

Resources 96 Conference

South Australian Cambrian Petroleum Potential

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The basins under investigation are the Officer (Neoproterozoic to Devonian, western SA), Warburton (Cambro-Ordovician, northeastern SA), and the Arrowie and Stansbury Basins (Cambrian on Neoproterozoic) in the Adelaide fold belt. Funding through the South Australian Exploration Initiative has enabled some key issues to be addressed, namely hydrocarbon source richness and maturity, the timing of trap formation and reservoir quality of these sedimentary rocks.

Reservoir studies were conducted in-house while other research was carried out in collaboration with the University of Adelaide, ACS Laboratories, Amdel Petroleum Services, Geotrack International and the Palaeontological Institute of the Russian Academy of Sciences (PIN). Some highlights of this work are listed below.

Officer Basin

The Officer Basin has received the closest attention because MESA rates its petroleum prospectivity as high. The eastern region of the basin is now under licence.

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- Structural style is compressional, with major thrust faulting in the Petermann Ranges Orogeny (540-560 Ma) as well as the Alice Springs Orogeny (300-360 Ma). The timing of trap formation was favourable for the generation and migration of Neoproterozoic and Cambrian oil.
- The high organic productivity of Ordovician source rocks is a global phenomenon related to the abundance of the cyanobacterium *Gloeocapsomorpha prisca* (Michaelsen et al., 1995). This organism has now been found in the Early Cambrian Ouldburra Formation in the Tallaringa Trough. There, the source rocks contain Type II kerogen with Hydrogen Indices in the range 360-520.
- Sufficient methylphenanthrene index measurements have now been obtained to produce regional maps of maturity trends in the Officer Basin for the first time.
- Apatite fission track data show that thermal events associated with the Alice Springs Orogeny have overprinted earlier thermal histories, even in wells 200 km south of the Musgrave Block. Heating to 90°C had also occurred prior to cooling during the Cretaceous, suggesting a greater thickness of Permo-Triassic cover over the region.
- The porosity/permeability characteristics of seven Neoproterozoic-Cambrian sandstone reservoirs up to 300 m in thickness have been documented and related with some success to wireline logs. Porous and permeable dolomite reservoirs in the Early Cambrian Ouldburra Formation have also been studied. With the exception of the low permeability Tarlina Sandstone, the other units average 15 per cent porosity and display measured permeabilities in the 10 millidarcy to darcy range.

Stansbury Basin

The majority of geological and geophysical research in the Stansbury Basin has been carried out by Canyon (Australia) Pty Ltd, licensee and operator of PEL 53. MESA initiatives relate mainly to sampling for vitrinite reflectance measurements and apatite fission track analyses. Work with PIN is also in progress. Some highlights include:

- Biostratigraphic documentation of the Early Cambrian-Middle Cambrian boundary at the base of the Coobowie Limestone.
- Detailed biostratigraphy of much of the Early Cambrian succession using small shelly fossils.

- Recognition of a major sequence boundary and possible sandstone reservoirs near the top of the Moonan Formation.

Arrowie Basin

The majority of geological and geophysical research in the Arrowie Basin has been carried out by Beach Petroleum and partners in PEL 45 and 51. In the older rocks of the Adelaide Geosyncline, research has been carried out by Frontier Petroleum in PEL 41. MESA contributions include:

- Geochronology of Early Cambrian tuffs from outcrops and drillcores.
- Detailed correlations between wells in the Moorowie Syncline.
- Further sampling of cored drillholes for source rock geochemistry.
- Additional biostratigraphic work, including recognition that a late Middle Cambrian trilobite from Lake Frome-3 is not from the Balcoracana Formation, but is from the overlying Pantapinna Sandstone.

New initiatives

Three new avenues of research are proposed as part of the second phase of the South Australian Exploration Initiative.

The first centres on the Warburton Basin beneath PEL 5 & 6, operated by Santos Ltd. Several commercial oil and gas discoveries have been made in porous sandstone, leached tuff and fractured reservoirs in the basement beneath the Cooper Basin. The basement consists of Cambro-Ordovician rocks of the Warburton Basin but the oil and gas are Permian sourced. The new study in collaboration with the National Centre for Petroleum Geology and Geophysics will map potential reservoirs and document their petrophysical characteristics from cores and cuttings.

The second field of research investigates the link between cyanobacterial (or algal) mats and Neoproterozoic-Cambrian source rocks in the Officer, Stansbury and Arrowie Basins. The work will be carried out by specialists at PIN, Moscow, over the next 12 to 18 months.

The third research project is a not related to the Early Paleozoic but emerged as a spin-off from investigations of Permian rocks in the Officer Basin region. Vitrinite reflectance had been measured on samples from the Permian Mount Toondina Formation to constrain thermal maturities in burial history models. However, it is evident that the reflectances are suppressed. Independent data from the Jurassic of the western Eromanga Basin also

points to vitrinite reflectance suppression (B. Michaelsen, University of Adelaide, *pers. comm.*, 1996). Both the Jurassic and the Permian will be investigated using the FAMM technique (Fluorescence Alteration of Multiple Macerals) developed by CSIRO, and organic geochemistry to properly document this phenomenon. The implications for petroleum exploration in the western Eromanga, Pedirka and Arckaringa Basins, as a result of this investigation, could be significant.

Reference

Michaelsen, B.H., Kamali, M.R. and McKirdy, D.M., 1995. Unexpected molecular fossils from Early Cambrian carbonates. Proceedings of the 1995 Organic Geochemistry Conference. The University of Adelaide: 46.