The Best Nickel Laterite Heap Leach in the World(?)

Authors : E Anne Oxley [a, b, c] MARK E SMITH [a, b]

A. Alyssum Ventures Ltd, United Kingdom

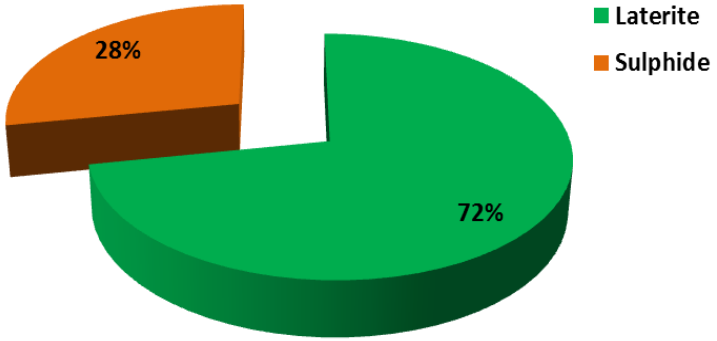
B. Brazilian Nickel Ltd, united kingdom

C. Scientific Associate of the Natural History Museum, London, UK

CONTENTS

AVL

WORLD RESOURCES OF NICKEL



World Resources on Land

Primary Nickel Production

AVL

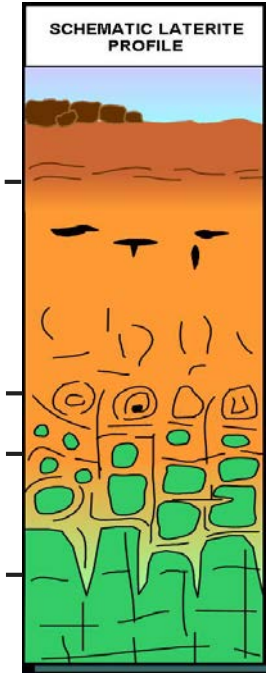
GLOBAL LATERITE PRODUCTION

Current View On Processing Options For Nickel Laterites

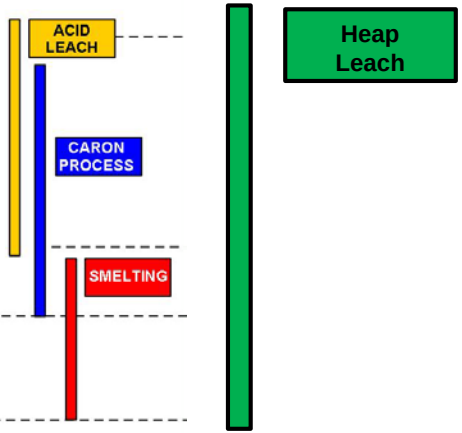
Limonite

Transition

Saprolite



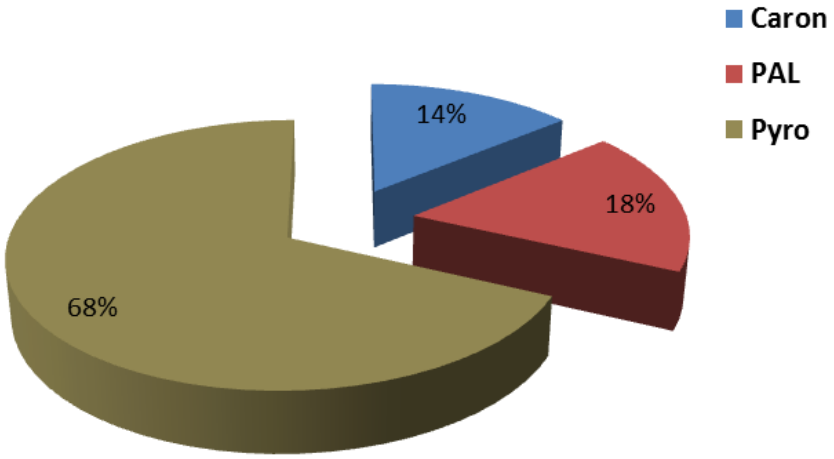
APPROXIMATE ANALYSIS (%)				EXTRACTION PROCESS
Ni	Co	Fe	MgO	
<0.8	<0.1	>50	<0.5	
0.8 to 1.5	0.1 to 0.2	40 to 50	0.5 to 5	
1.5 to 4	0.02 to 0.1	25 to 40	5 to 15	
1.8 to 3		10 to 25	15 to 35	
0.3	0.01	5	35 to 45	



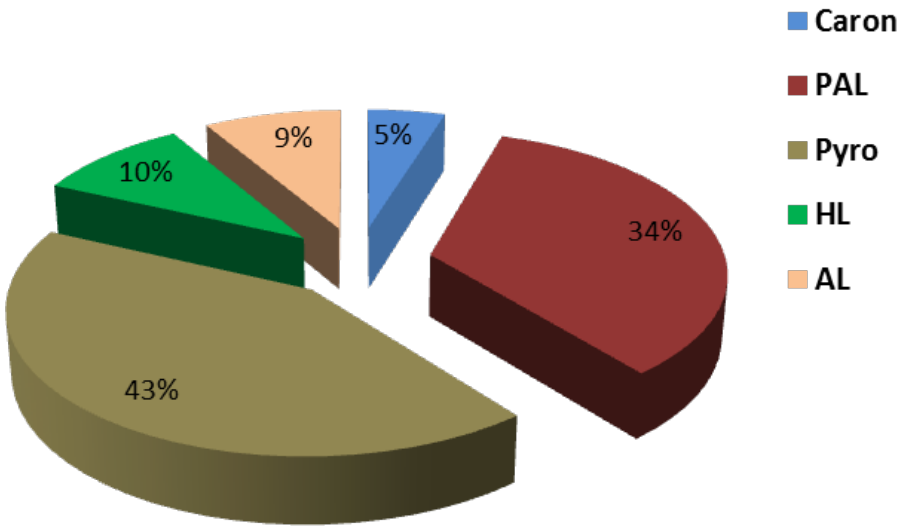
(after Elias 2001)

AVL

CURRENT & PLANNED LATERITE PROCESSES



Laterite Operations 2010



Probable Laterite Operations 2020
(source CRU & AVL)

AVL

STATE OF THE ART

➢Pyrometallurgy

- Reducing availability of acceptable smelting-grade laterites
- High Capital costs especially for lower Ni grade (<1.5%) deposits
- High infrastructure and build costs in many regions with higher grade laterites (eg Koniambo)

Koniambo – New Caledonia (2 x 80 MW DC furnaces)

AVL

STATE OF THE ART

- HPAL
  - High Capital Expenditure
  - Ambatovy – last HPAL planned for a while ?

STATE OF THE ART

- **Atmospheric Leach AL**
  - Forecast Lower capital than HPAL – 2/3 HPAL costs acc Wederburn 2009 Nickel Alta
  - Weda Bay – Investment decision 2013 – capital cost > USD 5 Billion
  - 2-3 projects in study stage
    - AFE's Dutwa (Company now in liquidation);
    - ENK's Acoje (now suspended)

Weda Bay 3D model
(source www.wedabaynickel.com)

AVL

STATE OF THE ART

- Heap Leach HL
  - Lowest capital costs <1/3 HPAL costs acc Wederburn 2009 Nickel Alta
  - >2,000,000t commercially HL'd at Murrin Murrin
  - > 100,000t demonstrated by various groups incl ENK, CMSA, Vale.
  - At least 5 projects in various stages of study >100ktpa

COMPARISON OF NICKEL PRODUCTION TECHNOLOGIES

Process Technology	Typical Capacity tpa of Ni	CapEx US $/pound-Ni capacity	OpEx US $/pound-Ni
Smelting	18,000 to 60,000	23 to 38	2.20 to 4.00
HPAL / AL	10,000 to 100,000	25 to 60	2.70 to 11.00*
Heap Leach	10,000 to 80,000	10 to 15	2.20 to 3.00

** High Opex from HPALs like Ambatovy & Goro currently operating at much < nameplate capacity*

AVL

WHY HEAP LEACH NICKEL LATERITES

- Nickel demand has been escalating faster than other metals
- Abundant, principally undeveloped but lower-grade nickel laterite sources
- Declining availability of high-grade sulfides
- Allows processing of entire laterite profile (increased resource utilization)
- Heap leaching has been successful on every other mineral attempted
- Low Capital Cost, Low Operating Cost, Low Risk

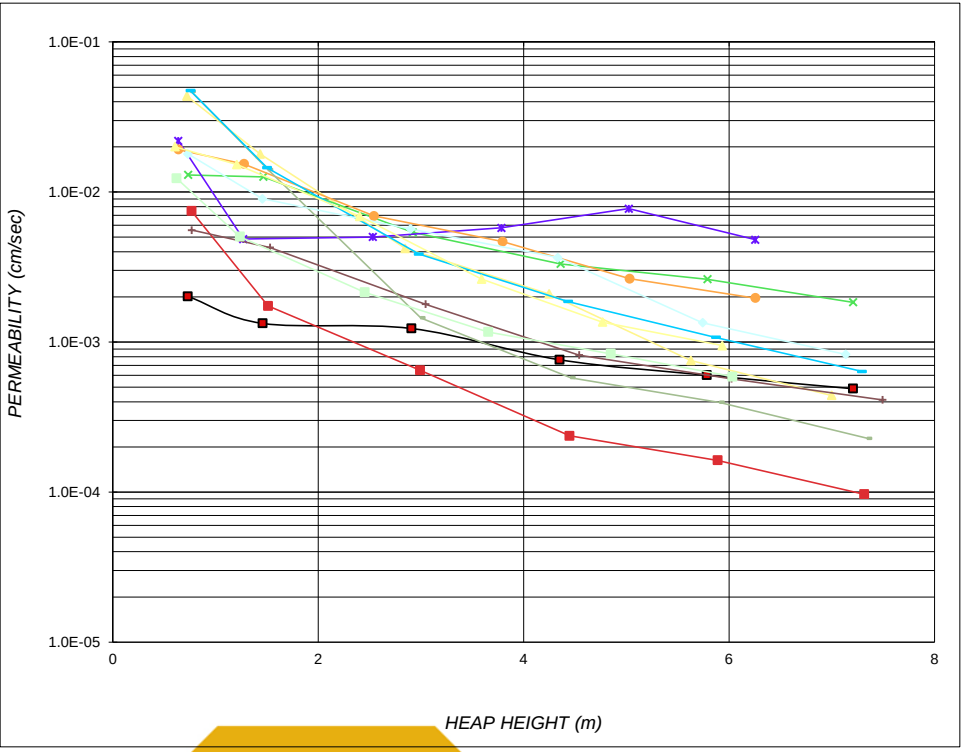
AVL

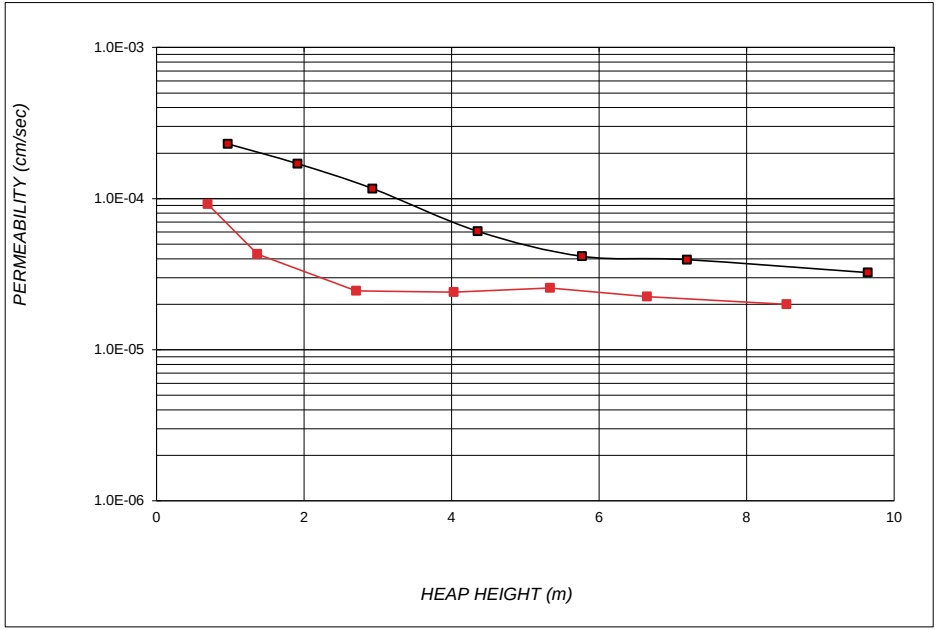
Almost All Ni Lats Amenable to HL

Country	# Deposits Studied	# Amenable to Heap Leaching
Albania	4	3
Brazil	3	3
Colombia	1	1
Dominican republic	1	1
Guatemala	2	2
Indonesia	6	6
Kazakhstan	1	1
Philippines	3	3
Poland	1	1
Russia	5	5
Turkey	5	5
USA	2	2

AVL

A Comparison of Laterite Permeability





AVL

THE PERFECT HEAP LEACH

Target Resource

- >1.0% Nickel
- >30 million tonnes
- High Silica content for
  - good stability
  - good permeability
  - Faster kinetics
  - Lower acid consumption

AVL

THE PERFECT HEAP LEACH

- **Climatic conditions**
  - **Low rainfall**
  - **No typhoons**
  - **Warm**
- **Topography**
  - **Flat terrain**
  - **Ample Operational Space**
- **E&S**
  - **non-sensitive environment**
  - **Positive social impact**
  - **Stakeholder support**

THE PERFECT HEAP LEACH

- **Infrastructure**
  - **Available choices of water**
  - **Transport route choices**
  - **Port choices**



AVL

CONCLUSIONS

Heap Leaching of Ni Laterites

- Lowest Cost Option
- Lowest Risk Option
- Highest Resource Utilisation
- Increased Access to Raw Materials
- Environmental Improvements

AVL

THANK YOU

AVL