ORAL PRESENTATION

Day 2: 4th April 2019

Session 8: New Frontiers

Chair: Euan Shand – Consultant, Evan Faris – Woodside Petroleum

15:15	Frontier exploration in Mongolia - The Search for Oil-Stained Marmots	Mike Buck	Petro Matad
15:40	Insights from New Geophysical Data in the North South China Sea	Patrick Ravaut	TOTAL E&P
16:05	The Exotica Carbonate Megabreccia Debris Flow and Linkages to Active Hydrocarbon Seepage: New Ireland Basin, Papua New Guinea	Brent McInnes	PeakOil (PNG)
16:30	The Hydrocarbon Potential of the Frontier Cape Vogel Basin, Papua New Guinea (PNG)	Andrew Weller	Searcher Seismic
16:55	New Zealand's Canterbury Great South Basin - An Emerging Deep-Water Province in a Frontier Basin?	Alex Wunderlich	OMV

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Frontier Exploration in Mongolia: The Search for Oil-Stained Marmots

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Mongolia is the world's 18th largest country by land area and has a population of only three million. Its petroleum geology has been long studied and documented and the prospectivity of its central and southern sedimentary basins has been highlighted by numerous authors and companies over the years. And yet, Mongolia is one of the last remaining onshore oil frontiers on the planet where exploration in earnest has yet to begin.

The primary reason for the lack of attention given to Mongolia's hydrocarbon potential is geopolitical. The country spent 70 years of the last century as a Soviet satellite and one in which the Soviet Union had no incentive to explore for oil, having sizeable resources much closer to its major demand centres. Since the fall of the Soviet Union, exploration in Mongolia has been sporadic at best and the drilling successes of the late 1990s that led to Mongolia becoming an oil producer and exporter did not ignite interest in its oil potential due to a combination of technical and commercial concerns. However, the potential of the country is large, the fiscal terms are good and the costs to explore and develop are low by world standards.

The combination of large prospects, good terms and low costs should make Mongolia an attractive destination for onshore explorers of all sizes.

SPEAKER BIOGRAPHY

Mike is a geologist/geophysicist by training and joined the oil industry in 1979. He spent 20 years with LASMO PLC working first as a prospect generator focused on the UK continental shelf. He then moved to international assignments in Indonesia, Colombia, Vietnam and Libya and was involved in the discovery of several commercial oil and gas fields. Following Eni's takeover of LASMO, Mike became Managing Director of Eni Pakistan and then Managing Director of Eni Iran, working on major oil and gas developments in both countries.

In 2006 Mike joined SE Asian focused Salamander Energy PLC as Chief Operating Officer. After the takeover of Salamander by Ophir Energy he was retained to help with the integration process following which he consulted for a number of companies in the S E Asian region before joining Petro Matad as CEO in late 2017.

Mike has worked on all aspects of the E&P value chain. He holds a BSc in Geophysics from Liverpool University and an MSc in Petroleum Geology from Imperial College, London.

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Insights from New Geophysical Data in the Northern South China Sea

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For several years TOTAL has had a significant exploration footprint in the South China Sea, as operator of several exploration blocks in Malaysia: DW-2E in Sarawak and SB-N in Sabah; in Brunei: CA-1; and more recently deep-water offshore China with the Taiyang Block on the northern margin of the South China Sea.

Taiyang PSC is a very large offshore block, almost 25,000km^2, between Mainland China and Taiwan, operated by TOTAL with its partners CNOOC and CPC. It is a frontier domain with limited seismic data coverage. In the first years of the PSC, TOTAL and partners acquired around 4,400 km of new 2D data and reprocessed some of the existing data.

These new data allow us to better understand the regional context, especially the different crustal domains, as well as possible sub-basin distribution and structural deformation and timing. From west to east, the geological context of the block is radically different: from a classical passive margin with normal faulting affecting a thick continental crust to a hyper-extended continental crust, which is then laterally subducted below the Pliocene to Recent Taiwan-Luzon arc. Consequences are the development of different fault families: ENE-WSW trending north to south dipping normal faulting, then reversing northward in the hyper-extended domain; and N-S trending inverse faults when entering the present-day Taiwan tectonic prism.

Further Tertiary basins are better imaged and can be mapped in a series of different E-W trending grabens in the outboard part of the thinned continental margin.

From these new elements, potential for new exploration plays in this part of the South China Sea will be discussed.

SPEAKER BIOGRAPHY

Patrick has a PhD in Geophysics on the Oman Obduction from Montpellier University in France. He has worked for TOTAL for 20 years with significant experience in SE Asia Exploration, based in Jakarta, Kuala Lumpur and, since 2015, in Singapore. His various roles include: NV & Interpretation manager, Australia / Indonesia Exploration Manager and, since January 2018, Exploration Manager for Malaysia & China.

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The Exotica Carbonate Megabreccia Debris Flow and Linkages to Active Hydrocarbon Seepage: New Ireland Basin, Papua New Guinea

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The New Ireland Basin (NIB) is a 900 km x 180 km frontier offshore basin in northern Papua New Guinea (PNG). From the Early Oligocene until the Middle Miocene, the NIB was a fore-arc depocenter between the New Ireland island arc and the Manus trench during the westward subduction of the Pacific Plate below NE PNG. Around 15 million years ago, the Ontong Java Plateau (OJP) collided with the Australia-Pacific plate margin. The thickness and relative buoyancy of the OJP prevented it from subducting, resulting in subduction reversal and thermal activation of the forearc sediments by Pliocene-Pleistocene alkaline volcanism.

On New Ireland, Oligocene andesitic lava and volcaniclastics (Jaulu Volcanics) make up the island arc basement. Subsidence throughout the Miocene resulted in deposition of tuffaceous limestones and mudstones (Lossuk River Beds) followed by thick deposits of carbonate platform sediments (Lelet Limestone). The karstification of the Lelet carbonate platform documents significant tectonic uplift on the order of 1 km during the Pliocene-Pleistocene. Basinward sediments are poorly known apart from offshore dredge samples which are Oligocene deepwater turbiditic sandstone and foraminiferal packstone and wackestone intercalated with dark organic-rich layers (TOC = 1.3%).

Research cruises in the 1990's reported submarine hydrocarbon seeps of thermogenic origin emanating from scarp slopes and volcanic mounds in the deep basin (1500 m bsl). In 2017, Searcher Seismic and BGP carried out a long offset, deep tow 2D multiclient seismic survey (SS2017) at reconnaissance scale over the NIB. The 1,275 km of new seismic data reveal substantial sediment thicknesses (up to 8 km) disrupted by horst blocks, half grabens and volcanic intrusions.

A key seismic line between New Ireland and Lihir Island (L107) crossing two seep locations shows evidence for a gas chimney linking the Mussel Cliffs seep to a seismic interval with numerous mounded, discontinuous and contorted reflections consistent with a debris apron. This seismic unit, named the Exotica Formation, is approximately 45 km long, 32 km wide, 250 m thick and buried to a depth of 2 km. The source of the Exotica debris apron can be traced back to the east coast of New Ireland, where a 160 km^2 section of Lelet Limestone (250-400 m thick) is missing from the stratigraphic record.

A model to explain the combined observational evidence is that tectonic uplift of New Ireland triggered a catastrophic collapse of the coastline, transporting substantial carbonate platform sediments downslope into deep-water to form a toe-of-slope carbonate megabreccia debris flow deposit. The seep emissions suggest that the Exotica Formation is charged with hydrocarbons. Detailed seismic infill lines and marine survey work are necessary to further evaluate this hypothesis.

The New Ireland region is cyclone-free, conflict-free and proximal to the energy-hungry markets of China, Japan and Korea. An energy-intensive gold mine on Lihir Island and a 2018 APEC pledge to promote regional electrification present opportunities to accelerate the development of its hydrocarbon resources.

SPEAKER BIOGRAPHY

Brent McInnes has 34 years' experience in technical exploration and resource development in Canada, USA, Australia, China, Indonesia, Chile, Mongolia, Pakistan, Iran and Papua New Guinea. He completed his PhD at the University of Ottawa in 1995 and worked as a research geoscientist at Caltech and CSIRO. He founded Peak Oil (PNG) Pty Ltd to explore for hydrocarbons in the New Ireland Basin and concurrently serves as Peak's Chairman, Professor of Economic Geology & Geochemistry at Curtin University and as a strategic advisor to the Institute of Geological and Nuclear Science in New Zealand.

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The Hydrocarbon Potential of the Frontier Cape Vogel Basin, Papua New Guinea (PNG)

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The predominantly offshore Cape Vogel Basin, north of the Papuan Peninsula, is thought to be underlain by Late Paleocene-Eocene oceanic crust and overlain by Cenozoic sediments. Two exploration wells were drilled in the basin in the early 1970s (Goodenough-1 and Nubiam-1) that chased Miocene reef plays that were thought to be analogous with the recent discoveries in the Gulf of Papua (GoP). No Miocene reefs were encountered in either well, with both wells TDing in volcanics. The wells encountered minor hydrocarbon traces with Goodenough-1 encountering good-to-marginal source material, although the enigma remains that both wells were "not valid tests" to assess the extent of the Basin's hydrocarbon potential.

Reassessment of the open file 2D seismic data, as well as the integration of modern long-offset PSDM 2D seismic data and shipborne gravity and magnetics data, has resulted in a significant improvement in subsurface imaging and understanding of the petroleum prospectivity of the Basin. The data has demonstrated the existence of a significant sedimentary section with the potential for Mesozoic section at depth and that the volcanics within the Basin are not laterally continuous but are a product of short periods of volcanism in the Cenozoic. The data also suggests the presence of various play types in the Basin (e.g. turbidite fans, pinch outs, compressional features and carbonate reefs / build-ups). Repeatable sea surface slicks identified on satellite imagery together with observable BSRs and DHIs also provide important clues regarding the existence of a working petroleum system and source rock in the area.

These observations have been integrated into a model that hypothesises that the area has affinities with the GoP, with the continuation of continental crust existing north of the Papuan Peninsula, with widespread deposition in the Mesozoic and Cenozoic, and with source rocks estimated to be within the hydrocarbon generative window.

SPEAKER BIOGRAPHY

Andrew holds a PhD in geology and computer science from the University of South Wales, UK. After a stint as a postdoctoral researcher at ETH Zurich, Switzerland, he joined the industry where he has over 10 years' experience with several service providers. Andrew is currently employed as a Geoscientist and Sales Manager at Searcher Seismic assessing the prospectivity of several regions including PNG, Australia and the Philippines.

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New Zealand's Canterbury Great South Basin - An emerging Deep-Water Province in a Frontier Basin?

Alexander Wunderlich[1], Jan Mayer[1], Sarah Cutten[1], Antony Harrison[1], Callum Kennedy[1], Alan Clare[1]

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The Canterbury Great South Basin covers about 160,000 km^2 off the southeast coast of the South Island of New Zealand. It formed during the Cretaceous as a rift basin and has experienced only very minor deformation (along its northwest margin) since then. The total sediment thickness is greater than eight km in the Central Sub-basin. Water depths range from 50 to 1600 metres.

Only 14 wells have been drilled in the basin, including in deep-water locations, but only one on 3D seismic. Despite being a frontier basin, 11 wells have encountered hydrocarbons in various syn- and post rift play intervals, and four technical successes have been made, proving a working petroleum system.

The eastern deep-water area of the basin, including acreage held by OMV New Zealand, is undrilled and the details of its history remain largely unknown. OMV has carried out a rigorous play-based exploration workflow that shows the main critical risks for the basin and the key syn- and post rift plays. It also offers the possibility to integrate dynamic well data and well failure mechanisms, so that early exploration activities can be focussed on the important aspects of the most valuable plays. This basin-focused approach and the in-depth petroleum system understanding forms the basis for OMVs subsequent play focused approach, which quantifies the various aspects of the system within each play and uses tools such as common risk segment mapping to highlight sweet spots within each play.

This approach has highlighted significant opportunities within the Cretaceous post-rift play, consisting of net transgressive shallow marine stacked sandstones that are compactionally draped over large basement highs. It also quantifies the exploration upside in OMVs operated PEP 50119, where we show that a proper basin and play focused workflow, coupled with an innovative pre-stack seismic interpretation workflow has added a material exploration opportunity for OMV with tremendous follow-up potential.

SPEAKER BIOGRAPHY

Alexander Wunderlich is the Geoscience Team Lead for Australasia in OMV New Zealand. Alex holds a MSc in Geology from the TU Bergakademie Freiberg in Germany and the Colorado State University in Fort Collins, USA. He has worked in New Zealand since February 2015, having previously worked for OMV in Madagascar as an Exploration Geologist for the Company's operated and non-operated interests in the Morondava Basin, Eastern, and Western Africa. Prior to joining OMV Alex has worked in technical exploration positions for operating companies in Norway and Germany, focusing on the North Sea, Norwegian Sea, and the Barents Sea.