



APPEX London 2018



T.D.J. ENGLAND, BUKIT ENERGY INC.

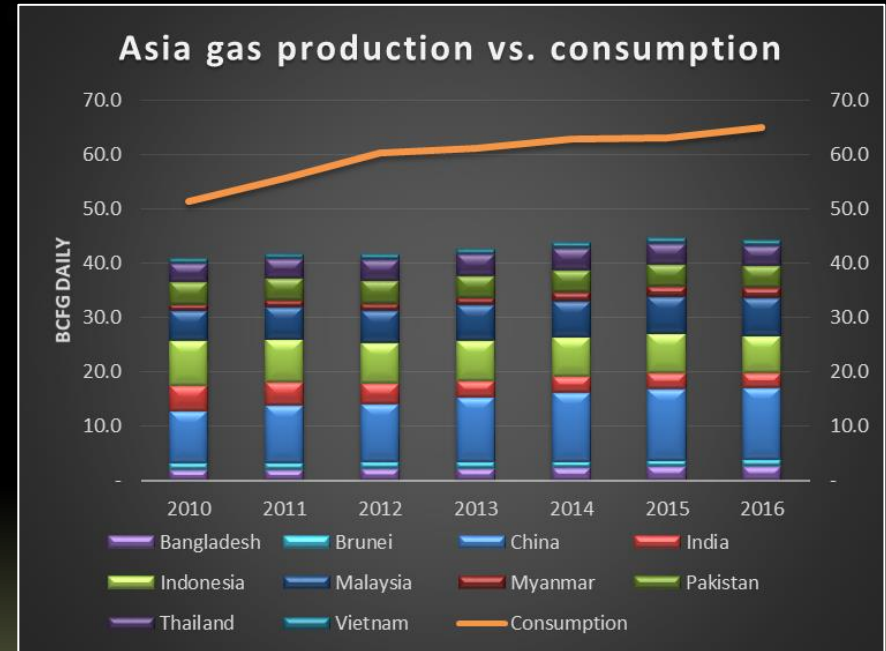
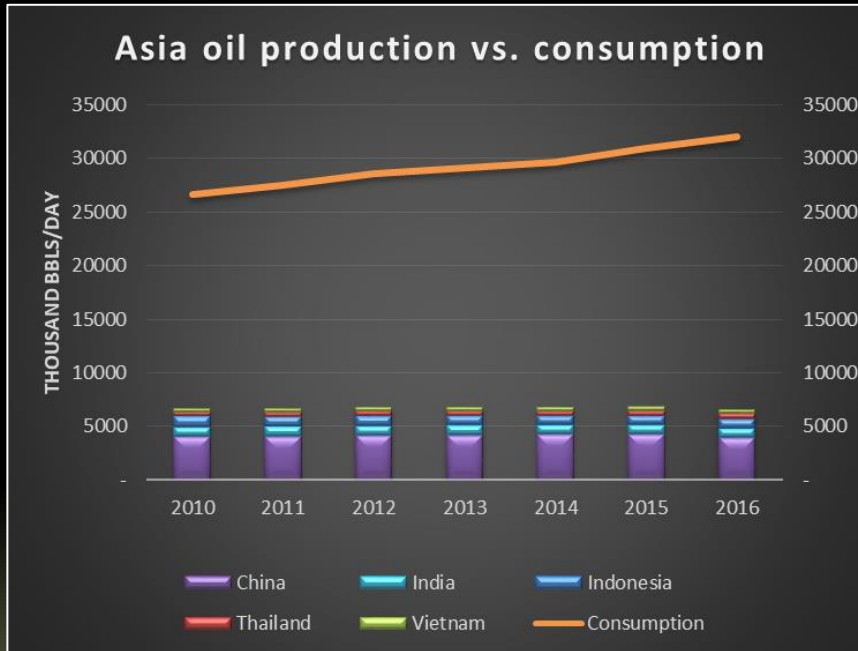
# DEEP RESOURCE POTENTIAL OF SOUTHEAST ASIAN TERTIARY BASINS



# SOUTHEAST ASIAN TERTIARY BASIN PLAY

- Regional energy supply situation
- Exploration for new resources
- Focus on Sumatran rift basin play
  - Background
  - Technical basis
  - Basin examples
- Summary

# REGIONAL ENERGY BALANCE - TRENDS

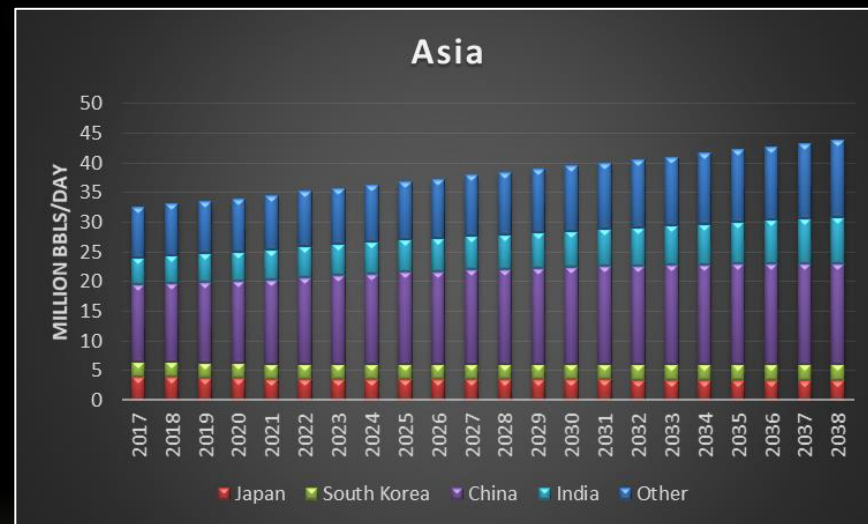


Marked and growing shortfall in regional supply versus demand

# REGIONAL ENERGY DEMAND - FORECAST

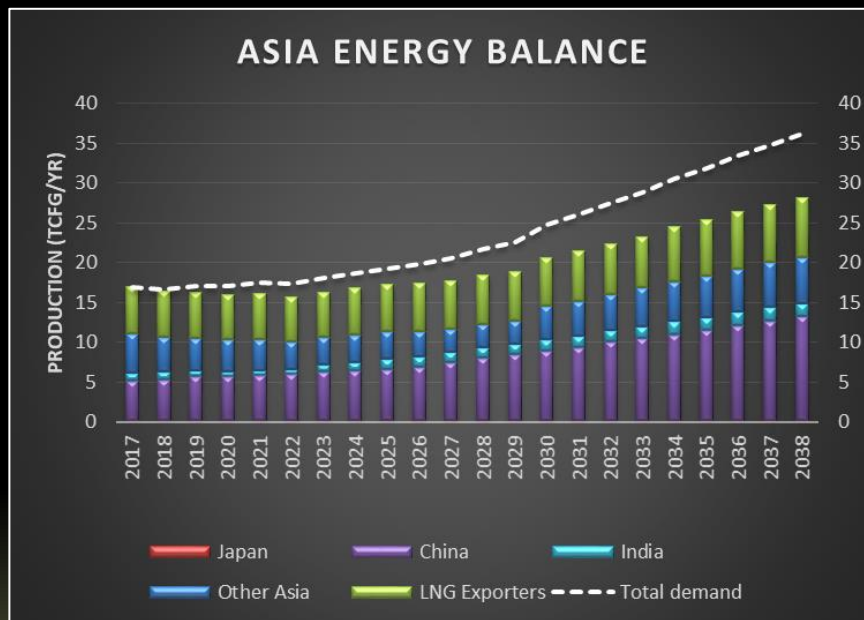


Gas consumption forecast: 187% by 2038

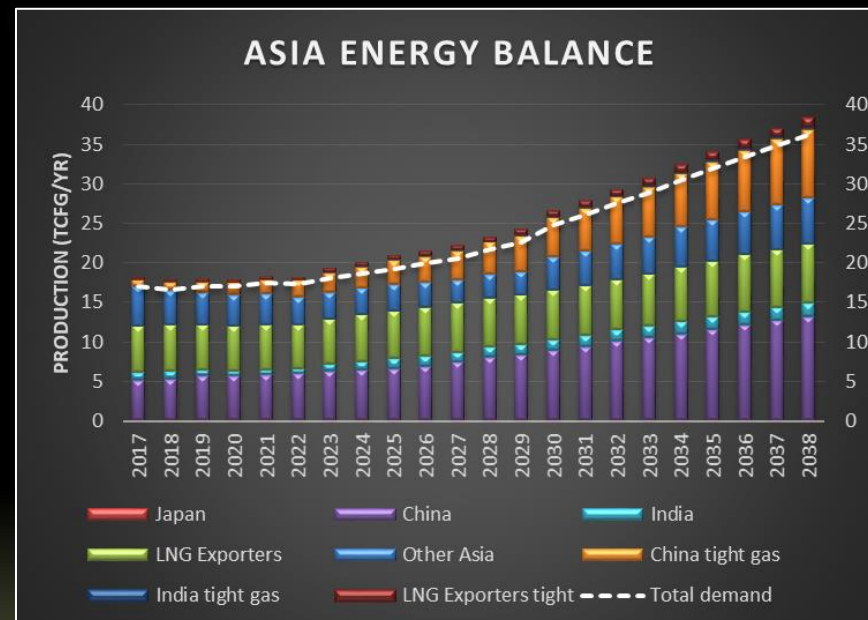


Oil consumption forecast: 134% by 2038

# FORECAST GAS SUPPLY VERSUS DEMAND

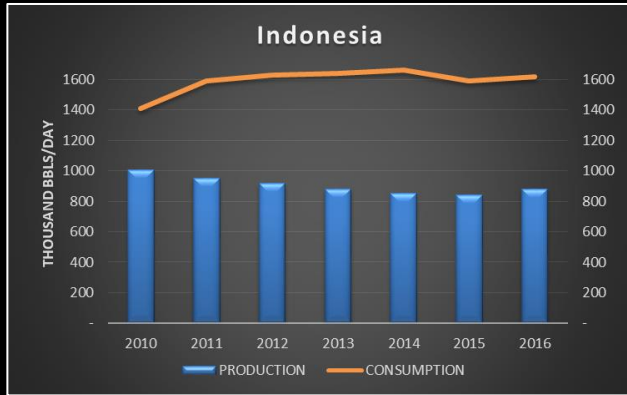


Present demand supplied by LNG exporters  
Increasing supply shortfall forecast...

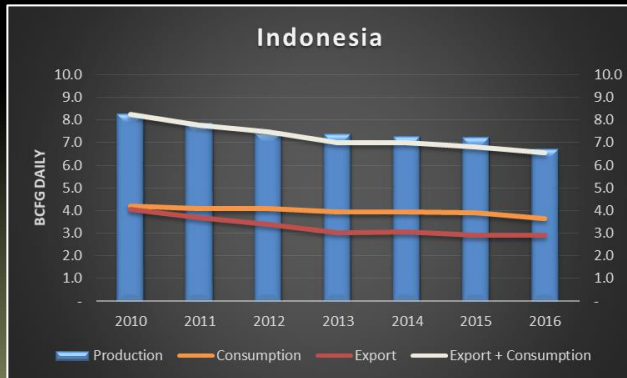


to be filled mainly by tight gas production

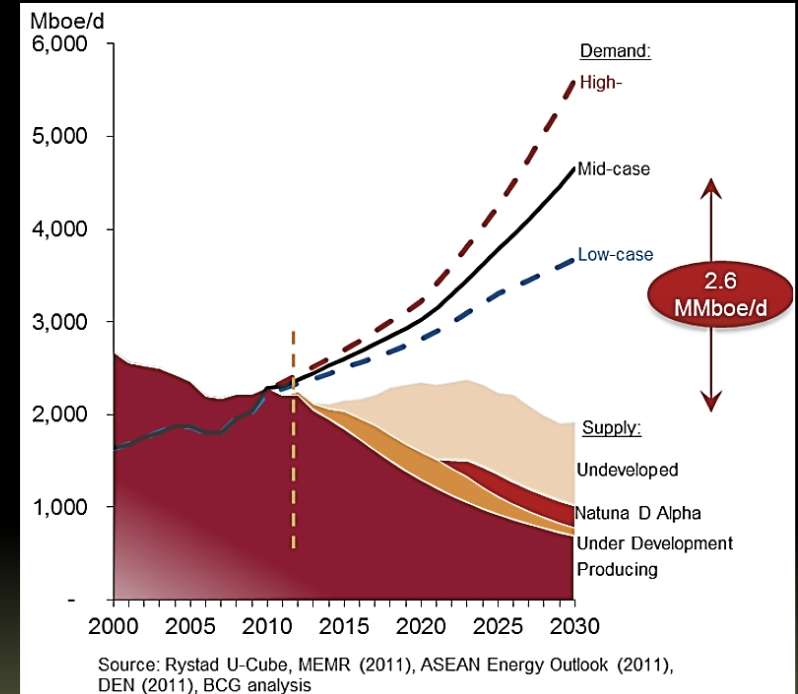
# INDONESIA DEMAND/SUPPLY SITUATION



- Oil imports supply over 45% of demand



- Self sufficient in gas, with surplus exported
- Exports are being reduced due to steady domestic demand and decreasing production



- Increasing energy supply deficit forecast



# REGIONAL ENERGY BALANCE SITUATION

- Large and increasing oil and gas supply shortfall
- Imports provided 77% of oil supply and 32% of gas supply in 2016
- Economic incentive exists to increase cheaper domestic supplies to offset expensive imports
- However, exploration and development spending has been curtailed during the industry downturn
- As exploration activity recovers, where does industry turn to for new reserves?

# THE SEARCH FOR NEW ENERGY SUPPLY

## ■ FRONTIER/DEEPWATER PLAYS

- China, Malaysia, Vietnam, Australia, Myanmar ✓
- Philippines ✓?
- Indonesia ✕

## ■ BASEMENT PLAYS

- Vietnam, Indonesia ✓?

## ■ CBM PLAYS

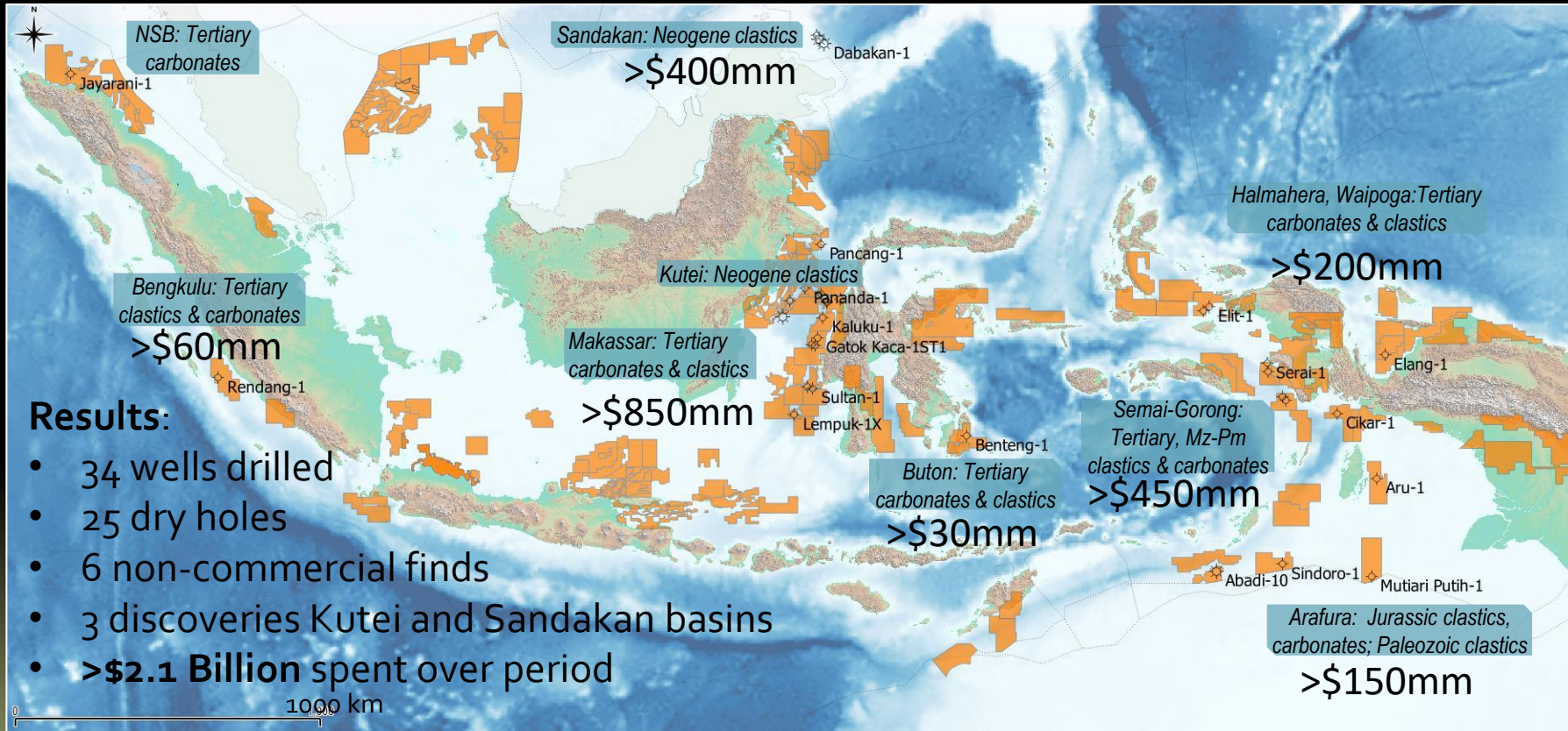
- Australia (1600 mmscfd), China (1300+ mmcfd), India (565 mmcfd) ✓
- Indonesia ✕

## ■ TIGHT RESERVOIR PLAYS

- Australia, New Zealand ✕?
- China (3900+ mmcfd) ✓
- Indonesia ?



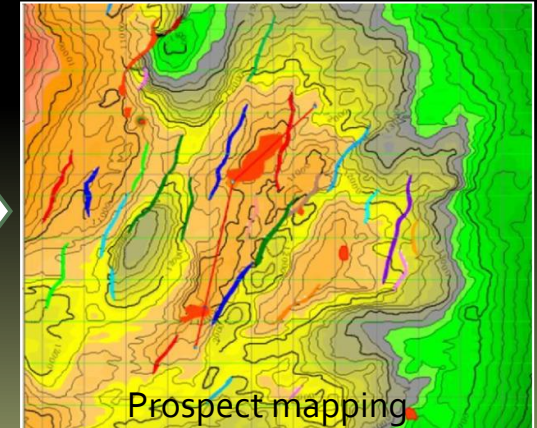
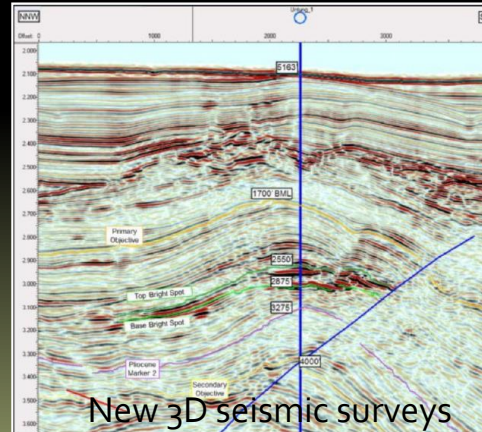
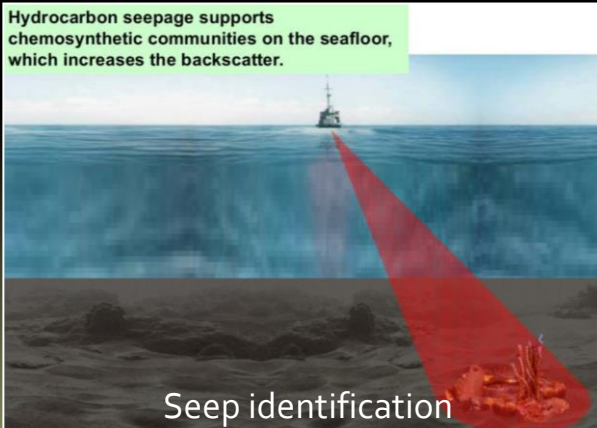
# FRONTIER EXPLORATION (2009-2013)



# FRONTIER EXPLORATION (2009-2013)



- Farm out 20 blocks within or adjacent to proven hydrocarbon basins
- 3rd party best estimate of in-place volumes on first four blocks exceeds 13.4 BBOE
- Exxon, Marathon, Repsol, Statoil, Hess, ENI and GDF farmed in on 11 blocks
- >20 high impact prospects identified for drilling program





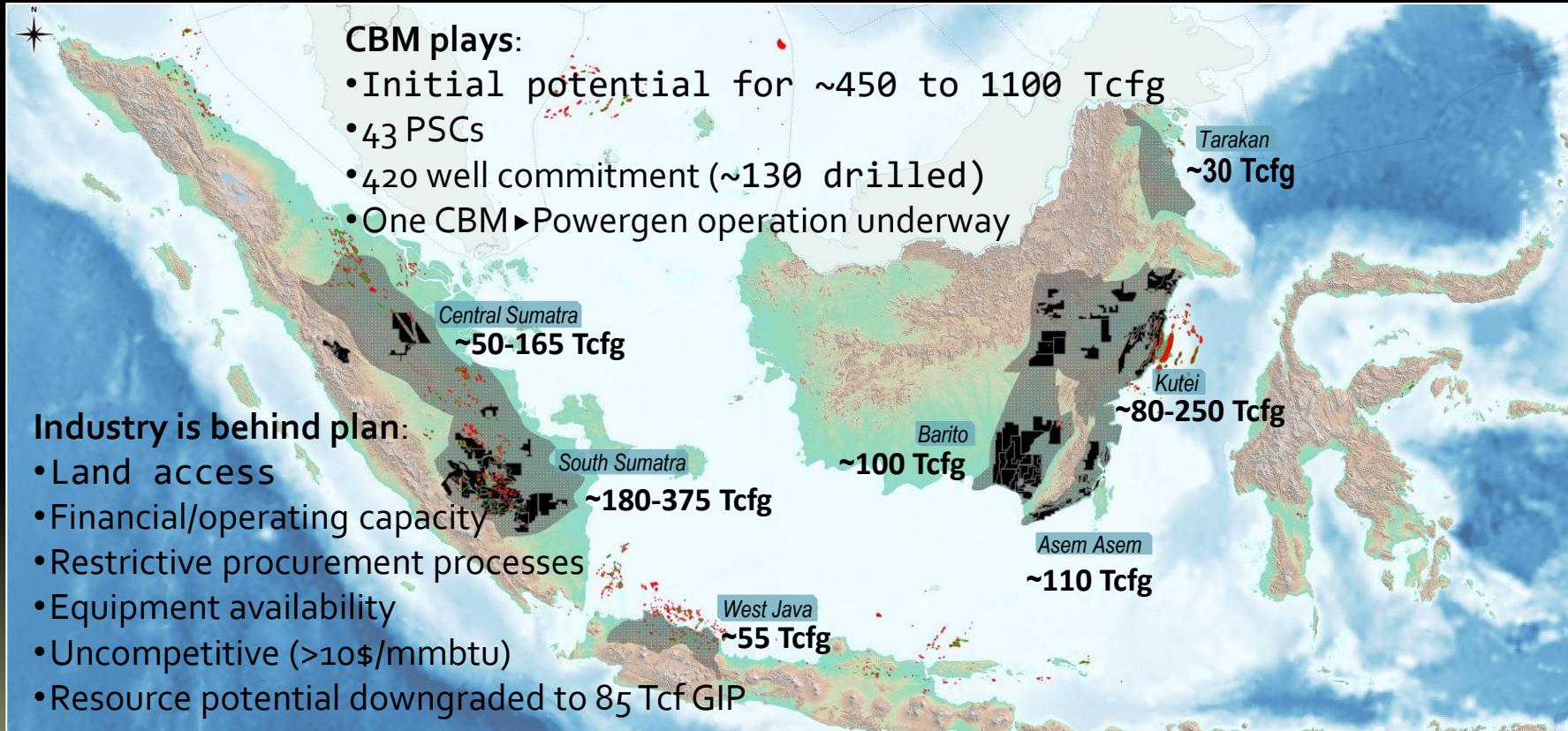
# CBM EXPLORATION (2008-2012)

## CBM plays:

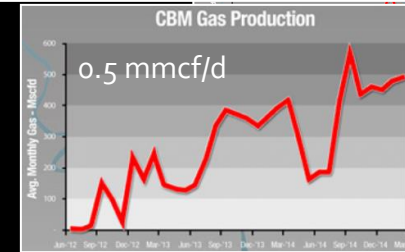
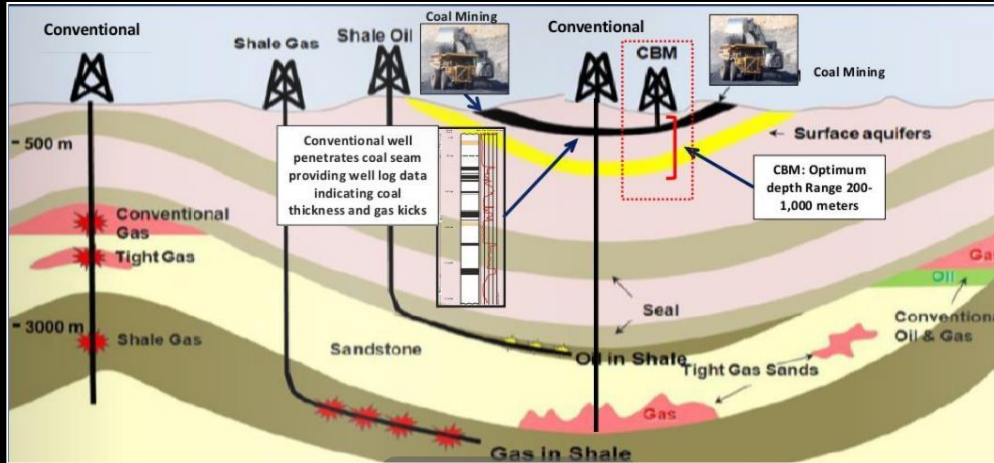
- Initial potential for ~450 to 1100 Tcfg
- 43 PSCs
- 420 well commitment (~130 drilled)
- One CBM ► Powergen operation underway

## Industry is behind plan:

- Land access
- Financial/operating capacity
- Restrictive procurement processes
- Equipment availability
- Uncompetitive (>10\$/mmbtu)
- Resource potential downgraded to 85 Tcf GIP

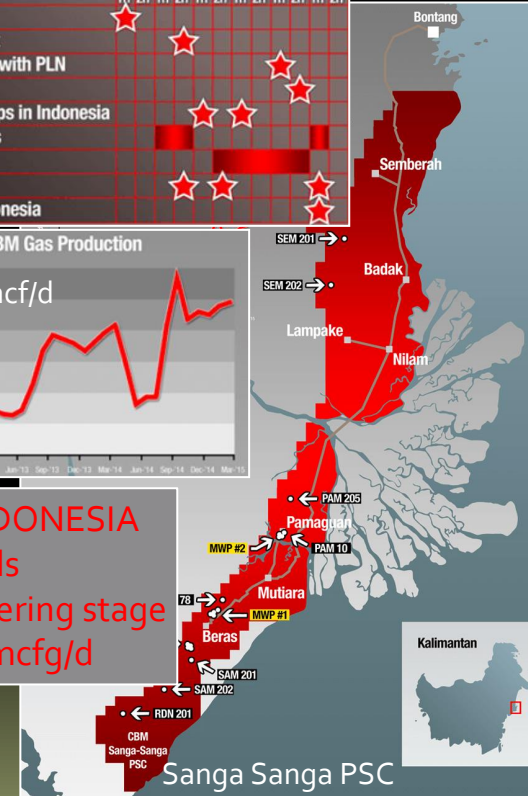


# CBM EXPLORATION



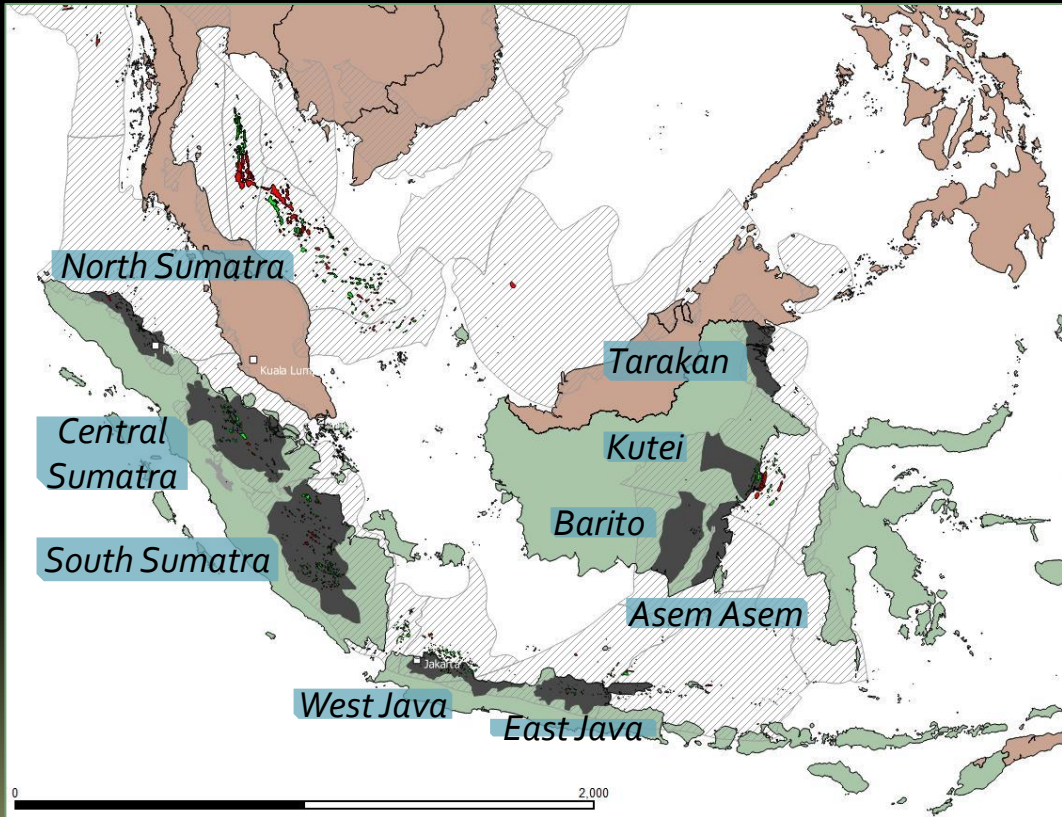
## VICO INDONESIA

- 19 wells
- dewatering stage
- 0.5 mmcf/d



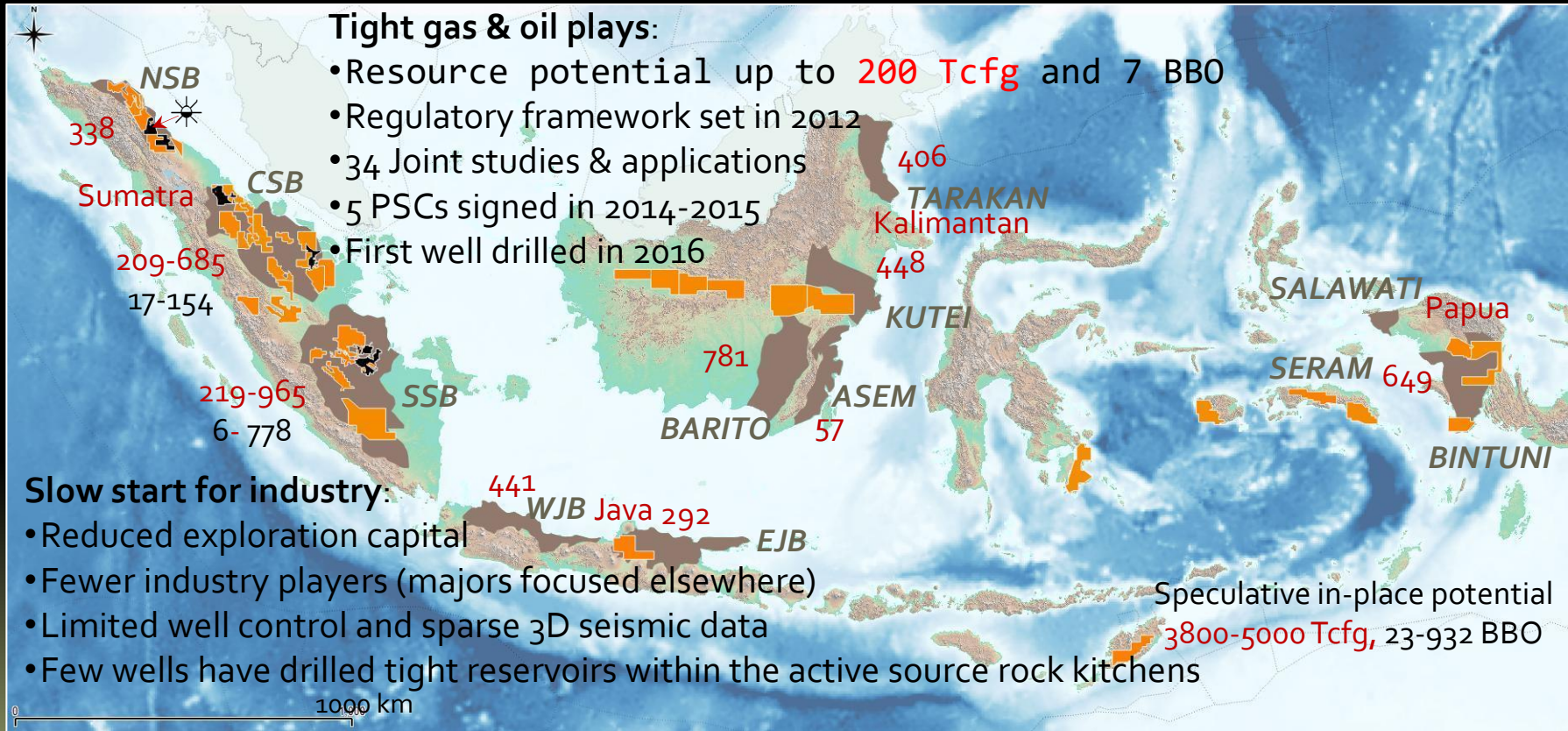


# TIGHT RESERVOIR EXPLORATION (2009-2018)



- China ✓ , Australia ✓? (onshore)
- Vietnam ✕ (mainly offshore)
- Malaysia ✕ (mainly offshore)
- Myanmar? (onshore potential issues with terrain and market)
- Philippines ✕ (mainly offshore)
- Thailand? (mainly offshore, limited onshore basins)
- Indonesia ✓ (many large onshore basins, good infrastructure and markets)

# TIGHT RESERVOIR EXPLORATION



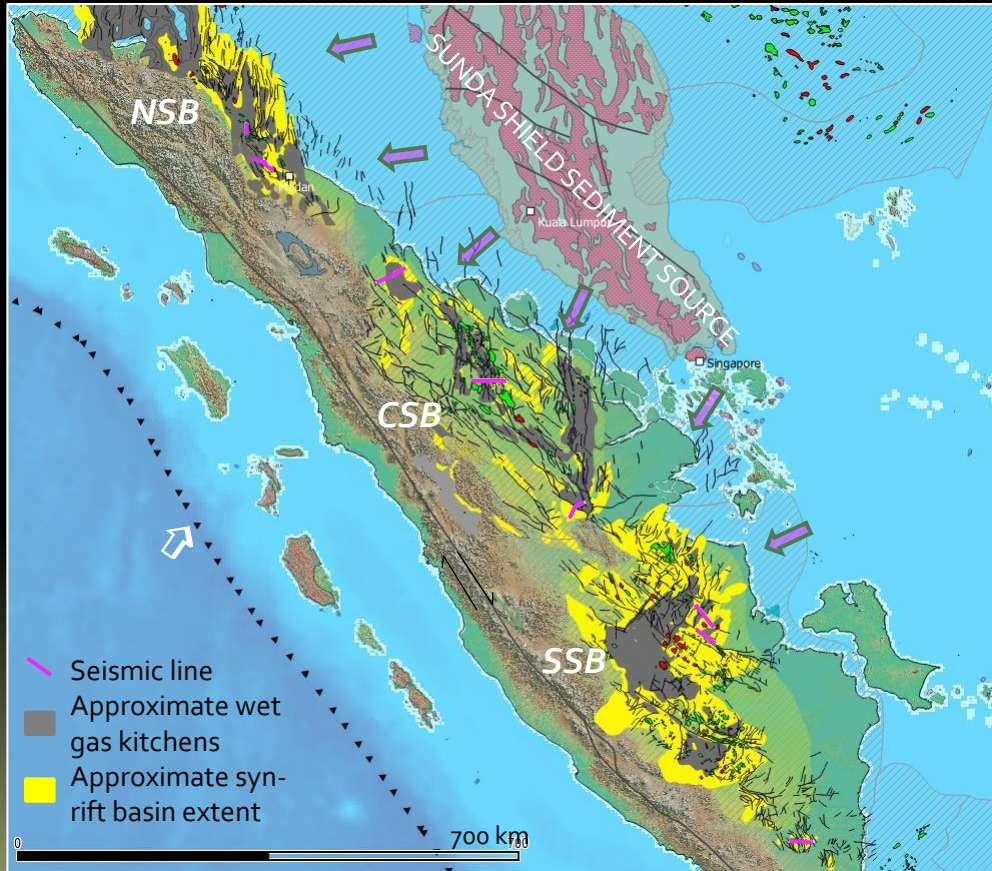


# TIGHT RESERVOIR EXPLORATION

- Tertiary rift basins host rich petroleum source rocks that have charged numerous oil and gas reservoirs in the region
- Many of these source rocks are actively generating hydrocarbons due to rapid late stage burial
- The play concept is that large volumes of hydrocarbon may remain trapped in the active source rock kitchens
- Estimates of prospective wet gas resources are large enough to significantly offset growing regional gas demand
- Few wells have tested these deeper, tight reservoir plays



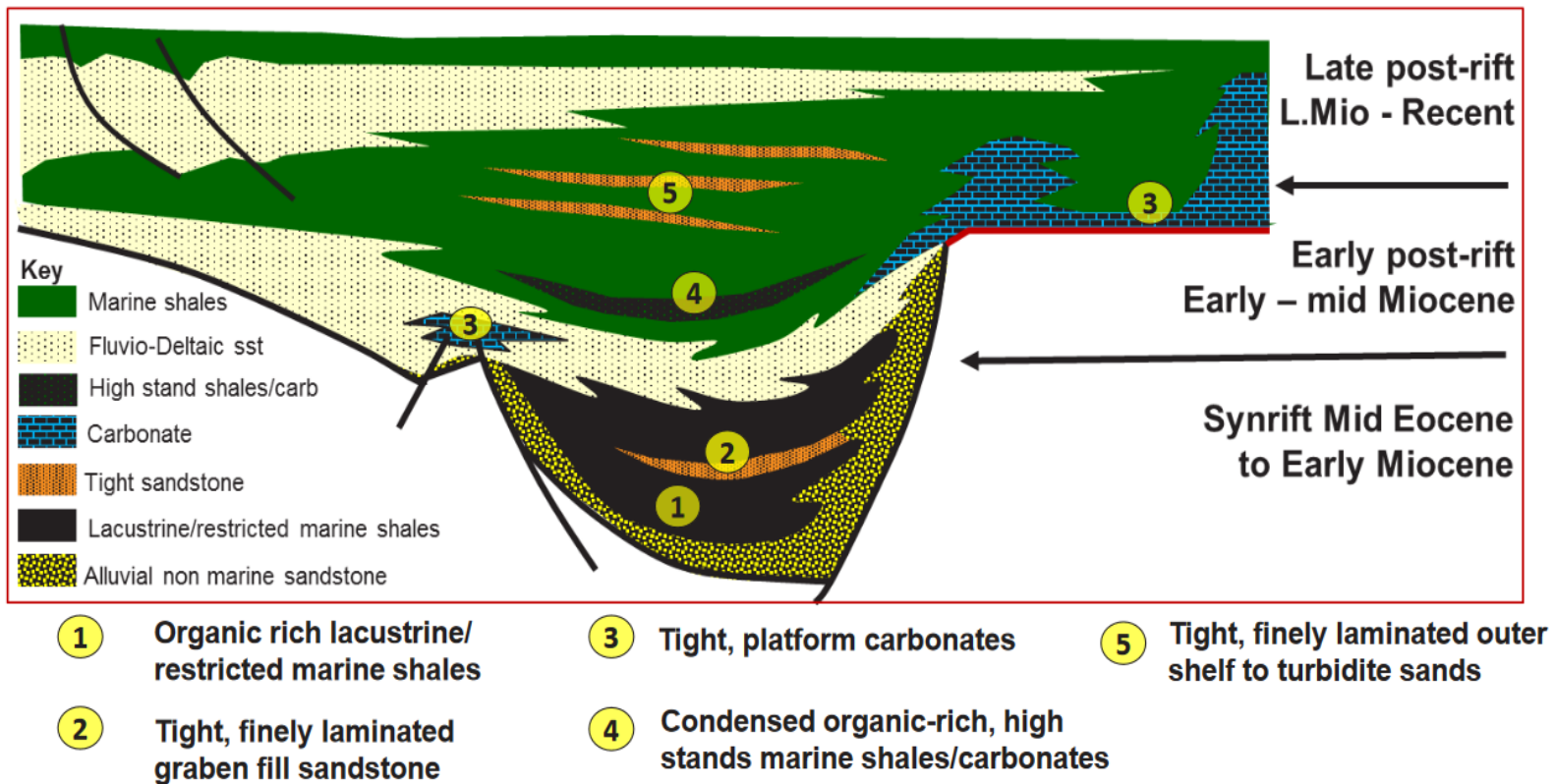
# FOCUS ON SUMATRA - BASIN FRAMEWORK



- Complex tectonic environment results from oblique subduction of Indo-Australian Plate beneath Eurasian (Sunda) Plate
- Narrow Paleogene rifts are buried by broader Neogene basins
- Substantial syn-rift provenance from exhumed granitic Sunda Shield

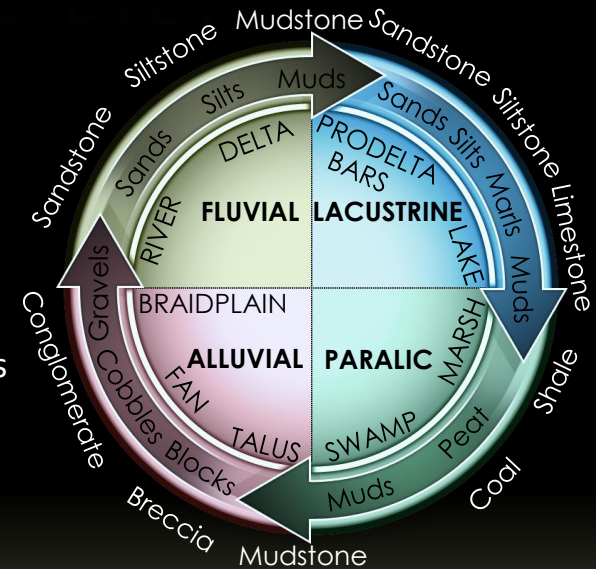


# FOCUS ON SUMATRA – GEOLOGY PRIMER



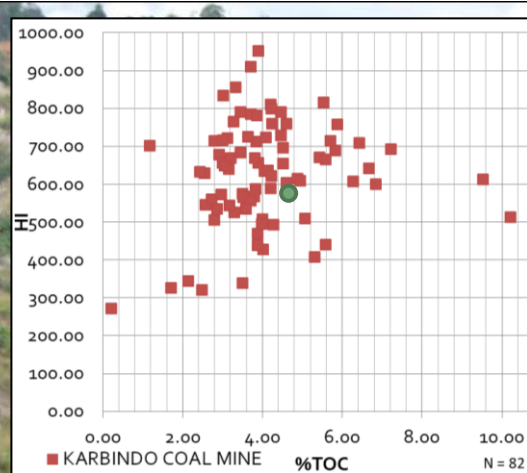
# FOCUS ON SUMATRA – PALEOGENE RIFTS

- Regional tectonic and climate analyses place these basins in an equatorial, humid, tropical climate throughout the Paleogene
- Syn-rift facies assemblage:
  - Thick non-marine deposits comprising alluvial, fluvial, paralic and lacustrine facies with common paleosol horizons
  - Stratified lacustrine mudstones with high organic richness levels typical of tropical settings
  - Abundant coals - evidence of widespread, warm, humid conditions – and locally present freshwater carbonates (with algae & gastropods); evaporites and marine rocks are absent
  - General stratigraphic progression in the basins from lower alluvial, fluvial and paralic deposits to medial mixed and open lacustrine sequences, succeeded by upper thick prograding fluvial sequences
- The Paleogene sediments indicate deposition in largely overfilled lacustrine basins; however distinct episodes of more balanced conditions prevailed locally, allowing organic-rich source beds to accumulate in lakes with stratified water columns



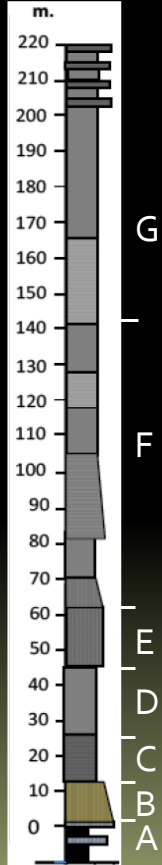
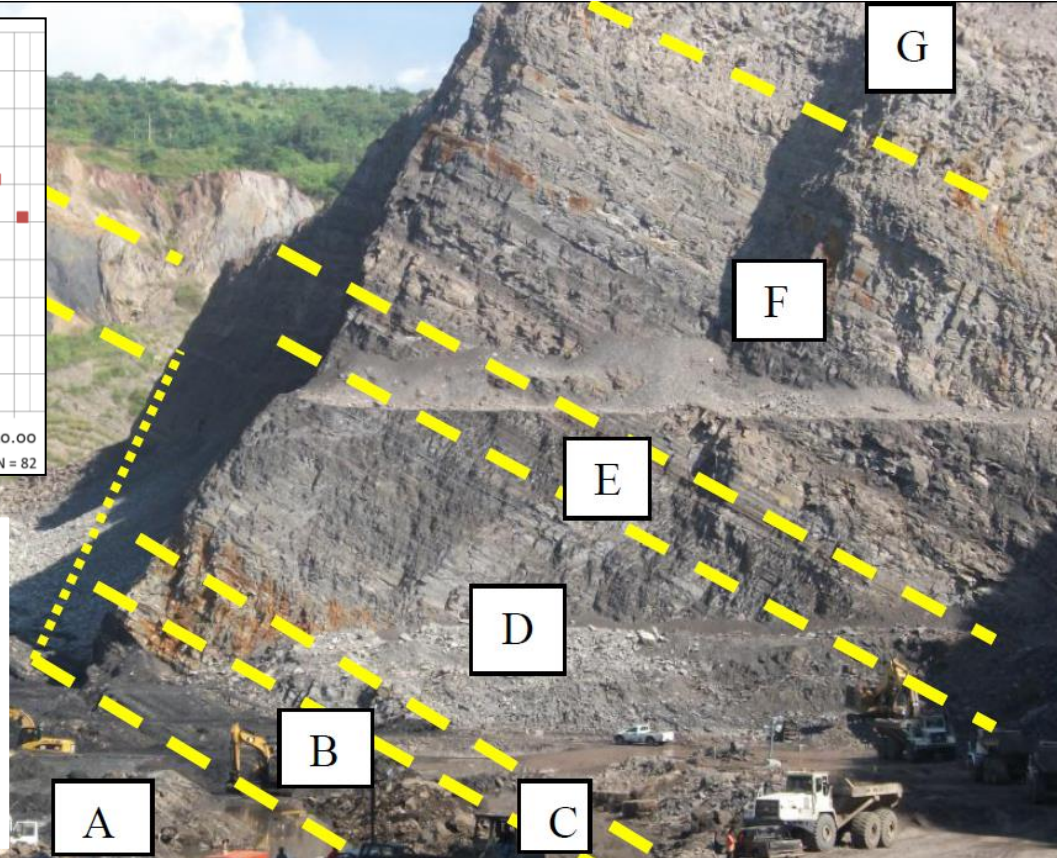
**Depositional environments and lithofacies of the syn-rift fill are spatially variable**

# PALEOGENE SOURCE ROCK OUTCROP

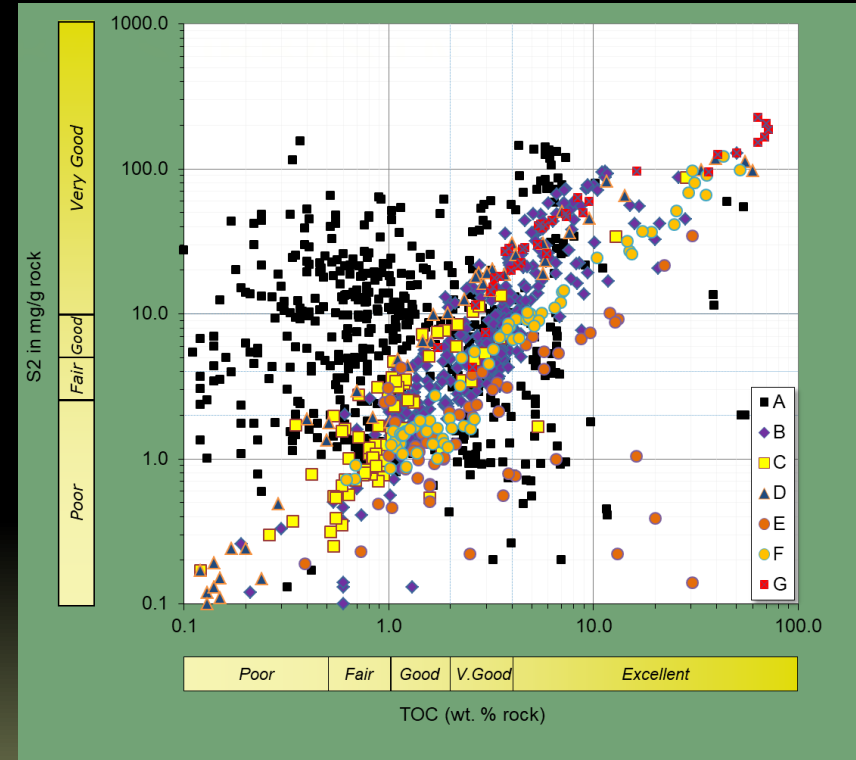
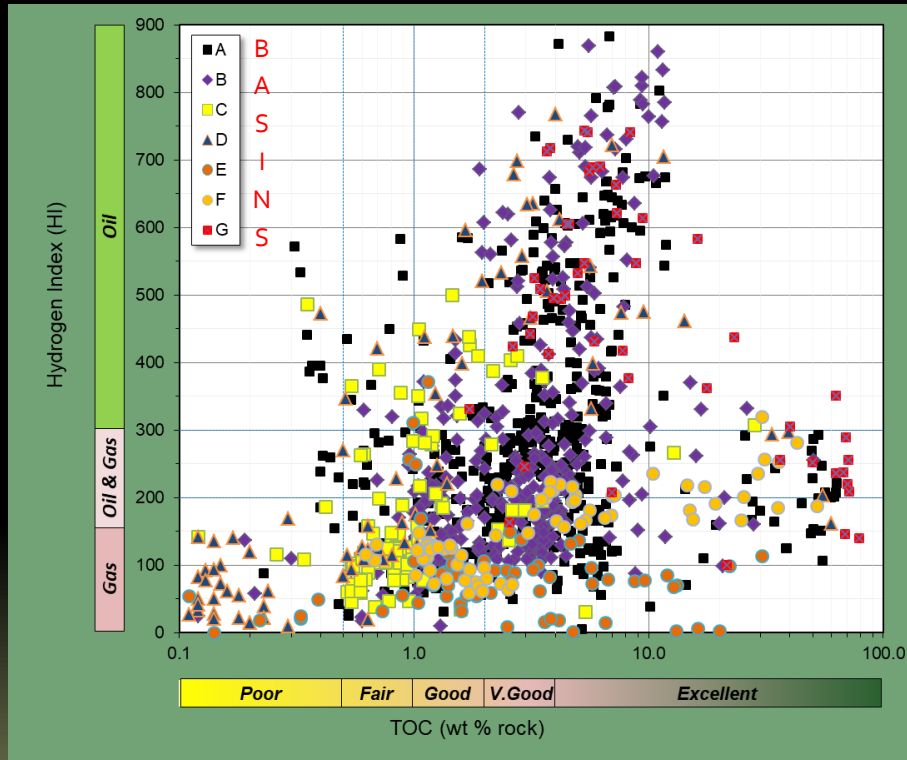


## Lithofacies:

- A. Coal and limestone on paleosol
- B. Massive shale
- C. Laminated shale and siltstone
- D. Interbedded gray and red shale
- E. Fossiliferous shale
- F. Massive shale
- G. Interbedded shale and sandstone



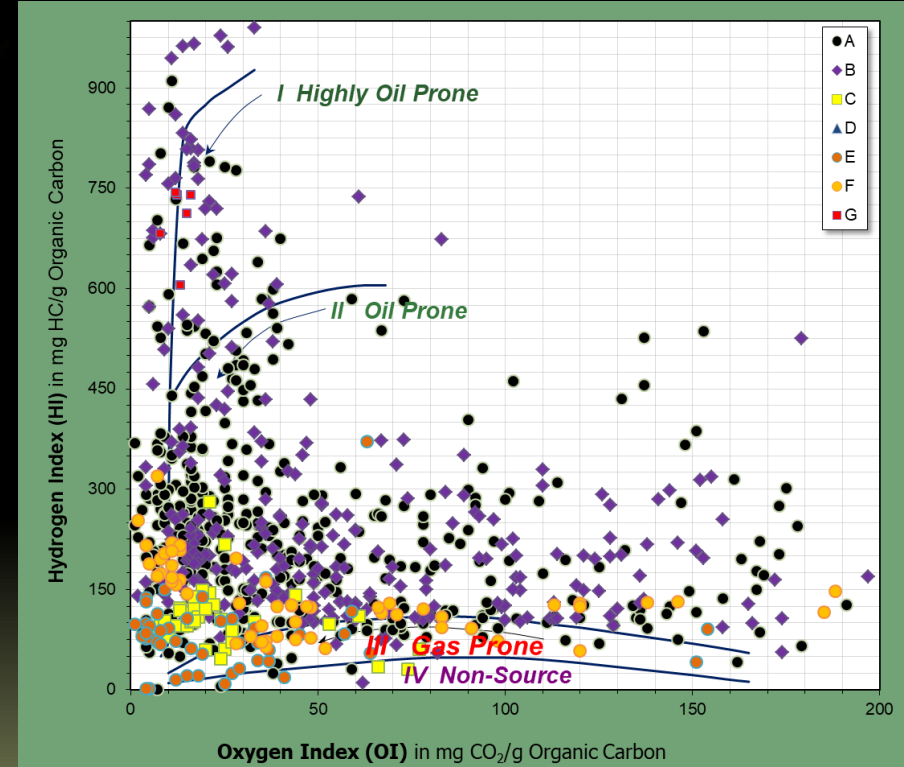
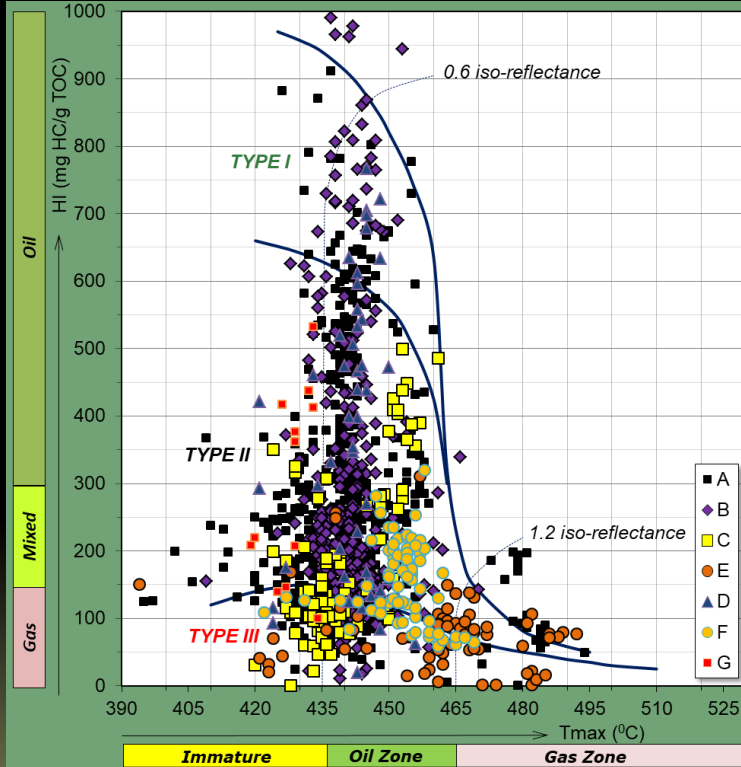
# SOURCE ROCK CHARACTER BY SUBBASIN



Abundant very good to excellent source rocks for oil and gas based on TOC and hydrocarbon yield

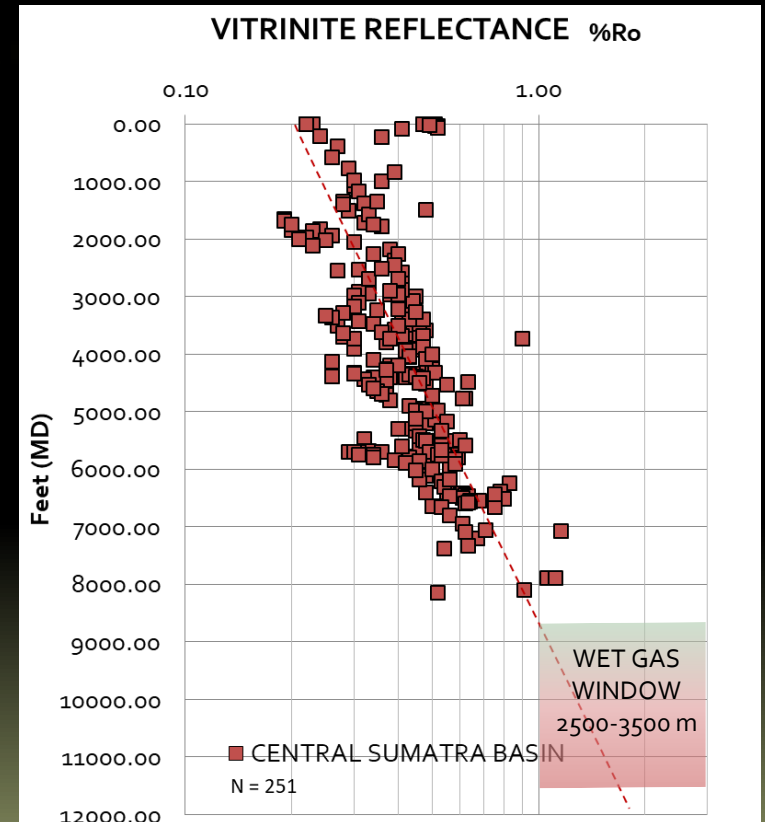
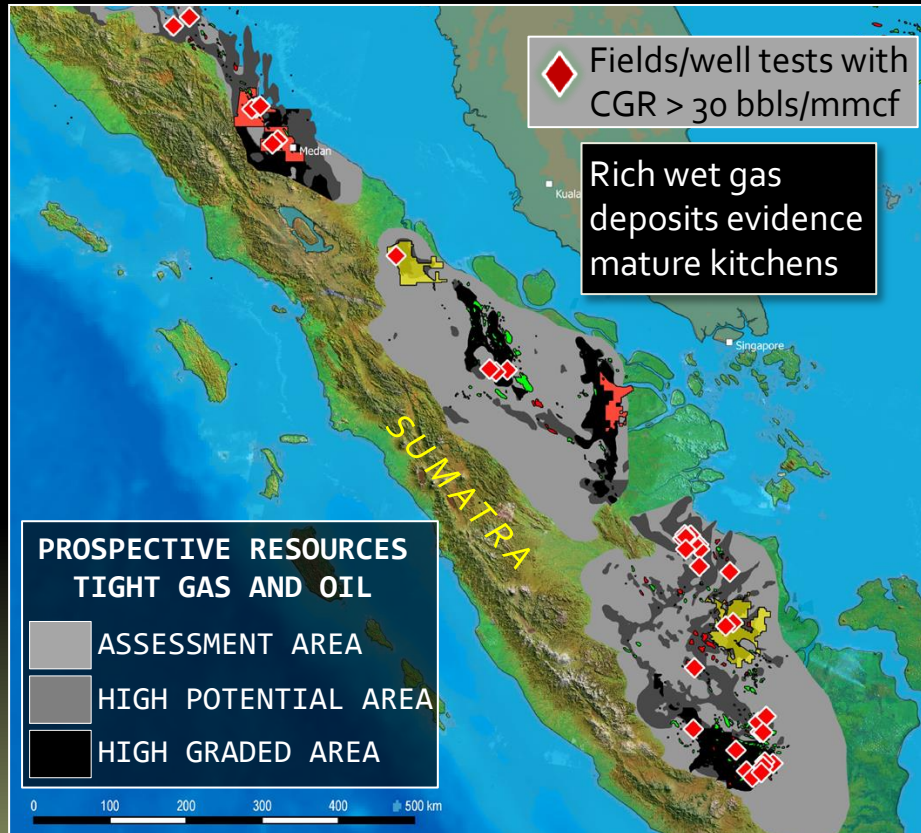


# SOURCE ROCK CHARACTER BY SUBBASIN



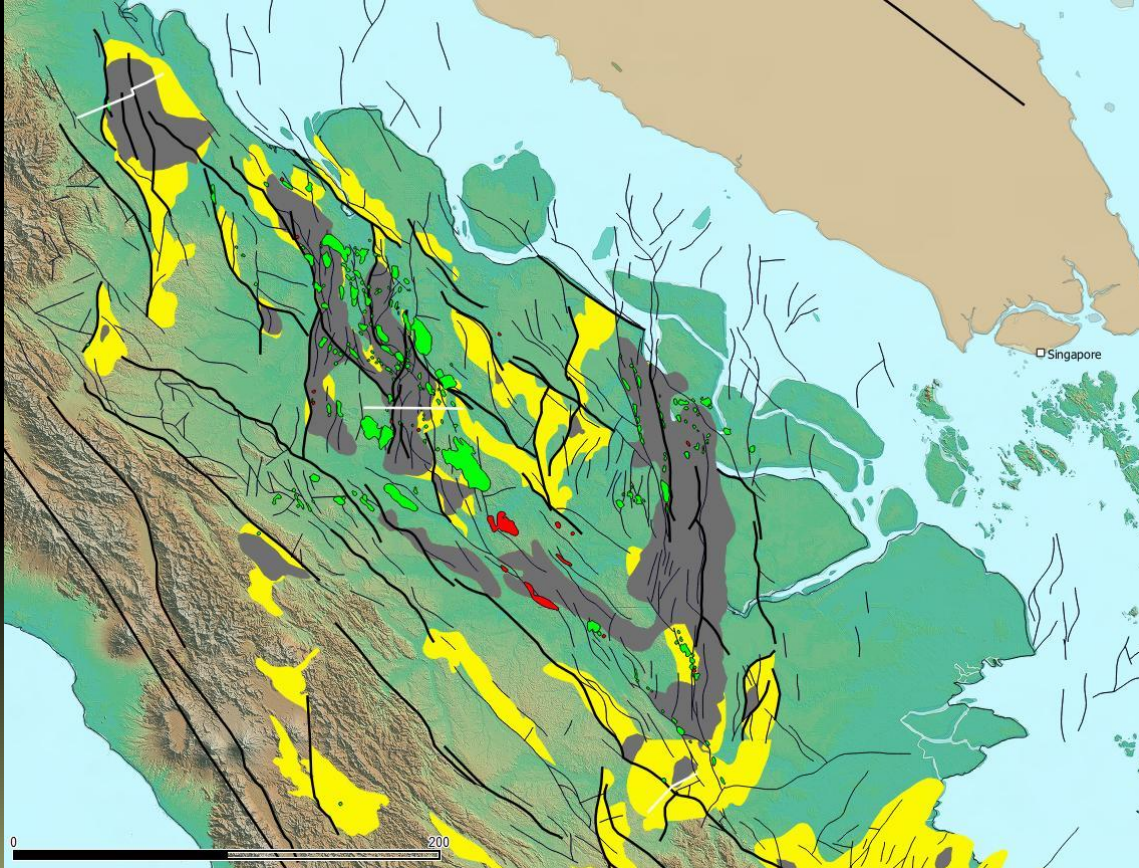
Type I and II oil prone source rocks are prevalent but some subbasins host dominantly Type III gas prone source rocks

# SOURCE ROCK KITCHENS - TARGET DEPTH



Various industry geochemical reports; England et al. (2015)

# CENTRAL SUMATRA SYN-RIFT PLAY DETAIL



- Complex multi-phase fault trends
- Initial E-W extensional domain in Paleogene
- Younger NW convergent wrench domain in Neogene
- Prospective deep syn-rift source rock kitchens (dark grey)



# CENTRAL SUMATRA SYN-RIFT PLAY

- Regional 2D seismic data available through PND (government agency) constrains the play
- Numerous wells have penetrated syn-rift strata, but few wells have drilled deep enough into the source rock kitchens to test the tight reservoir plays





# SUMATRA TIGHT GAS EXPLORATION SUMMARY

- ✓ Abundant seismic and well data provide good control on basin architecture and geology
- ✓ Rich source rocks are present in well bores and outcrops
- ✓ Wet gas fields evidence mature kitchens
- ✓ Hydrocarbons are actively being generated within source rock pods
- ✓ Burial history models explain oil and gas field distribution and predict the locations of optimal tight reservoir play fairways
- ✓ Effective paleo-sol, red bed, estuarine and marine mudstone top seals have allowed moderate overpressured conditions to build which should enhance reservoir productivity
- ✓ Oil and gas have been tested from tight sandstones interbedded with source rocks indicating hybrid play potential
- ✓ Brittle quartz-rich litharenites typify Paleogene reservoir sandstone targets Sumatra wide
- ✓ Low tonnage frac operations are effective in improving deliverability and additional reserves in conventional reservoirs
- ✓ Significant secondary porosity is evident in sandstone reservoir targets at depth
- ✗ Few cores have been taken in reservoir and source rocks at optimal thermal conditions
- ✗ Tight reservoirs have not been fraced and tested at optimal thermal conditions

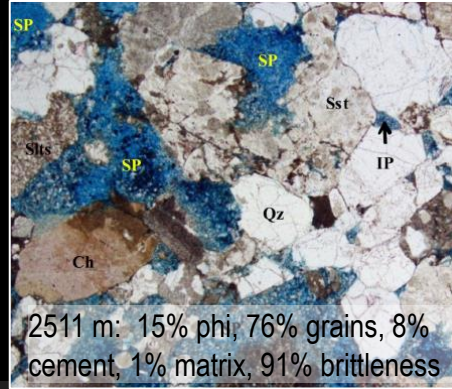
# TIGHT GAS EXPLORATION – A NEW FRONTIER



Seismic acquisition >



Drilling >



Coring & analysis >



Stimulation & testing



Suspension > Plan of development >

## Scoping development project

- 100 km<sup>2</sup> project with 180 wells (20 to 30 pads)
- 100 mmcf/d, 4000 bc/d recovering 140 mmbbl
- 25 year project with 12 year plateau
- \$US 2,000 MM CAPEX, >\$US 500 MM NPV

Pilot phase > Development sanction



# KEY TAKEAWAYS

- Regional energy supply is forecast to be outstripped by demand
- Exploration for new resources in region is merited
- Deepwater, CBM, fractured basement and tight resource plays are being pursued
- Western Indonesia may host significant tight resources within buried Paleogene rift basins
- Sumatra has high promise for commercial tight resources with abundant infrastructure, strong market demand and pricing, and abundant export capacity
- New PSCs have the best onshore terms offered to date