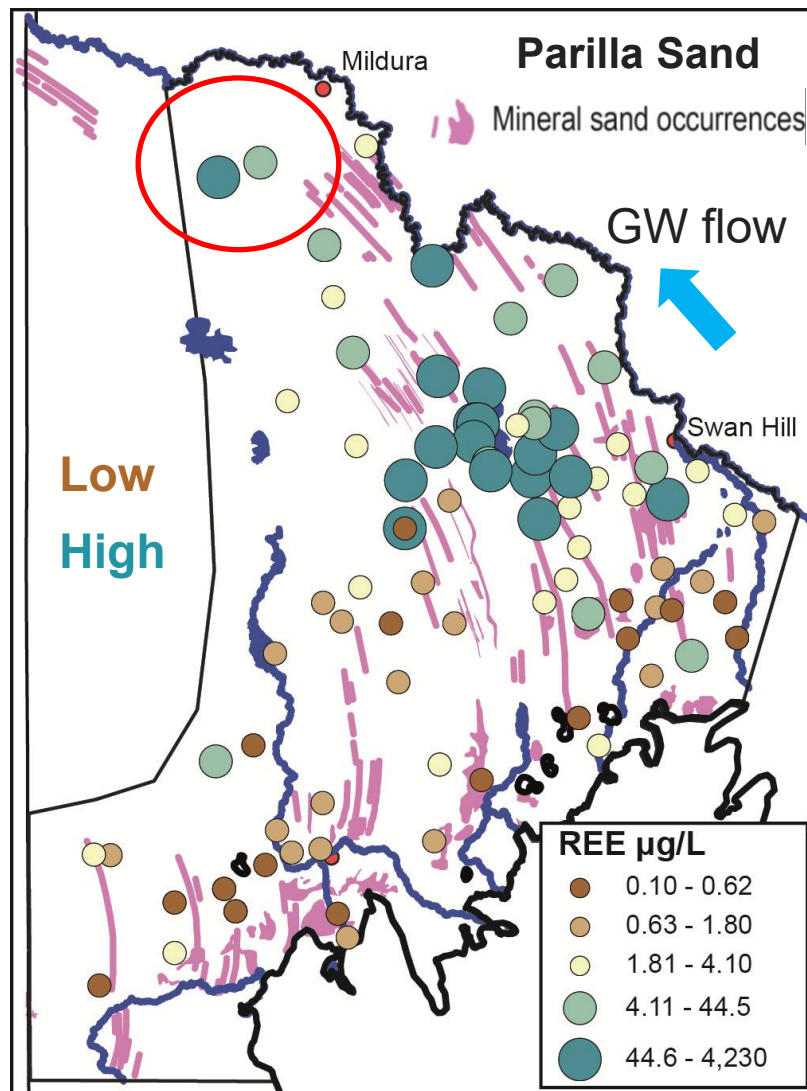


Increased mobility of metals

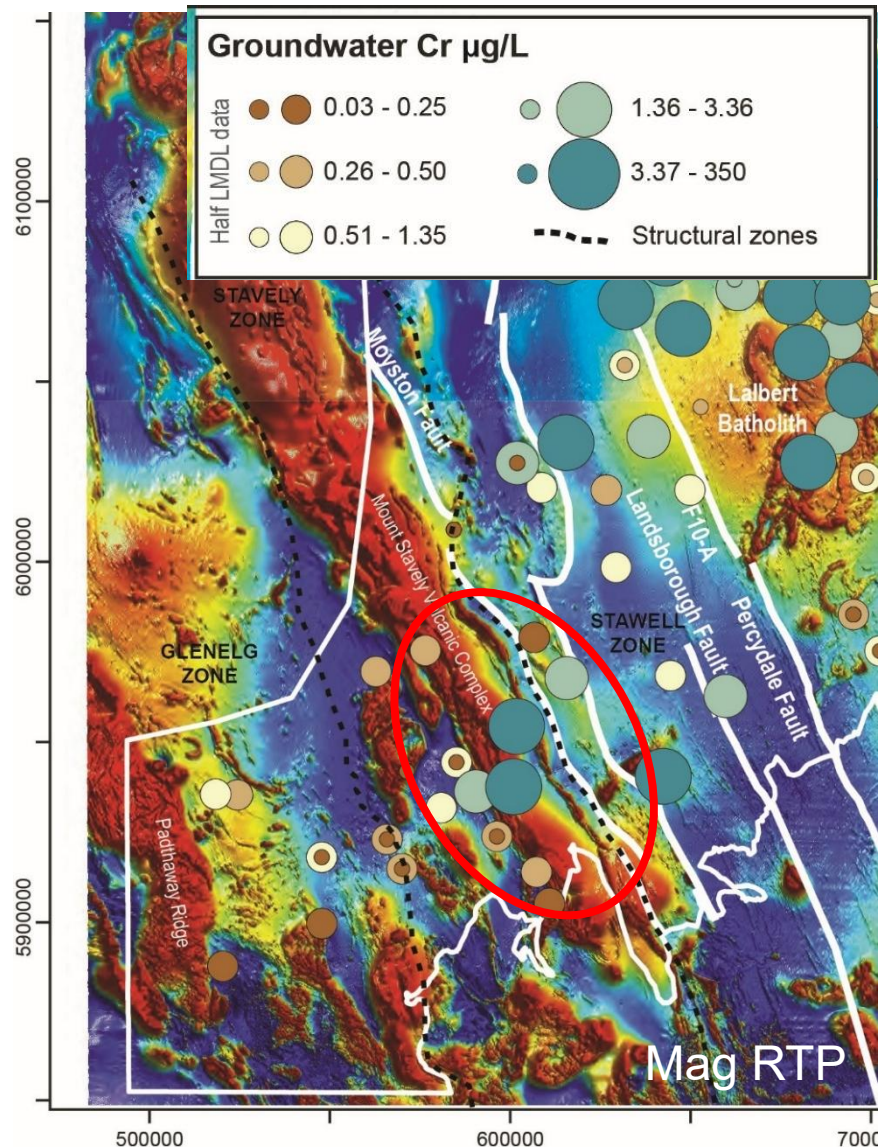


Accumulation in groundwater

- High REE in neutral pH and/or away from mineral sand occurrences warrant further investigation

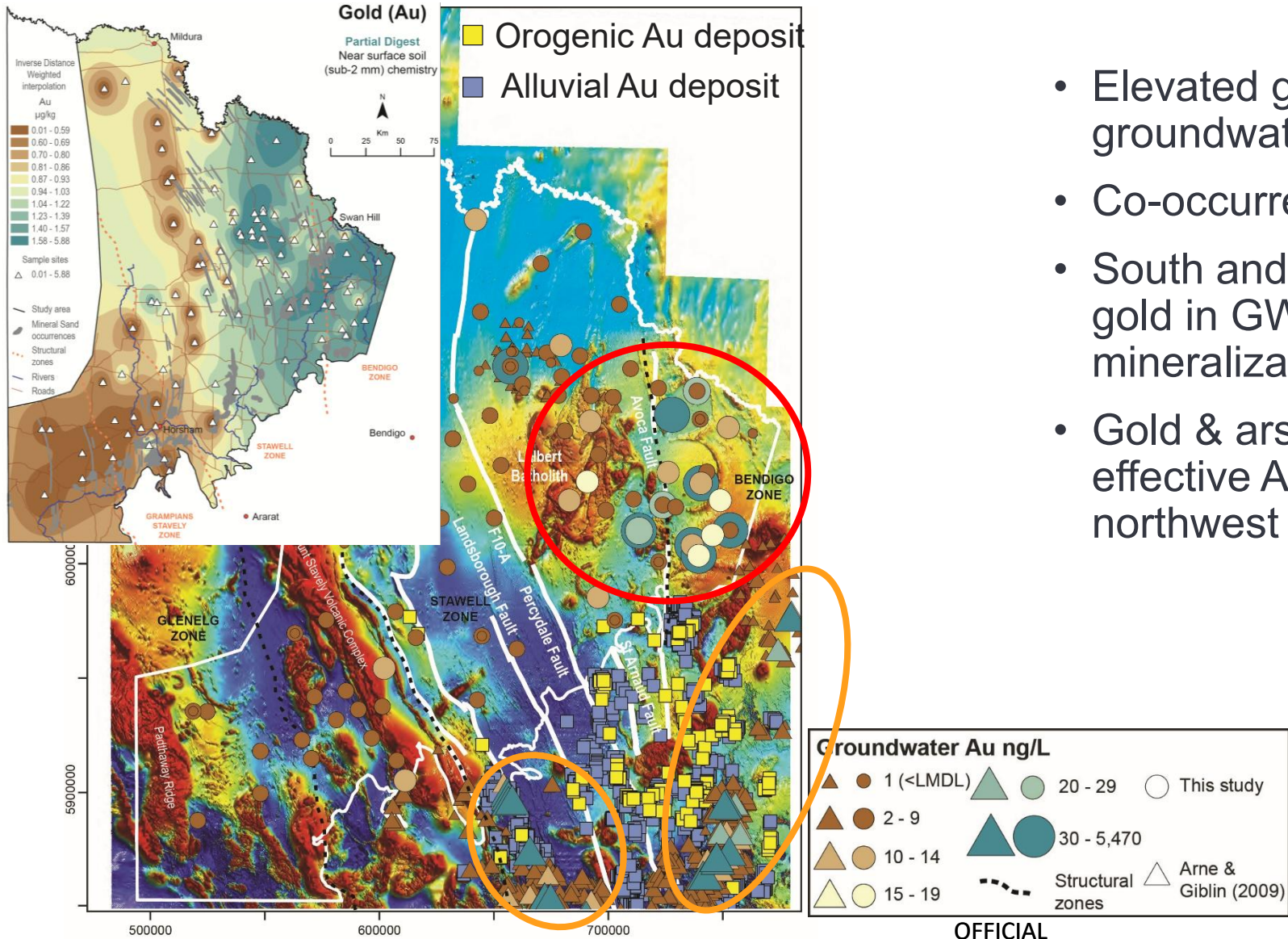


# Groundwater metals and basement geology



- Elevated metals (Cr, Cu, Se, V) in groundwater above the Mount Stawely Volcanic complex
- Potential reflection of mafic, ultramafic and intermediate basement rocks under the Murray Basin
- Elevated pathfinder elements for Cu, Au and massive sulphide mineralisation identified in groundwater south of the study area in Grampians-Stawely Zone (O'Neill et al. 2018)

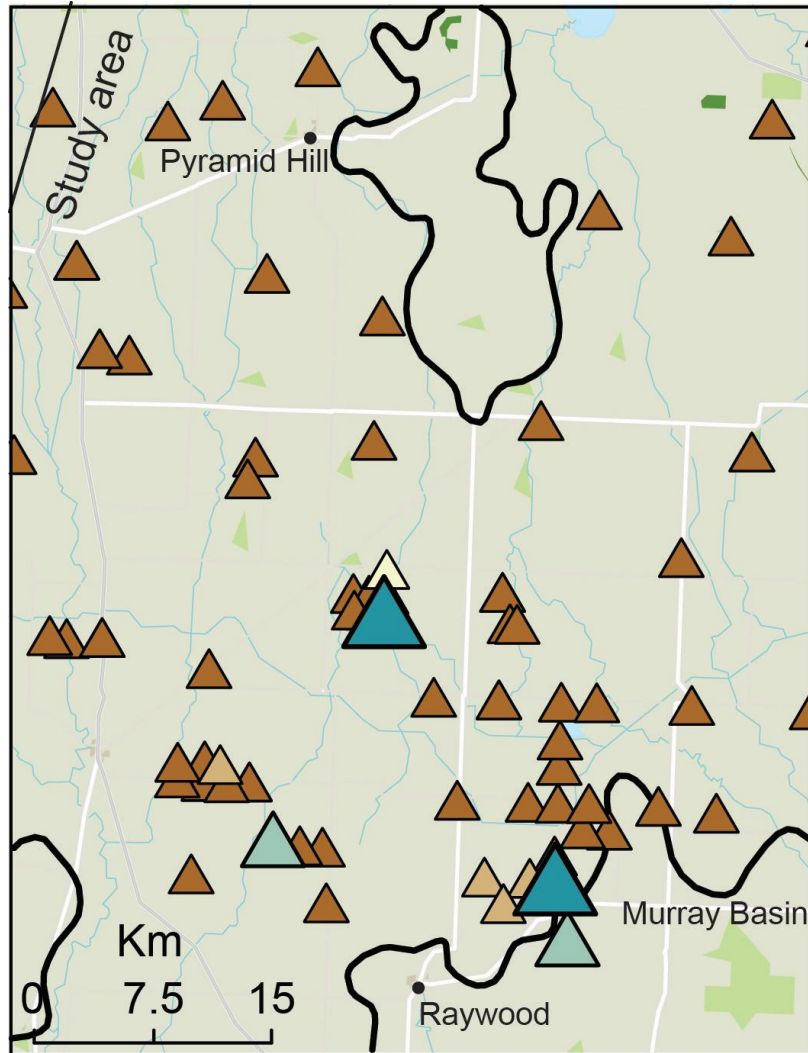
# Gold in groundwater



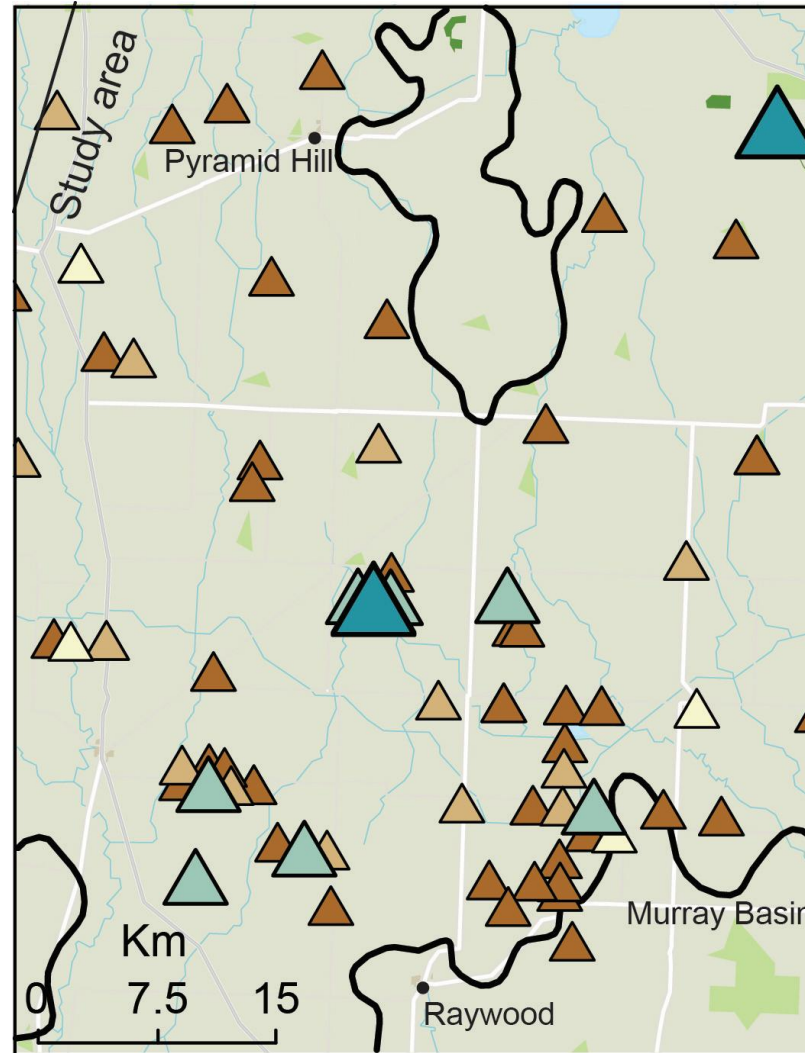
- Elevated gold ( $\pm$  arsenic, mercury) in groundwater in the eastern study area
- Co-occurrence with gold anomalies in soil
- South and east of the study area elevated gold in GW coincident with known gold mineralization
- Gold & arsenic in groundwater may be an effective Au exploration tool in the northwest

# Case study: North central Victoria

Au ng/L



As ug/L

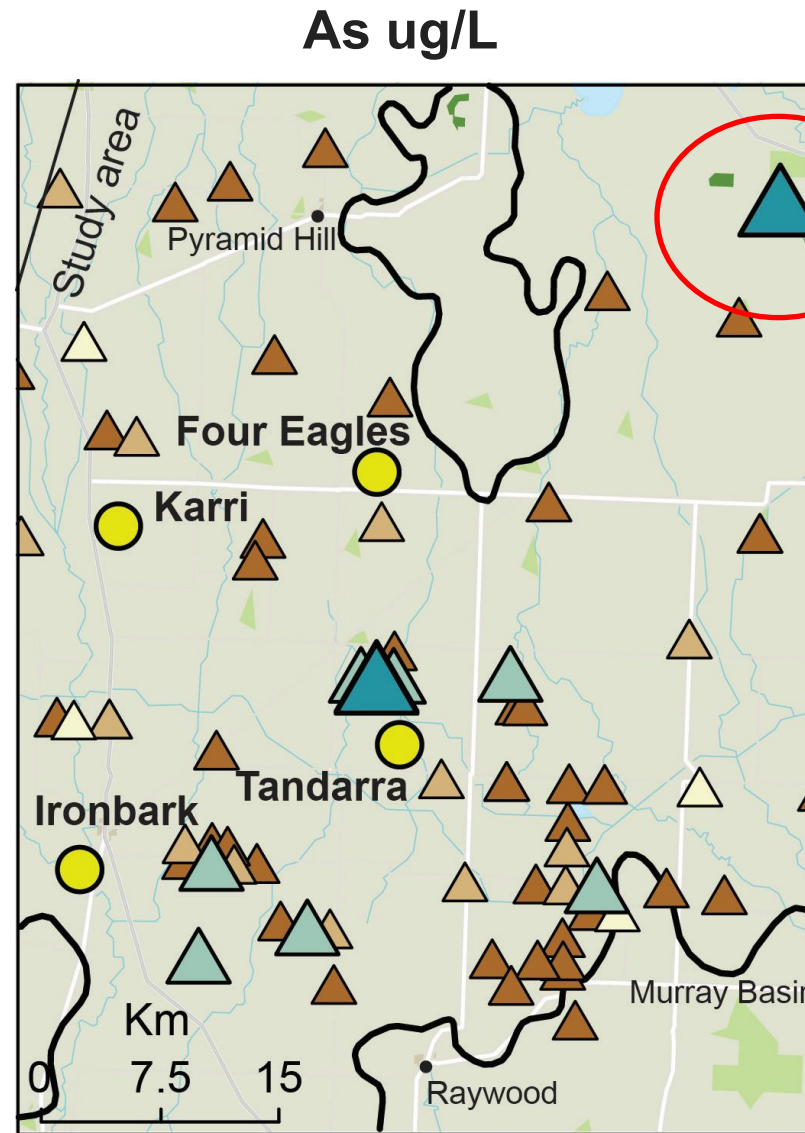


Primarily government bores, Murray Basin cover

Giblin (1993)  
Arne & Giblin (2009)

<https://earthresources.efirst.com.au/product.asp?pID=734&cID=42>

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Primarily government bores, Murray Basin cover

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## Summary

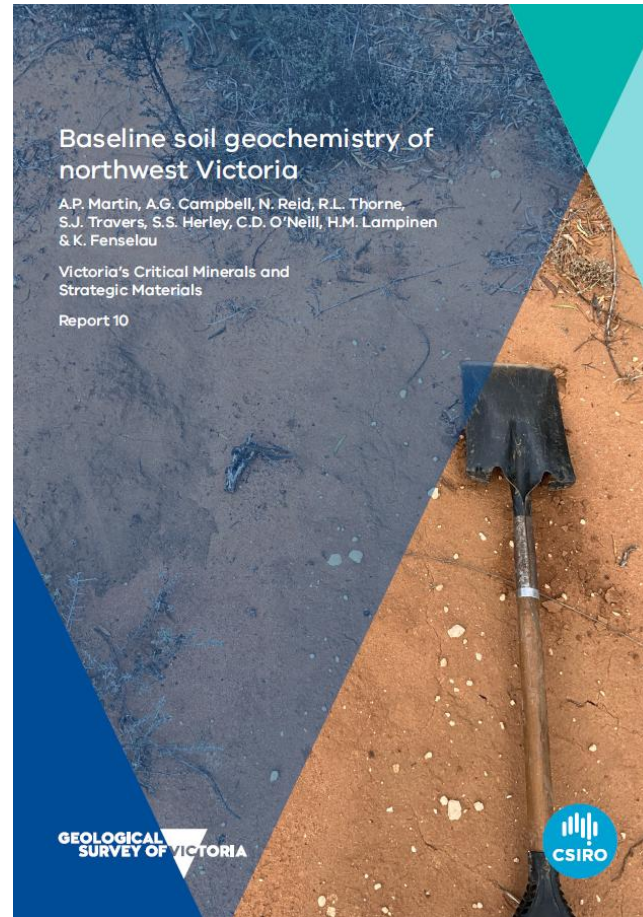
- A baseline of environmental geochemistry in an area of critical minerals potential
- Near-surface soil chemistry is primarily influenced by the geology of its parent material
- Metal concentrations (inc. REE) in groundwater can be significant and are often driven by acidic pH
- Anomalous gold and arsenic concentrations were measured in groundwater and soil in eastern parts of the study area
- Arsenic and gold in groundwater (+ soil) can be an effective exploration tool



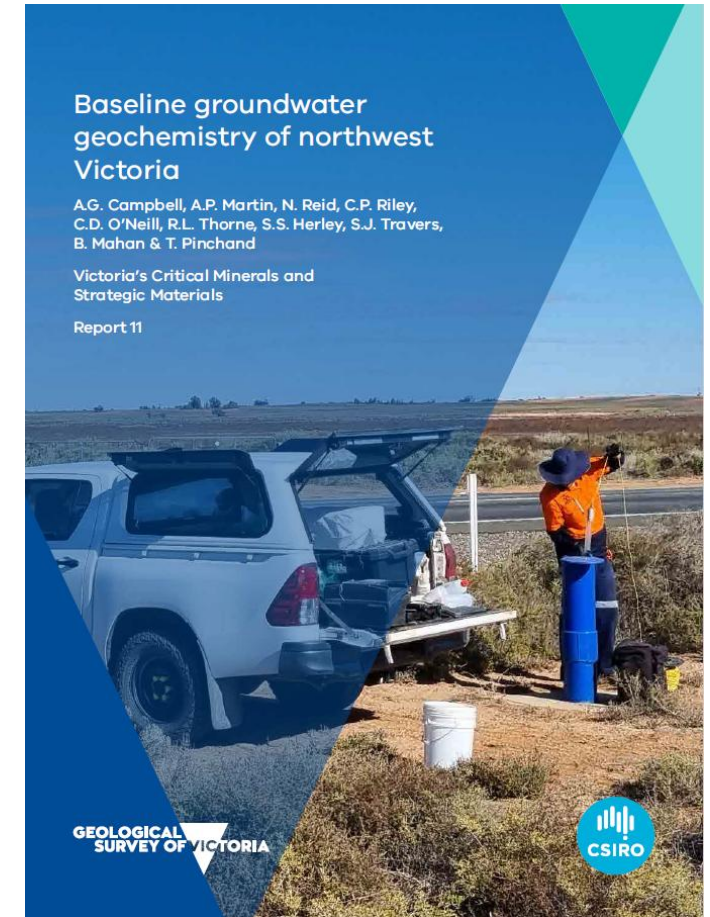
Observation bore, First People of the Millewa-Mallee

# Summary

- Reports and data freely available
- Vegetation and lake sediment geochemistry datasets on the horizon
- Application of dataset across multiple industries
- Scope for survey expansion into other areas of critical mineral/strategic material potential



<https://earthresources.efirst.com.au/product.asp?pID=1362&cID=70>



<https://earthresources.efirst.com.au/product.asp?pID=1363&cID=70>

# Thank you



Lake Crosbie, First People of the Millewa-Mallee