ORAL PRESENTATION

Day 1: 7th March 2023

Session 4: ALONG THE ARC

Co-Chair: Ian Longley, GIS-pax Pty Ltd

Co-Chair: Amy Gough, SE Asia Research Group, Royal Holloway, University of London

15:50	ExxonMobil's 101 years in PNG – Our Exploration Journey and What the Future Holds	Desmond Leech	ExxonMobil
16:15	Basin Development in the Arc-Collision Zones of New Guinea – Examples from Bintuni to the Gulf of Papua	Max Webb	Royal Holloway
16:40	New Insights into the Exploration Potential of the Plio-Pleistocene Foreland Basin of North-Eastern Seram	Kim Morrison	Lion Energy
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ORAL PRESENTATION

ExxonMobil's 101 years in PNG – Our Exploration Journey and What the Future Holds

Des Leech, Daniel Gillam, Jonathan Giddings, Sam Hemmings-Sykes

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This presentation describes and highlights key upstream and exploration phases in Papua New Guinea (PNG) in the context of ExxonMobil's activity in country. A linkage is made between geological and geophysical understanding, technology and permitting/ fiscal/ operating arrangements with five distinct phases recognised: (1) play definition; (2) technology advancement; (3) oil and gas discoveries; (4) search for oil ullage; and (5) search for new gas plays and ullage.

ExxonMobil made its entry into the upstream in PNG nearly 80 years ago with the formation of Australasian Petroleum Company (APC). Through strategic mergers and acquisitions over the years, ExxonMobil emerged as a key player in PNG post 2000. The company focused on monetising its stranded gas resources with first LNG from PNGLNG 2014.

ExxonMobil continues to conduct exploration in the Eastern Fold Belt for material opportunities (currently acquiring new onshore seismic) and Western Fold Belt for new plays and future near infrastructure ullage. Key exploration tests include the large isolated carbonate buildups in the east and "near-field wildcats" in the west. To date, we have successfully played the "long game", and within this context we will continue to explore for accretive resources in country.

SPEAKER BIOGRAPHY

Des Leech works for ExxonMobil as the Geoscience Technical Lead for the Global New Opportunities Group. He is based in Melbourne.

Before this assignment, he spent 10 years working on ExxonMobil's exploration and production assets in Papua New Guinea. Prior to joining ExxonMobil in 2011, Des worked for over 10 years at Cue Energy and InterOil working Asia-Pacific and Australian opportunities.

He completed his undergraduate from Trinity College, Dublin (1997) and PhD from Kingston University, London in 2002.

ORAL PRESENTATION

Basin Development in the Arc-Collision Zones of New Guinea – Examples from Bintuni to the Gulf of Papua

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The tectonic history of New Guinea has been dominated by arc-continent collisions and related uplift since the Oligocene, resulting in the opening and closing of fore-arc and back-arc basins along with the rapid exhumation of continental basement across the islands length. Previous tectonic reconstructions of New Guinea have favoured a two-part history for the island with the west governed by a stable Palaeozoic crust impacted by later strike-slip faulting and the east governed by a Mesozoic active to extensional margin. However, recent studies indicate that the island shares a common Cenozoic history of arc-collision and basement uplift that impacts our view of regional basin development. This study provides field-based interpretations for the Cenozoic development of the Salawati and Bintuni basins in West Papua within the context of new models on the timing and propagation of arc-collision and uplift across New Guinea before comparing this with other arc basins along the island (e.g., the Papuan Basin).

The Bintuni Basin in West Papua formed as the result of multiple periods of collision, extension, and subduction rollback between the Eurasian and Australian plates in the South and the Australian and Philippine Sea/Pacific plates in the North. The basin is bounded by three structural highs: the Misool-Onin-Kumawa Ridge (MOKR) in the West; the Kemum Basement High (KBH) in the North; and the Lengguru Fold and Thrust Belt (LFTB) in the East. Hydrocarbon-bearing Jurassic to Cretaceous clastic deposits form an East–West trending belt that was deposited on an extensional passive margin. More recently extensive Miocene-Pleistocene sedimentation has been driven by uplift in the KBH and LFTB following a period of Miocene–Pliocene collision which drove basin formation in the North and East before going into a period of extension. Seismic studies of the southern bounding MOKR indicate uplift occurred in the Pliocene due to the onset of subduction of Australian continental crust along the Seram Trough and followed by Pleistocene subsidence.

This geological history is remarkably similar to that of the Papuan Basin in eastern New Guinea, which initiated during a period of Triassic passive margin extension, followed by a compressional foreland basin regime during collision of the Melanesian arc in the Miocene. Mid-Miocene turbidites in the Gulf of Papua that are shed directly from uplifting basement and arc terranes in the Owen Stanley Range have been the site of recent interest and frontier exploration showing the importance of integrated study of Cenozoic arc basins across New Guinea.

SPEAKER BIOGRAPHY

Dr Max Webb is a Postdoctoral Researcher at Royal Holloway University of London and Research Group Manager for the Southeast Asia Research Group. Max completed his PhD on the Cenozoic tectonics and arc-collisional history of New Guinea in 2019 and has since worked on a range of sedimentary provenance and basin evolution projects from across SE Asia, including tracing the source of the Nicobar Fan offshore Myanmar, assessing the suitability of the East Natuna Basin as an appropriate CCUS analogue, and studying the arc-related basins of New Guinea.

ORAL PRESENTATION

New Insights into the Exploration Potential of the Plio-Pleistocene Foreland Basin of North-Eastern Seram

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The Late Miocene to Recent Seram foreland basin is situated on the northeast margin of Seram Island in Eastern Indonesia. It covers an area of over 12,000 km^2, predominately offshore, and has a maximum thickness of around 1,800m. The basin developed in response to Late Miocene convergence and under-plating of the leading edge of the overall northerly moving Australian plate with Indonesian micro-continents along the Banda Arc. This caused uplift and inversion of central Seram Island, where current elevations exceed 3000m. The NE-SW compression was responsible for the development of the NW-SE trending Seram fold belt, an actively explored proven province with major oil (Oseil field) and gas (Lofin field) discoveries reservoired in Jurassic age Manusela Formation carbonates.

The instability associated with this uplift and over-thrusting caused significant erosion and deposition around Seram Island, most notably in the northeast. The oldest stratigraphy of the Seram foreland basin consists of chaotic, mass transport deposits of the Late Miocene Early Pliocene Salas Block Clay Formation. Ongoing hinterland inversion and erosion filled accommodation space on the northeast of Seram with the Pliocene Wahai Formation deposited. Predominately deeper water sediments are preserved in outcrop and well data, including some interpreted turbidite sandstone deposits. With continued hinterland uplift and erosion through to present day, fast flowing rivers fed sediments resulting in deposition of the Late Pliocene - Recent Fufa Formation. Depositional environments range from coastal to deep water marine. Shelf edge deltas are interpreted with large, seismically imaged foresets marking the transition into deepwater deposits with turbidite sandstones interpreted. Well and seismic data show carbonate reefal development in areas removed from clastic sediment focus.

The 20mmbbl Bula Oil field discovered in the late 1800's, as well as other oil and gas discoveries, along with common oil and gas seeps and hydrocarbon indications on seismic are clear evidence of an active petroleum system. Geochemical analysis indicates the oil to be sourced from deeply buried algal marine carbonates and calcareous of the Late Triassic to Early Jurassic Saman-Saman Formation. Thrust faults provide the conduits for generated hydrocarbons to migrate into the shallow stratigraphy.

While around 30 exploration wells have targeted the onshore Plio-Pleistocene section, resulting in nine discoveries, the offshore extension of the basin is under-explored. Only one offshore well specifically targeting the shallow section has been drilled to date, Phillips 1971 Ceram-B1X. To improve the understanding of the offshore part of the basin, Lion Energy Ltd through its wholly owned subsidiary Balam Energy, operator of the East Seram PSC, shot a 664km high-resolution marine survey in November 2020. This was designed to specifically target the shallow Plio-Pleistocene section in water depths of 5 to 600m. Two areas were targeted with 507 km seismic recorded in the offshore Kobi area in north central Seram and 157 km shot in the area directly offshore of the Bula Oil field.

The new 2D data is a marked improvement in imaging the shallow section compared to previous data sets. The high-resolution data gives enhanced stratigraphic information showing well-defined prograding foresets, clear maximum flooding events and much better definition of interpreted carbonate build-ups (Figure 2). The new data shows that the structure in the foreland basin is partly a result of the interplay of normal deltaic growth faults and ongoing movement on the underlying NW-SE thrust fault trends.

Results of the interpretation of the new seismic has greatly enhanced the offshore potential with an impressive suite of prospects delineated. These include well defined reefal buildups, faulted deltaic traps and turbidite sandstone plays. Clear, structurally consistent AVO anomalies and flat spots de-risk a number of the structures. Lion continues to work towards a potential drill decision on the high graded prospects in both the shallow Plio-Pleistocene pay and the deeper fold belt play in the East Seram PSC.

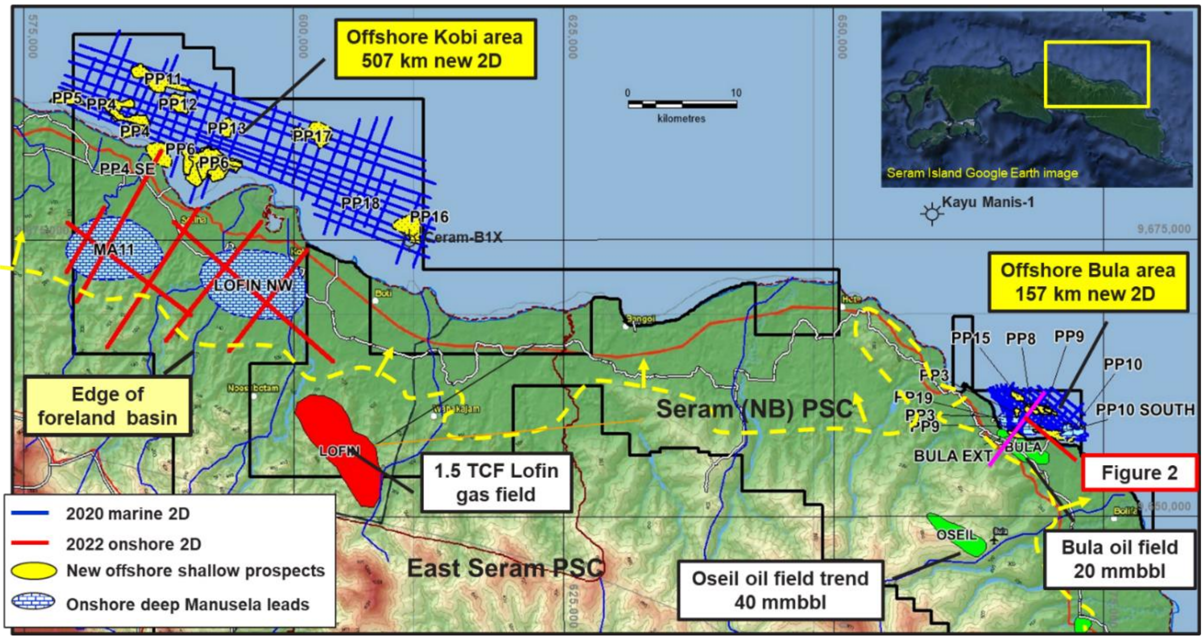

Figure 1: Map of NE of Seram Island showing location of 2020 marine seismic targeting the shallow Plio-Pleistocene foreland basin section and parts of 2022 onshore 2D targeting the deeper fold belt play

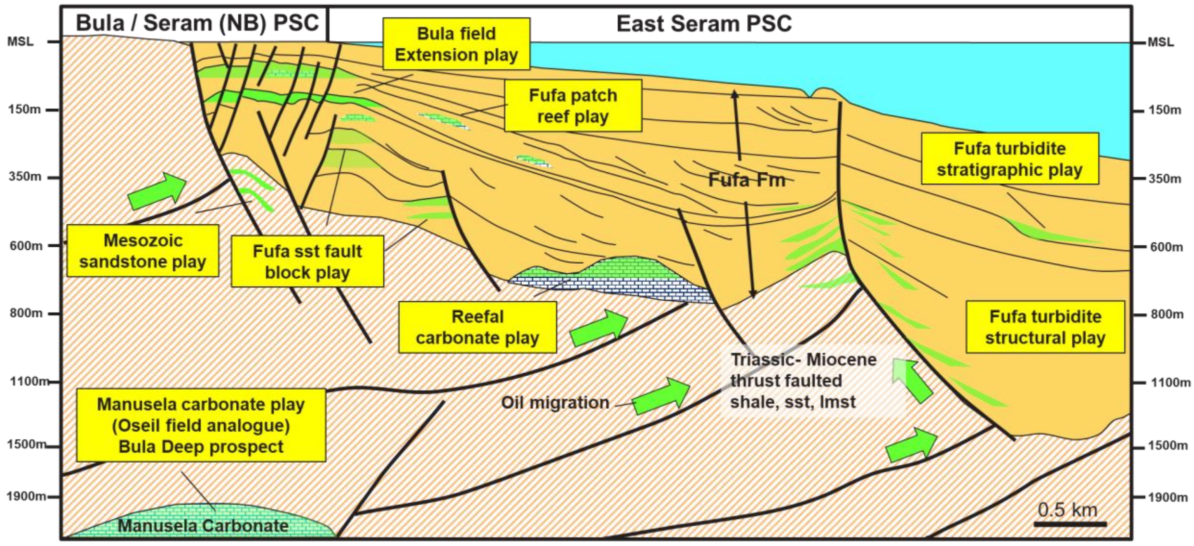

Figure 2: Geoseismic section of Bula Bay area showing key structural features and play types

SPEAKER BIOGRAPHY

Mr Kim Morrison is currently Exploration Manager of ASX listed Lion Energy Ltd and also provides exploration consultancy services to a number of other companies in the Asia-Pacific region. Kim continues to enjoy his work as an explorationist and is fortunate to have been involved in many oil and gas discoveries from Australia, Indonesia, Gulf of Mexico, Brunei, Malaysia to Libya. In his postings around the world, he has worked in senior technical and managerial positions with majors (Marathon, Shell, Woodside) through to small cap companies. Kim graduated from The University of Sydney in 1984 with an Honours degree in Geology and Geophysics and also holds a Diploma in Applied Finance and Investment from The Securities Institute of Australia. He is a frequent contributor to the SEAPEX Conference and is a member of the American Association of Petroleum Geologists, the Petroleum Exploration Society of Australia as well as SEAPEX.

Kim has worked on projects in Seram Island since 2012 and was instrumental in Lion's successful bid for the East Seram PSC in 2018. He is looking forward to exploration drilling in this exciting block.

ORAL PRESENTATION

New Exploration Potential in the Aure Moresby Fold & Thrust Belt, Papua New Guinea

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Submarine fans are important targets for oil and gas exploration and turbidites form prolific petroleum reservoirs in many sedimentary basins worldwide. Remarkable imaging from modern proprietary and multi-client 2D seismic data in south-eastern Papua New Guinea (PNG), has uncovered exciting new potential within large-scale Neogene channel-fan turbidite complexes.

Historic exploration in PNG has primarily focused on plays associated with the Jurassic Toro Formation and Miocene reef carbonates. Late Pliocene turbidites sourced from the Fly River Delta have been targeted in the Gulf of Papua (GoP), leading to the Flinders and Hagana discoveries in 2013.

The identification in the Aure Moresby Fold and Thrust Belt (AMFTB) of Mid-Miocene outcrops composed of fine– coarse, quartz, 'greywacke' sandstones, up to 122m thick in the Diamana village area, offered evidence for the presence of turbidite depositional fairways and the transport of quartz-rich material into deep water. These encouraging outcrops led to the drilling of two onshore wildcat wells: Oroi-1 in 1949 and Kaufana-1 in 1958. The wells were drilled on surface anticlines, without the benefits of seismic data and encountered off axis turbidite systems. And yet, despite advances in our understanding of turbidite reservoirs, as well as innovations in seismic acquisition and processing technology, clear evidence for large sedimentary basins extending for over 800km, plus the discovery of active light oil seeps, there has been no further exploration drilling in the AMFTB since the 1980s.

Regional high resolution, broadband, PSDM, multi-client 2D seismic data acquired by Searcher in 2015–2016, has revolutionised the understanding of the offshore AMFTB, and has driven recent exploration efforts. In the PPL579 area, seismic data has enabled the division of the Miocene to recent interval into multiple sequences, which record the evolution of a Neogene foreland basin to an active deep-water fold and thrust belt, the cessation of contractional tectonics and relative passivity.

A distinctive Mid-Miocene system has now been identified, exhibiting impressive seismic facies that differ greatly from subsequent transverse and long-ranging axial systems. Large-scale channel and lobe complexes are observed, which are involved in thrusted anticlines and overlain by a thick, seismically transparent interval, which is interpreted to be a sealing unit, composed of hemipelagic marine shales deposited during a period of relative tectonic quiescence.

The major Mid-Miocene pulse of sediment transport into deep water can be subdivided into four phases, marking the initial incision and erosion, followed by the backfill, waning and abandonment phases. At the base of slope, weakly confined to unconfined channel complexes are observed, which are captured within a broad canyon or basal scour. A thick, gross reservoir interval can be characterised by laterally extensive, stacked, amalgamated channels and shingled reflector pairs. The shingled seismic reflectors dip towards a final stage channel and are indicative of active, lateral channel migration, within a meandering channel belt. Constructional levee systems appear to be absent, indicating that there was an abundant supply and deposition of flow-stripped, coarse-grained material into to the proximal fan area. The unconfined channel complexes transition on the basin floor into laterally extensive, amalgamated, stacked sheet sands and lobe systems. These are characterised by two, thick, High Amplitude Continuous (HAC) packages, interspersed with more discontinuous events which are interpreted to be distributary channels.

Basement high systems associated with rift structure form prominent bathymetric highs, which ponded and diverted the Neogene turbidite systems to the east. The switch in orientation resulted in the depositional axis of the proximal fan to parallel the strike of the advancing AMFTB. This configuration is highly favourable for reservoir continuity within E-W striking frontal thrust anticlines, which postdate reservoir deposition.

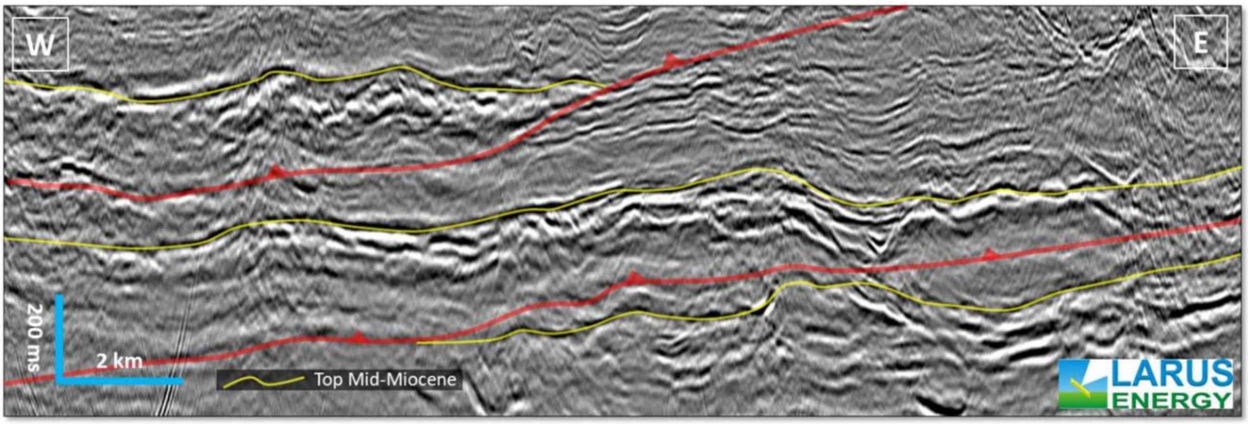

Figure 1: Proprietary 2D Seismic Data (strike line to structure): Showing Mid-Miocene, Semi-Confined to Unconfined Channel Complex Reservoir and Hemipelagic Shale Seal Pairs, Structurally Repeated by Thrust Systems

SPEAKER BIOGRAPHY

Alaister is the Exploration manager for Larus Energy, the Operator of PPL579, in Papua New Guinea. He is a structural geologist and petroleum geoscientist with technical expertise in the interpretation and analysis of geologically complex areas and has been exploring PNG for the last 6-years.

Prior to joining Larus, Alaister has worked both exploration & production roles with: Eni, DNO, Maersk Oil and Total Energies.