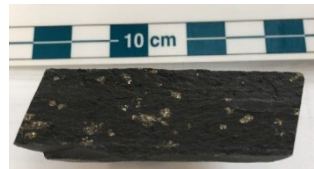
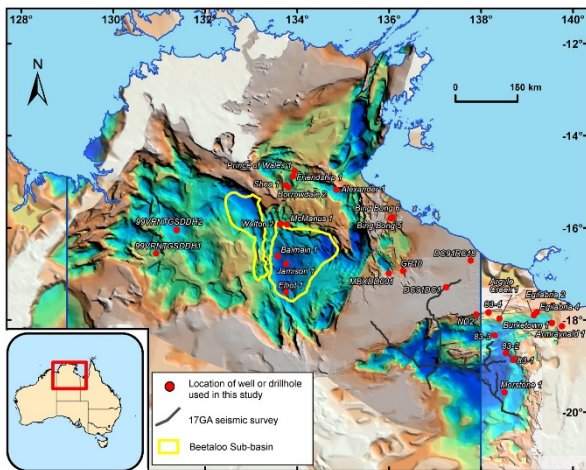




Source rock geochemistry and petroleum systems of the greater McArthur Basin and links to other northern Australian Proterozoic basins

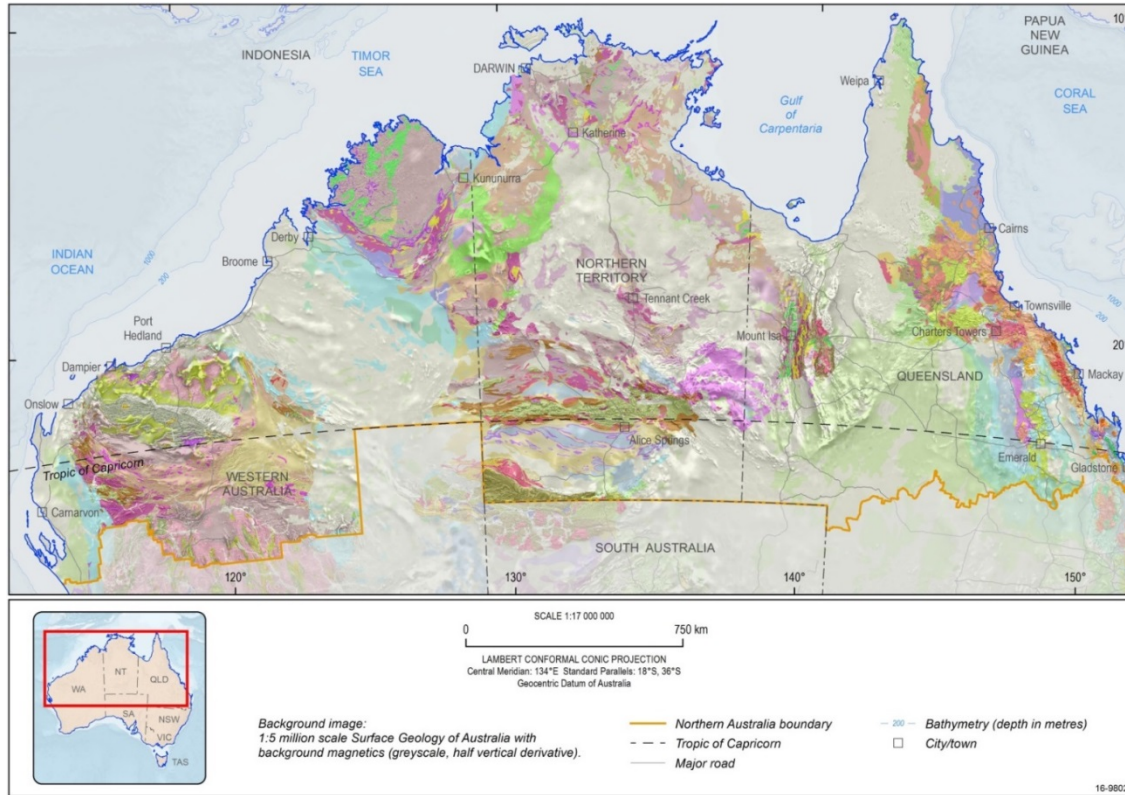


Susannah MacFarlane, Amber Jarrett, Tehani Palu, Chris Boreham, Lisa Hall, Dianne Edwards, Lidena Carr and Paul Henson (Geoscience Australia)
Grant Cox (Adelaide University), Jochen Brocks (ANU), and Tim Munson (NTGS)

Presentation outline

- Introduction
- Petroleum supersystems of Proterozoic northern Australia
- Source rock geochemistry
- Petroleum systems analysis
- Where to next?

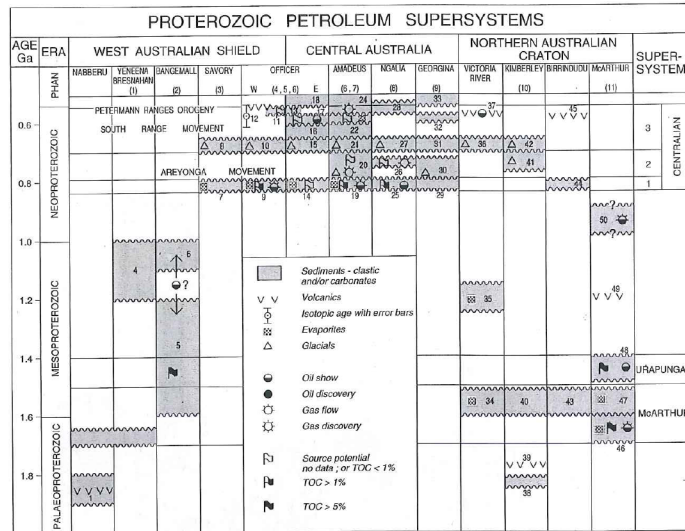
Exploring for the Future - Introduction



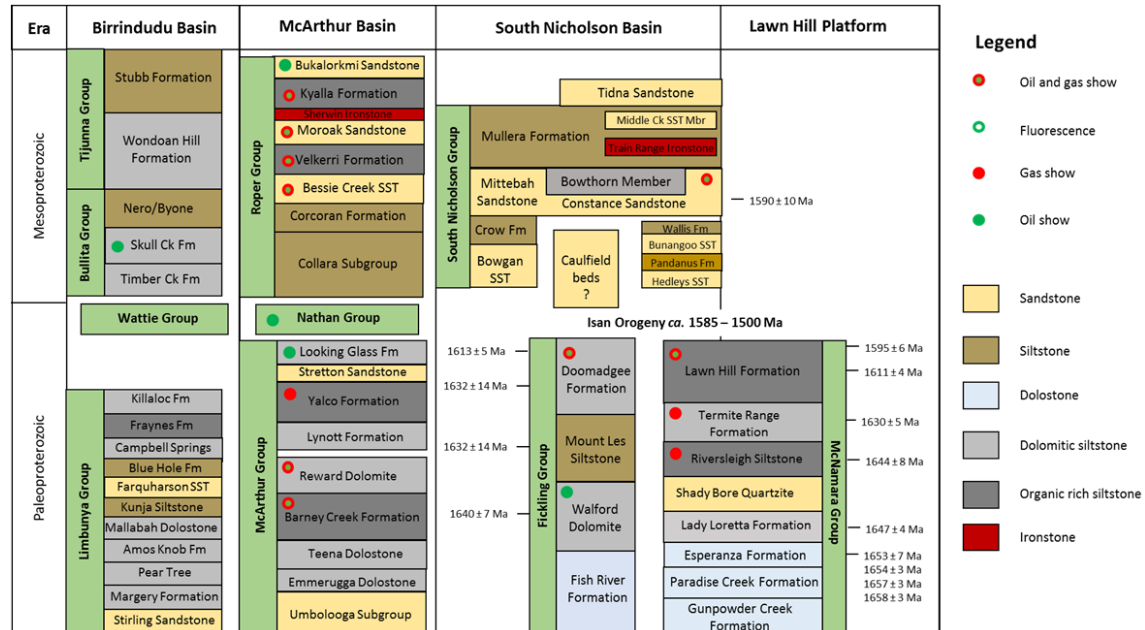
- A major new investment in pre-competitive geoscience from the Minister for Resources and Northern Australia - \$100.5 million over 4 years (2016 – 2020)
- Improving knowledge of potential oil and gas, mineral and groundwater resources in Northern Australia
- Resource exploration investment is needed to ensure the discovery and development of the next generation of oil and gas resources
- New discoveries also support regional development through economic growth and the creation of new jobs

Petroleum Supersystems

- Bradshaw *et al* (1994) defined seven petroleum supersystems across Australia; two are in the McArthur basin & regional coeval basins.
- A supersystem links families of source rocks on a continental scale; for example by depositional environment, age and tectonism.
- Exploration tool in frontier basins.

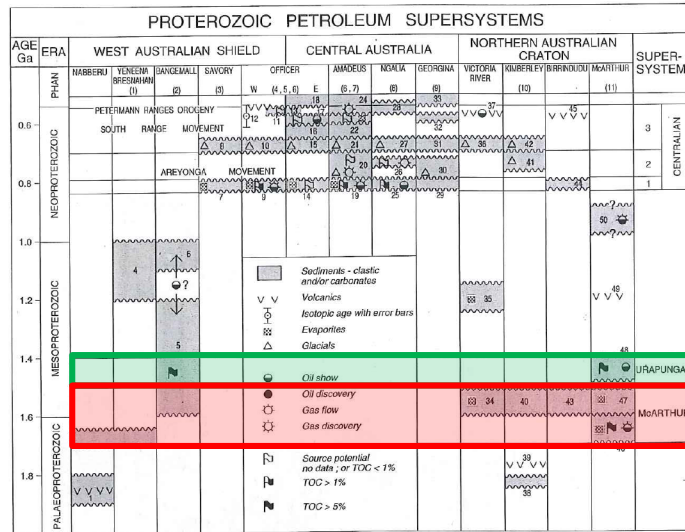


Bradshaw *et al.*, 1994

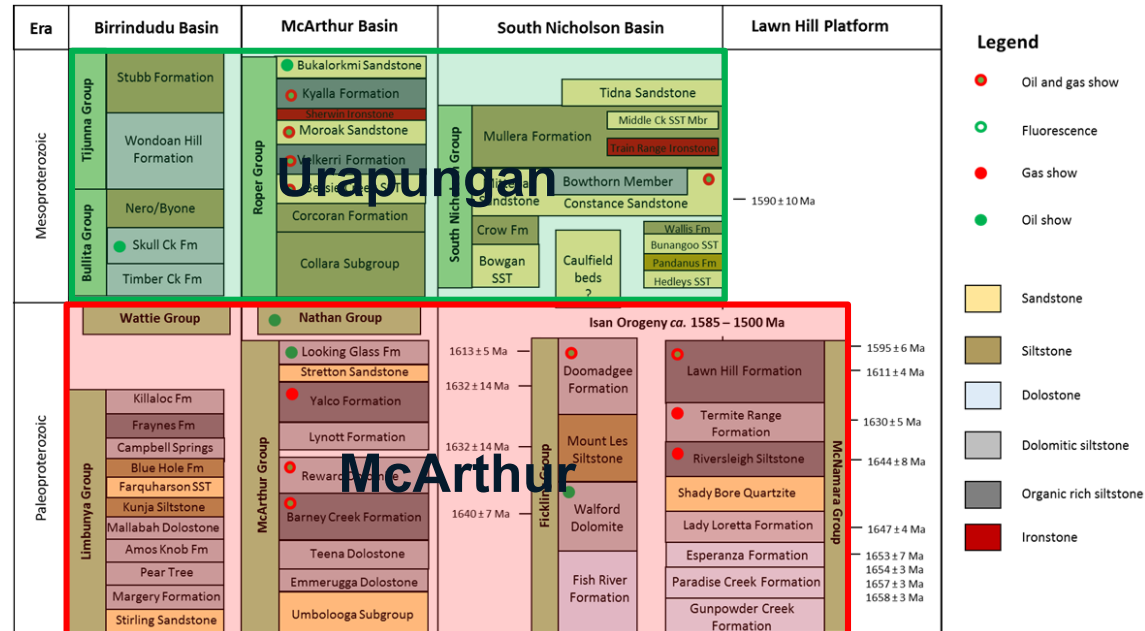


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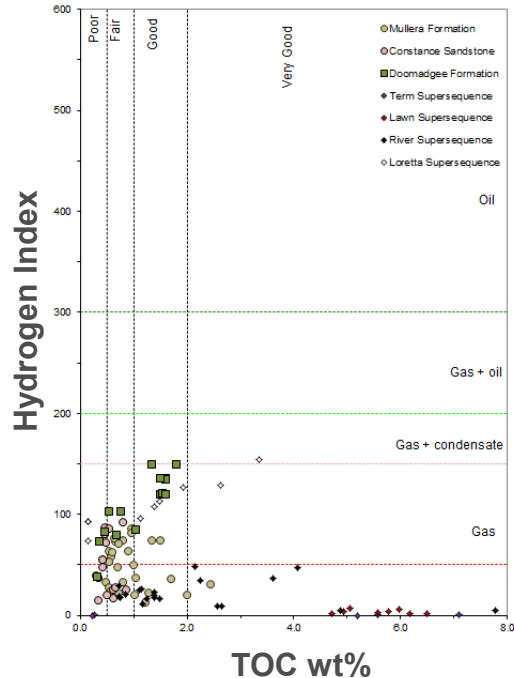


Bradshaw et al., 1994



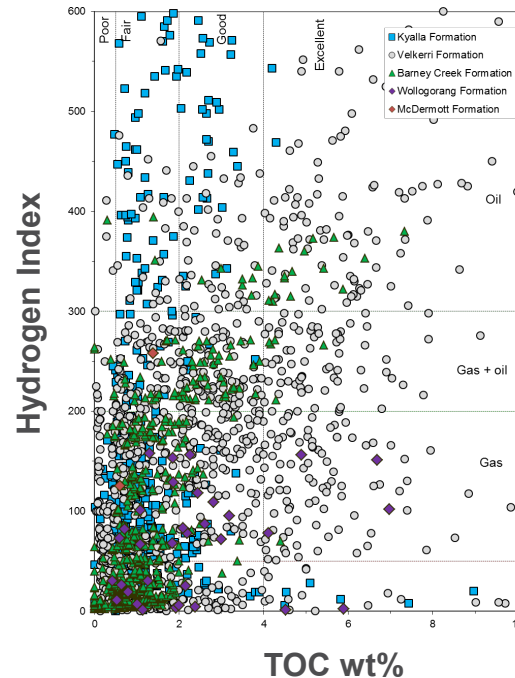
Source rock geochemistry

South Nicholson and Isa



Jarrett et al. 2018: Regional baseline petroleum potential of South Nicholson Basin and Isa Superbasin **GA Record 2018/038**

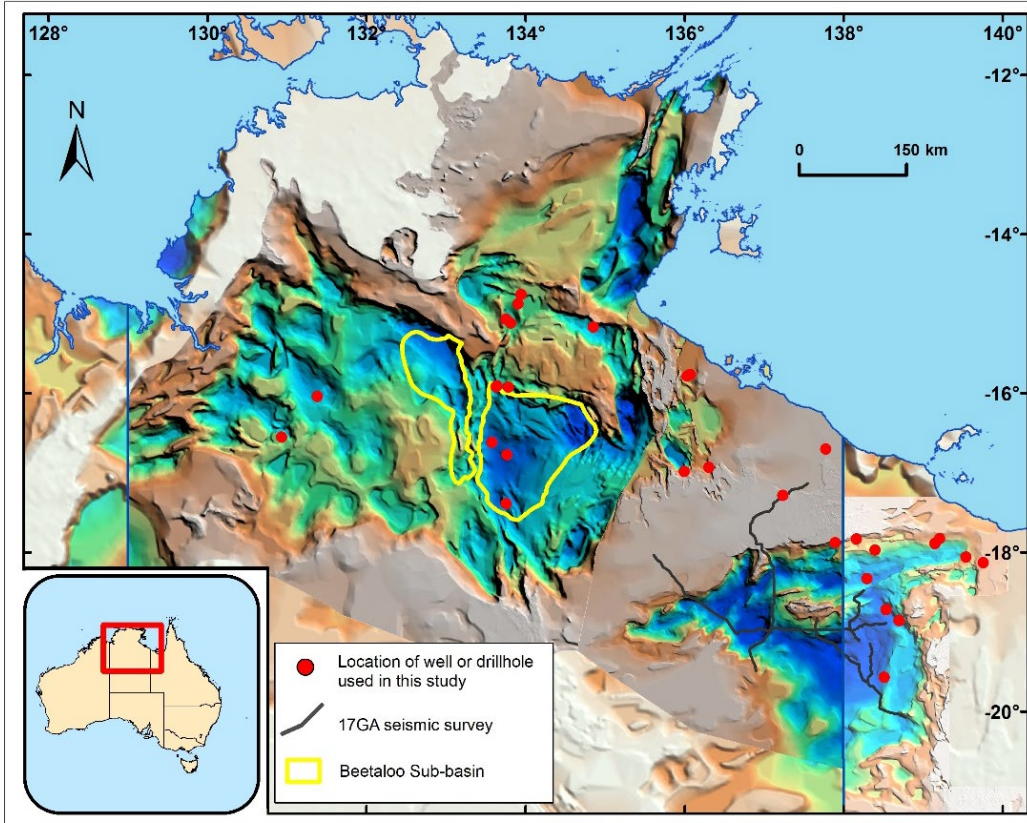
McArthur Basin



Revie & Normington (2018): Shale Resource data from the greater McArthur Basin **DIP-014**

- Data compilation of Isa Superbasin and South Nicholson Basin completed 2018
- Data plotted with pre-existing datasets for the McArthur Basin (Revie and Normington, 2018)
- Identified potential source rock intervals
- Target areas for future work under EFTF

Source rock geochemistry

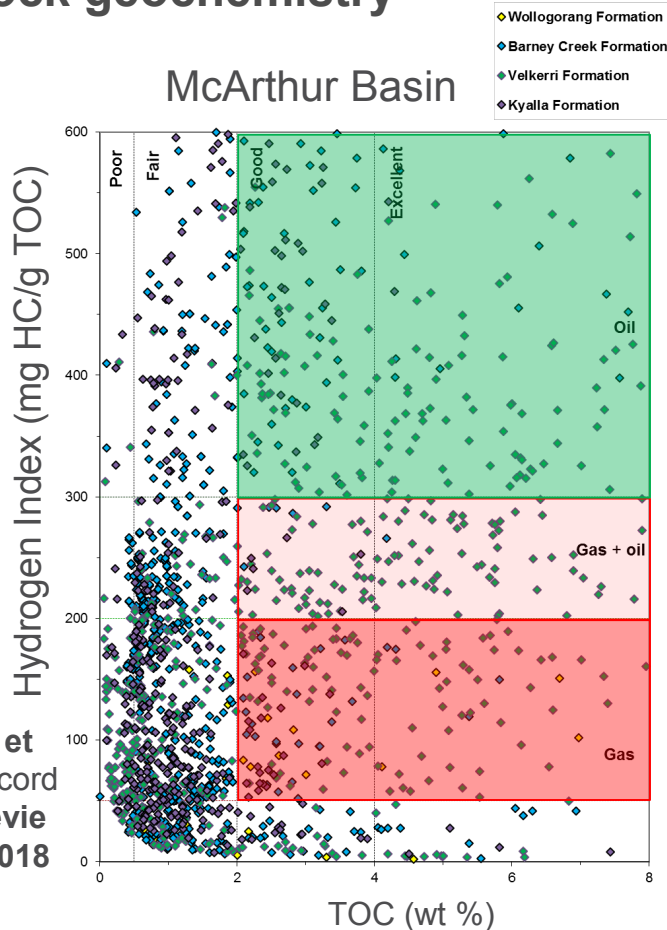


- More data required to understand resource potential of these formations.
- Infill sampling across the region targeting potential Paleo- and Mesoproterozoic source rock intervals carried out in 2018.
- Data analysis is ongoing....

Map showing the location of samples used in this study (red circles); the boundary of the Beetaloo Sub-basin (Department of Primary Industry and Resources, 2017); and the South Nicholson Basin seismic survey overlying merged SEEBASE depth to basement image (Frogtech).

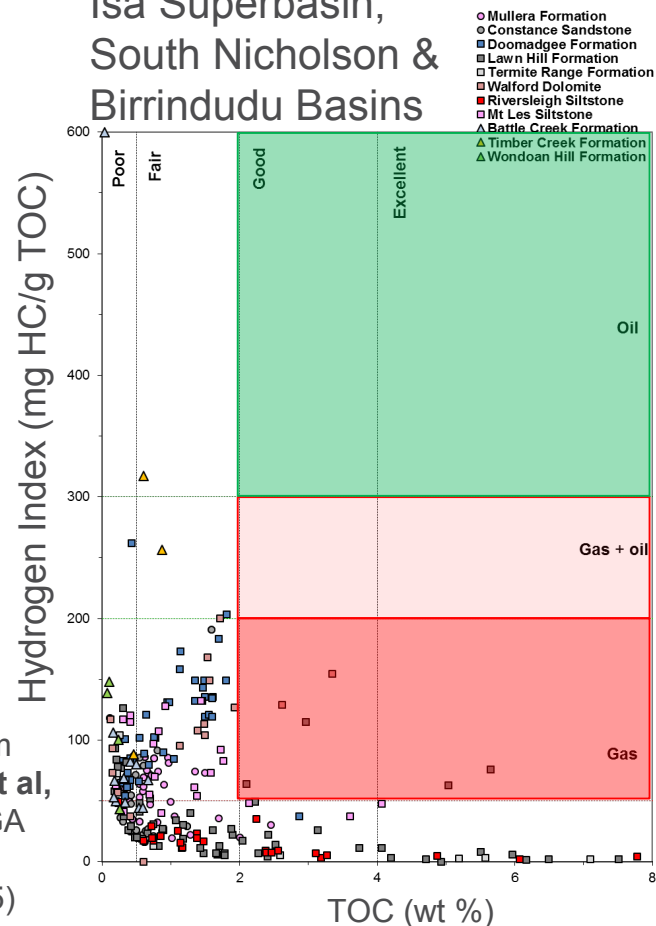
Source rock geochemistry

McArthur Basin



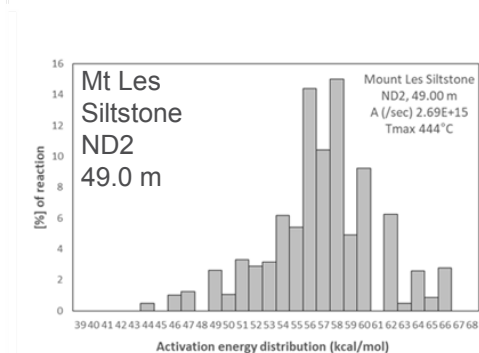
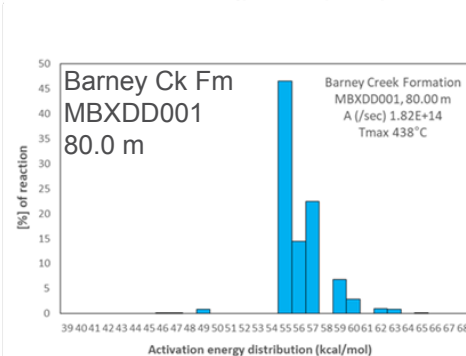
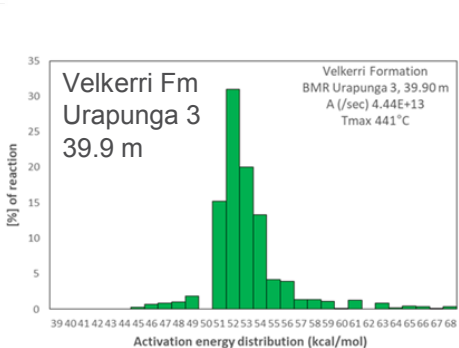
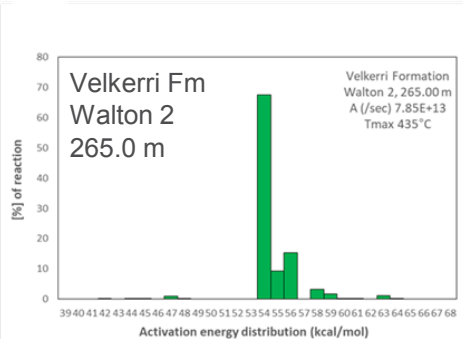
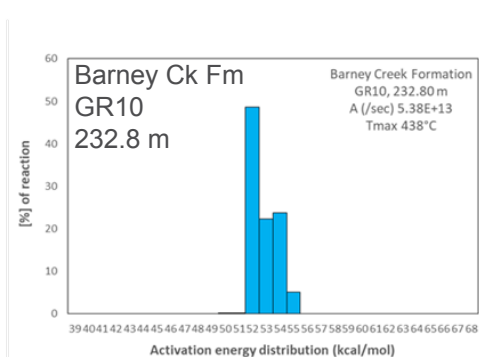
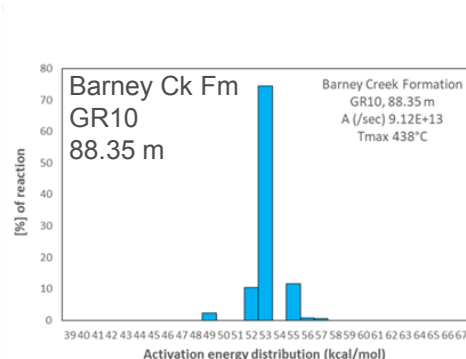
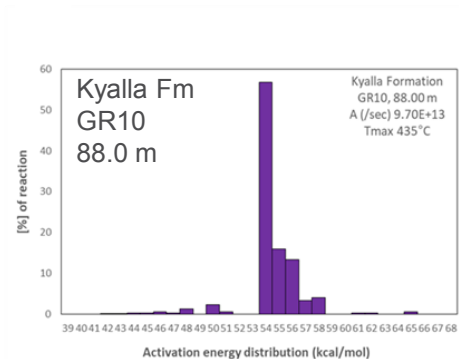
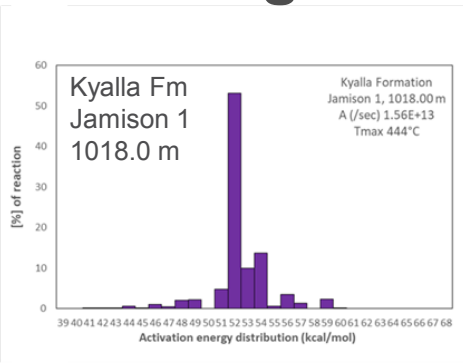
Data from **Jarrett et al, 2018b** (GA Record 2018/024) and **Revie & Normington, 2018** (NTGS DIP-014)

Isa Superbasin, South Nicholson & Birrindudu Basins

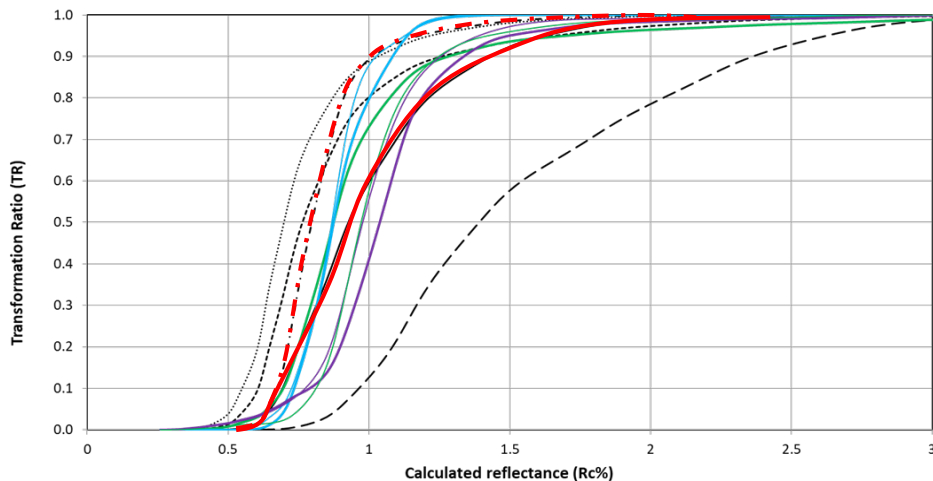


Data from **Jarrett et al, 2018a** (GA Record 2018/045)

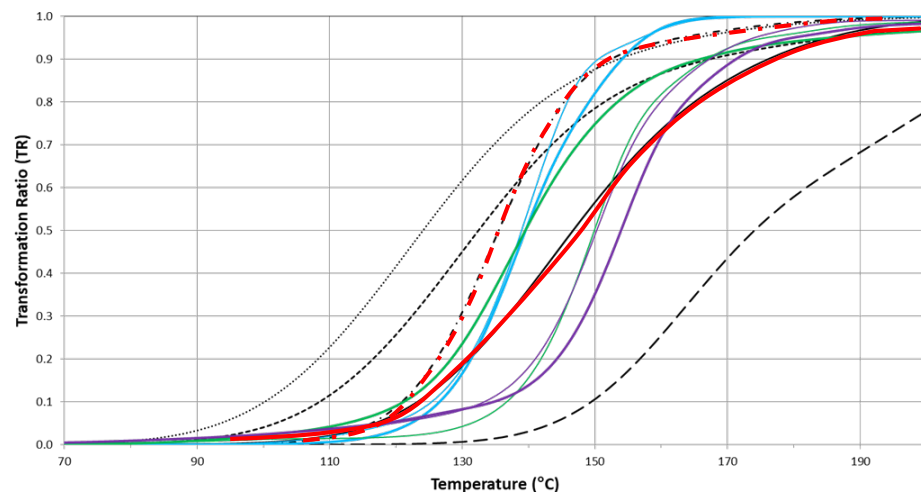
Kerogen kinetics



Kerogen kinetic modelling



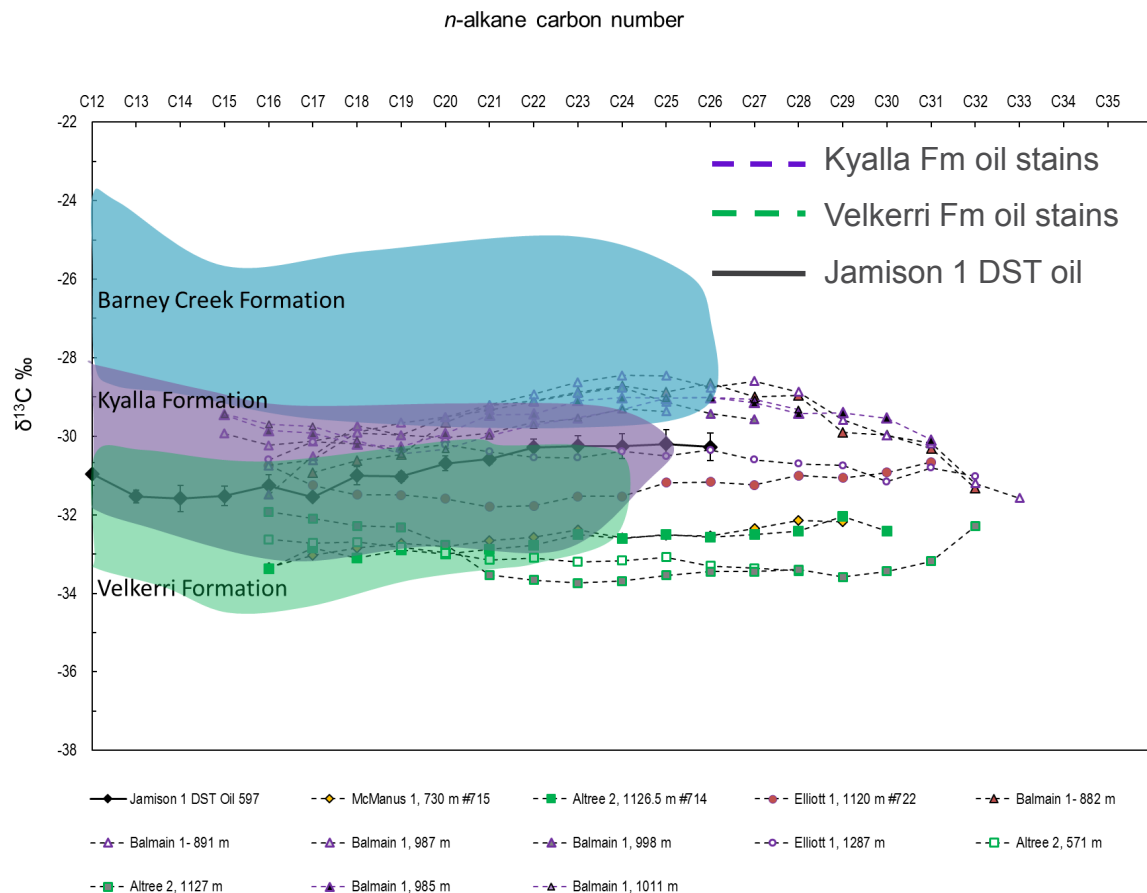
..... Type A (P&C) ----- Type B (P&C) - . - . Type C (P&C) — Type D/E (P&C)
 — Type F (P&C) — Urapunga-3 Velkerri Fm 39.9m — GR10 Barney Creek Fm 232.8m — GR10 Barney Creek Fm 88.35m
 — DIP014_Shea_124m_Kyalla Fm — DIP014_GR10_88m_Kyalla Fm — DIP014_Walton2_265m_Velkerri Fm



..... Type A (Pepper & Corvi, 1995) ----- Type B (Pepper & Corvi, 1995) - . - . Type C (Pepper & Corvi, 1995)
 — Type D/E (Pepper & Corvi, 1995) — Type F (Pepper & Corvi, 1995) — GR10 Barney Creek Fm 232.8m
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 — DIP014_Shea_124m_Kyalla Fm — DIP014_GR10_88m_Kyalla Fm

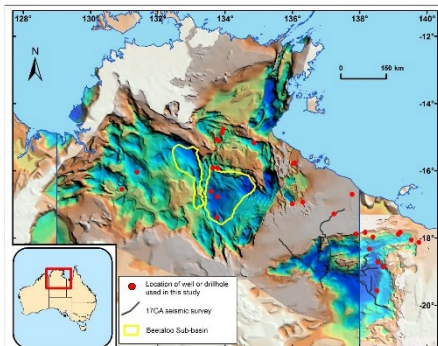
- Results plotted with standard kerogen types from Pepper and Corvi (1995).
- McArthur Basin source rocks have narrow activation energy and steep generation gradients.
- Similar to Type C organofacies; lacustrine (c.f. Type I kerogen).
- Some profiles similar to Type D/E organofacies (Type III kerogen).

Oil-source rock correlation: stable carbon isotopes



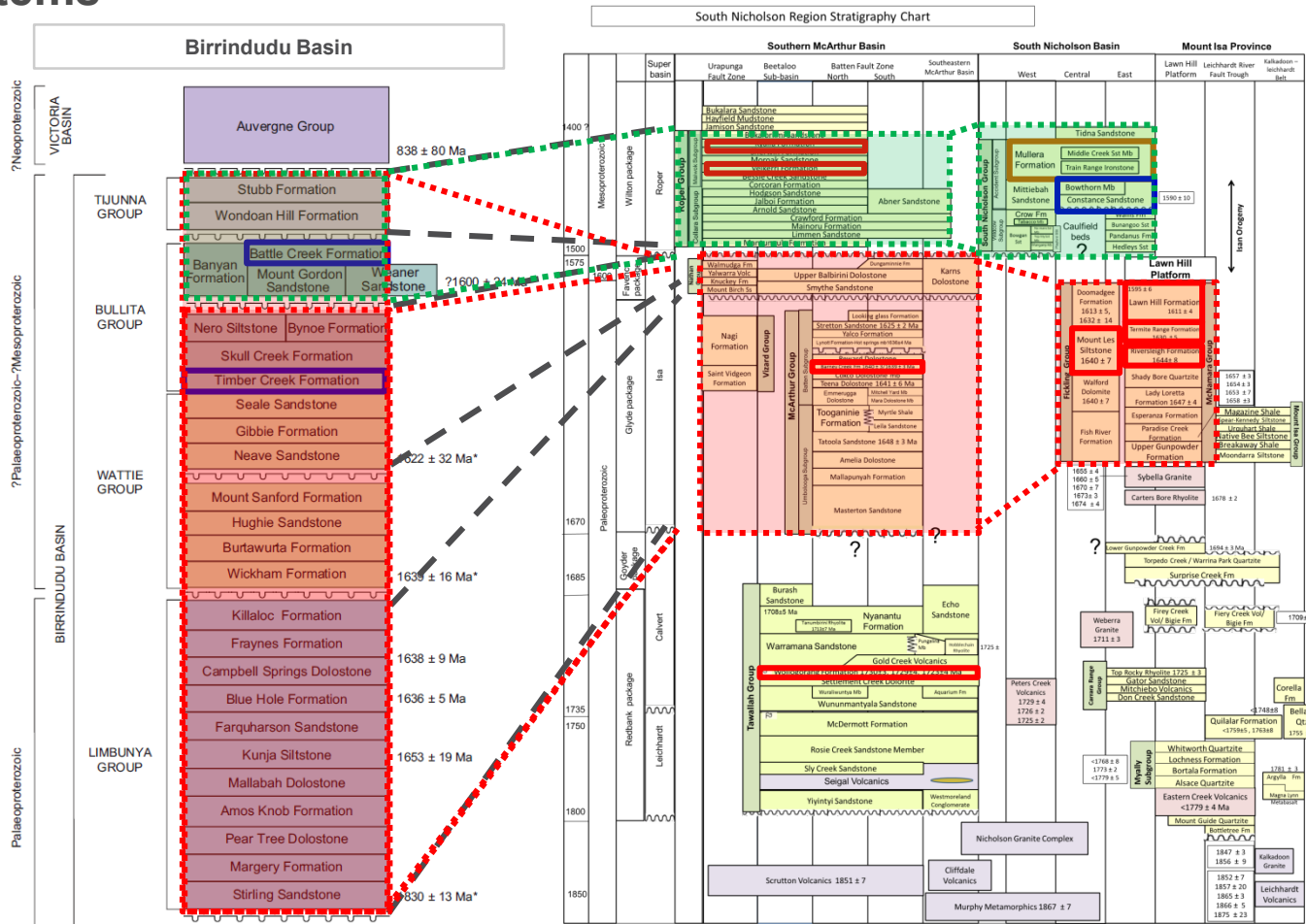
- Velkerri and Kyalla formation overlap.
- Barney Creek Formation has a distinct isotopically enriched profile.
- Evidence for self-sourcing oil-stains of the Velkerri Formation.
- Cross-over between Velkerri and Kyalla formations in Kyalla Formations oil stains.
- Jamison 1 oil similar trend to Kyalla Formation self-sourced oil stains.

Petroleum Supersystems

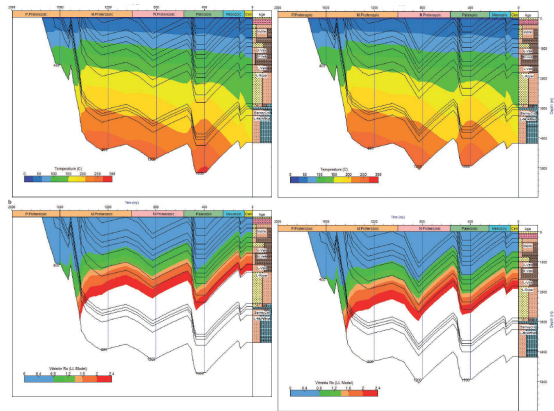


- Excellent organic richness 4+ wt% TOC
 - Good organic richness 2-4 wt% TOC
 - Fair organic richness 1-2 wt% TOC

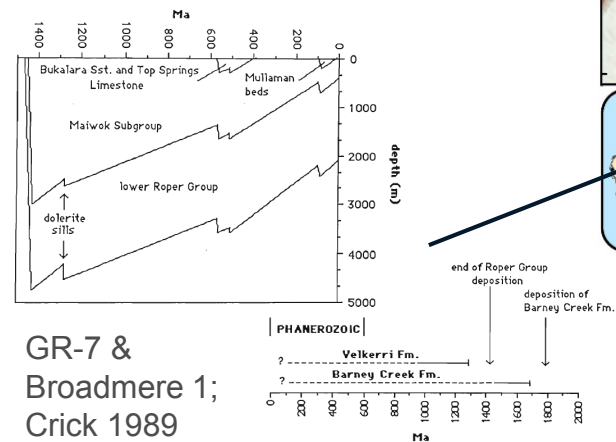
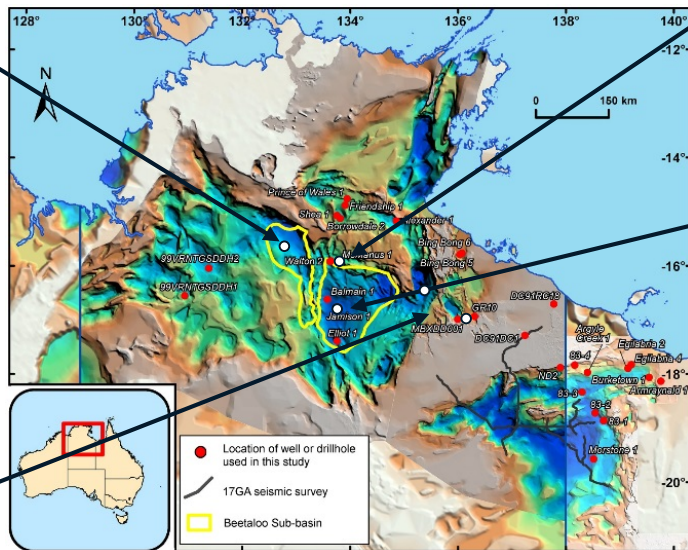
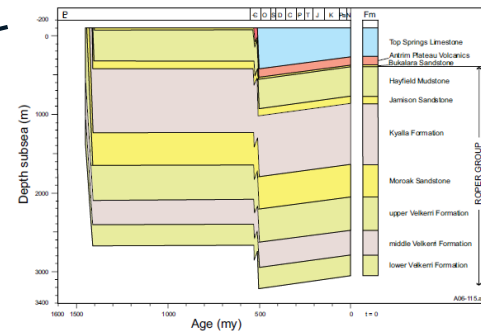
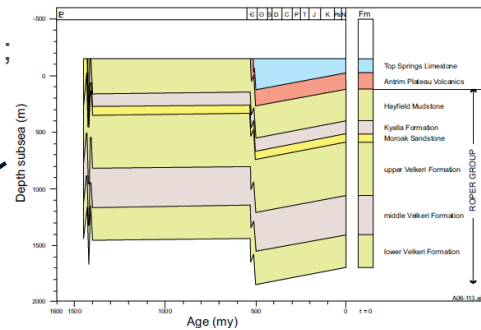
Birrindudu Basin stratigraphy from Ahmad & Munson (2012); stratigraphic correlations between Birrindudu and McArthur basins from Hoffman (2015). McArthur Basin, South Nicholson Basin and Mount Isa Province stratigraphy from Carr *et al* (2018). Supersystem definitions from Bradshaw *et al* (1994).



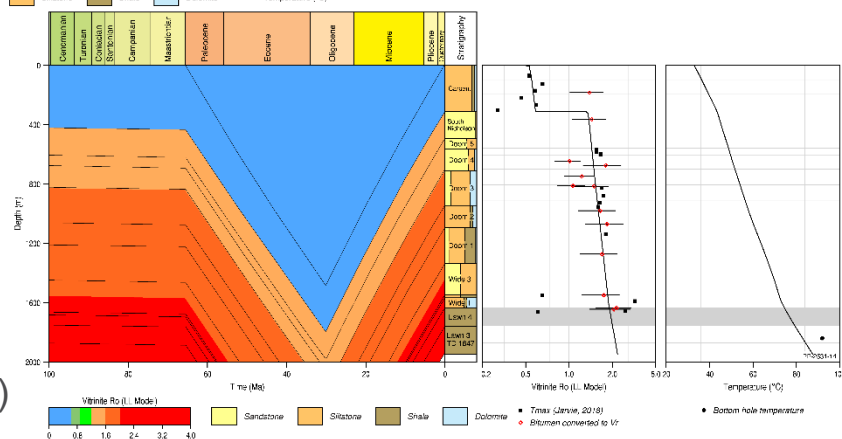
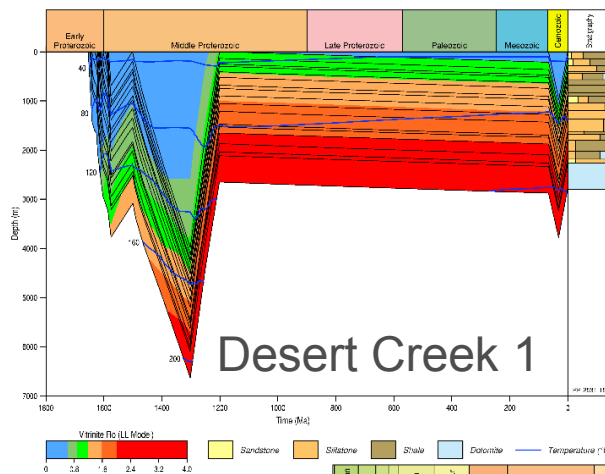
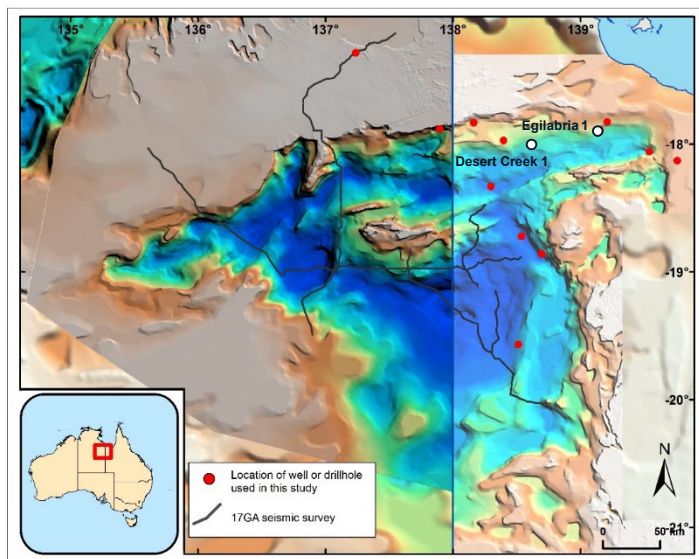
Petroleum Systems Analysis: Thermal and burial history the story so far...



McManus 1 & Jamison 1;
Silvermann et al 2005

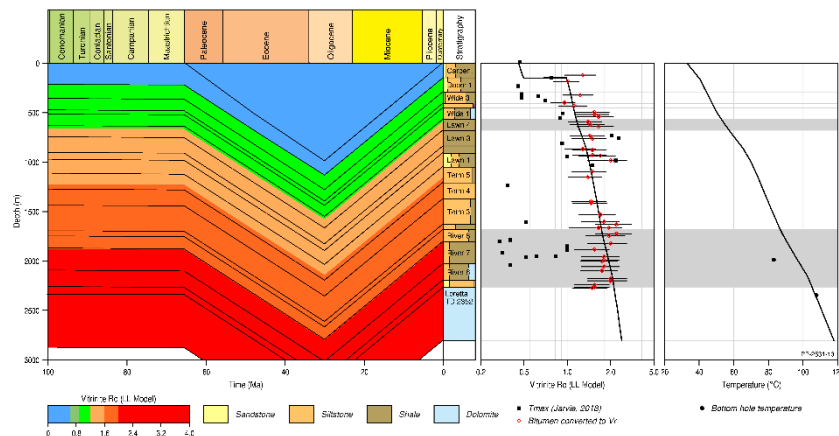
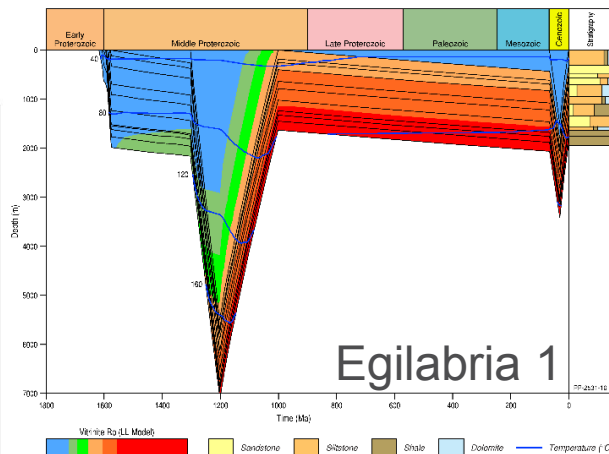
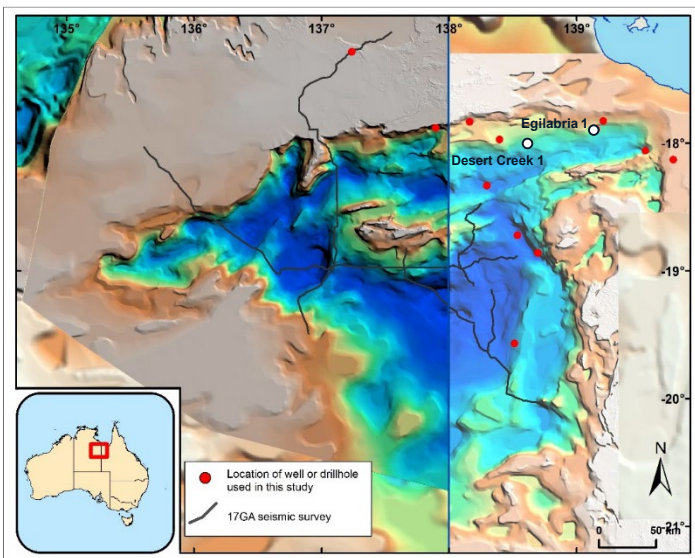


Petroleum Systems Analysis: Thermal and burial history of the Lawn Hill Platform



Palu et al, AOGC, 2018 (eCat 124056)

Petroleum Systems Analysis: Thermal and burial history of the Lawn Hill Platform

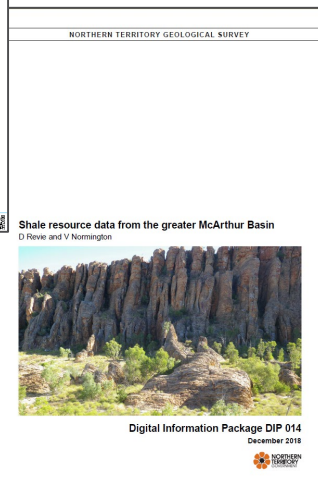
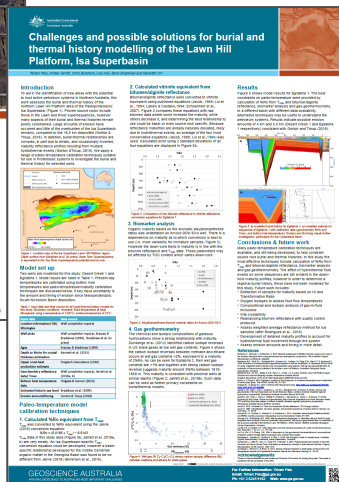


Palu et al, AOGC, 2018 (add eCat)

Discussion & future work

- The EFTF has already delivered pre-competitive data improving the knowledge of Proterozoic source rocks across northern Australia (Jarrett et al, 2018a & b).
- *Where to next?*
- Further investigation into differences in key geochemical parameters within a supersystem; e.g. the Barney Creek Formation and Mt Les Siltstone.
- Regional perspective on burial history, timing and generation and application into the petroleum supersystems concept.
- More data to come....

References

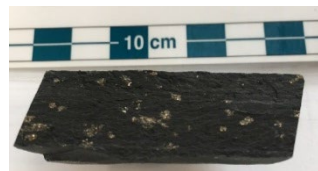
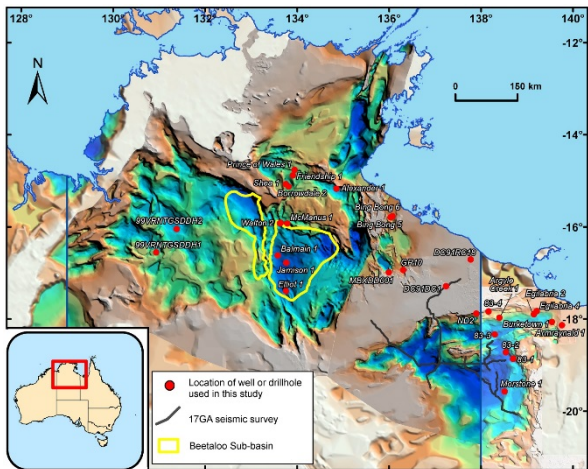


Jarrett, AJM *et al.*, 2018a. Source rock geochemistry of the Isa Superbasin and South Nicholson Basin, northern Australia: baseline regional hydrocarbon prospectivity. *Geoscience Australia, Record* 2018-038; eCat 121137.

Jarrett, AJM *et al.*, 2018b. Exploring for the Future - Source rock geochemistry data of the Isa Superbasin and South Nicholson Basin, TOC and Rock-Eval data release, northern Australia: baseline regional hydrocarbon prospectivity. *Geoscience Australia, Record* 2018/45.

Palu TJ *et al.*, 2018. Challenges and possible solutions for burial and thermal history modelling of the Lawn Hill Platform, Isa Superbasin: in Edwards DS, Grosjean E, Brocks JJ and van Maldegem M (compilers). '20th Australian Organic Geochemistry Conference: Origins of Oil, Old Organics and Organisms Program and Abstracts: 3–7 December 2018, Canberra, Australia'. *Geoscience Australia, Record* 2018/44, 117–118.

Revie, D and Normington VJ, 2018. Shale resource data from the greater McArthur Basin. *Northern Territory Geological Survey, Digital Information Package DIP 014*.



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<http://www.ga.gov.au/about/projects/resources/seismic>

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