RISC

decisions with confidence

Exploration of the Rakhine Basin, Pushing out the barriers with new 3D

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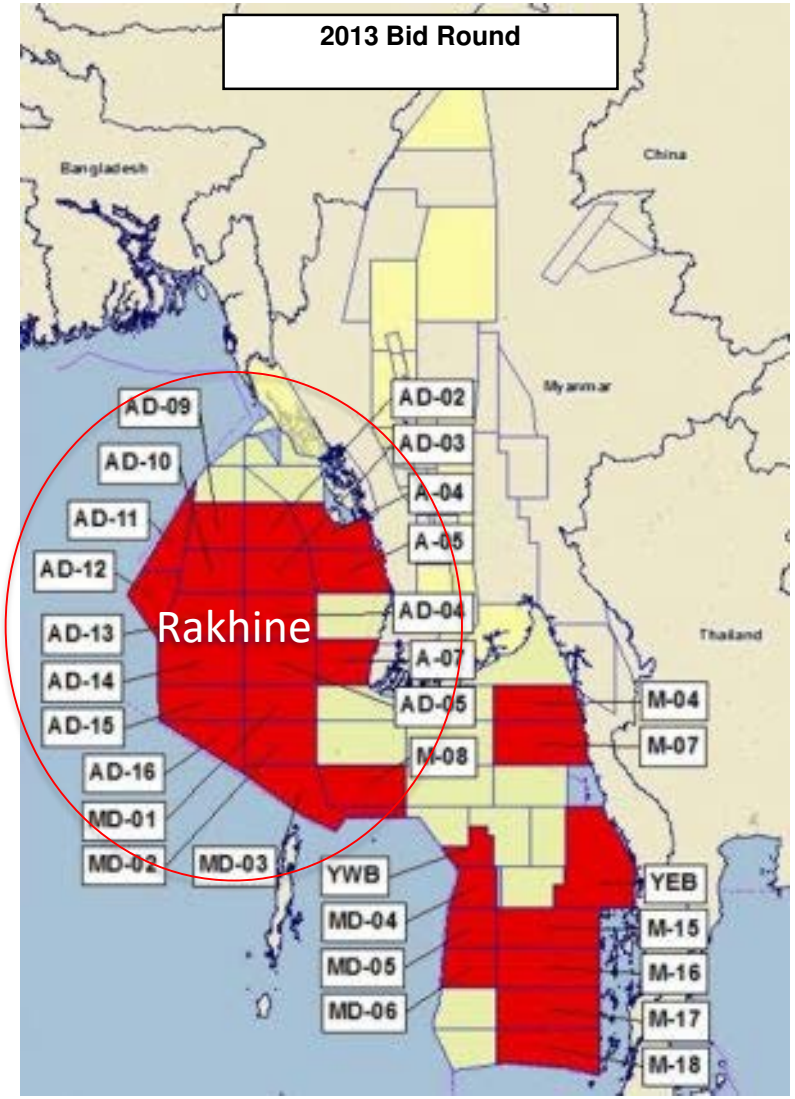
AAPG/EAGE/MGS Yangon
November 2015

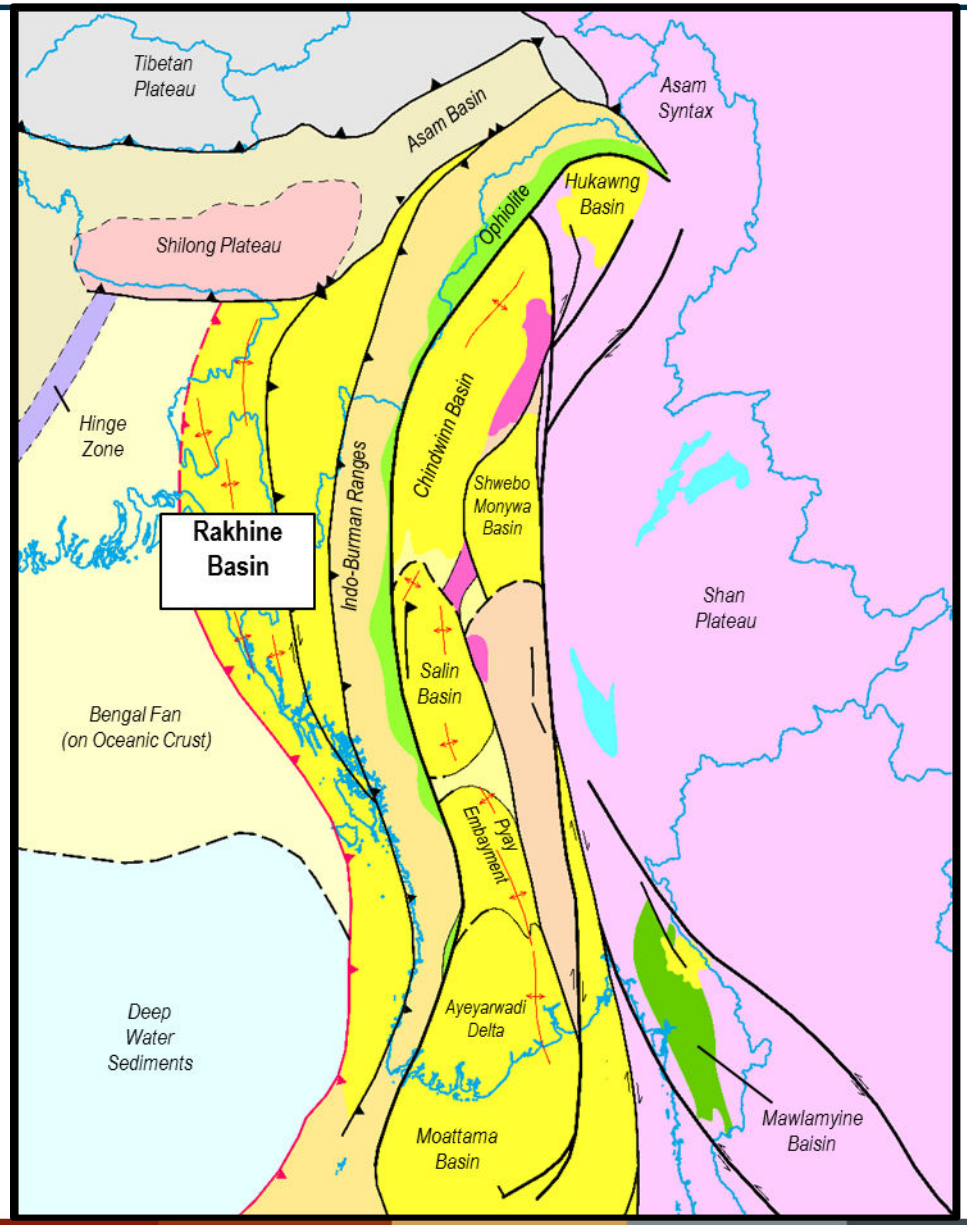
Introduction



Regional geology

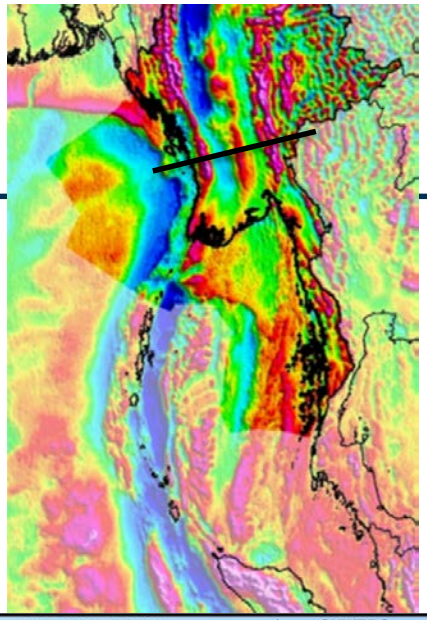
The Rakhine Basin is one of Myanmar's six major geological provinces:

- Shan Plateau (onshore)
- Central Burma Super Basin ("CBSB") (onshore)
- Indo-Burman Ranges (onshore/ offshore)
- Rakhine Basin (onshore/offshore)
- Bengal Fan (offshore)
- Moattama (or Martaban) Basin (offshore)

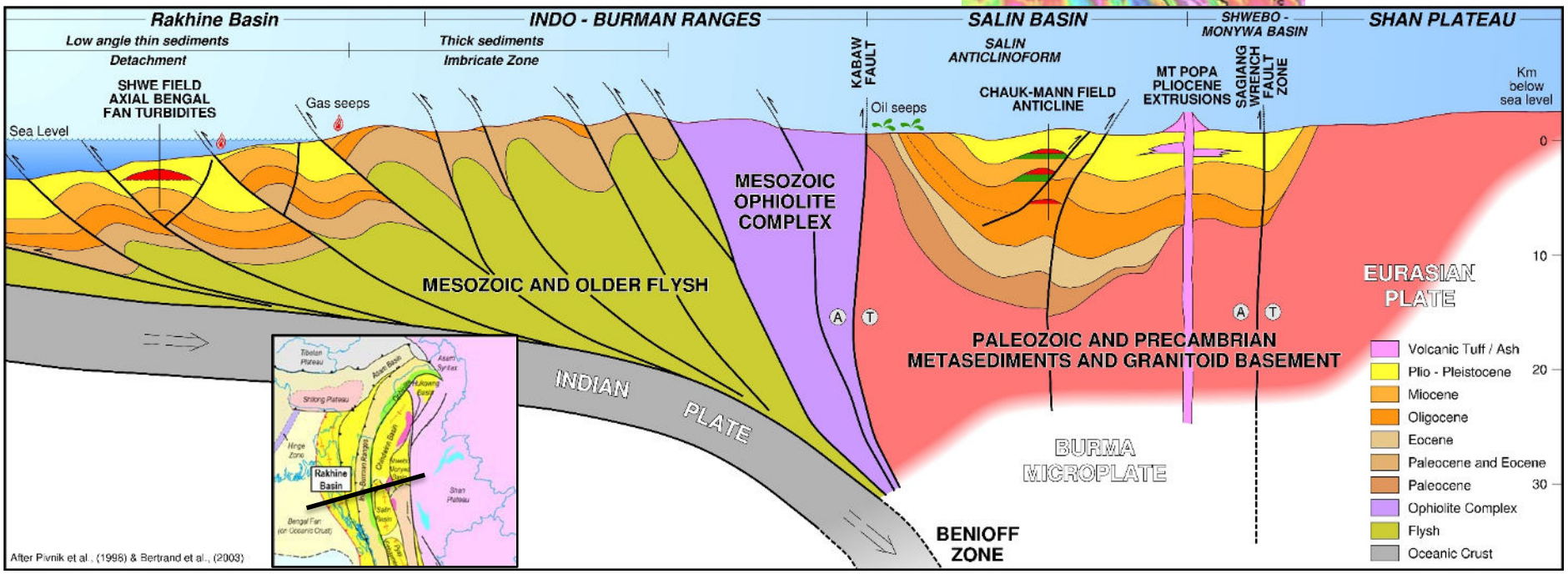


Regional geology

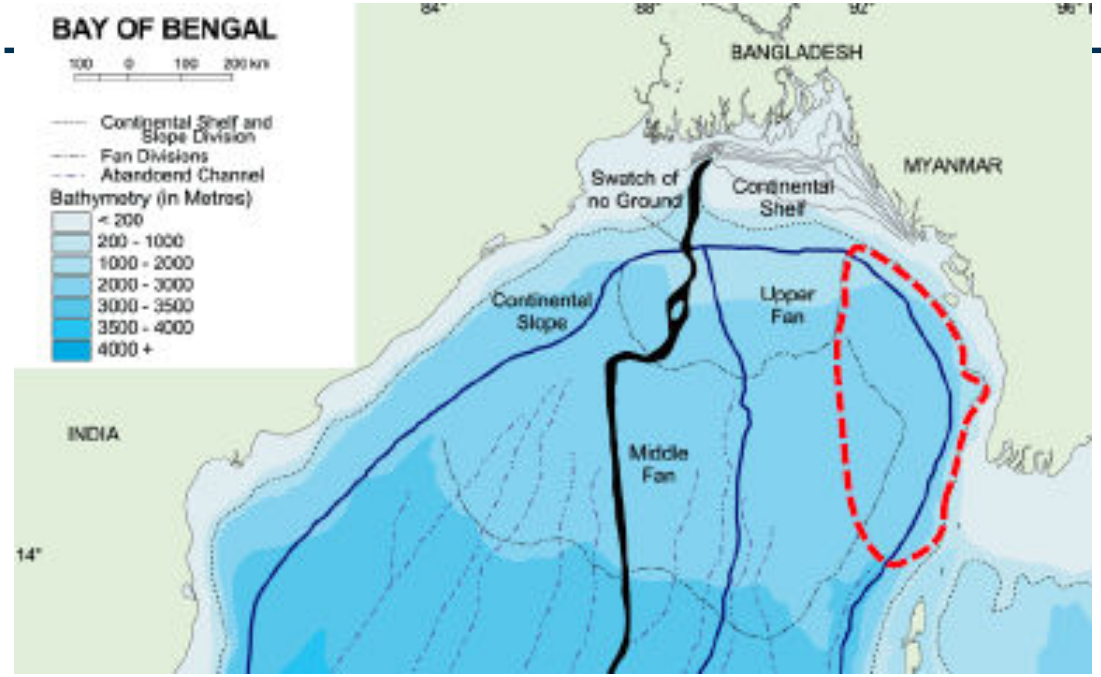
- Evolution of the basin was controlled by the oblique subduction of the Indian Plate beneath the Burma portion of the Eurasian/Sunda Plate
- Rakhine Basin is the accretionary prism that developed as subduction proceeded from mid Eocene to Present

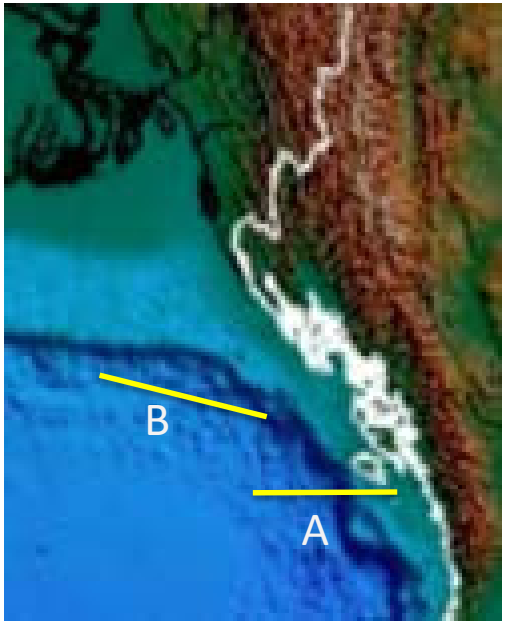


Extract from Satellite Free-Air Gravity Image. FROGTECH



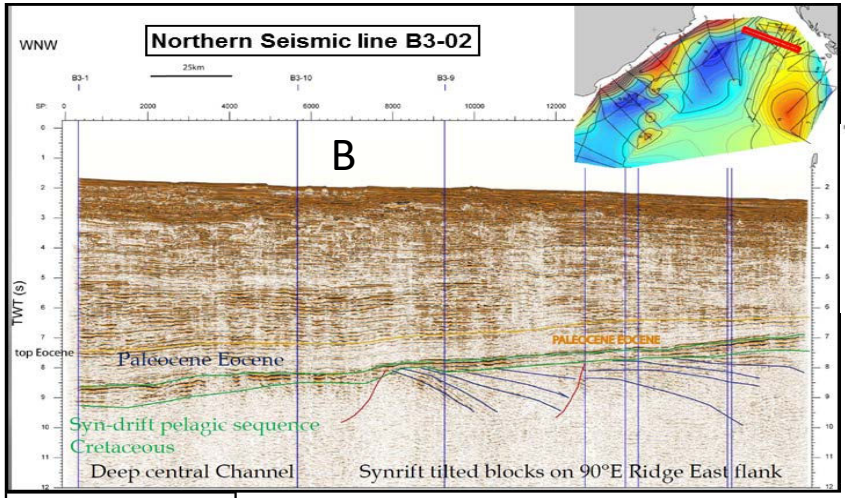
Rakhine Basin/Bengal Fan regional setting





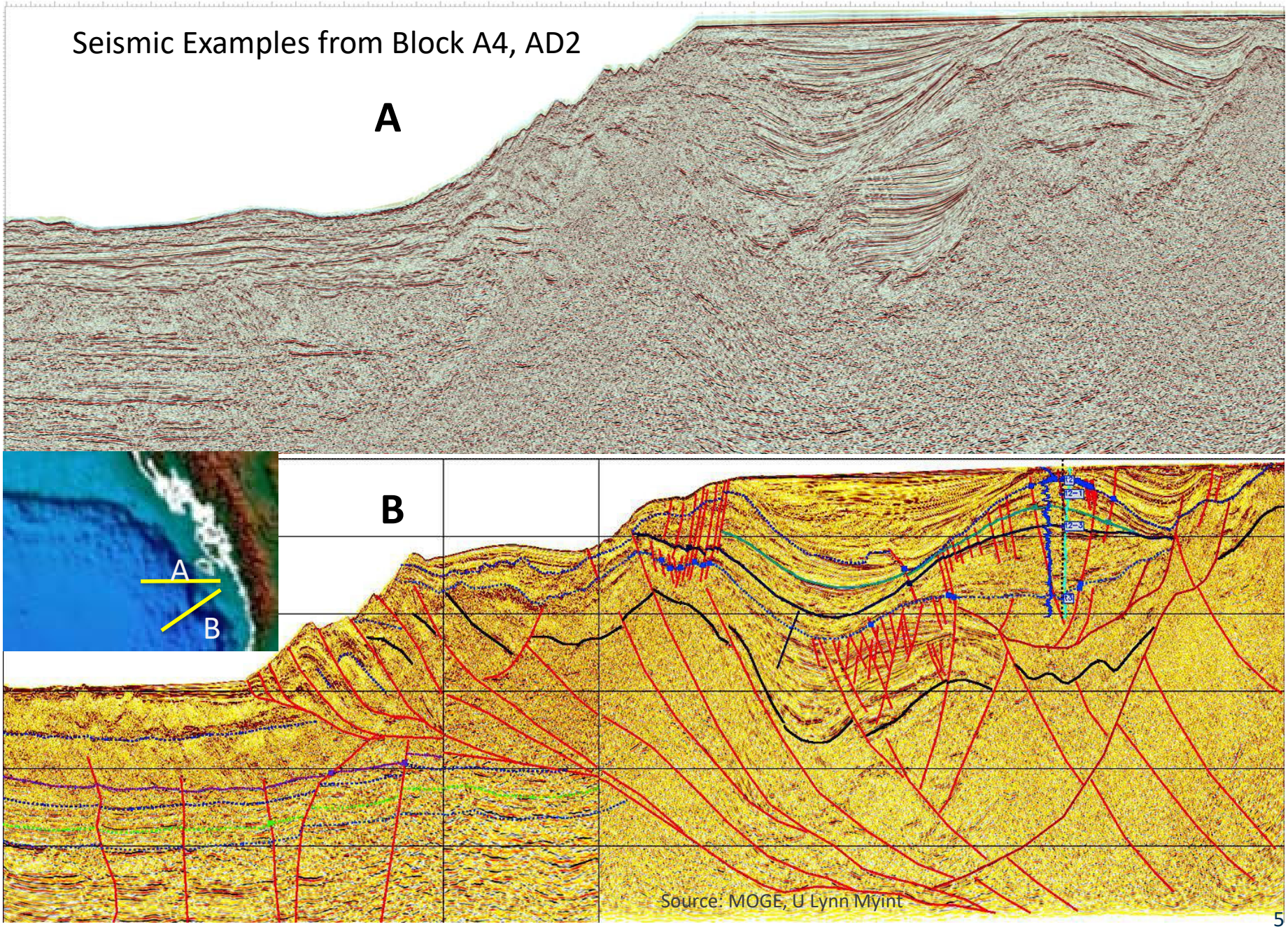
Bengal Fan

Rakhine Basin



C Rangin SEAPEX 2013

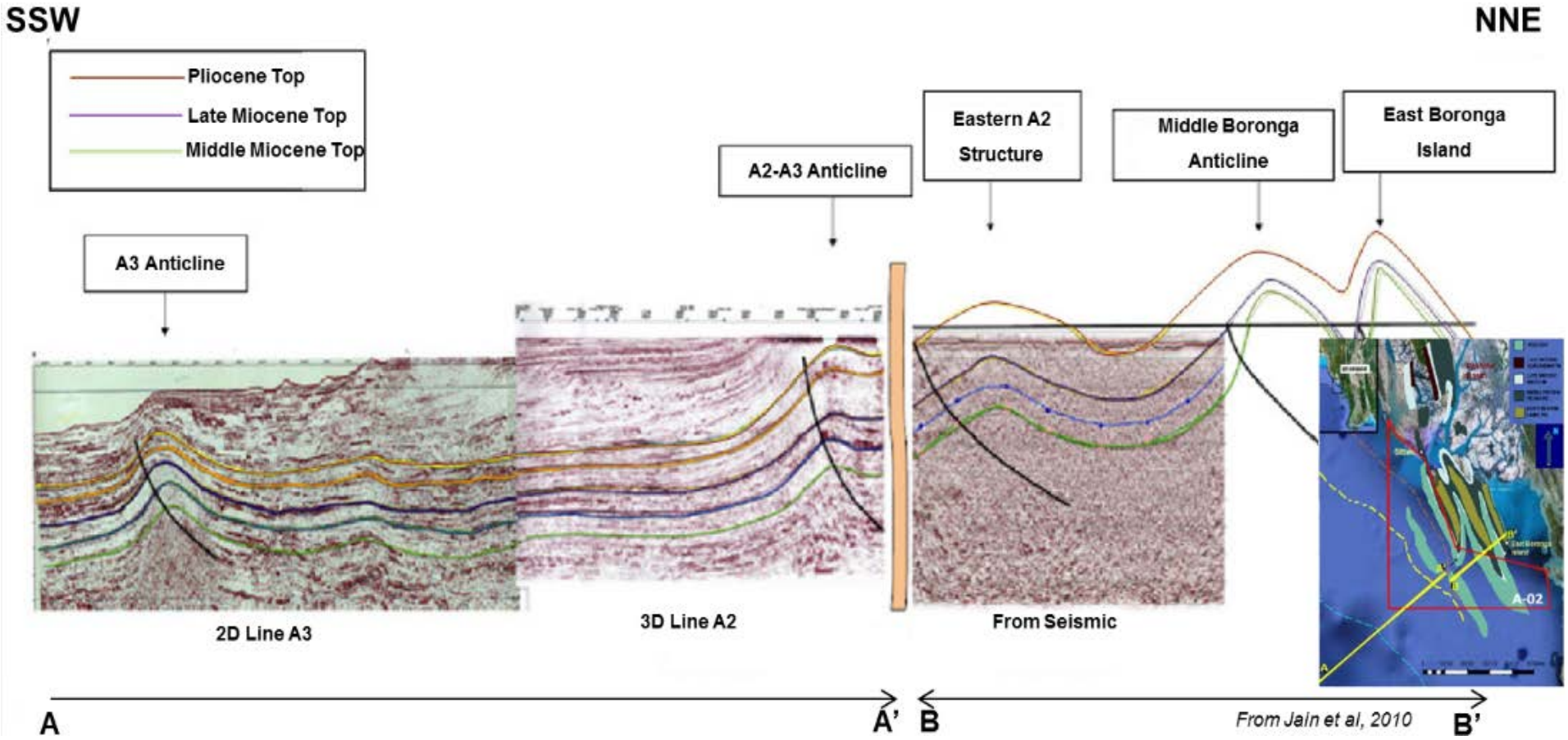
Seismic Examples from Block A4, AD2



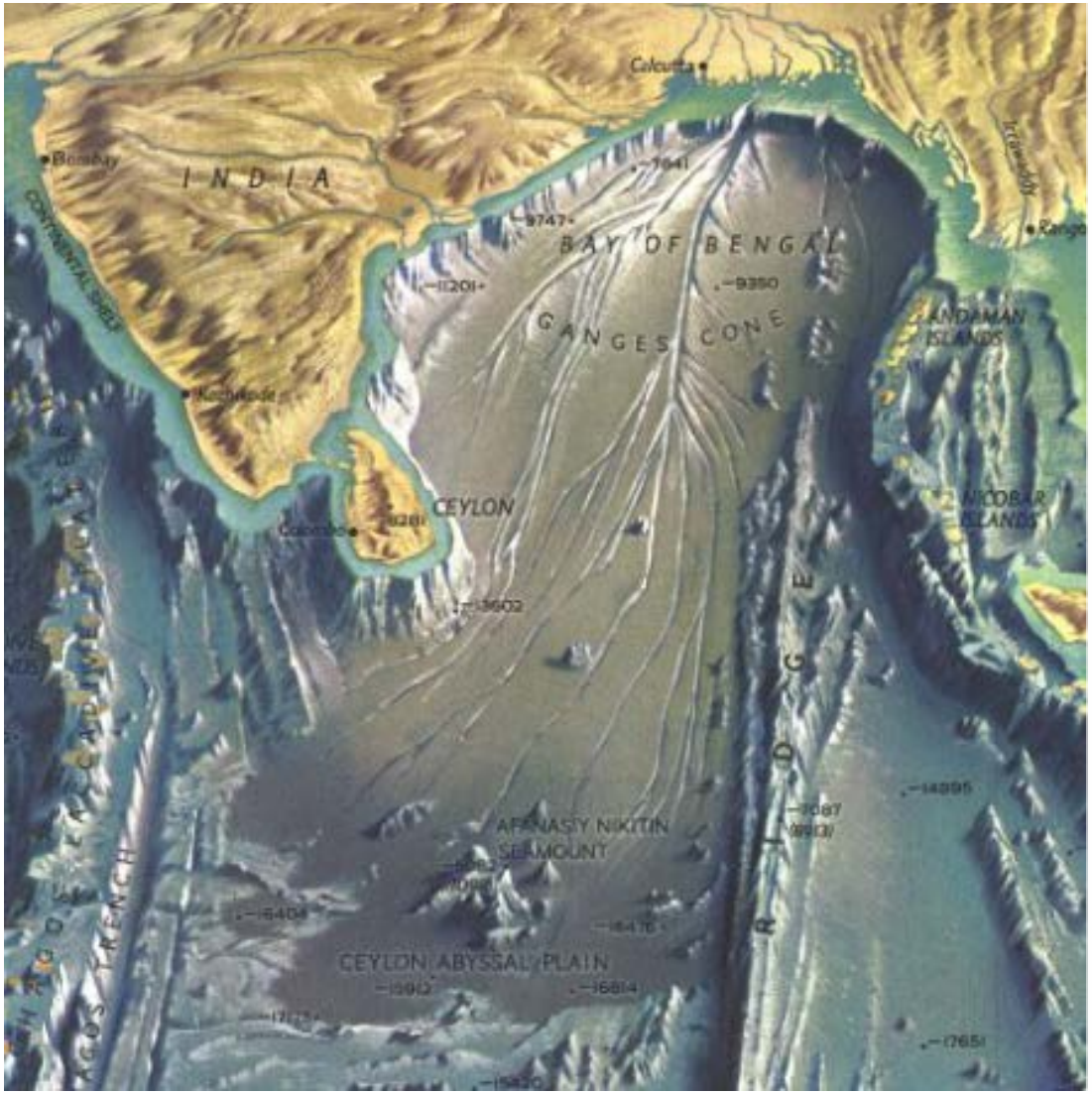
Source: MOGE, U Lynn Myint

Rakhine Basin regional setting

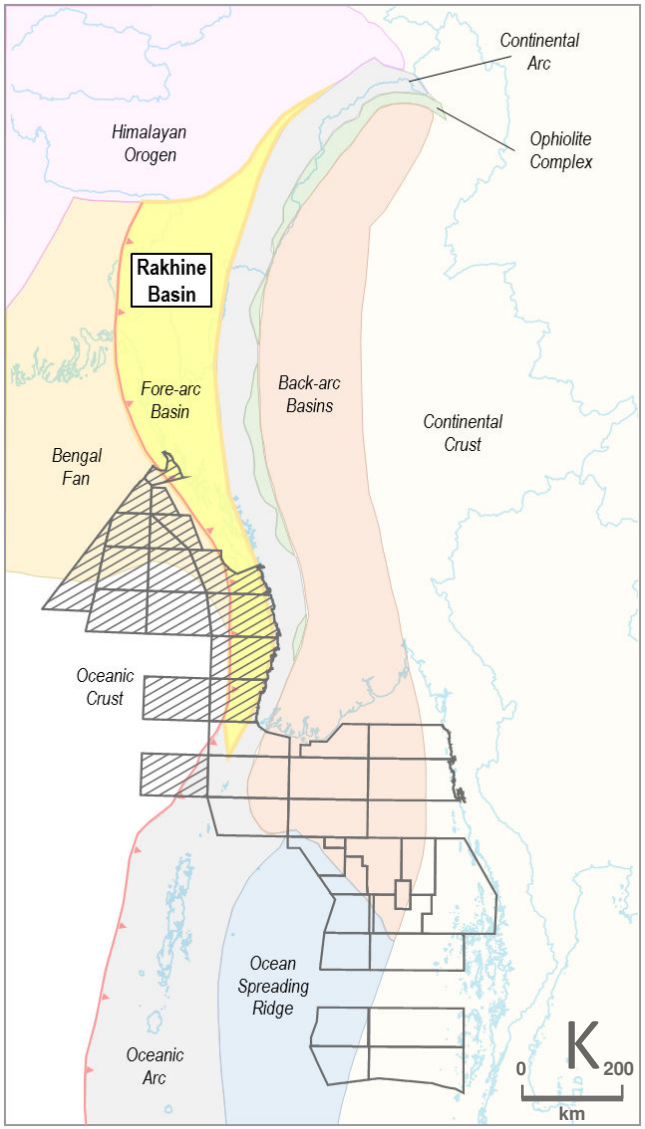
Onshore/offshore Rakhine Basin



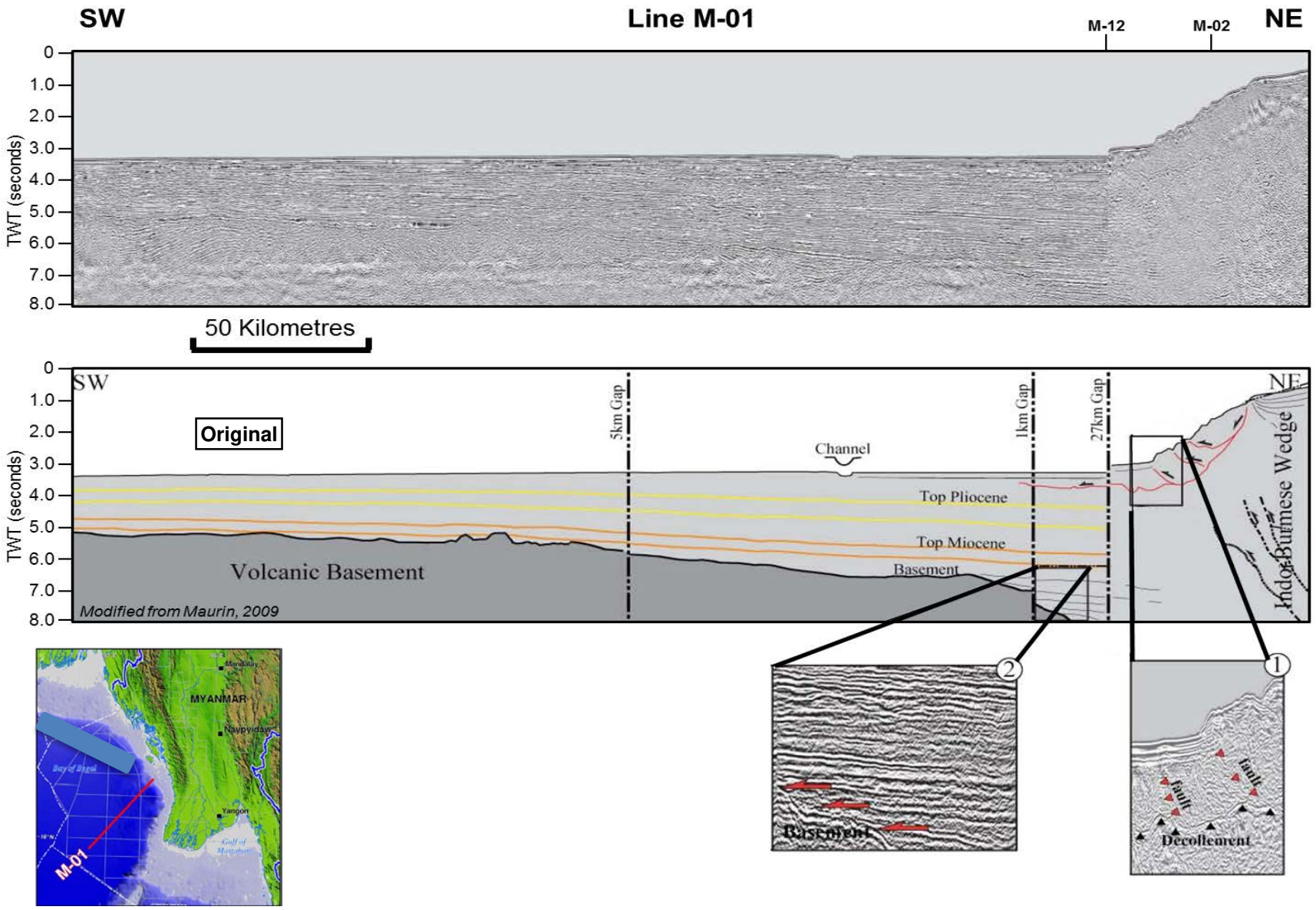
Bengal Fan regional setting



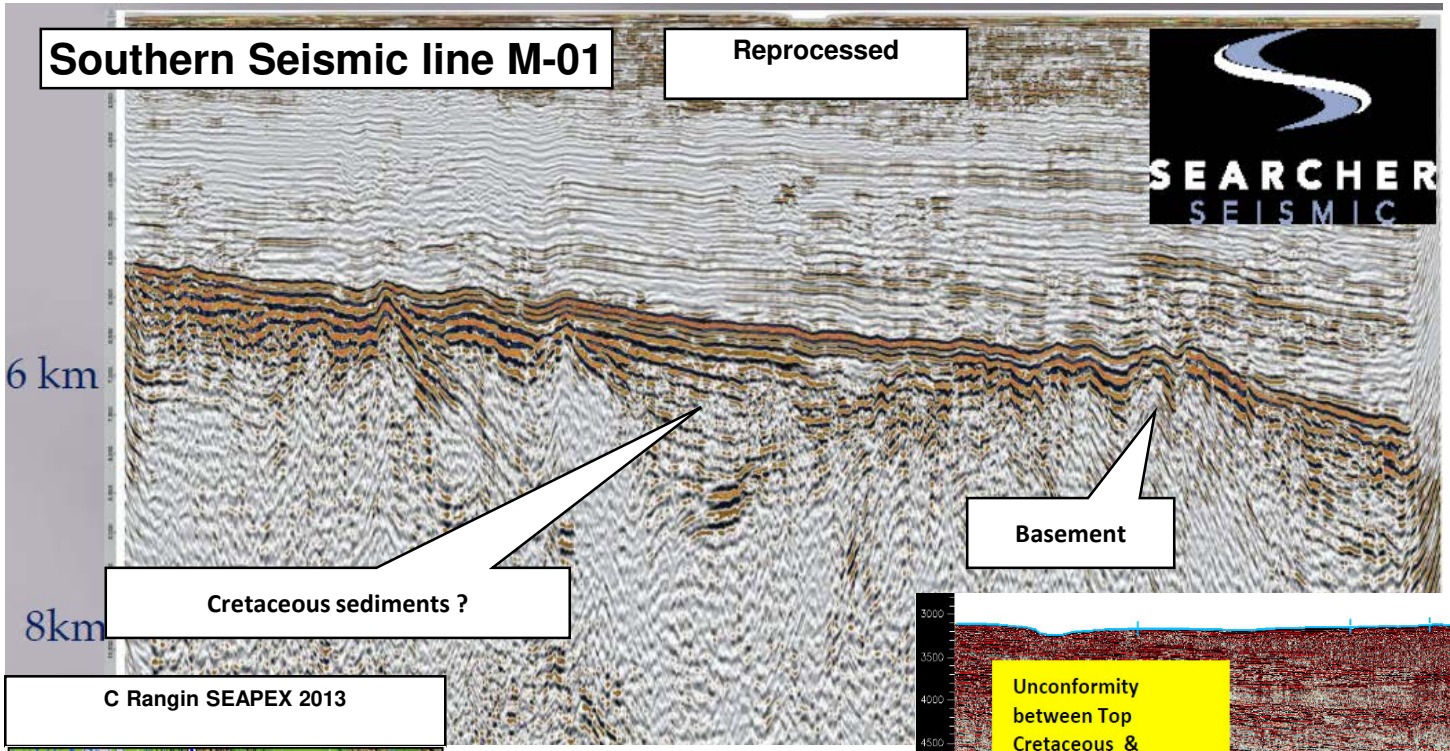
Source: Quora User



Bengal Fan regional setting



Bengal Fan regional setting



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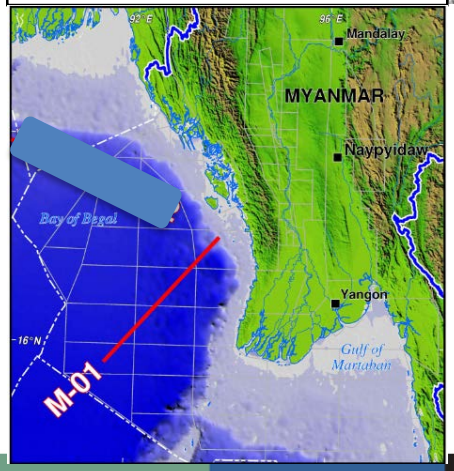
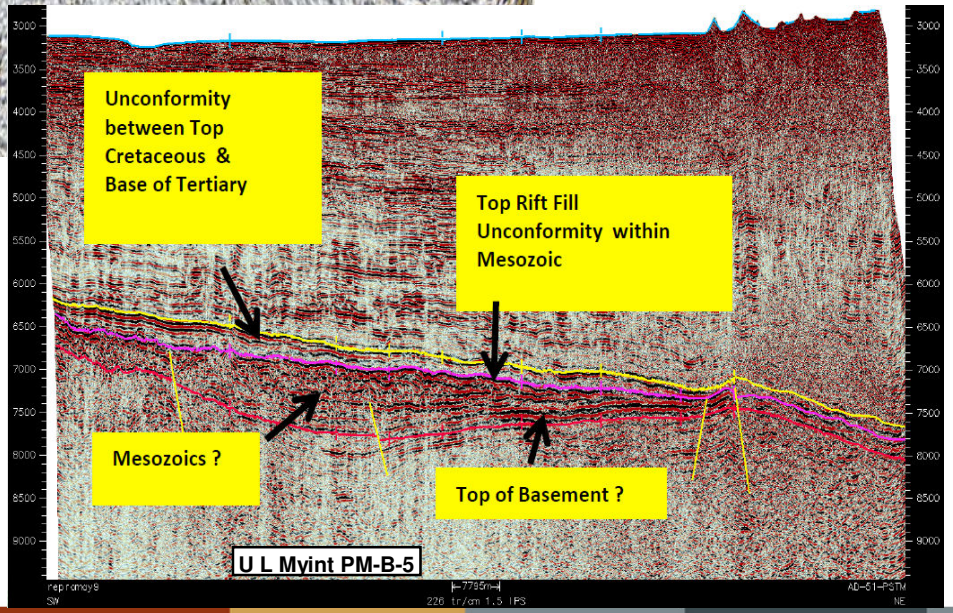
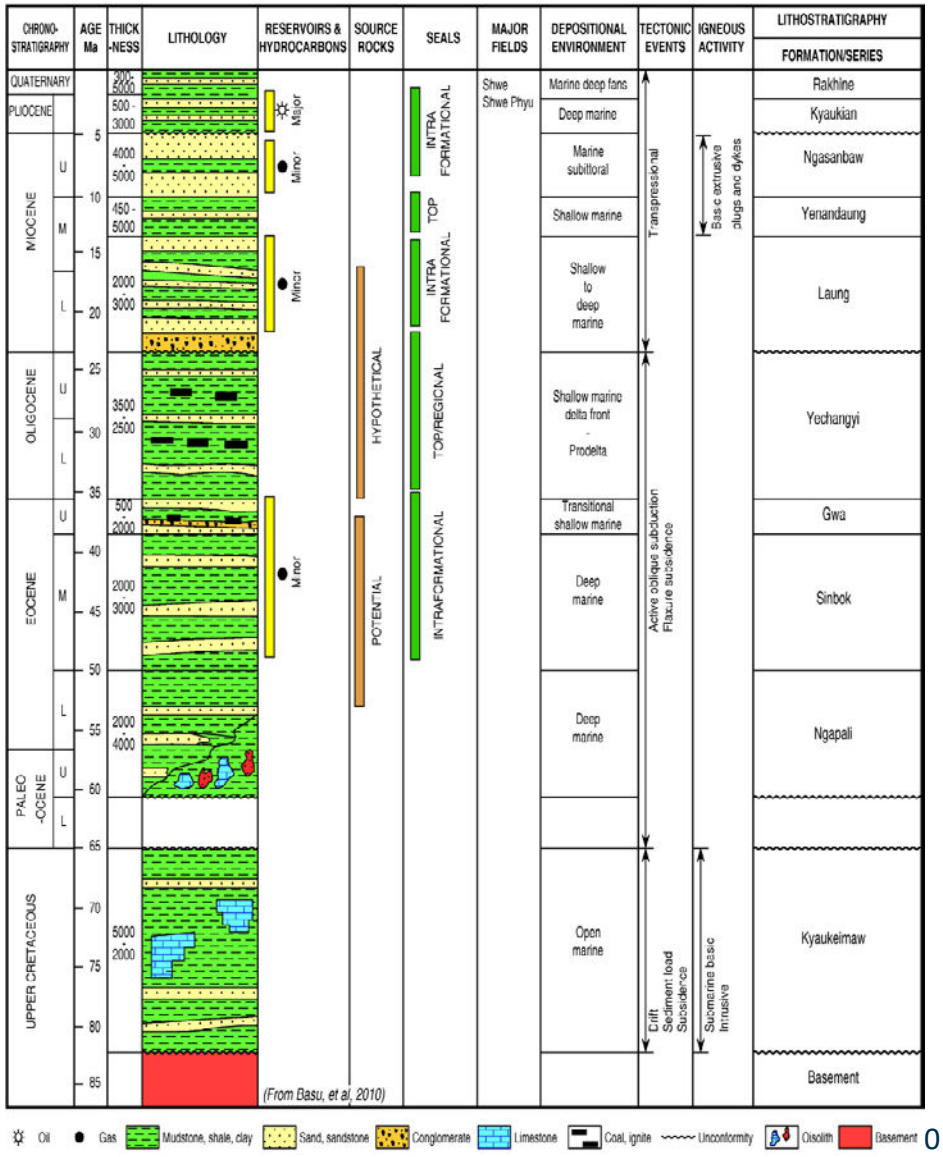




Petroleum systems

Three Petroleum Systems

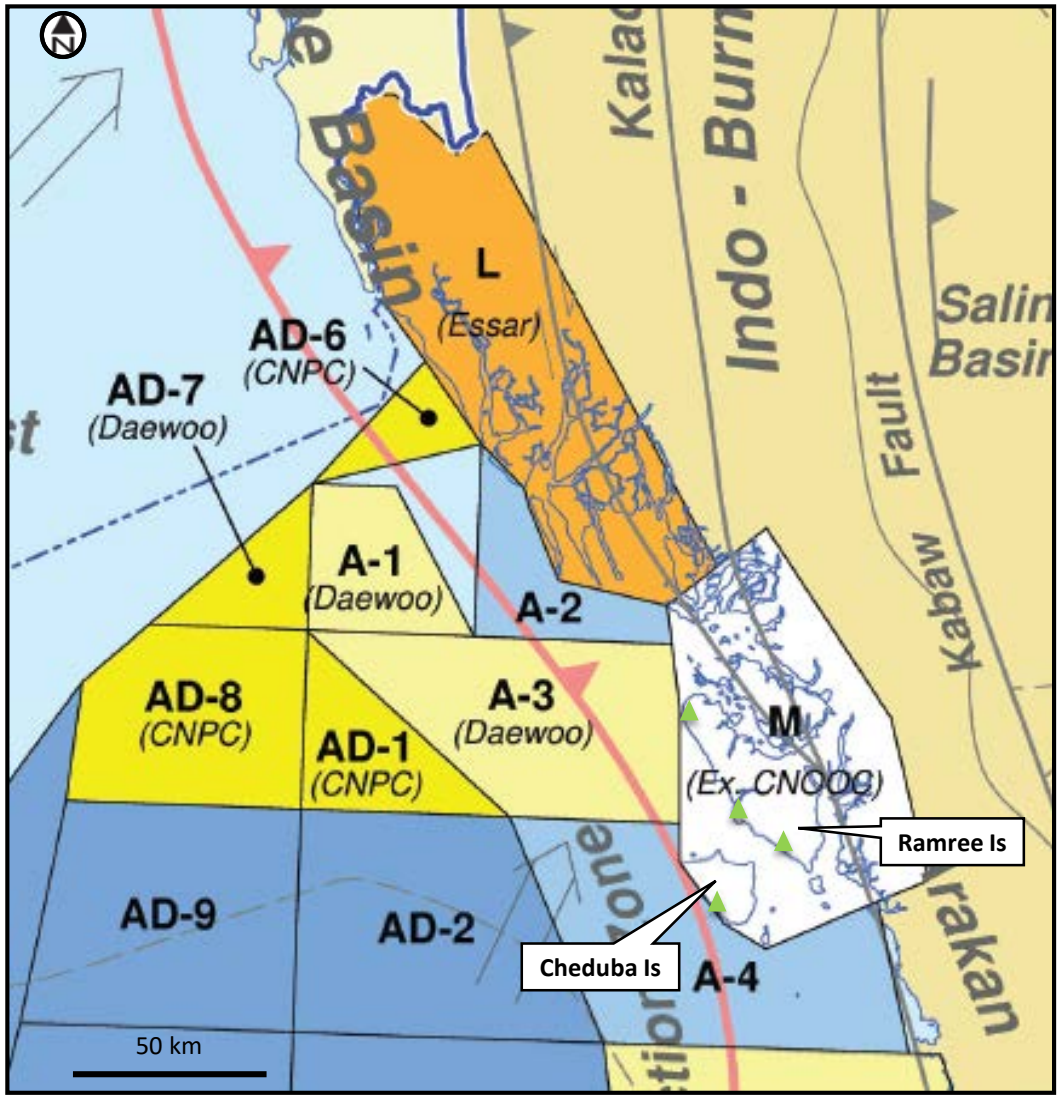
- Pliocene/Pleistocene Biogenic Gas – Shwe area
  - Miocene to Pleistocene section is immature for hydrocarbon generation
  - Modelling suggests gas generated from Mid Miocene to Early Pliocene shales
  - Pliocene reservoirs and seals
- Eocene/Miocene Oil-onshore/near-shore area
  - Oil on Ramree and Cheduba Islands produced from Late Miocene sands
  - Miocene and older aged source rocks capable of producing oil
- Late Cretaceous Oil and Gas – hypothetical
  - Postulated source rocks in restricted rift basin shales
  - Seismic data suggests potential oil mature source rocks
  - Reservoirs and seals in rift sequences and overlying Tertiary



Exploration history

Onshore

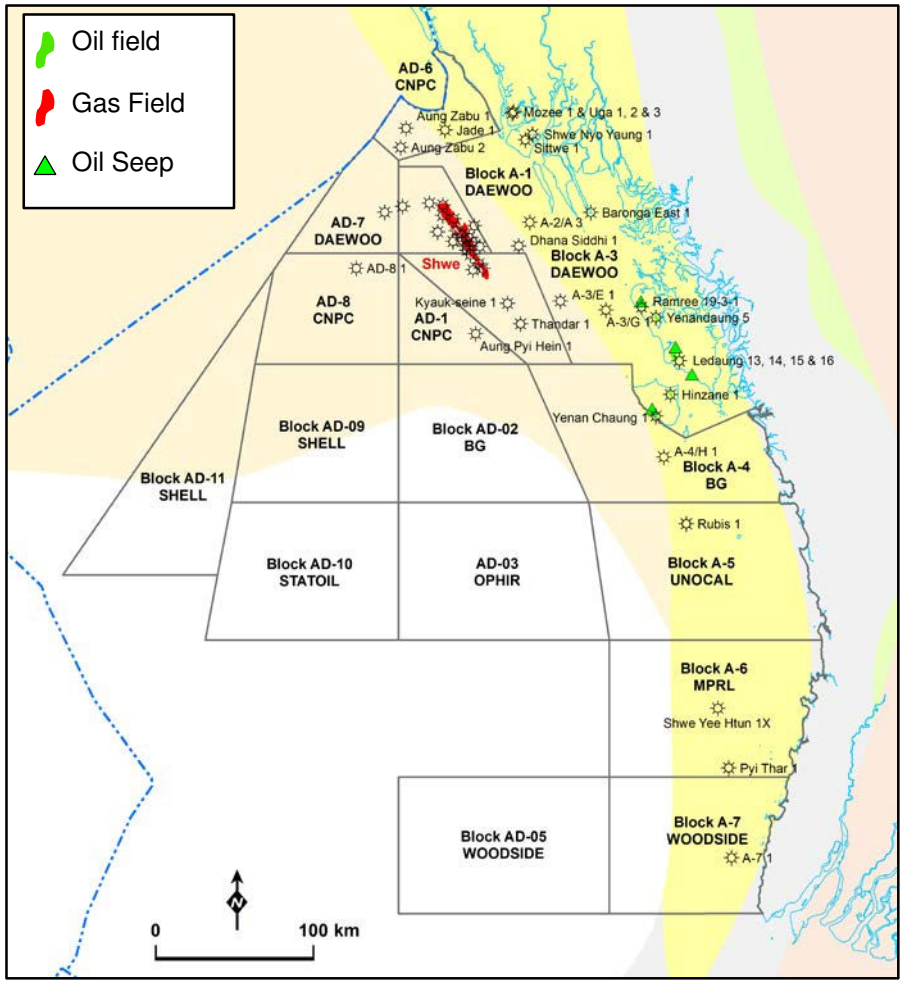
- Oil seeps on Cheduba and Ramree islands
- Oil has been mined onshore since 1870's
- There are over 5000 wells with an average depth of 60m
- Essar acquired 3D in Block L in 2008 and drilled 2 wells in 2009
- CNOOC acquired 2D seismic in Block M and drilled 2 wells in 2006/07 but relinquished all blocks after drilling



Exploration history

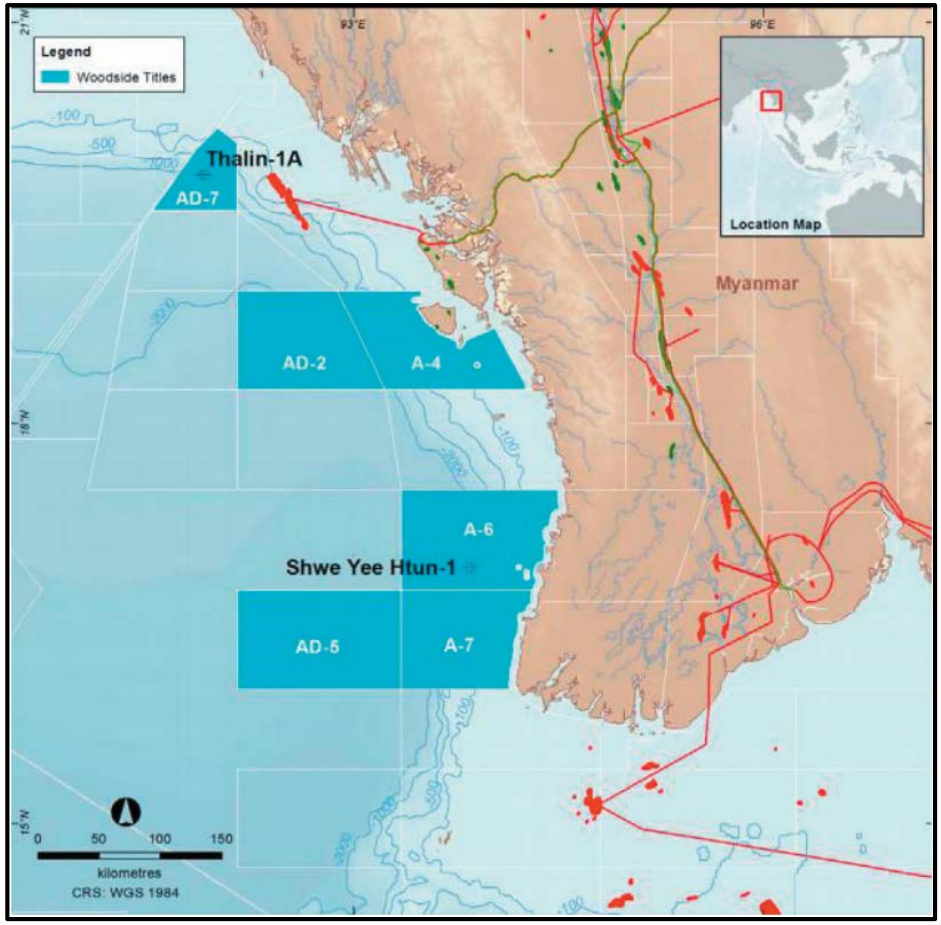
Offshore

- 1970's
  - Arrakan Oil drilled 4 wells (3 with gas shows), 1975/76
  - Total drilled 2 wells (1 with good oil/gas shows)
  - Cities drilled 1 well (dry) in southern offshore
- All 1970's licensed blocks were surrendered
- 1980's & 1990's Exploration hiatus
- 2000 - Daewoo drilled Shwe gas discovery well in 2002
- 2007
  - Daewoo signed PSC for A-3 & AD-7
  - CNPC awarded AD-1, -6, & -8
  - ONGC awarded AD-2,-3 & -9 but relinquished in 2011
- 2013/14
  - Offshore Myanmar bid round with 30 blocks offered
  - 6 Deepwater AD blocks awarded in the Rakhine Basin to Shell, Statoil, BG, Woodside and Ophir in 2014
  - 3 Shallow water blocks awarded in the Rakhine Basin to BG, UNOCAL and Woodside



Exploration History

- 2015/16
  - Woodside discovered gas in the Shwe Yee Htun-1 well in A-6 and in the Thalin-1 well in Block AD-7
  - Extensive 2D and 3D data is currently being acquired
  - PGS Ramform is towing a record 18 streamers and getting the cost of 3D down to US$7000 per Km^2
  - Acquisition rates have been up to 160 Km^2 per day (Woodside)
  - Block wide 3D data acquisition has become common



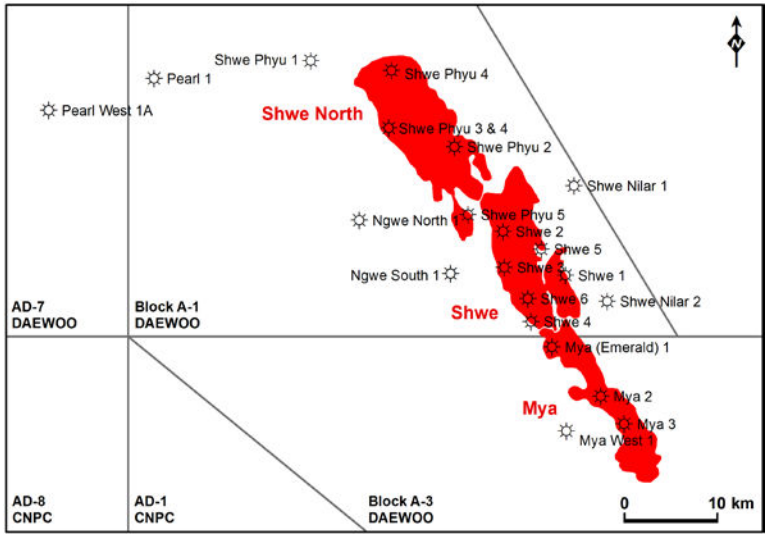
Source: PESA News

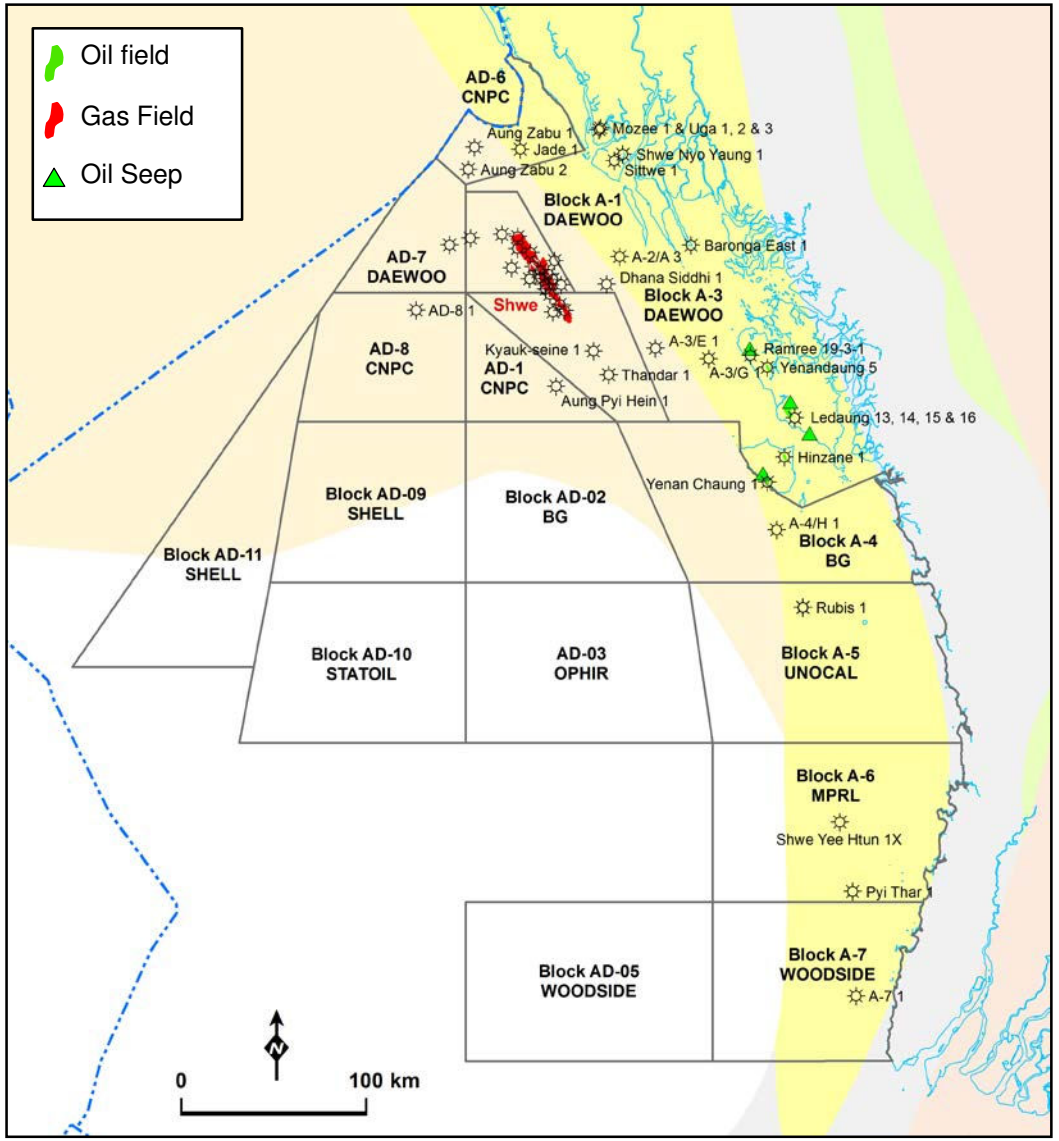
Well data base

Wells

Exploration wells:

- 16 (approx.) onshore
- 33 offshore exploration/appraisal wells
- All wells drilled in water depths <1,500 m
- Approximately 13 appraisal wells have been drilled in the Shwe, Shwe Phyu and Mya field areas.

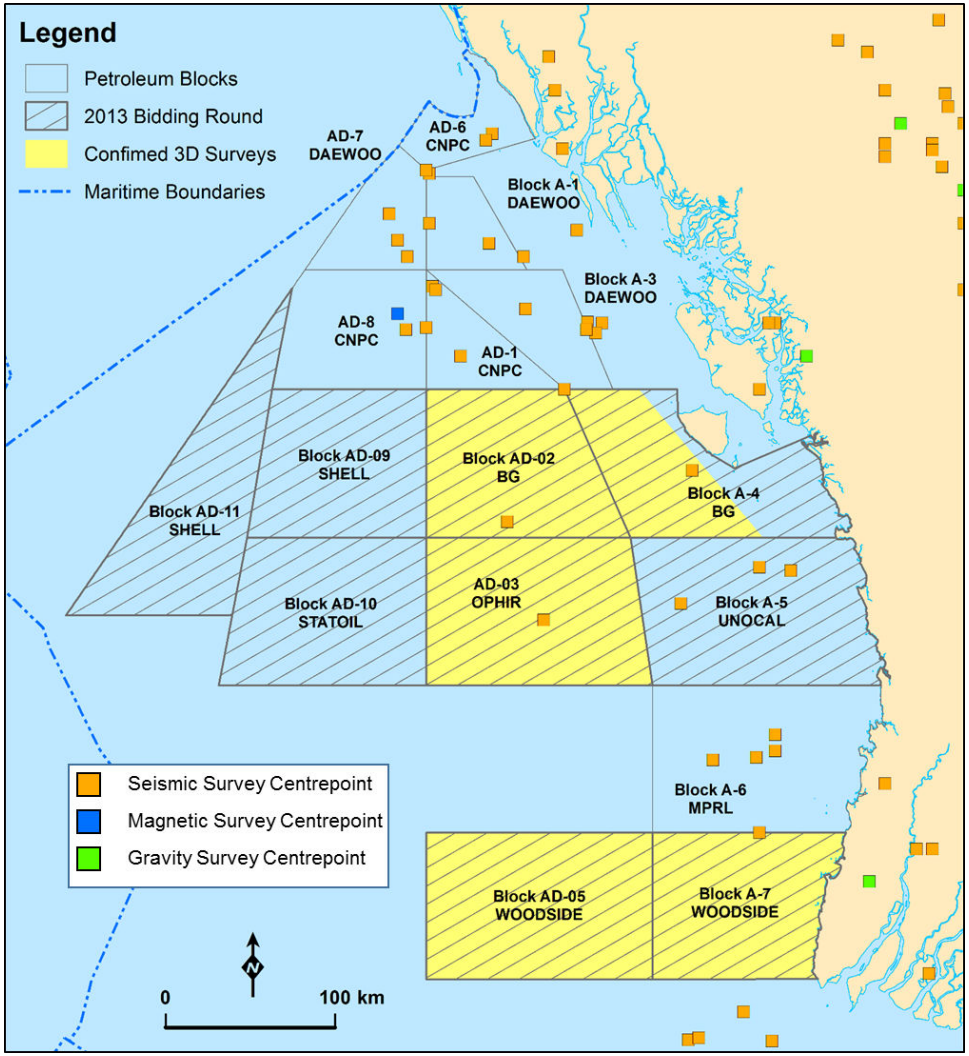




Seismic data base

Seismic Data

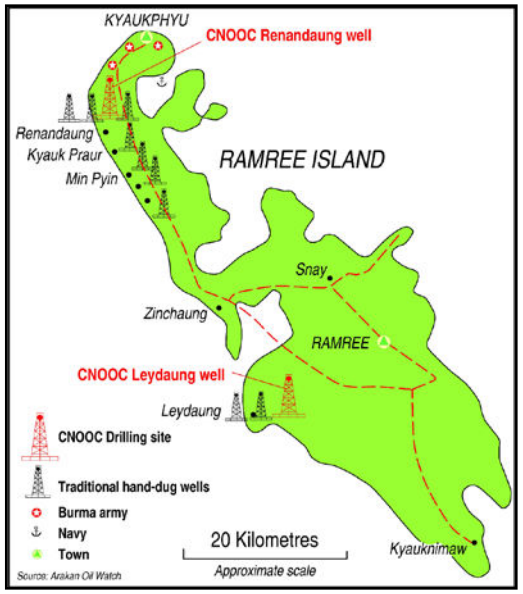
- Extensive 2D seismic data has been recorded
- A small number of 3D seismic surveys recorded
  - Daewoo across A-1 and A-3
  - The Shwe 3D (1,195 km^2)
  - Ophir have just acquired a block wide 3D survey (10,000 km2)
  - Woodside and BG are also shooting block wide 3Ds
- Most of the seismic data has not been made publicly available



Onshore discoveries and fields

Onshore

- Oil Fields on Boronga, Ramree and Cheduba Islands with production in 1925 of 1.7 BOPD from Ramree Is
- Yenandaung Oil Field in the northwest part of Ramree Is is a typical onshore field
  - Oil known from 1870's
  - Average depth of production 60m
  - Approx. 400 wells producing 8.6 BOPD in period 1876-1886
  - Estimated total production to 1981 was 730,000 bbl

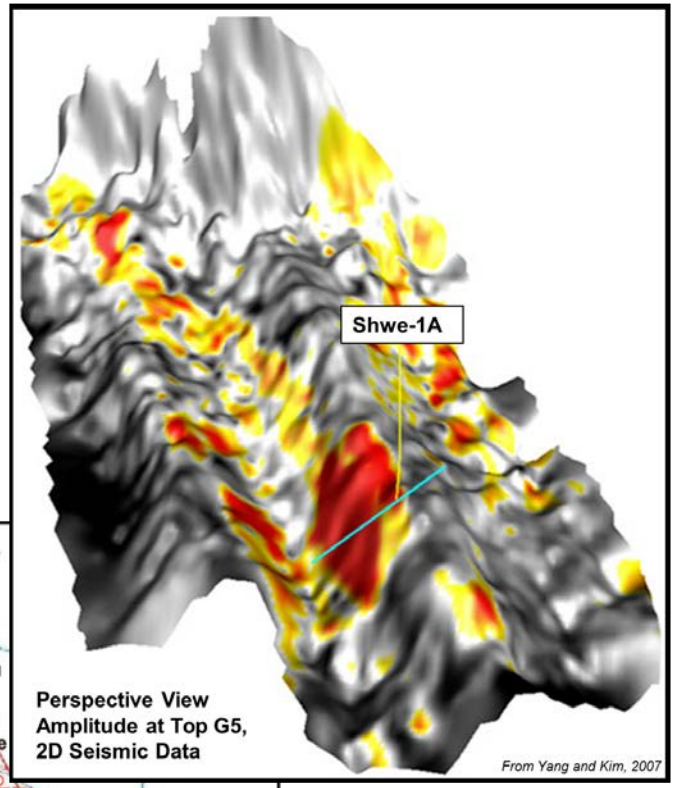


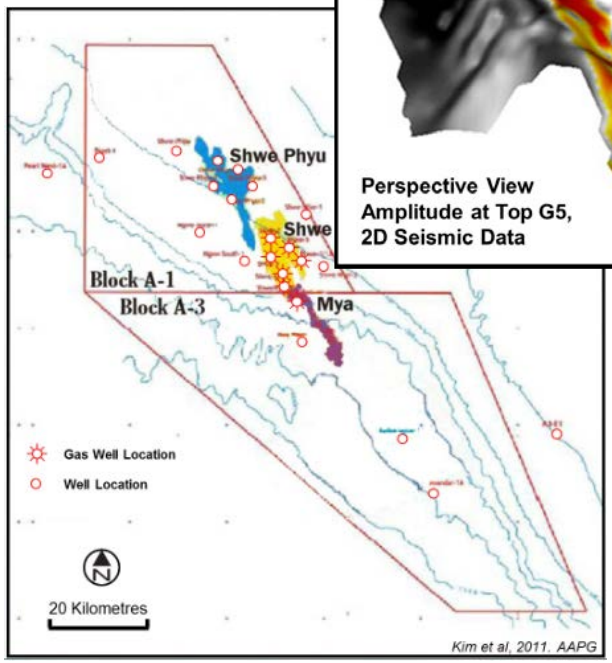
CNOOC Rig at Renandaung-1 next to Traditional Hand Dug Wells

Offshore discoveries and fields

Offshore

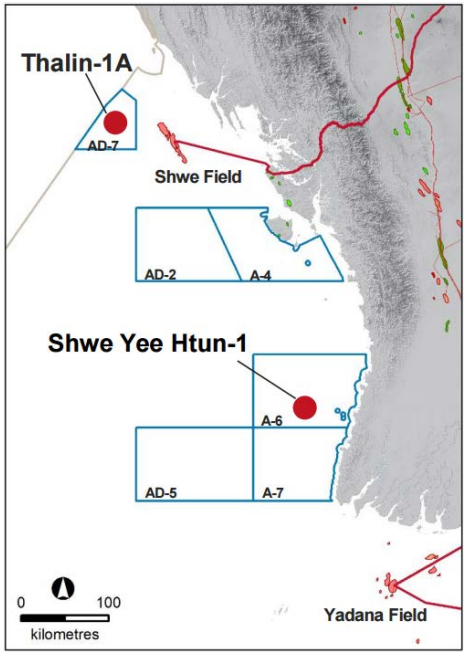
- Shwe, Shwe Phyu and Mya gas fields
  - Shwe-1ST1 gas discovery 2002, after vertical well devoid of reservoir
  - Drilled Shwe Phyu gas discovery in 2005
  - Drilled Mya gas discovery in 2006
  - Reservoir – Early Pliocene deep water turbidite sands
  - Trap – Structural / stratigraphic trap on SE plunging nose
  - Seal – Interbedded Pliocene shales
  - Source – Biogenic gas from Mid Miocene shales – dry gas > 99% methane
  - GIIP – 1P: 3.37 Tcf, 2P & 3P: 5.72 Tcf
  - Shwe production platform in 105m water and a 111 km/32” pipeline to shore
  - Shwe began production in 2013
  - Shwe exports ~400 mmcfd to China

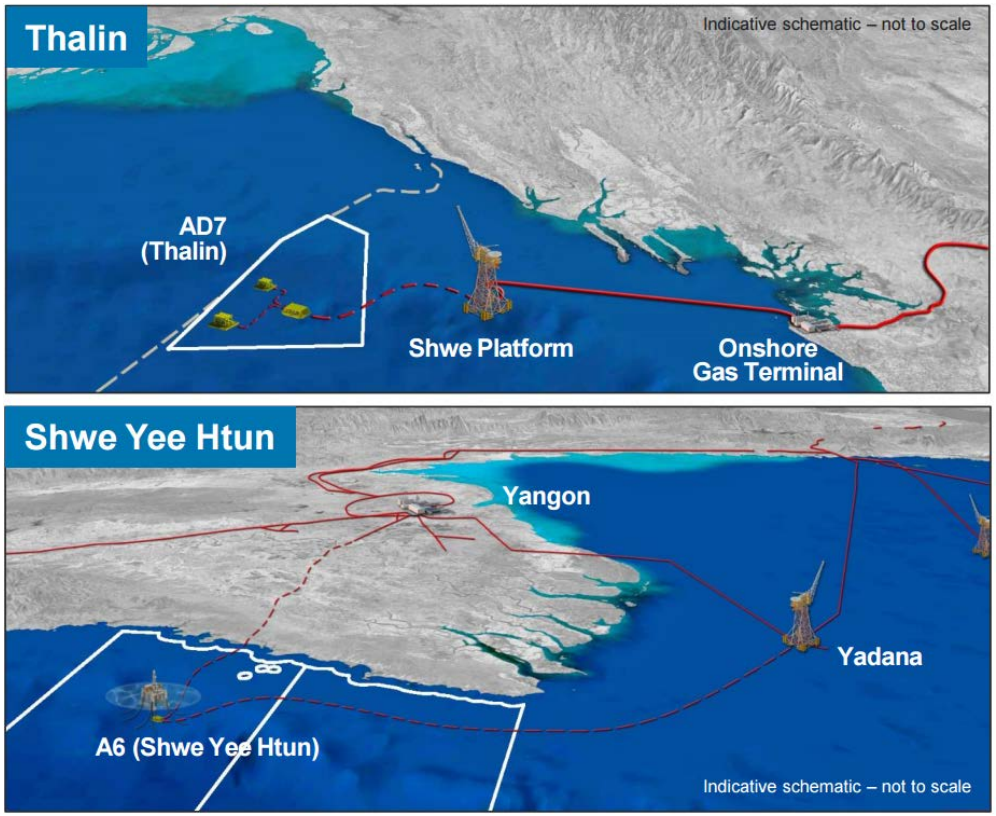




Woodside's Discoveries

- Discoveries
  - Thalin-1A, 62m gas pay, 1.5 Tcf 2C gross, appraisal drilling planned, development via tie back to Shwe Gas Field, additional 320 mmscfd train
  - Shwe Yee Htun-1, 32m gas pay, 0.9 Tcf 2C gross, appraisal planned, development via tie back to Yadana Gas Field or standalone.

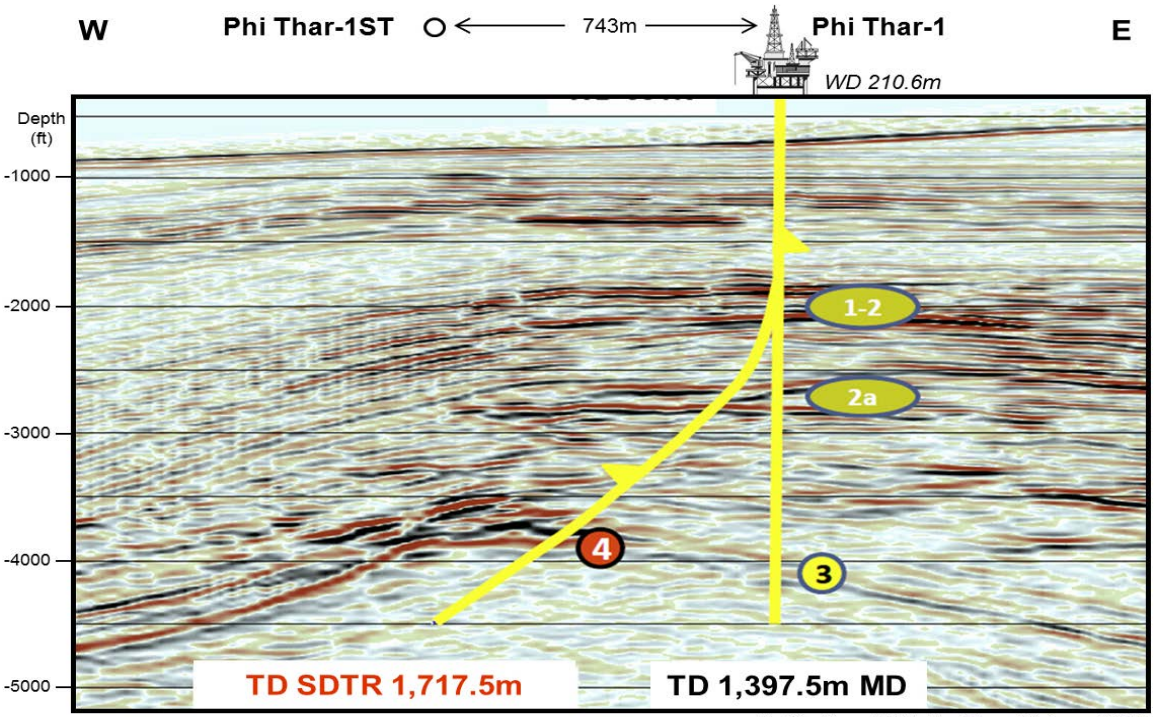




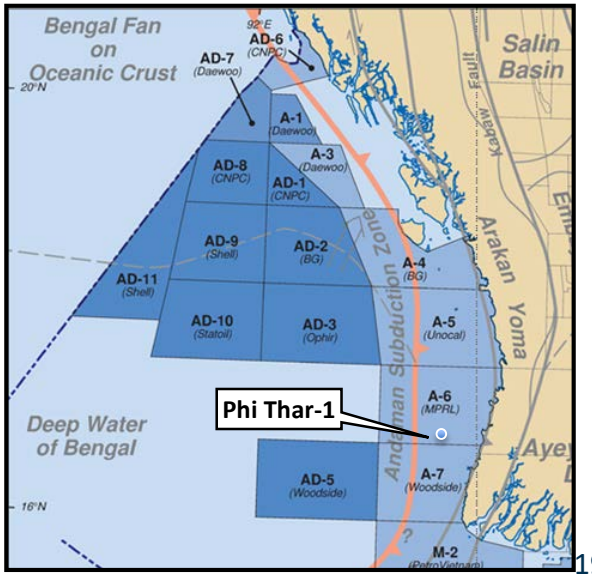
Woodside, 20 May 2016 Investor Presentation

Prospectivity of the Rakhine Basin/Bengal Fan

- **Near-shore oil petroleum system**
  - The extent of the near-shore oil play is unknown but very likely extends across much of the shallow water areas
  - The area is structured into a series of en echelon anticlinal trends along which discrete structural closures are likely.



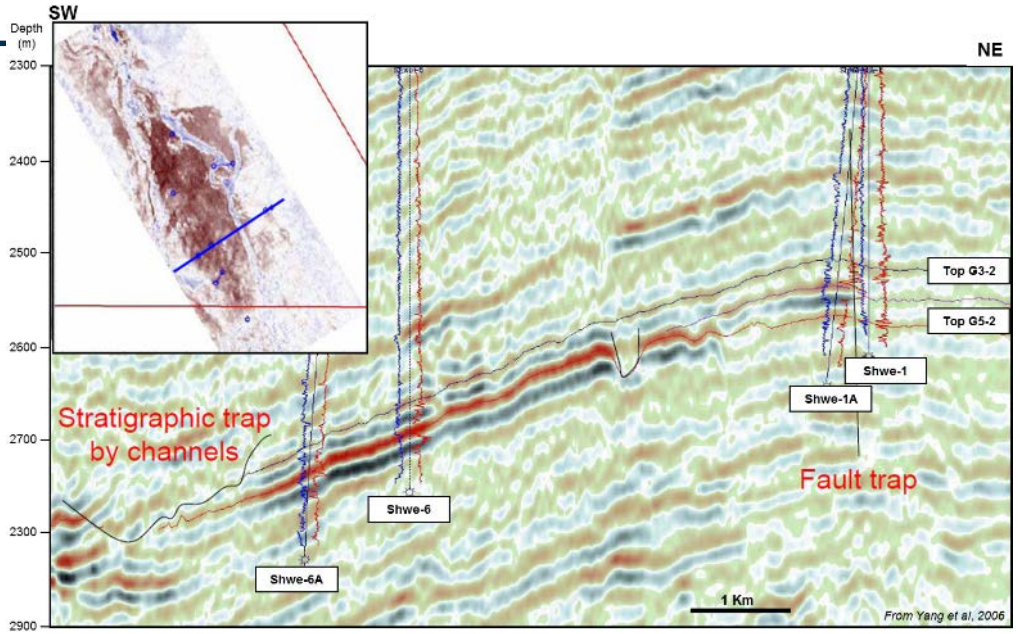
Modified from MPRL Roadshow, 24 August 2012

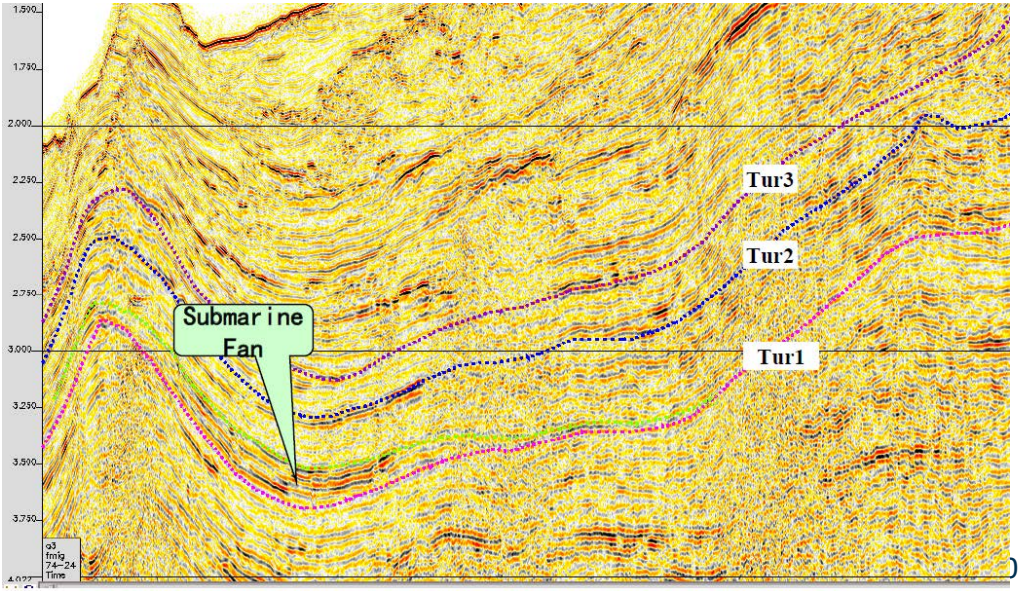


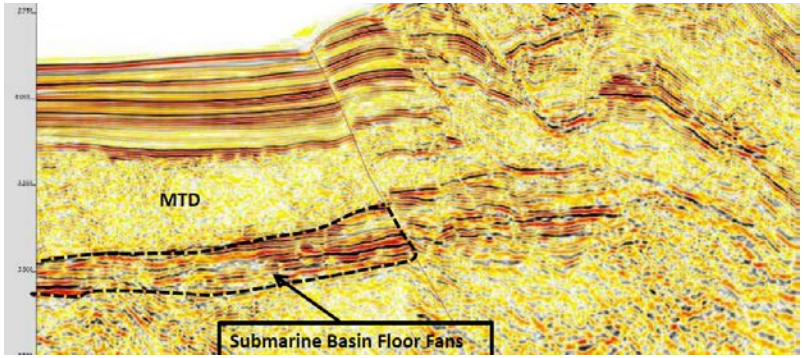
Prospectivity of the Rakhine Basin/Bengal Fan

Rakhine Basin/Bengal Fan

- **Offshore Biogenic gas petroleum system**
  - The biogenic gas play developed in Bengal Fan sediments is proven in the Shwe area.
  - The three known fields are genetically related, being all part of the same Pliocene turbidite complex.
  - Pliocene turbidite complexes exist across the Bengal Fan and are easily interpreted on 3D
  - Mass Transport deposits are not usually good reservoirs but the turbites that pond on them can be





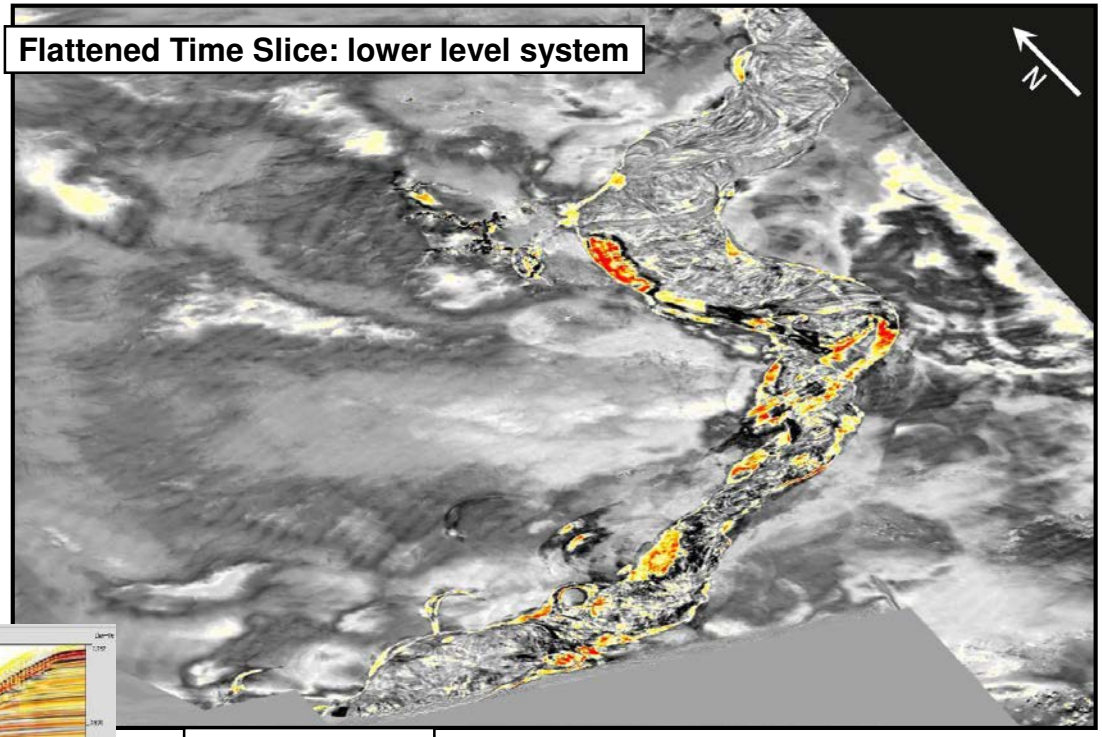


Source: MOGE, U Lynn Myint

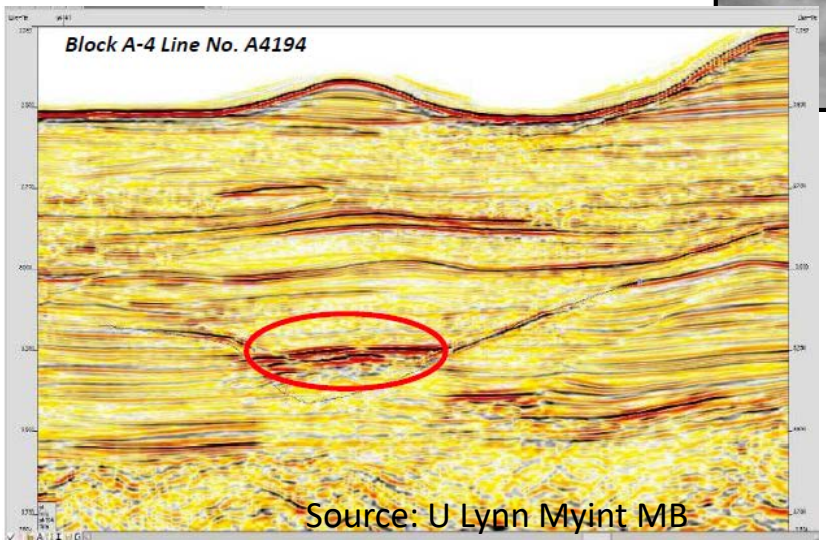
3D Seismic Data: A game changing step : Offshore case

3D Seismic Survey: Imaging is key

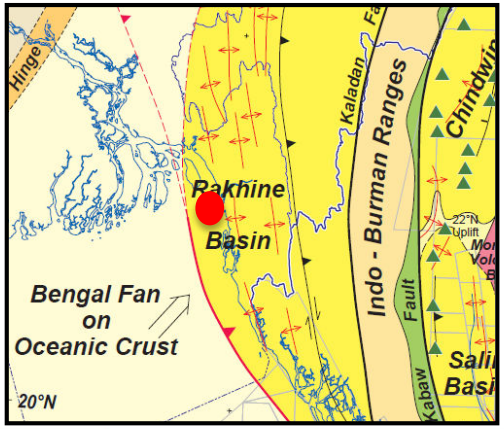
- Imaging of depositional systems on flattened time slices and coherency cubes
- Interpretation of environment of deposition greatly assists in reservoir predictions and characteristics
- A seismic sequence stratigraphic approach using 3D can define new plays
- 3D is a valuable tool for reducing the key geological risk of reservoir presence and quality



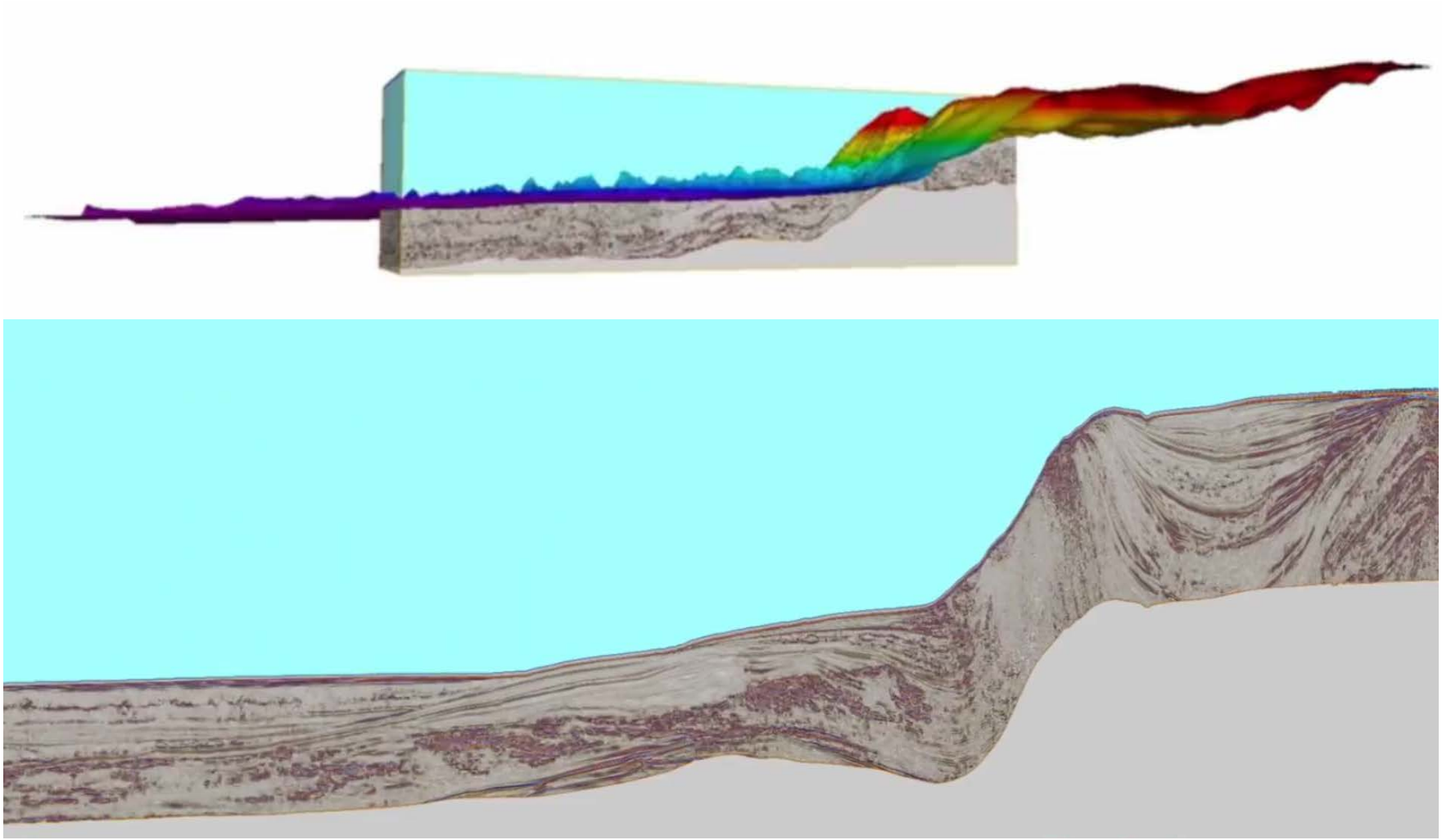
P Strong SEAPEX 2013



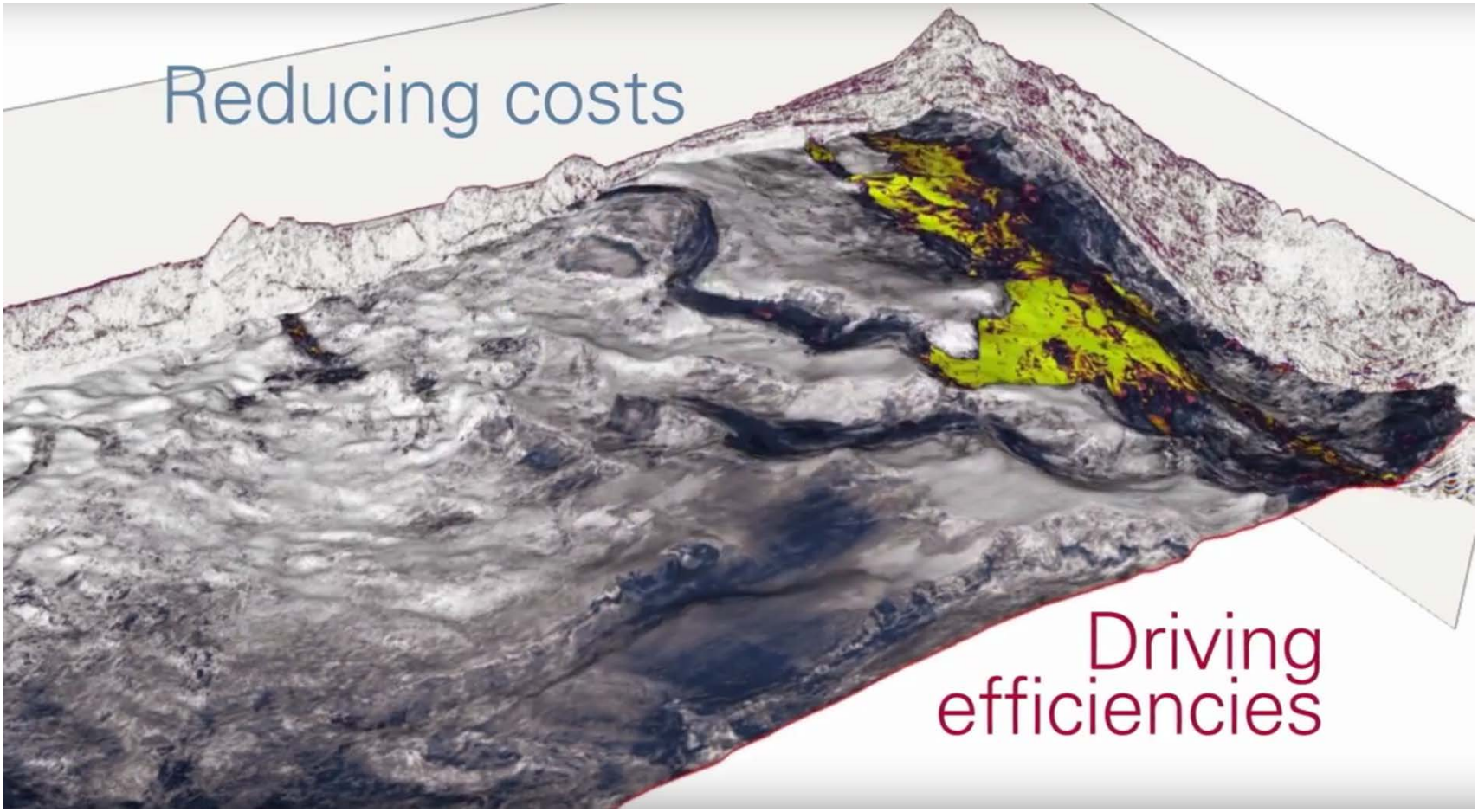
Source: U Lynn Myint MB



Woodside's Latest Data

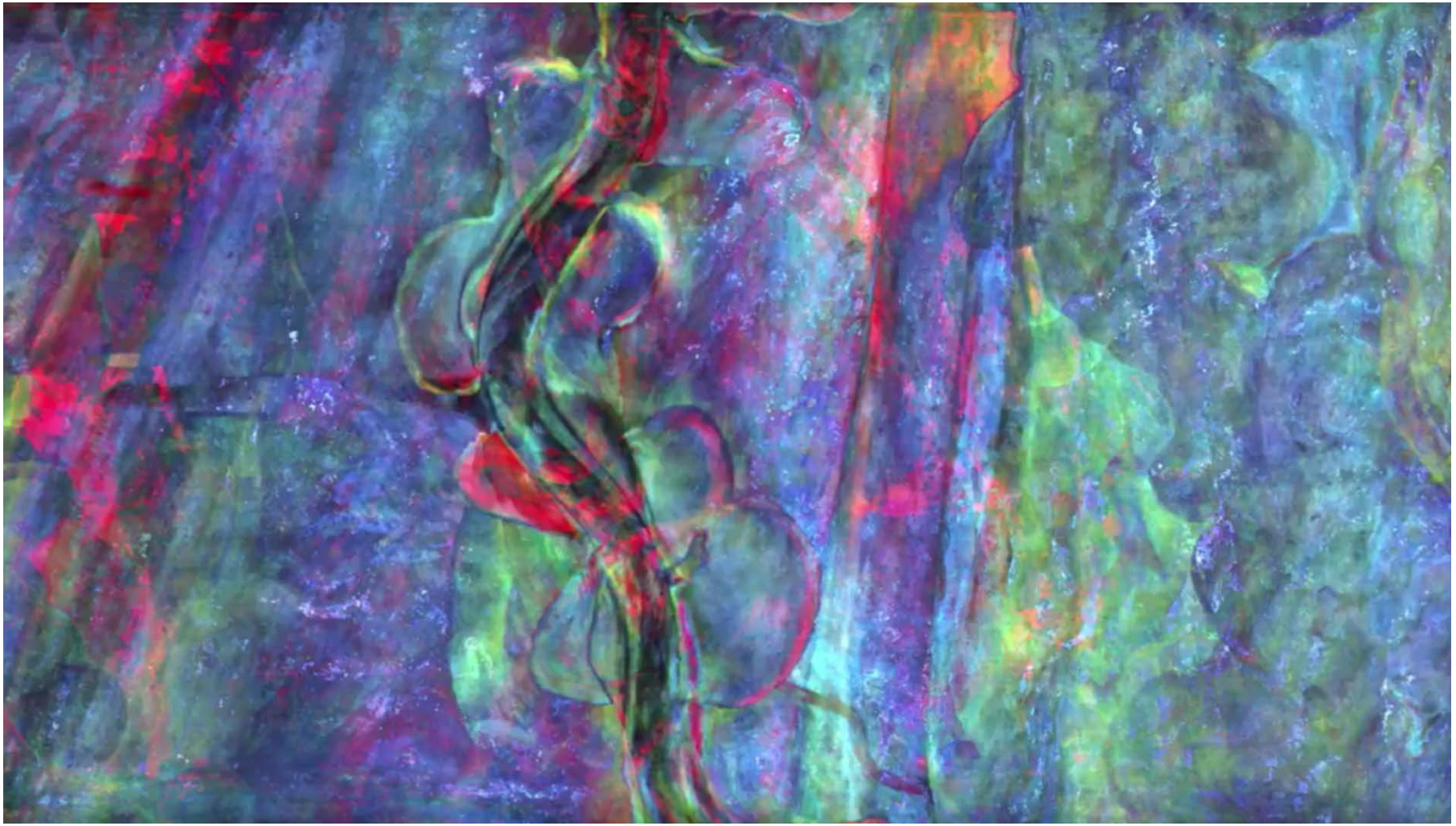


Woodside's Latest Data

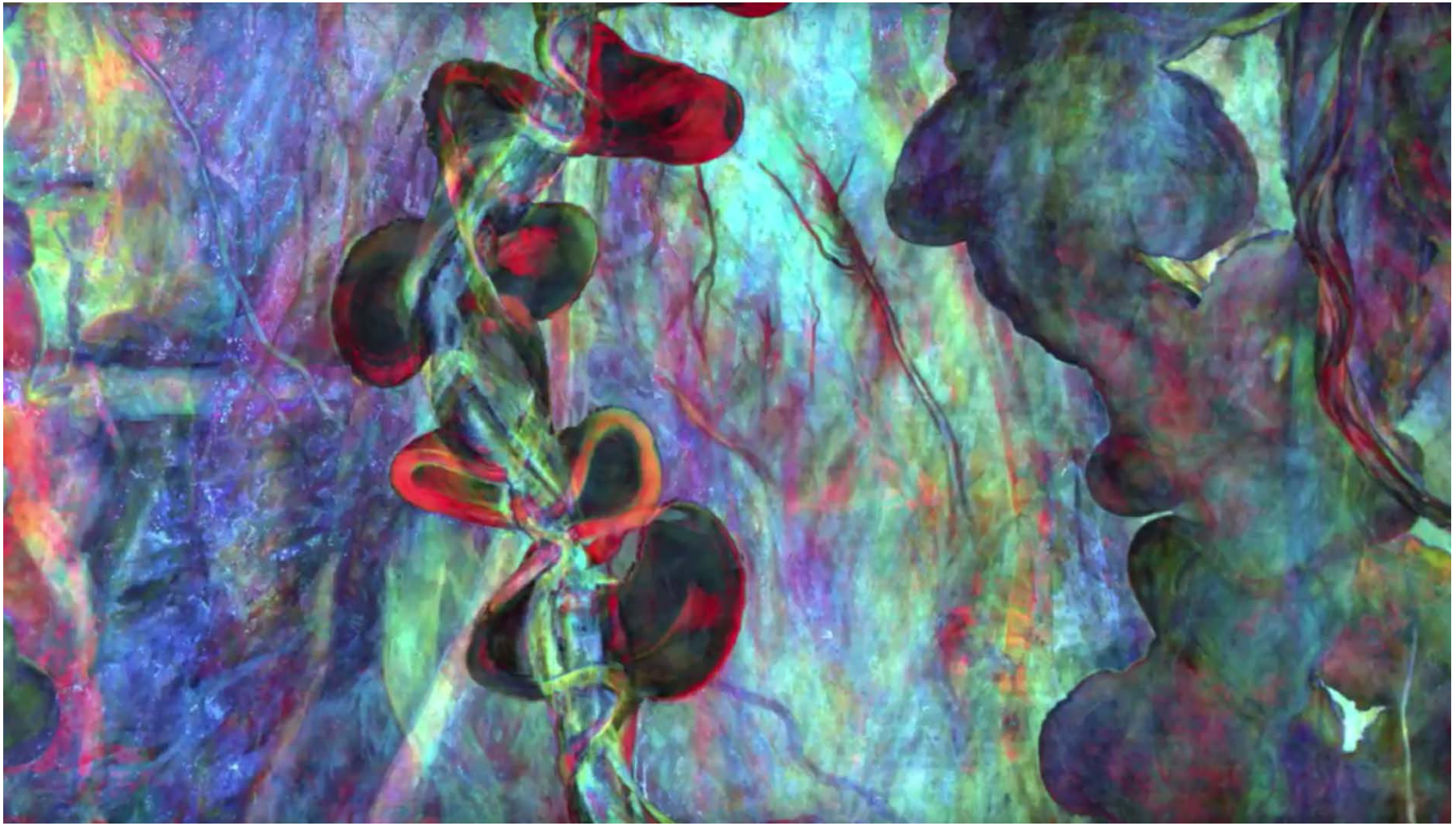


Woodside's latest data

Woodside's latest artwork



Woodside's latest Artwork



http://youtu.be/v5gHjPyG_VI

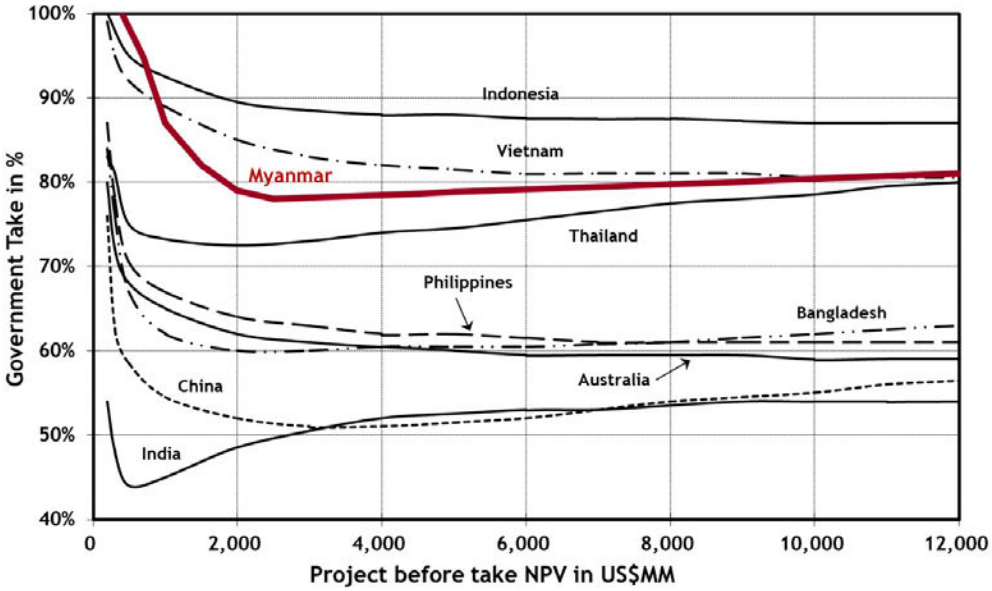
Economics

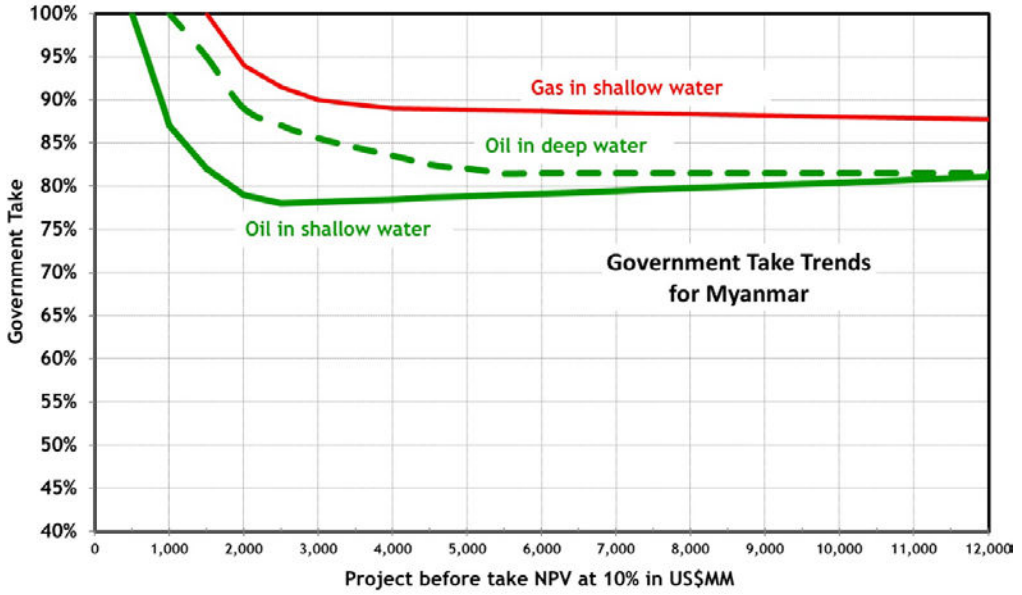
Myanmar's fiscal regime is one of the toughest in the region. It consists of:

- Significant signature bonuses
- 12.5% Royalty
- Cost Recovery at 70-50% depending on water depth
- Production splits of 65-80% to Myanmar dependent on production rates
- Production bonuses,
- 20-25% domestic requirement
- 20-25% State participation right
- Corporate and Capital gains tax

Total Government take for oil in shallow water is around 80% and in deepwater marginally higher.

For gas it is close to 90% in shallow water.

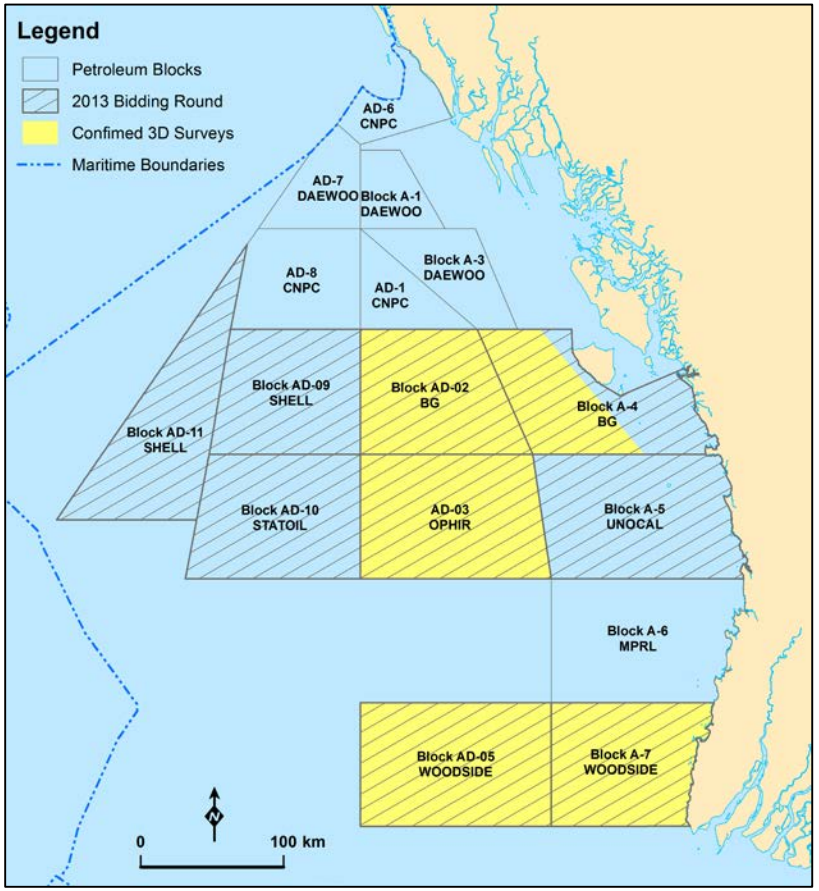




Conclusions

Rakhine Basin/Bengal Fan

- Essential for success is to adopt a regional approach
- Not releasing open file exploration data has greatly hampered exploration in Myanmar
- The Rakhine Basin/Bengal Fan is vastly under-explored
- Two proven Petroleum Systems exist, others may be there
  - Pliocene/Pleistocene Biogenic Gas system
  - Eocene/Miocene - onshore/near-shore Oil system
- Reservoir is the primary geological risk for the basin
- The key to unlocking the potential of the basin is modern 3D seismic data, tied to existing well data
- This will allow QI and seismic sequence stratigraphic approaches to define new play fairways
- Fiscal settings need to be adjusted to encourage the next round of exploration in this rank wildcat area
- The current 3D seismic activity will shape our understanding of this basin, pushing out the barriers to successful exploration.



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- RISC management for their support and approval
- SEAPEX for inviting me to present this paper