THE NATUNA SEA:
A HYDROCARBON POTENTIAL IN EAST NATUNA BASIN

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The Natuna Sea: A Hydrocarbon Potential in East Natuna Basin

Agenda:

• Introduction
  – Location and Regional Geology
  – Exploration History

• Geological Outline
  – Structure
  – Stratigraphy
  – Petroleum System

• Plays and Future Potential

• Summary/Conclusion
Geotectonic setting of the Natuna Sea area. Generalized Base Tertiary map showing major basin highs (red) and lows (blue). Oil and gas fields shown (green and red, respectively).Courtesy JMJ Petroleum, 2013.
The northern Natuna Sea was operated by AGIP and Continental (Conoco)
While the Indonesia – Malaysia maritime boundary had been fixed, Indonesia – Vietnam had not.
Natuna Sea Exploration History
Current Natuna Sea License Map

West Natuna
168 Exploration wells
68 discoveries
34 “commercial”
Ps=40%, Pcs*=20%
2B bbls oil equiv discovered
50% oil, 50% gas

East Natuna
44 Exploration Wells
15 discoveries
6 with high CO2
Ps=20%, Pcs=?
No fields on production

Approximately 230 Exploration wells drilled....

Operator errors!

Ps= Technical success rate (discovered hydrocarbons)
Pcs = Commercial success rate
Pcs=20% = 1 in 5 exploration wells yields a commercial discovery
Exploration wells in Natuna cost $20-40mm each
East Natuna Basin Exploration History

1970’s: AGIP – 17+ wells includes D Alpha and Bursa
1980’s:
- Mobil – 4 wells includes Komodo and Macan (both with oil and gas show)
- Total (south) – 2 wells
- Amoseas (north) – 2 wells
- Esso – D Alpha appraisal
1990’s:
- GFB/Exxon – Durian Besar-1
2000’s:
- Premier: BLU and GLU; Kuda and Singa Laut
- Mitra: Durian Besar Deep (methane plus H2S shows)


Area is gas prone, but some black oil (at Bursa and Kuda Laut).

D Alpha field is 222 TCF gas but is 71% CO2.
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East Natuna Basin Stratigraphy
Regional Oil and Gas Occurrences

Gabus Fm—rich oil & gas prone source where coals developed

- Thick clastic & carbonate reservoirs
- Stacked pays
- Prolific source
East Natuna Basin
GDE Maps for Reservoir Intervals

Upper Gabus (27 ma)
- Dominant continental conditions
- Coal deposits in “everwet” conditions - main source
- Fluvial sandstone reservoirs
- Beginning of Barat transgression

Arang (24 ma)
- Fluvio deltaic conditions, becoming more marine, with offshore bars. Reservoir interval.
East Natuna Basin
GDE Maps for Reservoir Intervals

**Lower Terumbu (15 ma)**

Widespread marine transgression

**Upper Terumbu (12 ma)**

Carbonate platform developed over the “Terumbu” high.
Timing of Muda top seal important since may post date oil expulsion
East Natuna Basin – Petroleum System

- Premier has undertaken extensive regional geoscience work to better understand the petroleum system.

- The dominant hydrocarbon source rock appears to be Upper Gabus Coals.

- The system is gas prone with some liquids: condensate and black oil, as observed at Bursa-1 well.

- Modeling indicates coals are mature and expelling gas in the eastern part of the basin.

- Further to the south and east large volumes of CO2 have been produced most likely due to the high geothermal gradient, and breakdown of carbonates/argillaceous material.
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Established/proven plays:

- Carbonate play: Upper Terumbu carbonate in Bursa (oil), D Alpha (gas), Banteng (gas), AV-1X (gas), Durian Besar Deep-1 (gas)
- Syn-inversion play: Lower Terumbu clastics in Kuda Laut
- Post-rift play: Arang clastics in Kuda Laut, Macan (?)
- Syn-rift play: Gabus clastics in Singa Laut (plus CRD in NCS Basin)
East Natuna Basin
Future Exploration

• Key Observations:
  – Many of the early exploration wells has been drilled/focused on easy to image Upper Terumbu carbonate buildups. Timing of top seal emplacement appears to be a key risk.
  – Often underlying clastics were not reached, or off structural crest at that location
  – Eastern side of the basin is constrained by reservoir porosity limitations due to depth of burial
  – Basin modeling indicate the basin dominated by gas charge
  – CO2 is common in the southeastern side of East Natuna (D Alpha and AV-1X). Will need advances in CO2 removal and handling technology to be commercial.
  – Deeper clastic plays in particular remain viable
  – Lower Terumbu carbonate identified as secondary target
East Natuna Basin – Tuna Field

Overview

• Discovered by Premier Oil in 2014 with the Kuda laut-1 and Sing laut-1 wells
• Multiple reservoirs of Late Oligocene - Mid Miocene Gabus, Arang, & Lower Terumbu clastics
• Multiple hydrocarbon phases
• Located in geopolitically strategy area
• Approximately 500 BCF gas recoverable resources with some condensate and black oil

Challenges:

• Requiring complex and expensive facilities due to mixed hydrocarbon phases
• Remote location requiring long pipeline for gas offtake

Possible solution:

• Link to pipeline networks in Vietnam/ Nam Con Son basin to the north
Tuna Commercialization options:
1) Build 383 km pipeline to West Natuna (WNTS) pipeline
   - expensive LPG removal to meet WNTS gas specification
   - >$400m pipeline cost
   - requires prohibitively high gas price to be commercial
2) Build 283 km pipeline to Natuna Besar
   - >$300m pipeline cost
   - no gas market exists on Natuna Besar
3) FLNG
   - insufficient gas volume to be commercial
   - gas composition (high LPG and condensate) not conducive to LNG process
4) Sell gas into Vietnam
   - nearby gas infrastructure with available capacity
   - potentially commercial depending on gas price achieved
• Exploration in the Natuna Sea is almost 50 years old. West Natuna has been oil producing since 1979 – gas production, facilitated by WNTS and GSA in the late 90’s, began in 2001. As yet East Natuna has yielded no commercial hydrocarbon developments

• In East Natuna exploration has focused on the Terumbu carbonate with many dry holes but notable success at D Alpha (East Natuna field). Deeper clastic plays in particular remain under-explored

• The supergiant D Alpha field, discovered by Agip in 1973 containing over 222 TCF including 71% CO2, requires technology to remove and re-inject, plus a pipeline to take the gas to market, maybe developed in the next decade depending on technology advances and market/gas price.

• Exploration success in the Tuna PSC prove that there is still hydrocarbon potential in East Natuna. To be commercial we need gas infrastructure (building new or extending existing pipeline networks) to provide an offtake solution for the gas, which in turn will promote further exploration in the area.

• Premier Oil in partnership with SKKMIGAS looks forward to be an active participant in commercialization of hydrocarbon resources in East Natuna
Terima Kasih