PNG Foldbelt Exploration
SEC2019

Luke Mahoney
Luke.Mahoney@oilsearch.com
ACKNOWLEDGEMENT & DISCLAIMER

Oil Search acknowledges the support of the PNG Department of Petroleum and the support and contributions of all of our Joint Venture partners.

While every effort is made to provide accurate and complete information, Oil Search Limited does not warrant that the information in this presentation is free from errors or omissions or is suitable for its intended use. Subject to any terms implied by law which cannot be excluded, Oil Search accepts no responsibility for any loss, damage, cost or expense (whether direct or indirect) incurred by you as a result of any error, omission or misrepresentation in information in this presentation. All information in this presentation is subject to change without notice.

This presentation may contain forward-looking statements which are subject to particular risks associated with the oil and gas industry. Oil Search Limited believes there are reasonable grounds for the expectations on which the statements are based. However, actual outcomes could differ materially due to a range of factors including oil and gas prices, demand for oil, currency fluctuations, drilling results, field performance, the timing of well work-overs and field development, reserves depletion, progress on gas commercialisation and fiscal and other government issues and approvals.
OIL SEARCH OVERVIEW

❖ Established in PNG in 1929

❖ 29% interest in PNG LNG Project (operated by ExxonMobil)

❖ ~ 60% interest in, and operator of, all PNG’s producing oil fields

❖ Pursuing major LNG growth opportunities in PNG in partnership with ExxonMobil and Total

❖ 25.5% interest in major oil resource in Alaska North Slope, USA, with significant appraisal and exploration upside

❖ Market capitalisation ~A$12bn (~US$9bn)

❖ Listed on ASX (Share Code: OSH) and POMSoX, plus US ADR programme (Share Code: OISHY)
PNG EXPLORATION OVERVIEW

- PNG has material exploration potential
- Actively testing proven and new plays
- 3 wells and > US$300 million gross exploration expenditure in 2018
- Exploration focus around current, planned and potential LNG hubs

- This talk is about new structural plays and exploration techniques in the Western Foldbelt

Offshore Papuan Gulf: Shallow and Deep Water
The Papuan Basin formed on the northern Australian margin from the Triassic to present; robust source, reservoir and seal.
The Papuan Basin formed on the northern Australian margin from the Triassic to present; robust source, reservoir and seal.

- **Key risk in Western Foldbelt is trap**
- The PNG foldbelt resulted from arc-continent collision at the northern Australian margin from the Late Miocene (~5 Ma) to present.
- Still active as shown by the 2018 7.5 magnitude earthquake.
WESTERN FOLDBELT BACKGROUND

❖ The Papuan Basin formed on the northern Australian margin from the Triassic to present; robust source, reservoir and seal

❖ **Key risk in Western Foldbelt is trap**

❖ The PNG foldbelt resulted from arc-continent collision at the northern Australian margin from the Late Miocene (~5 Ma) to present

❖ Still active as shown by the 2018 7.5 magnitude earthquake
WESTERN FOLDBELT BACKGROUND

❖ Extreme terrain and limited access:
  - Elevations up to 3,600 m
  - Dense rainforest cover
  - Large areas of severe karst topography
  - Very limited ground access
  - Weather-limited operational window

❖ Poor sub-surface imaging and complex structure:
  - Scattering of seismic energy by karst topography
  - Highly faulted and folded geometries
WESTERN FOLDBELT BACKGROUND

❖ **Extreme terrain and limited access:**
  - Elevations up to 3,600 m
  - Dense rainforest cover
  - Large areas of severe karst topography
  - Very limited ground access
  - Weather-limited operational window

❖ **Poor sub-surface imaging and complex structure:**
  - Scattering of seismic energy by karst topography
  - Highly faulted and folded geometries
WESTERN FOLDBELT BACKGROUND

❖ **Extreme terrain and limited access:**
  - Elevations up to 3,600 m
  - Dense rainforest cover
  - Large areas of severe karst topography
  - Very limited ground access
  - Weather-limited operational window

❖ **Poor sub-surface imaging and complex structure:**
  - Scattering of seismic energy by karst topography
  - Highly faulted and folded geometries
WESTERN FOLDBELT BACKGROUND

- **Extreme terrain and limited access:**
  - Elevations up to 3,600 m
  - Dense rainforest cover
  - Large areas of severe karst topography
  - Very limited ground access
  - Weather-limited operational window

- **Poor sub-surface imaging and complex structure:**
  - Scattering of seismic energy by karst topography
  - Highly faulted and folded geometries
WESTERN FOLDBELT BACKGROUND

❖ Extreme terrain and limited access:
   ▪ Elevations up to 3,600 m
   ▪ Dense rainforest cover
   ▪ Large areas of severe karst topography
   ▪ Very limited ground access
   ▪ Weather-limited operational window

❖ Poor sub-surface imaging and complex structure:
   ▪ Scattering of seismic energy by karst topography
   ▪ Highly faulted and folded geometries
A tale of persistence and technology
MURUK CASE STUDY: BACKGROUND

- Muruk Prospect located along trend of giant Hides Gas Field and up-dip of Juha Gas Field
- Darai Limestone syncline at surface, area historically considered to be non-prospective
- Huge uplift in Muller Ranges:
  - Surface syncline elevated >2km amsl
  - Toro SST reservoir in outcrop >7km above regional in Lavani Valley
- Limited sub-surface data prior to the acquisition of >120km of 2D seismic in 2014 and 2015
**MURUK CASE STUDY: THE TOOLS**

- **Top-down interpretation approach:**
  - Field geology fundamental to exploration and remains a crucial constraint on structural models

![Diagram showing Muruk Prospect: >3 km below surface]
Top-down interpretation approach:

- Sr-isotope method of dating Miocene limestones a key step in estimating base Darai Limestone
MURUK CASE STUDY: THE TOOLS

- Top-down interpretation approach:
  - Magnetotellurics (MT) to constrain Darai Limestone structure and identify potential repeats

Muruk Prospect: ~1.5 km below base Darai
MURUK CASE STUDY: THE TOOLS

❖ **Top-down interpretation approach:**

- Seismic reflection data generally of poor to moderate quality, most valuable when interpreted in combination with other datasets.
WHAT HAPPENED NEXT?

- Structural and potential field techniques important for interpretation validation
- Comprehensive technical evaluation suggested an anticline could be present beneath surface syncline
- Muruk chosen as drill candidate and spudded late 2016
- *Well results will be reviewed by ExxonMobil in the next talk*
WHAT ARE THE NEW TOOLS?

- LiDAR provides ability to “see through the canopy”
- Dramatically improved surface mapping, seismic and well planning
- Possible to define the level of decoupling between limestone and underlying section; key to understanding new structural plays
- Huge 3D datasets requiring state-of-the-art computing capabilities
WHAT ARE THE NEW TOOLS?

- LiDAR provides ability to “see through the canopy”
- Dramatically improved surface mapping, seismic and well planning
- Possible to define the level of decoupling between limestone and underlying section; **key to understanding new structural plays**
- Huge 3D datasets requiring state-of-the-art computing capabilities
WHAT ARE THE NEW TOOLS?

- Regional merges of historical, prospect-scale 2D seismic lines
- PSDM processing optimised by LiDAR, surface geology and iterative structural models
WHAT ARE THE NEW TOOLS?

- Regional merges of historical, prospect-scale 2D seismic lines
- PSDM processing optimised by LiDAR, surface geology and iterative structural models

![Diagram of PSDM velocity model with labels for clastic, karst limestone, and Sr base Darai.](image-url)
WHAT ARE THE NEW TOOLS?

- Regional merges of historical, prospect-scale 2D seismic lines
- PSDM processing optimised by LiDAR, surface geology and iterative structural models

*Processing courtesy of Thrust Belt Imaging (TBI)*
WHAT ARE THE NEW TOOLS?

- Until recently charge timing taken as a given
- With focus on new plays, especially sub-thrust structures, this is not sufficient
- Fully-linked structural, thermal, pressure and hydrocarbon generation and migration modelling now possible using IFP package *Kronos*

**Geological Evolution**

**Thermal Maturity**
Exploration in the PNG Highlands requires application of a variety of techniques and skills:

- Field geology
- Isotopic dating
- Magnetotellurics
- Seismic reflection
- Structural modelling
- Potential fields
- Physical and numerical analogues
- Remote sensing (LiDAR)
- Basin modelling (Kronos)

Moving beyond the historical to new-age detached structural plays has required the integration of all these tools and lateral thought, together with willingness to take a risk on drilling.

Even with the best models, surprises are common, and flexibility in the approach to drilling is required.

The Muruk 1 well history demonstrates the challenges and solutions and will be discussed by ExxonMobil in the next talk.
Thank you