Examing Petroleum Potential of Sibolga Forearc Basin, Sumatra

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Contents of Talk

- Discoveries of Supergiant Fields of West Aceh Offshore: Bizarre News and Why
- Exploration History of Sibolga Forearc Basin
- Geomarine Cruises of Sumatra-Andaman Waters
- Geology of Sibolga Forearc Basin
- Worldwide Producing Forearc Basins
- How Sibolga Differs
- What's Next

Quotes from Media
(11-13 February 2008)

- "Agencies discover hydrocarbon in Aceh" (The Jakarta Post)
- "BPPT : Lebih Besar dari Milik Arab Saudi" (Jawa Pos)
- "Cadangan Migas Terbesar Dunia Ditemukan di Aceh" (Media Indonesia)
- "Potensi Migas Terbesar Ditemukan di Penunjaman" (Liputan 6)
- "Menyingkap Berkah di Bawah Laut" (Kompas)
- "Potensi Migas 50 Miliar Barel Ditemukan di Aceh" (Investor Daily)
- "Ditemukan Lapangan Migas Raksasa" (Radar Lampung)
- "Cadangan Migas Terbesar di Dunia Ditemukan" (Media Aceh)
- "Potensi Migas Raksasa Ditemukan di Simeuleu" (Medan Bisnis Online)
Discoveries are based on post-24 December 2004's earthquake and tsunami geomarine surveys by BPPT and BGR. The surveys discovered carbonate build ups in offshore forearc basin west of Aceh with potential/reserve as much as 107 to 320 billion barrels of oil (BBO), or 54 BBO at the lowest, bigger than total oil fields in Saudi Arabia.

The reserve is obtained by applying 15 - 30 % porosity to bulk rock volume of identified carbonate build ups. The basin is similar in characteristics with producing forearc basins in Andaman, Myanmar, and California. The 24 December 2004's earthquake has matured and uplifted the basin's oil potential approaching the surface.

Quotes from Media
(11-13 February 2008)

- No drilling no discovery. No discovery no field. No field no reserve.
- The survey lines have very wide spacing (60 km) – the wider the line spacing the more obscure the structure.
- Volumetric calculation does not follow basic formula.
- It is bigger than Saudi Arabia (Arab’s in place reserves : 700 BBO) - not comparable.
- Forearc basin has been notorious for lack of petroleum potential. How come are there tens of giant to supergiant fields in west Aceh forearc basin with total reserves from 54 to 320 BBO ?
- Trapped 320 BBO will need 2133 BBO of oil generated using 15 % efficiency generated to trapped ratio. Sibolga Basin is impossible could generate such substantial amount.
- Carbonate build up is not a DHI, bright spot does not always show HCs.
- The 24 December 2004's EQ matured source rocks and uplifted the oil potential. How confident ?

Why It Is Bizarre

- Structure : subsurface trap, potential to entrap petroleum if all elements and processes of petroleum system are fulfilled.
- Field (lapangan/ladang) : drilled subsurface structure, contains petroleum to be produced or is producing petroleum.
- Reserve (cadangan) : recoverable petroleum accumulation of drilled discovery structure.

Care with Terms

SPE, AAPG, GCA definitions
**Care with Terms**

- Resources (sumberdaya): estimated potential petroleum accumulation of undrilled structure.
- Prospect: structure sufficiently well-defined to represent a viable drilling target.
- Lead: structure currently poorly defined and requires more data acquisition and/or evaluation in order to be classified as a prospect.

**BPPT-BGR findings**: just structures, not field, not prospect, may be lead

SPE, AAPG, GCA definitions

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**Giant oil field**: ultimately recoverable oil reserve is greater than 500 MMBO (Halbouty, 2001)

**Giant gas field**: ultimately recoverable gas reserve is greater than 3 TCFG (Halbouty, 2001)

**Supergiant oil field**: recoverable reserve is greater than 5 BBO (Simmons, 2007)

**Supergiant gas field**: recoverable reserve is greater than 30 TCFG (Simmons, 2007)

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*Care with Terms*

**Volumetric Reserves Estimation**

Basic formula for oil and gas: 

$$EUR = GRV \times N/G \times \emptyset \times (1 - Sw) \times RF^\beta$$

Formula for gas commonly modified: 

$$EUR = GRV \times N/G \times \emptyset \times (1 - Sw) \times RF \times E$$

- **GRV**: Gross Rock Volume
- **N/G**: Net to Gross ratio
- **\emptyset**: Porosity
- **Sw**: Saturation
- **RF**: Recovery factor
- **E**: Gas Expansion factor ($1/6g$)

Gaffney, Cline & Associates (2007)

**Saudi Arabia now has 1.2 trillion barrels of estimated reserve.**

(Saudi Minister of Petroleum and Mineral Resources Al-Nami, 2004)

The “king” is the Ghawar field, the greatest oil-bearing structure the world has ever known. It is 278 km long, and 50 km wide. Since its first production in 1951, it has now produced over 55 BBO (Simmons, 2007).

Exploration, delineation and development efforts have increased Saudi Aramco’s oil initially in place from 600 to 700 BBO during the past 20 years.

Map from Mann et al. (2003)

**“Simeulue fields” can not be compared with Saudi Arabia’s fields**
Exploration History of Sibolga Forearc Basin

  - 129,000 sq km
  - Did field geologic survey
  - Acquired 10,941 km 2-D offshore seismic data
  - Acquired 138 km 2-D onshore seismic data
  - Drilled 19 exploration wells (six non-economic biogenic gas wells)

  - 2D seismic survey surrounding Simeulue shelf

  - 10,000 sq km
  - Did field geologic survey
  - Acquired 1959 km 2-D seismic and gravity data
  - Acquired 1945 km magnetic data
  - Drilled 1 exploration well

Exploration Wells Drilled in Sumatra Forearc Basins

Rose (1983)

Yulihanto and Wiyanto (1999)
Surveyed and Studied by various countries (British, German, Japan, French, Indonesia, India) and organizations (BGS, BGR, JAMSTEC, LGM, BPPT, NGRI, etc.)

- Multibeam bathymetry
- Single and multi-channel seismic
- Marine gravity and magnetic
- Ocean bottom seismographs
- Wide-angle seismic refractions
- Seabed images from ROV

Parts of results of surveys and studies have been published.

Ladage and Tapan (2006)

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Geumarine Cruises for Offshore Studies of Andaman-Sumatran Earthquakes

- Multibeam bathymetry
- Single and multi-channel seismic
- Marine gravity and magnetic
- Ocean bottom seismographs
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Ladage and Tapan (2006)

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Publications Related with Petroleum from the Geomarine Cruises


Seismostratigraphy of Sibolga Forearc Basin by Geomarine Cruises

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Abraham et al. (2000)

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AAPG HEDBERG CONFERENCE

“Petroleum Systems Modelling in the Simeulue Forearc Basin off Sumatra”

- Lutz, Berglar, Gaedicke, Franke

The Simeulue forearc basin is situated between the island of Simeulue and northern Sumatra. It is one of several forearc basins which developed along the Simeulue arc from the early Miocene to the present. The Simeulue basin was the target of oil and gas exploration from 1984 to 1986, when Union Oil Company held an exploration-sharing license. During this time several wells were drilled and seismic data were acquired. At the activities on the northern part of the basin, the aim was to evaluate the possibility of producing oil and gas in an overlying reservoir, but none of the accumulations were commercial success.

Berglar et al. (2006)

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Oil and Gas in the Forearc Basins off Sumatra

- Lutz, Berglar, Gaedicke, Franke


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Petroleum Systems Modelling in the Simeulue Forearc Basin off Sumatra

- Lutz, Berglar, Gaedicke, Franke

Hydrocarbon Generation in the Forearc Basin off Sumatra (Neben and Wiedicke – 2006 – Hannover Workshop)

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Hydrocarbon Generation in the Forearc Basin off Sumatra (Neben and Wiedicke – 2006 – Hannover Workshop)

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Simandjuntak and Barber (1996)

Sumatran Forearc Basins

Pertamina and Beicip (1985)
Moore et al. (1980), Matson and Moore (1992), Barber et al. (2005)

Carbonate Build Up of Northern Sibolga Basin
Worldwide Producing Forearc Basins

- Sacramento Valley, Northern California
- Cook Inlet, Southern Alaska
- Talara Basin, NW Peru
- Progreso Basin, Ecuador
- Central Basin, Myanmar (with backarc position)
- Mergui Terrace, Andaman (backarc position)
- Honshu Shelf, Japan
Stratigraphy of Talara and Progreso Basins

Higley (2004)

Central Basin (Forearc-Backarc), Myanmar

Pivnik et al. (1998)

Talara (NW Peru) and Progreso (Equador) Forearc Basins

Fernandes (2007)

Fildani et al. (2005)
Curiale et al. (2002)

Central Basin (Forearc-Backarc), Myanmar

Imbus et al. (1998)

Smithsonian Institute

Yadana and Yetagun Gas Fields, Mergui Terrace, Andaman Back Arc Basin

Sibolga Forearc Basin : Differences

- Miocene carbonate build ups are traps.
- Miocene carbonates are reservoirs.
- Paleogene shales and coals sources are not identified.
- Sources are Miocene and younger marine shales, minor basal coals in eastern basin flank.
- The basin is residual, not constructed, not composite.
- The basin is not a poly-history basin.
- The basin is young aged.
- No nearby arc massif, no continental basement.
- Thermal is minimal.
Pollack et al (1993) NGDC dataset + IPA/SEAPEX data + estimate for active volcanoes

Thamrin (1987)

Forearc basin has the lowest HFU

Thamrin (1987)

For a hydrocarbon accumulation to be present and recoverable, nine independent geologic elements must be adequate to the degree that the Assessment Minimum volume of hc’s can be produced.

Source Richness - is there source lithology with sufficient TOC to generate hc’s?
Source Maturation - is the source rock sufficiently mature to generate hc’s?
Trap Closure - is there a geologic configuration capable of retaining hc’s?
Migration Pathways - are there paths along which the hc’s can move to the trap?
Trap-Migration Timing - did the trap exist when the migration occurred?
Trap Seal - is there a means for retaining hc’s in the trap?
Reservoir Facies - is there a suitable reservoir lithology in the trap?
Reservoir Quality - does the reservoir have suitably high N/G and porosity?
Hydrocarbon Recovery - can hc’s be recovered from the reservoir?

News of discoveries of supergiant fields of west Aceh offshore is bizarre. No discovery of oil field in the area. Geomarine cruises only identified structures appears to be carbonate build ups, which may have potential to trap HC’s if all elements and processes of petroleum system are good in space and time. Sibolga forearc basin has several negative aspects compared with other producing forearc basins. All producing forearc basins in the World have complex histories of not being single forearc basins during the histories, and they are all constructed-composite forearc basins (Sibolga is mostly residual). However, further surveys and studies are needed to conduct in Sibolga to disclose its real HC potential.
Sorting of 877 giant fields by basin classification proposed in this chapter

Mann et al. (2003)

Proven and Prospective Areas for Petroleum

Thank you for your attention

Awang H. Satyana