The Seram Fold-Thrust Belt
An emerging high impact play in Eastern Indonesia

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A New Approach to Asian Energy
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Competent Persons Statement: Qualified Petroleum Reserves and Resources Evaluator

Pursuant to the requirements of the ASX Listing Rules Chapter 5, the technical information, reserve and resource reporting provided in this presentation are based on and fairly represent information and supporting documentation that has been prepared and/or compiled by Mr Kim Morrison, Exploration Manager of Lion Energy Limited. Mr Morrison holds a B.Sc. (Hons) in Geology and Geophysics from the University of Sydney and has over 30 years’ experience in exploration, appraisal and development of oil and gas resources - including evaluating petroleum reserves and resources. Mr Morrison has reviewed the results, procedures and data contained in this website. Mr Morrison consents to the release of this report and to the inclusion of the matters based on the information in the form and context in which it appears. Mr Morrison is a member of AAPG.

Conversion from gas volume to barrels of oil equivalent (BOE) in this document is based a BOE conversion ratio of 6 mcf:1 bbl.
Presentation Outline

- Lion Energy overview
- Seram fold-thrust belt (FTB)
  - Regional setting
  - Play summary, Discovered fields
  - Reservoir
  - HC occurrences/Source
  - Structural model
  - Prospects and leads
- Global analogues
- Summary
Overview of Lion Energy
ASX listed, majority Indonesian owners, Seram focused E&P company

- 100% East Seram PSC
  - 6510 km², signed July 17 2018
  - Fold-thrust belt play, large leads
  - Plio-Pleistocene thrust foreland play
- 2.5% Seram (Non Bula) PSC
  - Fold-thrust belt play main target
  - Oseil field currently ~1800 bopd
  - Contains 2 TCF Lofin gas field
- 2000-2005 Lion operated the Bula oil field

Lion Seram database of over 3500 km² 2D, 200 km² 3D, 40 wells and 100’s of reports
Region contains prolific HC provinces

Proven Seram Basin fold-thrust belt (partly) analogous to Papuan FTB

- **Salawati Basin**: 500 mmbbl oil, 0.8 TCF gas, 135 mmbbl condensate, 220 exploration wells
- **Bintuni Basin**: 50 mmbbl oil, 20 TCF gas, ~100 mmbbl condensate, 65 exploration wells
- **Seram FTB**: >40 mmbbl oil, 2 TCF gas, 20 mmbbl condensate, 9 exploration wells, testing fold belt play (6 discoveries)
- **Papuan/Aure FTB**: 700 mmbbl oil, 30 TCF gas, 400 mmbbl condensate, ~100 exploration wells
Irian Jaya to Seram regional section

Collision along Banda Arc from Late Miocene has produced the Seram fold-thrust belt (FTB) consisting of imbricated/folded Australian continental margin.

Source: Darman & Reemst, 2012
Seram Island stratigraphy
Massive fractured carbonate reservoir, world-class source & seal

Stratigraphic Table - Seram Region

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<tr>
<th>System/Series</th>
<th>Seram</th>
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**Fufa Fm- Primary reservoir**
- Shallow water sandstone & limestone
- Intraformational shale/siltstone seal

**Kola Shale - Regional seal**
- Shelfal/neritic calc. claystone & siltstone
- Seals Lofin 1300m gas column

**Manusela Fm - Primary reservoir**
- Shallow water-shelf carbonate,
- Fracturing results in high flow rates

**Saman-Saman Fm – Source**
- Calcareous organic rich shales, marl
- Equiv. Buru Is shales TOC to 16% HI 540

(after Charlton, 2004; also Kemp et al, 1996)

Seram has Triassic rift related outboard highs with Jurassic shallow water carbonates and co-eval rich marine source rock deposited in syn-rift lows

Kola Shale claystone &

Manusela grainstone with swaley cross stratification
Manusela fractured carbonate: key objective
Over 2TCF gas & 60 mmbbl oil/condensate discovered to date from 6 discoveries

- Triassic/Jurassic Manusela reservoirs oil in Oseil area (with gas cap) & gas/cond. in Lofin Field
- 9 wells have tested fold belt play, 6 discoveries
  - East Nief 1 (1988) TD 2012m: 6.2 mmbbl (OIP 89.2 mmbbl)
  - Bolifar Utara 1 (1988) TD 3505m: Manusela not reached
  - Oseil 1 (1993) Oil discovery TD 3475m: 17 mmbbl produced
  - Kayu Manis 1 (2001) TD 3304m Manusela not reached
  - Lola Kecil 1 ST2 (2002) TD 2012m, Manusela not reached
  - Neif Utara A1 (2008) TD 2230m, 4.3 mmbbl (OIP 68 mmbbl)
  - Neif Utara B1 (2011) TD 2390m 0.8 mmbbl (OIP 12 mmbbl)
  - Oseil Selatan 1 (2011) TD 2238m: 3C 1.7 mmbbl
  - Lofin 1 ST1 (2012) TD 4427m: 2C: 2.02 TCF/18mmbbl cond.
- Large leads/structures on trend with discoveries

3C contingent resource numbers shown based on Degolyer & McNaughton Dec 31 2017 report on Oseil area
Oseil Field Area: 17 mmbbl produced, significant remaining volumes
Overall structure has numerous culminations with similar OWC (~1800mss)

- Up to 300m HC column, ~225m oil, gas caps to 75m
- 15-22 API oil
- Fractured, shallow water Manusela carbonate
- Primary porosity av 6.4% (up to ~14%)

Horizontal wells designed to maximise smaller fracture intersection while avoiding major fractures to minimise early water breakthrough

Fracturing of Manusela Fm in Oseil 1 core. Well flowed at 3800 bopd
Lofin gas discovery - 1300m gas column with closure of ~40 km²
Largest onshore discovery in Indonesia in decades, extends into East Seram PSC

• 2015 Lofin-2 confirmed 1300m gas column in fracture carbonate, flowed 17.8 MMscfg/d
• Numerous fractures from cores, image logs, losses while drilling, gas peaks
• Contingent Resource (2C) = 2.020 TCF, 18.25 MMbbl cond
Manusela Fm reservoir
Late Triassic to Middle Jurassic carbonate, up to 2000m thick

- Oolitic grainstone, grainstone, packstone and wackestones
- High energy oolitic sand shoals or barrier bars to lower energy tidal flat or offshore environments
- Abundant cross bedding
- Age dating difficult
- Samples in East Neif 1 assigned lowermost Oxfordian or Bathonian to Pliensbachian or older
- Porosity generally <10%, fractures give good deliverability

Source: Kemp and Mogg, 1992

Manusela Limestone East Nief 1

Oolitic & skeletal grainstone
Dolomite replacement of grainstone
Kola Shale
Manusela Fm

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www.lionenergy.com.au
April 2019
Seram Island oil and gas occurrences

Numerous oil and gas seeps support present day generation
Bula Field originally discovered due to drilling near seep documented in 1865

- GC-MS and biomarker data indicate sourcing from organic rich marine sediments of pre-Late Cretaceous age, deposited in an anoxic carbonate marine environment or anoxic algal rich tidal flat environment
- Oil differences due to differing maturity & varying degrees of biodegradation

Oil seep 1851 Wahai Basin geological map
Gas seeps 1985 Wahai Basin geological map
Gas and some flu shows in Ceram B1X
Oil seep 1985 Wahai Basin geological map
Bula seep 1865
Neif gorge seep
Belis area Oil seep (possibly from transported Bula crude?)
Widely recognised gas seeps around surface domes dating to 1927
Saman-Saman Fm source

L. Triassic–E. Jurassic marine carbonate source rocks partly co-eval with Manusela

• Limited Seram outcrops/subsurface penetrations of rich Saman-Saman source rocks.
• Weber (1926) described limestone with strong bituminous staining in the Central Mountains
• Banda Arc region shows age equivalent deep marine calcareous asphaltic/bituminous shales & limestones
  • Ghegan Fm, Buru Island TOC’s 16% and HI’s 539 mg/gm (Zhugang et al, 2016)
  • Winto Fm, Buton Island abundant asphalt occurrences numerous oil seeps TOC-1-16%, high pyrolysis yield up to 95,000ppm (Davidson 1991, Tanjung et al, 2008)
Maturation modelling shows present day Saman Saman-generation oil window from ~4000-5600m, gas window from 5600m due to low heat flow in area (~40mw).

Present day Oil and gas windows for inferred Saman-Saman source

Lofin 2 Burial History

Transformation ratio Top Saman-Saman Fm

Offshore more gas prone inboard becoming more oil prone outboard

Becoming more oil prone in Wahai area

Likely more gas prone in Lofin area

Likely more oil prone in SE onshore
East Seram structure – ongoing collision created NW-SE FTB
Inboard & outboard fold-thrust domains, allochthon front the leading edge of the FTB

- NE-SW max horizontal stress, sinistral transpression
- Inversion structures display complex internal fault architecture, fault sets (P, R, T) in multiple orientations
- T (NE-SW) and R (E-W) most likely dilational fault sets

Nicely defined transpressional pop-up structure (Manusela Mountains)
Tectono-stratigraphic model

Interaction of Mesozoic rift elements and Banda Arc collisional regime

- Rift/passive margin setting (distal Australian plate) underpins the geology of Seram
- Collision along Banda Arc from Late Miocene caused oblique inversion on rift faults resulting in the development of inversion anticlines (e.g. Lofin, Oseil) and many FTB leads
- With increasing shortening, inversion structures progressively deformed, dissected and overridden by low-angle thrust fault systems with Kanikeh overlying younger stratigraphy
- Overriding thrust stacks important for burial and maturation of syn-rift source rocks
Mapping of top Manusela event shows highly attractive targets.

Potential structures up to 90 km$^2$, Manusela limestone targets from 1500m to 5000m.
Seram fold belt play: impressive undrilled structures

2020 seismic program to cover key leads

MA-7 lead – closure up to 55 km\(^2\) (+)
Prospective resource\(^1\) P90: 45 – P10: 1006 mmboe
Structure supported by seismic and gravity and has topographic expression and seeps recorded in area

\(^1\)Prospective Resource: The estimated quantities of petroleum that may potentially be recovered by the application of a future development project(s) relate to undiscovered accumulations. These estimates have both an associated risk of discovery and a risk of development. Further exploration appraisal and evaluation is required to determine the existence of a significant quantity of potentially moveable hydrocarbons.
Emerging prospect and lead portfolio

Immature, underexplored play, imaging of top Manusela key issue

• 12 leads (to date) in East Seram PSC, combined mean 1.8 bboe

• Av. POS 23%, ~50% gas estimated

• Offshore leads & structures observed on gravity, field mapping, topography without seismic not yet characterised

Prospective Resource: The estimated quantities of petroleum that may potentially be recovered by the application of a future development project(s) relate to undiscovered accumulations. These estimates have both an associated risk of discovery and a risk of development. Further exploration appraisal and evaluation is required to determine the existence of a significant quantity of potentially moveable hydrocarbons. P90-P10 range given.
Global statistics for fold-thrust belts (FTB)
Globally host around 25% of total discovered reserves

• >700 bboe discovered
• ~520 bboe in Zagros FTB
• ~180 bboe in ~30 other FTB’s (av 6 bboe)
• Source rock richness key success factor (marine oil prone source typical)
• ~40% reservoirs shelf carbonates
• ~60% reservoirs are fractured

Source: Goffey et al, 2010

Seram FTB ~400 mmboe discovered
Mid case YTF estimate ~2.5 bboe

From Goffey et al, 2010 (map credited to Albert Bally)
Early-Mid Jurassic paleo-geography provides interesting insights
Seram has paleogeographic affinities to Arabian plate & Pakistan FTB regions
Widespread carbonate deposition outboard of fluvio-deltaic clastics
Marrat Fm (Kuwait) comparison with Manusela Fm (Seram)

Lwr Jurassic Marrat Fm Kuwait
- Oolites, mixed high energy grainstone facies and biostromal algal accumulations,
- Aggrading and prograding shoreface/shoal environments separating a lagoon, tidal flats and sabkha from an open shelf.
- Typical production 5,500 bopd & 15 MMSCFGD

Al-Eidan et al, 2009

U Trias – M. Jur Manusela Fm
- Oolitic grainstone, grainstone, packstone & wackestones
- High energy oolitic sand shoals or barrier bars to lower energy tidal flat or offshore environments
- Production up to 5000 bopd (+) possible although limited to 500-1000 bopd so not to produce water from fractures. Lofin gas rates 15-18 mscfg/d, AOF ~40 mmscf/d

Source: Kemp and Mogg, 1992
• Carbonates (Permian to Miocene) form the majority of the Zagros reservoirs
• Jurassic carbonates (i.e. Marratt Fm in Kuwait), similar thickness facies/deposition environment as Manusela
• Jurassic-Neocomian reservoirs have laterally equivalent anoxic marine carbonate source beds (Garau & Sargelu Fm)
• Generally, carbonate zones have poor primary reservoir quality, production dependent on fracturing
• Late Miocene-Pliocene collision

Source: Ala, 1982
Seram fold-thrust belt - summary

Proven, uncreamed province, all 6 expl. tests reaching Manusela are discoveries

• Syn-rift topography influenced Manusela carbonate & Saman-Saman source distribution
• Late Miocene Banda Arc collision reactivated & inverted rift faults, producing fracture network (and permeability) within massive Manusela carbonate
• Continuing collision caused overriding thrust stacks, important for burial/maturation of source rocks
• Oil & gas seeps support active generation
• Impressive portfolio of P&L’s from seismic (albeit limited), gravity, topography & surface mapping
• Imaging Manusela key challenge
• Compelling similarities with major productive fold-thrust provinces (PNG, Zagros, Sulaiman)

Source UGM/Lion field trip

Lion planning seismic in 2020 to high grade portfolio
Thank you

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