UNDERSTANDING UNCONVENTIONAL PETROLEUM RESOURCES OF THE GREATER MCArTHUR BASIN FROM POTENTIAL FIELD, WELL AND SEISMIC DATA

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Outline

• Introduction
• Datasets
• Regional Geology
• Basement interpretation
• SEEBASE™
• Seismic and well data
• Integration of datasets
• Conclusions
Introduction

- Based on historic seismic and well data
- Integrated with potential field data in order to extend interpretation beyond the limited seismic and well data
Potential Field Data

Bouguer

200km HP Bouguer

RTP

Ternary of RTP
Regional Geology

- Stratigraphy
- Definition of basement
  - Crystalline basement
  - Economic basement
  - Magnetic basement

Surface geology
(modified from NTGS and GA)
Regional Geology

Stratigraphic columns modified from Rawlings et al. (2004; left) and Bradshaw et al. (2000; right).
Basement Terranes

- North Australian “craton” = amalgamation of smaller terranes during Barramundi Orogeny (1870-1820 Ma)
- Two smaller cratons
- Some relatively competent blocks with minimal reactivation
- Some elongate curvilinear belts with evidence of repeated reactivation
SEEBASE™

- 3D depth to basement model (magnetic basement)
- Hand contoured
- Integrated *structural model* based on basement rheology and tectonic events history
- Allows prediction of depocentre geometry and location

Updated SEEBASE™ depth to basement 3D model
SEEBASE™

- Basement depth from magnetic data
- >3.5s TWT = 7 km (or more)
- Depocentre deepens to south 8-10km

Modified from Bradshaw and Scott (1999)
SEEBASE™

- Calibrate interpretation of depth to magnetic basement using seismic data

Need to understand the basement composition in order to interpret the 3D geometry of basement and the potential distribution of the unconventional targets.
Risks

Derim Derim Dolerites ~1324 Ma

Antrim Basalt ~510-500 Ma

In covered areas, magnetic data can be used to assess the distribution of Upper Roper Group stratigraphy which includes the Kyalla and Velkerri unconventional targets.
McArthur - Isa groups

Well documented in some areas; poorly known elsewhere

Significant variations in thickness and preserved stratigraphy

Superbasins

- Mesozoic cover
- Paleozoic cover
- Kalkarindji Suite (Antrim)
- Neoproterozoic
- Roper / Wilton pkg
- Fitzmaurice

Surface geology

(Modified from NTGS and GA)
McArthur - Isa groups

Barney Creek is present in the Batten depocentre but absent on Malapunyah Ridge and Wearyan Shelf.

Seismic and gravity model from Rawlings et al. (2004)

SEEBASE™ depth to basement model
Estimated thickness of McArthur – Isa gp in red
McArthur - Isa groups

Growth into ~ENE and ~NNW faults
Beetaloo Sub-basin

Focus on Roper Group

Kyalla and Velkerri

2D seismic and well data provide good understanding of stratigraphy, but deep horizons are not well image and only local “hints” of basement.
Well and Seismic data

Well data, logs, rock properties database; well composites and well ties

Assess maturity and prospectivity

Interpreted present-day hydrocarbon maturity based on pyrolysis data (e.g., Tmax), organic petrology measurements (alginate reflectance values and maturation parameters such as the methyl-phenanthrene index (MPI-1)).
Seismic Data

Kyalla and Velkerri Depth Surfaces

Ternary Image of Bouguer
Integration and Prediction

Near top Velkerri Formation

Extrapolated Near top Velkerri Formation

Stratigraphic Model

SEEBASE™ Model
Conclusions

Importance of understanding basement
Conclusions

- **Basement** – major control on deposition and inversion in overlying basins, e.g.
  - Arnhem and Wearyan shelves
  - Murphy Inlier
  - Batten and Walker troughs
- **McArthur / Isa groups** - major variations in thickness and preserved stratigraphy
  - Thickest McArthur / Isa deposited in E-W (Lawn Hill) and N-S (Batten-Walker) depocentres – controlled by basement terranes
  - Uplift and erosion controlled by basement terranes and variations in basement rheology
- **Roper Group** – more uniform stratigraphy
  - Some syn-depositional variation but most variation in thickness related to erosion / inversion along major faults (especially terrane boundaries)
  - Thickest sections overlie competent basement (terranes and large granitoids)
- Prediction of new depocentres / sub-basins with prospective unconventional targets (thermally mature)