Oil Shale Resource in Mae Sot Basin, Thailand

By

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Outlines

- Distribution of Oil Shale Resources
- Previous Exploration and Development
- Oil Shale Resource in Mae Sot Basin
  - Occurrence
  - Characteristics of Mae Sot Basin
  - Reserves of Oil Shale
  - Quality of Oil Shale
- Future Plan of Oil Shale Development
Distribution of Oil Shale Sources

15 sources in 11 provinces

Mae Hong Son Province
Chiang Mai Province
Lamphun Province
Tak Province
Kung Petch Province
Surat Thani Province

Chiang Rai Province
Lampang Province
Uttaradit Province
Petchabun Province
Petchaburi Province

The largest oil shale reserve in Mae Sot Basin is 18,668 million tons (97.3% of total reserve)

Source: Surapol Tanomsap, 1983
Previous Exploration and Development

- Department of Mineral Resources exploration program 1935 - present
  - Geology and Geophysics of Mae Sot Basin
  - Quality of Oil shale in many areas
  - Direction of oil shale development including oil production and using as fuel for power generation and cement industry

- In 1982, Thai Government co-operated with a German company on feasibility study of oil shale for power plant

- Other developments:
  - Ash left over from the oil shale development project is used in other industries, i.e., Cement, Brick, Fertilizer.

- Thai Government currently studying feasibility of oil shale for power plant at Ban Haui Kalok, Mae Sot Basin.
Mae Sot Basin

Location: Mae Sot and Mae Ramat Districts, Tak Province

- Latitude: 16° 42’42’’ N
- Longitude: 98° 34’42’’ E
- Approximately 600 sq. km.
- 55 km long and 15 km wide
- 2/3 located in Thailand
- 1/3 located in Myanmar
General Geology and Reserve

General Geology

Intermontane Tertiary basin

Era : Cenozoic
Environment of deposit: Fluvial to Lacustrine environment

Reserve of Oil shale in Mae Sot Basin

<table>
<thead>
<tr>
<th></th>
<th>Oil shale (million tons)</th>
<th>Oil recover (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>18,668</td>
<td>810</td>
</tr>
</tbody>
</table>

Source: Department of Fuel and Surapol Tanomsap, 1983
Characteristics of Mae Sot Basin

Gravity Magnetic Survey

2 Subbasins
- Northern Subbasin (A)
- Southern Subbasin (B) cover 250 sq.km.

Source: Department of Mineral Fuel
Further Study

- Department of Mineral Resources (1997)
- Investigated 315 sq. km. area
- Detailed study of
  - Geology
  - Geophysics
  - Drill holes
Characteristic of Mae Sot Basin

Type of fold : Syncline

Direction of Fold Axis : NW-SE

Direction of Bedding
  East : N17° W /20-25° W
  West : N20° W /30-45° E

Main faults
  Trending : NS
  Dip direction : E

Trending of minor faults
  NE and NW
The Stratigraphy in Mae Sot Basin

Recent

Tertiary (Surapol Tanomsap, 1983)
- Mae Sot Formation
- Mae Pa Formation
- Mae Ramart Formation

Pre Tertiary

Limestone

Source: Department of Mineral Fuel
Seismic Coverage
of
Mae Sot Basin

Consist of

10 Seismic lines in southern part
7 Seismic lines in northern part
Seismic Lines of Southern Mae Sot Basin

Consist of 10 Seismic line
Seismic Stratigraphy of Southern Part

From the seismic interpretation, the stratigraphy can be divided into 6 Units

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Time section (MSO 0640)</th>
<th>Depth (m)</th>
<th>Seismic Unit</th>
<th>Age</th>
<th>Description</th>
<th>Environmental of Deposit</th>
<th>Rock Unit (Fig. 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>Quaternary</td>
<td></td>
<td>Soil, unconsolidated clay and sand.</td>
<td>Fluvial</td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>A</td>
<td>Middle-Upper Miocene</td>
<td></td>
<td></td>
<td>Shale interbedded with oil shale thick bed and some thin bed in lower part of unit.</td>
<td>Lacustrine</td>
<td></td>
</tr>
<tr>
<td>310</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td>Shale, thin bed and calcareous siltstone, low-medium grade oil shale intercalation.</td>
<td>Shallow Lacustrine</td>
<td></td>
</tr>
<tr>
<td>460</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>Shale and oil shale, thick bed, medium - high grade.</td>
<td>Lacustrine</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>D</td>
<td>Lower Miocene</td>
<td></td>
<td></td>
<td>Shale, low grade oil shale and sandstone interbeded.</td>
<td>Fluvial - Lacustrine</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>E</td>
<td>Upper Oligocene</td>
<td></td>
<td></td>
<td>Shale, marl and sandstone with oil shale.</td>
<td>Shallow Lacustrine and Fluvial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>Sandstone, calcareous sandstone with limestone lens.</td>
<td>Fluvial and Barrier</td>
<td></td>
</tr>
</tbody>
</table>
Unit A

Time-Depth Structural Contour of Lower surface of Unit A

(seismic datum 100 ms = 150 MSL)

The first priority unit in oil shale exploration

Thickness of Unit A : 200 - 500 m

Oil shale bedding : 4-5 layers of thick bed

Quality of oil shale : High grade

Environment of Deposit : Lacustrine

Age : Upper Miocene

The deepest unit A : 500 m
Unit C

Time-Depth Structural Contour of
Lower surface of Unit C
(seismic datum 100 ms = 150 MSL)

One of target units in oil shale exploration

Thickness of Unit C: 250 m

Oil shale thickness: Thick bed

Grade of oil shale: Medium to High grade

Environment of Deposit: Lacustrine

Age: Middle Miocene

The deepest unit C: 900 m
Seismic Coverage of Northern Mae Sot Basin

Consist of 7 Seismic lines
Seismic Stratigraphy of Northern Part

Thickness of Unit A: in Northern Part > in Southern Part

<table>
<thead>
<tr>
<th>Layer</th>
<th>Deposition of Depletion</th>
<th>Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Soil</td>
<td>Soil, unconsolidated sand and gravel</td>
<td>Fluvial</td>
</tr>
<tr>
<td>Middle-Upper Miocene</td>
<td>Shale interbeded with oil shale thick bed and high graded oil shale in the middle part of unit.</td>
<td>Lacustrine</td>
</tr>
<tr>
<td>Shale, thin bed, low-medium grade oil shale intercalation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Oligocene-Lower Miocene</td>
<td>Shale, marl and sandstone with oil shale interbeded.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Mineral Fuel
Boreholes in Mae Sot Basin

166 Drill Holes
# Oil Shale Reserve

**Estimated by USGS Cir 891 method**

**Circle Area around 166 Drill Holes**

(Radius 400 m)

<table>
<thead>
<tr>
<th>Oil shale</th>
<th>Oil Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million Tons</td>
<td>Million Gallons</td>
</tr>
<tr>
<td>Measured</td>
<td>952.38</td>
</tr>
</tbody>
</table>

*Remark 1 barrel = 42 gallons*

Source: Department of Mineral Resources, 1998
Oil Shale Layers

Thickness ranges from 0.5 – 30 m

Depth: Northern area shallower than Southern area

Thickness of oil shale layer: North > South

Conformity of oil shale bedding: North > South

Source: Department of Mineral Resources
Quality of Mae Sot Oil Shale

Composition of organic material: Exinite
The common Exinite: Alginite (Cook et al., 1981)
The others: Resinite, Sporinite, and Humic

Classification of Oil Shale Quality

(T.A Hendricksen, 1975)

<table>
<thead>
<tr>
<th>Grade of oil shale</th>
<th>Oil content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gallons/ton</td>
</tr>
<tr>
<td>Low-grade</td>
<td>10</td>
</tr>
<tr>
<td>Medium-grade</td>
<td>27</td>
</tr>
<tr>
<td>Good-grade</td>
<td>36</td>
</tr>
<tr>
<td>High-grade</td>
<td>62</td>
</tr>
</tbody>
</table>

Quality of Mae Sot oil shale: Low grade to High grade

Oil yield: varies from 1-26% by weight or about 2.5 – 65 gallons per ton

Average of oil yield: about 5% by weight or 12 gallons per ton
## Quality of Oil Shale

<table>
<thead>
<tr>
<th>Properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat capacity (cal/g)</td>
<td>700 -4,000</td>
</tr>
<tr>
<td>Ash %</td>
<td>56-70</td>
</tr>
<tr>
<td>Organic%</td>
<td>10 - 24</td>
</tr>
<tr>
<td>Moisture (wt %)</td>
<td>3.3 – 69.7</td>
</tr>
<tr>
<td>Sulfur (wt %)</td>
<td>0.6 - 1.3</td>
</tr>
<tr>
<td>Spent shale %</td>
<td>66 - 94</td>
</tr>
<tr>
<td>C : H</td>
<td>7.5</td>
</tr>
</tbody>
</table>

### Ash Analysis (wt %)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>38</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>13</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>5</td>
</tr>
<tr>
<td>CaO</td>
<td>23</td>
</tr>
<tr>
<td>MgO</td>
<td>7</td>
</tr>
<tr>
<td>Others</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: Department of Mineral Fuel and Department of Mineral Resources
Potential Area

Results of Seismic line and borehole location

Potential area: Northern part, above Ban Haui Kaloke

Average of oil yield: more than 5 gallons per ton

Overburden: between 0 - 30 m.

Thickness: between 2 - 50 m.

Striping ratio: 7.02

Source: Department of Mineral Resources
**Oil Yield Estimate in Potential Area**

Ranges of oil yield:
- **Oil yield ≥ 5%** (24% of area)
- **4% ≤ oil yield < 5%**
- **Oil yield < 4%**

Oil yield average: 14.04 gallons/ton

Thickness average: 11.35 m.

Striping ratio: 155,127,5794 ton

: 163,964,757 ton

: 9.46

Source: Department of Mineral Resources
Future Plan of Oil Shale Development

There is cooperation among Government agencies including Department of Mineral Resources, Department of Mineral Fuel and Electricity Generating Authority of Thailand, to conduct a feasibility study on the use of Mae Sot oil shale for power generation.
Conclusion

1. The measured reserve is 952.38 million tons and oil yield is 182.85 million barrels

2. Quality of oil shale varies from low grade to high grade because of highly heterogeneous texture

3. The thickness and conformity of oil shale layers in Northern area is better than Southern area

4. The depth of oil shale in Northern area is shallower than Southern area

5. The potential area is at Ban Huai Kaloke
Thank you

Q & A