Department of Industry, Tourism and Trade

Prospectivity of the world's oldest stacked petroleum systems with emphasis on the McArthur Supersystem

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Vaughton Siltstone, northern McArthur Basin (McArthur Supersystem)

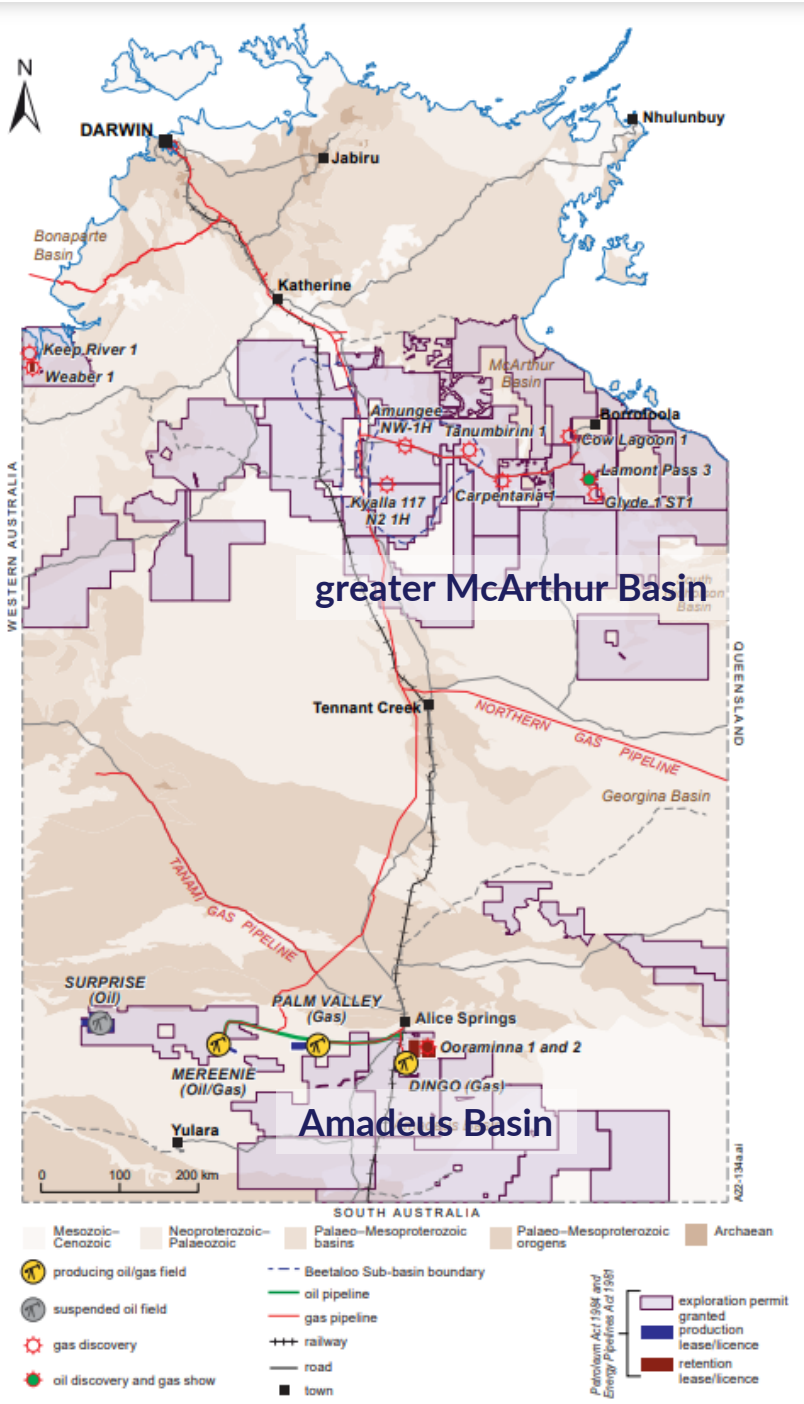
Outline

1. Northern Territory oil and gas
2. The greater McArthur Basin project
3. New exploration framework: Stacked Petroleum supersystems to plays

   (using Proterozoic McArthur Supersystem as an example)

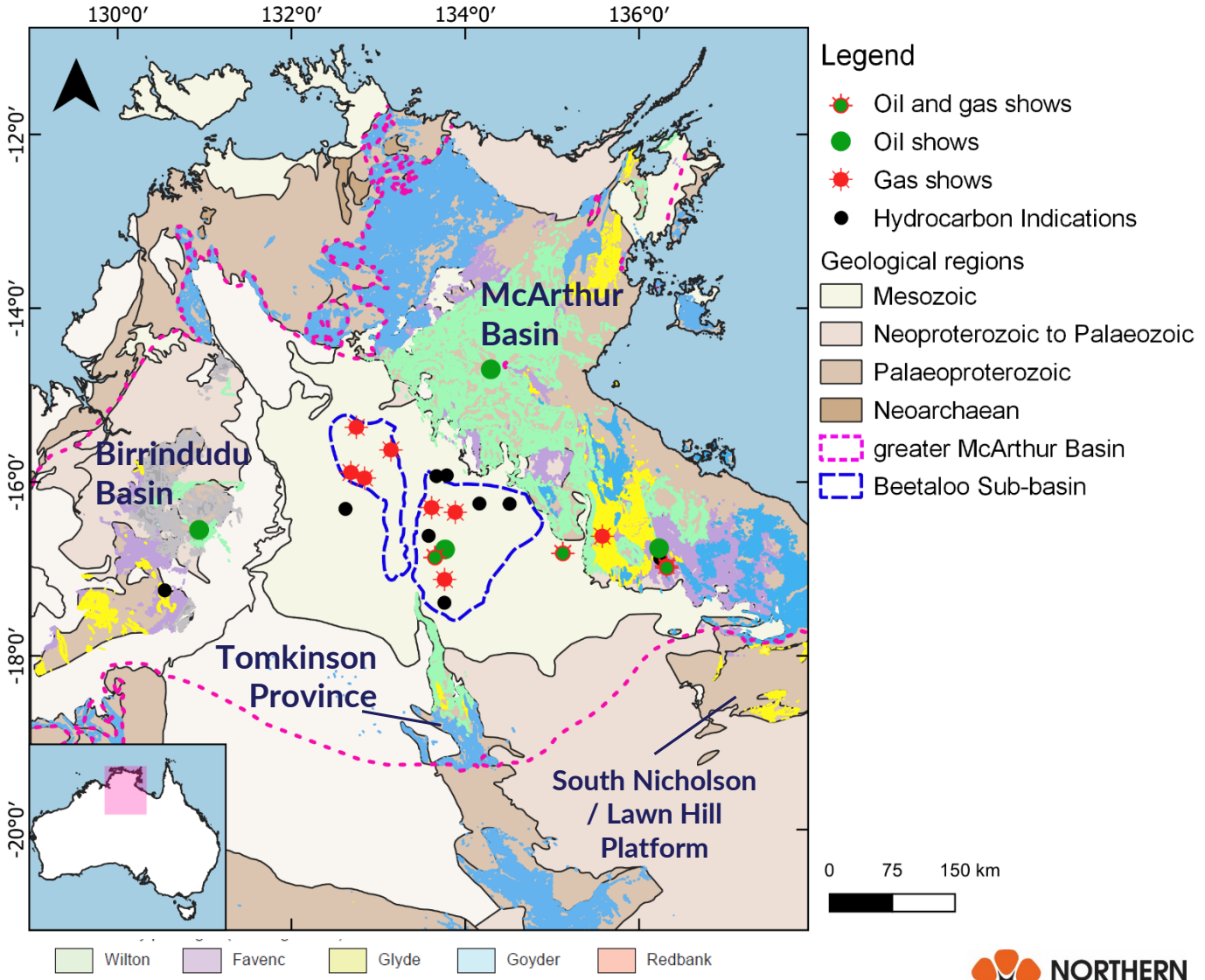
Northern Territory energy

- Oil and gas production in the Amadeus Basin
- Exploration in the Amadeus Basin
  - Sub-salt hydrogen and helium
  - CCS potential
  - Conventional oil and gas
- Advanced exploration for shale gas in the greater McArthur Basin (including Beetaloo Sub-basin)
  - Exploration and appraisal of Beetaloo Sub-basin
  - New wells and flow testing 2021/22
- Many other NT basins are frontier, have great potential but are underexplored
- See NTGS Report 22 for a comprehensive summary

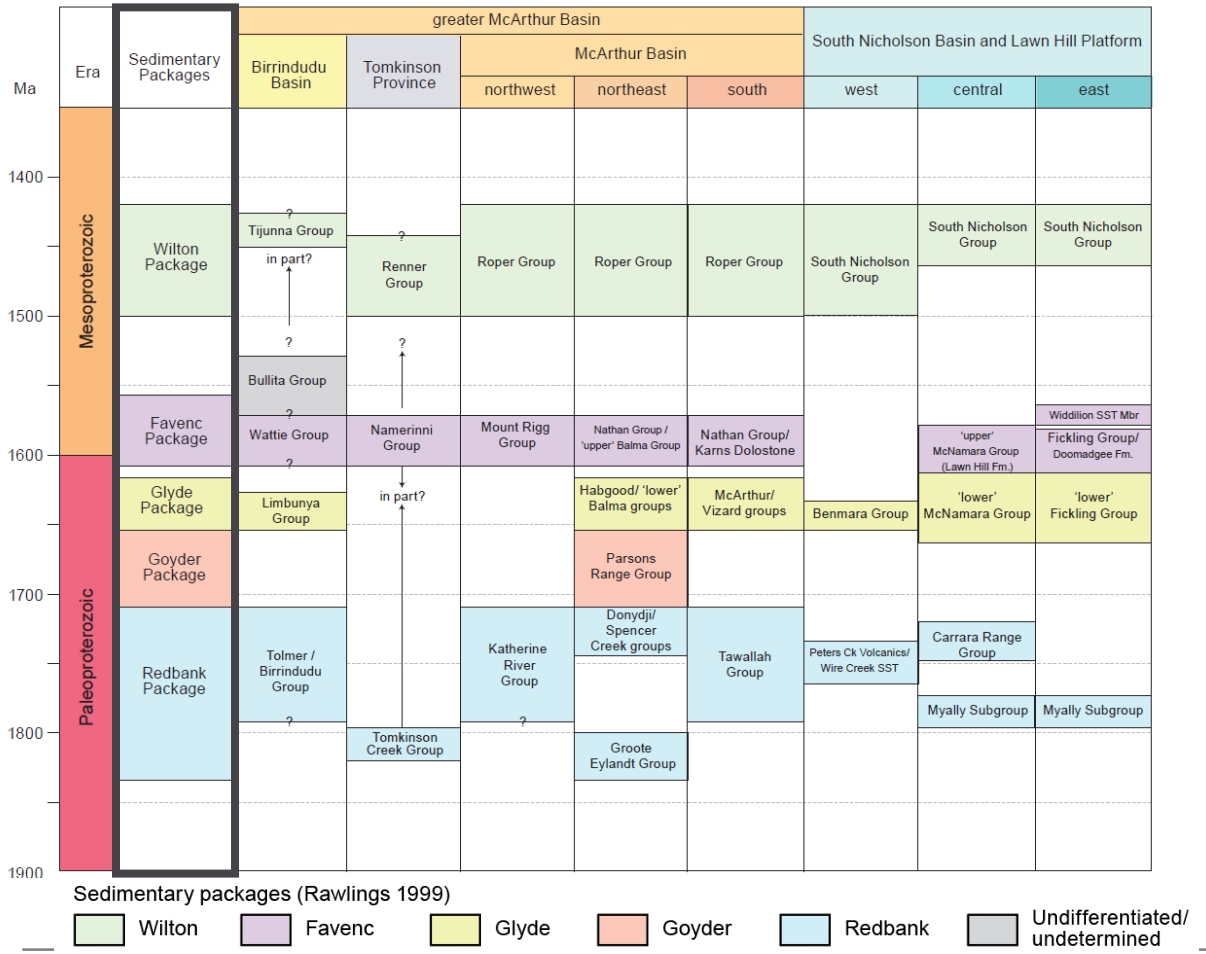


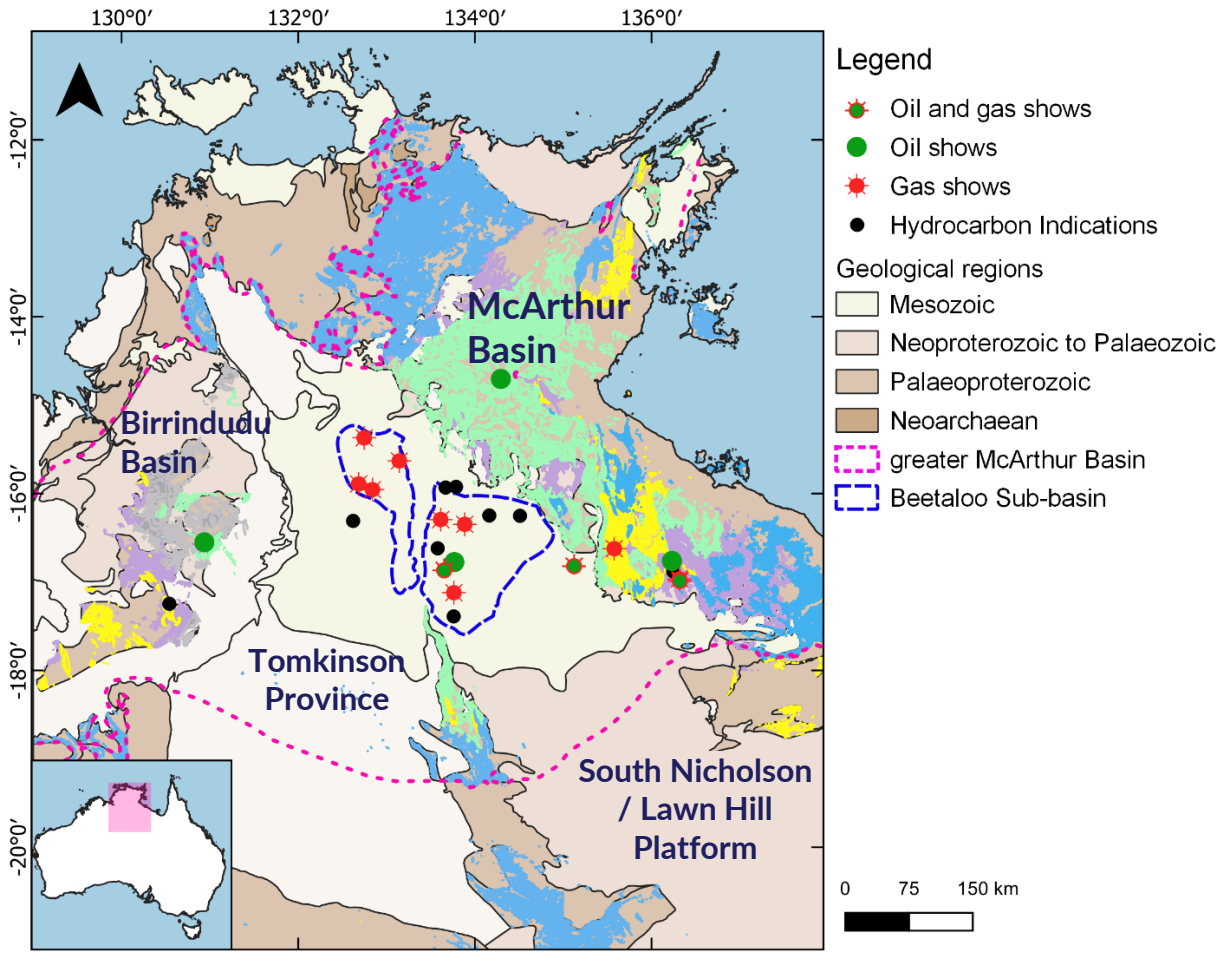
Resourcing the Territory initiative

- Supporting exploration in the NT
- Providing precompetitive geoscience to unlock new areas for exploration
- This study focuses on creating a clear and consistent exploration framework across the greater McArthur Basin
- Bridges exploration scales from continent to prospect in both advanced and frontier regions



The greater McArthur Basin



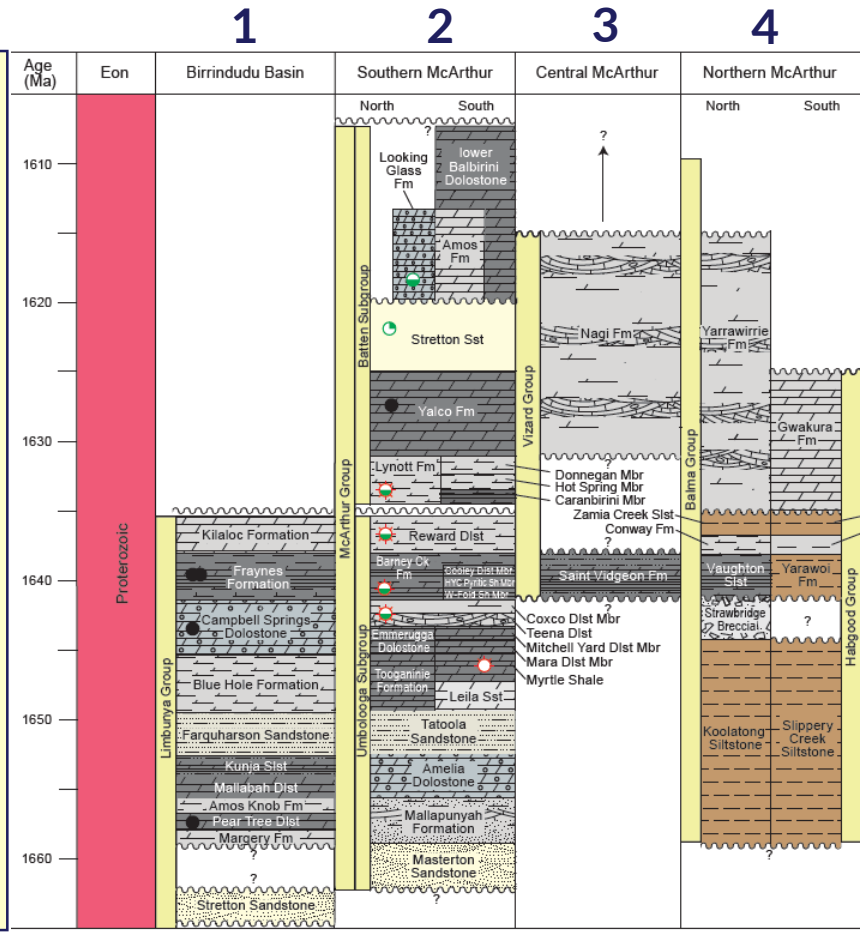


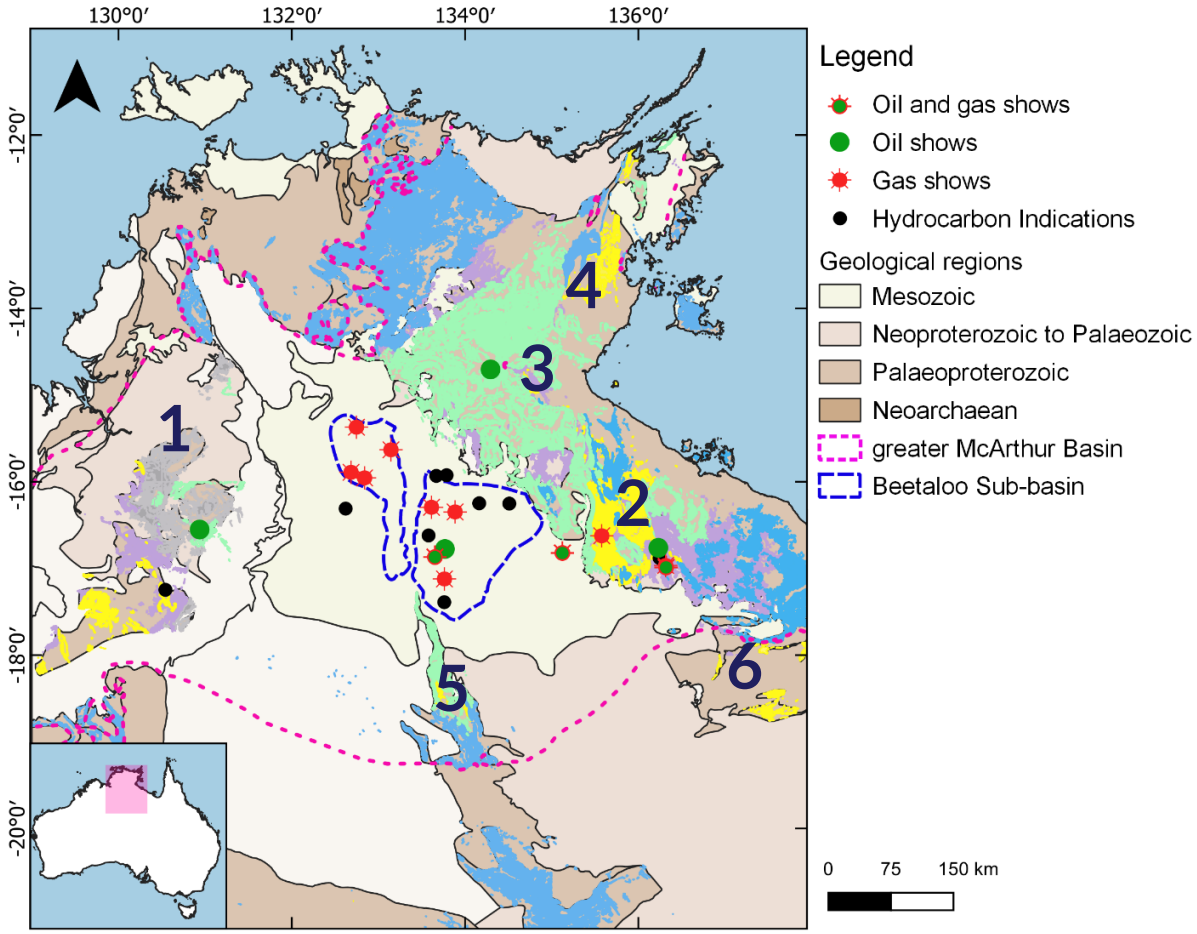
NORTHERN TERRITORY GOVERNMENT

Exploration challenges:

Correlation and petroleum potential across the Glyde Package

Glyde package





Lithologies

- shale, siltstone and fine sandstone
- sandstone, siltstone
- siltstone, shale and shaley silt
- stromatolitic dolostone and dolarenite
- dolomitic sandstone, silicified carbonate, dolarenite
- dolomitic siltstone, shale and fine-grained sandstone
- sandy dolostone
- mudstone, dolostone, carbonaceous shale, dolomitic siltstone
- dolostone
- stromatolitic and/or oolitic dolostone
- breccia

5 = Tomkinson Province 6 = Lawn Hill Platform (not shown in correlation chart)

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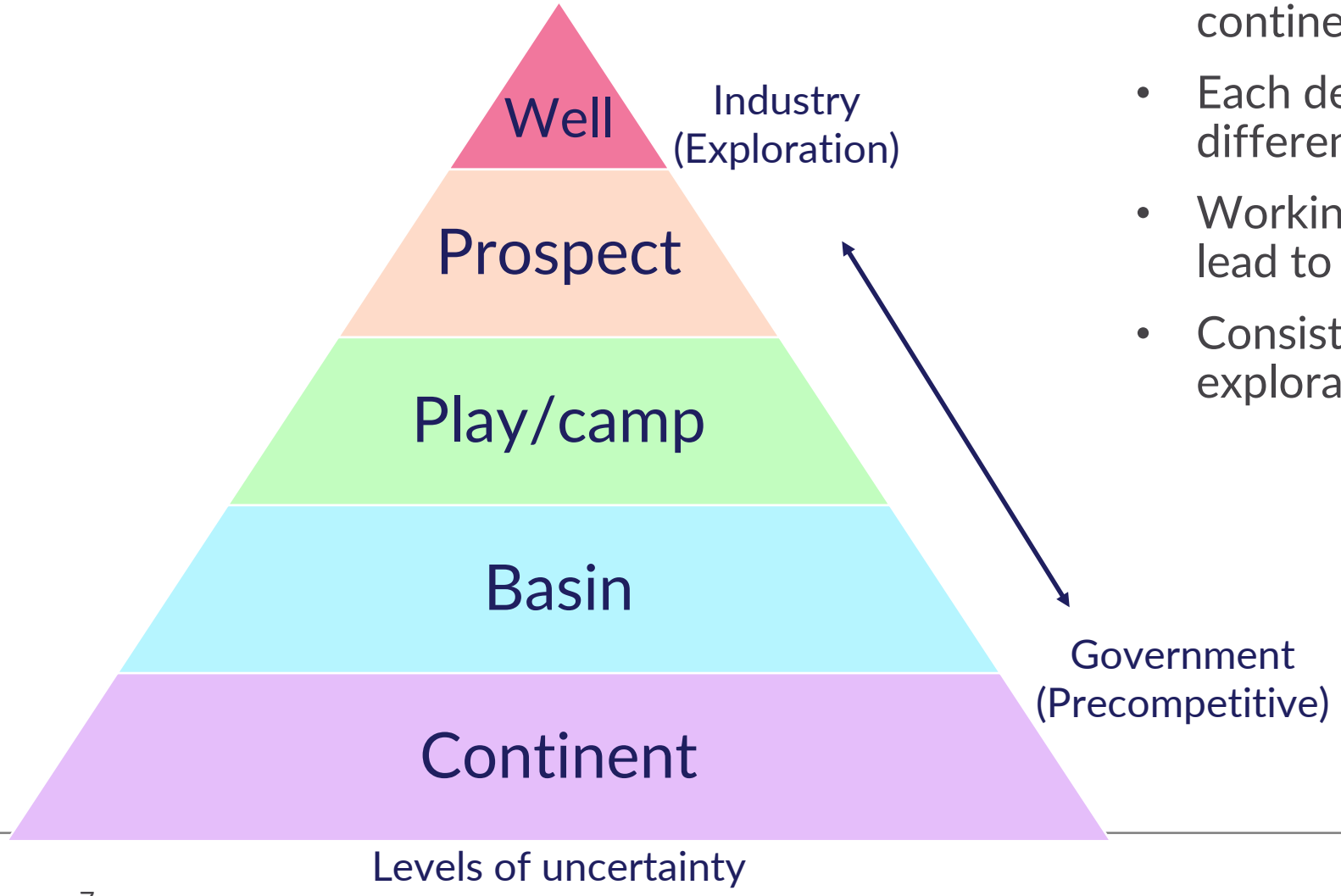
Exploration scales



- Exploration crosses multiple scales from continent-to-well-scale
- Each decision-making point requires different information
- Working at different scales can often lead to different terminology
- Consistent framework can lead to better exploration outcomes

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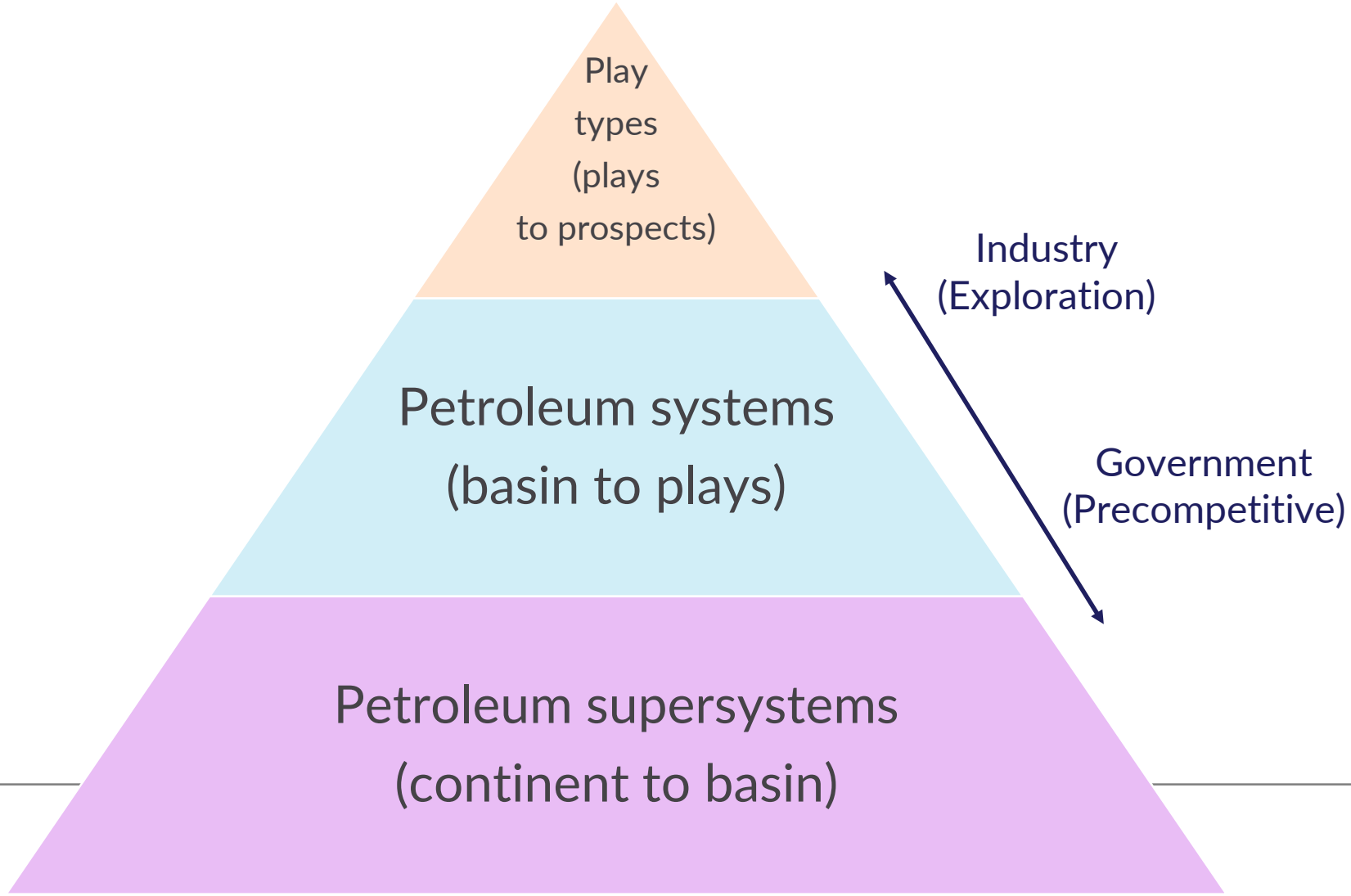
New stacked petroleum system framework



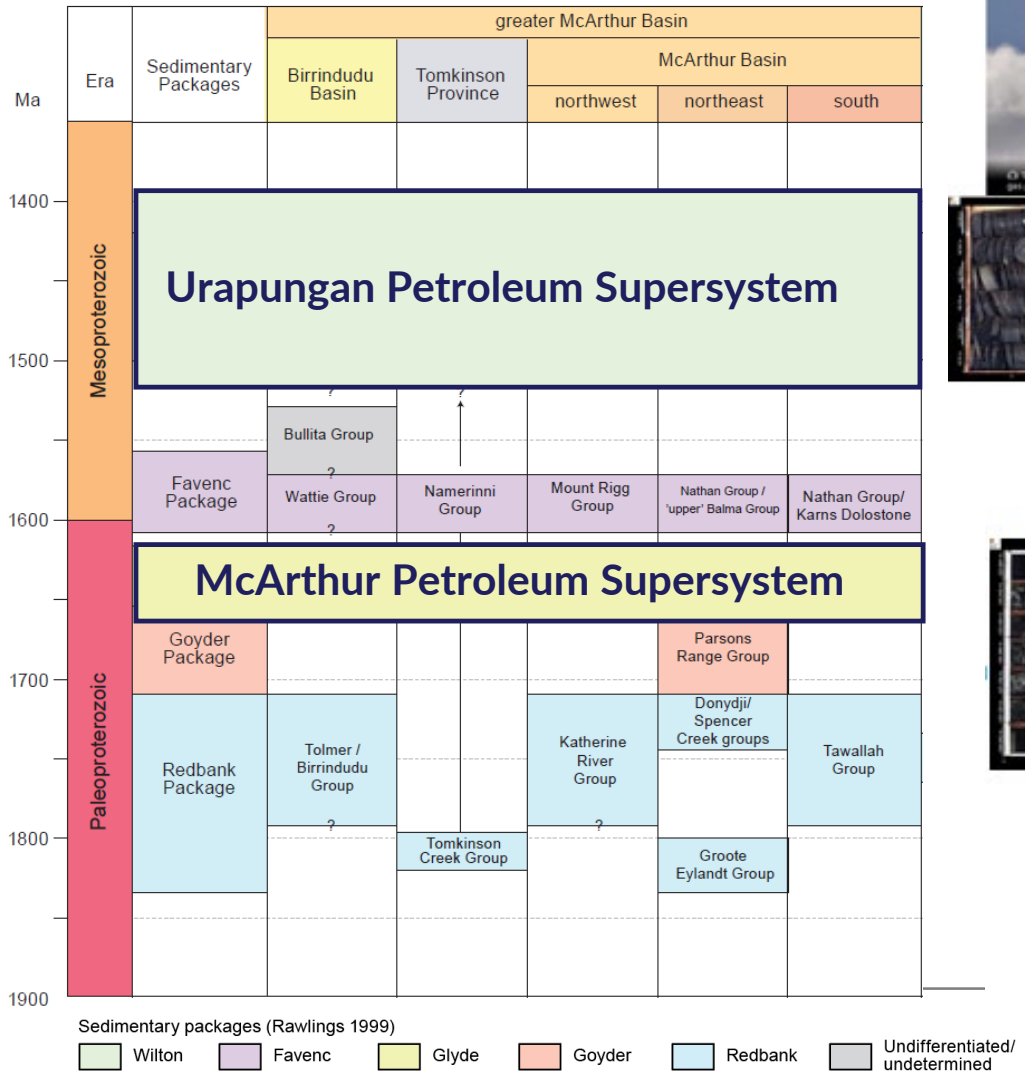
NORTHERN TERRITORY GOVERNMENT

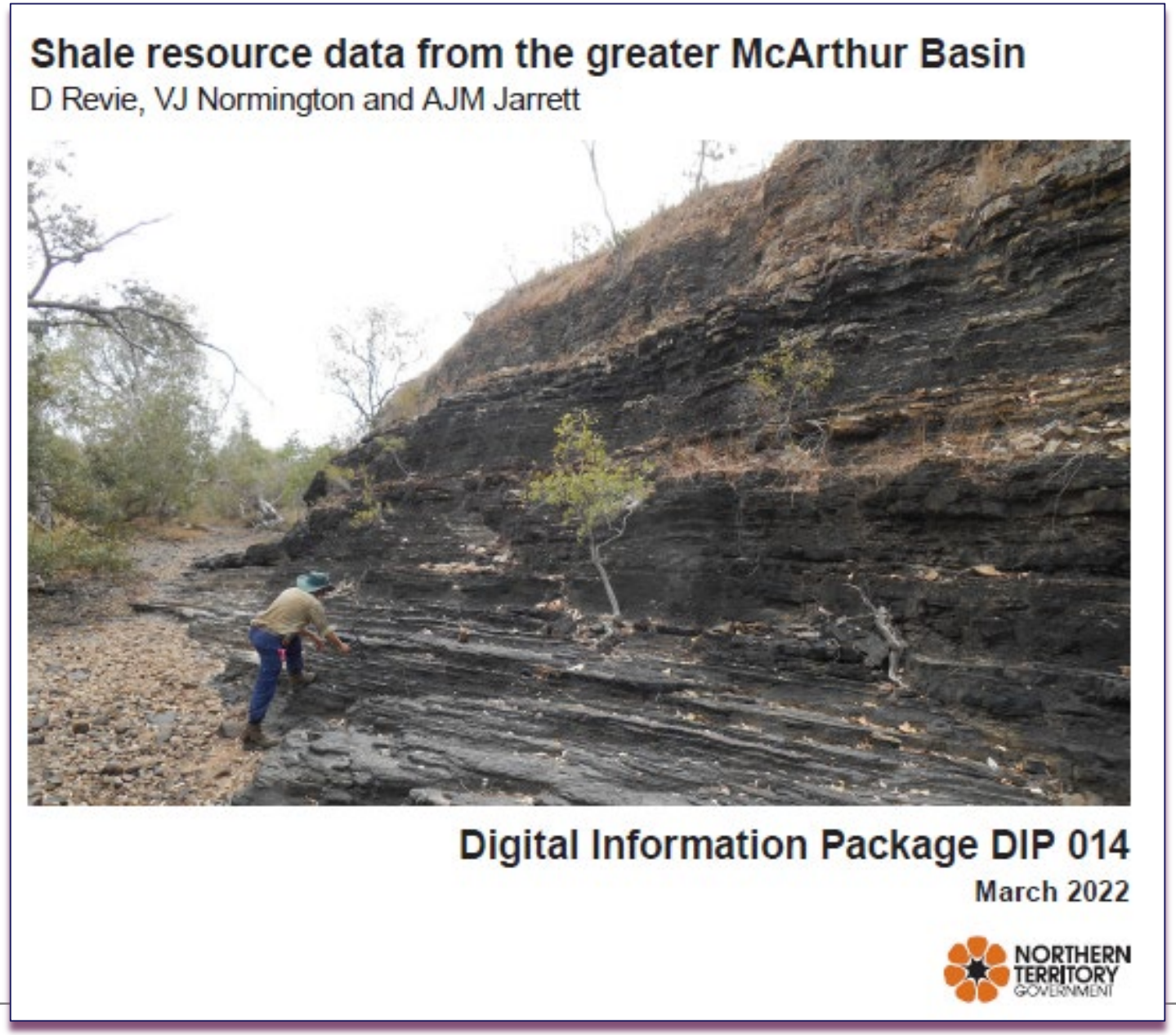
Petroleum supersystems (continent to basin scales)

Previous version (Bradshaw *et al.* 1994)

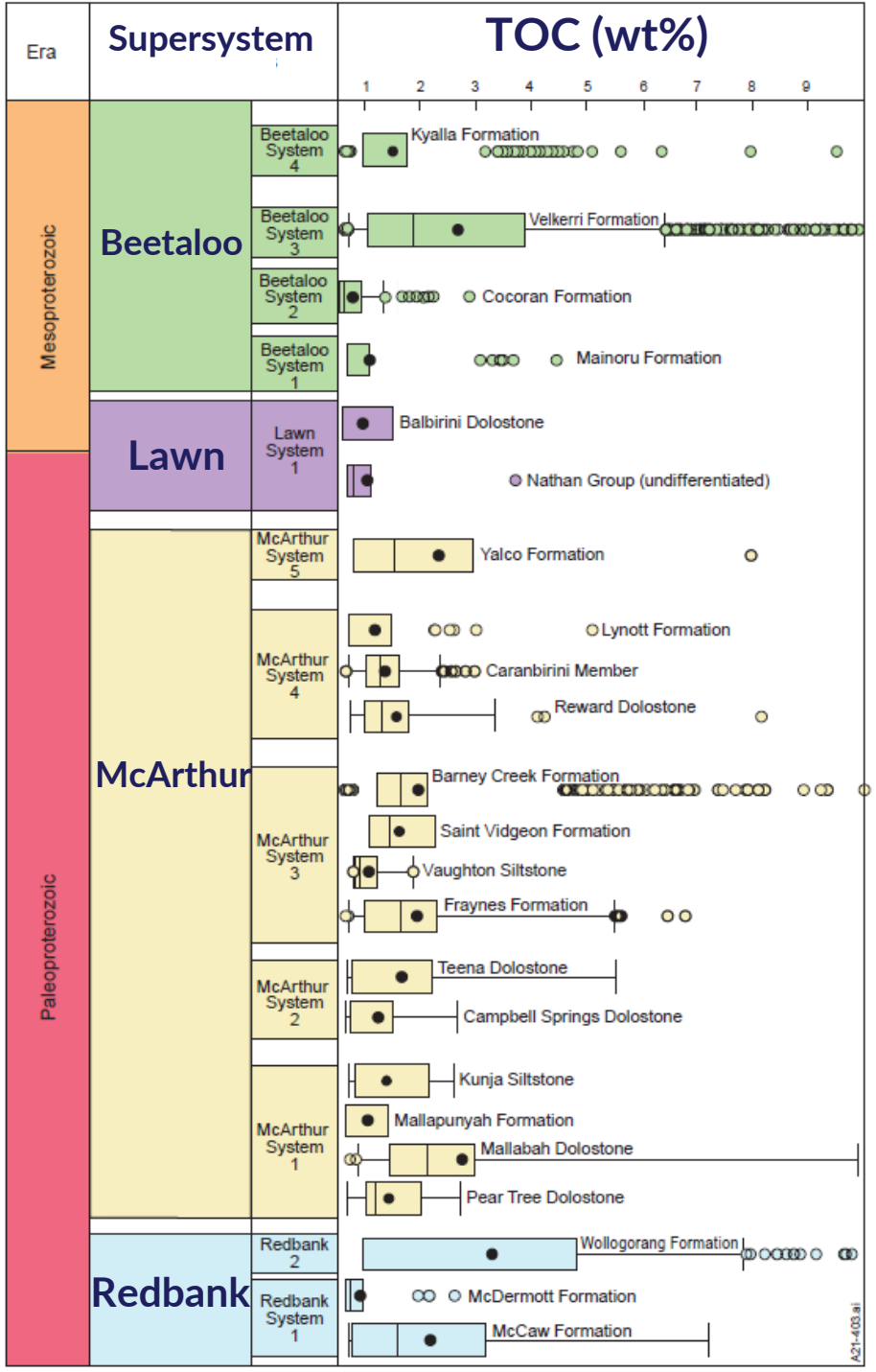
- Continent-scale framework linking basins of similar age, depositional environment and hydrocarbon potential
- Can be used to make predictions in frontier regions
- Definition based on organic-richness and a hydrocarbon show
- Bradshaw *et al.* (1994) defined two Proterozoic supersystems

Petroleum Supersystems
(continent to basin)





Cover image: Tim on the Vaughton Siltstone, Balma Group, Northern McArthur Basin (McArthur Supersystem)
https://www.geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/82595



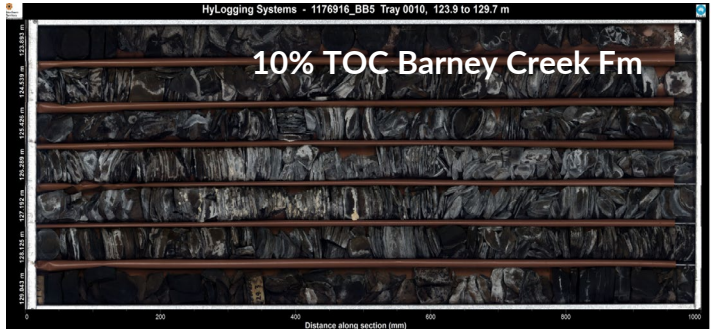
Beetaloo Supersystem

(formerly Urapungan Supersystem, new systems 1 and 2)
See Jarrett *et al.* (2022) AGES

Newly defined Lawn Supersystem

McArthur Supersystem

(new systems 1, 2, 4, 5)



Newly defined Redbank Supersystem

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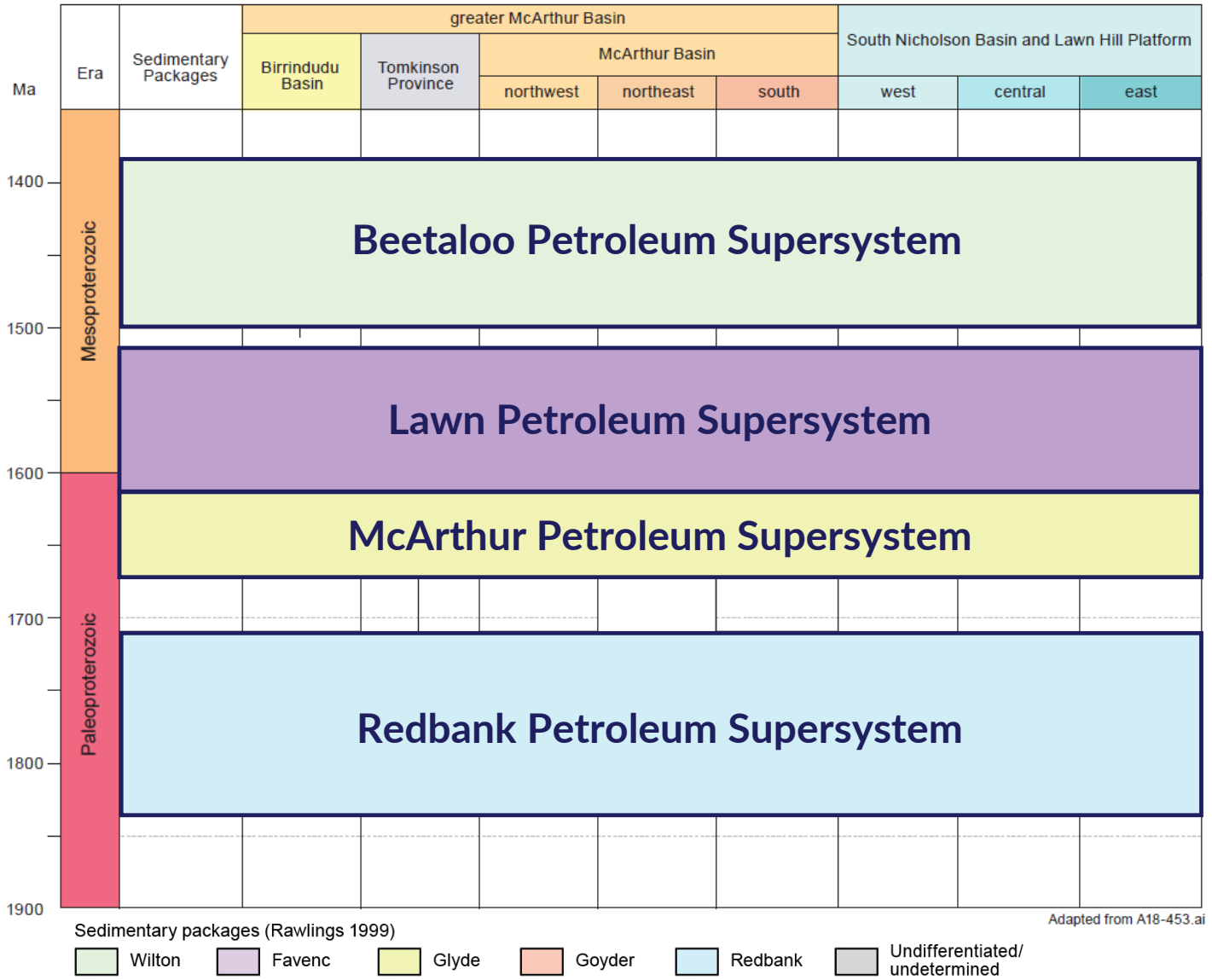
Petroleum supersystems (continent to basin scales)



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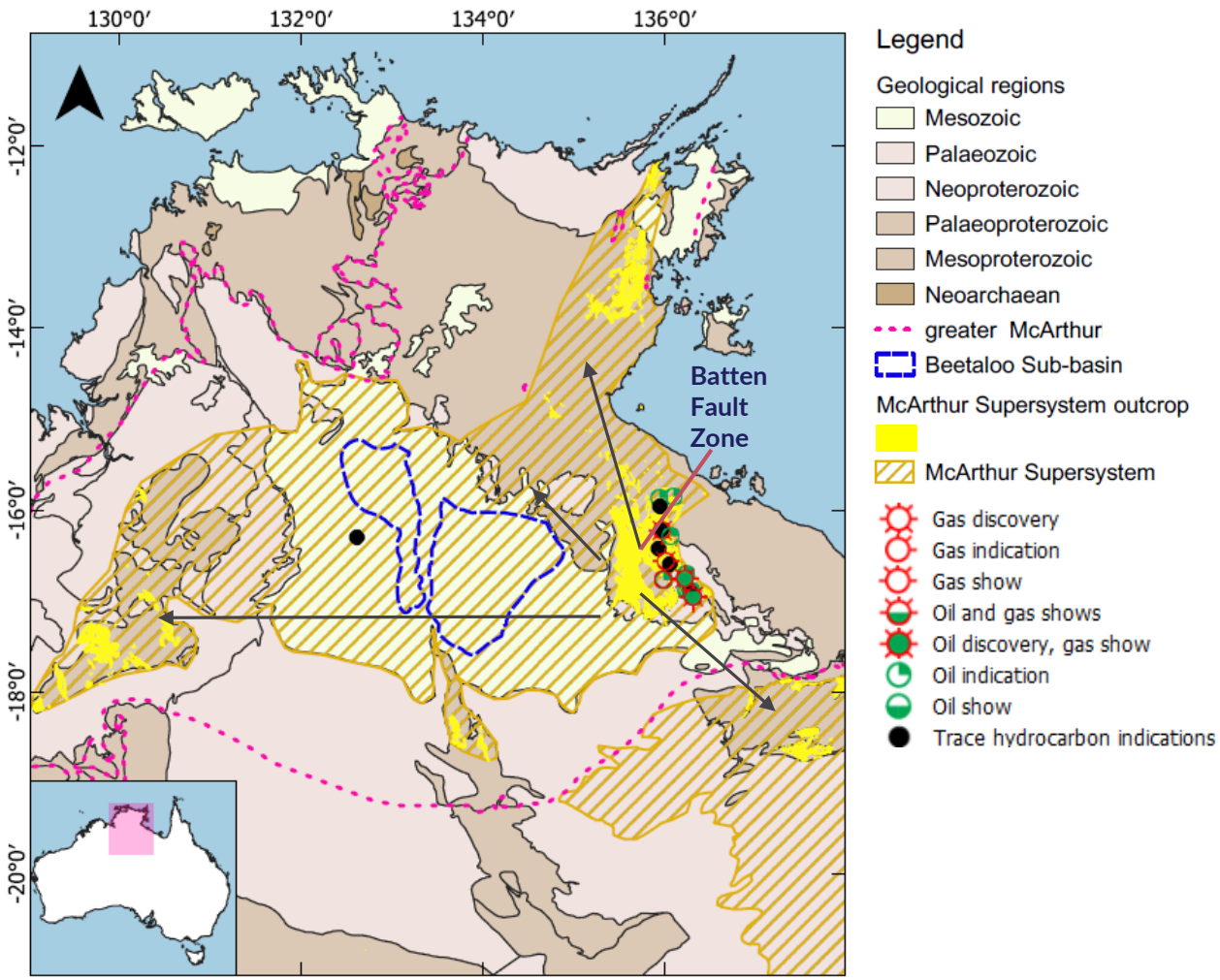
Petroleum Supersystem (continent to basin scale)
McArthur Supersystem

- Named by Bradshaw *et al.* (1994)
- Includes Paleoproterozoic shales from the Birrindudu and McArthur basins and the Lawn Hill Platform
- Multiple discoveries and hydrocarbon shows in the Batten Fault Zone
- Can predict potential systems in frontier basins or regions of the greater McArthur Basin
- Uncertainties beneath cover due to minimal well penetration and seismic



Petroleum Supersystems
(continent to basin)

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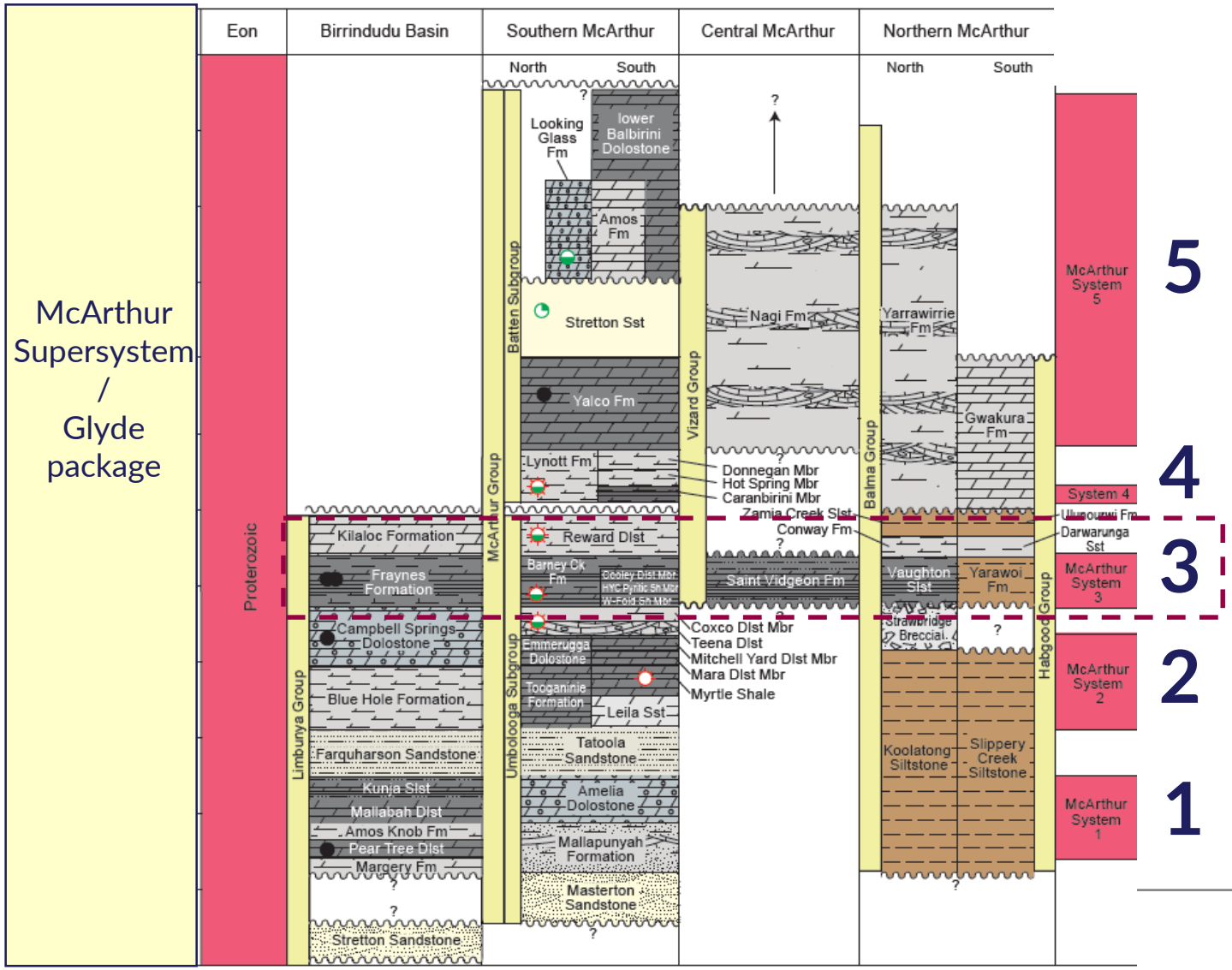
McArthur Supersystem



- McArthur Supersystem contains five systems
- All have excellent source rock potential (TOC >5%)
- Barney Creek Formation has best well penetration, thus is best defined
- Higher uncertainties in the central and northern McArthur Basin because of no/poor well control
- Can our understanding of Barney Creek Formation be used to make predictions on contemporaneous shales?

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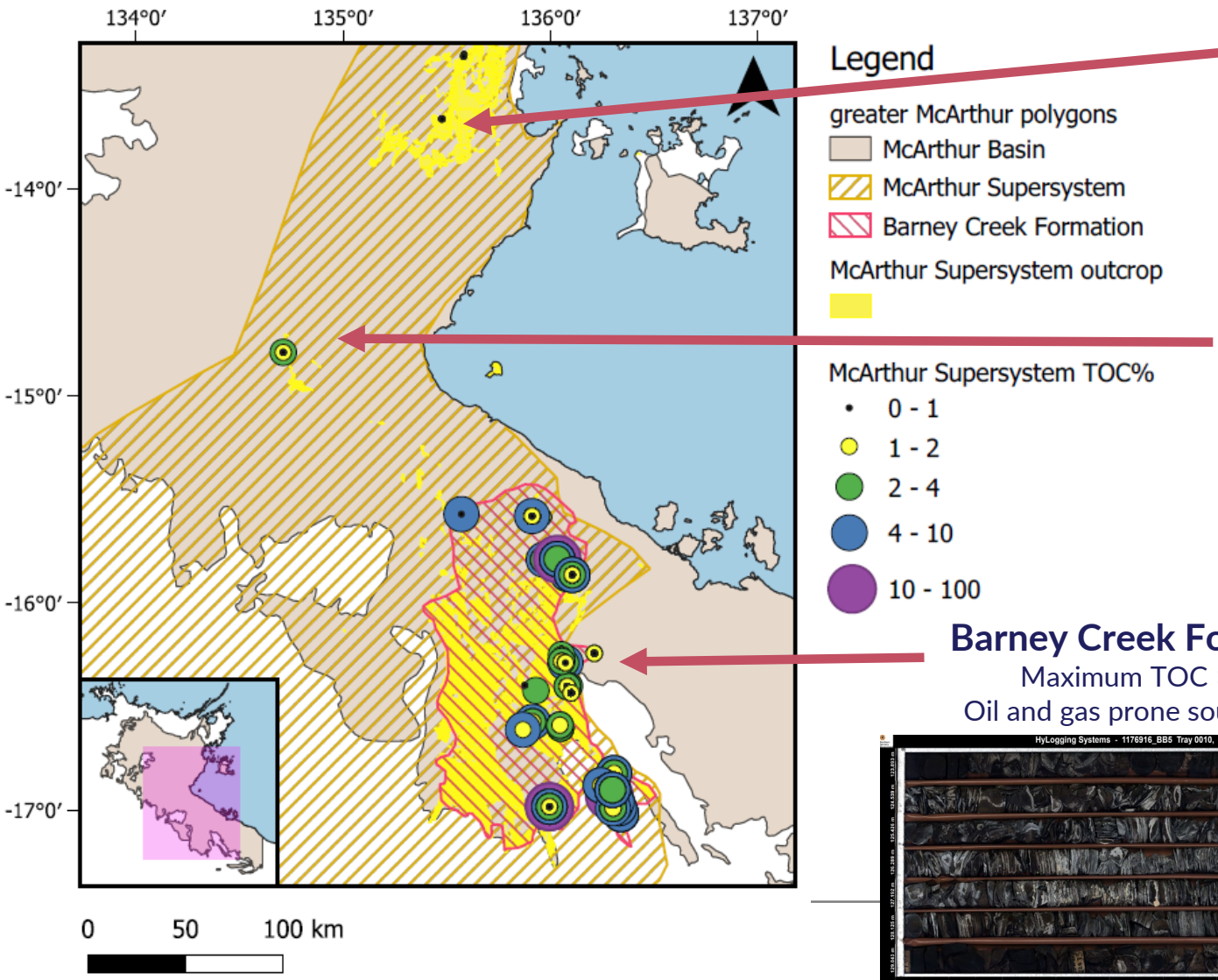
McArthur System 3

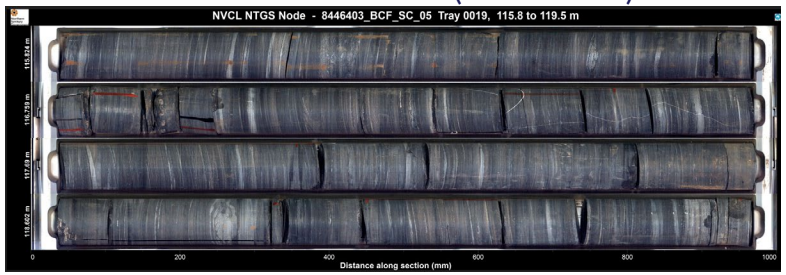


Vaughton Siltstone

(outcrop only)
Maximum TOC 1.3%

BCF SC 04- Saint Vidgeon Formation

Imperial Energy and NTGS drilling collaboration hole
Maximum TOC 1.5% (overmature)



Barney Creek Formation

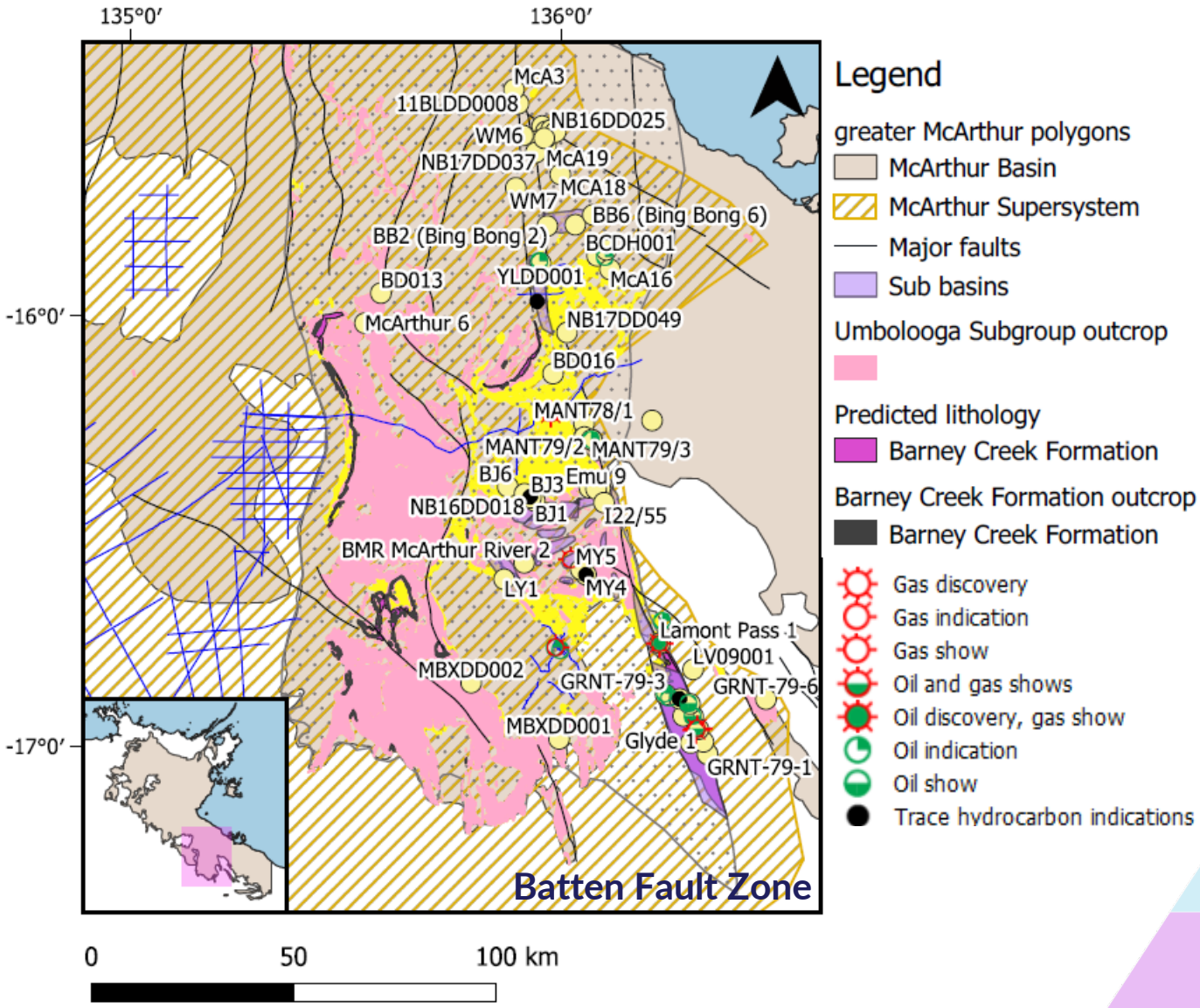
Maximum TOC >10%
Oil and gas prone source rocks

Glyde 1 gas flare

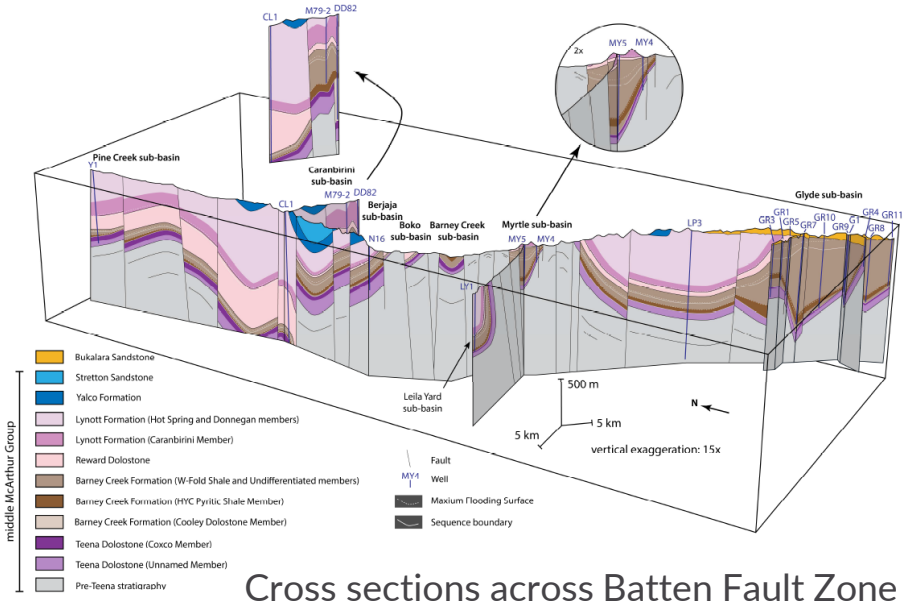
Image from Armour Energy ASX Release
https://www.asx.com.au/asxpdf/20210303/pdf/44t9hj0xxq4z9n.pdf

Petroleum systems (basin- to play-scale)

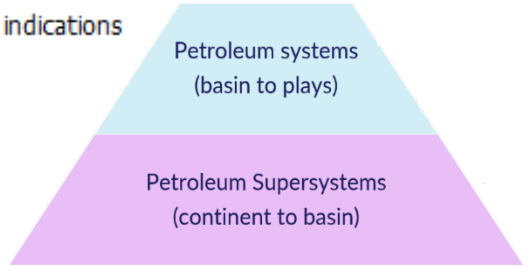
McArthur System 3 focus



- Hydrocarbon discoveries, shows and flows
- Thickest and deepest sections in structural sub-basins

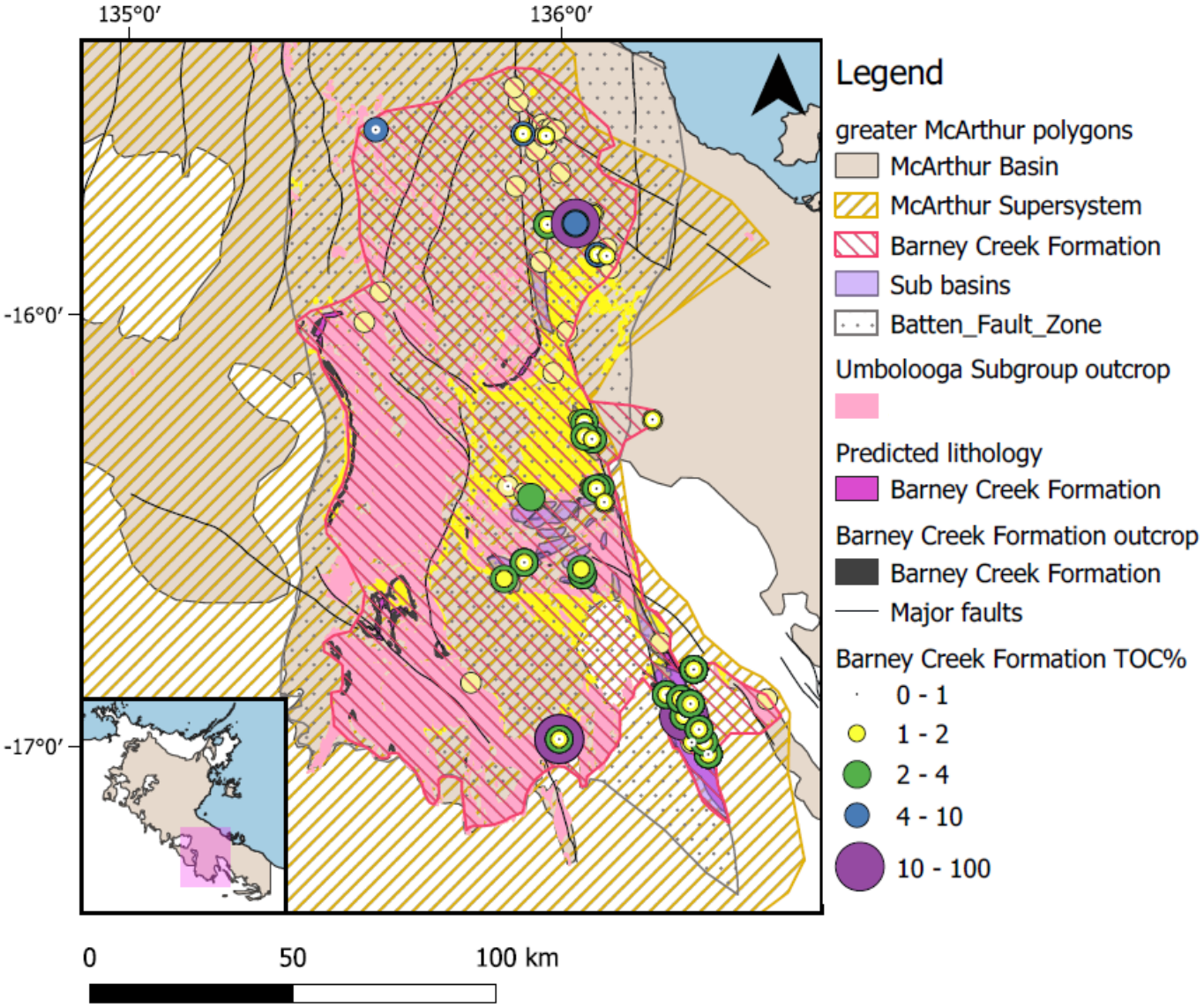


Cross sections across Batten Fault Zone
Kunzmann *et al.* (2019)
NTGS Record 2019-016



Petroleum systems (basin to play scale)

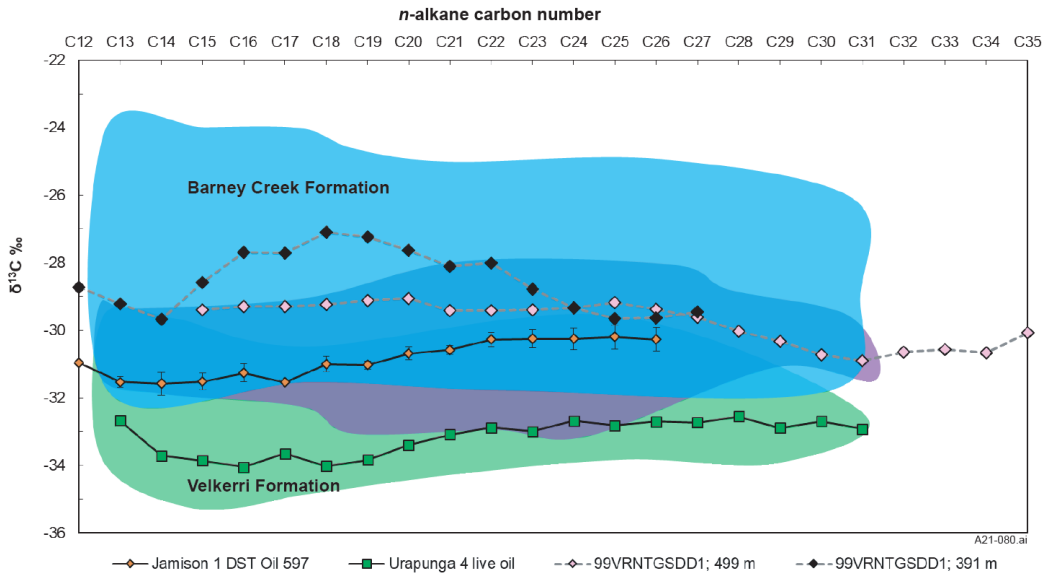
McArthur System 3 focus



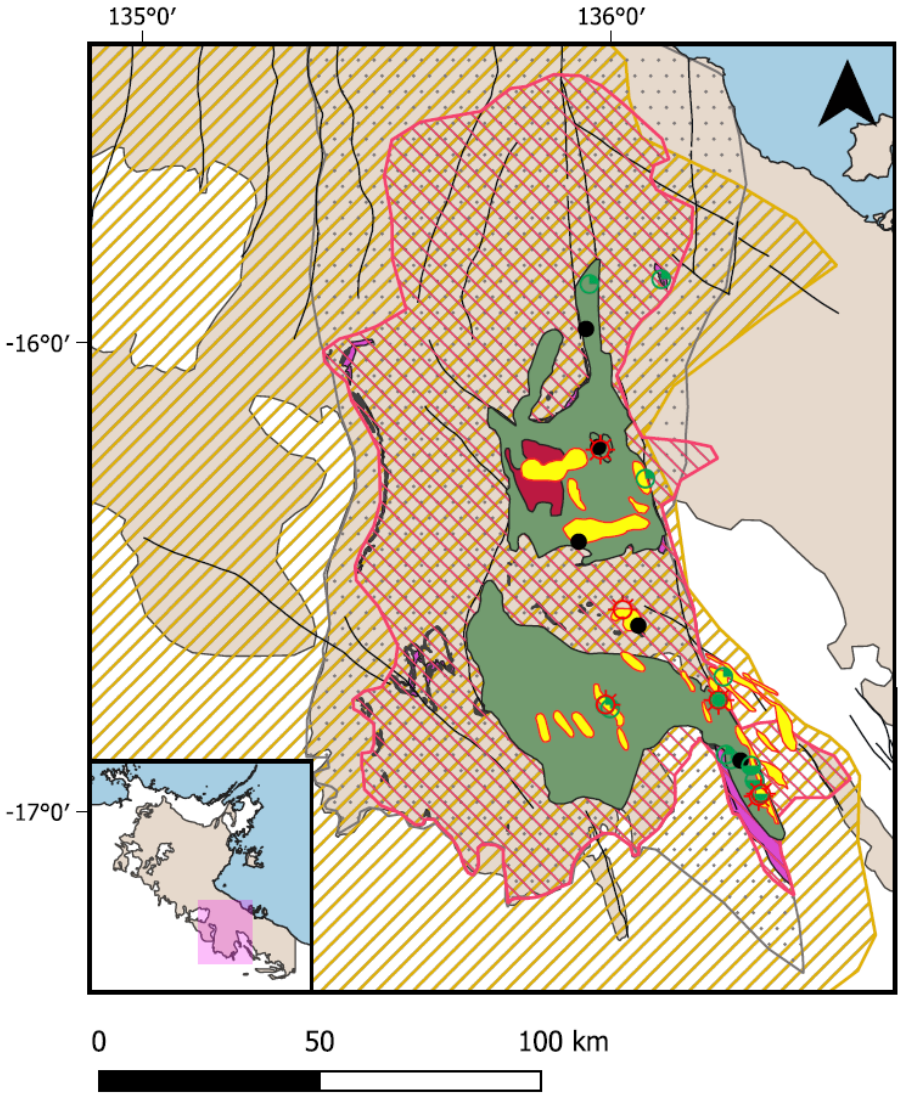
- McArthur System 3 extent based on outcrop, seismic and intersecting wells
- Good to excellent TOC throughout the basin
- Detailed geochemistry for Barney Creek Formation and related oils and source rocks (Jarrett *et al.* 2019 AGES)

McArthur Supersystem 3

Oil and source rock geochemistry available



Petroleum play types (play- to prospect-scale)

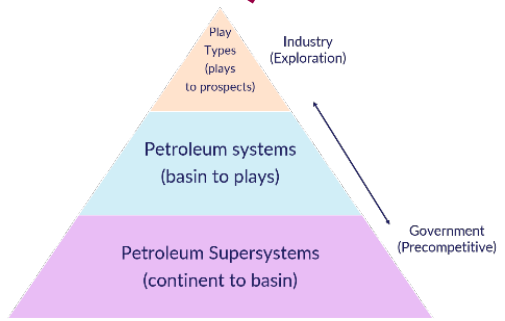


Legend

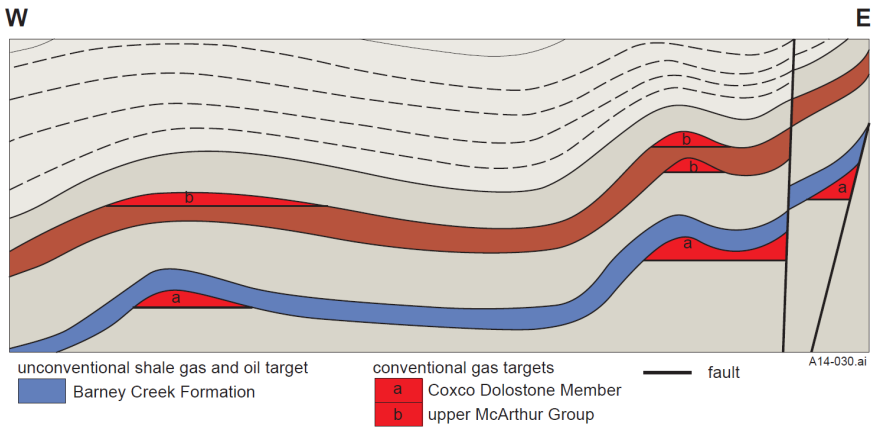
Geological regions
- Mesozoic
- Neoproterozoic to Palaeozoic
- Palaeoproterozoic
- Neoarchaean
- McArthur Supersystem

Major faults

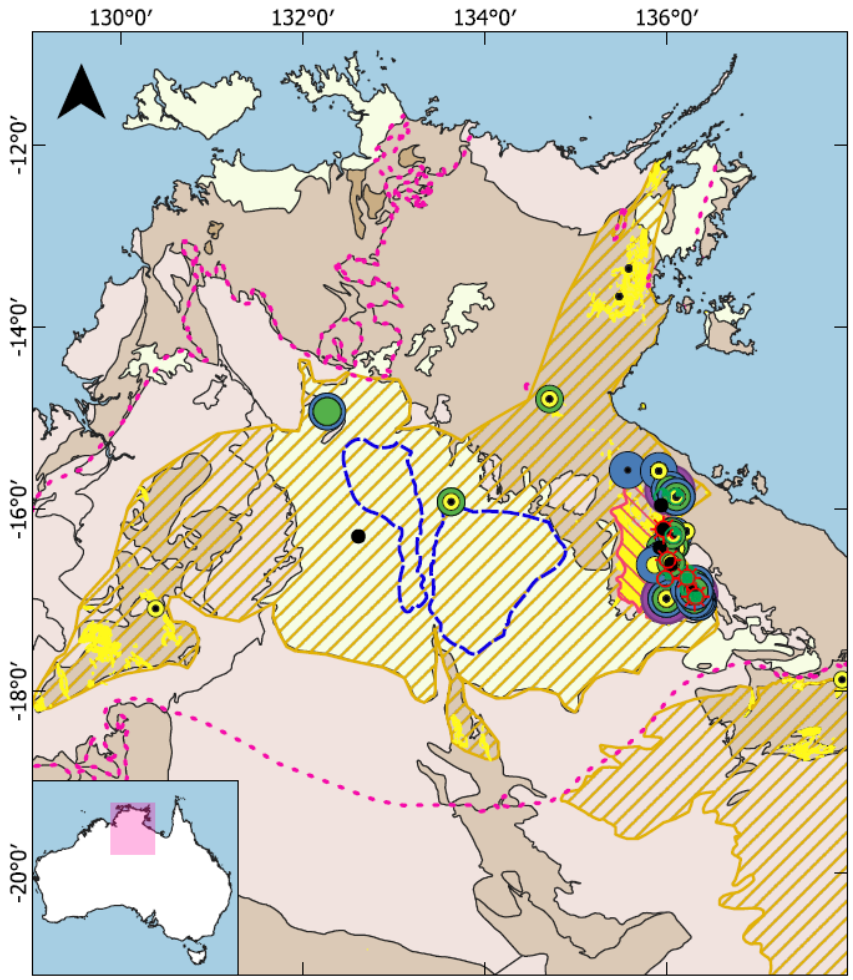
- Barney Creek Formation drillcore intersections
- Barney Creek Formation extent
- Barney Creek - Teena/Reward(!) leads
- Barney Creek- dry shale gas play
- Barney Creek- wet shale gas play
- Gas discovery
- Gas indication
- Gas show
- Oil and gas shows
- Oil discovery, gas show
- Oil indication
- Oil show
- Trace hydrocarbon indications



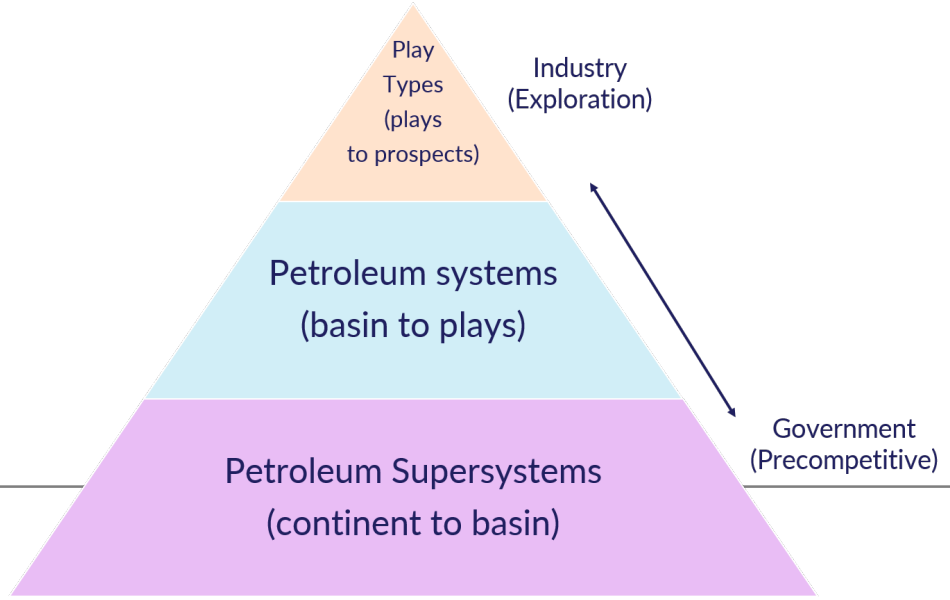
- Conventional gas plays
- Unconventional wet and dry gas leads
- Challenges still exist in correlating units across the basin and testing these plays



Summary and next steps



- We present a new exploration framework across the greater McArthur Basin
- Petroleum system framework will be released as an NTGS Record
- Challenges still exist in correlating units across the greater McArthur Basin and testing these plays
- Systems have the flexibility to be updated as required



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Thank you

Any questions please email
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Data access questions please email
Geoscience.Info@nt.gov.au

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'Fossilised Koala' Caranbirini Mbr, Photo: J.J. Brocks