Wang Baowen, Ramu NiCo

Lateritic nickel ore in Papua New Guinea

Ramu NiCo Management（MCC）Ltd
Ramu Nickel project which integrates mining, beneficiation and refining is located in Madang Province, Papua New Guinea. As a successful mining projects completed over the past two decades, the total capital investment reached US$2 billion. The project is designed to produce nickel/cobalt intermediate product, in which the aggregate nickel metal accounts for 31,000 tones per year and cobalt 3,000 tones per year.

- Fully permitted and construction from 2006-2011
- Construction completion and load commissioning in December 2012
- 20-year mine life plus another 20-year resource
The project is composed of Kurumbukari (KBK) Mine, Basamuk (BSK) Refinery and a 135km long slurry pipeline connecting both sites.

KBK Mine is located on the Kurumbukari plateau, 600m to 800m above sea level and 75km to the southwest of Madang.

BSK Refinery is on the coast of Basamuk bay, 55km to the southeast of Madang, along the Rai Coast of Vitiaz Basin in PNG.

135km slurry pipeline is constructed along the Madang-Lae Highway and the coast line.
HISTORY

• First discovered in 1962. Followed by pre-feasibility study and exploration carried out by Highlands Pacific

• Special Mining License granted in 2000 and Metallurgical Corporation of China (MCC) joined the joint venture with Highlands Pacific and PNG government

• 2003-2005 Due Diligence, feasibility study and financing

• Project design and construction rolled out from 2006-2011

• Load commissioning commenced in March 2012. Project construction completion and commissioning ceremony held in December of the same year.
INVESTMENT STRUCTURE

- MCC Ramu, a subsidiary 100% owned by MCC, entered into a joint venture with Highlands Pacific and MRDC (Mineral Resources Development Company). MCC nominated Ramu NiCo Management to be the manager of the Ramu Nickel Joint Venture.

- MCC is a Chinese based multinational group which focuses its activities on engineering EPC, resources development, as well as equipment fabrication and real estate development.

- Highlands Pacific and MRDC are the PNG Parties. Highlands is incorporated in PNG and listed on the Australian Stock Exchange. MRDC represents the interest of PNG state and landowners in the Project.
In 2015, output is expected to increase to 83% and reaches full capacity in 2016.
With the completion of two enhancement projects, production is expected to reach 90% before the end of this year.
RESOURCES & OREBODY

- KBK Mine: Kurumbukari, Ramu West and Great Ramu
- Resources: 143.2 million tonne dry ore.

<table>
<thead>
<tr>
<th>Category</th>
<th>Mt Dry</th>
<th>Ni %</th>
<th>Co %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured</td>
<td>42.4</td>
<td>0.995%</td>
<td>0.11%</td>
</tr>
<tr>
<td>Indicated</td>
<td>29.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferred</td>
<td>71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- By-product: chromite concentrate annual output 160,000 t under full capacity

Laterite orebody Stratigraphy
- Back-hoe excavator mines the orebody and loads into articulated Volve truck.
- Truck transports ore on the haul road constructed by reject rocks from Washing plant and feeds into 4 ore-washing streams, which include drum washer, log washer and vibrating screen to remove rock and large size material above 3mm.
- Head slurry from washing is pumped to Beneficiation Plant to remove chromite through cyclone, spiral chutes and shaking table. Chromite is removed due to its abrasive effect on the long-distance pipeline.
- Slurry is thickened to 18% before being delivered to BSK processing plant. As altitude difference between KBK and BSK is about 700m, pumping pressure is normally not needed.
- Other facilities in the mine include diesel generators, fuel depot, maintenance workshop.
• Thickened slurry from mine is preheated before being fed into autoclaves for sulfuric acid leaching.
• Iron and aluminum are removed from the system after limestone neutralization and disposed through DSTP (Deep Sea Tailings Placement), a successful tailing disposal method used by the Project under environment permit.
• Precipitate nickel and cobalt is filtrated and bagged before storage and shipment.
• Most of MHP is sold in China’s market.
• Other facilities in the refinery include Acid Plant, Limestone processing plant, backup boilers, power generators and a 50,000t wharf.
3rd Asian Nickel Conference

SITE GALLERIES
**CHALLENGES**

**RESOURCE**
- Measured and indicated Ni grade 0.955% (vs 1.3% in other laterite mine); pulped nickel in the slurry 1.138% (autoclave)
- Nickel delivered to BSK 1.04% in 2014
- Nickel grade 1.096% in first half 2015, lower than design; impossible to reach designed target
- Nuisance metals (Mg, Al and Cr) higher than design

**MINING**
- Uneven stratigraphic distribution, high moisture and gravel
- Mining difficulty in wet season; demanding on road condition
- Geological disaster (flood, landslide) impacting slurry pipeline.
- Variance of large particle chromium content in slurry.
- Intensive pipeline maintenance in dry season; road construction and maintenance; new projects to remove chromium
CHALLENGES

• PROCESSING
  • Higher Al content and extraction creates more burden to Al/Fe removal circuit
  • Premature failure of autoclave feed pump check valve
  • Maintenance practice need to be improved from breakdown to planned
  • More AL/Fe processing facilities to be installed; technical improvement to extend check valve life over 1000hrs; preventative maintenance

• COMMUNITY AND LANDOWNER ISSUES
  • Private ownership of land title
  • Strong reliance on project developer to develop
  • Poor infrastructure, low education level and great sensitivity to environment protection
  • Followed project MoA (Memorandum of Agreement signed in December 2013) to involve with community development in relocation, land compensation, business opportunity, agricultural program, educational assistance etc.
ENVIRONMENT PROTECTION

• Approach: to ensure all business processes account for our environmental risks and impact

• Guideline: Environment Permit 2007
  Operational Environment Management Plan (OEMP)
  Final OEMP approved as the long-term plan for project operation by Department of Environment and Conservation on Sept 7, 2015

<Similarly, safety management is in strict compliance with PNG mining act and regulation as well as industry practice>

• Environment monitoring and control
• Daily, monthly, quarterly and yearly monitoring plan for dust, noise, water, emissions, biology, waste and tailings
• Third party independent consultants contracted to conduct survey; final report submitted to Department of Environment and Conservation

• KEY CONTROLS:
• Mine run-off and water erosion pit design, water sedimentation pond and rehabilitation
ENVIRONMENT PROTECTION

• SO2 emission from Acid Plant: designed as per World Bank standard and endeavor to minimize impact by engineering project (gas scrubber)

• Tailings

• DSTP: the most environmentally sound and practical decision in PNG given its landscape, continual erosion and high risk of earthquake

• We have been doing in
  ➢ the tailings toxicity analysis
  ➢ Determination of tailing discharge depth
  ➢ Total tailings discharge predication
  ➢ Impact control on marine life
  ➢ Awareness to communities

• Marine Baseine survey, ROV (remote operating vehicle) survey, underwater pipeline survey etc indicated good performance of system
FORECAST

- Laterite nickel ore: growing to be the most important source of nickel metal for world demand (as sulfide nickel ore deposits run out).

- PAL or HPAL matures to process and recover low grade limonite ore in an economic way.

- Hydrometallurgy (PAL): MSP vs MHP

| MSP (mixed sulphide precipitate) | Relatively complex processing circuit  
|                                | Higher investment  
|                                | Potential environmental impact  
|                                | Lower operating cost  
| MHP (mixed hydroxide precipitate) | Relatively simple process  
|                                | Safe and reliable  
|                                | Smaller investment  

- Bright prospect for laterite nickel mine.
3rd Asian Nickel Conference

Thank You