URANIUM AND THORIUM EXPLORATION ACTIVITIES AND THEIR PROCESSING RESEARCH IN INDONESIA

Interregional IAEA-CYTED-UNECE Workshop on Recent Developments in Evaluation of Uranium and Thorium Resources
15 – 18 October 2012
by
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CENTRE FOR DEVELOPMENT OF NUCLEAR GEOLOGY
NATIONAL NUCLEAR ENERGY AGENCY (BATAN)
INDONESIA
✓ GENERAL URANIUM EXPLORATION ACTIVITIES
   Exploration and maintenance facilities in West Kalimantan

✓ GENERAL THORIUM EXPLORATION ACTIVITIES
   Uranium and Thorium Exploration In Bangka and Ketapang

✓ MINING ASSESSMENT
   Uranium type at Eko Remaja, Kalan, West Kalimantan

✓ RESEARCH ON URANIUM AND THORIUM PROCESSING
   • Uranium Ore Processing (Tourmaline and Monazite Type)
   • Thorium Processing (Monazite and Slag II Material)

✓ CONCLUSION
Exploration activities have been carrying out since early 1960s, with peak of the activities was on 1976 – 1985.

Since 1996 the exploration activities was focused in Kalan area and its surrounding in Kalimantan, related with Metamorphic Rock.


Since 2011 – 2012 Exploration in Papua

Uranium and Thorium exploration as placer deposit in Bangka Island and Ketapang, West Kalimantan
# EXPLORATION OF URANIUM

<table>
<thead>
<tr>
<th>NO.</th>
<th>EXPLORATION RESOURCES AREA</th>
<th>STAGE</th>
<th>COVERAGE AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sumatera</td>
<td>Reconnaissance and General prospection</td>
<td>146.523 km²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detail and Systematic prospection</td>
<td>1.686,25 km²</td>
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<tr>
<td></td>
<td></td>
<td>Exploration Drilling</td>
<td>2.805 m</td>
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<td>2.</td>
<td>Java</td>
<td>Reconnaissance and General prospection</td>
<td>2.125 km²</td>
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<td></td>
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<td>Detail and Systematic prospection</td>
<td>10 km²</td>
</tr>
<tr>
<td>3.</td>
<td>Kalimantan</td>
<td>Reconnaissance and General prospection</td>
<td>230.140 km²</td>
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<td></td>
<td></td>
<td>Detail and Systematic prospection</td>
<td>83.178,2 km²</td>
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<td></td>
<td></td>
<td>Exploration Drilling</td>
<td>62.461,02 m</td>
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<tr>
<td>4.</td>
<td>Sulawesi</td>
<td>Reconnaissance and General prospection</td>
<td>36.190 km²</td>
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<td></td>
<td>Detail and Systematic prospection</td>
<td>107 km²</td>
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<td>5.</td>
<td>Papua</td>
<td>Reconnaissance and General prospection</td>
<td>7.815 km²</td>
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<tr>
<td></td>
<td></td>
<td>Detail and Systematic prospection</td>
<td>240 km²</td>
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<td>6.</td>
<td>Bangka Belitung</td>
<td>Reconnaissance and General prospection</td>
<td>9.487 km²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detail and Systematic prospection</td>
<td>4 km²</td>
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</table>
The uranium exploration discovered the resources areas classified as speculative, indicated and potential of radioactive minerals occurrence.
Several Uranium Sectors have been recognized in Kalan Prospect.

Two sectors have been selected for represent its prospect based on the ore types ie. Eko-Remaja sector for tourmaline type uranium ore and Rirang sector for monazite type uranium ore.

Total amount of uranium in this area is about 24,100 tonnes $U_3O_8$, comprises of speculative to potential resources.
KALAN PROSPECT

EKO-REMAJA SECTOR

• Tectono-genetically uranium deposits comprises of 66 veins almost parallel to the schistocity strike of superstructure of Kalan Basin (N70°-N90°E). The veins consist of 6 types classified into 3 mineralization groups: sulphide-breccia vein, felspathic vein and quatzo-felspathic vein.

• Uranium minerals as uraninite and brannerite associated with sulphide minerals as pyrite, pyrhotite, chalcopyrite, lollingite, cobaltite, safflorite, gedorsfite, arsenopyrite, and sphalerite
EKO REMAJA URANIUM EXPLORATION TUNNEL
• Similar to Eko-Remaja, lithologically, the area consist of a favorable bed of metasiltstone enveloped by sterile massive metapelites consisted of upper andalusitic biotite metapelite and lower andalusitic jeronang metapelite.
URANIUM IN VOLCANIC ROCK, EAST KALIMANTAN AREA

Regionaly the geological of Kawat Area consist of four rocks unit:

Unit 1: Quartzite, metaclaystone, associated with ofiolit greenstone, and radiolaria (Upper Jura)
Unit 2: Blackshale associated with siltstone, and boulder of quartzite. (Middle-Lower Cretaceous)
Unit 3: Massive conglomeratic sandstone, alterated claystone, and sandstone (Upper Cretaceous – paleocene)
Unit 4: Plateau sandstone, conglomerate and acid volcanic rocks series whiches rich of Uranium (U) (Middle – Upper Eocene)

The Uraniferous occurrences are located in rhyolitic rocks in the lower part of Unit 4
Volcanic Vent Features

Vent Belug

Vent Palug
General Survey in Yahukimo Region, Papua, 2011

- Preliminary result of geological survey are found the zone of unconformity as brecciated zone as favourable zone of uranium prospect with relatively high of radiometric value (300 – 500 cps) with anomalous of geochemical analysis result from stream sediment samples value 3.84 to 19 ppm U in total prospect area of 175 km$^2$

Unconformity form in this field as very broad of breccia and fraturated zone. The zone has a relatively high radio metric value between 300 – 500 cps
URANIUM AND THORIUM EXPLORATION

General Survey in Bangka Island, and Ketapang, West Kalimantan

Jurassic – Triassic
Granitic Belt (Back Arc)
Reconstruction
Katili (1973)
Geologically U & Th as Monazite minerals on Bangka Belitung Island occurred in granite rock and deposition as placer deposits associate with other metal minerals. Monazite occurrence related with tin and zircon mining, and found in following process:

- **Granite Rocks**
- **Alluvial Deposit**

**Insitu**

- Mining Process
- Tailing
  - Tailing of Mining
  - Tailing of Washing Process

**Mining Product**

- Tin Sand
- Zircon Sand

**Processing Plan**

- By Product of Tin Processing
  - Monazite Concentrate
  - Ilmenite Concentrate
  - Zircon Concentrate
  - Slag II

**Tin Block**

: Natural Material contains U, Th & REE

: By Product Material contains U, Th & REE
In Granite Rocks

Insitu monazite minerals consist U, Th & REE occurred in weathered and fresh granite rocks.

Both weathered and fresh granite contained:
- U : 11-25 ppm
- Th : 25 – 500 ppm
Alluvial Deposits

Hypothetic Reserve Estimation

Based on Regional geological map alluvial wide area in Bangka island about ± 400,000 hectare, with alluvial thickness average about 12 m, grade U 100 ppm, Th 500 ppm and REE 3%.
Onshore and offshore mining process will produce tin and zircon sand. Besides that the mining process will produce waste materials contain light minerals (mainly quarts) and heavy minerals (casiterite/tin, ilmenite, monazite, zircon, xenotime, etc.)

Casiterite/tin or zircon upgrading process will dispose minerals that have less density, like monazite, xenotime, etc.

Grade U = 6 – 12 ppm
Th = 25-250 ppm
Physical Processing Unit (Washing Plant): Cyclone, Jig, Evaporator, High Tension Separator, Magnetic Separator.

Light Minerals

Tin Concentrate ≥ 70% → Processing Plan(*)

Zircon Concentrate ≥ 85% → stock pile

Ilmenit concentrate ≥ 80% → stock pile

Monazite Concentrate ≥ 60%, (RE ± 60%, U ± 0.3%, Th ± 3%, PO₄ ± 20%)
Slag-2

Slag-2 from tin smelter contains unsure, such as REE, U, Th, Ti, etc.

Contains:
- Sn = 1 – 7%
- RE = 7 – 10%
- U = ± 500 ppm
- Th = ± 5,000 ppm
- Ti = ± 14%
- Si = ± 22%
- Ca = ± 8%
- Al = ± 2%
- Fe = ± 7%
Monazite minerals on Ketapang, west Kalimantan occurrence related with zircon and spread in the fine – coarse sand alluvial deposits.

Based on Regional geological map alluvial debris that result from granitic rocks that contain monazite and deposited in the area around the river has a very wide distribution.
MINING METHODE ASSESSMENT

Mining method for uranium type in Eko Remaja, Kalan, West Kalimantan
LOADING POINTS AT BOTTOM LEVEL

- Stope
- Loading points
- Vertical centre pillar
- Decline
Uranium ore of Kalan was determined as tourmaline and monazite types.

tourmaline type can be more effectively processed to produce the yellow cake by implementing acid method.

monazite type have been done to yield the yellow cake by basic method.

processing of uranium and thorium from monazite as by product of tin and zircon mining still conducted.
Yellowcake Product Composition

<table>
<thead>
<tr>
<th>Elements</th>
<th>Assay (%)</th>
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<tbody>
<tr>
<td>$\text{U}_3\text{O}_8$</td>
<td>66.8</td>
</tr>
<tr>
<td>$\text{H}_2\text{O}$</td>
<td>4.32</td>
</tr>
<tr>
<td>$\text{NH}_4$</td>
<td>5.6</td>
</tr>
<tr>
<td>$\text{SO}_4$</td>
<td>3.2</td>
</tr>
<tr>
<td>$\text{PO}_4$</td>
<td>0.23</td>
</tr>
<tr>
<td>$\text{Fe}_{\text{Tot}}$</td>
<td>0.42</td>
</tr>
<tr>
<td>Mg</td>
<td>0.12</td>
</tr>
<tr>
<td>Ca</td>
<td>0.32</td>
</tr>
<tr>
<td>Si</td>
<td>1.40</td>
</tr>
<tr>
<td>Mn</td>
<td>0.19</td>
</tr>
<tr>
<td>Na</td>
<td>1.9</td>
</tr>
<tr>
<td>Cu</td>
<td>0.19</td>
</tr>
<tr>
<td>Cr</td>
<td>0.015</td>
</tr>
<tr>
<td>Ni</td>
<td>0.010</td>
</tr>
<tr>
<td>V</td>
<td>0.005</td>
</tr>
<tr>
<td>Al</td>
<td>0.79</td>
</tr>
<tr>
<td>Undissolved elements in $\text{HNO}_3$</td>
<td>2.23</td>
</tr>
<tr>
<td>Others</td>
<td>12.26</td>
</tr>
</tbody>
</table>
Flowsheet Thorium extraction (from monazite)
- Uranium and Thorium exploration still in progress and continued in some potential places to inventory and increase category of the resources.

- Uranium and Thorium as a by product of tin and zircon mining have significant content, and need an intensive data collection.

- Uranium and Thorium processing from uranium ore and monazite as by product of other mining still developed.
For your kind attention

TERIMAKASIH