Australian Government
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Correlations between spectral mineralogy and borehole rock properties in the Eromanga Basin

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NSW GOVERNMENT

Queensland Government

Introduction

- The Southern Thomson Project
- Stratigraphic drilling & logging program
- Rock properties 101
- HyLogger data correlations and interpreted causations

The Southern Thomson Project

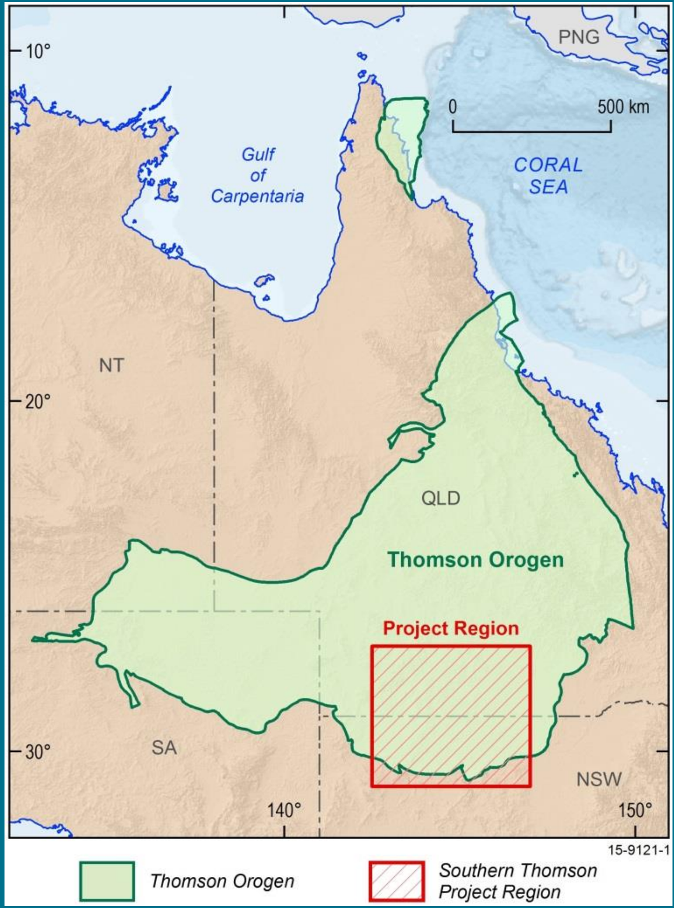
A collaborative project between:

- Geoscience Australia
- Geological Survey of New South Wales
- Geological Survey of Queensland

Improve minerals systems and basement geology understanding by pre-competitive data acquisition and regional stratigraphic drilling

Encourage mineral exploration by reducing exploration risk

Develop an Explorer's Toolbox of techniques for cover thickness mapping and exploration through cover



The Thomson Orogen

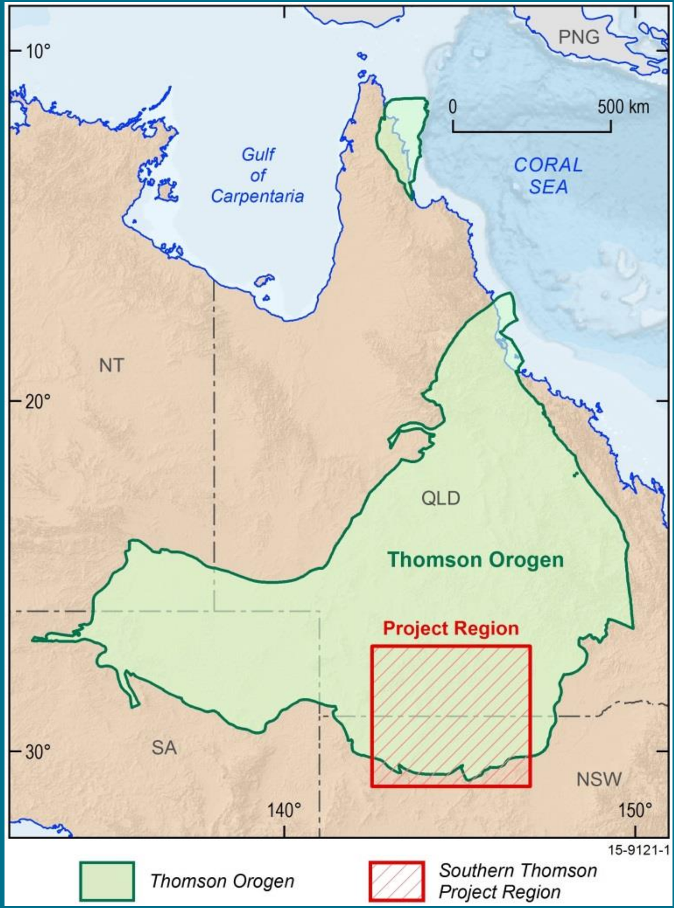
An inferred Paleozoic orogen

~1,150,000 km^2

Outcropping geology

~15,500 km^2

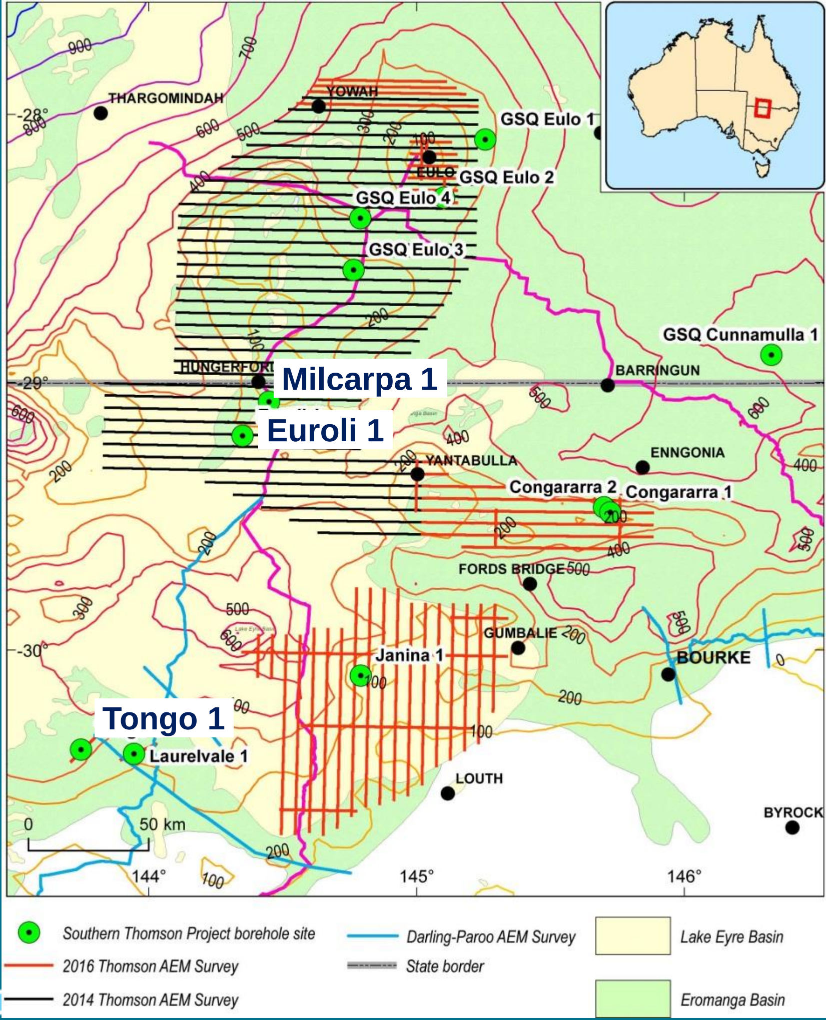
~1.4% outcrop, mostly in the NE



Regional exploration problems

Much of the project area lies underneath cover of the Eromanga and Lake Eyre basins:

- Variable-thickness cover
- Variable-resolution cover thickness mapping
- Electrically conductive, but not overly magnetic, cover
- Some difficulty in discriminating magnetic anomalies in the cover from those in the Paleozoic basement



Stratigraphic drilling and logging

12 boreholes were drilled between 2016 & 2017

Comprehensive natural gamma, electrical conductivity, and magnetic susceptibility logging program for each borehole

Magnetic susceptibility on chips and core

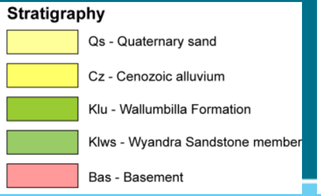
Stratigraphic drilling and logging

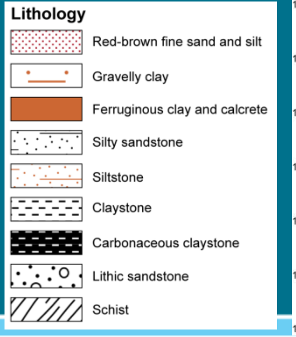
Lithological chip and core logging in the field

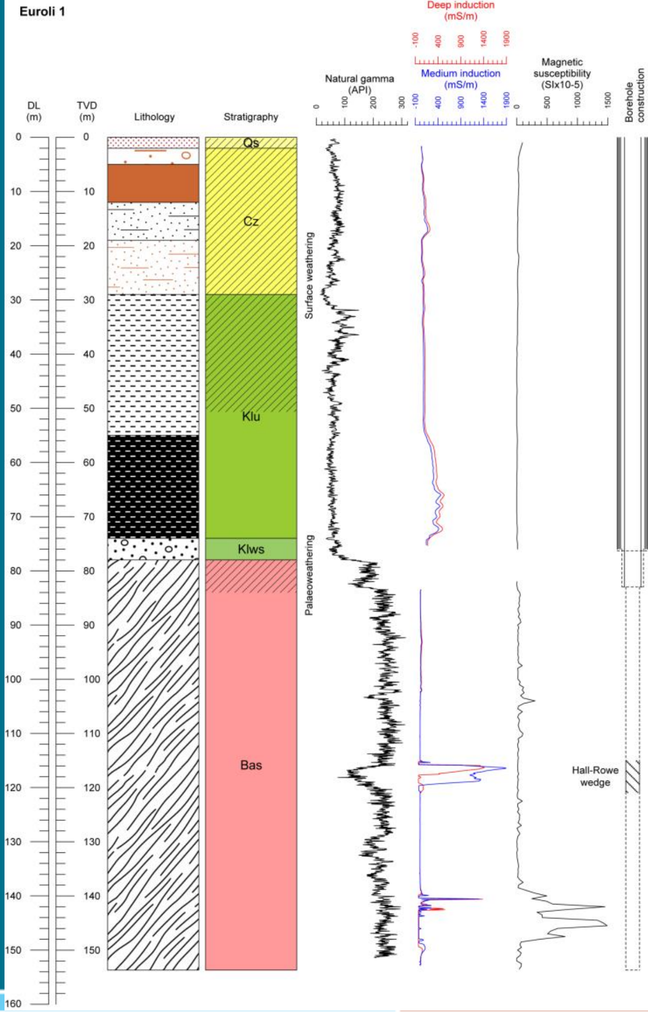
Stratigraphic units interpreted based on surrounding boreholes, surface geological mapping and previous experience

Wireline & hand-held rock properties data were used to verify stratigraphic unit interpretations and prior geophysical interpretations of:

- Potential field (aeromagnetics, gravity)
- Airborne electromagnetic data







AEM data validation

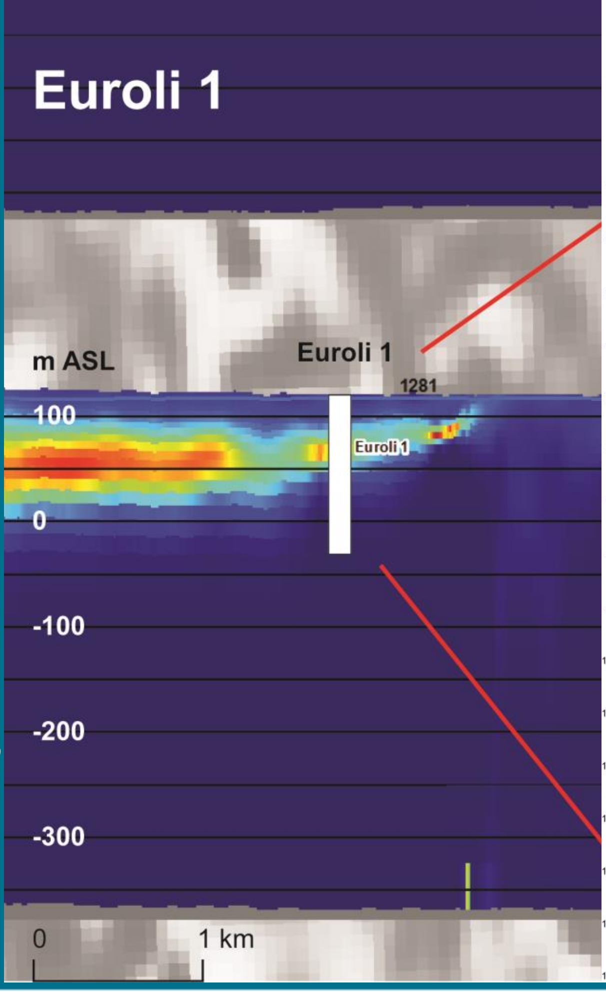
Euroli 1 borehole

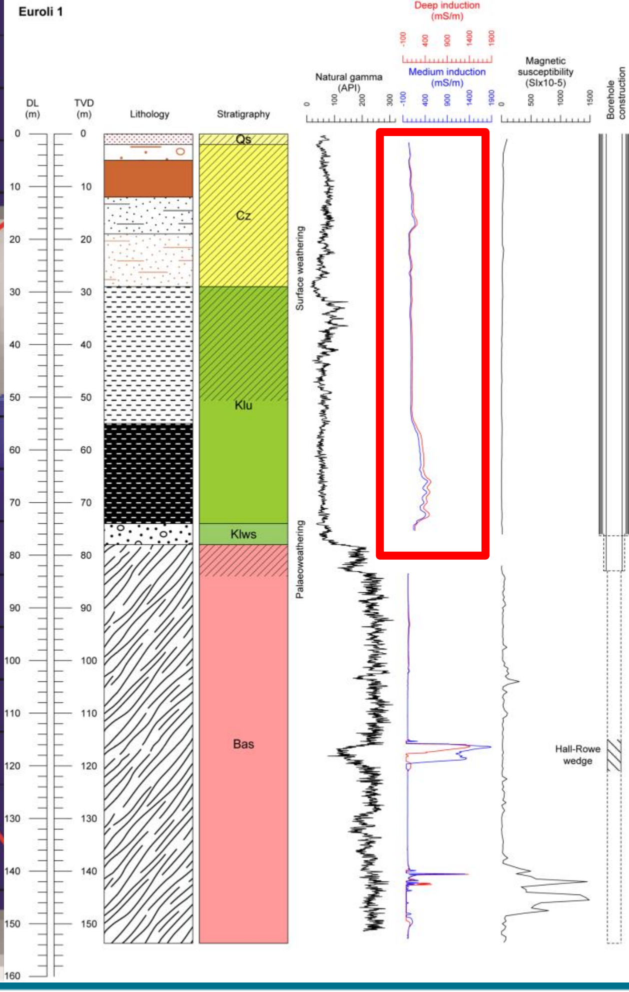
- ~500 m S of flight line

Variably conductive cover

Cover conductivity appears to be strongly affected by surface weathering

What is it about the regolith and fresh rocks that controls the rock properties?





Rock properties 101

Natural gamma response:

- Controlled by the abundance of radioactive K, Th and U (and daughter products) in minerals or as adsorbed ions,

Bulk electrical conductivity response

- Controlled by mineralogy (e.g. quartz, clay CEC, sulphides), groundwater EC, porosity, permeability, tortuosity and saturation

Magnetic susceptibility response

- Controlled by the abundance of magnetisable minerals such as magnetite & pyrrhotite, (maghemite), ((ilmenite, hematite))

Each response is strongly affected by weathering

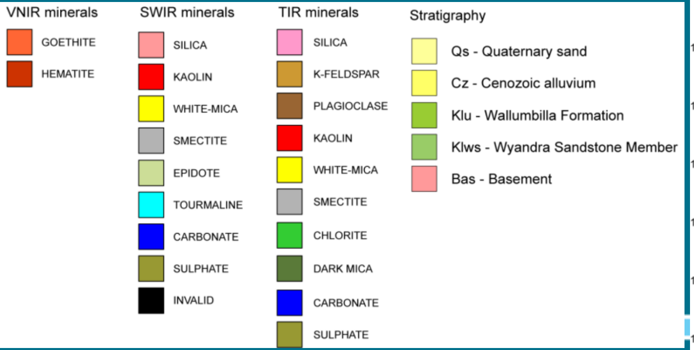
HyLogger data

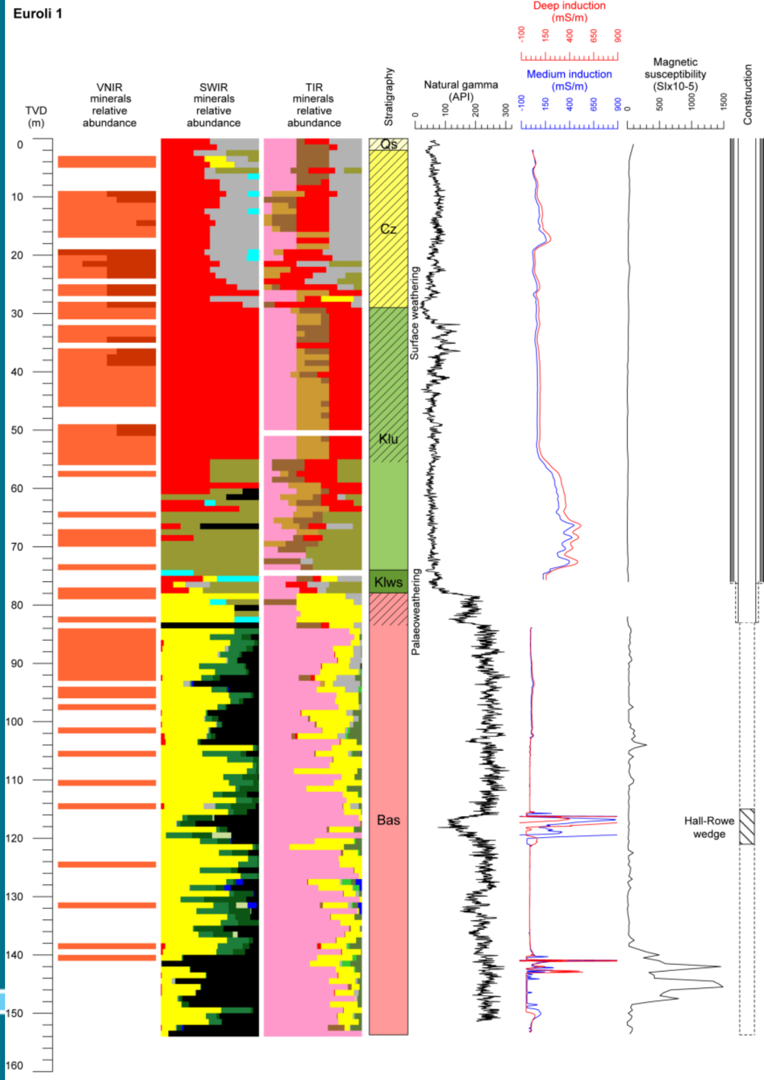
Mud rotary chips and diamond core were scanned in GSNSW and GSQ core repositories in Sydney and Brisbane

Mineral spectra summary data were compared to litho-strat and borehole wireline logging

Correlations between lithological packages, rock properties and AEM interpretations are eminently interpretable

Also a good validation of field chip logging





Euroli 1

Modern regolith:

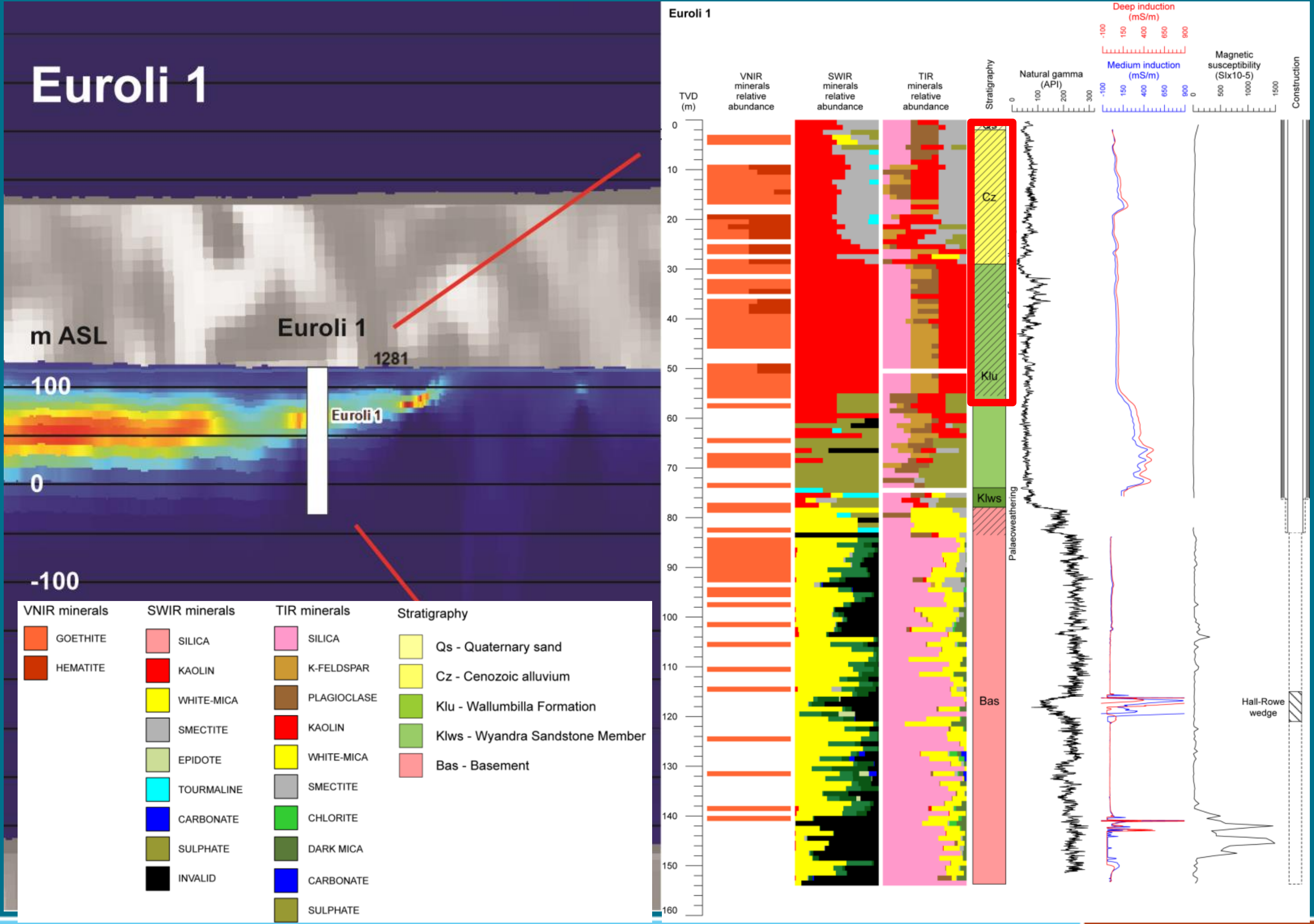
- Smectite-kaolinite-silica correlated with low EC
- Plagioclase correlated with variable natural gamma
- Low/no magnetic susceptibility

Fresh cover:

- “sulphate”, no smectite, correlated with high EC

Palaeoregolith:

- Increasing gamma
- Low EC



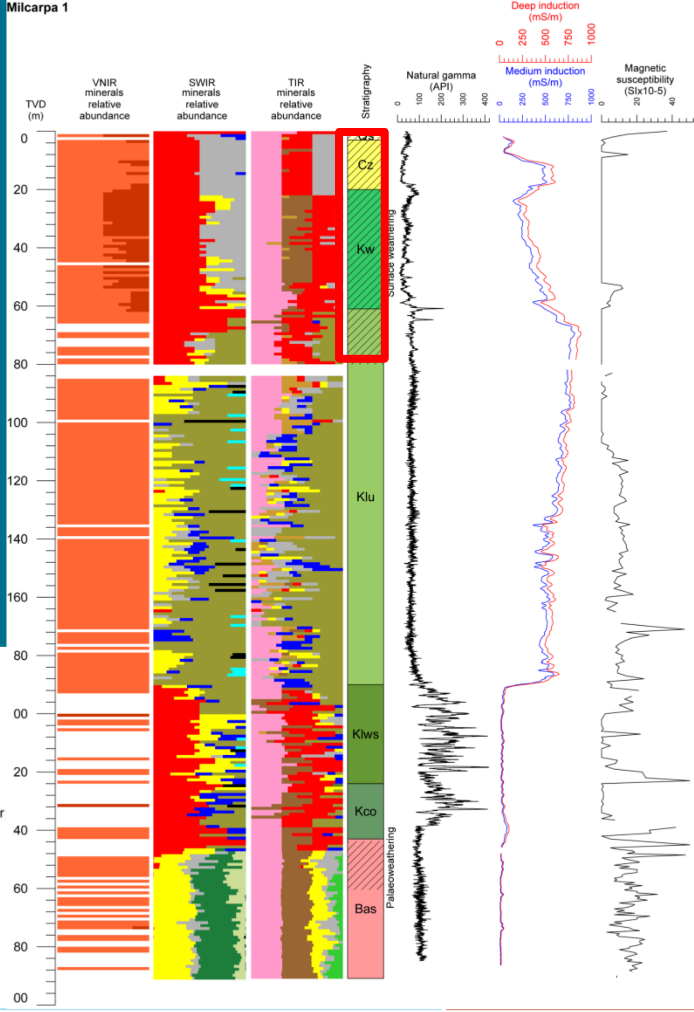
Milcarpa 1

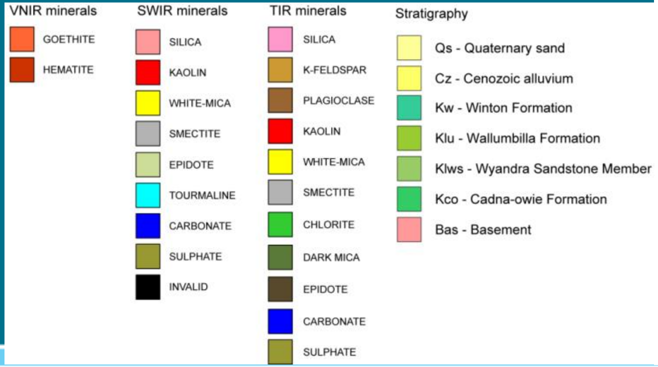
Modern regolith:

- Low but variable natural gamma (clay:quartz ratio)
- Increasing EC with a bump in the Cz (brackish groundwater)
- Generally low magsus
- Gamma spike, EC low, magsus high at base of Winton Fm (quartz & heavy mineral gravel?)

Fresh cover:

- Wallumbilla Formation – low gamma, high EC, low but variable magsus
- Wyandra & Cadna-owie - high gamma, low EC, variable magsus





Differences?

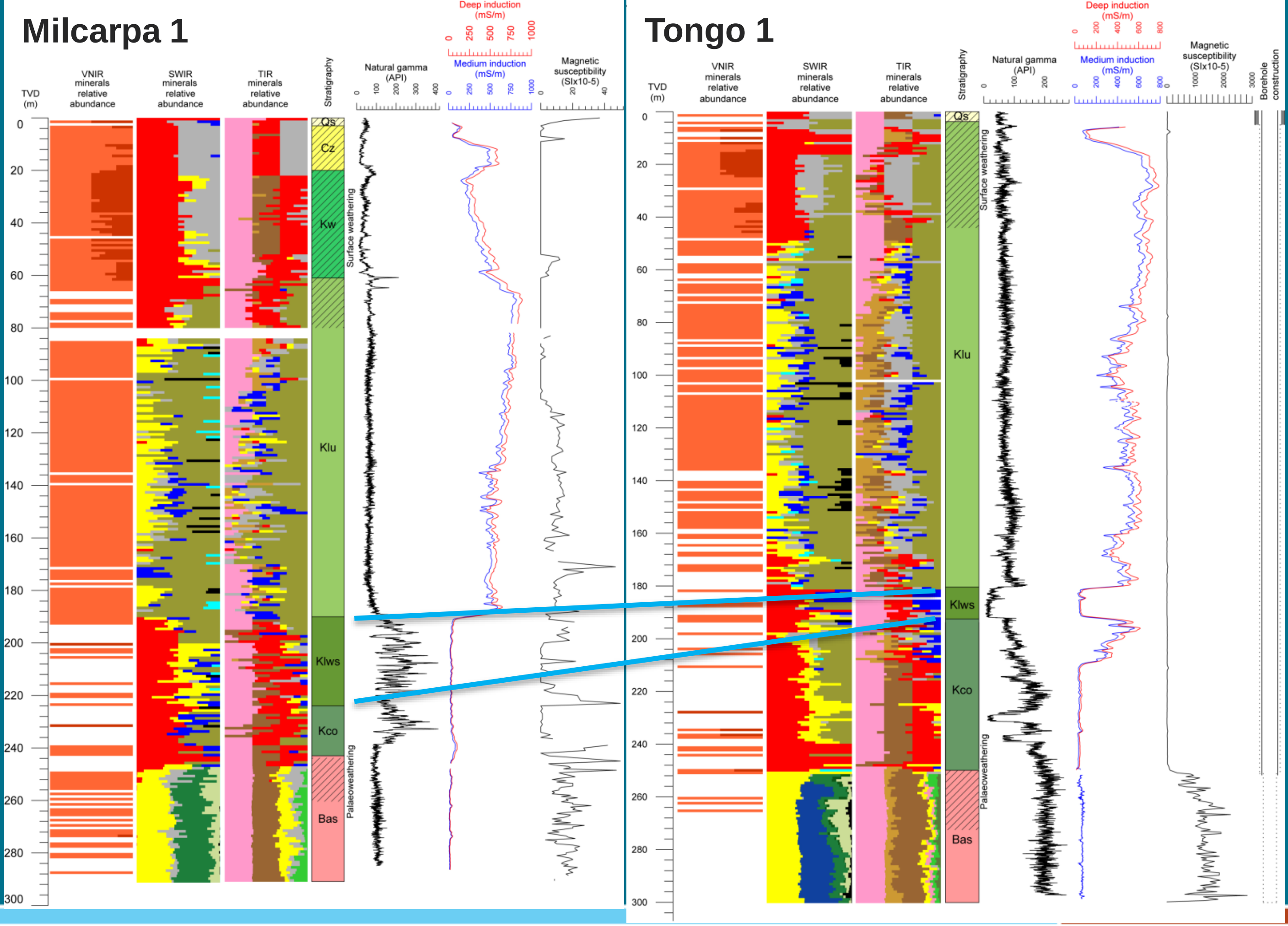
Q: Why should the rock properties of the Wyandra Sandstone Member be so different between boreholes?

Milcarpa 1: muscovite, kaolinite, silica, “carbonate”, plagioclase

= Labile (granite lithic-rich) sandstone

Tongo 1: kaolinite, silica, sulphate, “carbonate”

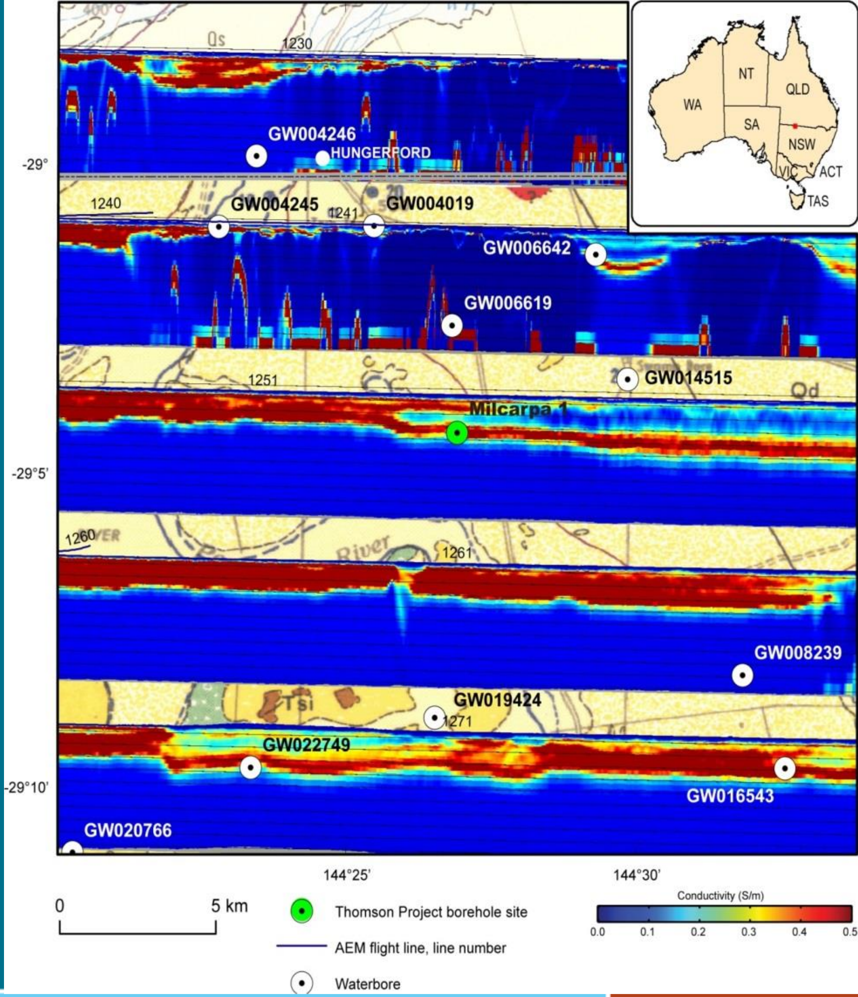
= Clean, quartz-rich sandstone



Discussion

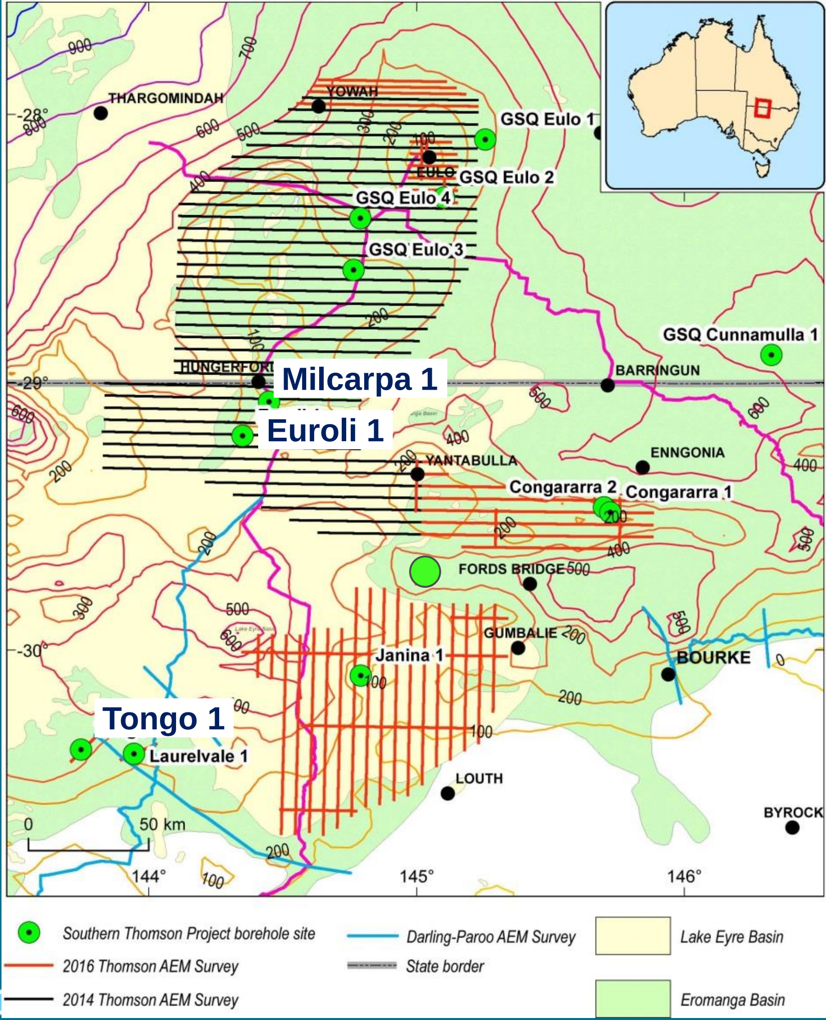
Why should the same stratigraphic unit be so different between boreholes?

- The boreholes were selected to sample regional background geological units or igneous intrusions
- Cover thickness was considered during site selection to stretch the budget
- The boreholes sampled the same stratigraphic units, but in different parts of the palaeotopography:
    - In the deeper Eromanga Basin
    - On the flanks or tops of basement rises
    - Milcarpa 1 and Tongo 1 ~155 km apart



Conclusions

- Basement rock type and degree of palaeoweathering affected the mineralogy of the sediment supply, as shown by HyLogger, therefore the petrophysical attributes of stratigraphic units
- The sediment supply to the same stratigraphic unit is different between boreholes:
    - Milcarpa 1: nearby granite basement high
    - Tongo 1: 300 m of cover, no nearby basement high
- Interpretations are confirmed by spectral mineralogy



Conclusions

Spectral mineralogy data are immensely useful for learning more about modern and ancient regolith processes in the southern Thomson Orogen by:

- Validating field chip and drill core logging
- Validating stratigraphic unit boundaries
- Providing an independent data source to interpret borehole rock properties logs
- Helping interpret palaeoenvironment and landscape evolution

Acknowledgement:

- David Tilley at GSNSW core repository, Londonderry, for HyLogger help

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Thank you

AEM data are described in GA record 2015/29 and TBA

Borehole completion records GA 2017/07-QGR 2017/03 and GA 2017/08-QGR 2017/04

Final borehole completion records will be released in May 2018 at Exploration In The House, Sydney

Final Southern Thomson Project presentations will be at AGCC 2018, October 2018

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