# GAS/CONDENSATE COMPOSITION AND SOURCE ROCK FACIES IN THE CASWELL SUB-BASIN, OFFSHORE NORTHWEST AUSTRALIA

Toshinori Inaba[1]

[1] INPEX Corporation, Japan

## Introduction

Browse Basin is situated on the Australian northwest shelf. It extends for approximately 140,000 km$^2$ and contains in excess of 15km of a Paleozoic to Cenozoic sedimentary section (Struckmeyer et al., 1998). The basin is divided into Caswell, Barcoo, Scott, and Seringapatam Sub-basins, Prudhoe Terrace, and Yampi Shelf. The Caswell Sub-basin is characterized by thick Mesozoic section.

Gas bearing sandstones have been discovered in the Brewster Member (Early Cretaceous Upper Vulcan Formation) and in the Jurassic Plover Formation in the central part of the Caswell Sub-basin. Another field series was confirmed on the outer shelf of the Caswell Sub-basin in the Plover Formation reservoir.

Gas accumulation is predominant in the Caswell Sub-basin, but its CGR (condensate gas ratio) is variable. The ratio is generally higher in the Brewster reservoirs than in the Plover reservoirs. This research aims to find out key geological factors that are controlling the CGR in the Caswell Sub-basin by applying carbon isotope geochemistry and petroleum system simulation.

## Results

Biomarkers are not always available to characterize accumulations in the Caswell Sub-basin due to their gas predominance. Stable carbon isotope ratio was used instead. However, careful discussion is needed as the carbon isotope ratio depends both on source and maturity.

Carbon isotope ratio could divide gas samples into two major groups: one from the Jurassic Plover reservoir and the other from the Cretaceous reservoirs (Upper Vulcan Formation including Brewster Member, and Echuca Shoals Formation). The former was heavier than the latter. Gas from the Plover reservoir was heavier in the central part than on the outer shelf.

Hierarchical cluster analysis was attempted for the carbon isotope ratio of gas and condensate samples. They were divided into several families, respectively, and the analysis indicated a strong control of reservoir formation. It was very interesting that some gas and condensate families shared similar well members probably reflecting common source rock facies and common petroleum system process.

Three-dimensional basin and petroleum system simulation (Schlumberger's PetroMod 3D) was applied to the most parts of the Caswell Sub-basin. There is a limitation in using the existing source-rock potential data. As many wells have been drilled with the Inverted Emulsion Mud, source potential data were sometimes less reliable. We, therefore, referred the Passey's method (Passey et al., 1990) to estimate TOC (Total Organic Carbon content) values from wireline logs. Hydrogen Index (HI) was evaluated from comparatively reliable source

potential data, then original TOC and HI values were estimated by considering their maturity. The estimated source potentials were highly variable and they were quantitatively uncertain.

The 3D simulation suggested complicated petroleum system processes in the Caswell Sub-basin. Gas accumulations were predicted mainly in the sandstone reservoirs of Plover Formation and Brewster Member. Multiple source-rock layers contributed to the accumulations, and their relative contribution changed among them. Simulated CGR was generally higher in the Brewster reservoirs than in the Plover reservoirs. It was also interesting that the simulated CGR varied within the Brewster reservoirs and within the Plover reservoirs.

## Conclusions

As suggested from the 3D simulation, gas in the Plover reservoir was derived mainly from the Jurassic Plover Formation source, and the gas in the Brewster Member was, in contrast, derived mainly from the Cretaceous Vulcan Formation sources. Gas maturity was generally higher from the former source than from the latter sources. These simulation results were consistent with the carbon isotopic observation.

High condensate content promotes exploration and development of gas fields. Interesting suggestion came from the comparison between CGR and source maturity and between CGR and source potential. Comparatively low maturity Plover source tends to be distributed close to high-CGR accumulations. Some high-CGR accumulations were simulated in the area where high potential Plover source was predicted (Inaba, 2018).

In summary, some Plover and Vulcan source facies were suggested by the results from gas-condensate family analysis and three-dimensional basin and petroleum system simulation. These facies may be accompanied by local changes.

## References

Inaba, T., 2018: Interesting geological factors controlling gas and condensate composition in the Caswell Sub-basin: Proceedings Australian Organic Geochemistry Conference, Canberra, 3-7 December 2018, 94-95.

Passey, Q. R., Creaney, S., Kulla, J. B., Moretti, F. J., and Stroud, J. D., 1990: A practical model for organic richness from porosity and resistivity logs. The American Association of Petroleum Geologists Bulletin, 74(12), 1777-1794.

Struckmeyer, H. I. M., Blevin, J. E., Sayers, J., Totterdell, J. M., Baxter, K., and Cathro, D. L., 1998: Structural evolution of the Browse Basin, North West Shelf: new concepts from deep-seismic data. In Purcell, P. G. and R.R. eds.: The Sedimentary Basins of Western Australia. Proceedings of Petroleum Exploration Society of Australia Symposium 2, Perth 1998, 315-332.