Exploring the sub-salt play in the frontier Amadeus Basin – Insights from potential field data analysis

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EXPLORING THE SUB-SALT PLAY IN THE FRONTIER AMADEUS BASIN – INSIGHTS FROM POTENTIAL FIELD DATA ANALYSIS

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Alice Springs
Introduction: Exploring the Sub-salt Play in the Southern Amadeus Basin

Sub-salt Play

- Primary exploration target
- Neoproterozoic lower Gillen-Heavitree petroleum system
- Gas flows from Magee-1 (1992) and Mt Kitty-1 (2014) have proven the sub-salt play

2013 AMSAN 2D Seismic Survey

- First regional framework 2D seismic
- 1586 line km over an area totalling 43,000 sq km
- Line length up to 387km

Objectives

- Provide regional structural and stratigraphic framework
- Link isolated 2D grids
- Identify key leads for follow up
Introduction: New Sub-salt Leads Identified

- Two significant sub-salt leads identified (Dukas shown here)
- Regional framework seismic grid - higher spatial density magnetic and gravity surveys useful for interpolating trends away from seismic and well control.
- Santos contracted FROGTECH to update the SEEBASE™ Depth-to-Basement Model of the Amadeus Basin
Introduction: SEEBASE™ update

FROGTECH update for Santos of 2004 and 2005 SEEBASE™ of Amadeus Basin, calibrated with newly acquired seismic data
Basin Stratigraphy

- Central and eastern parts dominated by NW-SE trends, with exceptions.
- More random trends in western parts, above Gillespie Craton.
- Central zone with Neoproterozoic units at surface with a broadly anticlinal geometry, but extensively brecciated in many areas.
Potential field data

Gravity data:
- ~E-W-trending long-wavelength positive and negative gravity anomalies
- ~NW-SE-trending, elongate short-wavelength positive gravity anomalies (central and east)
- Variable moderate to short-wavelength gravity trends in west

Magnetic data:
- Shallow magnetic (and “non-magnetic”) basement surrounding Amadeus Basin
- ~NE-SW-trending moderate to long-wavelength anomalies below central and eastern Amadeus Basin
- ~NW-SE-trending, elongate short-wavelength magnetic anomalies (central and east)
- Variable moderate to short-wavelength magnetic trends in west
Potential field data and basement terranes

- Cratonic basement below western Amadeus Basin
- Link with Albany-Fraser Orogen for basement below central and eastern Amadeus Basin (cf. Betts et al., 2011)

Musgrave Province / Petermann Orogeny
Deformation style and link with gravity data

- Predominantly detached Petermann Orogeny deformation style, facilitated by Bitter Springs Formation salts
- Local basement-involved Petermann Orogeny deformation style
- Deformation asymmetry decreases N-ward, away from Musgraves
- Seismic wash-out zones flanked by upturned sediments, interpreted as (brecciated) salt mobilisation zones

Seismic wash-out zones correspond to local positive gravity anomalies and are interpreted to be zones of intensely brecciated carbonate and anhydrite as a result of salt mobilisation.
Deformation style and link with gravity data

- Elongate ~NW-SE-trending short-wavelength positive gravity anomalies are linked to upturned carbonates of Bitter Springs Formation
- Edges of seismic wash-out zones correspond to elongate short-wavelength positive gravity anomalies
- In general seismic wash-out zones correspond to positive gravity anomalies
Deformation style and link with gravity data

- High-density intrabasinal sources contributing to central positive gravity anomaly:
  - (1) coherent sedimentary packages containing dolomite and limestone
  - (2) highly disrupted zones that show up as wash-out zones on seismic.
Deformation style and link with gravity data

- Basement in Mereenie area shallower than expected from position relative to regional negative gravity anomaly

Hermannsberg section (Warren & Shaw, 1995) ~ 11km

Neoproterozoic deformed during Petermann Orogeny

Interpreted Centralian fault

Basement-involved Alice Springs Orogeny deformation

Petermann Unconformity

Neoproterozoic deformed during Petermann Orogeny
Deformation style and link with gravity data

- Basement-involved Alice Springs Orogeny (II and III) deformation style
- Strong basement control on compressional deformation geometry in central and northern part of Amadeus Basin

Surface geology
- Alice Springs Event
- Post-Petermann Ord-Sil
- Cambrian post-Petermann
- Petermann Event
- Boord-Inindia
- Neoproterozoic deformed during Petermann Orogeny
- Interpreted Centralian fault

Interpretation of gravity data and seismic images showing the deformation style and link with gravity data in the Amadeus Basin.
Gravity Modelling

- Three regional gravity models
- East line to investigate contribution of high-density Neoproterozoic sediments to central positive gravity anomaly
- Gravity models constrained by seismic data, wells, cross-sections, surface geology and density values from wells.
Gravity Modelling

- Eastern gravity model shows significant contribution of high-density Neoproterozoic sediments to central positive gravity anomaly.

Legend
- Devonian-Carboniferous sequence
- Silurian sequence
- Cambrian sequence
- Intensively deformed carbonates and evaporites related to salt mobilisation
- Neoproterozoic sequence
- Basement (Musgrave or Warumpi equivalent)
- Basement (Musgraves S, Warumpi N)
- Basement (Arunta West Terrane)
- Fault zone
- Lower crust
Gravity Modelling

- Central gravity model focuses on source of long-wavelength gravity anomalies

Legend
- Syn-Petermann sequence ("Winnall Beds")
- Boord Formation / Inindia Beds
- Bitter Springs Formation
- Deformed carbonates and evaporites (basal Bitter Springs Fm.) and Dean/Heavitree Quartzite
- Basement (Musgrave equivalent)
- Basement (Arunta and Warumpi terranes)
- Lower crust

High-density basin units beneath thrust nappe

Tikelmungulda Seismic Province

Musgrave Province

Petermann Nappe Complex

Central Australian Suture

Legend
- Bitter Springs Formation
- Boord Formation / Inindia Beds
- Deformed carbonates and evaporites (basal Bitter Springs Fm.) and Dean/Heavitree Quartzite
- Basement (Musgrave equivalent)
- Basement (Arunta and Warumpi terranes)
- Lower crust
Potential field data interpretation

Gravity data:
- Short-wavelength anomalies caused by intrabasinal sources (upturned carbonates, salt mobilization residuals)
- ~E-W-trending long-wavelength positive and negative gravity anomalies are result of shallow high-density basin units, changes in basement depth, changes in Moho depth, and crustal density variations

Magnetic data:
- ~NE-SW-trending moderate to long-wavelength anomalies reflecting compositional variations related to Albany Fraser Orogen (cf. Betts et al., 2011)
- Illustrate changes in depth of magnetic basement
- Top of magnetic basement usually deeper than top economic basement
Potential field data interpretation

Magnetic data:

- Top of magnetic basement usually deeper than top economic basement
Conclusions

New SEEBASE of Amadeus basin based on Santos seismic new NTGS potential field data and open file data from GSWA
2016 Exploration Program

2016 2D Seismic Survey

- 1300 km 2D seismic infill program
- Designed to mature leads identified from the 2013 seismic survey and the 2014–2015 SEEBASE™ depth-to-basement map to drillable prospect status
- Two rounds of acquisition – Round 1 lines are firm
- In-field processing and preliminary interpretation to determine which Round 2 lines will be acquired