



**ORAL PRESENTATION**

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**Day 1: 3<sup>rd</sup> April 2019**

**Session 3: Onshore Papua**

**Chairs: Huw Evans – Twinza Oil, Christelle Demars - TOTAL**

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13:30	Papua New Guinea Exploration Techniques	Luke Mahoney	Oil Search
13:55	Muruk Discovery, Western Foldbelt - Papua New Guinea	Jonathan Giddings	ExxonMobil
14:20	TOTAL Exploration in PNG, Exploration Optimization Through Technology and Innovation	Damien Deveaux	TOTAL E&P
14:45	Western Flank of Papuan Basin – Indonesian Papua	Ian Longley	Transform Exploration



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### Papua New Guinea Exploration Workflows

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Exploration in the PNG fold belt has a long history and a good drilling success rate, despite being characterised by complex structural geology and difficult surface conditions. Early successes relied on drilling surface anticlines based on field geology and limited seismic data. With most of these anticlines now drilled, recent exploration work has focussed on integrating new and existing techniques including remote sensing, potential field and seismic acquisition and processing technologies to define more subtle structures which may not be reflected at the surface. Also, innovative new modelling tools are providing a unified and quantitative approach to structural geology and basin modelling, providing significant insight into hydrocarbon timing and migration history. Workflows employed by Oil Search will be discussed using a recent example which led to a successful and exciting gas discovery close to the existing PNG LNG project fields.

#### SPEAKER BIOGRAPHY

Luke graduated from The University of Melbourne, Australia, in 2011 after completing a BSc (Hons) in geology and has subsequently worked on minerals and energy exploration projects throughout Australia and PNG. Since 2014, Luke has been exploring the PNG Fold Belt while completing a PhD, supported by Oil Search, on the structure, evolution and hydrocarbon potential of the western Papuan Fold Belt, where he has spent significant time in the field. Luke joined Oil Search full-time early last year, where he is a member of the Fold Belt Exploration Team.



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### Muruk Discovery, Western Fold Belt – Papua New Guinea

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The Muruk-1 well in the Western Fold belt of Papua New Guinea provides important constraints on the geometry of the Muruk structure and the interpretation of structural style in the frontal part of the fold belt. Muruk-1 was spudded on 2<sup>nd</sup> November 2016 by the PPL402 joint venture (Oil Search Operated) after more than 12 months of civil construction works. The exploration well and the associated appraisal sidetracks intersected two separate gas accumulations within the pre-drill assessed area.

The Muruk discovery represents the first successful test of a prospect interpreted to be decoupled from the overlying surface structures. The outcome of the well improves prospectivity in areas that have previously been considered non-prospective due to the lack of discrete surface anticlines. The presence of at least one major detachment above reservoir level (Early Cretaceous Toro Sandstone) facilitates the decoupling of surface and deep structures along the frontal trend of the fold belt and allows prospective structures with subtle, or no direct surface expression, to be interpreted and modelled.

Integration of multiple datasets, consideration of multiple structural models, and planning for operational flexibility proved essential to a successful Muruk-1 operation. Data used to constrain the Muruk pre-drill interpretation included surface geological mapping and dip measurements, poor-quality 2D seismic, LIDAR, potential fields (airborne gravity/magnetics, magnetotellurics), surface age data (Sr-isotope stratigraphy and biostratigraphy) and regional wells. Key elements of the prospective model included a north-east dipping back limb, counter to predominately south-west surface dips, and the presence of a triangle zone (structural wedge) south the of Muruk-1 well location. Evidence of a triangle zone in both seismic and potential field data allows adoption of a structural interpretation that transfers shortening through the stratigraphic section via deep-cutting fore-thrusts below the detachment and shallow back- and fore-thrusts above the regionally extensive roof thrust. The model implies significant variation in the thickness of the Ieru Formation due to structural duplication. Due to the density contrast between the lower density Ieru Formation and the overlying higher density Darai Limestone, gravity modelling can be used to better predict where thicker Ieru Formation exists and therefore where decoupled Toro-involved structures may be present.

The Muruk-1 well results validated the predicted structural style and demonstrated additional complexity not modelled pre-drill, including the major thrust fault separating the two discoveries and additional folding / faulting on the back limb of the greater Muruk anticline. Advanced technologies, including high-resolution dip data interpreted in real time from resistivity image logs and while-drilling biostratigraphic analysis, were critical to the success of the Muruk-1 well, allowing operational decisions to be made quickly. Leveraging the strengths of the Joint Venture through high-quality technical engagement was critical to implementing this flexible approach in such a logistically challenging operational environment. Appraisal of the deeper Muruk B structure by the Muruk-2 well in 1Q 2019 will investigate the extent of the gas discovery to the north-west, incorporating a similar evaluation plan to Muruk-1.

#### SPEAKER BIOGRAPHY

Jonathan is a member of ExxonMobil's PNG Exploration team based in Melbourne. After completing his PhD and post-doctoral studies at The University of Melbourne, on Neoproterozoic carbonates, he joined ExxonMobil in 2010. He has worked multiple exploration projects in the Asia Pacific region, from deep-water Vietnam to onshore Papua New Guinea Highlands. Jonathan has been working PNG geology for the last 5 years on projects from regional-scale interpretation and opportunity generation, to the drilling of exploration and development wells - most recently leading the planning and execution of the Muruk 1 and 2 exploration wells.



## ORAL PRESENTATION

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# TOTAL Exploration in PNG, Exploration Optimization Through Technology and Innovation

Damien Deveaux<sup>1</sup>, W. Gordon-Canning<sup>1</sup>, A. Pichon<sup>1</sup>, P. Jusselin<sup>1</sup>, Q. Zhao<sup>1</sup>, A. Shakerley<sup>1</sup>, W. Vetel<sup>1</sup>, C. Kergaravat<sup>1</sup>,

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Total is present within PNG both in M&S, since 2012, and E&P since 2014, with Total's entry to the PRL15 licence. Total's E&P activity in PNG covers both exploration and pre-development in the onshore PRL15 licence (767 km<sup>2</sup>, comprising Elk-Antelope gas field appraisal area of approximately 50 km<sup>2</sup>) as well as deep and ultra-deep offshore exploration in the PPL576 and PPL589 licenses.

This presentation will focus on activity within the PRL15 licence where Total operates with 40.13% interest, with joint venture partners ExxonMobil (37.04%) and Oil Search (22.84%). PRL15 is located approximately 120 km inland from the township of Kerema and 360 km northwest from Port Moresby, and hosts the Elk- Antelope Field, one of the most significant discoveries in Asia over the last 20 years. The license lies at the junction of two major Fold Belt (FB) systems: the Papuan and the Aure Fold Belts. Reservoirs are associated with the Early-Mid Miocene Darai Formation, dominated by shallow-water carbonate deposits passing laterally to the Puri mud-prone deep-water carbonates. The appraisal program on Elk-Antelope was completed in 2017, and the recent signature of the MOU for gas agreement is pushing towards the future development of the Papua LNG project.

Additional exploration potential remains significant on PRL15 and primary exploration focus is on the Miocene carbonates equivalent to the reservoir of Elk-Antelope. A number of additional exploration targets have been identified and maturation is ongoing with additional data acquisition for mid-term drilling. The complex structuration results in difficult data acquisition and resulting imagery. Total has significant global foothills experience combined with onshore operational expertise and uses modern technology and data acquisition advantages for optimal prospectivity de-risking over PRL15.

In 2018 Total acquired 120km of 2D seismic in synergy with joint ventures partners via a delegated program operated by Oil Search and in synergy with surrounding acquisitions in the Eastern Fold Belt. The program offered an opportunity to push further acquisition parameters for enhanced imagery on a production basis and to test them on a line for future program optimization. Furthermore, 34 MT stations were acquired in synergy with seismic program, increasing significantly MT coverage over the PRL15.

Additional and ongoing future activity includes a multi-scenario structural modeling approach from surface and sub-surface data, integration of seismic, airborne and non-seismic technologies, along with innovative methods, such as shot based interpretation and advanced imagery techniques including FWI. Constant data integration is done collaboratively with our Joint Venture partners and utilizing our global expertise through our dedicated technical and R&D centres enabling full data integration, modelling and rapid turnaround.

In parallel, Total is continuing to push technological innovation into our operations, with a first industrial test of the in-house METIS R&D project completed successfully in early 2018 on PRL15. The project focuses on acquiring high density 3D seismic imagery in remote areas such as PRL15, while ensuring a high quality image and minimizing HSE, environmental impact and cost.

This presentation will cover an overview of Total's current E&P activity on PRL15 and how Total tackles the operational complexities in such a complex environment by integrating our global experience along with technology and innovation within our current exploration program in PNG.

## **SPEAKER BIOGRAPHY**

Damien is a geophysicist with an MSc in Petroleum Geosciences from IFP-School. He joined Total Exploration & Production nine years ago, with a first position working on Africa new venture projects, before moving to operational and geophysical coordination on East African operated assets. He was then posted for three years in Angola, working on deep offshore green-field development projects.

He is currently senior exploration geophysicist within Total's PNG Exploration team, with a specific focus on onshore assets.



## ORAL PRESENTATION

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### Western Flank of Papuan Basin – Indonesian Papua

Ian Longley<sup>1,2</sup>, Agu Kantsler<sup>1</sup>

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The onshore Papuan Basin is a world class hydrocarbon province with some 27 Tcf gas and 750 mmbbl of oil and natural gas liquids reserves and resources discovered to date. Around 65% of the gas volumes and some 90% of the oil volumes will have been developed by 2025 via the Kutubu oil project and the PNG LNG and Papua LNG gas projects. All of these projects are situated in the Fold and Thrust belt of PNG where development is favoured by substantive field size, attractive fiscal terms and the high liquids yield and calorific value of the gas.

Many smaller discoveries of gas, the largest of which is around 650 Bcf, have been made in the foreland of the Papuan Basin of PNG, but none has yet been developed because of a lack of critical mass, distance to export point and the paucity of infrastructure. The western flank of this highly prospective basin, however, lies largely within Indonesian Papua. Whilst poorly explored, it presents significant opportunity with the structural domain changing from PNG into Papua, suggesting larger trap sizes with several large structures visible on gravity and sparse seismic data. The play is also characterized by shallow depth to the principal objective sequence, surface seeps of oil, typed to Jurassic source rocks, excellent access to ocean going vessels via river ports and new fiscal terms which offer considerable upside.

#### SPEAKER BIOGRAPHY

Ian Longley is a regional petroleum geologist with 30 years of experience who has worked for Lasso, Woodside, Shell and Oil Search in various locations around the planet in junior and executive exploration roles. He has specialised in the plate tectonic evolution, regional petroleum geology, play and prospect analysis and the hunt for new exploration opportunities in the Australasian region. He currently runs the industry training course on the Petroleum Geology of SE Asia and co-presents the Petroleum Geology of the North West Shelf course. He has published extensively on the regional petroleum geology and, after deciding senior management is not for him, is currently enjoying working on his hobbies (now businesses) looking at real geology. He is also joint developer and joint owner of the Player ArcGIS play analysis software.