Day: Wednesday 26 April **Session: 3**
Time: 2:45pm

Exploration of a Sub-salt Play in the Southern Amadeus Basin, Central Australia – Searching for Big Gas in Proterozoic Reservoirs

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The Neoproterozoic to Devonian Amadeus Basin covers an area of 170,000km2 in central Australia. The basin was initiated approximately 1000 Ma ago as a component of the more extensive Centralian Superbasin formed in response to the breakup of the Rodinia supercontinent (Edgoose 2012).

The basin is bounded to the north by the Arunta Province and to the south by the Musgrave Province (Fig. 1). The southern margin of the basin was affected by the 600-520Ma Petermann orogeny that deformed a Neoproterozoic basin fill that included a thick mobile evaporite sequence (Gillen Member) (Fig. 2). The later 450-310Ma Alice Springs orogeny resulted in the uplift of the northern margin and the south westerly thrusting of up to 14km of Phanerozoic and Proterozoic sediments.

The northern Amadeus basin has been extensively explored, aided by excellent surface outcrop and the development of large surface anticlines. Commercial gas and oil production has been established from the Ordovician succession in the Mereenie and Palm Valley fields. In the southern Amadeus, by contrast, there is little surface expression of the underlying structure and exploration has been limited to a few wells and local seismic grids. Nevertheless, a likely extensive Neoproterozoic play has been demonstrated by gas flows from the Magee-1 and Mt Kitty-1 wells. Gas was produced from a thin Heavitree sandstone above basement (Magee-1), and from fractures within basement (Mt Kitty-1). Significant quantities of Helium were found in both wells testify to the effectiveness of the overlying Gillen evaporite seal. The hydrocarbon source is likely to be an early pre-salt Gillen Member shale.

In order to further evaluate the prospectivity of the Neoproterozoic plays of the Southern Amadeus, Santos farmed into Central Petroleum's acreage in 2012, and in 2013 a 1586km regional 2D seismic grid was acquired over an area of 43,000km2. Higher density magnetic and gravity surveys were used to interpolate trends between seismic and well control and create a high resolution depth-to- SEEBASETM basement model (Debacker et al 2016.) The objective was to provide a regional structural and stratigraphic framework and identify leads and structural trends that, if deemed prospective, could be addressed by a subsequent seismic infill program.

Data quality of the 2013 survey was generally good with excellent resolution of the Neoproterozoic post-salt succession. Data quality associated with the evaporite succession was poorer, as a result of mobilisation and associated deformation. Basement definition was often negatively impacted by the overlying evaporites and varies from good to poor.

The survey identified a potentially large prospective sub-salt high feature (Lead A) in the central part of the basin. The interpretation of a high is supported by the SEEBASETM model. To the south of this regional high deformation primarily results from the Petermann orogeny and the effects of the Alice Springs orogeny appear limited. To the north of the high, the Phanerozoic section is more strongly deformed reflecting the influence of the Alice Springs orogeny. The high is situated under a seismic wash-out zone interpreted to be highly deformed interbedded carbonates and evaporites as evidenced by the occasional presence of Proterozoic carbonates at surface. It is likely that foreland loadings as a result of the Petermann orogeny in the south and the Alice Spring orogeny in the north contributed to the creation of this basin centre high

The 2013 seismic demonstrated the dominantly thin-skinned nature of deformation associated with the Petermann orogeny. Thrust faults associated with the Petermann orogeny and other Late Proterozoic movements appear to detach primarily within the Gillen salt. The salt has been mobilised and exhibits significant lateral thickness variations. Possible carbonate bodies within the Gillen salt are interpreted to have been carbonate shoals, formed during deposition of the Gillen evaporite sequence, and subsequently deformed during salt mobilisation. These carbonate bodies are an important secondary objective. Basement-involved deformation is less evident in the basin centre but does occur locally and at the margins of the basin adjacent to the Musgrave block.

On the eastern margin of the basin, basement faults reactivated during the Petermann orogeny resulted in the formation of a large inverted basement block –Lead B - tested at its down dip limit by Magee-1 (Fig. 3). In this area Heavitree sandstone and Gillen evaporite deposition was probably limited as evidenced by onlap of the Neoproterozoic sequences and the thin reservoir encountered in the Magee well. Likewise in Mt-Kitty-1 the prospective Heavitree reservoir was absent, possibly because of the well's basin margin position. It is anticipated that the Heavitree sandstone will thicken westwards into the basin centre.

As a result of the 2013 seismic data acquisition and interpretation, Lead A, Lead B and other leads identified are currently being addressed by a 1300km infill seismic grid initiated in 2016. Acquisition and processing parameters for the seismic have been modified in order to improve sub-salt imaging. Major changes include longer offsets to compensate for the steeply dipping geology, higher sampling rate to reflect the complex geology, longer sweep length to maximise energy, infield and fast-track processing to provide flexibility to the program and parameters as well as the use of the Nodal recording system. If robust prospects are confirmed by the current seismic campaign, these prospects will be firmed up for drilling in 2019. It is anticipated that the more basinal position of the identified prospects will favour the development of a thicker Heavitree sandstone reservoir and lower Gillen source interval.

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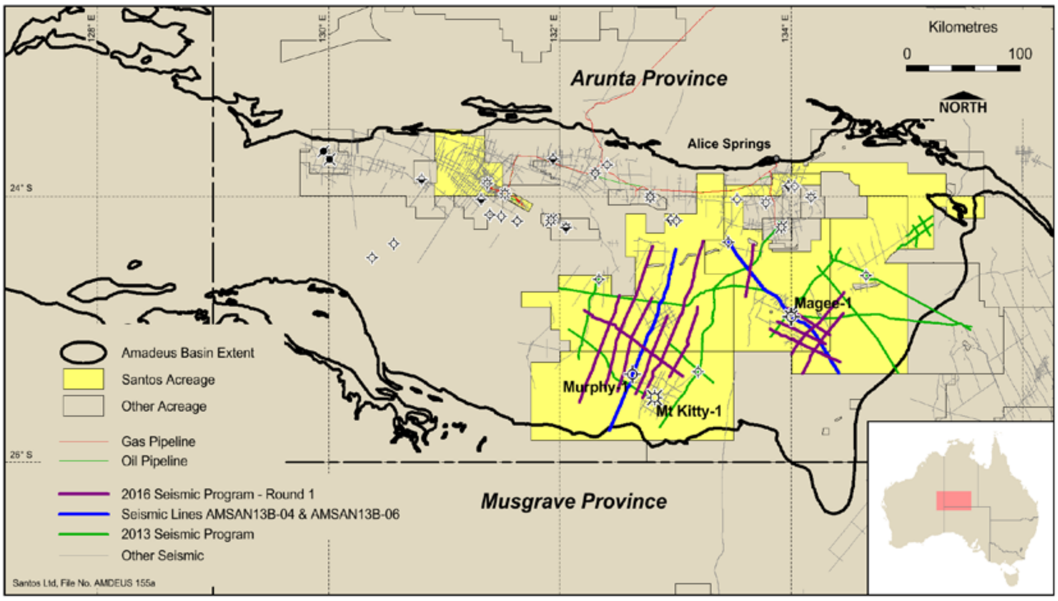

Figure 1: Location of the Southern Amadeus Basin seismic surveys.

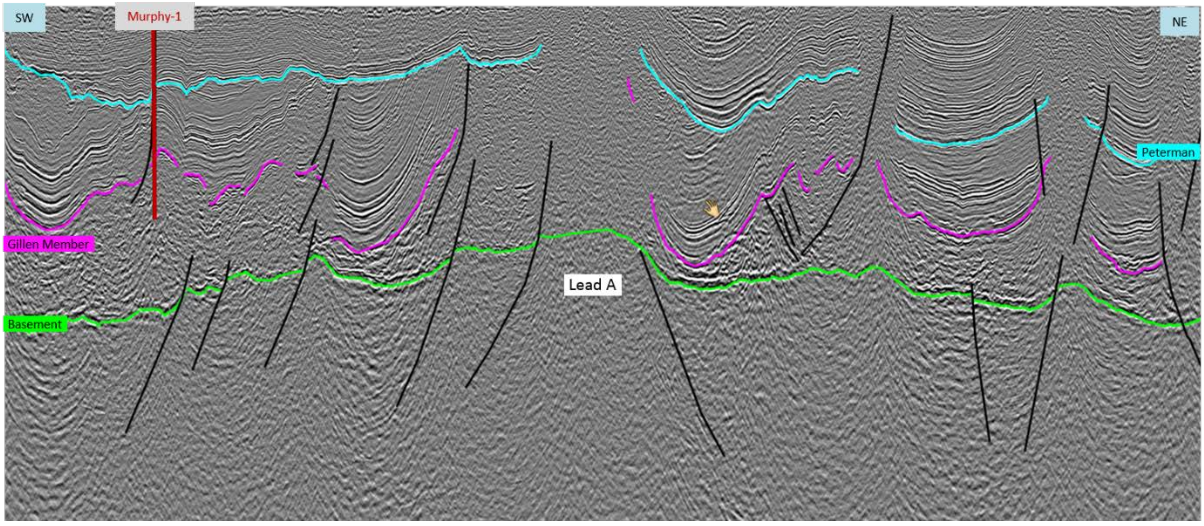

Figure 2: Seismic line AMSAN13B-04 showing thin-skinned deformation with detachment primarily within the Neoproterozoic Gillen Salt member of the Bitter Springs Formation; seismic wash-out zones occur in salt mobilisation zones. An interpreted large regional basement high (Lead A) is supported by depth-to-basement modelling. Note than the Petermann orogeny in the south is represented by the base Cambrian unconformity (blue horizon). This has been deformed to the north of the regional high by the Alice Springs orogeny.

Speaker Biography

Rhodri Johns is Santos' Onshore Australia Exploration Manager. He is a geologist, a graduate of Manchester University and has a PhD from Cambridge University. He started his career with Shell in the Netherlands, worked for Sun Oil in London for several years before moving to Adelaide to work for Santos.