CCOP – KIGAM Unconventional Oil and Gas Project:
Mapping of Black Shale Formations for the Prediction of Shale resources (UnCon or UC Project)

HYDROCARBON SHALE RESOURCES IN INDONESIA
Siem Reap, Monday 7 March 2016.

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
Outline

• Introduction
• The development of hydrocarbon shale research in Indonesia
• Future Expectations
• Closing Remarks
Introduction

- Indonesia has identified 128 Sedimentary Basins (Geological Agency, 2009). Basin assessments will reveal the conventional and unconventional hydrocarbon potential.
- Indonesia that has a long history for an oil & gas producing country, is predicted to have abundant of Hydrocarbon Shale that spread out in some mature basins.
- Indonesia geologically has large potential of hydrocarbon shale. Geological Agency (2011) propose total speculative resources of shale gas in Indonesia for about 574.07 TCF.
- Shale gas pilot project is conducted in the most prospecting areas by Lemigas and Geological Agency in order to prove their potential reserves in a commercial basis.
Indonesia Sedimentary Basins and Hydrocarbon Shale Potential

The Promising Hydrocarbon Shale Resources in some Sedimentary Basin in Indonesia
The development of hydrocarbon shale research in Indonesia

- Lemigas Pilot Project
- General Overview of Hydrocarbon Shale Basin
- Latest Conditions and Ongoing Research Projects
ROAD MAP PILOT PROJECT OF SHALE GAS EXPLORATION IN NORTH SUMATRA AND SOUTH KALIMANTAN

Lemigas cooperation with PT. Pertamina EP in: Pilot Project Phase 1

- Regional Geology and Geophysics Study of Shale Gas Potential
- Geology, Geophysics and Reservoir (GGR) Study of Shale Gas Prospect, and propose well location
- Detail Geology and Geophysics Study of Shale Gas potential
- Drilling, Fracturing and Production Evaluation of Shale Gas Prospect
General Overview of Hydrocarbon Shale Basin

• North Sumatera Basin
• Barito Basin
• South Sumatera Basin
  – South&Central Palembang SubBasin
  – North Palembang&Jambi SubBasin
Methods of mapping and resource calculation of hydrocarbons shale that do are as follows:

Workflow of sweet spot identification
North Sumatera

(Kjellgren & Sugiarto, 1989)
Sample No: BK-25

Amount of sample: 42 (4 well, 32 sample; outcrop: 10 sample)

- **Litology**: Shale/ Fossilliferous Shale
- **Mineralogy**: Quartz (27 - 42%), Carbonate (17 - 44%), Clay (15 -33%)
- **Britt. Index**: 0.44 – 0.78 (rata2: 0.64)
- **TOC**: 0.53 – 1.93 (average: 1.18)
- **Tmax**: 426 - 464°C (average: 433°C)
- **VR**: 0.56 – 0.64 (average: 0.60)

Summary: fair - good shale gas quality
BELUMAI FORMATION

Amount of Sample: 17 (2 well, 9 sample, outcrop: 8 sample)

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

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

Amount of Sample: 18 (1 well, 3 sample, outcrop: 15 sample)

- **Litology:** *Silty Shale*
- **Mineralogy:** Quartz (33 - 48%), Carbonate (0 – 19, Clay (20 - 60%))
- **BI:** 0.45 – 0.76 (average: 0.56)
- **TOC:** 0.1 - 0.76 (average: 0.44)
- **Tmax:** 437 - 441°C (average: 438 °C)
- **VR:** 0.92 – 1.09 (average: 0.95)

**Summary:** fair shale gas quality
NW – SE SEISMIC SECTION OF NORTH SUMATRA BASIN

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 (Barito Basin)

(Satyana et al., 1999

(Rotinsulu, 1993)

SHALE GAS PROSPECT
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
South Kalimantan:
- Formations prospect containing shale gas is Tanjung
- Tanjung Formation indicates poor-fair shale gas quality
- Resources shale gas calculation of the formations reveal 165.1 TCF
South Sumatera Basin (South and Central Palembang SubBasin)
Regional Stratigraphy of South Sumatera Basin
SEISMIC SECTION IN BETWEEN JELAPANG-1 – WAHALO-1

Shale gas Play
Perhitungan P-50 dari *Original Gas In Place (OGIP)* berdasarkan Interpretasi area *sweet spot* Sekuen II antara SB-1.1 – SB-2 di area Kemang dan sekitarnya berdasarkan kriteria:
- Cenderung Tipe Kerogen III
- Gas Window (Ro sekitar 1,0) pada kedalaman sekitar 3100 m
- (batas garis merah)
- Perhitungan P-50 dari *Original Oil In Place (OOIP)*, batas garis kuning
- Ketebalan > 30 m dan kedalaman ≤ 4000 m

<table>
<thead>
<tr>
<th>Area</th>
<th>Sekuen</th>
<th>Kedalaman gas window (m)</th>
<th>Bulk Volume (acre.ft)</th>
<th>Bulk Volume (m³) [pet]</th>
<th>Bulk Volume (cm³)</th>
<th>Net Volume (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kemang</td>
<td>SB-1.1 - SB-2</td>
<td>3100</td>
<td>7,99E+07</td>
<td>9,85E+10</td>
<td>9,85E+16</td>
<td>4,92588E+16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density (gr/cm³)</th>
<th>Mass of Rock Unit (gr)</th>
<th>Mass of Rock Unit (ton)</th>
<th>Gas Content (scf/ton)</th>
<th>Ads. Gas in Place (TCF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,6</td>
<td>1,28073E+17</td>
<td>128,072,750,000</td>
<td>40</td>
<td>5,123</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density (gr/cm³)</th>
<th>Mass of Rock Unit (gr)</th>
<th>Mass of Rock Unit (ton)</th>
<th>PH₁e</th>
<th>Sw</th>
<th>Bg (rcf/scf)</th>
<th>Free Gas volume (scf/ton)</th>
<th>Free Gas in Place (TCF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,6</td>
<td>1,28073E+17</td>
<td>128,072,750,000</td>
<td>0,04</td>
<td>0,6</td>
<td>0,0069</td>
<td>28,633</td>
<td>3,667</td>
</tr>
</tbody>
</table>

N/G shale ~ 50%
South Sumatra (South and Central Palembang Subbasins):

- Formations prospect containing hydrocarbon shale are Lahat, Talang Akar and Gumai.
- Lahat Formation indicates good shale hydrocarbon quality.
- Resources hydrocarbon shale calculation of the formation reveals 15.6 TCF and 1,552.22 MMBOE.
South Sumatera Basin (South and Central Palembang SubBasin)
Characteristics of Shale Hydrocarbon plays,

**Depend on:**

- *Field survey data (surface geology)*

Location of field observations

Kolom Stratigrafi Detil Lintasan survei area LMD
COMPOSITE SEISMIC LINE PAST THROUGH DEEP AREA
(MERANG DEEP, EAST KETALING DAN KETALING)

Structural Element Map of South Sumatera Basin

Stratigraphy Column
South Sumatera Basin
Deep Area as target Source Rock Reservoir (SRR)
South Sumatra (North Palembang and Jambi Subbasins):

- Formations prospect containing shale hydrocarbon are Lahat/Lemat, Talang Akar and Gumai.
- Lahat Formation indicates good shale hydrocarbon quality.
- Resources shale hydrocarbon calculation of the formation reveals 54.77 TCF and 165.55 MMBOE.
Latest Conditions and Ongoing Research Projects

• The government accommodates mapping and calculation of potential hydrocarbon Shale conducted by LEMIGAS

• In fiscal year 2016 mapping was continued and as the roadmap that has been made then this year's event is in Central Sumatra Basin

• Until now, the activities carried out are still limited exploration (preliminary exploration)
Future Expectations

• Government Policy
  – Non Conventional contract revisions to increase exploration
  – To accelerate exploration Hydrocarbon, the government formed a national Exploration committee on June 11, 2015. One of its tasks is non-conventional oil and gas research on Tertiary basins, the government encouraged companies to drill shale hydrocarbons

• Business activities
  – Until now there are 5 blocks WK MNK operated by national private and only at the exploration stage with locations in North Sumatra Basin, central Sumatra and South Sumatra

<table>
<thead>
<tr>
<th>Block</th>
<th>Year</th>
<th>Basin</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNK SUMBAGUT</td>
<td>17 MAY 2013</td>
<td>North Sumatera</td>
<td>Explorasi</td>
</tr>
<tr>
<td>MNK KISARAN</td>
<td>22 MAY 2015</td>
<td>North Sumatera</td>
<td>Explorasi</td>
</tr>
<tr>
<td>MNK SAKAKEMANG</td>
<td>22 MAY 2015</td>
<td>South Sumatera</td>
<td>Explorasi</td>
</tr>
<tr>
<td>MNK SELAT PANJANG</td>
<td>22 MAY 2015</td>
<td>Central Sumatera</td>
<td>Explorasi</td>
</tr>
<tr>
<td>MNK PALMERAH</td>
<td>22 MAY 2015</td>
<td>South Sumatera</td>
<td>Explorasi</td>
</tr>
</tbody>
</table>

  – Currently being offered by the government three blocks located in South Kalimantan and Central Java
Closing Remarks

• Results of mapping and resource calculation Shale gas is was done in Sumatra and Kalimantan showing results quite promising.
• Until now there has been no direct technical evidence about whether shale basins in Indonesia can be fracturing to produce oil or gas, drilling should be done immediately.
• Pertamina as the government company plans to drill in 2017.
• Is very important in terms of psychological and investment as soon as possible to prove whether shale Indonesia is technically able to produce hydrocarbons.
• With the existence of CCOP - KIGAM Unconventional Oil and Gas Project: expected to encourage an increase in science and knowledge in the exploration of shale Hydrocarbon.
Thank You

www.lemigas.esdm.go.id
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)
<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Formation</th>
<th>Sample No.</th>
<th>Analysed Lithology</th>
<th>Petroleum Potential (Quantity)</th>
<th>Thermal Maturity</th>
<th>Kerogen Type (Quality) and Expelled Product</th>
<th>Geochemically Shale Gas Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Sanga Bala (Basement)</td>
<td>S.BGL-22</td>
<td>Cvt.digs, per</td>
<td>1.25</td>
<td>Good</td>
<td>3.73</td>
<td>1.32</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Sanga Bala (Basement)</td>
<td>S.BGL-20</td>
<td>Cvt.digs, per</td>
<td>1.70</td>
<td>Good</td>
<td>4.84</td>
<td>0.83</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Sanga Bala (Basement)</td>
<td>S.BGL-18</td>
<td>Cvt, med.digs, per</td>
<td>0.67</td>
<td>Fair</td>
<td>1.46</td>
<td>1.63</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Panga Bala (Kyanite)</td>
<td>KS-1A</td>
<td>Sh, brngs, calc</td>
<td>1.74</td>
<td>Good</td>
<td>7.72</td>
<td>8.27</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Panga Bala (Kyanite)</td>
<td>KS-18</td>
<td>Sh, brngs, calc</td>
<td>1.50</td>
<td>Good</td>
<td>6.51</td>
<td>7.03</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Panga Bala (Kyanite)</td>
<td>KS-1C</td>
<td>Sh, brngs, calc</td>
<td>1.30</td>
<td>Good</td>
<td>5.29</td>
<td>5.79</td>
</tr>
</tbody>
</table>

**Notes:**
- TOC: Total Organic Carbon
- S2: Amount of Hydrocarbon released from kerogen
- Tmax: Maximum Temperature (°C) at the top of T2 peak
- PI: Potential Index
- TAI: Thermal Alteration Index
- NPD: No Determination - Possible
- *: Erroneous Tmax Readings due to lack of S2
METHODOLOGY