3D architecture of the Wilton package throughout the greater McArthur Basin: structural implication for petroleum systems at various investigation scales

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The Wilton package in the greater McArthur Basin

- Huge basin
- Complex stratigraphy and large thickness variations
- Simple rock-types
- Mainly flat-laying

Modified after Bruna et al., 2014 and DIP 015

Urapunga Fault Zone
- Hayfield mudstone
- Jamison sandstone
- Bukalorkmi Sandstone
- Kyalla Formation
- Sherwin Formation
- Moroak Sandstone
- Velkerri Formation
- Bessie Creek Sandstone
- Corcoran Formation
- Hodgson Sandstone
- Jalboi Formation
- Arnold Sandstone
- Crawford Formation
- Mainoru Formation
- Limmen Sandstone
- Mantungula Formation
- Phelp Sandstone

Dominant rock type
- Coarse clastic
- Fine clastic
- Mixed clastic (sandstone/shale)

Modified after Munson 2014

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Objectives

- Architecture of the subsurface of the greater McArthur Basin → 2 models
- What is the variation of thickness along key units?
- Zones of priority = refinements – economic targets?
- Identification of fault type
- How to represent these objects in a 3D model (property) ?
- Natural fracture directions
- Is there any directional pathways or barrier for fluid flow ?

Modified after Bruna et al., 2014 and DIP 015

Legend
- Repartition of the Wilton package in the greater McArthur Basin
- Exclusions of the Wilton package
- Limit of the regional model
- Limit of the small model
- Wells with geochemical investigations (Revie 2015)
Constraints of the model, 1 – Stratigraphy

Modified after Munson 2014

Dominant rock type
- coarse clastic
- fine clastic
- mixed clastic (sandstone/shale)
- source rock
- reservoir
- unconventional reservoir
- gas show
- oil show

Topography
- Unconformable contact

Cover
- Unconformable contact

Chambers River group
- Conformable contact

Bukalorkmi-Kyalla-Sherwin group
- Basemap contact

Moroak-Velkerri group
- Conformable contact

Bessie Creek-Corcoran group
- Basemap contact

Hodgson-Jalboi group
- Unconformable contact

Arnold-Crawford-Mainoru group
- Conformable contact

Limmen-Phelp group
- Basemap contact

Base Roper Unconformity
- Conformable contact

Ante-Roper Group
- Conformable contact

Regional model
- Small model

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Urapunga Fault Zone = Target of 2014 field season

- Digitisation of real top and real base of each of the selected groups of formations in the McArthur Basin s.s. and in the Tomkinson Province
- Collection of additional data along traverses close to existing seismic surveys → Balanced cross-sections
Constraints of the model, 2 – Surface data & XS

α version

β version
Constraints of the model, 3 – Seismic data

Recent reprocessed (closed) and reinterpreted (open) Roper Valley seismic survey

Available data are
- **Base Roper** Group unconformity
- Near top **Limmen** Sandstone
- Near top **Bessie Creek** Formation
- Near top **Moroak** Formation
- Near top **Jamison** Formation
152 wells re-investigated = stratigraphy + markers

- Markers represent top AND base of each considered stratigraphic interval
- The location of wells is confined to the central and the eastern part of the greater McArthur Basin
Constraints of the model, 5 – Faults

Modified after DIP 015
Constraints of the model, 5 – Faults

Fault wall

Slickensides

DIP 015
3D Model realisation, 1 – Regional scale

- Resolution of the regional model = 1200 m × 400 m (Horizontal-vertical)
- Three surfaces generated that fit to well, seismic, surface geology, faults throw and stratigraphic relationships
- All of these element are released in the Digital Information Package 012

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3D Model realisation, 1 – Grid

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3D Model realisation, 1 – Regional scale – grid

Grid population with the TOC property analysed with variographic analysis

This property is highly variable in space

High value of TOC are cyclic in vertical direction

Bodies organisation is patchy + trends in various horizontal directions

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Ellipsoid modelled from spheric variogram
3D Model realisation, 1 – Regional scale – grid

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Geometric anisotropy (High variability)

Ellipsoid modelled from spheric variogram

- A single simulation of the TOC repartition in the entire grid (not formation specific) → need refinement and combinations
3D Model realisation, 2 – Beetaloo scale

- Resolution of the small model = **700 m × 200 m (Horizontal-vertical)**
- Four surfaces generated that fit to *well, seismic, surface geology, fault throw and stratigraphic relationships*
- Resolution issues due to the strong thickness variation between shelf and basin
The future…

Legend
- filled with mineral
  - mode 1: "closed" joint
  - mode 2: largely open joint
- pin line

n=29
Mode = 8
Density = 9.11/m
Unimodal gaussian distribution

Scale: 1:462,100

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Small scale deformations, results

- Fracture type mode 1 (prior tilting) and mode 2 / Ø mechanic stratification

- N010-020, N070 and N120-140

- Statistical distribution does not clearly emphasize the presence of huge fault damaged zone
Conclusions

• **Large model → resolution 1200 × 400 m**
  - Provides the first regional structural framework for the greater McArthur Basin → fits with available data and can be refined as new data became available
  - Show the importance of large-scale WNW-ESE structures
  - The modelled deepest part of the basin coincides with wells showing the highest values of TOC
  - This model is accessible for everyone in DIP 012 (Bruna and Dhu, 2015)

• **Small model → resolution 700 × 200 m**
  - Will be released soon, facing resolution issues
  - Designed to generate probabilistic models on = TOC, maturity, facies, volume estimation...

• **Small scale → faults and fractures**
  - Facies do not have a significant impact on fracture orientation (but may partially control the density of fractures)
  - Faults objects need to be considered as their trace only (damage zone dimension is mainly negligible), the diffuse fracturing compartmentalise potential reservoirs