Nickel Production and Supply: Market Implications

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RNC Minerals
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Overview

- Nickel market supply/demand has performed better than other base metals over the past 3 years

- Nickel market will need another 400-500kt to meet trend nickel demand by 2021 (and significantly more if forecasts for batteries come anywhere close to expectations!)
  - Equivalent to doubling Chinese NPI industry at its peak

- Very little visibility into future supply - extended period of low prices has resulted in very few opportunities for new supply and more dependence on future growth from higher political risk areas
  - Underinvestment led to flat to declining production at most large nickel operations
    - Old, deep operations take several years and hundreds of millions of dollars to ramp-up
  - Nickel supply becoming highly dependent on higher political risk countries (Indonesia, Philippines)
  - Remaining ramp-up from new large HPAL projects uncertain
  - Indonesian developments create massive uncertainty for the most active source of new supply
  - Project cupboard outside Indonesia largely empty

- Relaxation of Indonesian ban has hurt nickel market in near-term but setting stage for very robust long-term nickel market outlook
Nickel supply / demand trends very favourable versus other base metals

Source: Macquarie, RNC analysis
Nickel demand growth remains robust – will require 400-500kt of new supply by 2021 – much more if battery forecasts are realized.

Source: Macquarie, RNC analysis
Nickel supply increasingly dependent on higher political risk countries as “Old Guard” has declined from 50% of global supply in 2006 to less than a third today.

Mined Nickel Production by Country — 2006 vs 2016

<table>
<thead>
<tr>
<th>Country</th>
<th>2006 (1.4 Mt)</th>
<th>2016 (2.0 Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>15%</td>
<td>18%</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Philippines</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Russia</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Canada</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>Cuba</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Australia</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>China</td>
<td>15%</td>
<td>21%</td>
</tr>
<tr>
<td>Cuba</td>
<td>4%</td>
<td>10%</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: CRU
Nickel Supply
Continued Decline of the “Big Six”

Nickel supply from the six largest sulphide producers was still 40% of global supply as late as 2005 – their influence continues to decline

“Big Six” Nickel Production (% of Total Supply)

2005
- 60%
- 40%

“Big Six” Sulphide

2016
- 76%
- 24%

Source: Company, Reports, Macquarie Research, Wood Mackenzie, RNC Analysis
Nickel decline from the 6 largest sulphide operations has declined over the last decade (excluding Vosiey`s Bay ramp-up) as low nickel prices deterred investment.

Source: Company reports, CRU, Wood Mackenzie
Nickel Supply – HPAL/FeNi Billion Dollar Ramp-ups

The amount of additional nickel supply from the billion dollar laterite projects of the last decade is relatively uncertain...

Source: Company reports
Nickel Supply – Established HPAL Producers

...While established HPAL producers are facing challenges to maintain existing production levels

Source: Company reports
Nickel Supply – China Production Leveling Out

Chinese nickel supply of both NPI and non-NPI metal has leveled out in recent years - cost pressures and lower ore grades will limit future growth.

Source: Antaike, RNC analysis
Nickel supply / costs benefited greatly from the decline in currency/oil prices over the last five years sustaining production as nickel prices fell.

Source: Thompson Reuters, Bloomberg
Nickel Supply - Little Momentum in Existing Supply & “Project Cupboard” Largely Empty

By 2021, 400-500 kt of new supply is required, but “project cupboard” is empty — few projects in pipeline and 35+ years of inertia to overcome

400-500+ kt New Supply Required

Where is new project supply going to come from?
- Laterites – HPAL?
- Laterites – FeNi?
- NPI?
- Sulphides?

Source: CRU, RNC Analysis
New Nickel Supply: Laterites – HPAL?  
Too High Cost, Too Much Risk?

HPAL projects not expected to play a major role in nickel supply going forward

- HPAL projects have faced large capital overruns, delays, and commissioning issues. Industry will have little appetite for new projects
  - Improved Cobalt prices will help economics to some extent

- Operating costs for many HPAL operations remain high
  - Operating costs are much higher than many other companies are indicating for their projects

- Many jurisdictions with the most attractive resources for HPAL continue to be among the more difficult jurisdictions globally
  - Indonesian change in ban and domestic investment rules will not help investment case

Source: CRU, RNC analysis
New Nickel Supply: Laterites – FeNi?

Little High Grade Left to Be Developed?

FeNi also not expected to play a major role in nickel supply going forward as the highest grade resources are already being developed and no new high grade discoveries have been made

- The current set of projects have now developed ALL known saprolite deposits with large resource of 2%+ average grade or higher (Koniambo, Onca Puma, Barro Alto, Tagaung Taung)

- NO NEW HIGH GRADE LATERITE DISCOVERIES HAVE BEEN MADE IN MORE THAN 30 YEARS TO REPLACE THESE PROJECTS IN THE PROJECT PIPELINE
  - Tagaung Taung was discovered in early 1980s, Onca Puma in the 1970s, Barro Alto in the 1960s and Koniambo in the 1900s

- With several projects with grades 2%+ incurring multi-billion dollar price tags, what will capital cost of next generation of projects be?

Source: CRU, RNC analysis
Nickel sulphides are an attractive source of nickel production, but the pipeline is largely empty as there have been few new large scale discoveries. RNC’s Dumont project and First Quantum’s Enterprise projects are among the few large scale projects that could be in production with next few years.

- Over last several decades, the only large greenfield discoveries have occurred when exploration was occurring for other metals: Voisey’s Bay (diamonds), Kabanga (gold), Enterprise (copper)
  - Sirius Resources Nova-Bollinger discovery in Australia and Anglo American’s Sakatti discovery in northern Finland are the only large greenfield nickel discoveries made during a nickel-focused exploration program in recent decades

- Sulphides have a number of inherent advantages over laterites
  - Typically use standard mine/mill facilities utilizing commonly used technology
  - Inherently less energy intensive to refine
  - Less capital intensive as smelting/refining facilities don’t typically need to be constructed

- In the mid-1990s, Mt. Keith showed that large scale, lower grade, ultramafic nickel deposits could be profitably developed

- Further growth in sulphide nickel production will likely come from large scale, lower grade deposits (following similar moves in both the copper and gold industries) such as RNC’s Dumont project, one of few large scale projects that could be in production by 2020
RNC’s strategic alliance with Tsingshan led to the development of the first integrated nickel pig iron (“NPI”) plant to directly utilize nickel sulphide concentrate as part of the stainless steel production process through concentrate roasting.

- Significant potential benefits to producers of suitable nickel sulphide concentrate feed such as RNC’s Dumont Project:
  - **Lower costs** due to simpler processing compared to traditional smelting and refining
  - **Higher payabilities** than traditional smelting and refining
  - **Greater flexibility** for more potential partners and customers

- Roasted nickel concentrate is effectively a very high grade laterite ore feed – creates new source of demand for nickel sulphide concentrate, notably at a time when many NPI and ferronickel producers face feed shortages as a result of Indonesia’s nickel ore export ban.
RNC foresaw significant growth in NPI and stainless production; however, recent Indonesian moves jeopardize future growth in the one area of nickel supply seeing active investment

- The ban achieved many objectives with substantial investment in nickel capacity and downstream stainless steel production

- Indonesian nickel production was expanding rapidly and it had became a global scale stainless steel producer

- The relaxation of the ban and further changes to investment rules cause substantial investment uncertainty

Source: Company reports
Today’s “empty cupboard” is a result of inertia from 35 years of relatively little project development after “nickel boom” in late 1960s (which discovered or advanced the development of many of the projects sitting in cupboard in 2001).

Global Nickel Supply Growth
“Traditional” vs. Alternative
1965–2010 (% CAGR)

- 1965–75 saw a burst of new projects driven by inability of existing operations to meet global demand
- 1975–90 saw significant project rationalization
- Collapse of former Soviet Union demand (20% of world total) provided supply during 1990s
- Ni pig iron and demand destruction in 2000–10 closed gap caused by lack of new supply from weak project pipeline development

Source: Wood Mackenzie, Macquarie, RNC Analysis
Nickel Supply
Many Projects Sitting in “Cupboard” For Decades

- The bulk of the current wave of projects developed during last cycle were known for many decades: either discovered/developed too late during the 1965–75 period or inferior to other projects that were developed.
- Most of current project wave has sat “in the cupboard” for many decades (even back to the beginning of the last century).

<table>
<thead>
<tr>
<th>Project</th>
<th>Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koniambo</td>
<td>Early 1900s</td>
</tr>
<tr>
<td>Goro</td>
<td>Early 1900s</td>
</tr>
<tr>
<td>Ramu</td>
<td>Early 1960s</td>
</tr>
<tr>
<td>Ambatovy</td>
<td>Early 1960s</td>
</tr>
<tr>
<td>Barro Alto</td>
<td>Early 1960s</td>
</tr>
<tr>
<td>Onca Puma</td>
<td>Mid 1970s</td>
</tr>
<tr>
<td>Talvivaara</td>
<td>Early 1980s</td>
</tr>
</tbody>
</table>
Nickel Supply
Project Pipeline Largely Empty

The fundamental issue facing the nickel industry in 2017 is an empty “project cupboard” outside Indonesia

- At the beginning of the last decade prior to the significant run-up in nickel prices, the “project cupboard” was very full with many projects known for decades
- Today’s picture is very, very different – few large scale feasibility study stage projects

<table>
<thead>
<tr>
<th>Laterite (ferronickel)</th>
<th>Laterite (HPAL)</th>
<th>Sulphide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barro Alto</td>
<td>Ambatovoy</td>
<td>Talvivaara*</td>
</tr>
<tr>
<td>Koniambo</td>
<td>Goro</td>
<td>Kabanga</td>
</tr>
<tr>
<td>Onca Puma</td>
<td>Ramu</td>
<td>Voisey’s Bay</td>
</tr>
<tr>
<td>Tagaung Taung</td>
<td>Ravensthorpe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weda Bay</td>
<td></td>
</tr>
</tbody>
</table>

Project Cupboard 2001 (20+kt) TOTAL: 500+ kt

- Nova Bollinger ramping up
- Terrafame (Talvivaara) ramping up
- Enterprise built, but capacity used for copper
- Dumont one of few construction ready projects
- Indonesia – new projects future?
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