

# Asia-Pacific Unconventionals

## Where to next?

**Kim Morrison**

CEO, Lion Energy

**Andrew Cullen**

VP Geology, Warwick Energy

Seapex

26-28 April 2017

A large, stylized background image of a globe, showing a grid of latitude and longitude lines. A black pushpin is stuck into the center of the globe, with its head pointing towards the top right. The globe is rendered in shades of blue and grey.

A **New** Approach to Asian Energy

# Important notice and disclaimer



## Forward-looking statements

Certain statements contained in this presentation, including information as to the future financial or operating performance of Lion and its projects are forward-looking statements. Such forward-looking statements:

- should or can generally be identified by the use of forward looking words such as “anticipate”, “believe”, “expect”, “forecast”, “estimate”, “will”, “could”, “may”, “target”, “plan” and other similar expressions within the meaning of securities laws of applicable jurisdictions, and include earnings guidance and statements of intention about future matters and the outcome and effects of the equity raising. Indications of, and guidelines or outlook on, future earnings, distributions or financial position or performance are also forward looking statements;
- are based upon a number of assumptions and estimates that, while considered reasonable by Lion, are beyond the control of the Company as they are inherently subject to significant technical, business, economic, competitive, political and social uncertainties and contingencies;
- involve known and unknown risks and uncertainties that could cause actual events or results to differ materially from estimated or anticipated events or results reflected in such forward-looking statements; and
- may include, among other things, statements regarding targets, estimates and assumptions in respect of production, prices, operating costs, results, capital expenditures, reserves and resources and anticipated flow rates and are or may be based on assumptions and estimates related to future technical economic, market, political, social and other conditions.

This Document is provided to the recipient on the basis that the recipient understands and acknowledges that it may not rely in any way whatsoever on the Document or other information. Unless legally required, the Company undertakes no obligation to update publicly any forward looking statements, whether as a result of new information, future events or otherwise.

## General Disclaimer

The Company has taken all reasonable care in producing the information contained in this document, however it does not guarantee the accuracy of information or analysis provided. The Company will not be responsible for loss or damage arising from the use of this information. The contents of this document should not be used as a substitute for detailed investigations or analysis and we strongly recommend you obtain independent professional advice before making any investment decisions about the Company. You may use the information for your own personal use or to inform others about our materials, but you may not reproduce or modify it without our express permission.

## Competent Persons Statement: Qualified Petroleum Reserves and Resources Evaluator

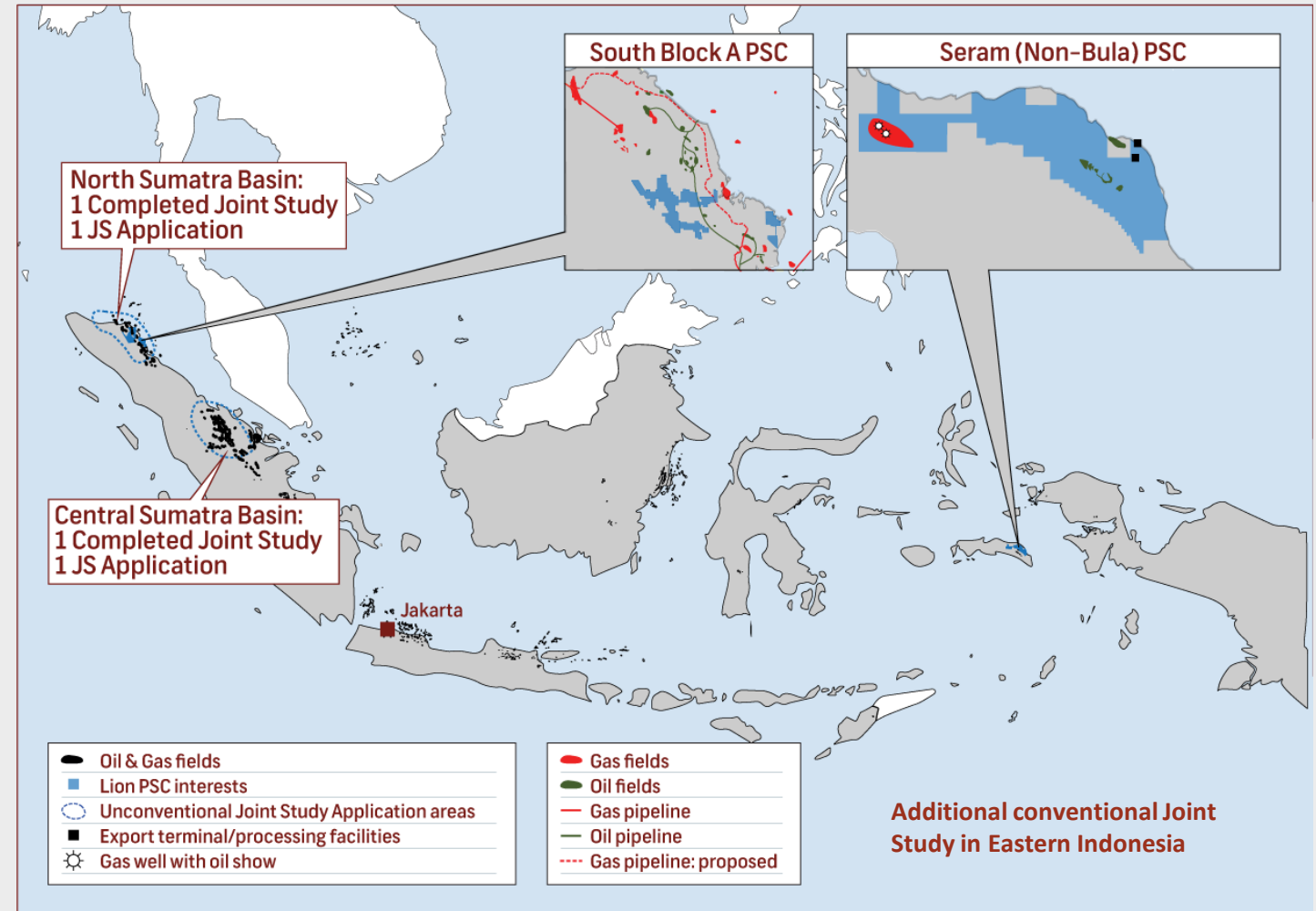
Pursuant to the requirements of the ASX Listing Rules Chapter 5, the technical information, reserve and resource reporting provided in this document are based on and fairly represent information and supporting documentation that has been prepared and/or compiled by Mr Kim Morrison, Chief Executive Officer of Lion Energy Limited. Mr Morrison holds a B.Sc. (Hons) in Geology and Geophysics from the University of Sydney and has over 28 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.

# Lion Energy Overview

Actively involved in Indonesia since 1999, combined conventional/unconventional strategy

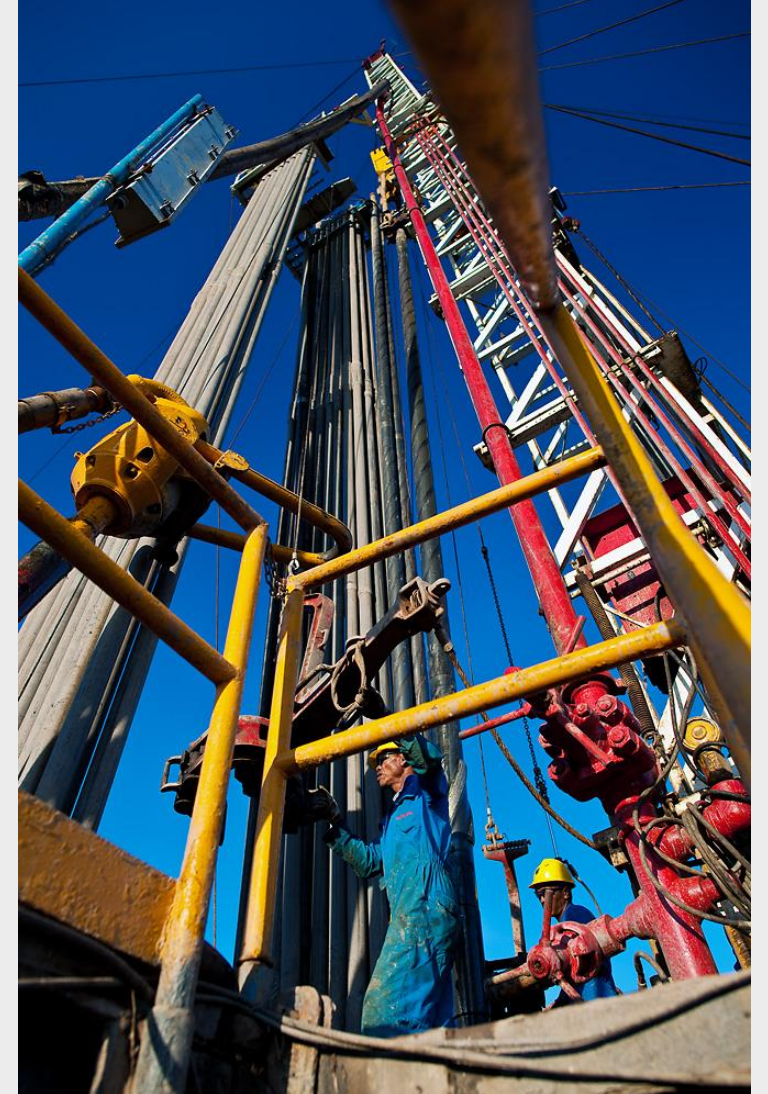


- Highly experienced, Indonesian focused E&P company
- ASX listed, majority Indonesian owned
- 2.5% Seram PSC (delivers US\$40K+ per month net cash)
- 40.7% in North Sumatra SBA PSC (recent AMT-1 oil/gas discovery, large upside gas prospects)
- Eastern Indonesian conventional rights
- **Rights to >8000 km<sup>2</sup> net unconventional acreage in North & Central Sumatra through Indonesian joint study process (applications made in 2012)**



# Presentation Outline

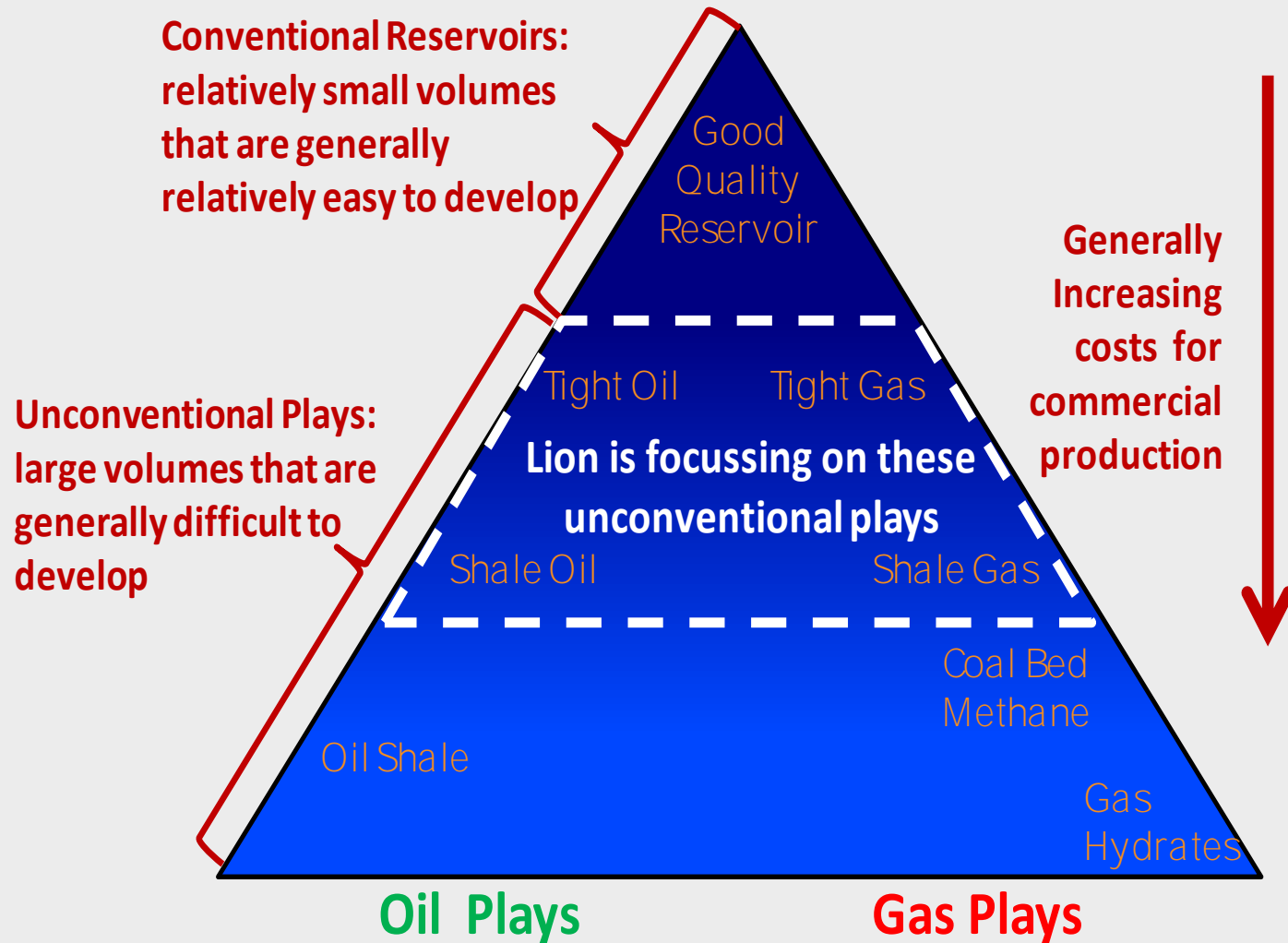
- ✧ Unconventional reservoirs
- ✧ North America current situation, some lessons
- ✧ Key Asia-Pacific onshore conventional basins
- ✧ Asia-Pacific unconventional update:
  - ✧ China
  - ✧ Australia
  - ✧ Indonesia
  - ✧ India
  - ✧ Elsewhere in AP
- ✧ Issues, catalysts, key success factors
- ✧ Next steps



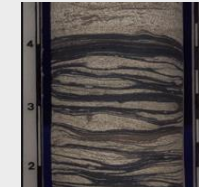


# Unconventional Reservoirs

Definition: Rock and/or fluid properties (permeability/viscosity) that require enhanced recovery techniques (i.e. fracture stimulation) to be produced at commercial rates



**Continuum between conventional & unconventional reservoirs**



10

# US Unconventional/Conventional Comparison

Unconventional resources similar order of magnitude to produced conventional

## Williston Basin

Conventional<sup>1</sup>: 3.8 bbo & 0.47 tcfg  
Bakken reserves<sup>2</sup>: 3.2 bboe

## Denver Basin

Conventional<sup>1</sup>: 1.05 bbo & 3.67 tcfg  
Niobara<sup>3</sup>: 0.98 bbo

## Anadarko Basin

Conventional<sup>1</sup>: 2.3 bbo & 65.5 tcfg  
Woodford ~40 tcf

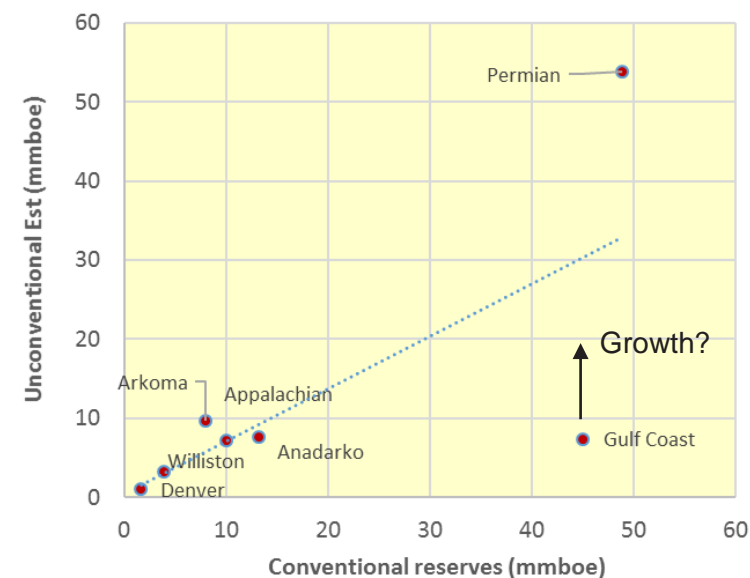
## Permian Basin

Conventional<sup>1</sup>: 41 bbo & 47 tcfg  
Barnett<sup>2</sup>: 23 tcf  
Spraberry/Wolfcamp<sup>5</sup> 50bboe (est)

## Appalachian Basin

Conventional<sup>1</sup>: 3 bbo & 42 tcfg  
Marcellus<sup>2</sup>: 42.8 tcf

US Basins Conventional vs Unconventional estimate

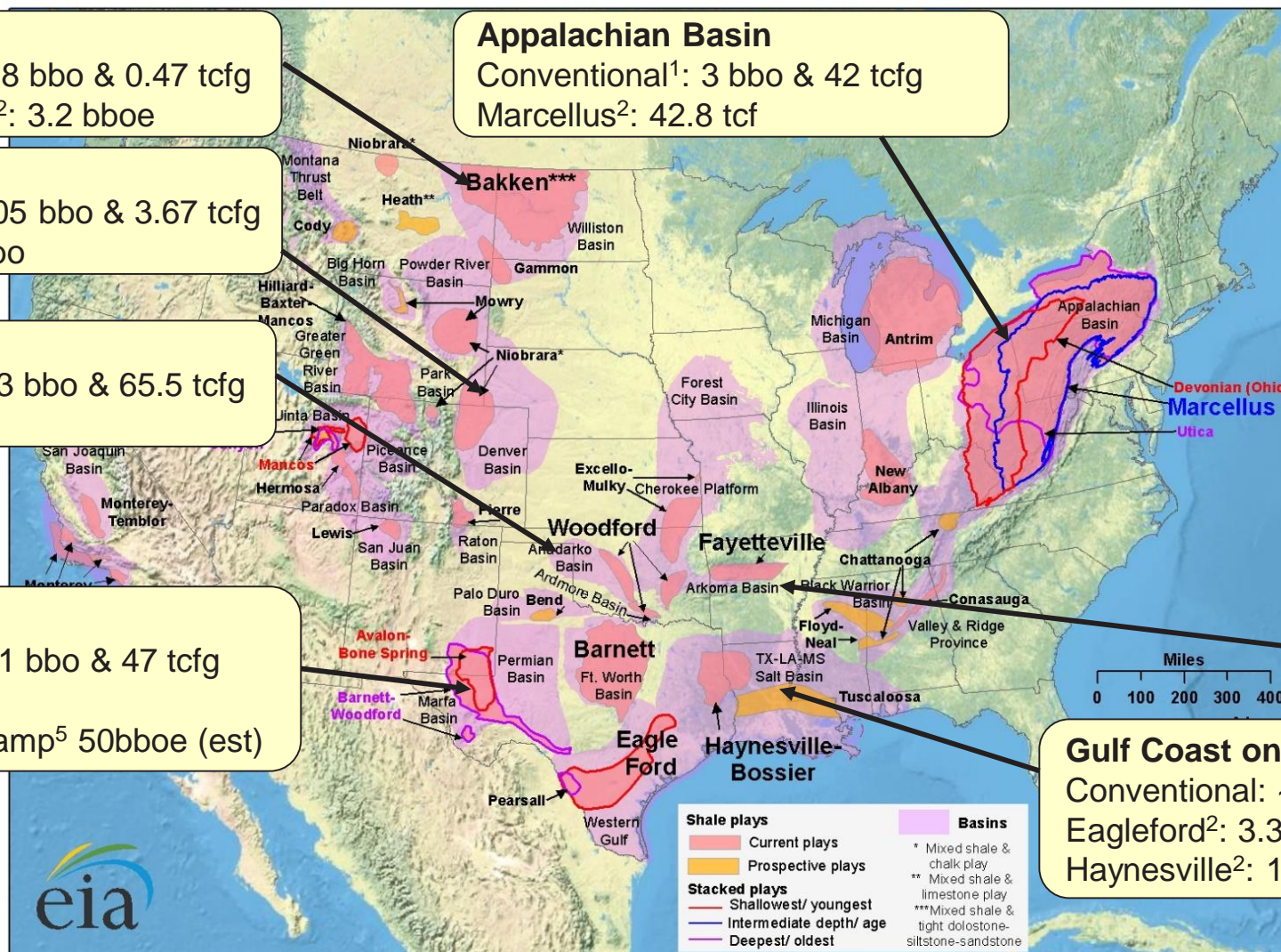


## Arkoma Basin

Conventional<sup>1</sup> 8.0 tcfg  
Fayetteville<sup>2</sup>: 9.7 tcfg

## Gulf Coast onshore

Conventional: ~20 bbo<sup>4</sup> 100's tcfg (est)  
Eagleford<sup>2</sup>: 3.37 bbo/c 6.2 tcfg 2014 USGS 23 – 91 Mean 50 tcf  
Haynesville<sup>2</sup>: 17.7 tcfg 2014 USGS 44-81 Mean 61 tcf



<sup>1</sup> USGS reports: produced HC through 1992/1993

<sup>2</sup> EIA 2014

<sup>3</sup> USGS 2013 Mean est

<sup>4</sup> US Dept Energy 2006

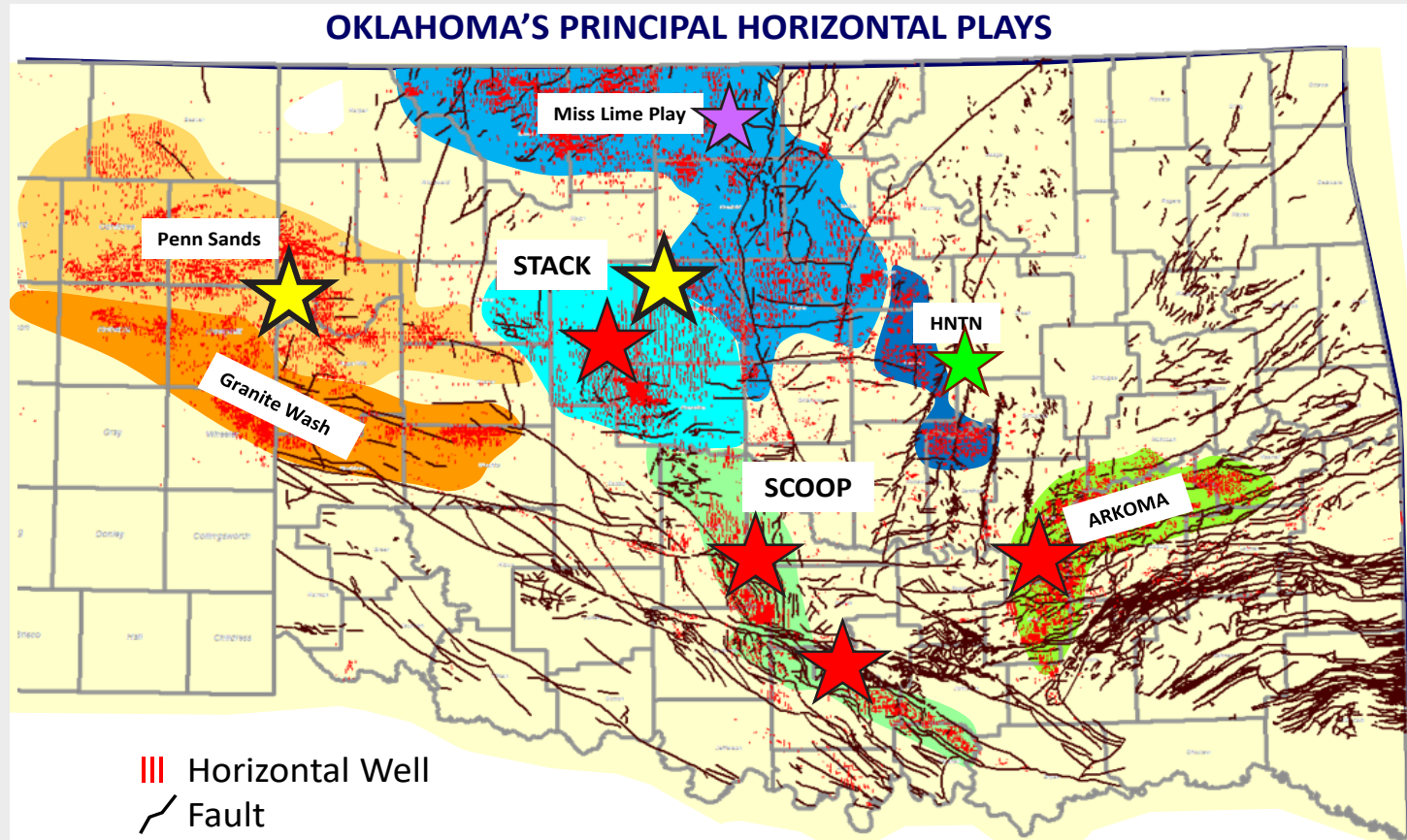
<sup>5</sup> Pioneer Resources 2013

(USGS 2016 est 20bbo for Wolfcamp)



# Anadarko Basin example: multiple horizontal plays

28,000 horizontal wells since 2000, vertical wells are now unconventional



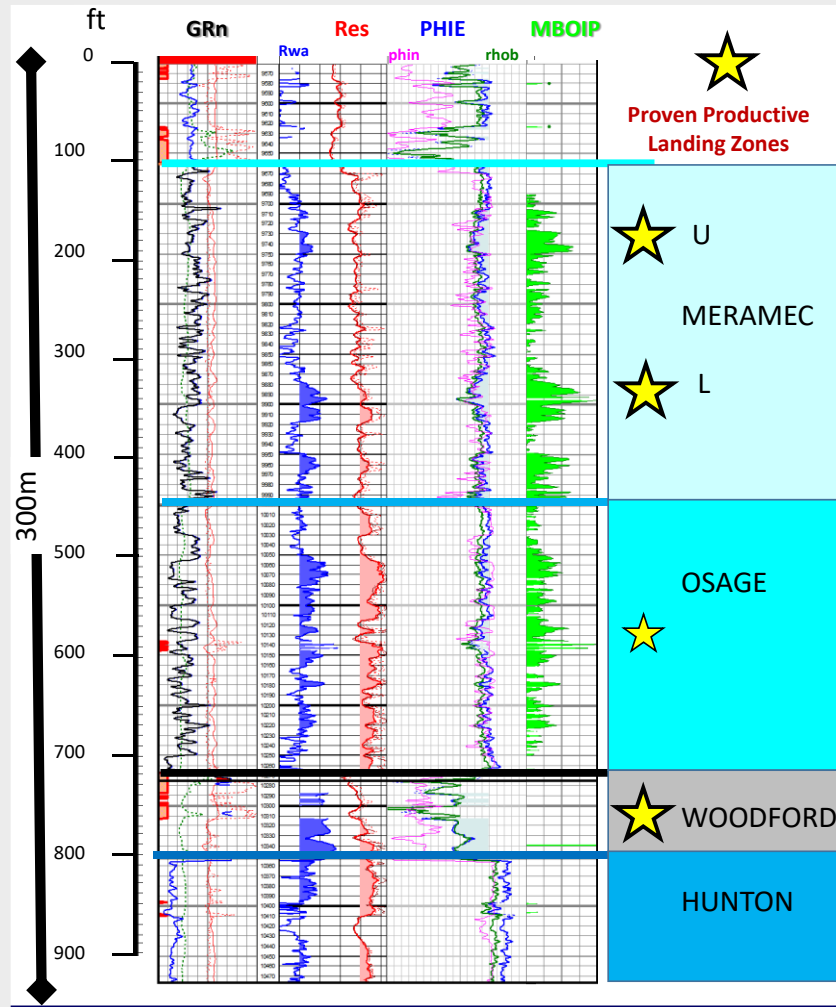
## 4 Horizontal Play Types

1. Source-rock shales (Woodford/Springer shales) ★
2. Tight reservoirs adjacent to source rocks (Meramec) ★
3. Transition zones in tight reservoirs - long distance migration ★
4. Dewatering of dual porosity carbonates ★

*Courtesy of Warwick Energy*

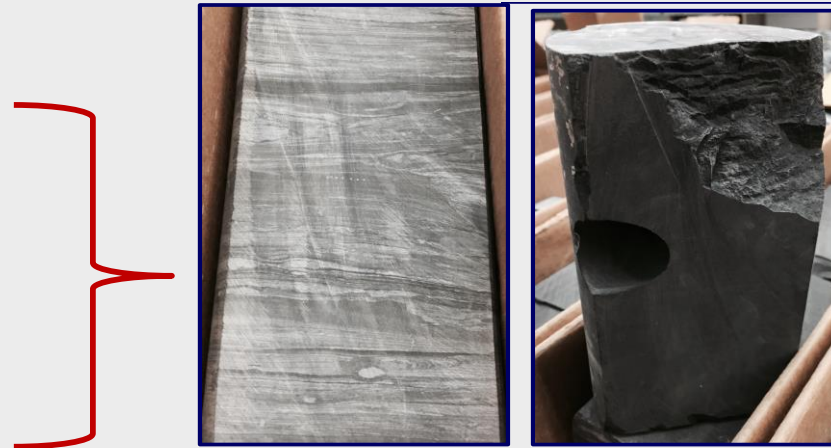
# Anadarko Basin Meramac Play: analog for tight plays in AP?

Lwr Carboniferous siltstones interbedded with thin mature oil-prone source rocks.



*Courtesy of Warwick Energy*

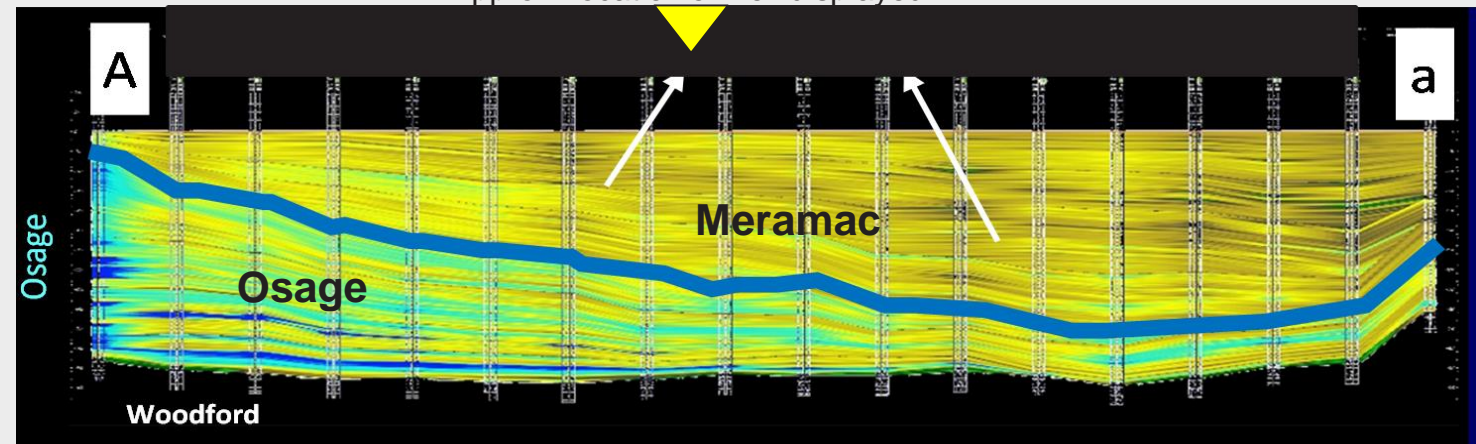
## Silt to LF Sand Source Rock



## Meramac play stats

- IP30 >1,000boepd;
- EUR 800-1,200 mboe/well
- 40-80% liquids.
- Well costs ~\$7.5M
- Completed 8,000ft horizontal, total 17,000ft

Approx Location of well displayed



Eolian fed wave dominated delta & slope fans



# Key observations/lessons from US unconventional industry

Shale gas production exceeds 40 bcf/d and tight oil ~4.5 mmb/d



**Rich subsurface dataset**

**Key plays produced initially in some vertical wells**

**Define core early integrate geology, production data to optimise reservoir management**

**Competition/drill to hold partially drives activity**

**Entirety of petroleum systems developed: dry gas window to high water cut transition zones (i.e. Anadarko Basin).**

**Storage in thin carbonates, role in enhancing brittleness (i.e. Wolfcamp)**

**“GREAT rock trumps good rock”**

**Focus on innovation, optimization, maximizing EUR, building type curves**

**Drilling efficiency, pad drilling, continuous operations with same crews**

**Transition zone plays high volumes of water to be disposed. suitable aquifer above basement for water disposal.**

**High sand volume fracks (2500lbs/ft), customized closely spaced completion jobs.**

**Supply chain critical. large volumes of high quality sand potential bottleneck**

# Highlights of improvements in efficiency and production

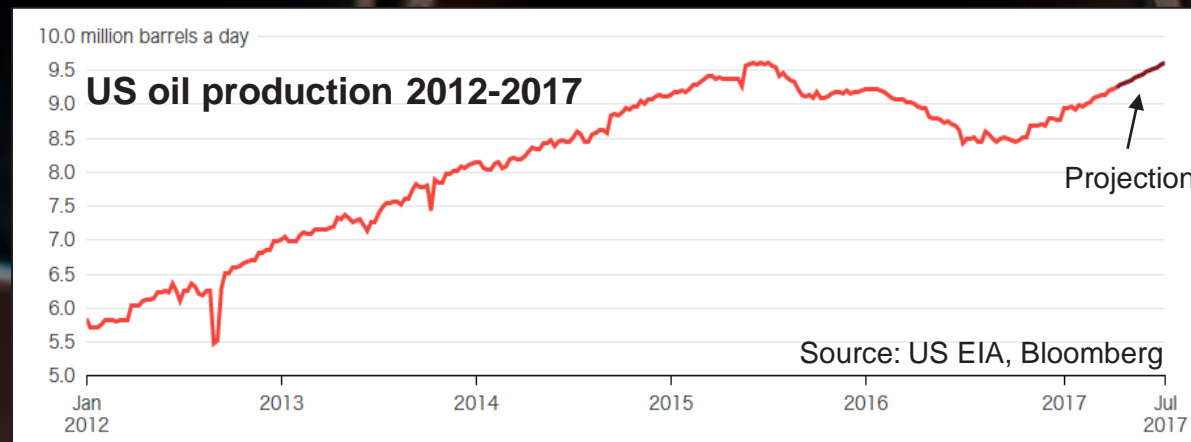
Since early 2014, major oil plays peak rates average ~30% improvement

**STACK PLAY** (Meramec benches Anadarko Basin): Angus Trust well: IP 2,088 bopd, 15.3 mmcf/d. Down-spacing tests indicate 6 to 10 well per section in development

**UTICA SHALE** (Appalachian Basin): IPs > 70mmcf/d and some operators drilling 15,000ft lateral section in 16 days. Midstream bottlenecks being solved

**PERMIAN**- 2nd Wolfcamp bench: rates of 3,000boepd with some operators pushing 4,000 boepd. Better completions and extended reach laterals.

**HAYNESVILLE SHALE**: super fracks (5,000lbs/ft) of extended reach laterals are delivering 40,000mmcf/d. Operators are eying US LNG export market.





# Stunning Impact of Unconventionals on US economy

Governments in region should be actively encouraging unconventional



Contribution to  
value-added GDP:  
\$1,400 per capita

**\$1,400**

Jobs supported:  
2.7 million

**2.7M**

Salary currently  
supported by  
unconventionals:  
1.9 times the  
national median  
income

**1.9X**

Source: America's  
Unconventional  
Energy Opportunity  
Harvard Business  
School and Boston  
Consulting Group 2015



Annual savings from  
low-cost natural gas:  
\$800 per household

**\$800**

Federal tax revenue  
contribution: Equal to a  
13% reduction in the  
federal budget deficit

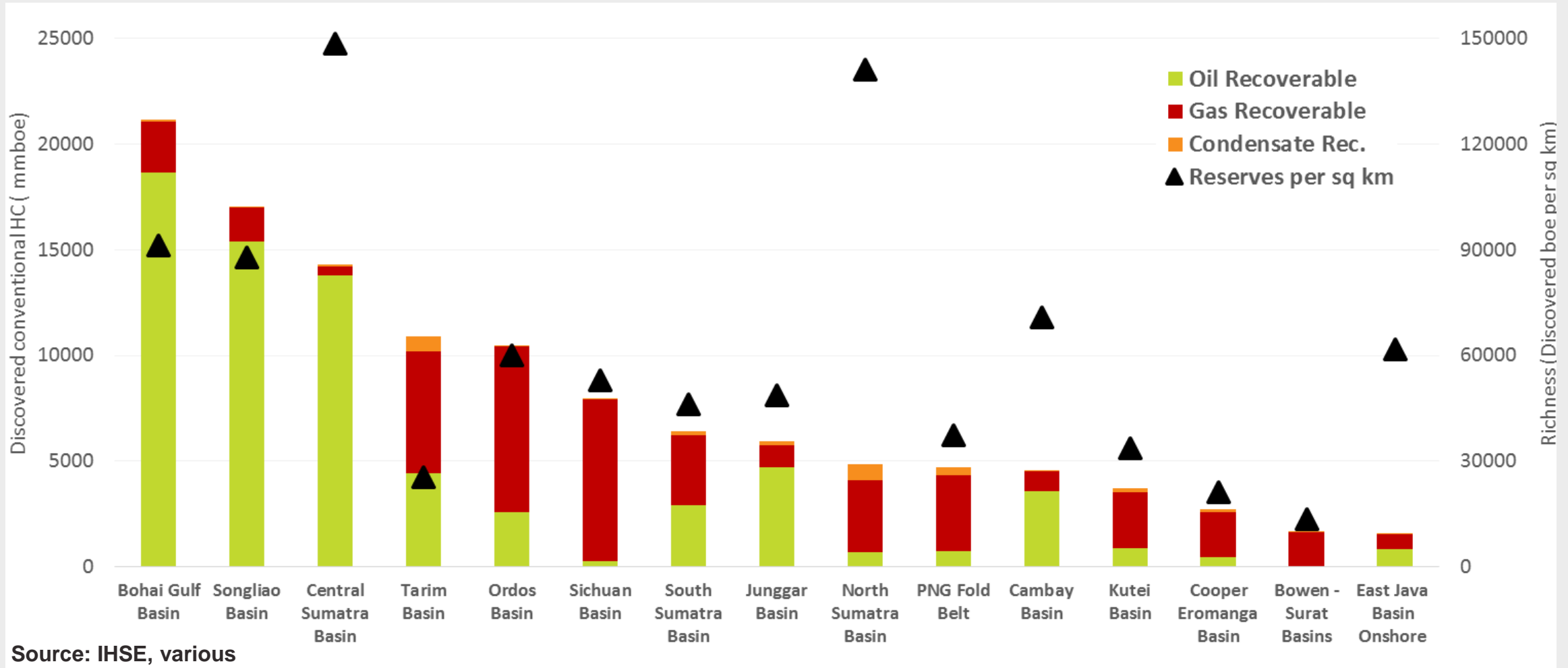
**13%**

**Overall positive  
environmental impact**  
2015 energy-related CO<sub>2</sub>  
emissions ~12% below  
2005 levels (EIA)



# Asia-Pacific top 15 onshore basins by discovered HC's

## Basins in China and Indonesian dominate



# CHINA: Huge effort on shale gas since mid-late 2000's

Conv. onshore: ~50 bbo/cond, ~170 tcf gas; EIA est tight res. 1115 tcf gas. 32 bbo

- Major existing tight gas production (i.e. Tarim Basin)
- Significant CBM but coals lower permeability, lower rates than US & Aust.

## Shale gas

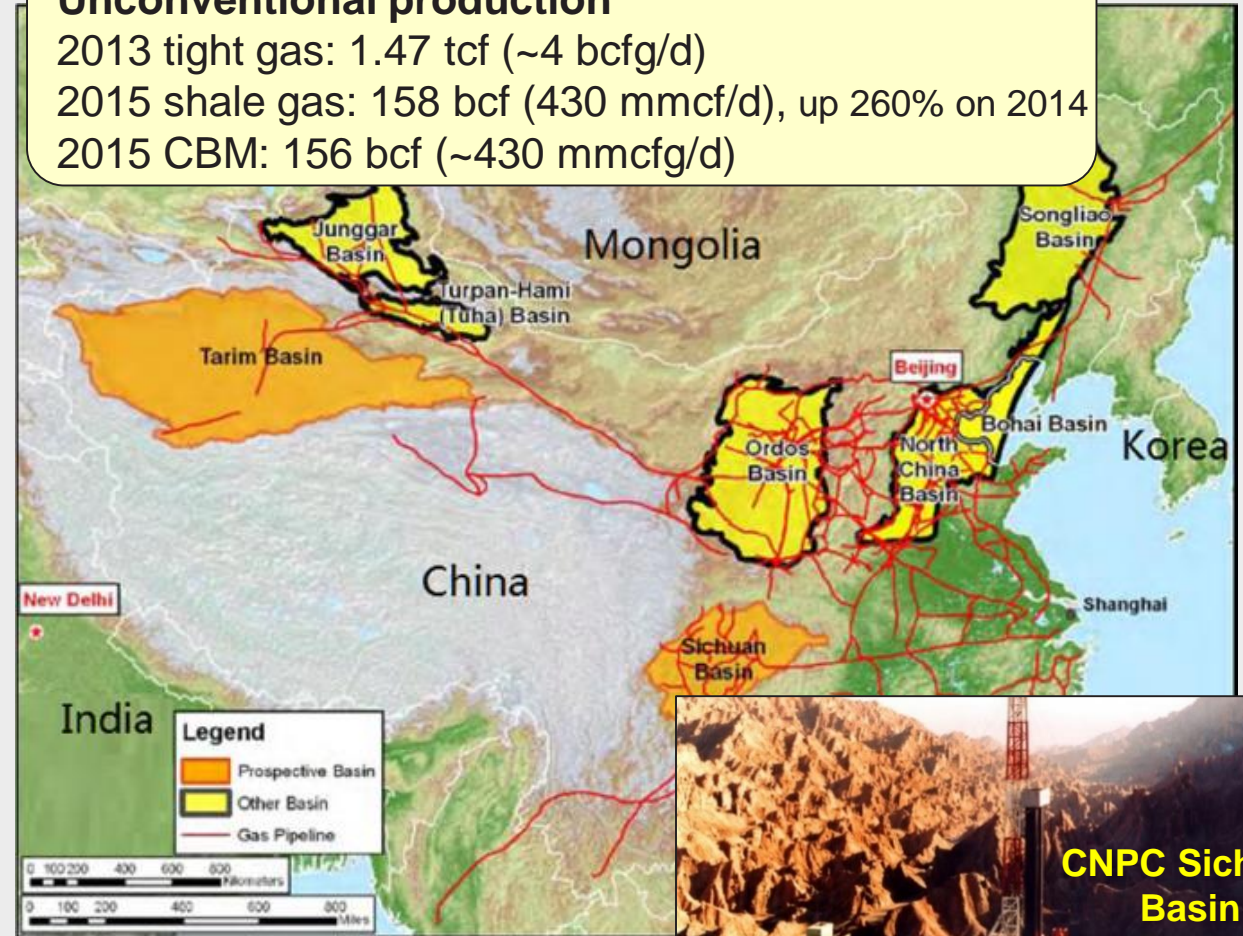
- Marine siliceous Silurian shales of Sichuan Basin:
  - Sinopec Fuling / CNPC Weiyuan-Changning projects
  - Mean well production 4.5 MMcf/d but some
  - 2013 to 2015: 23% reduction in well costs
- Mixed results of international majors CoP, Shell exiting, 2016 BP agreement with CNPC in Sichuan
- Challenges with terrain, water, economics
- Gov't policies promoting gas over coal, including subsidies (up to \$1.80 mmbtu) for shale gas
- Growth (including shale/tight oil) will continue as new plays in the prolific onshore basin unlocked

## Unconventional production

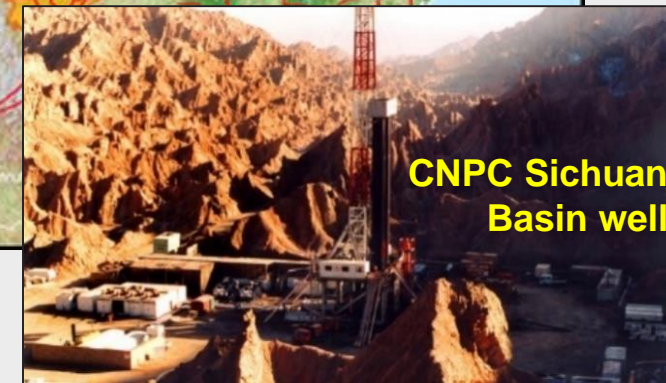
2013 tight gas: 1.47 tcf (~4 bcfg/d)

2015 shale gas: 158 bcf (430 mmcf/d), up 260% on 2014

2015 CBM: 156 bcf (~430 mmcf/d)



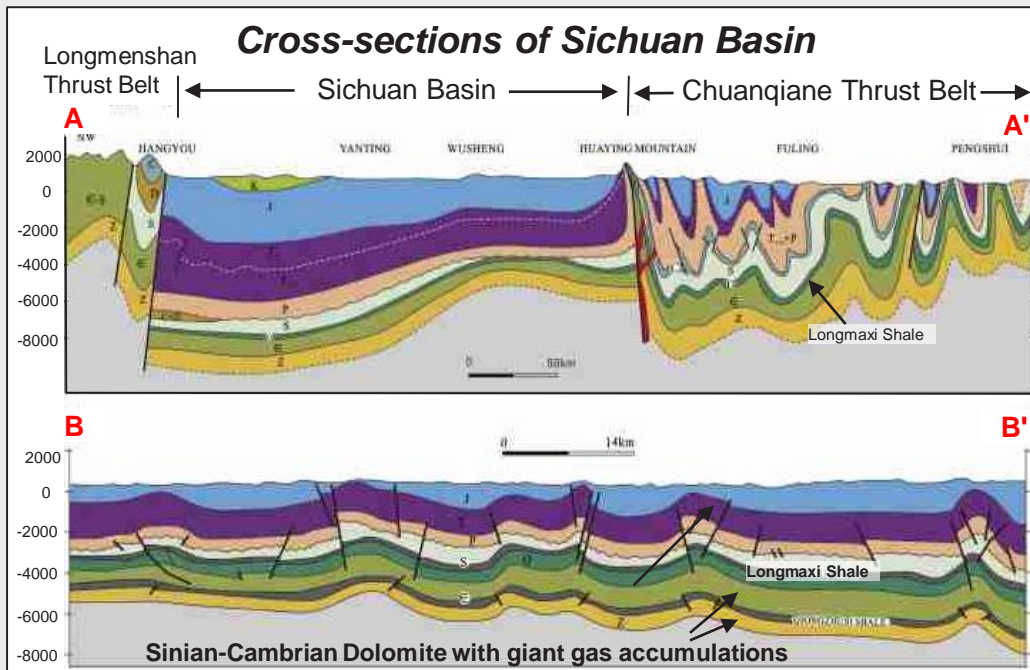
Overall China gas production  
around 13 bcf/d



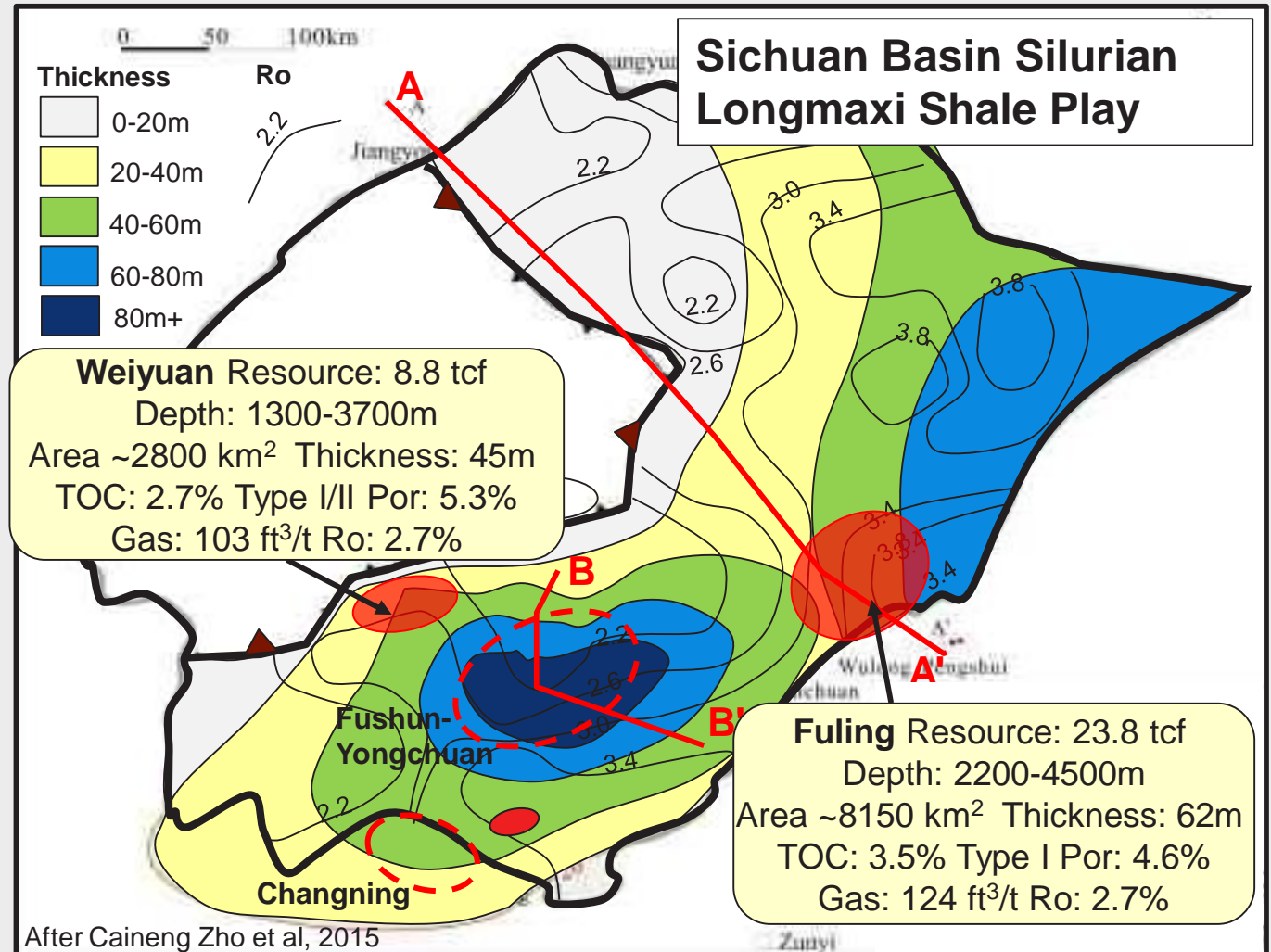
# Sichuan Basin: Lower Silurian Longmaxi Shale play

Conventional Sinian-Cambrian dolomite-hosted resource & unconventional Cambrian-Silurian shale deposit, both trillion cubic meters gas accumulations

- ~140 tcf shale gas in four blocks: Weiyuan, Fushun-Yongchuan, Changning, Fuling,
- Prospect areas 2800 - 13500 km<sup>2</sup>



Source: The characteristics and significance of conventional and unconventional Sinian-Silurian gas systems in the Sichuan Basin, Central China Caineng Zho et al. Marine and Petroleum Geology 19, March 2015

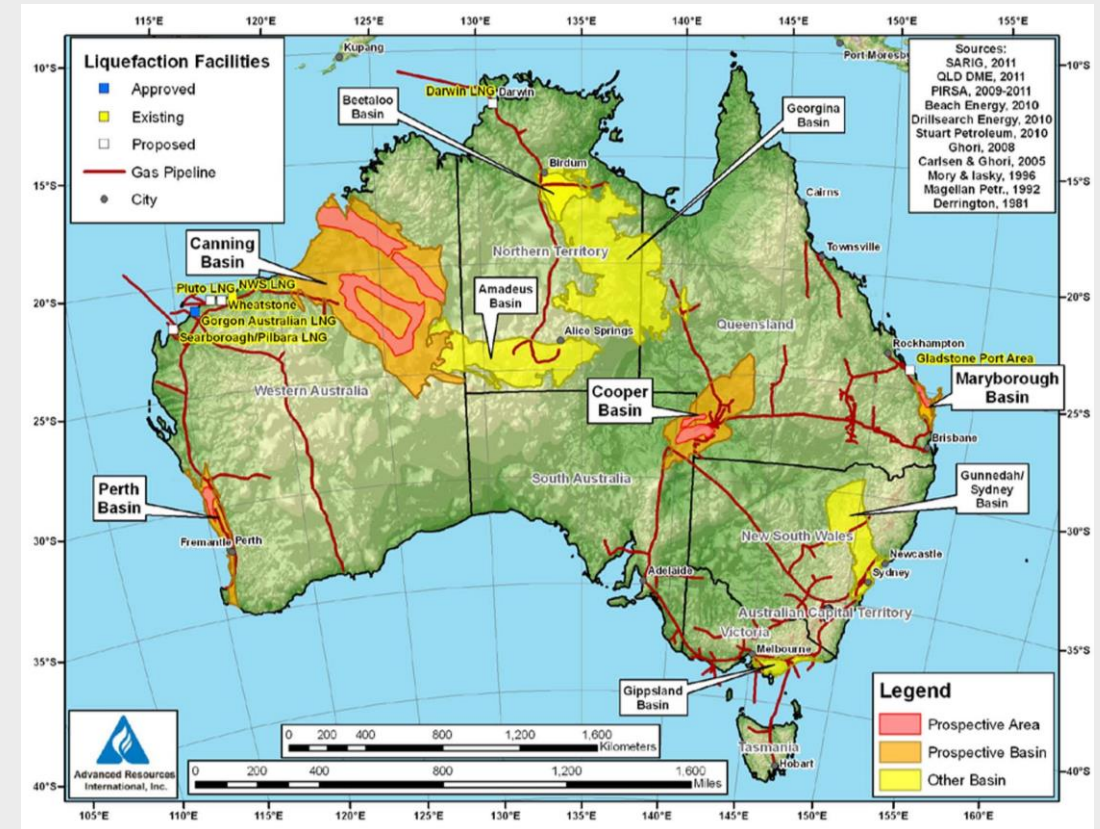




# AUSTRALIA: Major CBM projects, limited success on tight plays

Conv. onshore: 1.1 bbo/cond, 20 tcf gas / EIA est. tight resources: 430 tcf/15 bbo<sup>1</sup>

- 2015 CBM production was ~0.6 tcf/1.6 bcf/d (APPEA 2016) ~4400 producing wells, Qld reserves ~40 tcf
  - Queensland Curtis LNG, Gladstone LNG, Asia Pacific LNG
- **Shale/tight oil and gas - significant activity since 2010**
- \$100's millions spent & >100 wells in focus areas:
  - SA's/Qld Cooper Basin, WA's Perth, Canning basins and NT's Amadeus, Beetaloo, McArthur, Georgina basins.
  - 2013 First horizontal shale well by Santos in Cooper Basin
  - Beach Cooper wells, up to 4mmsf/d but high CO<sub>2</sub> 25-30%
  - Buru Energy 0.5-3 mmscf/d wet gas from Carb. tight Laurel Sst
  - Origin Amungee NW-1H in Beetaloo Basin, Fraced 600m section in Pre-Cambrian Middle Velkerri shale. Flow of ~1 mmscf/d dry gas OGIP: 61 tcf & Contingent Resources: 6.6 tcf over 1,968 km<sup>2</sup>
- Fracing moratoriums in NT, NSW, Tas, Vic, WA
- Challenges with licence to operate & geological/operation issues (lack of OP, dry gas, high costs, infra-structure, service sector capability)



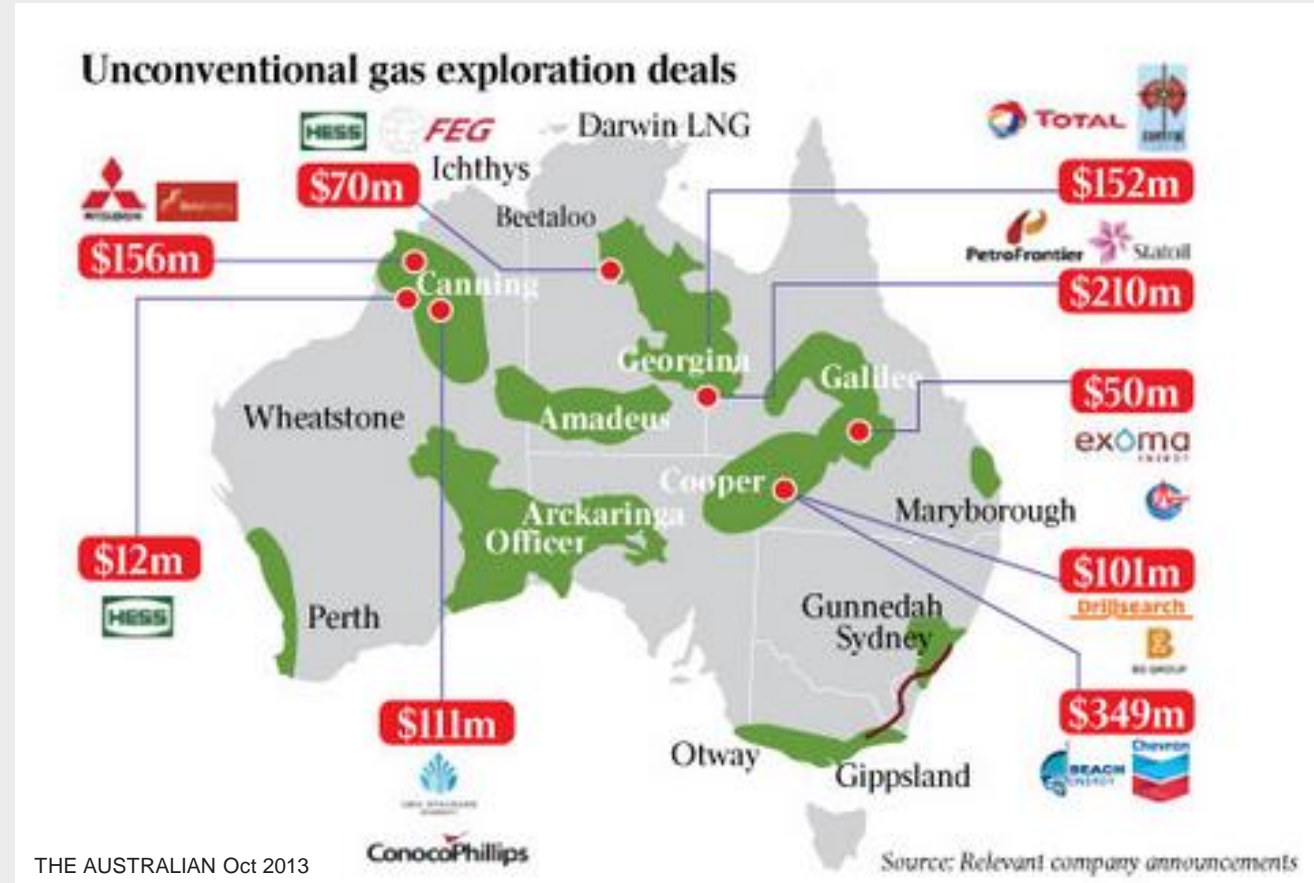
*East coast gas shortage presents opportunity, Govt's under pressure to increase gas exploration*

<sup>1</sup>Unproven technically recoverable

# Deals >A\$1.2bbl (by 2013) for Aust. shale/tight plays

Some technical through no commercial success, gas flows Cooper, Beetaloo, Canning

- Key local players have been Beach/Drillsearch, AWE, Buru Energy, Senex, Strike Energy, Origin and Santos.
- Significant international companies have had forays into the industry with transaction commitment of up to A\$1.6 billion (RFC Ambrian, 2013).
- Commercial success elusive, many players have withdrawn.
- Chevron spent US\$190 million in the Nappamerri Trough with Beach prior to the decision to withdraw in 2015.





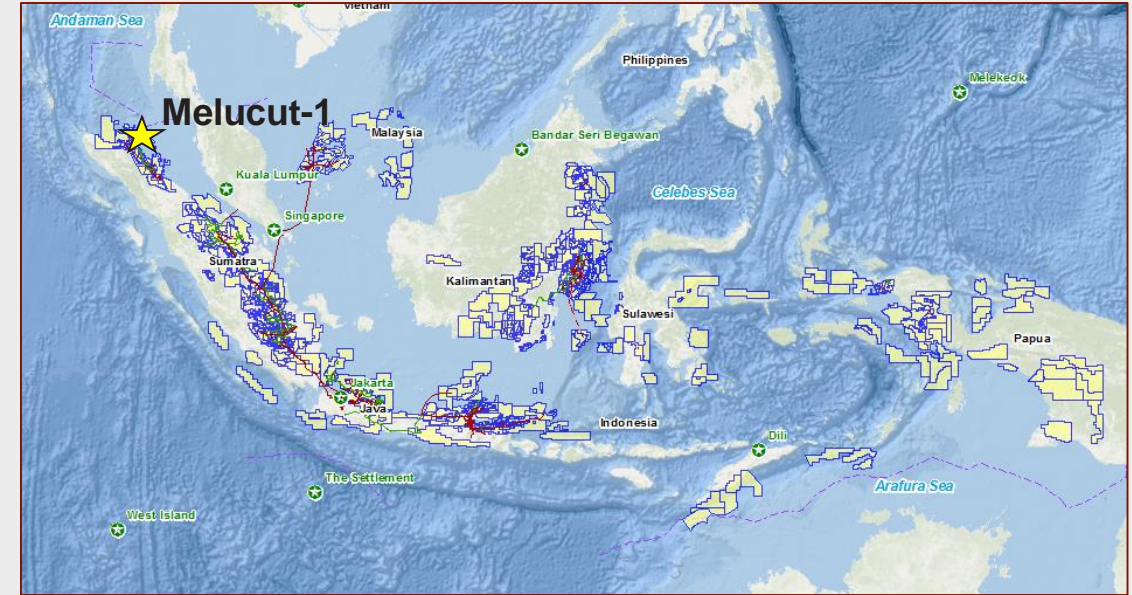
# INDONESIA: Significant shale/tight gas & oil potential

Conv. onshore 22.5 bbo/cond, 90 tcf gas; EIA est. tight resources: 96 tcfg/7.9 bbo<sup>1</sup>

- 54 CBM PSC's (mainly Kalimantan/South Sumatra)
  - ~160 wells drilled, no proven commercial projects (issues with fit-for-purpose services e.g. drilling rigs; permeability; infrastructure logistics)
- Jan 2017 new (potentially) more favourable fiscal terms announced, combined with work on reducing costs, may help turnaround industry

## Shale Tight Gas oil

- 2012 Gov't introduced new unconventional licences (defined as rocks requiring fracture stimulation)
- Joint Study applications (including by Lion) made over most of the productive onshore basins
- Only 6 JS progressed to Unconv. PSC's
- Government introducing ways to promote unconventional exploration activity including new regulations & improved data access
- PERTAMINA drilling the country's first shale well, Melucut-1 in North Sumatra
  - Vertical well to ~3600m. coring planned of Miocene age tight-sandstone and key marine source rocks intervals.
  - Fracture stimulation/testing of key zones planned

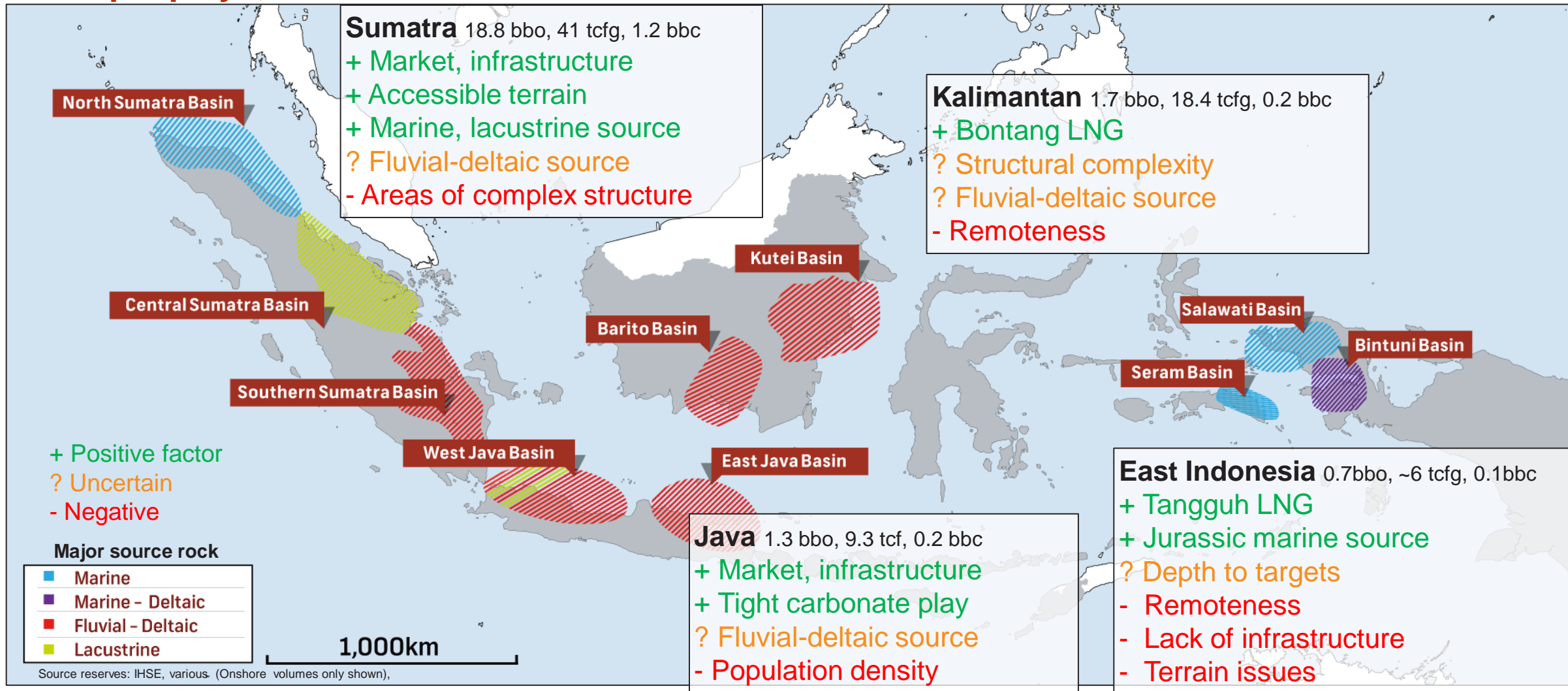


*Tight (hybrid) sst & carbonate plays largely untested*



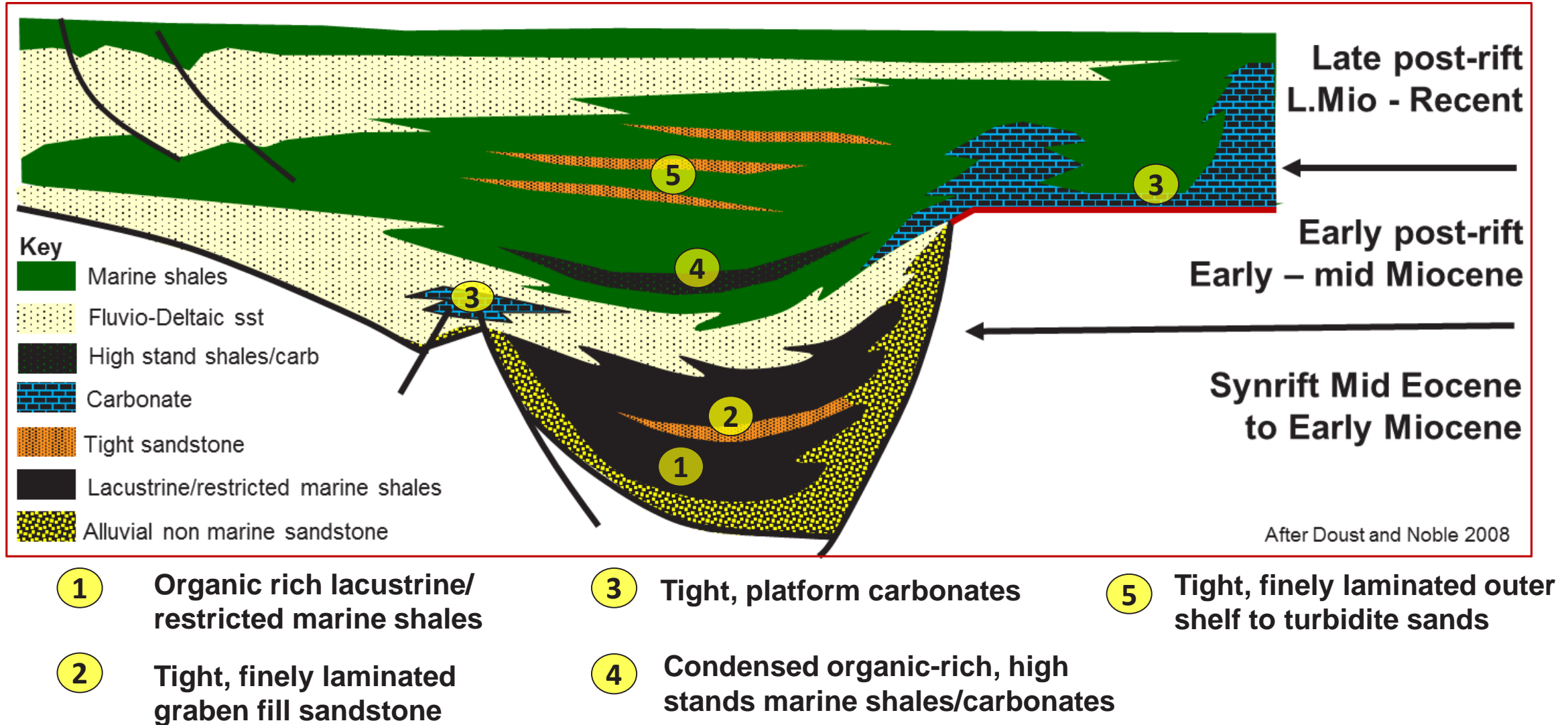
# Key Indonesian Onshore Basins

Sumatra basins standout for unconventional focus in terms of discovered HC's, multiple plays, market access & infrastructure
























# Sumatran (and elsewhere) rift basin unconventional plays

Ductile shales, waxy oil present issues



# Sumatran Unconventional (Shale) Targets

Building core data and analysis will be critical to high-grade plays


Properties	North Sumatra			Central Sumatra		South Sumatra	
	Lower Baong	Belumai Formation	Bampo Shale	Telisa Formation	Brown Shale/Kelesa	Talang Akar Fm	Lehat/Lemat/Benakat Shale
<b>Rock Description</b>	Marine shale with carbonate lenses	Marine calcareous shale, carbonate and sandstone	Restricted marine black claystone, siltstone and thinly bedded sandstone	Marine shale with sandstone and siltstone	Lacustrine black organic rich algal mudstone with carbonate rich lenses	Lacustrine to marine delta plain shale, quartzose sandstone and siltstone	Lacustrine shales, tuffaceous shale, siltstone, sandstone and coals
<b>Age</b>	Middle Miocene	Early Miocene	Late Oligocene	Middle Miocene	Oligocene	Late Oligocene to middle Miocene	Mid-late Eocene to early Oligocene
<b>Organic Content/TOC</b>							
<b>Recorded TOC</b>	0.5-2.9%	0.5-3.4	0.5-1.0% (limited data)	0.5-3%	2-23% mean of 3.7%	1.5-8 %	1.7-8.5%
<b>Maturity</b>							
<b>Maturity window</b>	Mid Oil to Gas window	Late Oil to Gas window	Gas window	Early Oil	Peak Oil to Gas window	Peak Oil to Gas window	Peak Oil to Gas window
<b>Mineralogy/brittleness</b>							
<b>Pressure</b>	Generally moderately to occasional high overpressure	Normal to moderately overpressured	Normal to moderately overpressured	Normal to moderately overpressured	Normal to moderately overpressured	Normal to minor overpressure	Normal to moderately overpressured


Tight plays exist with interbedded tight sandstones, carbonate and siltstones


Source: Lion in-house, various


## Unconventional Potential Assessment for Key Parameters

 Positive

 Reasonably Positive

 Uncertain

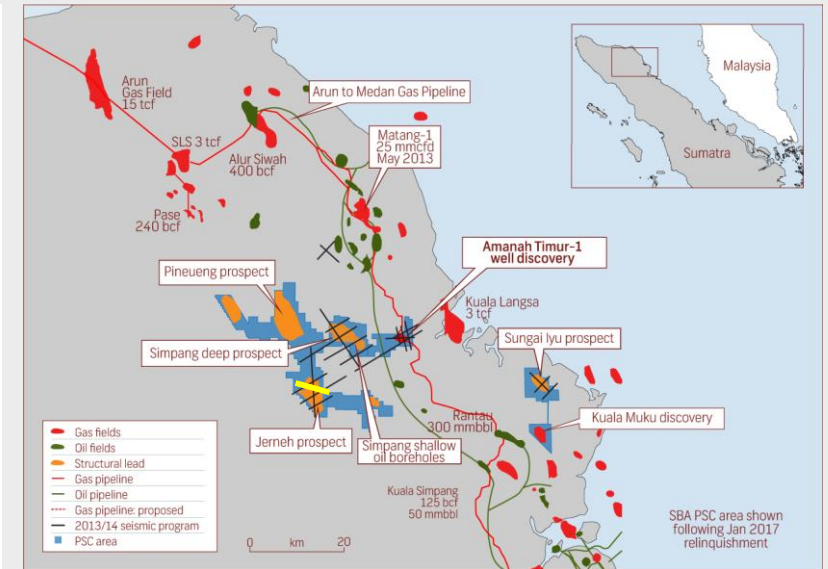
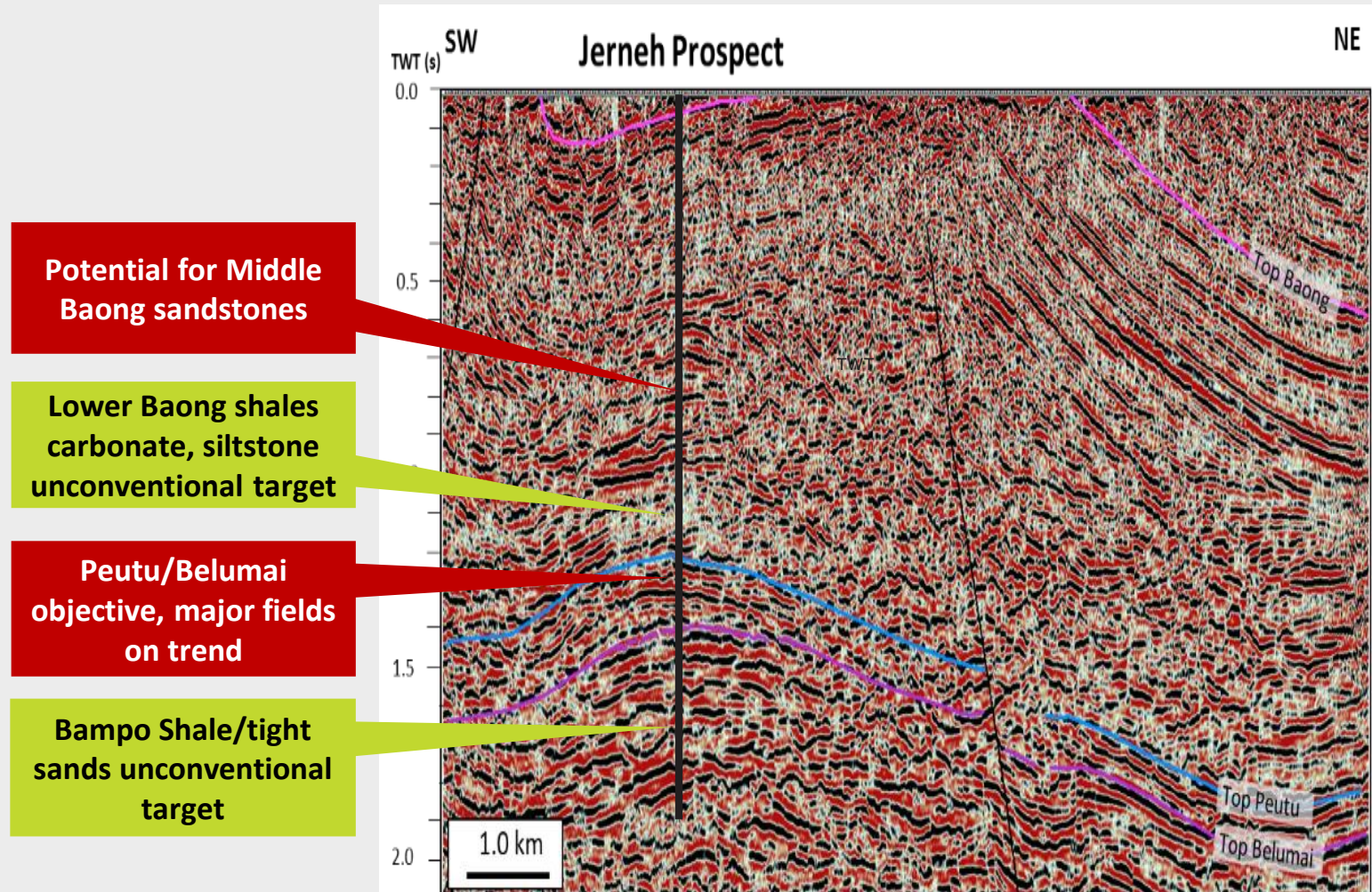
 Negative Factors

 Negative



# Conventional/Unconventional Strategy

Use conventional exploration synergies to de-risk unconventional potential



*Lion's Jerneh prospect in North Sumatra South Block A PSC provides attractive conventional and potential unconventional targets that can be evaluated in single well bore*



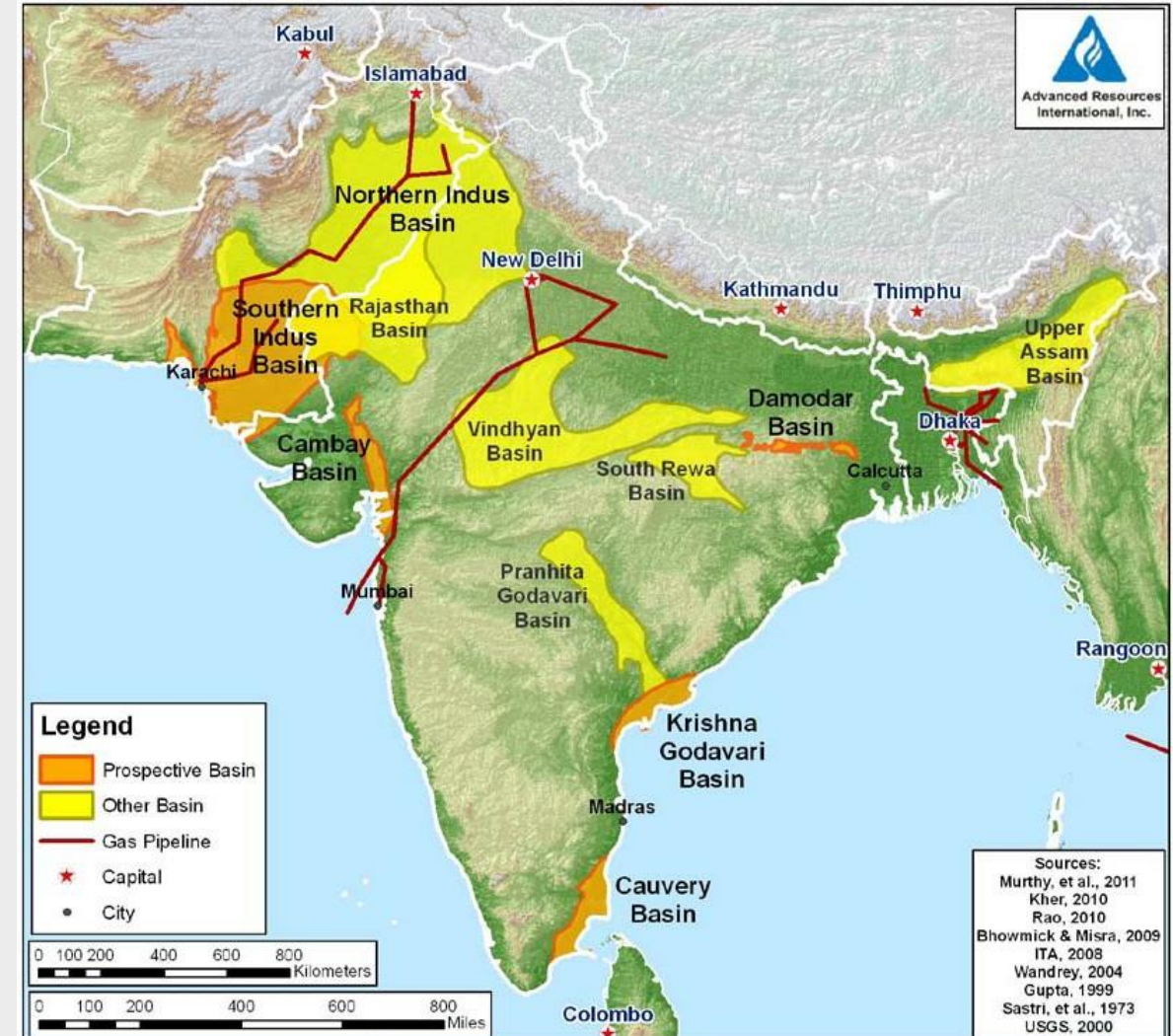
# INDIA: Significant CBM potential & ONGC taking lead in shale gas

Conv. Onshore: 5.5 bbo/cond, 20 tcf gas; EIA est. tight resources: 46 tcfg/3.8 bbo<sup>1</sup>

- 2015 CBM: 27 mmscfg/d forecast to grow
- Gondwana sediments of eastern India host bulk of coal reserves.
- CBM potential ~92 tcf (DGH website)

## Shale Gas -

- Main focus basins: Cambay, Gondwana Basin, KG Basin, Cauvery Basin, Indo-Gangetic Basin and Assam-Arakan Basins.
- ONGC dominant player: ~50 shale licences, planning on up to 17 dedicated shale wells
- Oilex Ltd in Cambay Basin has attempted to fracture stimulate horizontal wells testing tight gas potential - modest results to date.
- Continued growth in activity anticipated, especially if foreign participation is encouraged



<sup>1</sup>Unproven technically recoverable

# Elsewhere in Asia Pacific

## Issues with materiality, terrain, land access

### Myanmar Conv onshore: 1.0 bbo, 2.5 tcfg

- Tertiary basin potential limited details on shale targets
- Issues with terrain, logistics infrastructure, market
- Tight gas potential?

### Thailand Conv. onshore: 0.3 bbo, 2.2 tcfg

- Tertiary rift lacustrine source rocks, sweet spot areally limited
- USGS (2014) Phitsanulok Basin Unconv. est: 53 mmbbl oil gas at 320 bcf (~750 km<sup>2</sup>)
- Tight gas and shale gas in Permian/Triassic of Khorat Plateau - infrastructure issues

### Malaysia: Conv onshore: 0.1 bbo, Gas 0.2 tcf)

- Main potential Onshore Sarawak i.e. Balingian Basin (tight sands)
- Highly structured away from coast (as is Brunei)

### Vietnam Conv: minor gas only

- Hanoi Trough CBM wells 2008-2011 limited success
- Some tight gas potential in Hanoi trough but CO<sub>2</sub>

### Philippines Conv: minor onshore gas/oil

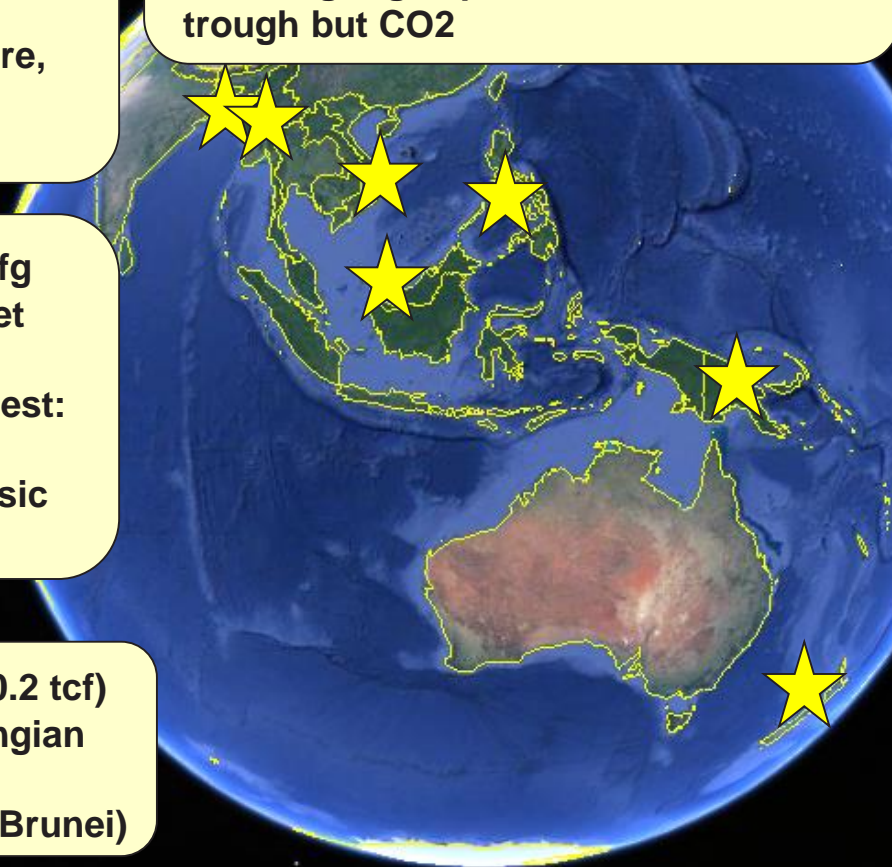
- Some unconv. potential Cagayan Basin of Luzon Island

### PNG Conv onshore: 1.3 bbo/cond 30 tcfg

- 2016 South Pacific Resources awarded rights to unconventional blocks in fold belt / foreland area, recent alliance with Malaysian co. Tamarind
- Major challenges with terrain, cost of operations infrastructure, market

### NZ Conv onshore: 0.1 bbo, 2.6 tcfg

- Main potential: North Island Taranaki and the rich L. Cretaceous/E. Tertiary source rocks in the East Coast basins .
- TAG 2013 Ngapaeruru-1 TD 1417m, wet gas/ oil shows in Waipawa/Whangai source rocks
- Issues with complex structure, adequate depth, infrastructure, land use





# The Challenge: developing Asia-Pacific's unconventional industry

US experience shows unlocking the industry will have huge impact

## Catalysts

- Prolific basins
- Energy demand/gas prices
- Government support

## Issues

- (Largely) unproven rocks
- Large areas, limited data
- Time frame to production
- Capability in-country
- Flexibility of fiscal regimes
- Community, land use

## Success Factors

- Basins with proven conventional production, manageable terrain and infrastructure
- Focus initially on tight reservoirs (hybrid plays) proximal to mature, over-pressured source rocks
- Leverage conventional E&P
- Identify best rocks/fluids (OP, high GOR oil / high BTU gas)
- Balance overseas (US) with extensive local expertise
- Industry/service sector co-operation
- Viable, relatively unregulated gas market.
- Good midstream contracts with market driven pricing
- Engagement/buy-in with Governments/regional authorities
- Contracts that recognize the scale and timing of horizontal tight-reservoir plays
- Multi-well programs to allow efficiency
- Good community relations (all stakeholders must benefit)

# Asia Pacific Unconventionals - a new dawn?



If AP basins were in the US, many more would be producing unconventional oil/ gas

- Each basin/play is different, unique above/below ground challenges
- North American plays cover broad spectrum of geological settings
- Australia, China, India and Indonesia have main potential
- Focus on most likely plays, build the database, identify sweet spots, test the concepts
- Work cooperatively with all stakeholders





# Thank you

For more information please contact:

Kim Morrison  
Chief Executive Officer  
kmorrison@lionenergy.com.au  
Office: +61 8 9211 1500  
Mobile: +61 404 490 964

Andrew Cullen  
Senior VP Geology Warwick Energy Ltd  
andrew.cullen@warwick-energy.com  
Office: +1 405 607 3437  
Mobile: +1 405 318 2840