LEMIGAS PILOT PROJECT OF SHALE GAS EXPLORATION

KRABI, 22-23 MARCH 2015

RESEARCH AND DEVELOPMENT CENTER FOR OIL AND GAS TECHNOLOGY “LEMIGAS”
AGENCY OF RESEARCH AND DEVELOPMENT FOR ENERGY AND MINERAL RESOURCES
MINISTRY OF ENERGY AND MINERAL RESOURCES REPUBLIC OF INDONESIA
<table>
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INTRODUCTION
BACKGROUND PROJECT

- The increase of gas demand in future years
- Indonesia geologically has large potential of shale gas
- Shale gas pilot project is conducted in the most prospecting areas including North Sumatra and South Kalimantan
THE AIMS OF THE PROJECT

- To evaluate shale gas potential in these two area which will be followed up by drilling to find the new gas reserve.
- To support government in making policy of shale gas exploration.
- To encourage investors increasing exploration activity to discover shale gas field
- Mastery of exploration and exploitation technologies of shale gas
Shale Gas Reservoir:

- Unconventional natural gas reservoir contained in fine grained sedimentary rocks, dominated by shale containing clay and other minerals like quartz, calcite.

- The shales typically serve as source, reservoir and seal of the hydrocarbons.

- Total organic carbon, Thermal maturity, Mineralogy and Natural fractures are key.
Characteristics of gas shales reservoir:

- High Gamma Ray
- High Resistivity
- High organic content (>3%)
- High maturity (late oil window or higher)
- Brittleness (>40% Qz., carbonate content)
- Thickness (>100ft)
- Porosity (>4%)
- Deposited in marine environments
- Type II kerogen
- Presence of fracture barriers (usually carbonates)

(Lewis et al., 2004)
Global shale gas basins, top reserve holders

- Topreserveholders200-Trlncubicmetres

Canada11.0
U.S.24.4
Mexico19.3
Argentina21.9
Poland5.3
Libya8.2
Algeria6.5
Brazil6.4
China36.1
Australia11.2
SouthAfrica13.7

Assessed basins
- With resource estimate
- Without resource estimate

Source: EIA based on Advanced Resources International Inc data, BP

Reuters graphic/Catherine Trevethan
SHALE GAS POTENTIAL IN INDONESIA

Large Shale Basins, with ~5,000 TCF GIP (DIRECTORATE GENERAL MIGAS OF ABOUT ~ 1000 TCF, BADAN GEOLOGI OF ABOUT ~ 574 TCF)

- **North Sumatra**
  - Shale Gas—338 Tcf
  - CBM—375 Tcf

- **Central Sumatra**
  - Shale Gas—558 Tcf
  - CBM—165 Tcf

- **South Sumatra**
  - Shale Gas—964 Tcf
  - CBM—375 Tcf

- **West & East Java**
  - Shale Gas—722 Tcf
  - CBM—56 Tcf

- **East Kalimantan**
  - Shale Gas—1,723 Tcf
  - CBM—496 Tcf

- **South Sulawesi**
  - Shale Gas—20 Tcf
  - CBM—2 Tcf

- **West Papua**
  - Shale Gas—648 Tcf

Source: Modified from IHS CERA

Source: After Talisman 2012
ROAD MAP OF THE PROJECT

2011

- BALITBANG ESDM
- PUSDATIN ESDM
- PERTAMINA
- UNIVERSITY

GGR CASE STUDY OF NORTH SUMATERA AND SOUTH KALIMANTAN

- BALITBANG ESDM
- PUSDATIN ESDM
- PERTAMINA
- UNIVERSITY

2013

- BALITBANG ESDM
- DJ MIGAS
- PERTAMINA

DETAIL GGR STUDY OF NORTH SUMATERA AND SOUTH KALIMANTAN TO DEFINE WELL LOCATION

- BALITBANG ESDM
- PUSDATIN ESDM
- PERTAMINA
- UNIVERSITY

- NAT/INTERNATIONAL PUBLICATION

LAND PREPARATION AND DRILLING PERMITTION

- BALITBANG ESDM
- DJ MIGAS
- PERTAMINA

- NAT/INTERNATIONAL PUBLICATION

2015

- BALITBANG ESDM
- DJ MIGAS
- PERTAMINA

- RESERVE ESTIMATION
- NAT/INTERNATIONAL PUBLICATION

DRILLING, WELL EVALUATION AND RESERVE CALCULATION

- BALITBANG ESDM
- DJ MIGAS
- PERTAMINA

- NAT/INTERNATIONAL PUBLICATION

MONITORING PRODUCTION

- BALITBANG ESDM
- PERTAMINA

- RESERVE ESTIMATION
- NAT/INTERNATIONAL PUBLICATION

DISCOVERY?

NEW GAS RESERVE

LAND PREPARATION AND DRILLING PERMITTION

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- PERTAMINA

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- NAT/INTERNATIONAL PUBLICATION

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DISCOVERY?
SHALE GAS POTENTIAL STUDY IN NORTH SUMATRA
METHODOLOGY

1. Basement Configuration Mapping
   1a. Plotting key lines and key wells

2. Identification of Shale gas bearing Fm

3. Mapping of shale bearing Formation
   3a. Velocity modeling
   3b. Basin history

4. Inversion and attributes
   4a. Petrophysical analysis

4b. Temp. Calibration

Source Rock Analysis

5. Mapping of Shale Gas Play

6. Define Play fairway

7. Shale Gas Resources calculation

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PARAMETER | DESIRED RESULT
---|---
Mineralogy | > 40% Quartz or Carbonates < 30% Clays Low expandability Biogenic vs detrital silica
Thickness | > 30 m
Depth | Shallowest depth in wet gas window
TOC | > 2%
Thermal Maturity | Wet Gas window > 1.0 Ro
Gas Composition | Low CO2, N, and H2S
Gas Filled Porosity (Bulk Volume Gas) | > 2% Gas Filled Porosity
Gas Type | Thermogenic
Internal Vertical Heterogeneity | Less is better
Wettability | Oil prone wetting of Kerogen
OGIP (free and Sorbed) | > 100 BCF / section
Permeability | > 100 mD and < 0.1 mD
Poisson’s Ratio (static) | < 0.25
Pressure | > 0.5 psi/ft
Reservoir Temperature | > 230 F
Seals | Fracture Barriers Present Top and Base
Shows | High gas Readings - Production
Fracture Fabric and Type | Vertical vs horizontal orientation
Stress | < 2000 psi Net Lateral Stress
Young’s Modulus | > 3.0 MMPSIA
Dehydration effect (Sw) | < 40% Sw

Modified after George E. King, Apache Corporation SPE
LOCATION OF NORTH SUMATRA BASIN
STRATIGRAPHY OF NORTH SUMATRA BASIN

(Kjellgren & Sugiarto, 1989)
Number of Sample: 42 (4 wells: 32 samples; outcrop: 10 samples)

- **Lithology**: Shale/ Fossilliferous Shale
- **Mineralogy**: Quarzt (27 - 42%), Carbonate (17 - 44%), Clay (15 - 33%)
- **Britt. Index**: 0.44 – 0.78 (Av.: 0.64)
- **TOC**: 0.53 – 1.93 (Av.: 1.18)
- **Tmax**: 426 - 464˚C (Av.: 433˚C)
- **VR**: 0.56 – 0.64 (Av.: 0.60)

Summary : fair - good shale gas quality
**BELUMAI FORMATION**

**Number of Sample:** 17 (2 wells: 9 samples; outcrop: 8 samples)

- **Lithology:** Fossiliferous Shale
- **Mineralogy:** Quartz (36 - 52%), Carbonate (18 -30%), Clay (20 - 32%)
- **Britt. Index:** 0.54 – 0.78 (Av.: 0.67)
- **TOC:** 0.69 – 1.75 (Av.: 1.06)
- **Tmax:** 423 - 472˚C (Av.: 447 °C)

**Summary:** fair - good shale gas quality
Sample No : TKH-11-5

**BAMPO FORMATION**

**Number of Sample**: 18 (1 well: 3 samples; outcrop: 15 samples)

- **Lithology**: *Silty Shale*
- **Mineralogy**: Quartz (33 - 48%), Carbonate (10 – 19%), Clay (20 - 60%)
- **Britt. Index**: 0.45 – 0.76 (Av.: 0.56)
- **TOC**: 0.1 - 0.76% (Av.: 0.44)
- **Tmax**: 437 - 441°C (Av.: 438 °C)
- **VR**: 0.92 – 1.09 (Av.: 0.95)

**Summary**: fair shale gas quality
## Table 4
**Thermal Maturity and Potential Source Rock Summary**

**DIPA 2013 - Shale Gas Study on North Sumatera Surface Samples**

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<thead>
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<th>No.</th>
<th>Age</th>
<th>Formation</th>
<th>Traverse</th>
<th>Sample No.</th>
<th>Analised Lithology</th>
<th>TOC (% of Total Organic Carbon)</th>
<th>S2 (Amount of Hydrocarbon released from kerogen)</th>
<th>PY (Potential Yield)</th>
<th>VR (Vitrinite Reflectance)</th>
<th>Tmax (Maximum Temperature (°C) at the top of S2 peak)</th>
<th>TAI (Thermal Alteration Index)</th>
<th>Liptinite (Macerobranchiate)</th>
<th>Fluorescence</th>
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**Notes**
- TOC: Total Organic Carbon
- S2: Amount of Hydrocarbon released from kerogen
- PY: Potential Yield
- NDF: No Determination Possible
- VR: Vitrinite Reflectance
- Tmax: Maximum Temperature (°C) at the top of S2 peak
- TAI: Thermal Alteration Index
- Liptinite Fluorescence
- Stage of Thermal Maturity
- Geochemically Potential Shale Gas Potential

**Columns:**
- **No.**
- **Age**
- **Formation**
- **Traverse**
- **Sample No.**
- **Analised Lithology**
- **TOC (% of Total Organic Carbon)**
- **S2 (Amount of Hydrocarbon released from kerogen)**
- **PY (Potential Yield)**
- **VR (Vitrinite Reflectance)**
- **Tmax (Maximum Temperature (°C) at the top of S2 peak)**
- **TAI (Thermal Alteration Index)**
- **Liptinite (Macerobranchiate)**
- **Fluorescence**
- **Stage of Thermal Maturity**
- **Geochemically Potential Shale Gas Potential**
ATTRIBUTE AND MODEL COMBINE TO IDENTIFY SWEET SPOTS

LITHOLOGY DISTRIBUTION

AI DISTRIBUTION + FREQUENCY CONTENT
SHALE GAS POTENTIAL STUDY IN SOUTH KALIMANTAN
LOCATION OF BARITO BASIN, SOUTH KALIMANTAN

(Satyana et al., 1999)
STRATIGRAPHY OF BARITO BASIN, SOUTH KALIMANTAN

SHALE GAS PROSPECT

(Rotinsulu, 1993)
TANJUNG FORMATION

Sample No : GB-7

No. samples : 20

- Lithology : Silty Shale
- Mineralogy : Quartz, Carbonate, and Clay
- Brittleness Index (average) : 0.59
- TOC (average) : 0.53
- Tmax (average) : 450°C

Summary : poor - fair shale gas quality
PROSPECT SHALE GAS OF TANJUNG FORMATION

PROSPECT AREA
(BELOW 5200M)
PILOT PROJECT II (2014-2019)
ROAD MAP OF THE PROJECT
SHALE GAS POTENTIAL STUDY IN SOUTH SUMATRA
LOCATION OF SOUTH SUMATRA BASIN

Area Jelapang-Rukam

Area Tepus

Area Kemang

Area Singa

Batas antara Sub-Cekungan
TARGET OF SHALE PLAY
ESDM untuk Kesejahteraan Rakyat

OUTCROPS IN GUMAI AREA
(LAHAT AND BUNGA MAS)
SOUTH SUMATRA PROVINCE

Kesimpulan:
1. Lintasan S. Lematang termasuk pada F. Gumai yang berumur Miosen Awal (NN4 atau N8) setara dengan Sikuen-5.
2. Lintasan S. Aek Asam termasuk pada F. Talang Akar yang berumur Miosen Awal (NN1 atau N4).
4. HI dibawah 200, Gas prone, Berdasarkan nilai Tmax percontoh yang dianalisis berada pada kategori awal hingga puncak kematangan (454-472), namun percontoh-percontoh tersebut memiliki nilai S2 yang rendah. Hal ini menyebabkan nilai dari Tmax yang dihasilkan menjadi kurang akurat. Menanggapi hal tersebut maka diperlukan analisis vitrinite reflectance (dalam proses pengerjaan).
5. Tingkat kerapuhan kedua formasi (sikuen) tinggi, ditandai oleh kelimpahan mineral-mineral rapuh (kuarsa, karbonat dan feldspar) bernilai >50% dan mineral lempung (15-40%). Pada Sikuen-3 (F. talang Akar) kerapuhan terutama dikontrol oleh kuarsa, namun pada Sikuen-5 (F. Gumai) selain dikontrol kuarsa, kerapuhan juga dikontrol mineral karbonat.
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<th>X</th>
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**KEROGENE TYPE : TYPE III**
CONCLUSION
North Sumatra:
- Formations prospect containing shale gas are Baong, Belumai and Bampo
- Bampo Formation indicates fair shale gas quality, whereas Belumai and Baong Formations show fair-good shale gas quality
- Resources shale gas calculation of the formations reveal 114.35 TCF

South Kalimantan:
- Formation prospect containing shale gas is Tanjung
- Tanjung Formation indicates poor-fair shale gas quality
- Resources shale gas calculation of the formation reveals 165.1 TCF

South Sumatra (South and Central Palembang Subbasins):
- Formations prospect containing shale hydrocarbon are Lahat, Talang Akar and Gumai
- Lahat Formation indicates good shale hydrocarbon quality
- Resources shale hydrocarbon calculation of the formation reveals 15.6 TCF and 1552.2 MMBOE
Thank You