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Source rocks of the Birrindudu Basin: Perspectives from a new sampling program

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Source Rocks of the Birrindudu Basin

Perspectives from a new sampling program

Grace A. Butcher[A], Emmanuelle Grosjean[A], Tehani J. Palu[A], Padmasiri Ranasinghe[B], Richard H. Kempton[C] and Siyumini Perera[C]

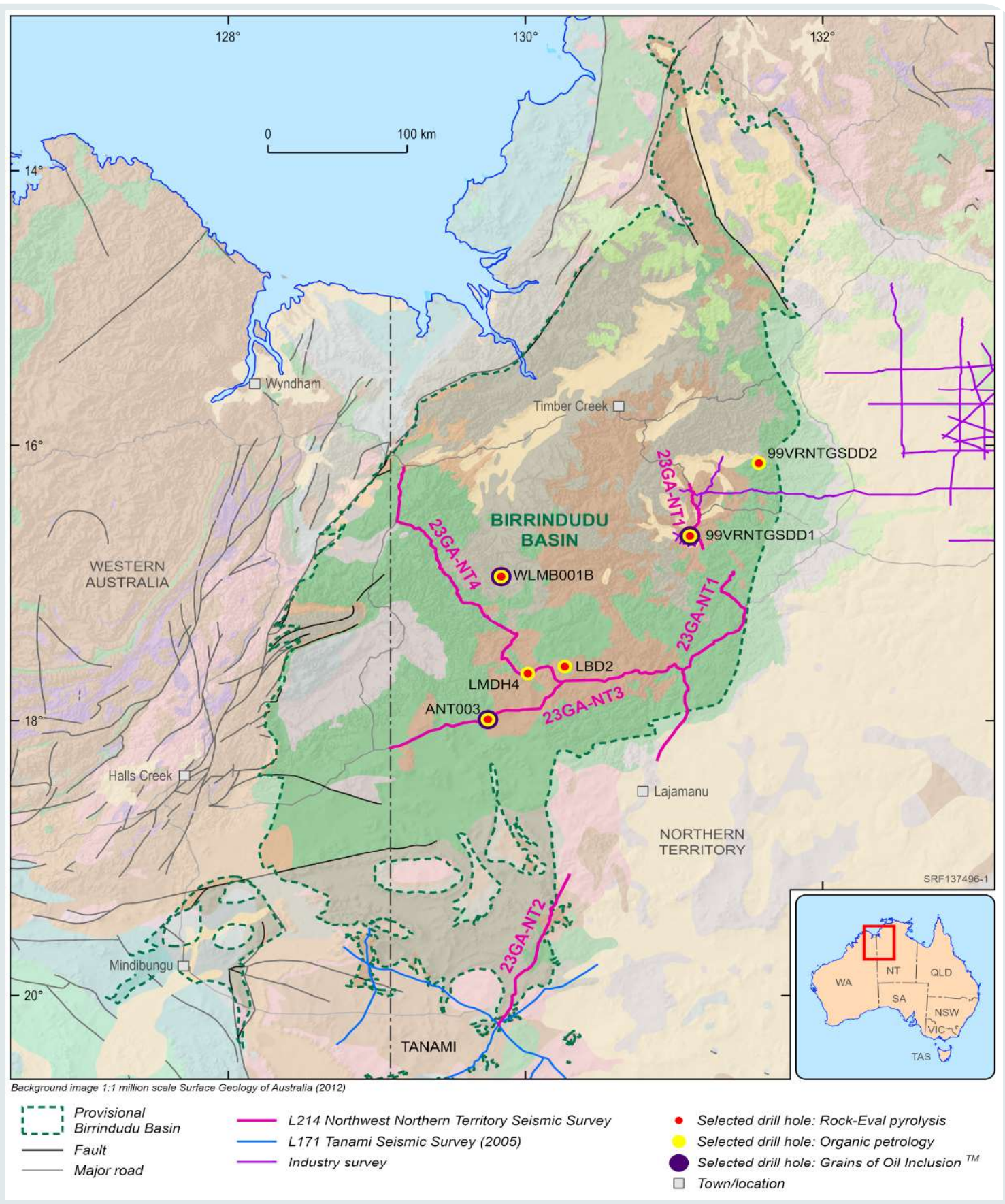
[A]Geoscience Australia, Canberra, ACT, Australia.
[B]Energy Resources Consulting Pty Ltd, Brisbane, QLD, Australia.
[C]CSIRO, Kensington, WA, Australia.

Overview

The Birrindudu Basin is an underexplored frontier basin. Newly collected drill core samples from legacy drill holes were analysed for organic geochemistry and petrology. These new data provide an update on understanding the source rocks and petroleum systems in the Birrindudu Basin.

Hylogger imagery of LMDH4 426.2–431.7 m section of the Mallabah Dolostone

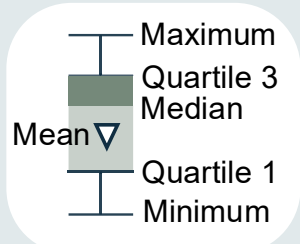
Hylogger imagery of ANT003 295–302.7 m (stratigraphy unknown)



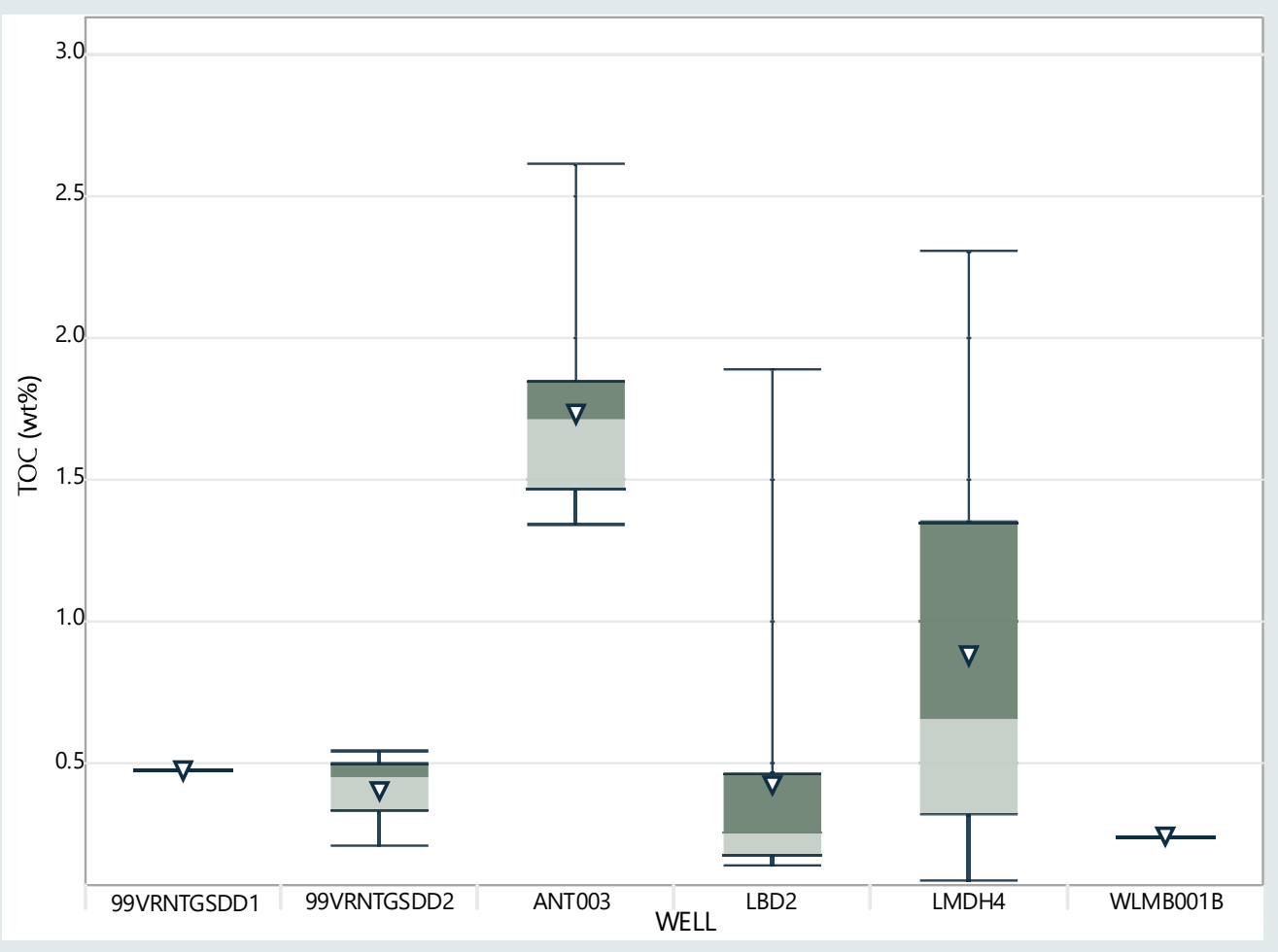
Regional geological map showing the provisional Birrindudu Basin outline (dashed), drill holes for selected analyses and seismic survey lines.

New Rock-Eval Pyrolysis Data

- 178 samples analysed for hydrocarbon potential (Butcher *et al.* 2023), including previously unsampled drillholes ANT003 and LBD2
- After quality analysis (Grosjean *et al.* 2023), 48 samples remain
- LMDH4 and ANT003: 'good' organic richness with Total Organic Carbon (TOC) 2–4 wt.%
- LBD2: 'fair' organic richness with TOC 0.5–2 wt.%
- About half of the samples lack organic matter
- 99VRNTGSDD1 (over 300 m) and WLMB001B (240 m to 793.6 m) show no structured organic matter
- 99VRNTGSDD1, 99VRNTGSDD2, WLMB001B: TOC below 0.5 wt. %

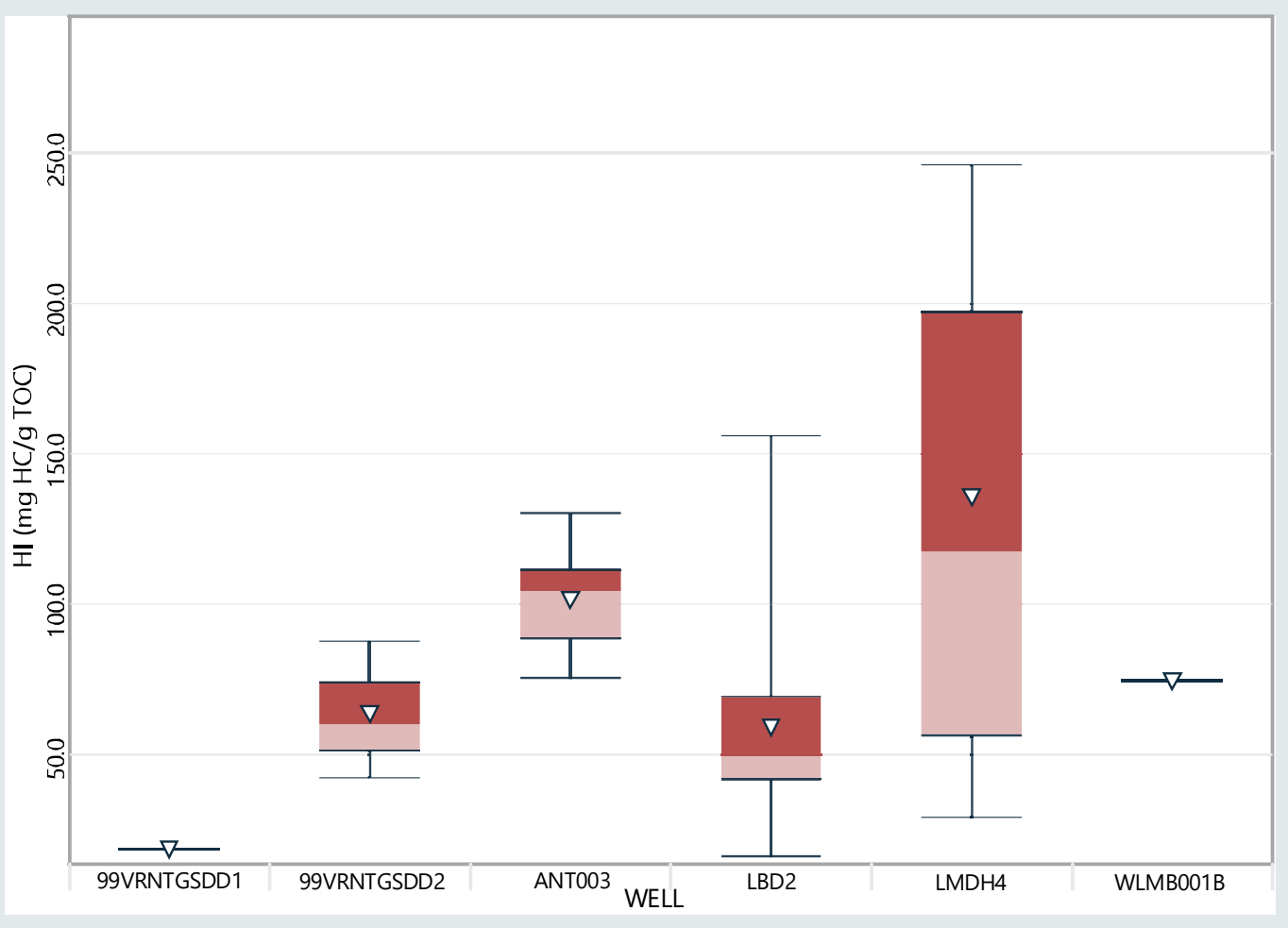


TOC



Box and whisker plots showing results of the 48 TOC samples from the 6 wells sampled

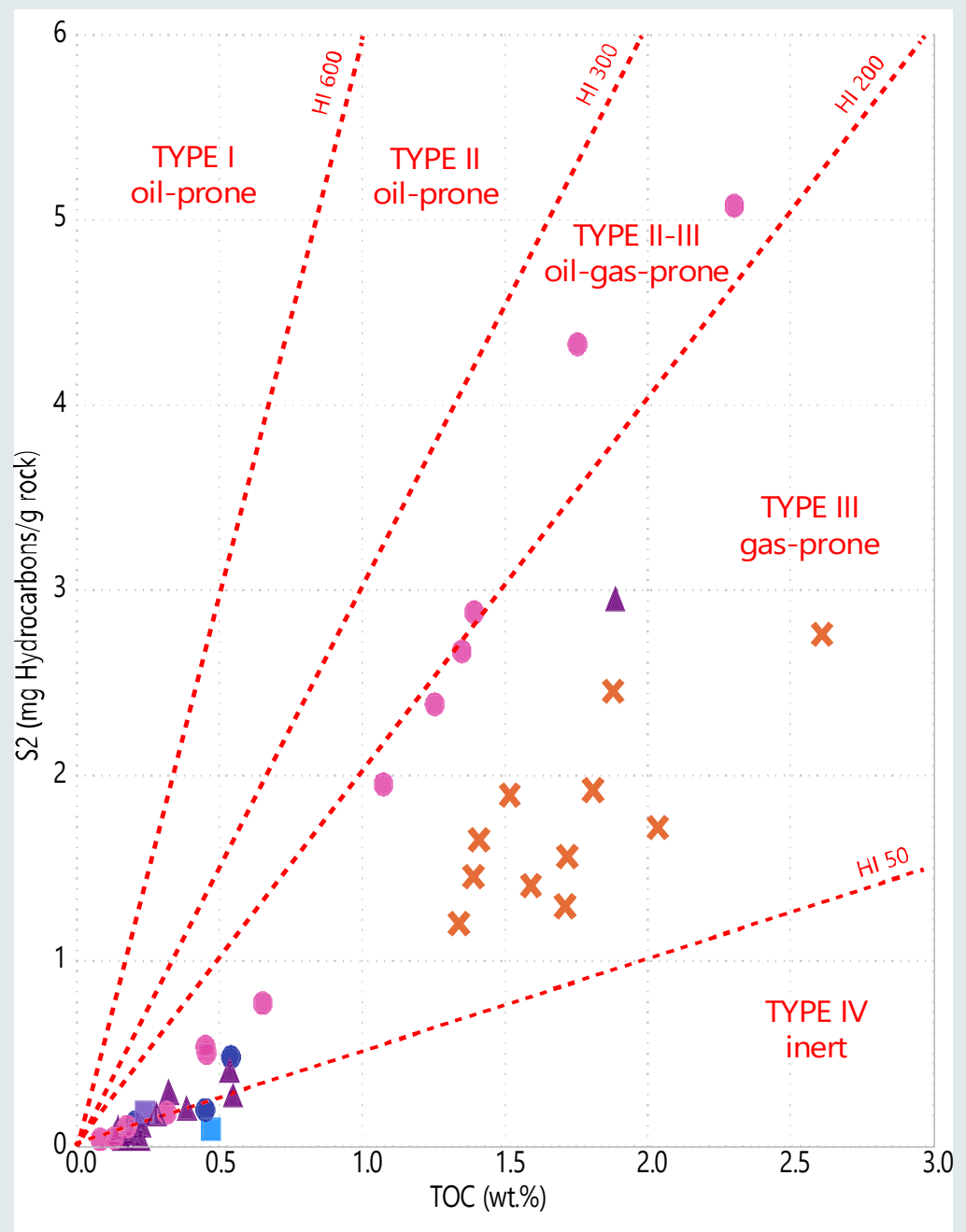
HI



Box and whisker plots showing results of the 48 HI samples from the 6 wells sampled

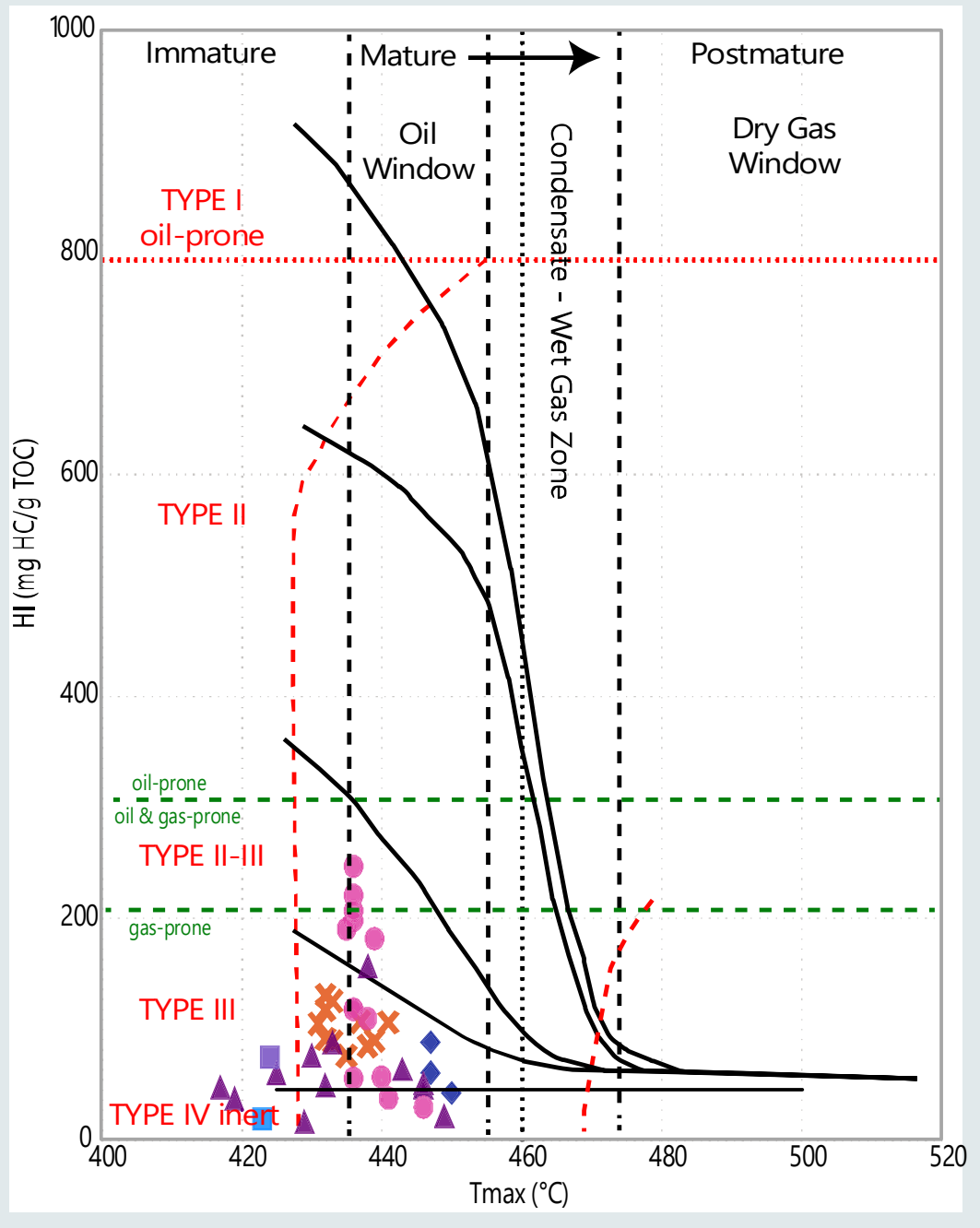
- Present-day Hydrogen Index (HI) indicates:
  - LMDH4: prone to generate gas or mixed oil and gas
  - ANT003: gas-prone
  - 99VRNTGSDD1, 99VRNTGSDD2, WLMB001B: inert

TOC vs. S2 Yield



Plot of TOC vs S2 for all 6 wells

Tmax vs. Hydrogen Index



Plot of Tmax vs HI for all 6 wells

■ 99VRNTGSDD1 ◆ 99VRNTGSDD2 × ANT003 ▲ LBD2 ● LMDH4 ■ WLMB001B

Acknowledgements and References

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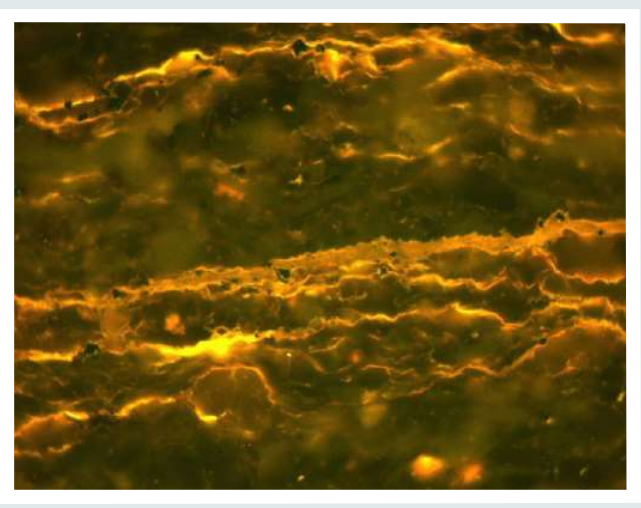
TGS HyLogger Data from GEMIS https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/81429

New Thermal Maturity Data

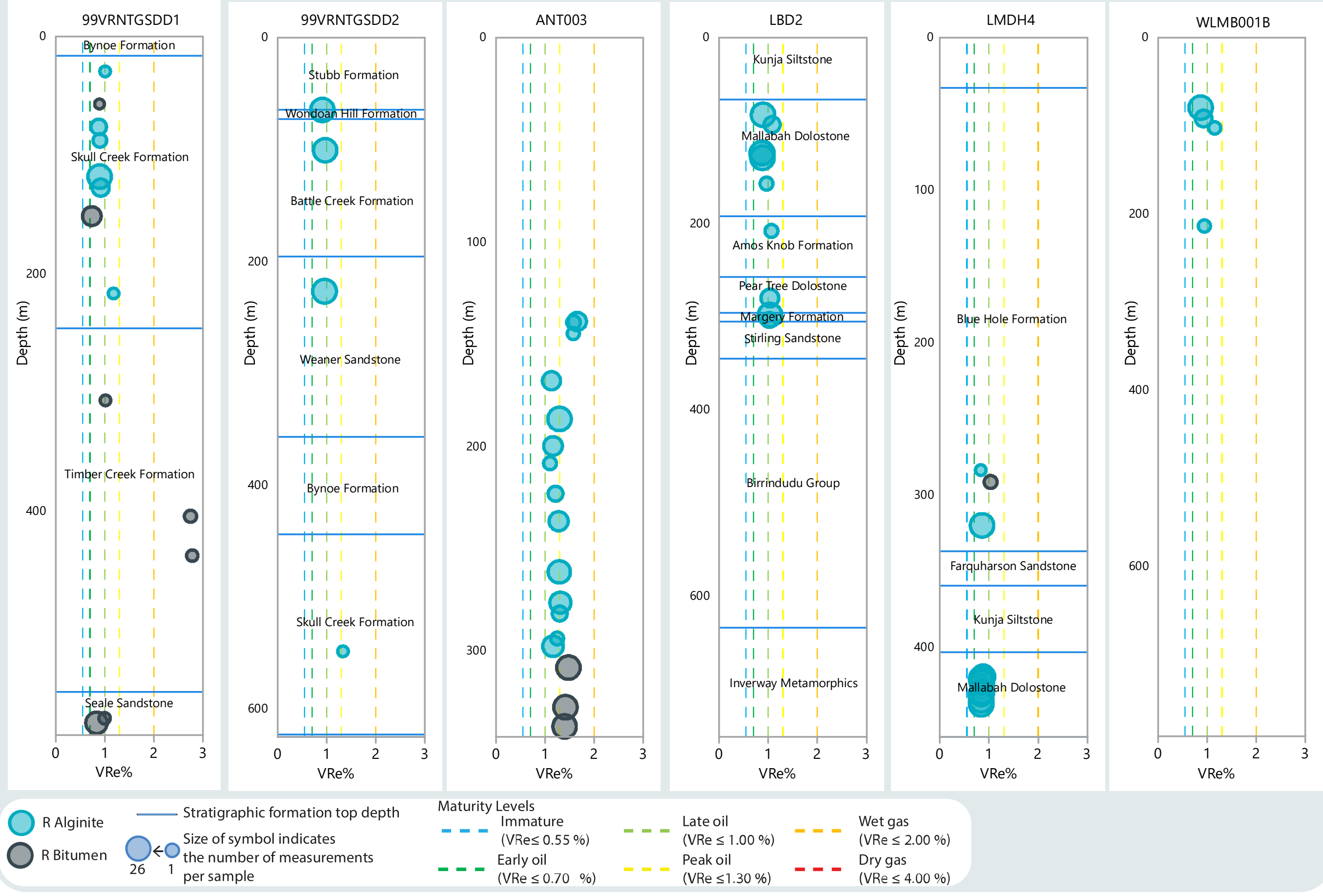
- 130 samples analysed for organic petrology (Ranasinghe and Crosdale 2023)
- Predominant maceral type: fluorescing alginite, likely from filamentous cyanobacteria
- Bitumen is the most common unstructured secondary organic matter
- Alginite and bitumen reflectance used for thermal maturity assessment
- Formulas for vitrinite reflectance equivalent values (VRe%):
  - Alginite: $VRe\% = 0.708 * e^{(0.33716 * R\ Alginite)}$ (Faiz *et al.* 2022)
  - Bitumen: $VRe\% = 0.87 * R\ Bitumen + 0.25$ (Luo *et al.* 2021)



Low reflecting alginite in silty claystone, RAlginite = 0.44% LMDH4 420.8–420.82 m (Blue light excitation, X50)

- 99VRNTGSDD2 and ANT003: peak oil zone, overmature at the base (reached wet gas maturity)
- WLMB001B, 99VRNTGSDD1, LBD2, and LMDH4 are largely within the oil window
- Reflectance measurements in WLMB001B acquired only at the top (rocks below 240 m barren of organic matter)
- Best source potential in LMDH4, with a 17 m thick alginite-rich zone

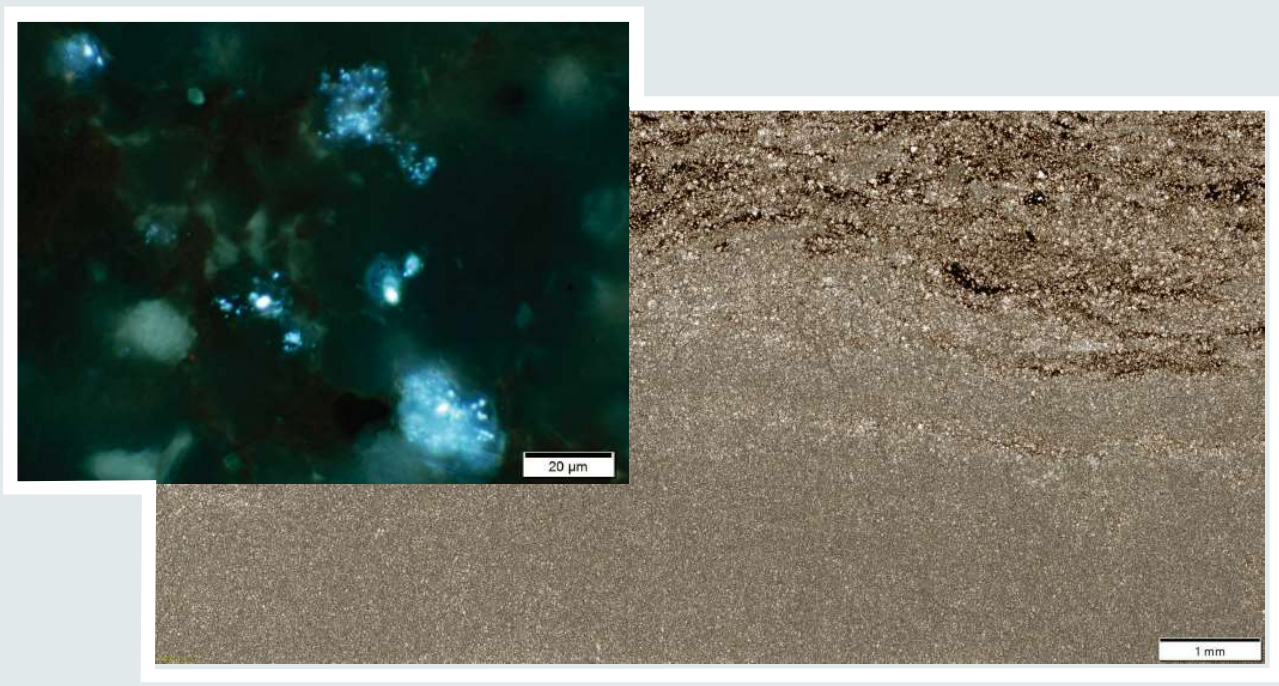
Vitrinite Reflectance Equivalent Profiles



Evidence for Oil Migration

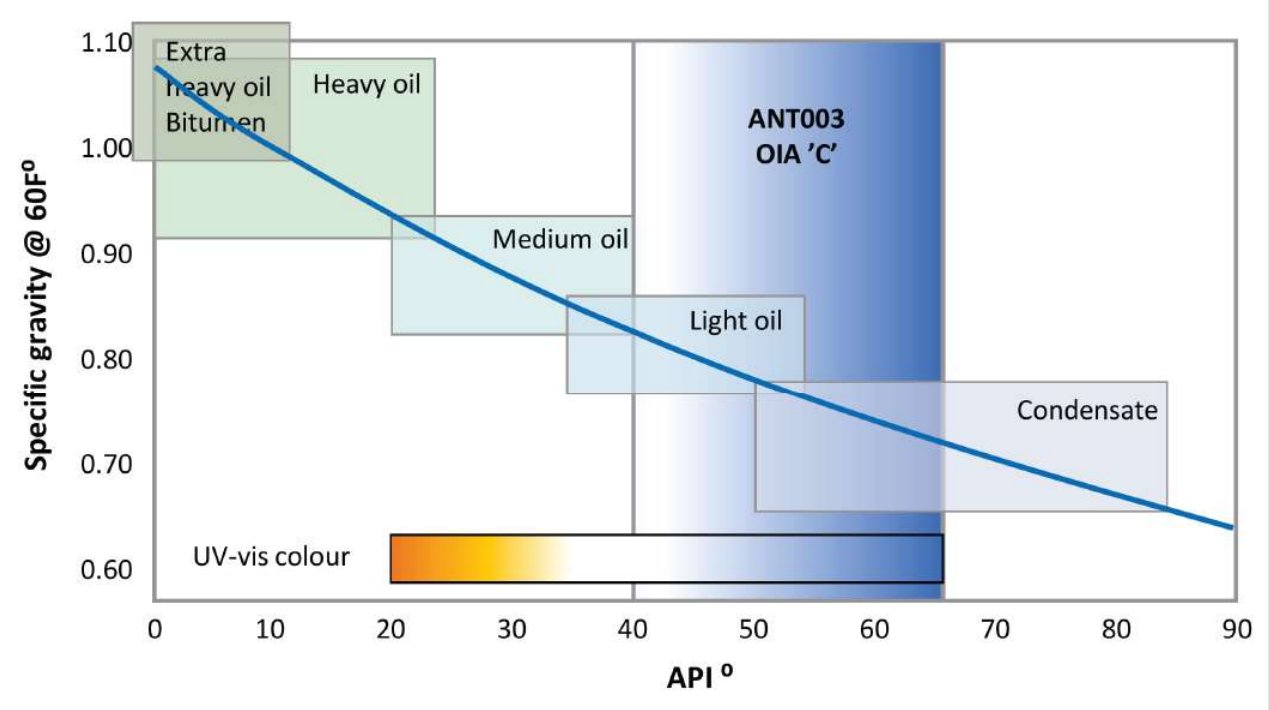
- 45 samples analysed for hydrocarbon-bearing inclusions (Kempton and Perera 2023)
- Grains with Oil Inclusions (GOI™) and Frequency of Oil Inclusions (FOI™) methods
- WLMB001B and ANT003 found to contain oil-filled inclusions

ANT003



Oil inclusion assemblage 'C' – ANT003 305.90–309.97 m

- Elevated FOI values (up to 98%) in calcitic dolomicrite samples between 305 m and 343 m



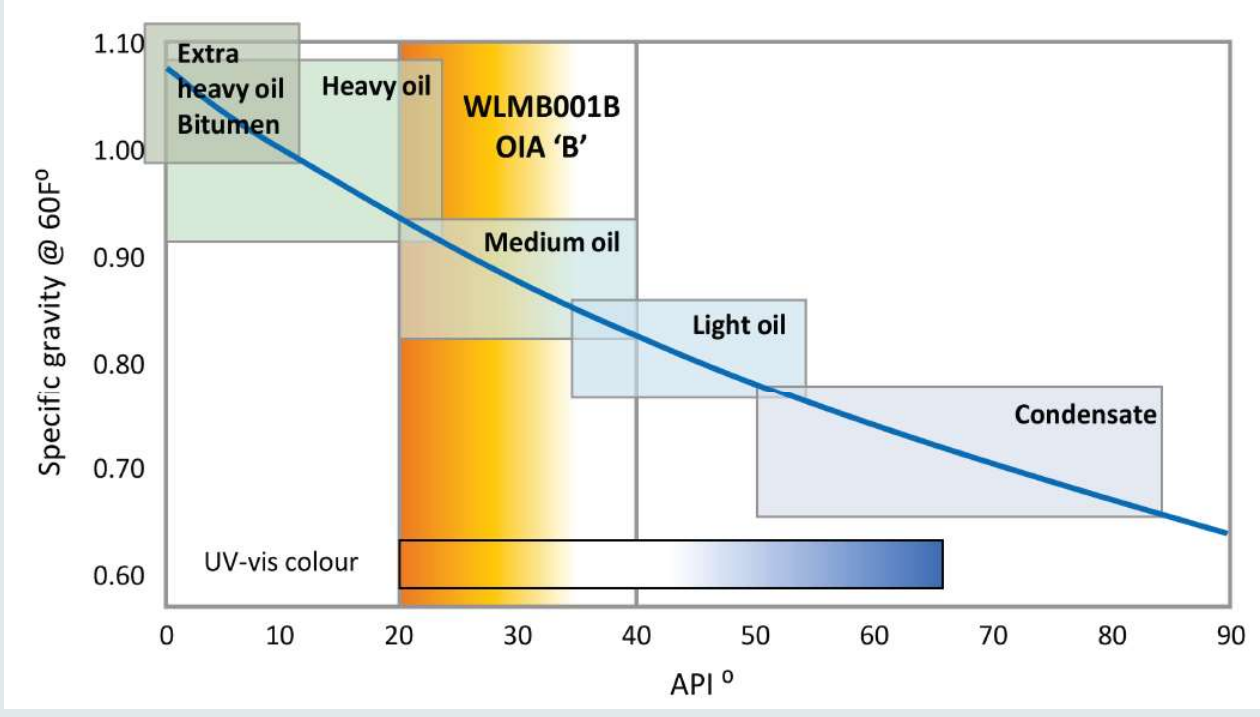
ANT003 – Inference of API gravity for OIA 'C'

- Primary migration — in-situ generation from local organic matter with limited migration
- Entrapment of a light gravity oil (>40°API)

WLMB001B

Oil inclusion assemblage 'B' – WLMB001B 484.30–484.40 m

- Elevated FOI values (up to 100%) confined to calcite-filled veins between 444 m and 521 m



WLMB001B – Inference of API gravity for OIA 'B'

- Secondary migration — strong evidence for paleo-oil migration through fracture pathways now cemented by hydrothermal calcite
- Entrapment of a medium gravity oil (<40°API)

Conclusions

- New geochemical analyses from various drill cores (99VRNTGSDD1, 99VRNTGSDD2, ANT003, LBD2, LMDH4, WLMB001B) in the Birrindudu Basin (publicly available)
- Sampled sections in drill holes are thermally mature for hydrocarbon generation
- Alginite, likely from filamentous cyanobacteria, is the main organic maceral that is detected
- Hydrocarbon-generating potential confirmed in several rocks
- Best oil-generating potential identified in LMDH4 in Mallabah Dolostone
- FOI™ results indicate generation and migration of oil in the basin demonstrating elements of a petroleum system

Further information on information in this poster can be found at https://www.eftf.ga.gov.au/officer-musgrave-birrindudu

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