Exploration of the Rakhine Basin, Pushing Out the Barriers with New 3D*

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Abstract

Building a regional understanding of the Rakhine Basin offshore Myanmar has not been easy for those who entered the Basin in the 2013/2014 bid round. However, the recent frantic pace of seismic acquisition is about to change the understanding of the basin and hopefully unveil its great potential. It has been interpreted from remote sensing and seismic that the Rakhine Basin formed over a converging plate boundary where the mainly oceanic crust of the Indian Plate is being subducted in a right lateral slip motion under the Myanmar portion of the Eurasian Plate. The nearshore and onshore Rakhine Basin developed as an accretionary prism as subduction proceeded from Early Eocene to Present. Beyond the subduction zone to the west, the deep water exploration PSC's cover a vast area of sediments that have been deposited in the Tertiary Bengal Fan. To the north, possible Cretaceous synrift sediments have been interpreted below the fan. These packages may represent remnants of Early Cretaceous rifting and subsequent fill in the Late Cretaceous associated with Greater India's separation from Gondwanaland and subsequent northward drift.

Selected References

Jain, Mukesh, Prabal Shankar Das, and Bidesh Bandyopadhyay, 2010, Structural framework and deep-marine depositional environments of Miocene- Pleistocene sequence in Western Offshore Myanmar: 8th Biennial International Conference & Exposition on Petroleum Geophysics, Hyderabad, India. Web accessed May 20, 2016.
http://www.spgindia.org/2010/058.pdf

Kim, Dongil (David), Su-Yeong Yang, and Jaewoo Kim, 2012, Geological Modeling with Seismic Inversion for Deepwater Turbidite Fields Offshore Northwestern Myanmar: AAPG Search and Discovery Article #40877.
Maurin, Thoman, and Claude Rangin, 2009, Structure and kinematics of the Indo-Burmese Wedge: Recent and fast growth of the outer wedge: Tectonics, v. 28/2, p. Web accessed May 20, 2016.

http://onlinelibrary.wiley.com/doi/10.1029/2008TC002276/epdf

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

Presented by: David Cliff
Co- Author: Paul Carter
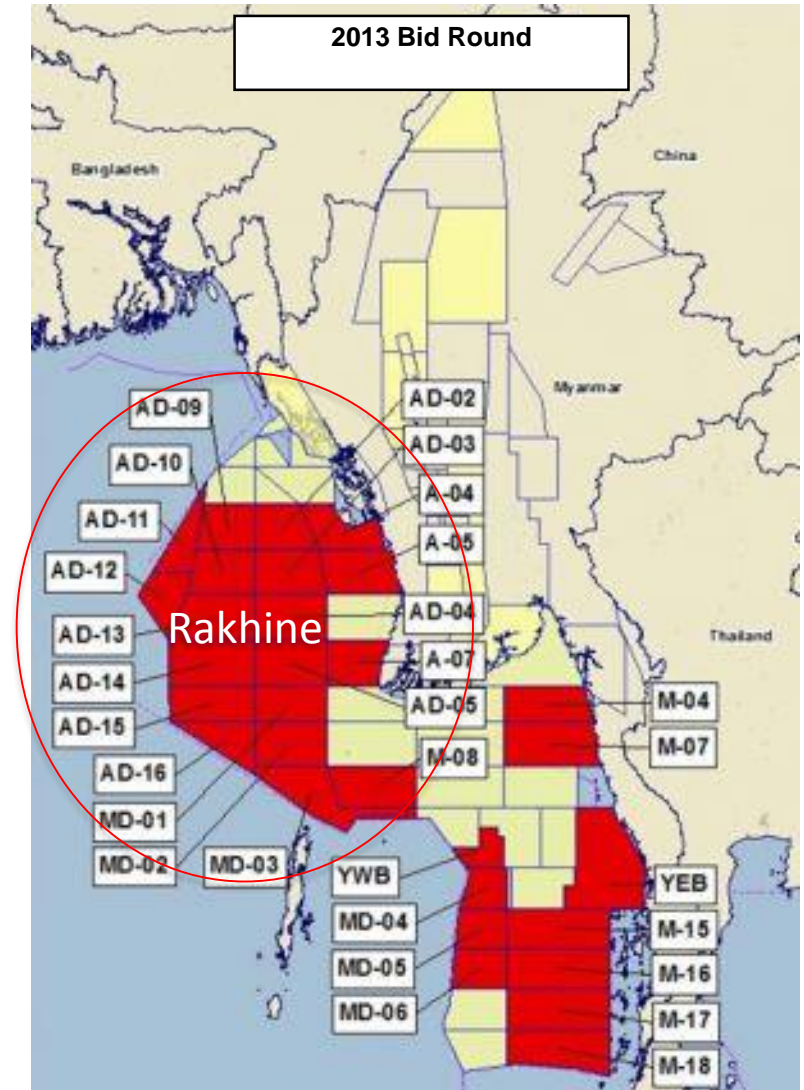
AAPG/EAGE/MGS Yangon
November 2015

RISC

decisions with confidence

# 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)
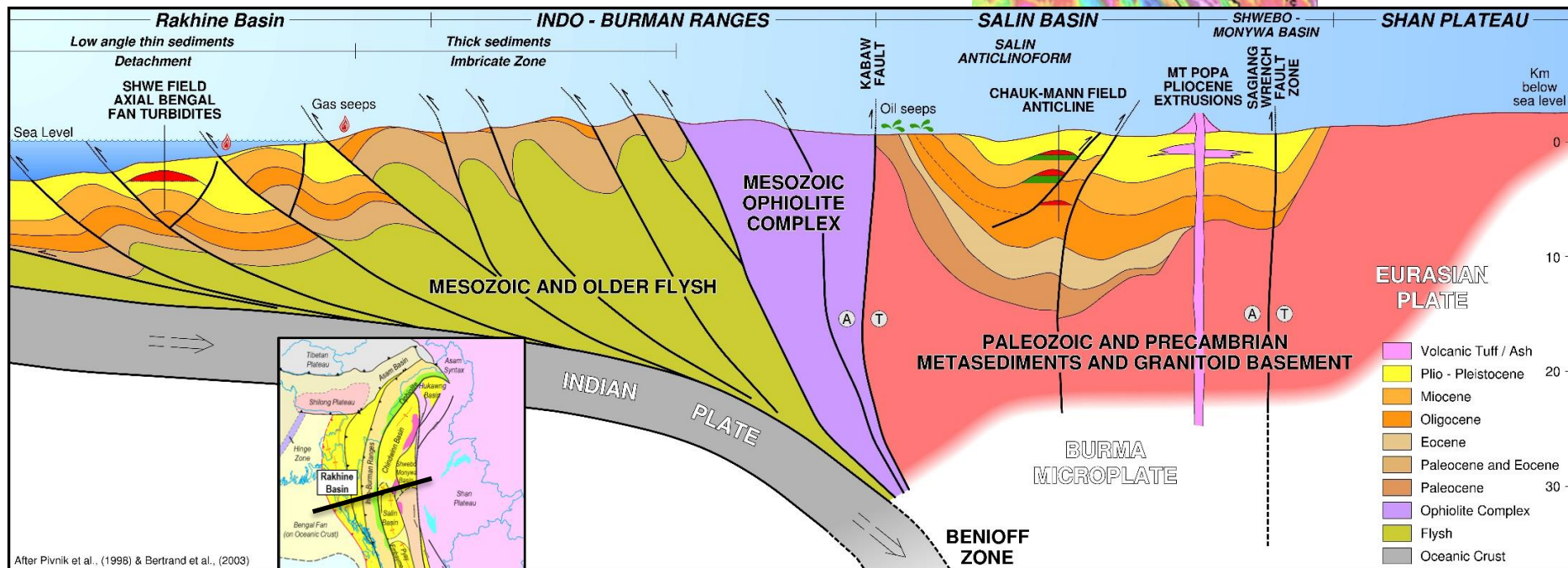- Moattama (or Martaban) Basin (offshore)
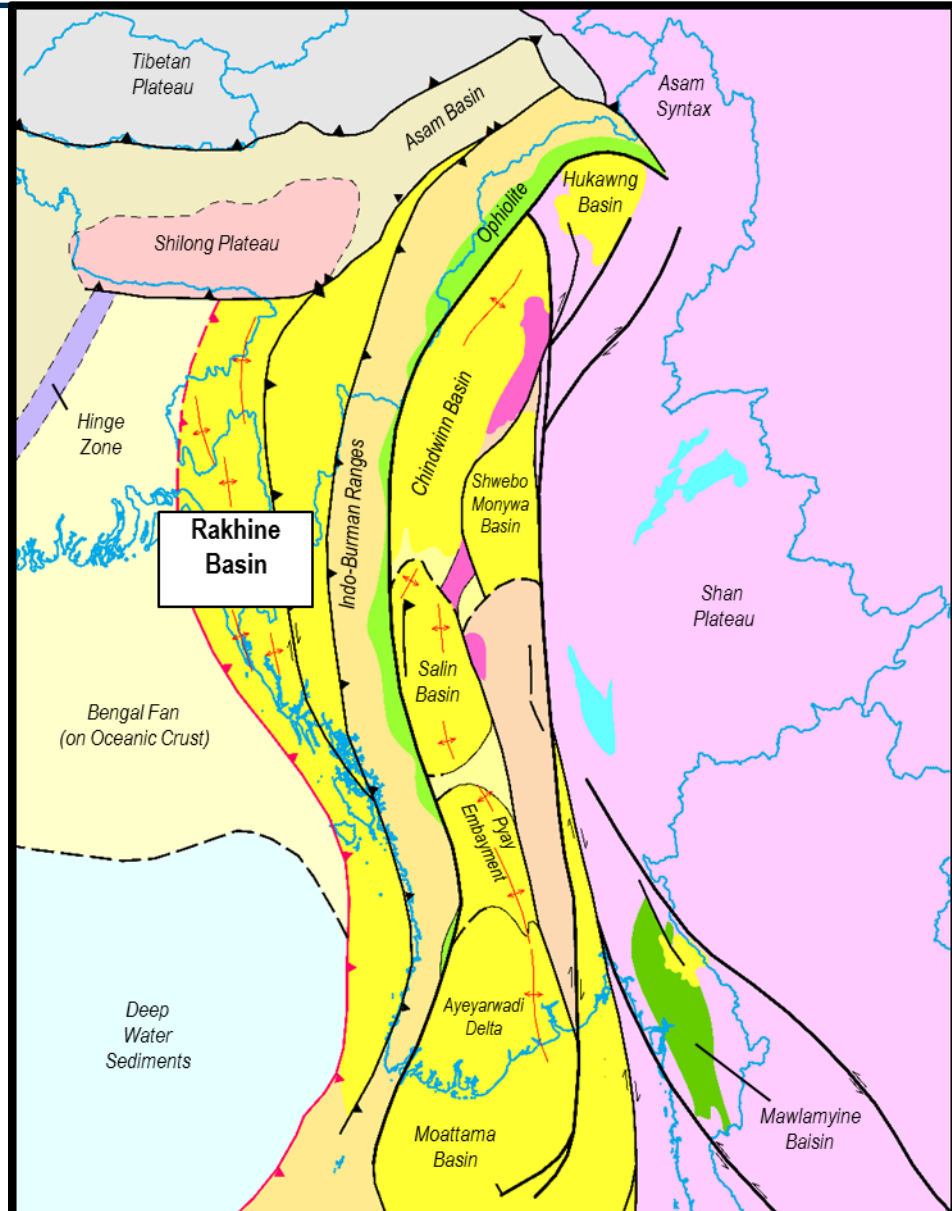
Regional geology

- 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
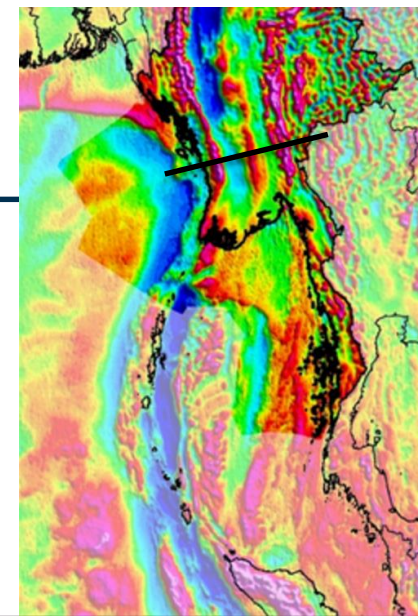
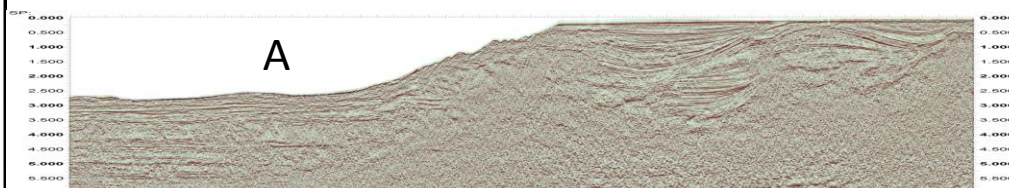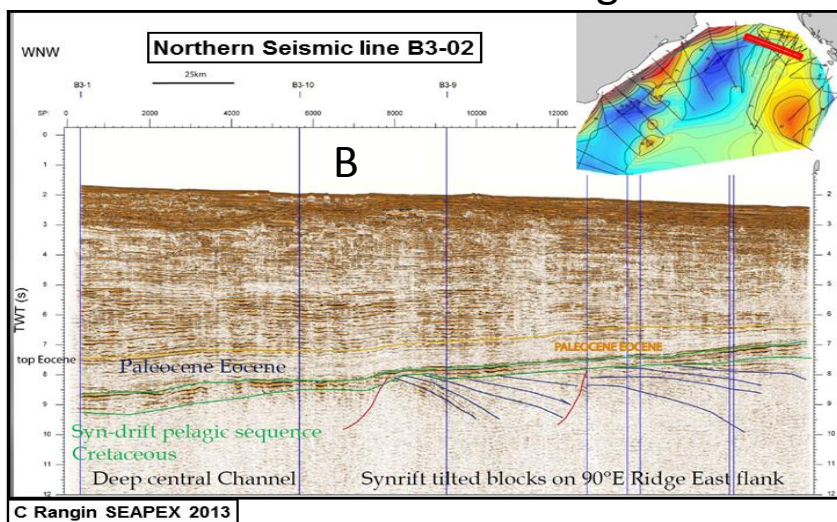Extract from Satellite Free-Air Gravity Image. FROGTECH

Rakhine Basin/Bengal Fan regional setting
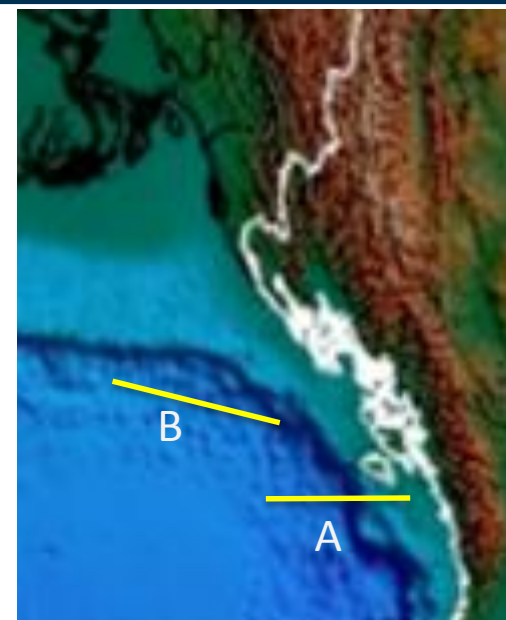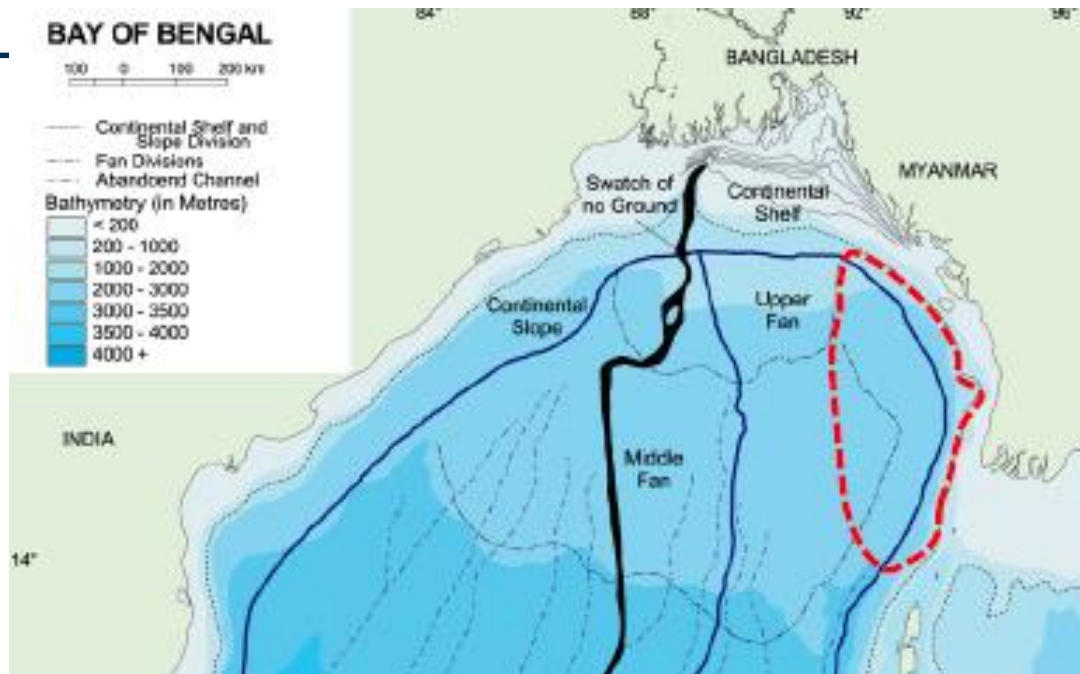
Bengal Fan

Rakhine Basin
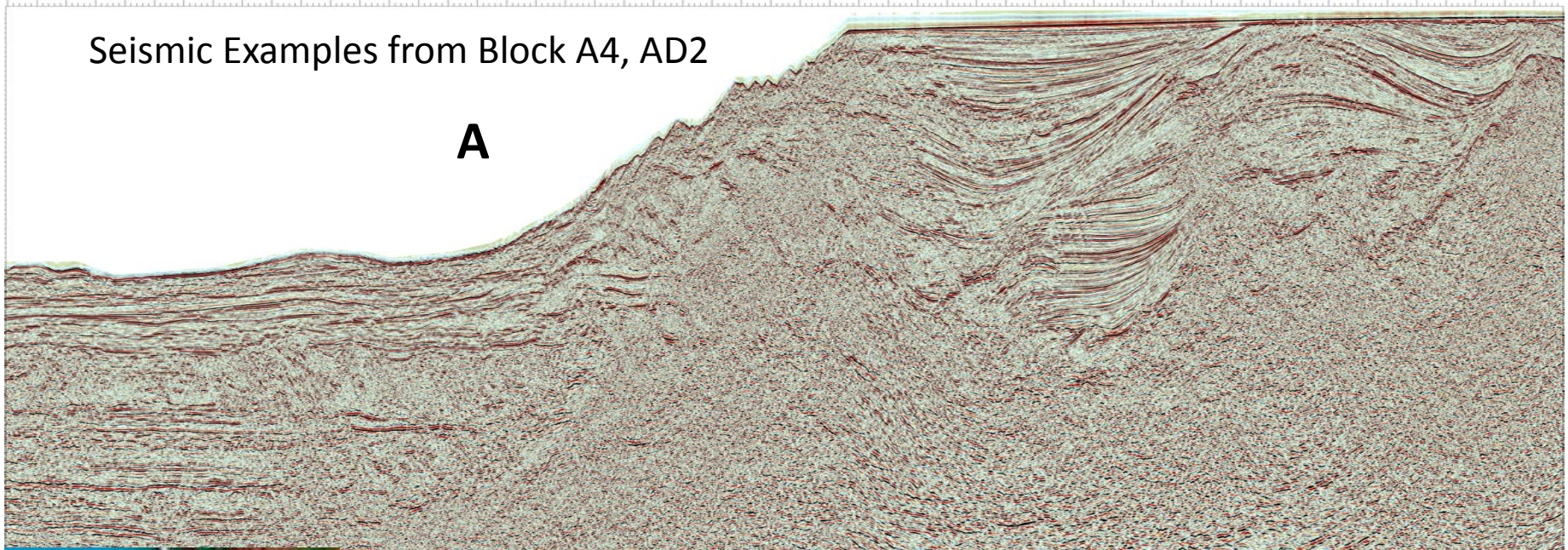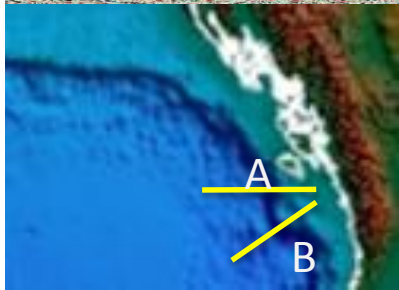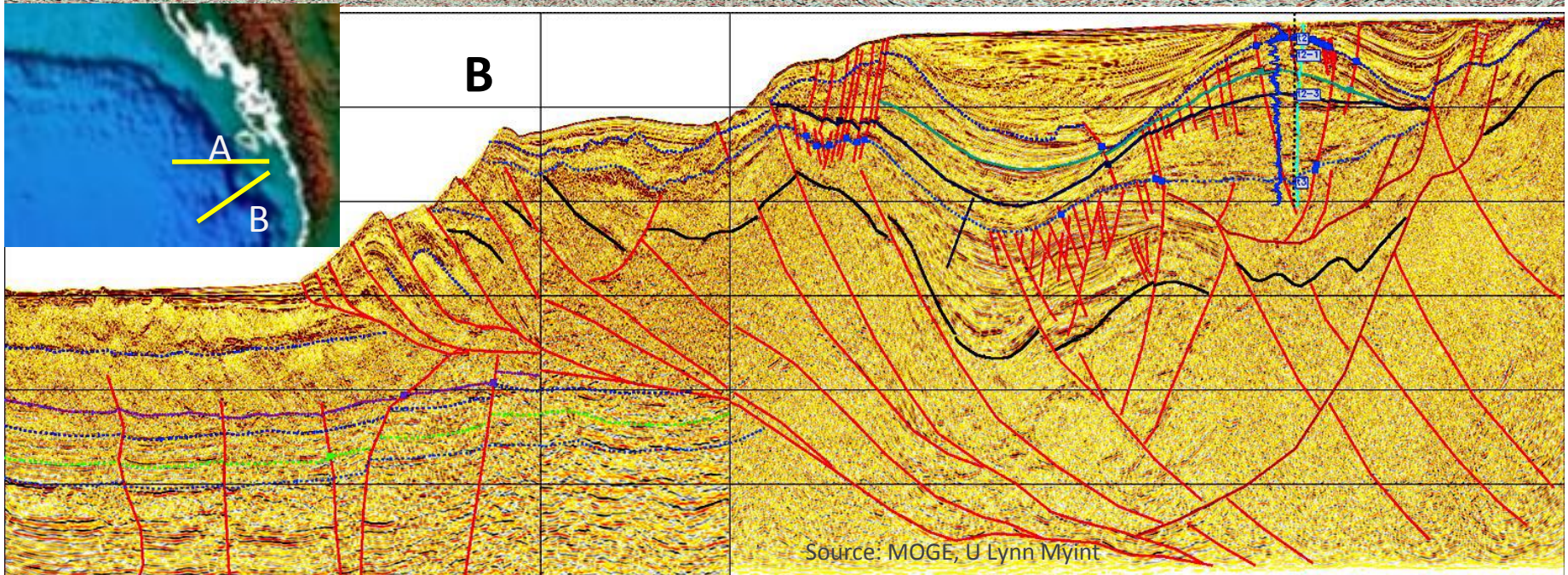
Seismic Examples from Block A4, AD2

A

B

Source: MOGE, U Lynn Myint

Rakhine Basin regional setting

Onshore/offshore Rakhine Basin

From Jain et al, 2010

Bengal Fan regional setting

Source: Quora User

Bengal Fan regional setting

Bengal Fan regional setting

Southern Seismic line M-01

Reprocessed

SEARCHER SEISMIC

6 km

8km

Cretaceous sediments ?

Basement

C Rangin SEAPEX 2013

MYANMAR

Mandalay

Naypyidaw

Yangon

Bay of Bengal

Gulf of Martaban

M-01

Unconformity between Top Cretaceous & Base of Tertiary

Top Rift Fill Unconformity within Mesozoic

Mesozoics ?

Top of Basement ?

U L Myint PM-B-5
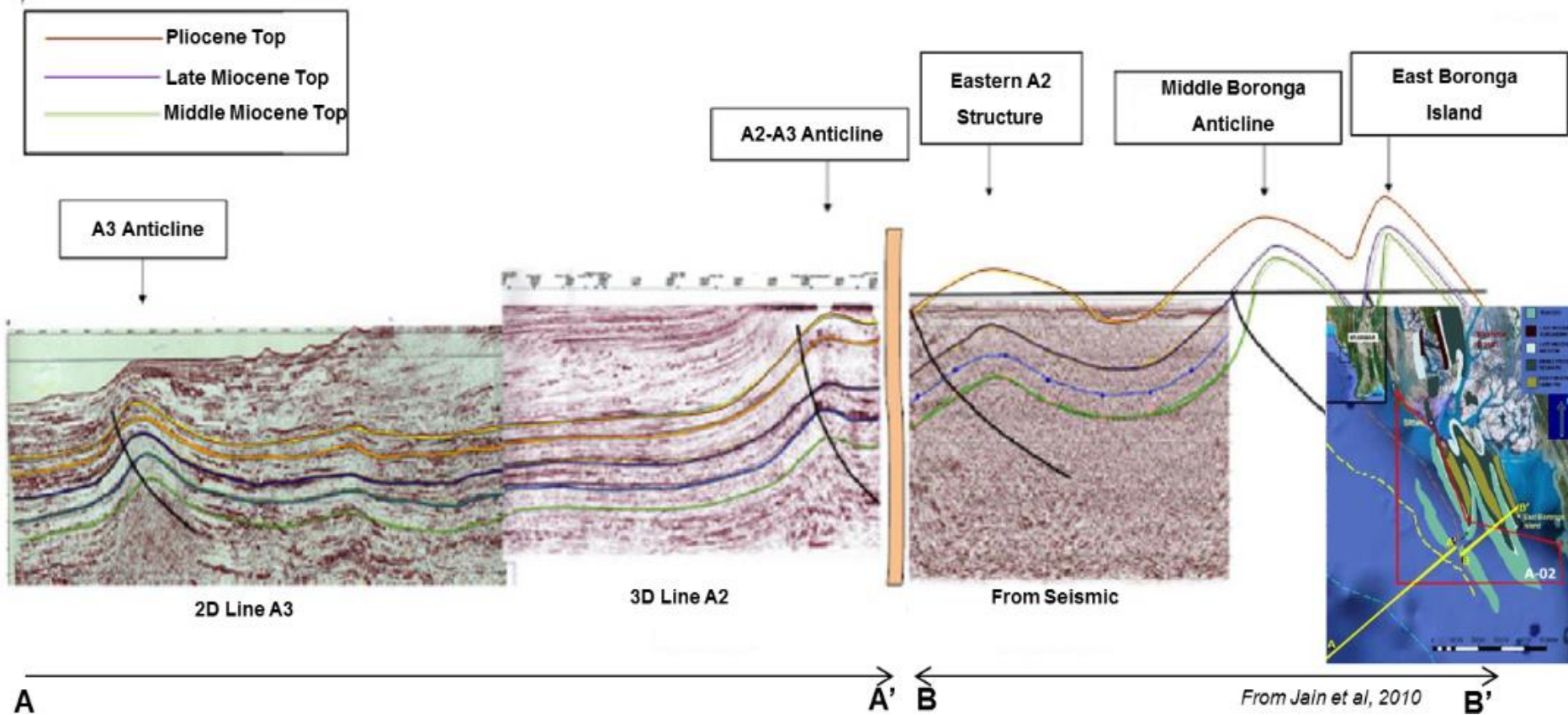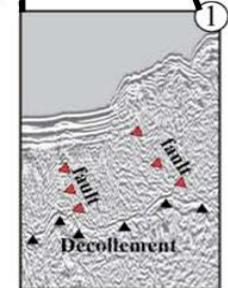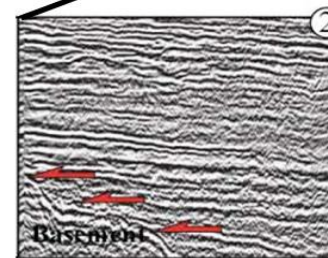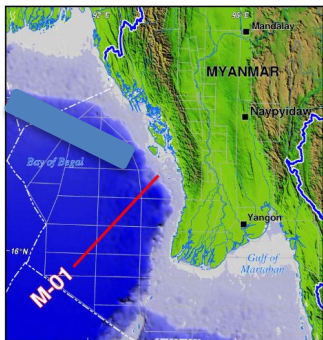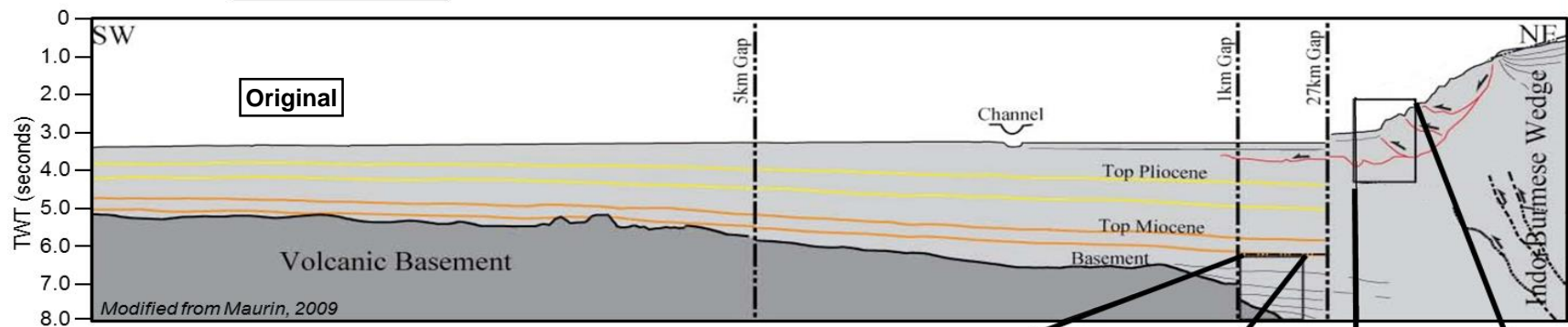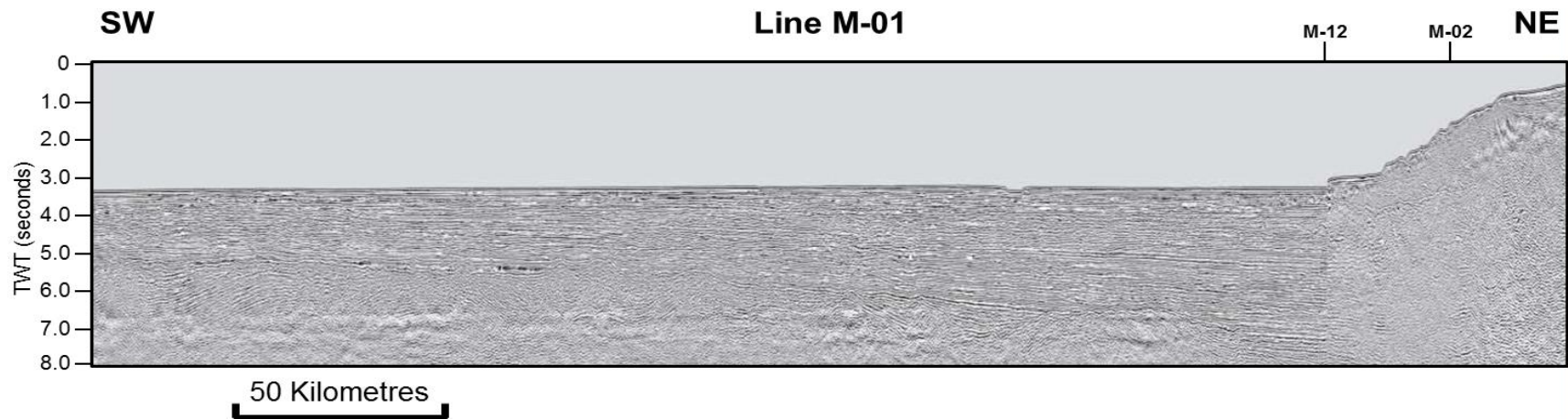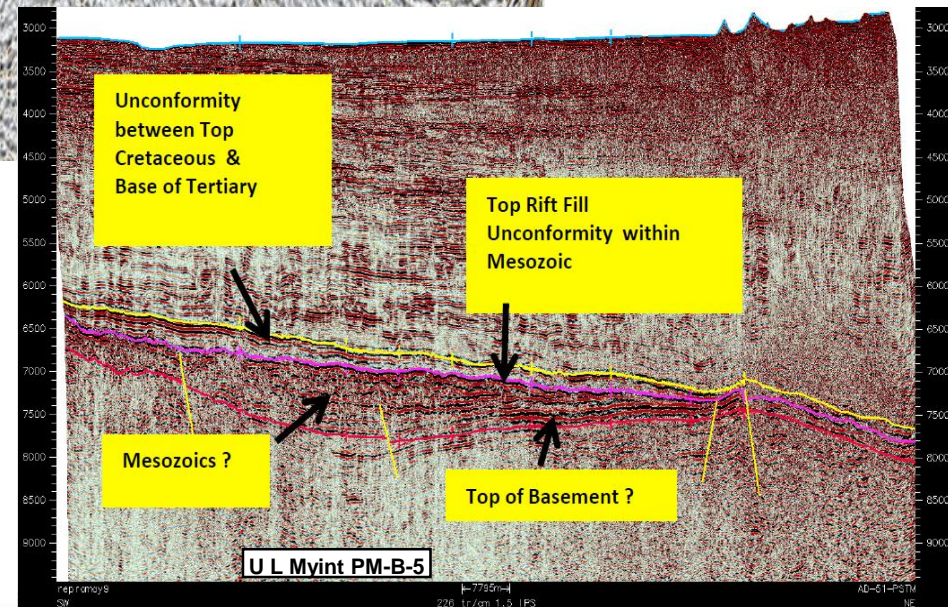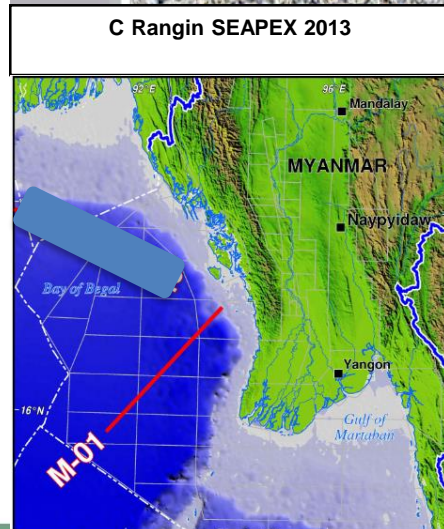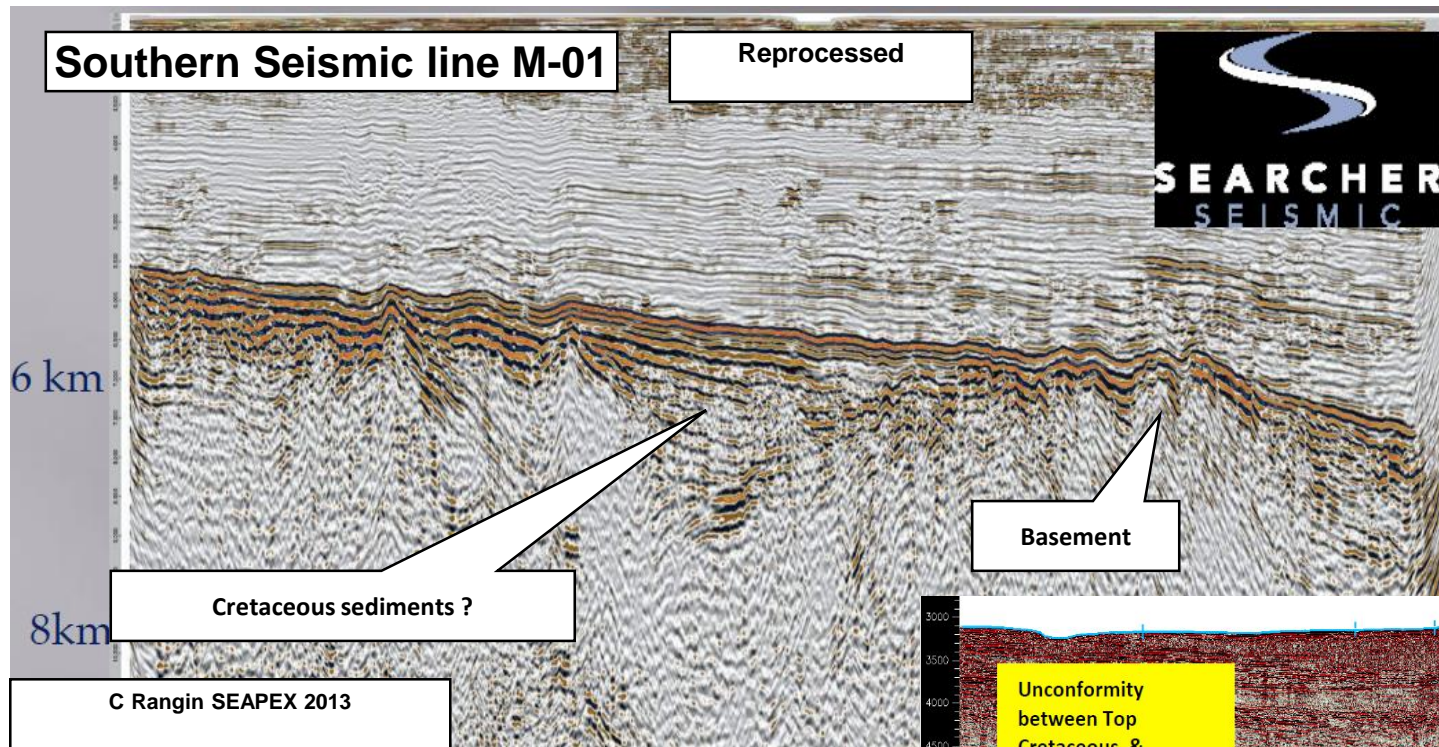
Petroleum systems

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

(From Basu, et al, 2010)
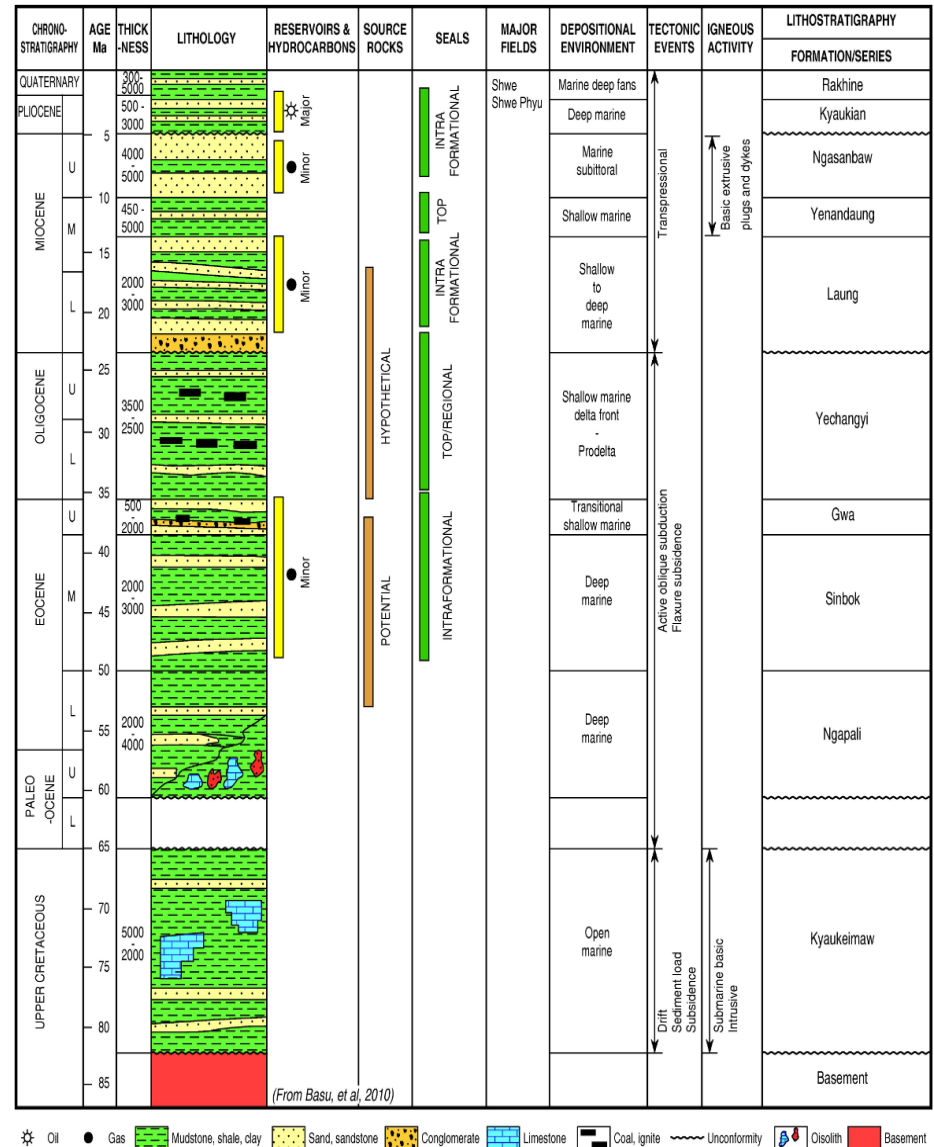
Exploration history

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
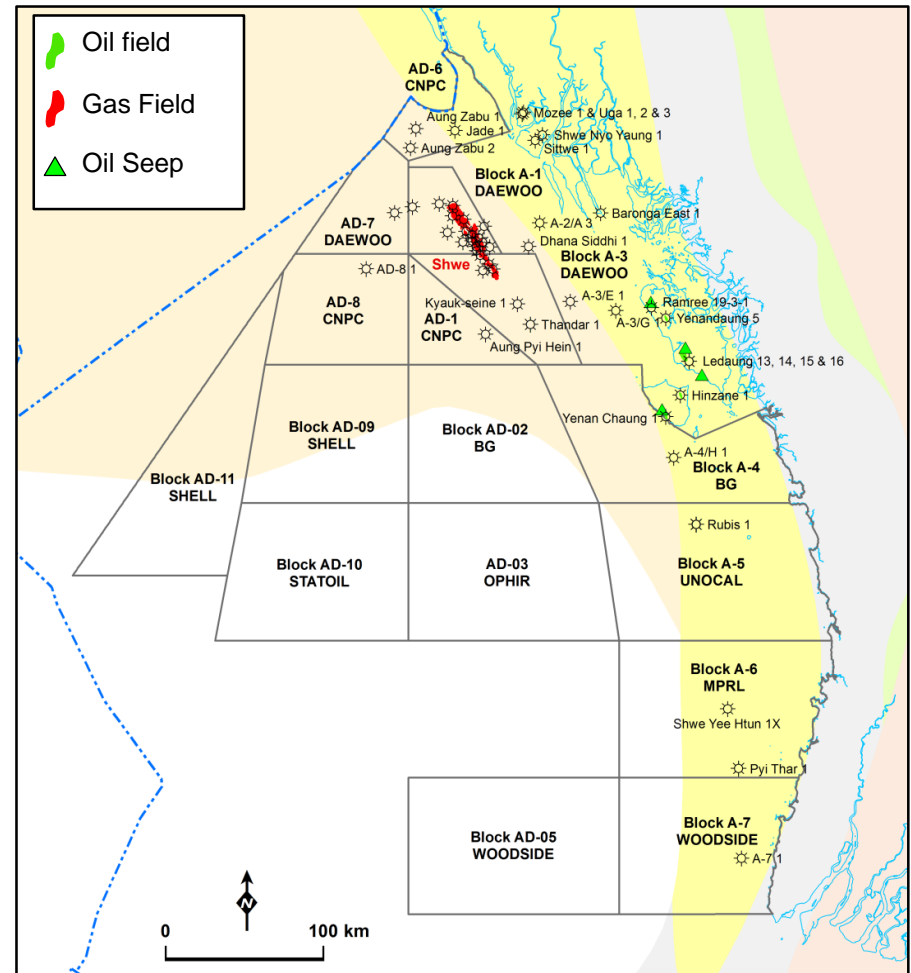- All 1970's licensed blocks were surrendered
- 1980's & 1990's Exploration hiatus
- 2000 - Daewoo drilled Shwe gas discovery well in 2002
- 2007
  - Daewoo signed PSC for A-3 & AD-7
  - CNPC awarded AD-1, -6, & -8
  - ONGC awarded AD-2,-3 & -9 but relinquished in 2011
- 2013/14
  - Offshore Myanmar 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
- 2015
  - Daewoo are about to drill in AD-7 and MPRL is about to drill in A-6
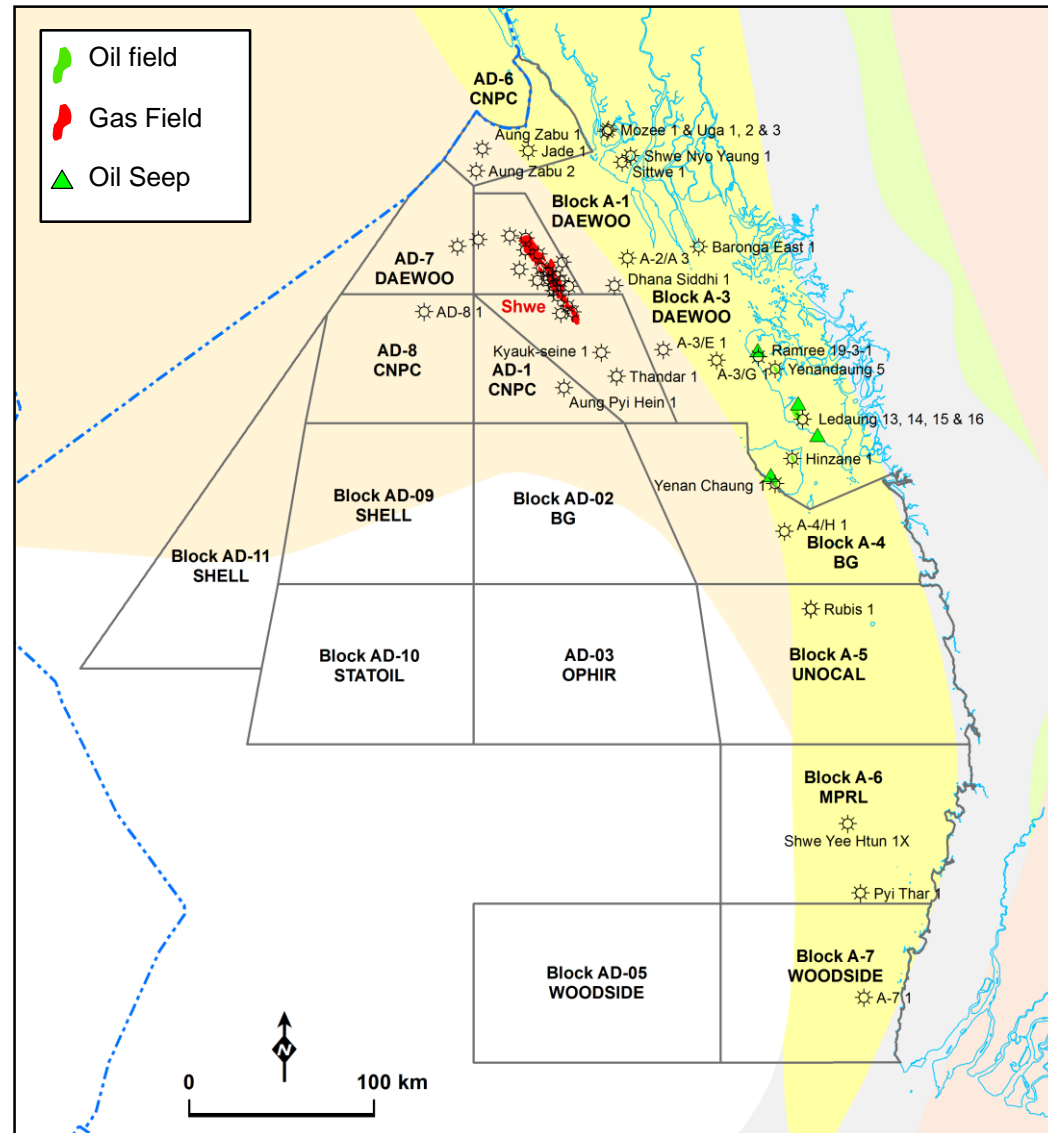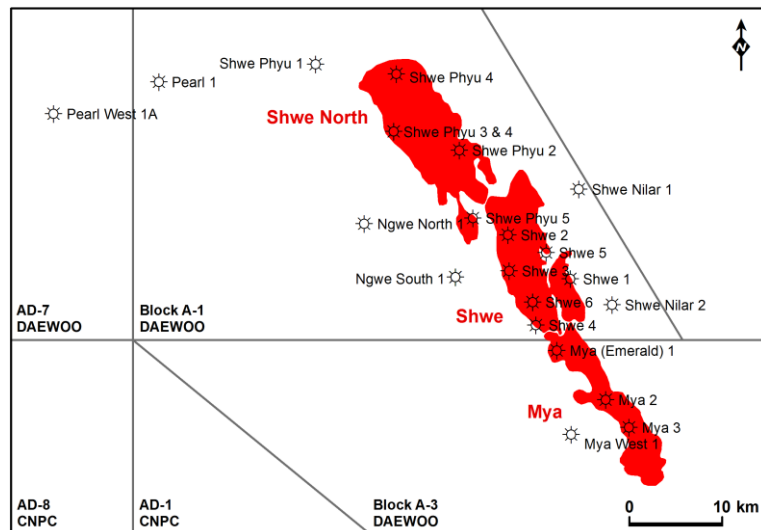 - Extensive 3D data currently being acquired

Well data base

Wells

Exploration wells:

- 16 (approx.) onshore

- 31 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
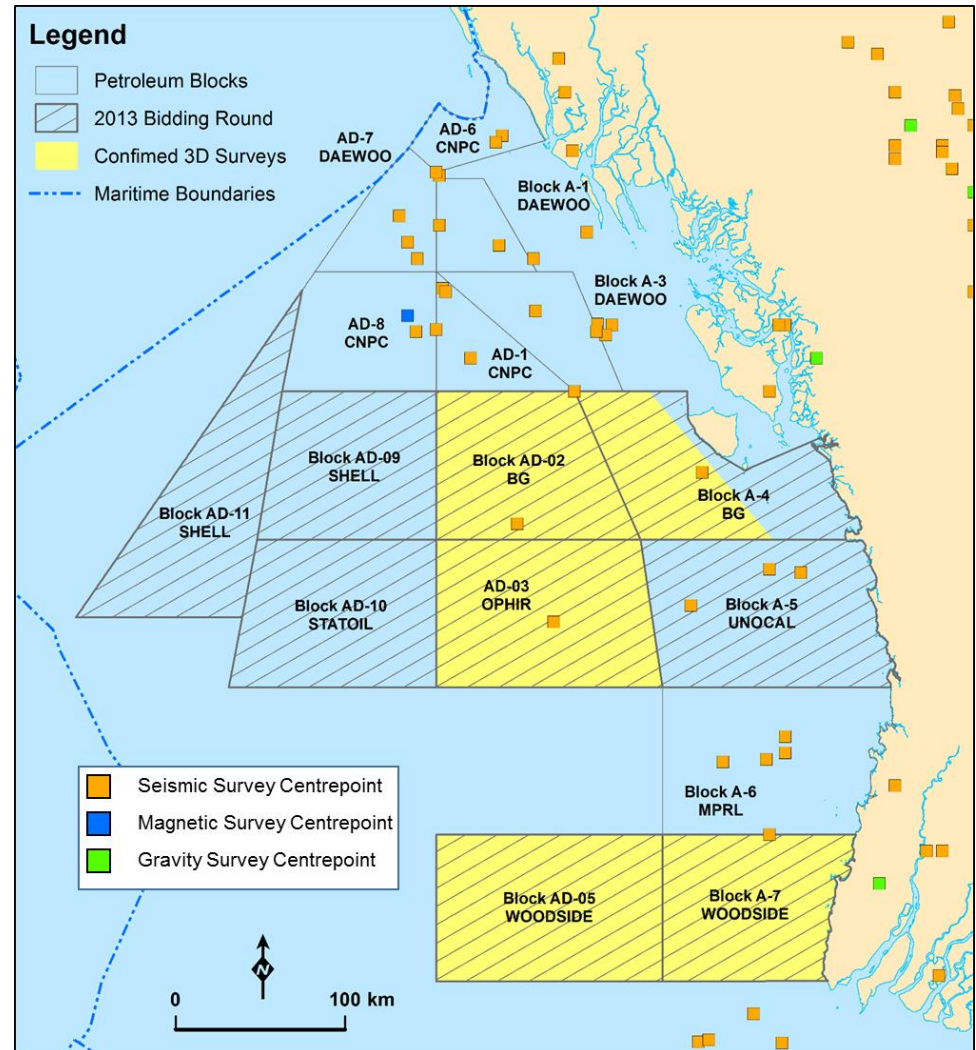
Onshore discoveries and fields

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
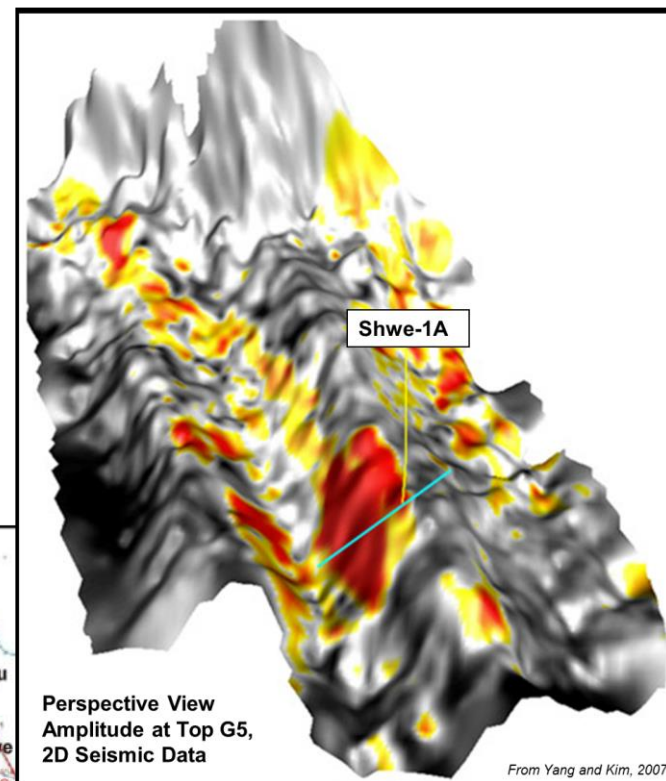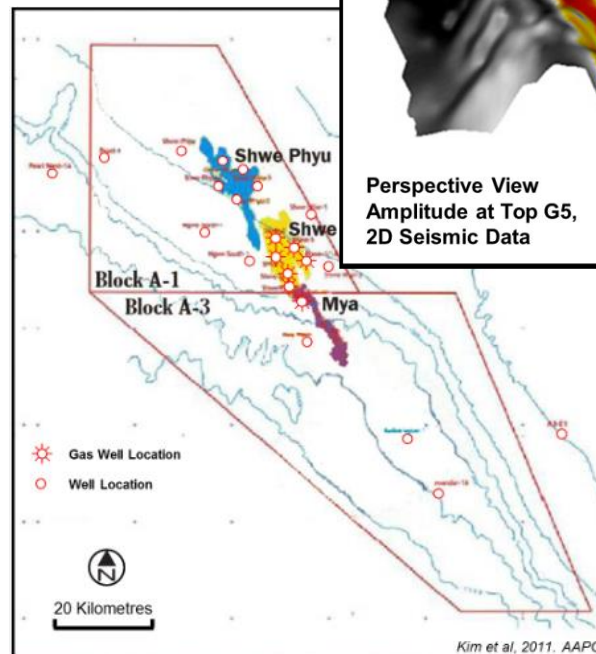
  - Estimated total production to 1981 was 730,000 bbl

Source: Arakan Oil Watch, 2008

Source: Arakan Oil Watch, 2008
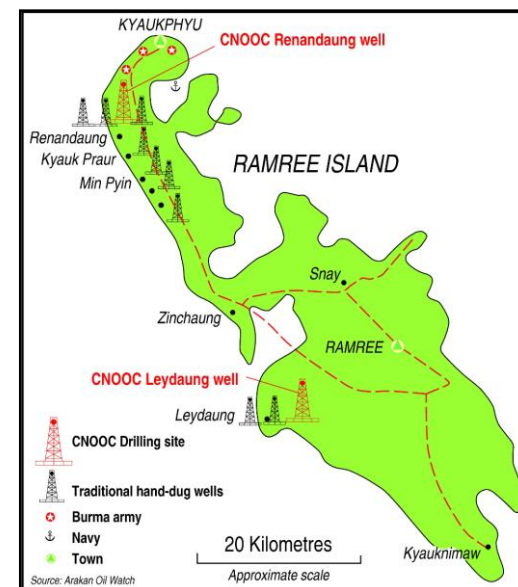
CNOOC Rig at Renandaung-1 next to Traditional Hand Dug Wells

Offshore discoveries and fields
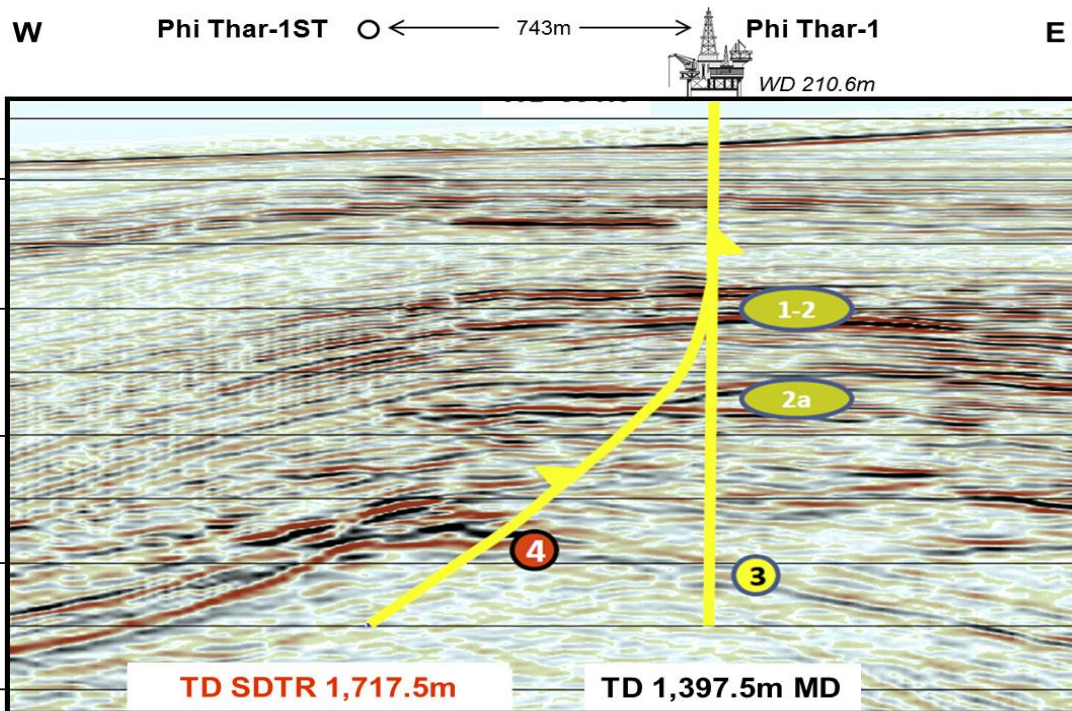
Offshore

- 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


Shwe-1A

Perspective View
Amplitude at Top G5,
2D Seismic Data

From Yang and Kim, 2007

Shwe Phyu

Shwe

Block A-1
Block A-3

Mya

☼ Gas Well Location
○ Well Location

Ⓝ

20 Kilometres

Kim et al, 2011. AAPG

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
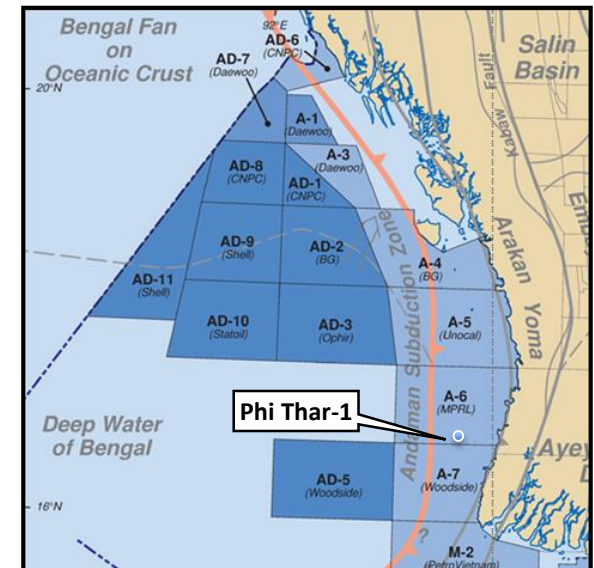
Prospectivity of the Rakhine Basin/Bengal Fan

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

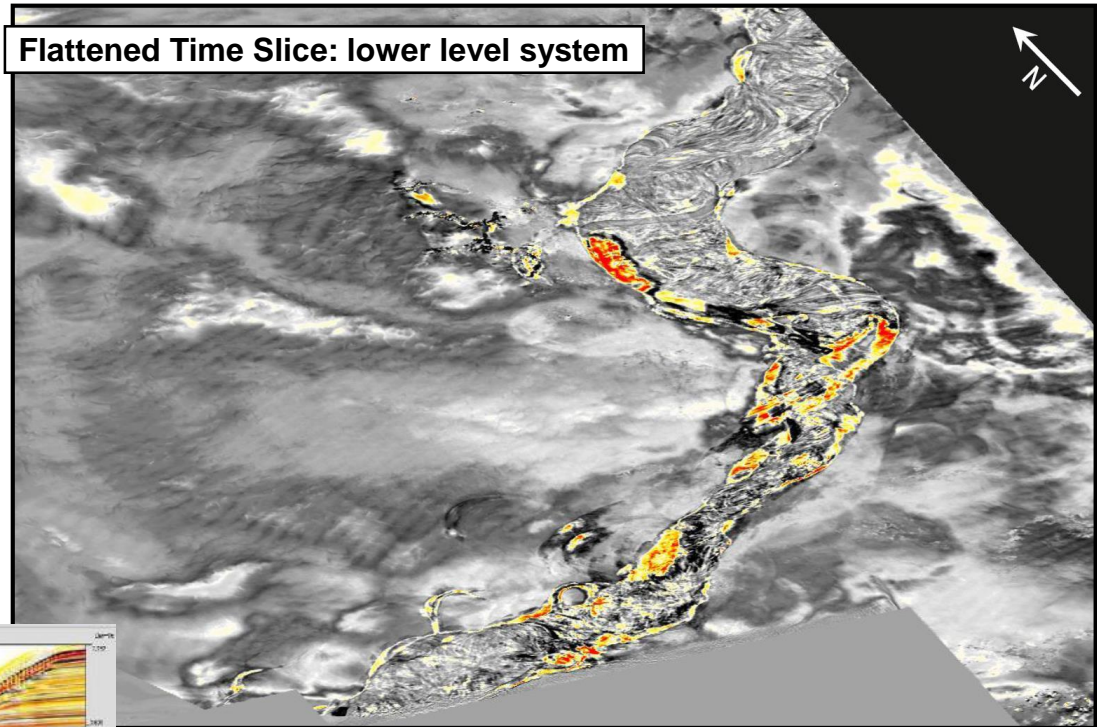 - Mass Transport deposits are not usually good reservoirs but the turbites that pond on them can be
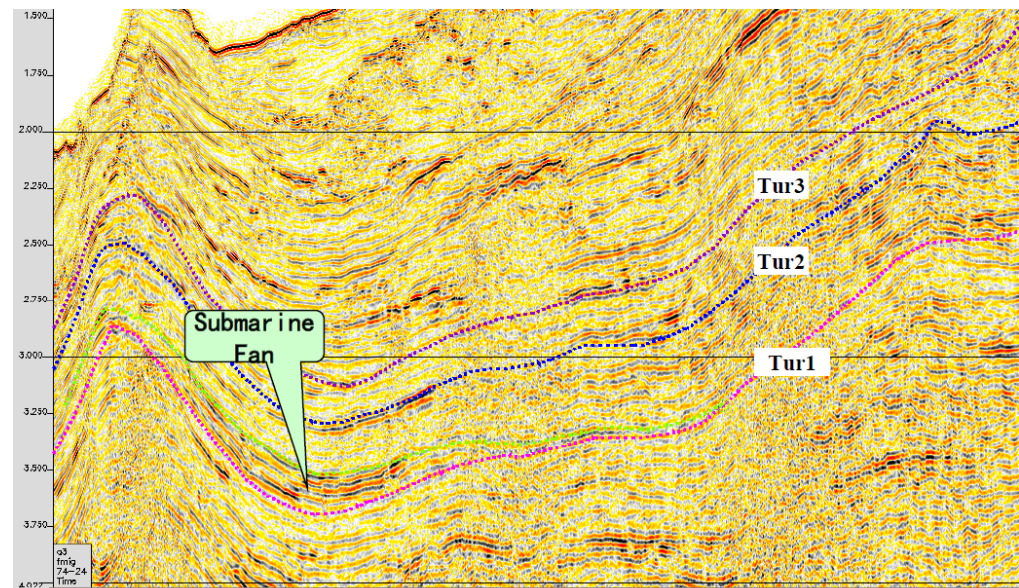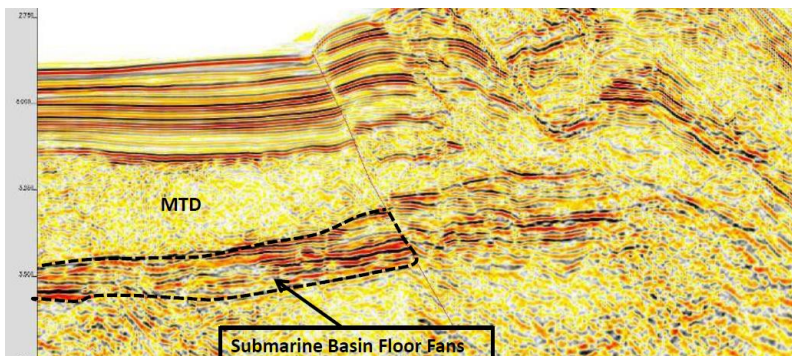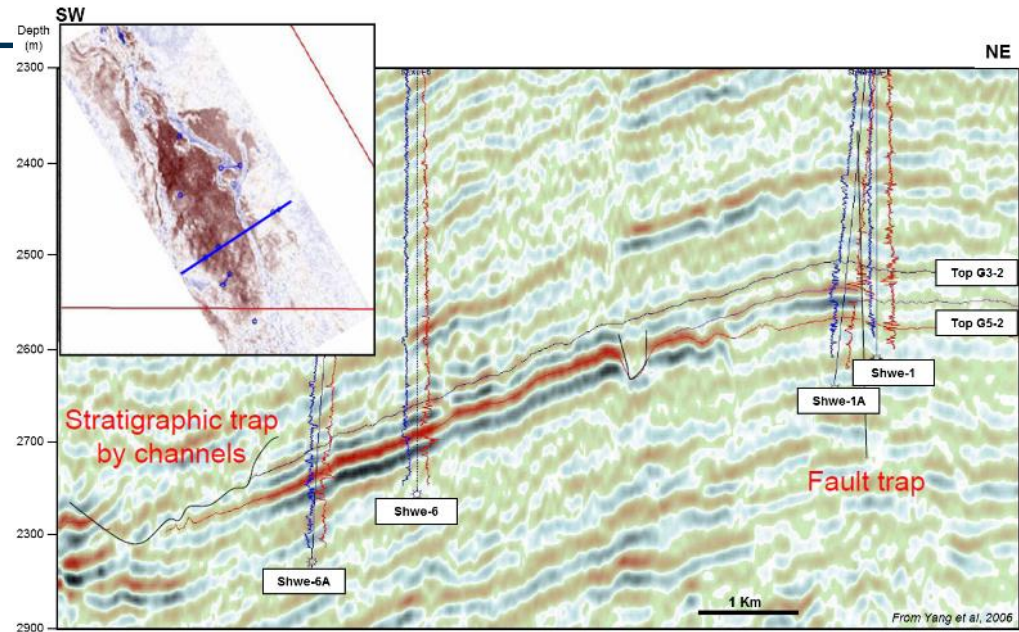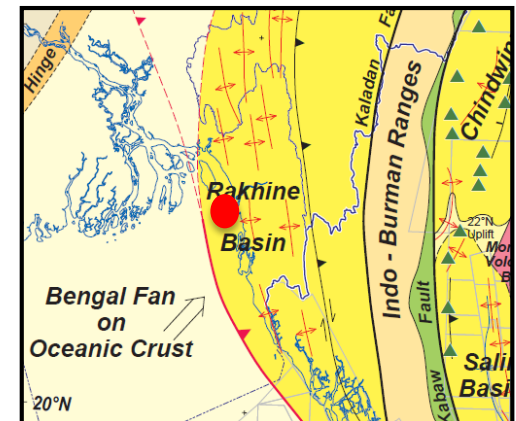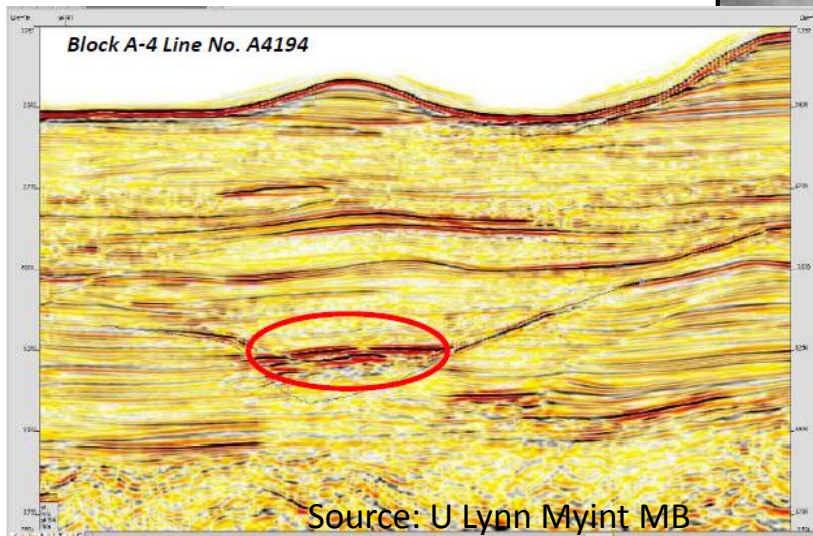

Source: MOGE, U Lynn Myint

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

Flattened Time Slice: lower level system

P Strong SEAPEX 2013

Block A-4 Line No. A4194

Source: U Lynn Myint MB

Hinge
Kaladan Fa
Indo - Burman Ranges
Chindwi
Rakhine Basin
22°N Uplift
Mo Vol
Bengal Fan on Oceanic Crust
Fault
Sali Basi
Kabaw
20°N

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.
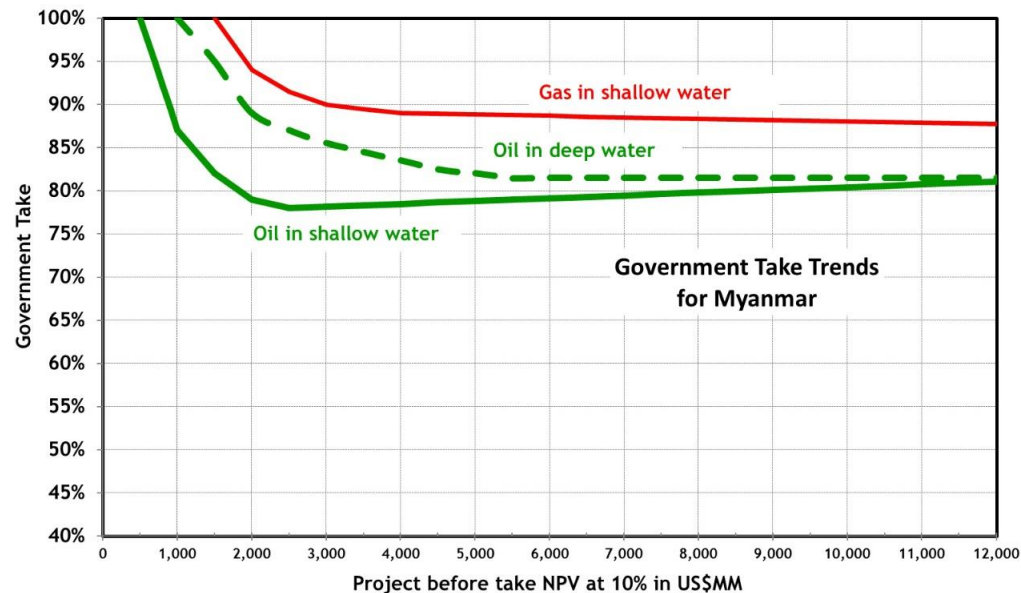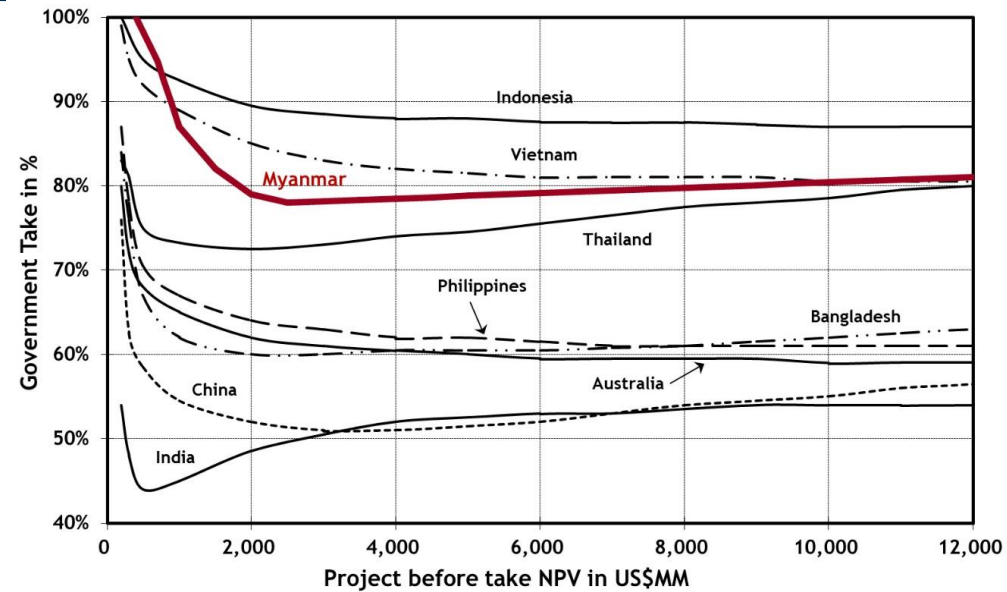
Conclusions

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.
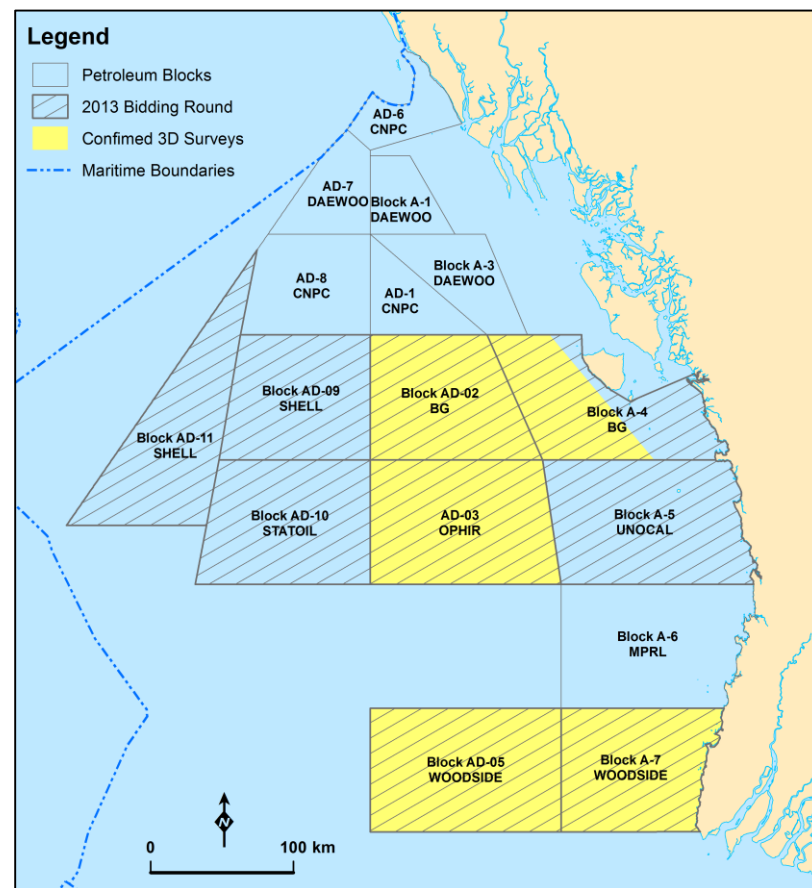
Acknowledgement

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- RISC management for their support and approval

- The AAPG/EAGE/MGS Conference organisers for inviting me to present this paper