What is the investment thesis for Nickel? Update

(1st Edition: June 2019)

2nd Edition: November 2019

JF Bertincourt, Terra Studio

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- Nickel market in its historical context
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PART 2

- How to invest to benefit from the next nickel boom with a focus on the Australian nickel sector?
  - Laterite vs sulphide
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  - ASX-listed players

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Introduction

Mining is cyclical

Timing is critical

- Mining is cyclical: exploration & mining activities relate to economic activities, capital markets, metal prices, …
- Timing is critical: the value of a project and even the viability of a project is highly dependent of its development timing relative to the underlying metal price cycle

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How critical is nickel among the battery metals?

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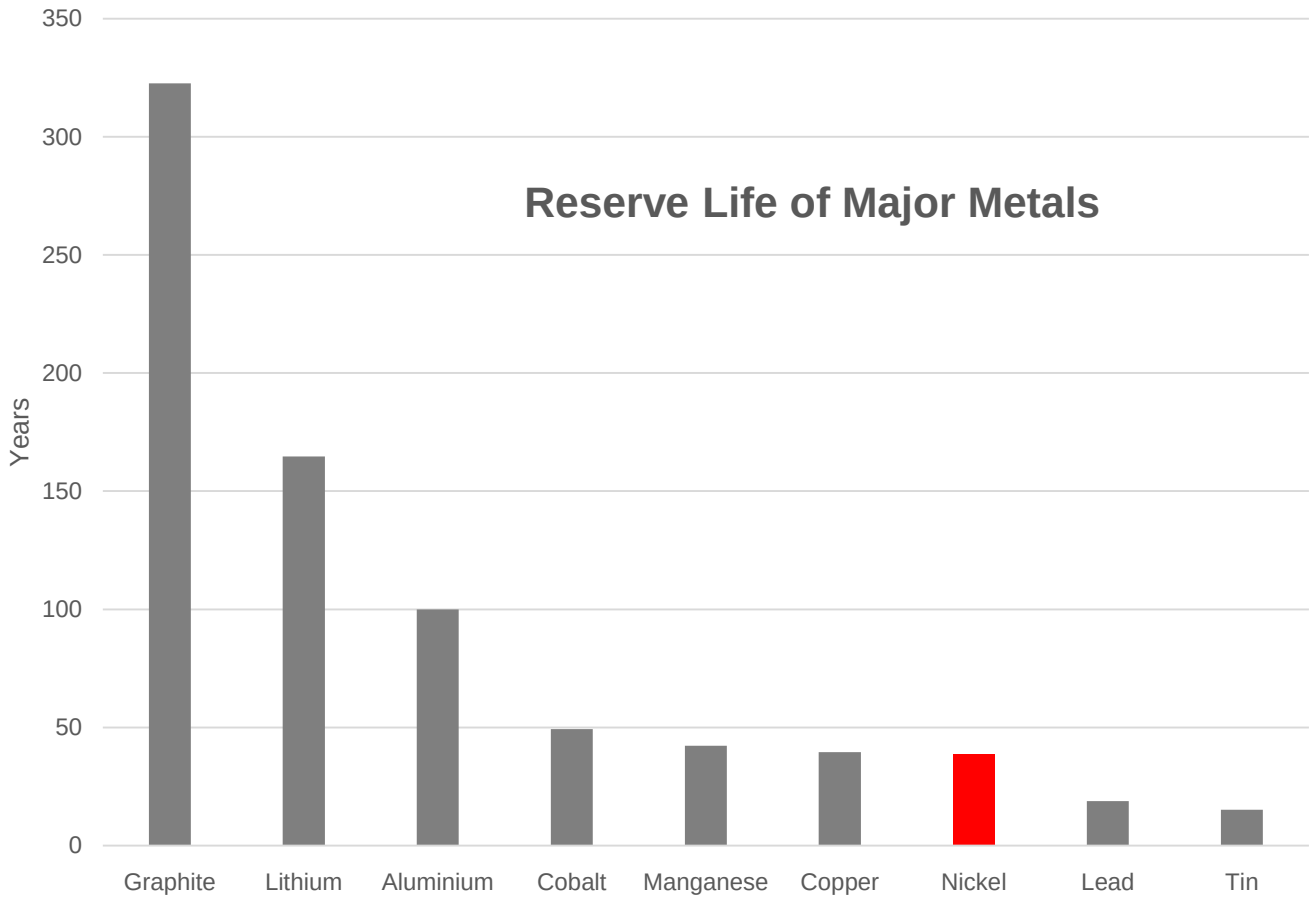
Nickel is scarce



- Graphite: no issue with quantity, but rather quality
- Lithium: beyond the brines, pegmatites are everywhere and can be quickly developed
- Nickel appears more critical as a battery metal

Source: USGS

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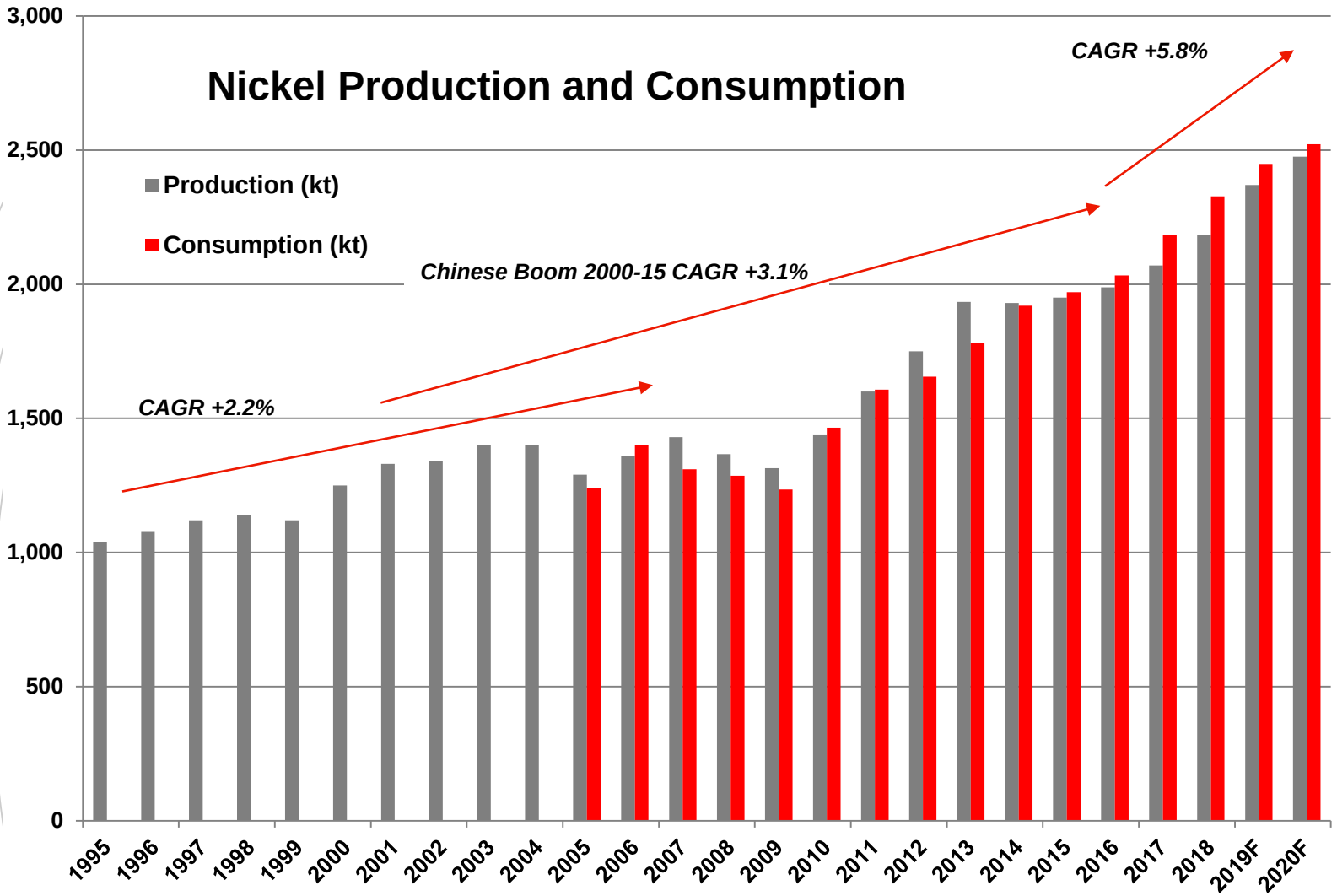
Market Growth Acceleration



Source: INSG, USGS

- Production and consumption growth are accelerating, while the battery sector is not yet significant
- The Chinese economic boom over 2000-2015 with GDP growth between 10 and 30% p.a. has initiated the acceleration
- But it is going even faster for the last five years
- Market size doubled between 1995 and 2016, i.e. ~20 years, to add 1 million tonnes.
- Currently adding ~½ mt in 5 years in a price-depressed market

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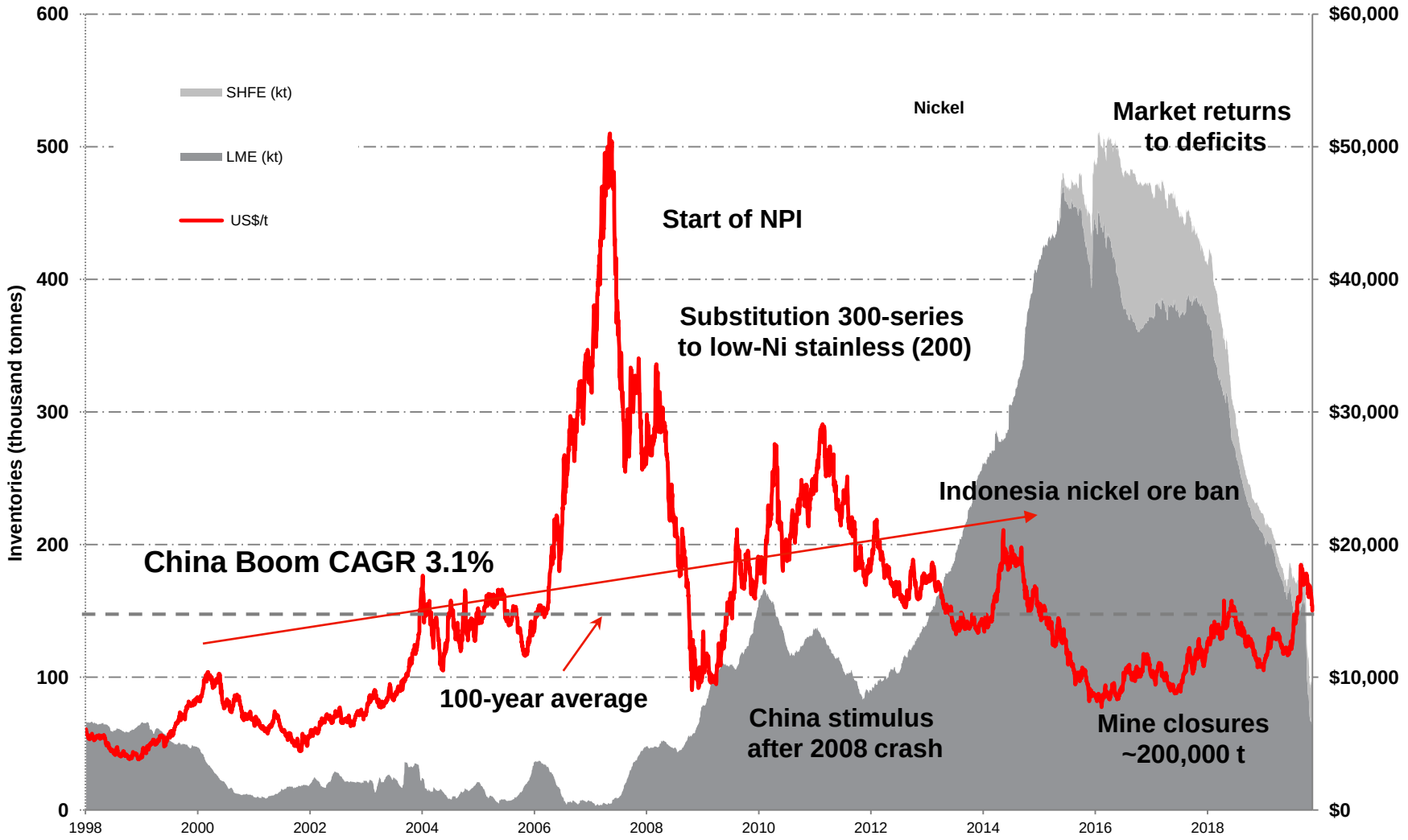
Nickel: the Boom and Bust Metal



Source: Terra Studio

- Supply response (+technology and substitution) generated considerable inventories
- NPI now 35% of global nickel supply vs ~0% in 2006
- Low-point $8,000/t, 80% of sector losing money
- Nickel market deficits since 2015 have decreased the level of inventories from a peak of 511,000 tonnes in January 2016 to about 103,000 tonnes currently
- Nickel stocks losing 82,000 t in last two months to 22 Nov

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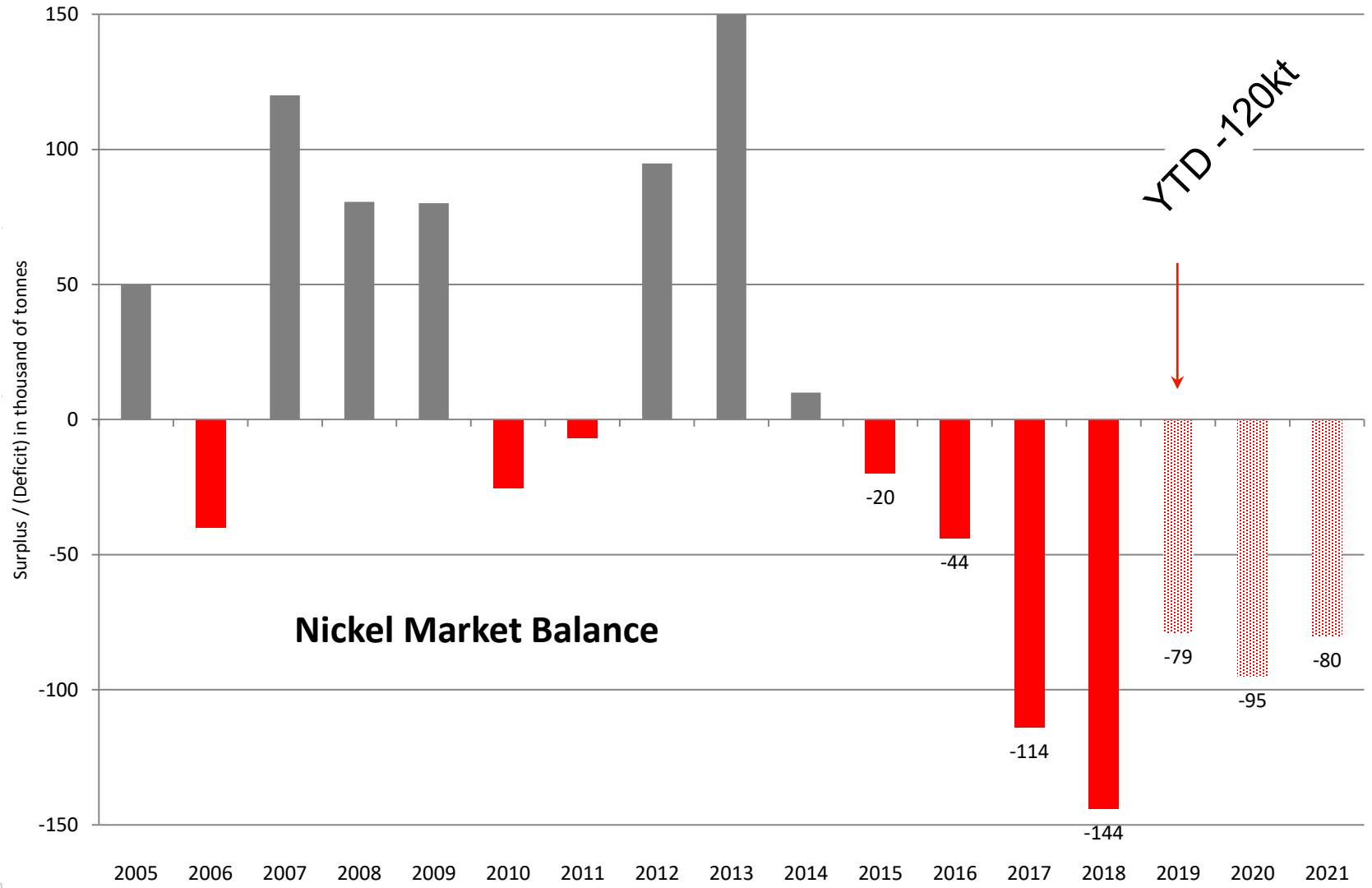
Market Imbalance



- The market growth acceleration has resulted in significant market deficits since 2015
- YTD deficit 120,000 t based on inventories' movement
- By the end of 2020, the official inventories (103,000 t currently) should vanish, making the market quite tight, ready for the next price boom

Source: INSG, S&P Global

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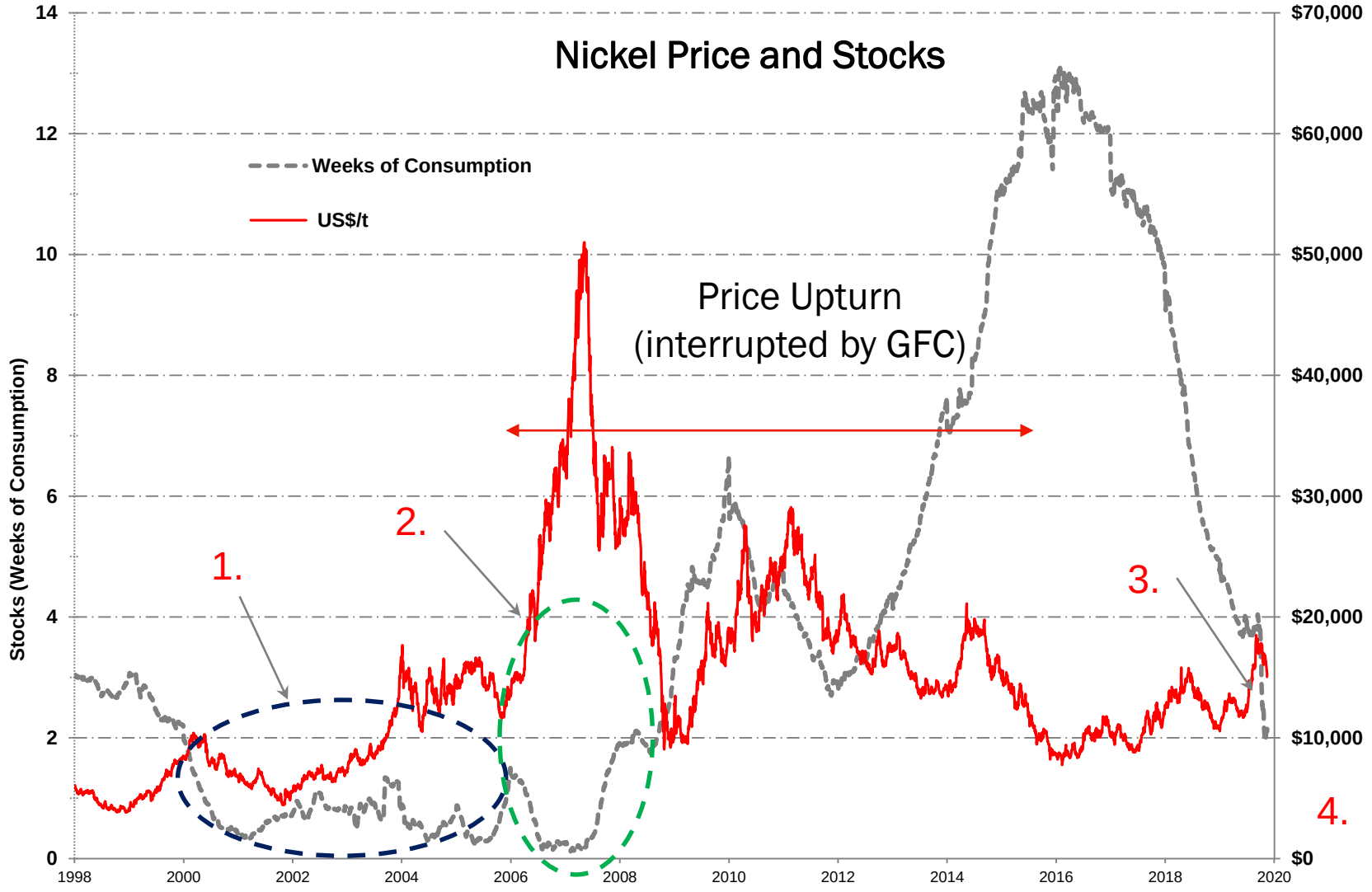
Tightning Market



Source: Terra Studio

1. In the early 2000's, despite a strong (4.5% p.a.) and tight market with about one week of consumption in official inventories, nickel prices remained quite depressed
2. Nickel price surged above $20,000/t as inventories were decreasing rapidly to just a couple of days of consumption
3. Inventories have never felt at such high pace since 1998. Chinese buying in reaction to Indonesian ore export ban?
4. Start of next price spike likely to coincide with an extremely low level of inventories. We are not there yet, but likely in 2021

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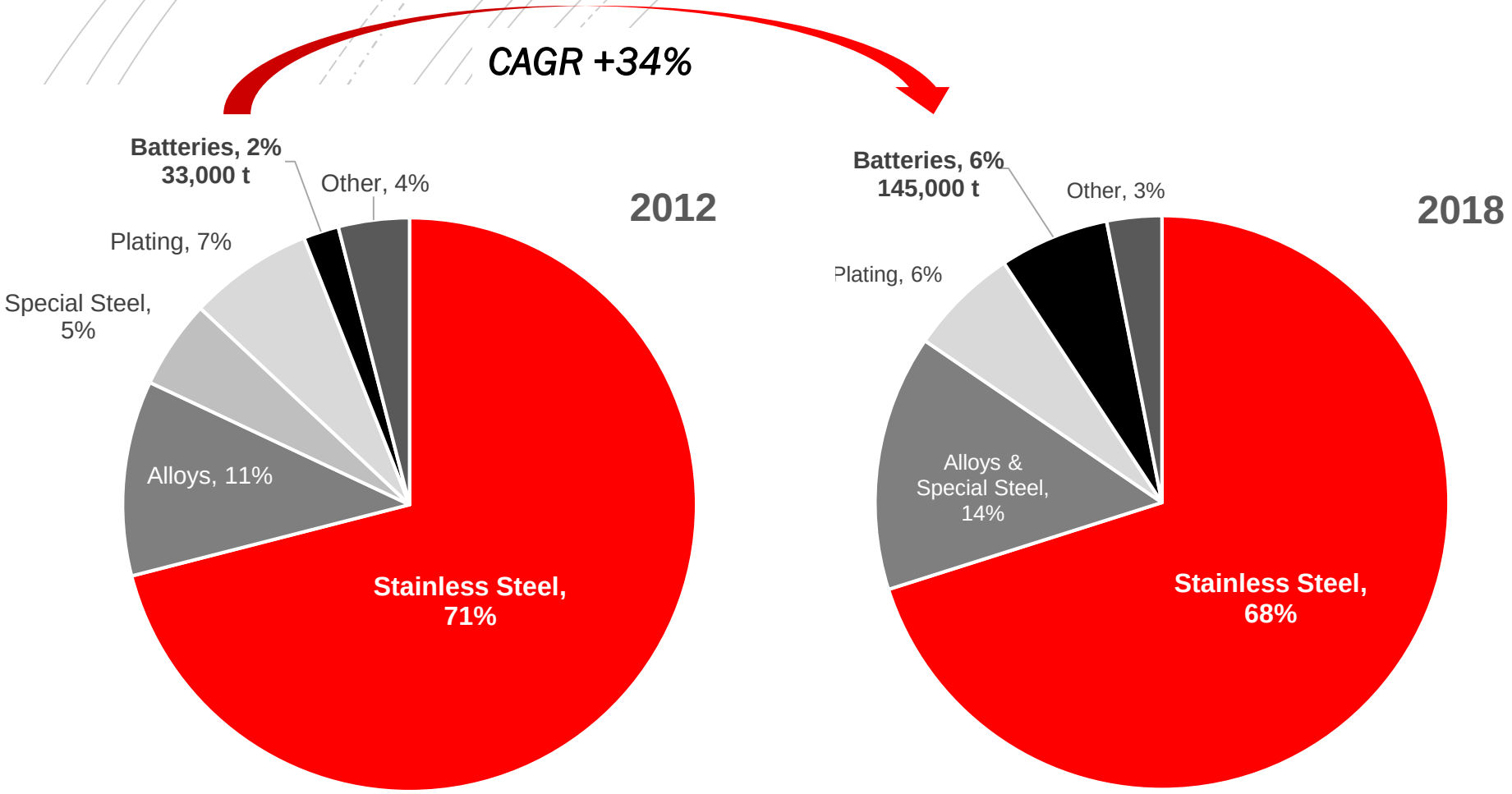
Indonesian Supply Factor

- Since our previous published analysis in June 2019, the nickel price has reacted positively, rising 59% to $18,475/t early September before retracing about half of its gain, currently $14,500/t (~100-year average)
- Going forward, continued trade tensions, stainless steel and nickel ore stocks, and fast-growing class-two nickel production (ferronickel and NPI) from Indonesia is expected to maintain downward pressure on prices in the short term before battery demand improves the demand outlook for end uses that only class-one nickel can satisfy.
- The ore export ban from Indonesia will reduce the Chinese NPI production significantly (-300,000 t) from 2021, after stocks are consumed over 2020.

Demand by End-Use



Source: Company announcements

- Stainless steel still represents close to 70% of the nickel demand
- Batteries sector +32% YoY in 2018
- Nickel demand from batteries growing strong but not significant yet

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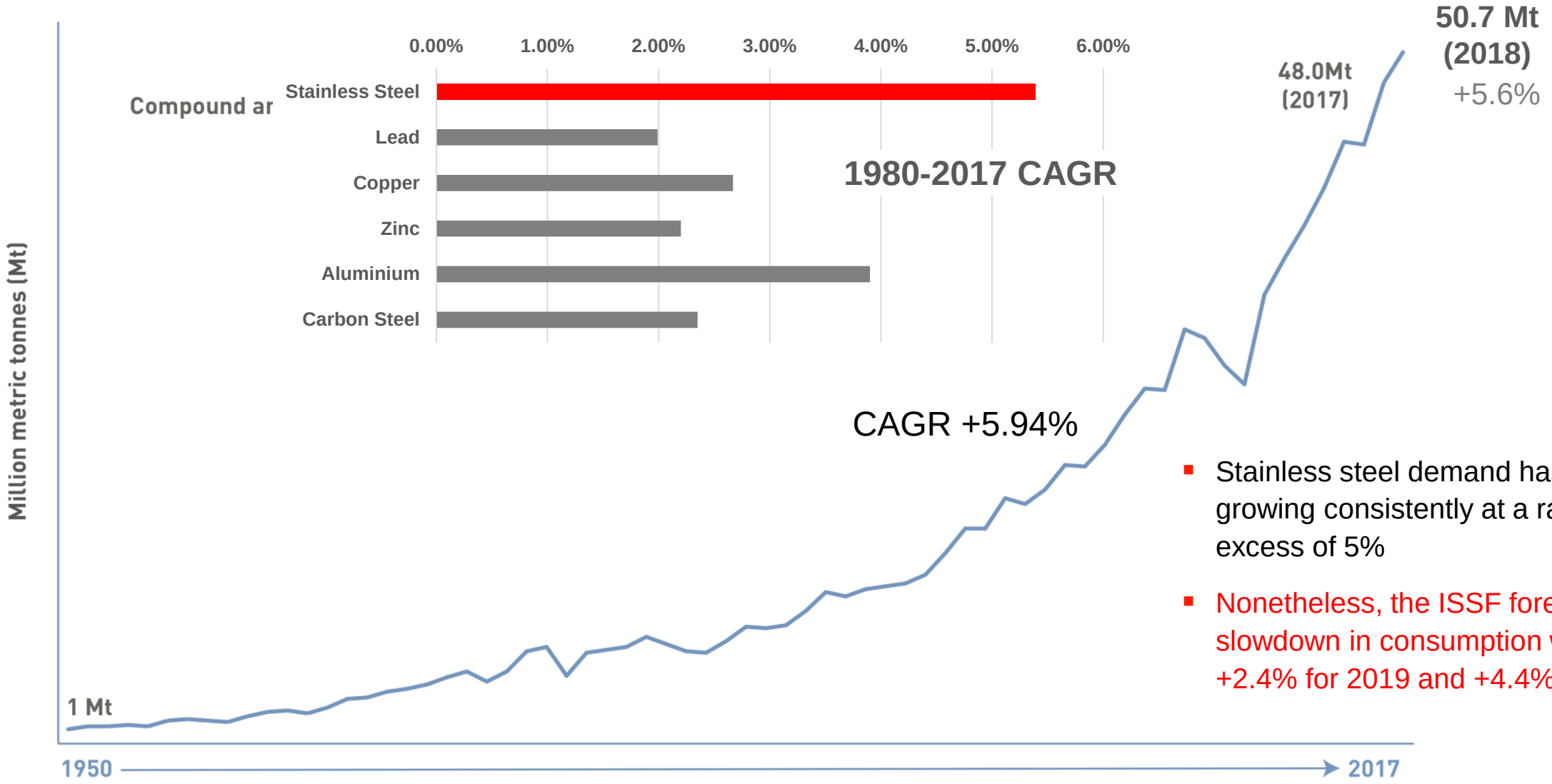
Nickel Use: Stainless Steel (70%+)



- Stainless steel demand has been growing consistently at a rate in excess of 5%
- Nonetheless, the ISSF forecasts a slowdown in consumption with +2.4% for 2019 and +4.4% in 2020

Source: ISSF. Note stainless steel is made up of ~ 60% recycled content (reclaimed and industrial scrap) and 40% new raw materials

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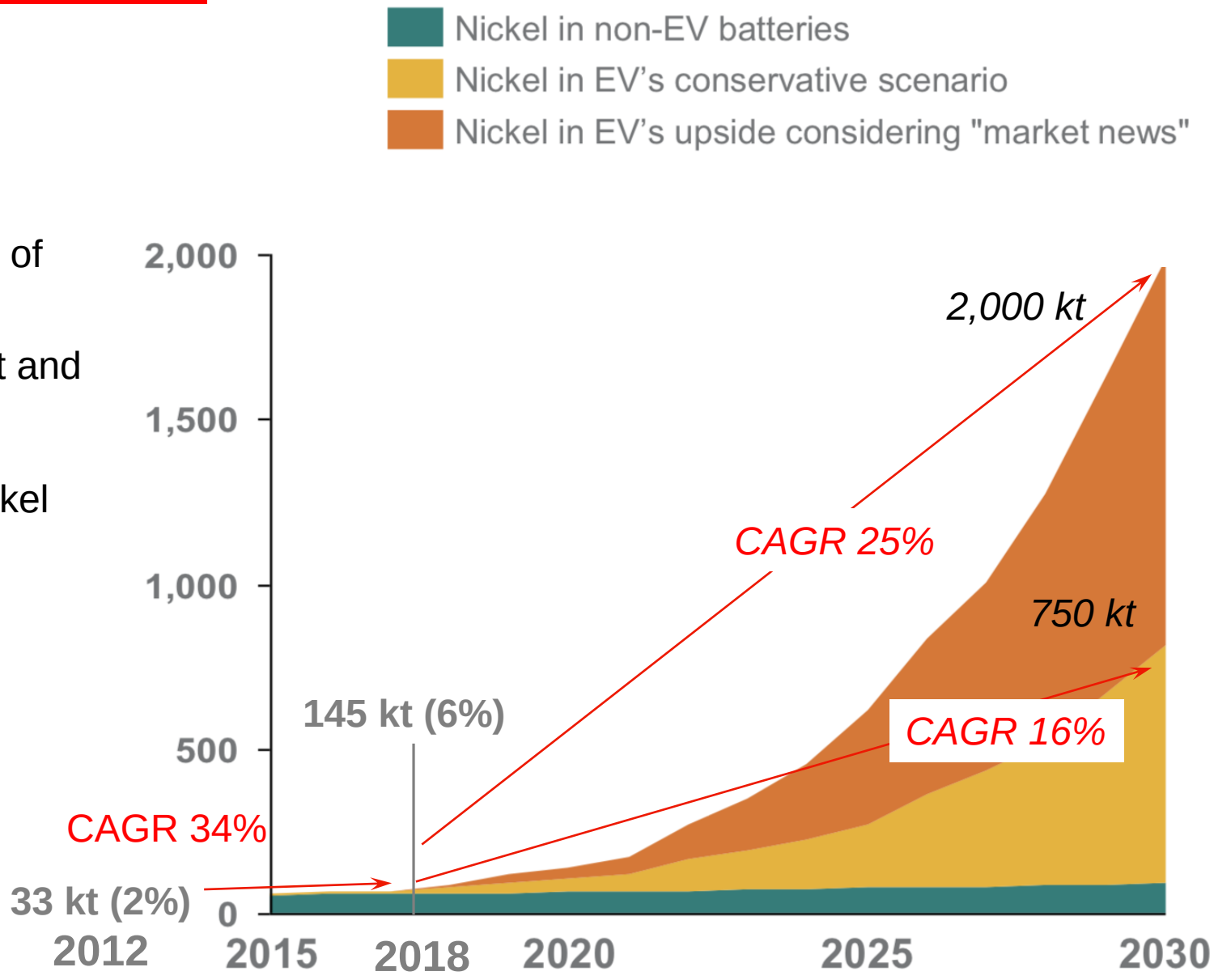
Nickel Use: Energy Revolution

- Current market size ~2.5 million tonnes
- Depending on the scenario for the EV rate of adoption, nickel volumes to meet this additional demand vary between 750,000 t and 2 million tonnes
- Nickel demand from EV will far exceed nickel production from existing operations in any scenario of EV adoption



Source: Vale, Terra Studio

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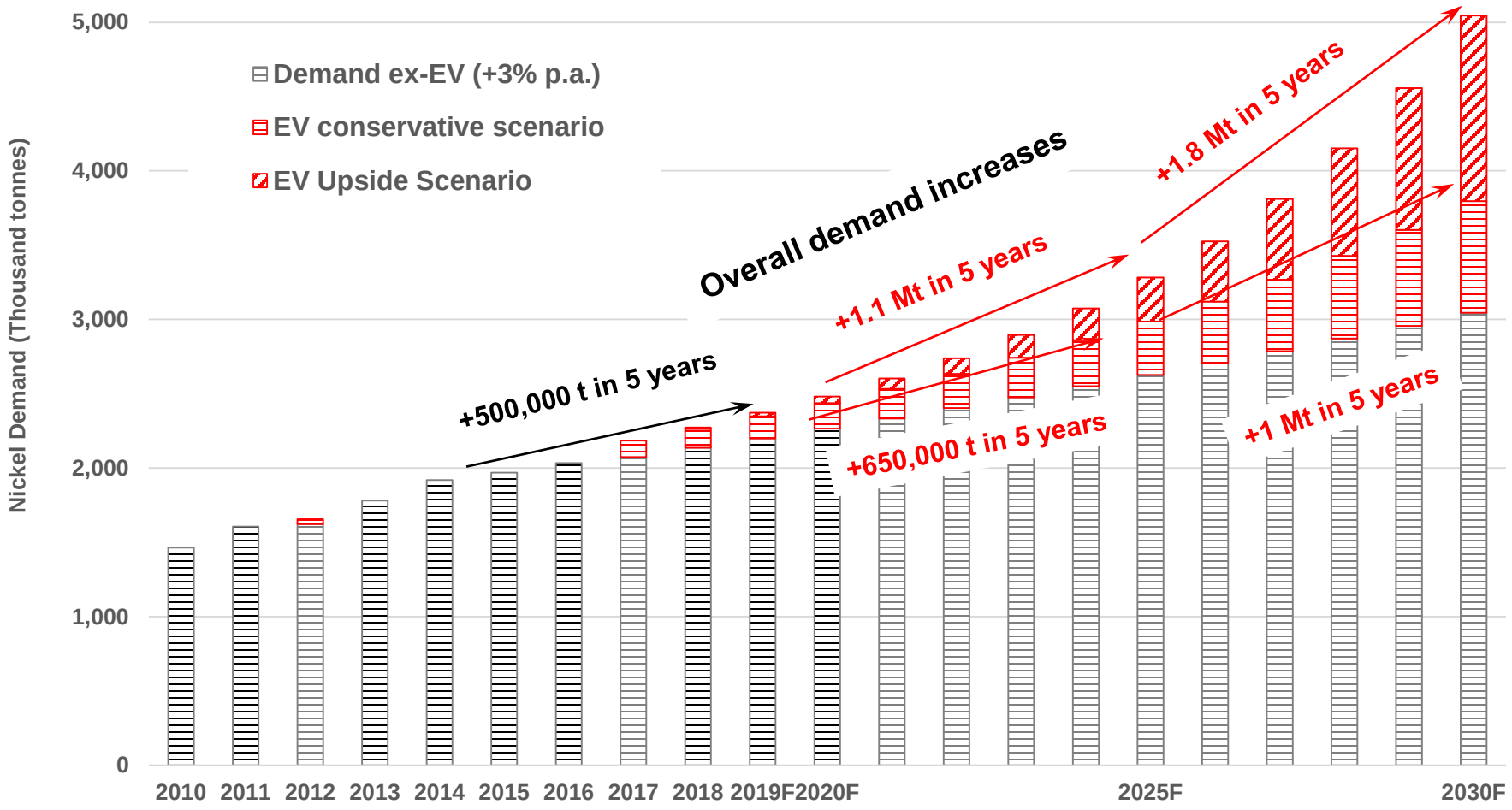
EV Nickel Demand in Perspective



- Conservative scenario put in context appears “manageable” over the next couple of years
- Supply growth needs to accelerate significantly beyond that point
- Where is the new supply going to come from?
- Also EV nickel demand requires class-I nickel provided by sulphide and HPAL projects

Source: Terra Studio

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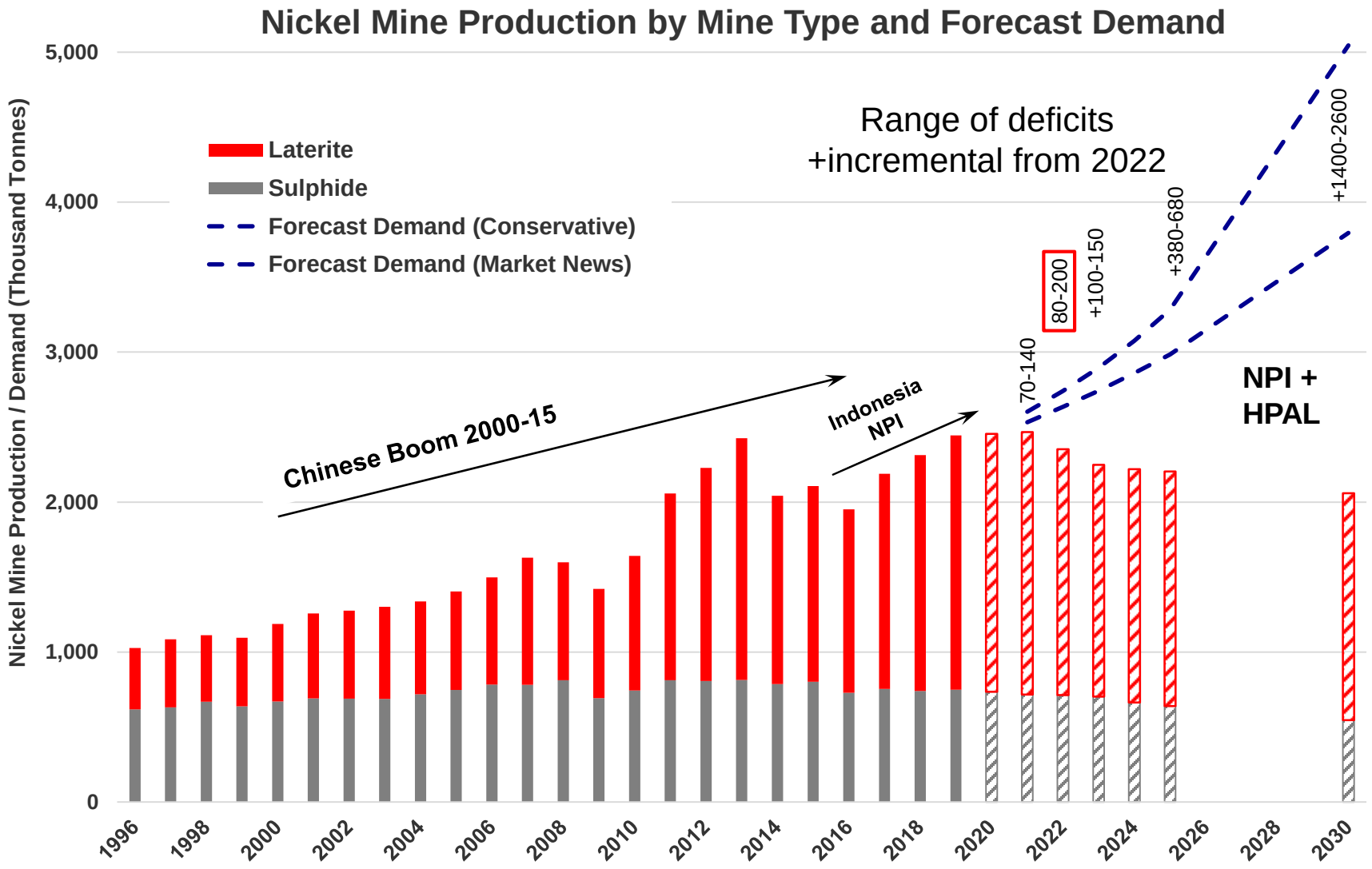
2021: Start of New Nickel Boom



Source: Wood Mackenzie for mine supply

- Tight market from 2021:
  - ✚ 100,000 t inventories
  - ✚ 200,000 t mine restart
  - ➖ 300,000 t Chinese NPI
  - 〓 Indonesia holding key to market balance but only serving the stainless steel market
- 2021 = Start of new Ni boom
- Very limited supply response from nickel sulphide mines during Chinese boom and high nickel prices
- Bulk of supply growth to come from lateritic projects from Australia, Indonesia and the Philippines

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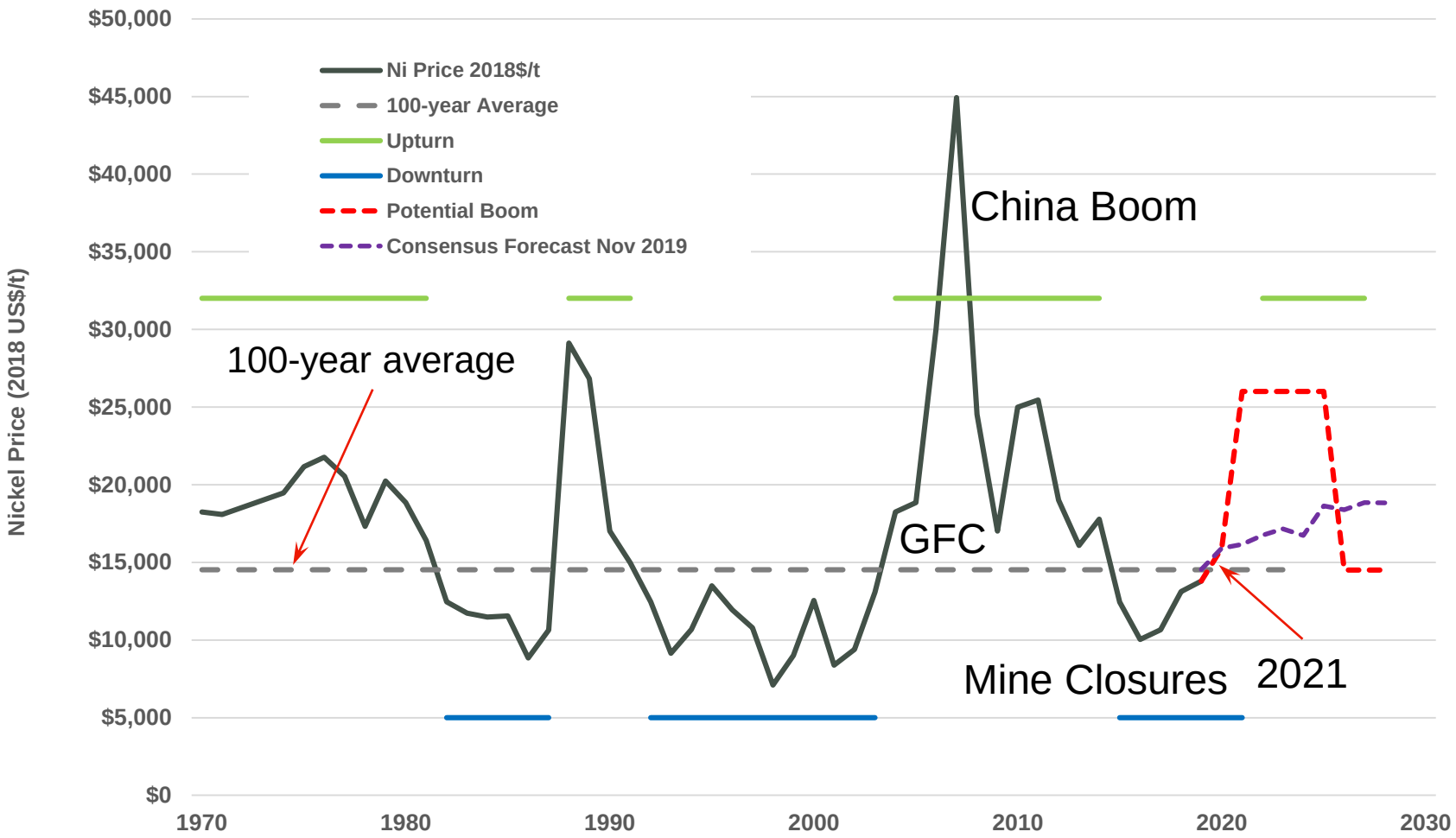
LT Analysis of Nickel Price Cycles



- EV/Energy revolution is a major disruptive event
- Price history shows sharp switch from bust to boom
- Possibly further price weakness before boom
  - Overstocking in stainless steel
  - Ore stocking in China
  - US-China trade dispute
- Latest consensus forecast certainly going in the right direction but shy of a potential price spike
- Considering the high demand pressure over time and the supply constraints, a high price cycle is likely to last for a few years
- Price spike likely to start in 2021

Source: Federal Reserve Bank, USGS, S&P, Terra Studio

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Terrafame to go ahead with nickel-cobalt sulphate plant in Sotkamo, Finland

Posted by Daniel Gleeson on 25th October 2018

Terrafame is to build a battery chemicals plant in Sotkamo, Finland, after finding the €240 million ($273 million) it needs to build the nickel-cobalt facility.

Rio Tinto Aims to Increase EV Battery Metals Position

Priscila Barrera - May 14th, 2019

Speaking at a conference in Barcelona, CEO Jean-Sebastien Jacques talked about how Rio is positioning itself in a lower-carbon economy.

...Tinto (ASX:RIO,LSE:RIO,NYSE:RIO) is looking to boost its position in battery metals ...als for the electric car revolution continues to pick up pace.

ASX RELEASE
2 April 2019

DOWNSTREAM NICKEL SULPHATE STUDY UPDATE

igo

Mincor To Divest Gold Operations To Focus On Nickel

Michael McCrae
Friday June 07, 2019 15:14

China to build $700m nickel plant in Indonesia for EV batteries

HPAL -> Ni sulphate

BHP to keep Nickel West, chief executive Andrew Mackenzie says

Stuart McKinnon | The West Australian
Tuesday, 14 May 2019 5:27PM

From Sale Sign to Strategic!

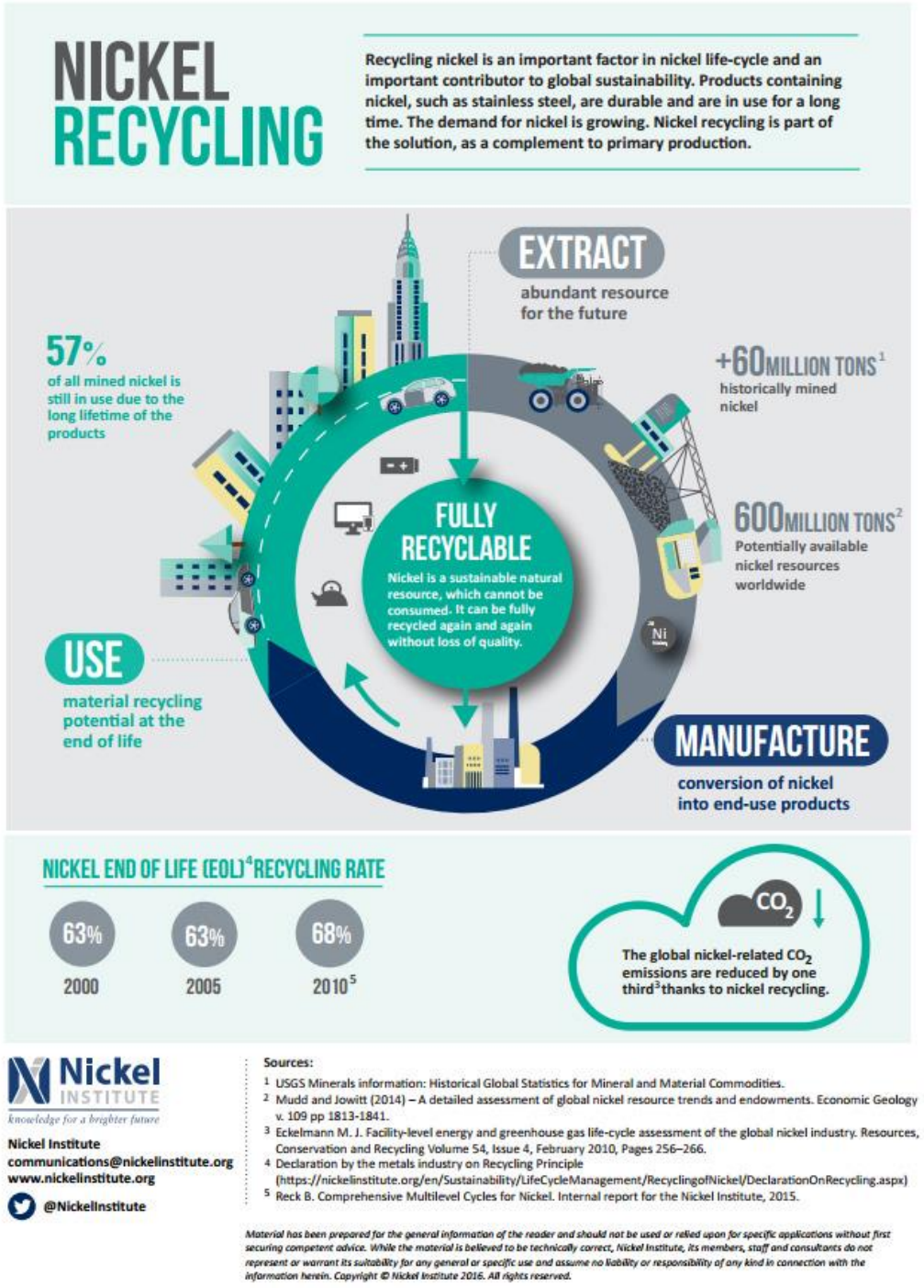
- In 2020, the first production of nickel sulphate expected from BHP Nickel West, adding 22,000 tpy (Stage1)
- Then 45,000 tpy Stage 2 (3x Sumitomo Metal)

Nickel sulphate/ Class I nickel

- Nickel sulphate <50,000 tpy in 2010.
- In 2018, production increases by 21% yoy to reach 160,000 t Ni.
- Forecast for 2029 > 900,000 t Ni - *Roskill*

Sustainability

- Around 68% of all nickel available from consumer products is recycled and begins a new life cycle
- Another 15% enters the carbon steel loop.
- However, around 17% still ends up in landfill, mainly in metal goods and in waste electrical and electronic equipment.



Source: Nickel Institute

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Investment themes to benefit from the next nickel boom

Focus on the
Australian Nickel Sector

Potential Supply from Laterite Projects

Code	Company	Project	Location	Stage	Capex	Process	Ni Capacity
NIC	Nickel Mines	Hengjaya Ranger	Indonesia	Operating	US$200m	NPI	16,500 t
	Tsingshan/ GEM	Morowali	Indonesia	Permitting	US$700m+	HPAL	29,200 t
-		Various	Indonesia	Various		Mainly NPI	
-		Various	Philippines	Various		DSO / NPI?	
FM	First Quantum	Ravensthorpe	WA, Australia	Care & Maintenance	*US$3,000m*	HPAL	40,000 t
CLQ	Clean Teq	Sunrise	NSW, Australia	DFS Jun 18	US$1,495m	HPAL	20,000 t
ARL	Ardea Resources	Goongarrie	WA, Australia	PFS Jul 18	US$918m	HPAL	18,000 t
AUZ	Australian Mines	Sconi	QLD, Australia	BFS Nov 18	US$974m	HPAL	11,900 t
GME	GME Resources	NiWest	WA, Australia	PFS Aug 18	US$676m	HL	19,200 t
JRV	Jervois Mining	Nico Young	NSW, Australia	PEA May 19	US$779m	HL	15,000 t
PM1	Pure Minerals	QPM	QLD, Australia	SS Jan 19	US$279m	DNi	5,678 t
MLX	Metals X	Wingellina	WA, Australia	PFS 2008	US$1,750m	HPAL	38,200 t

Source: Company announcements. NPI = Nickel Pig Iron, HPAL = high pressure acid leach, HL = Heap Leach, DNi = Direct Nickel

- There are a number of pyrometallurgical projects (ferro-nickel or NPI) in Indonesia at various stages: commissioning, in construction or at permitting stage
- The Australian HPAL projects are progressing towards DFS at which point they face a major hurdle due to the considerable capital required for construction

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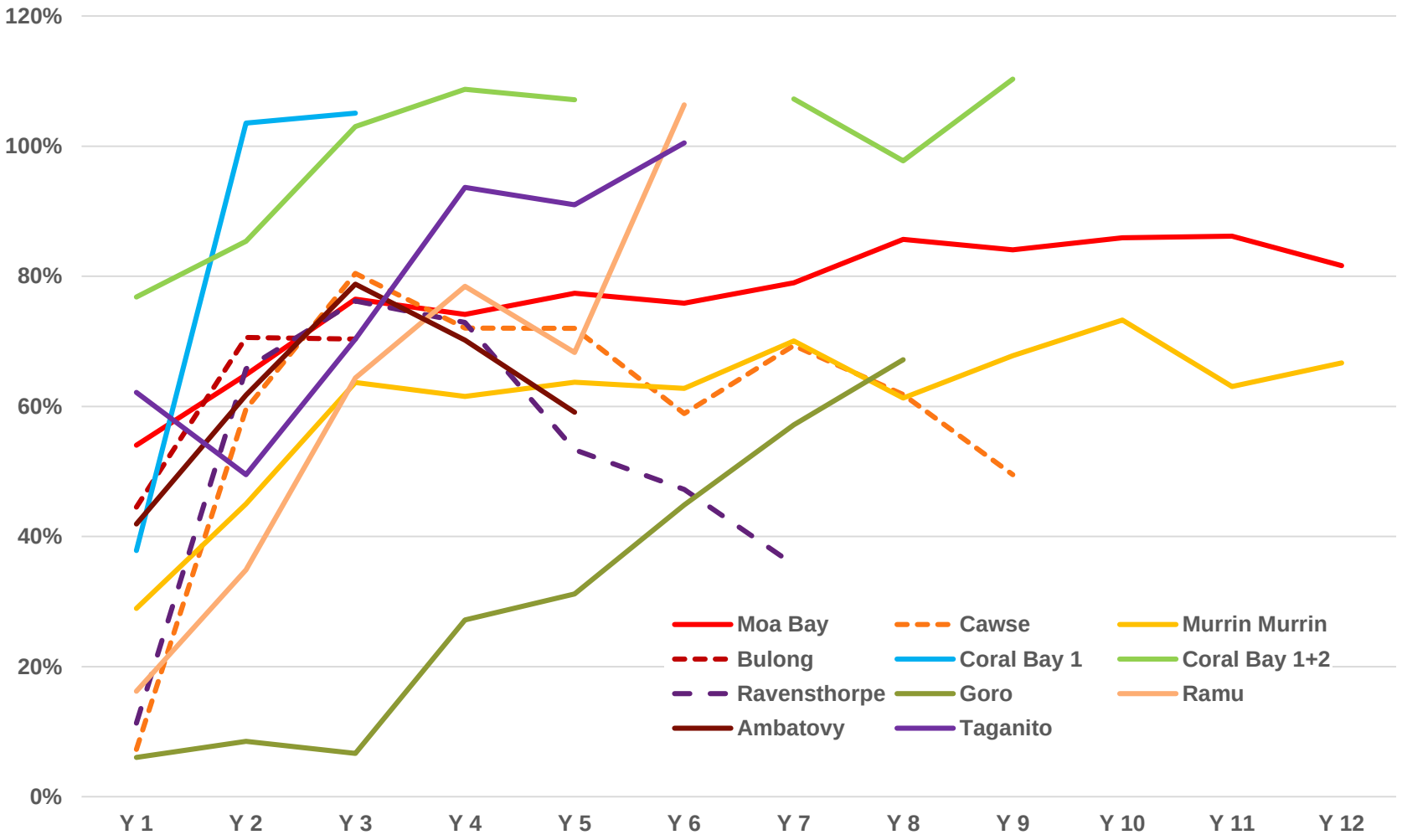
HPAL RAMP-UP



- Beyond the financial hurdle, slow ramp-up and often do not reach nameplate capacity
- Coral Bay and Taganito in the Philippines, both developed by Sumitomo are the exceptions: superior Japanese engineering?

Source: company announcements, Terra Studio

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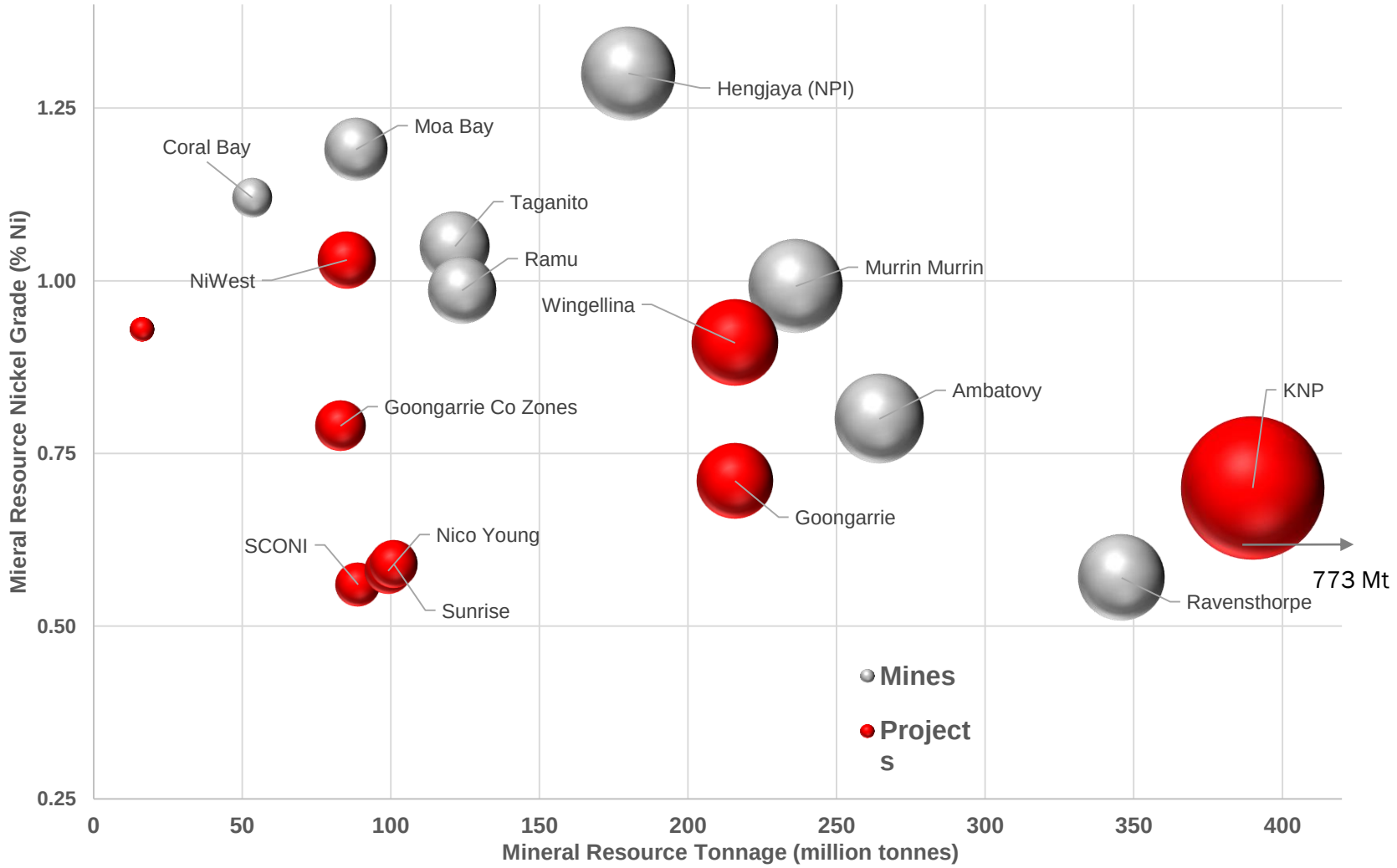
Mineral Resource Grades (HPAL/NPI/DNi)

New Caledonia ore feed 1.6% Ni for PM1 (DNi)



- Successful HPAL projects benefited from the best resource grades
- Most of the Australian projects have to deal with much lower nickel grades
- The NPI process requires higher nickel grades than HPAL
- Pure Minerals (PM1) will benefit for a much higher grade compared to the Australian HPAL projects

Source: company announcements, Terra Studio

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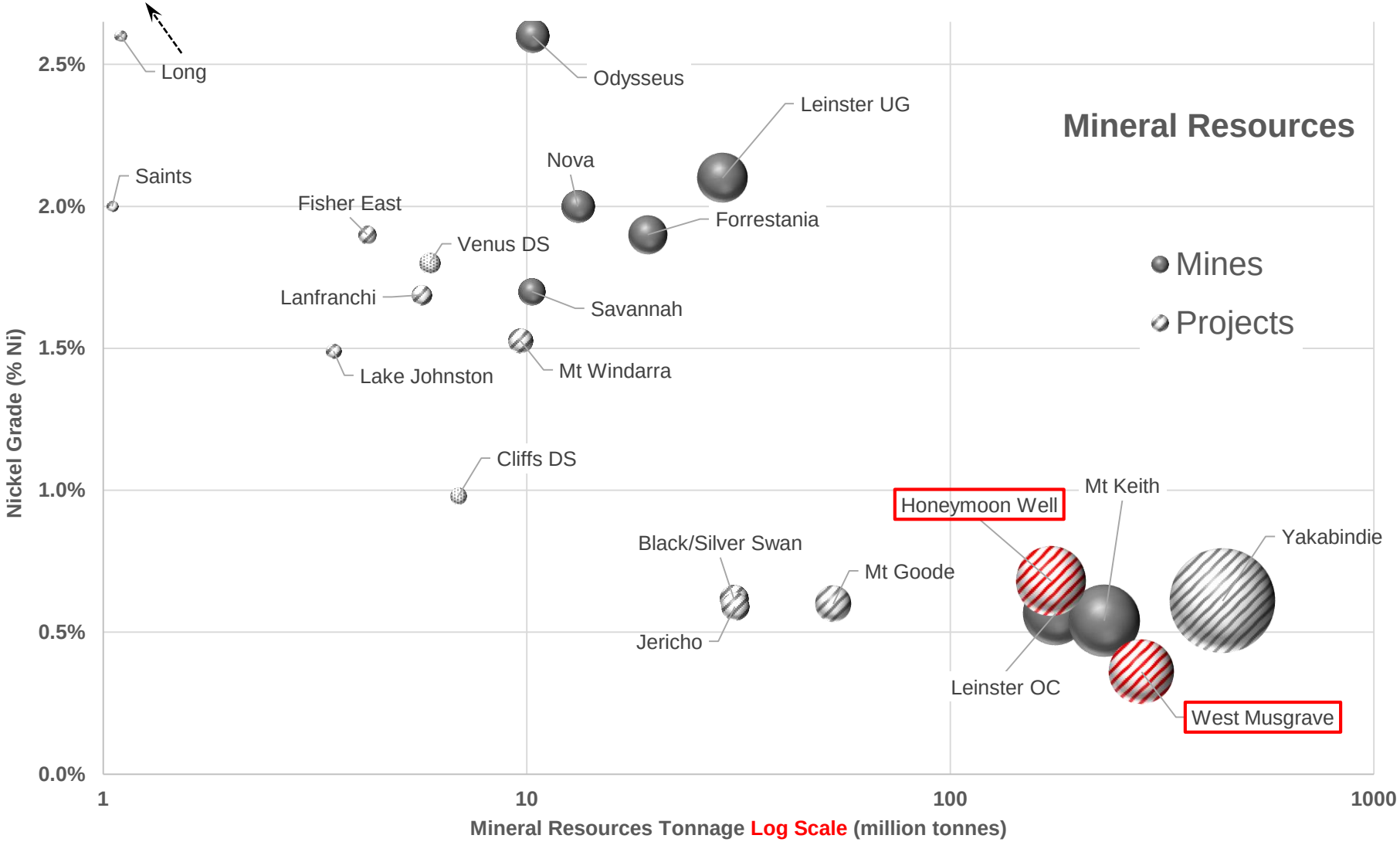
Australian Nickel Sulphide Mines & Projects



- A number of mines and projects have changed hands
  - Long from IGO to MCR
  - Lanfranchi from PAN to Black Mountain Metals (US)
  - Saints from MEP to AOU
  - Current take-over of PAN by IGO
- Relatively limited nickel content in massive sulphide compared to disseminated sulphide deposits
- Honeymoon Well for sale?
- West Musgrave (Nebo-Babel) low grade but large resource

Source: company announcements, Terra Studio, DS = disseminated sulphide

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Strategic Importance of Disseminated Sulphides

- In a context of
  - limited supply growth from nickel massive sulphide mines and projects, and
  - supply growth from laterite projects focused on NPI and the stainless steel sector,

➢ Disseminated sulphide deposits should attract increasing interest

Source: company announcements, S&P, Terra Studio

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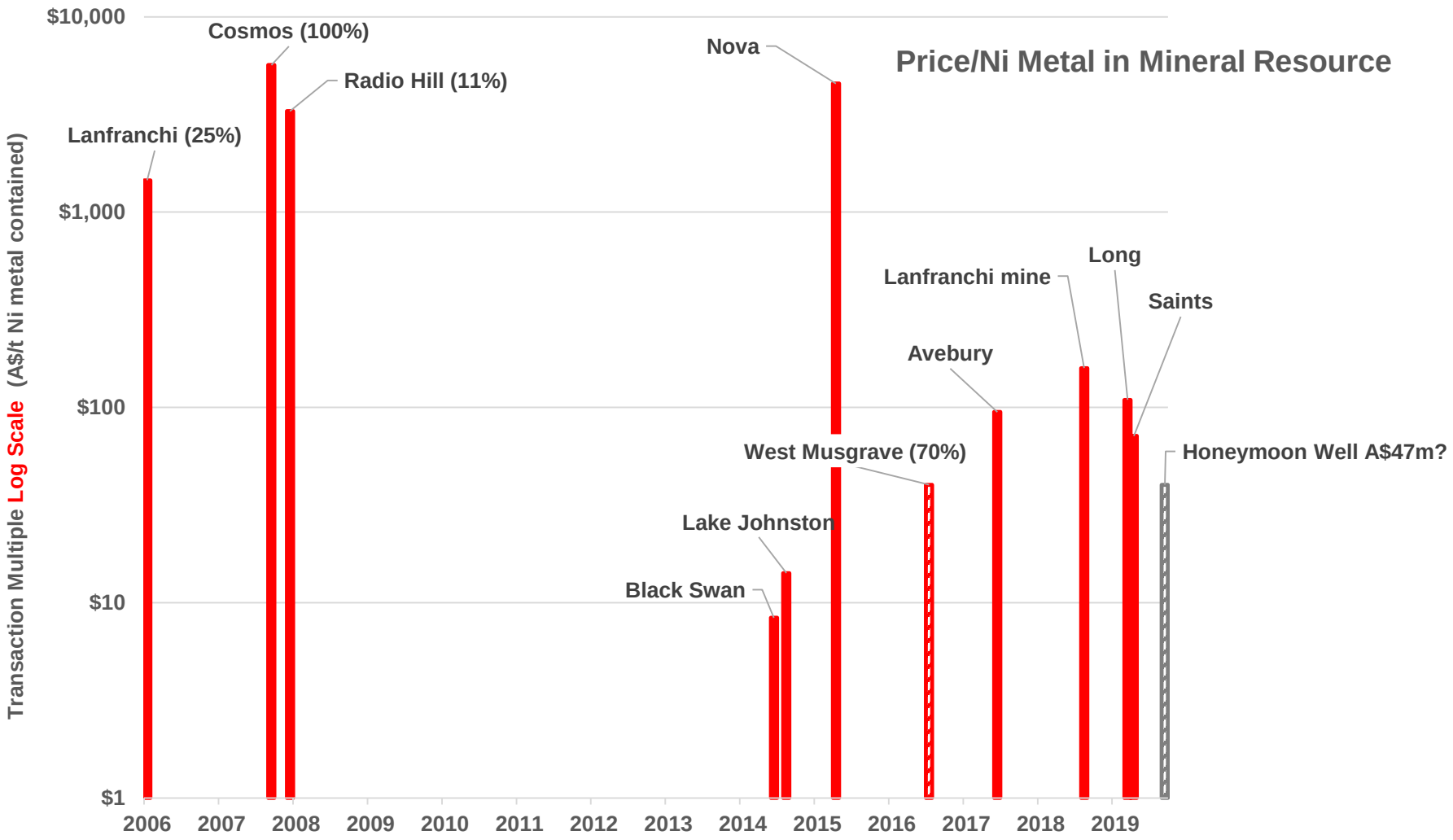
Transaction Multiples



- Quality of assets but also time in the price cycle attract highly different valuations.
- Honeymoon Well purchase opportunity?
- Using the 2016 OZ Minerals – Cassini JV transaction multiple observed at West Musgrave, one could derive a potential value of Honeymoon Well around A$50m

Source: company announcements, Terra Studio

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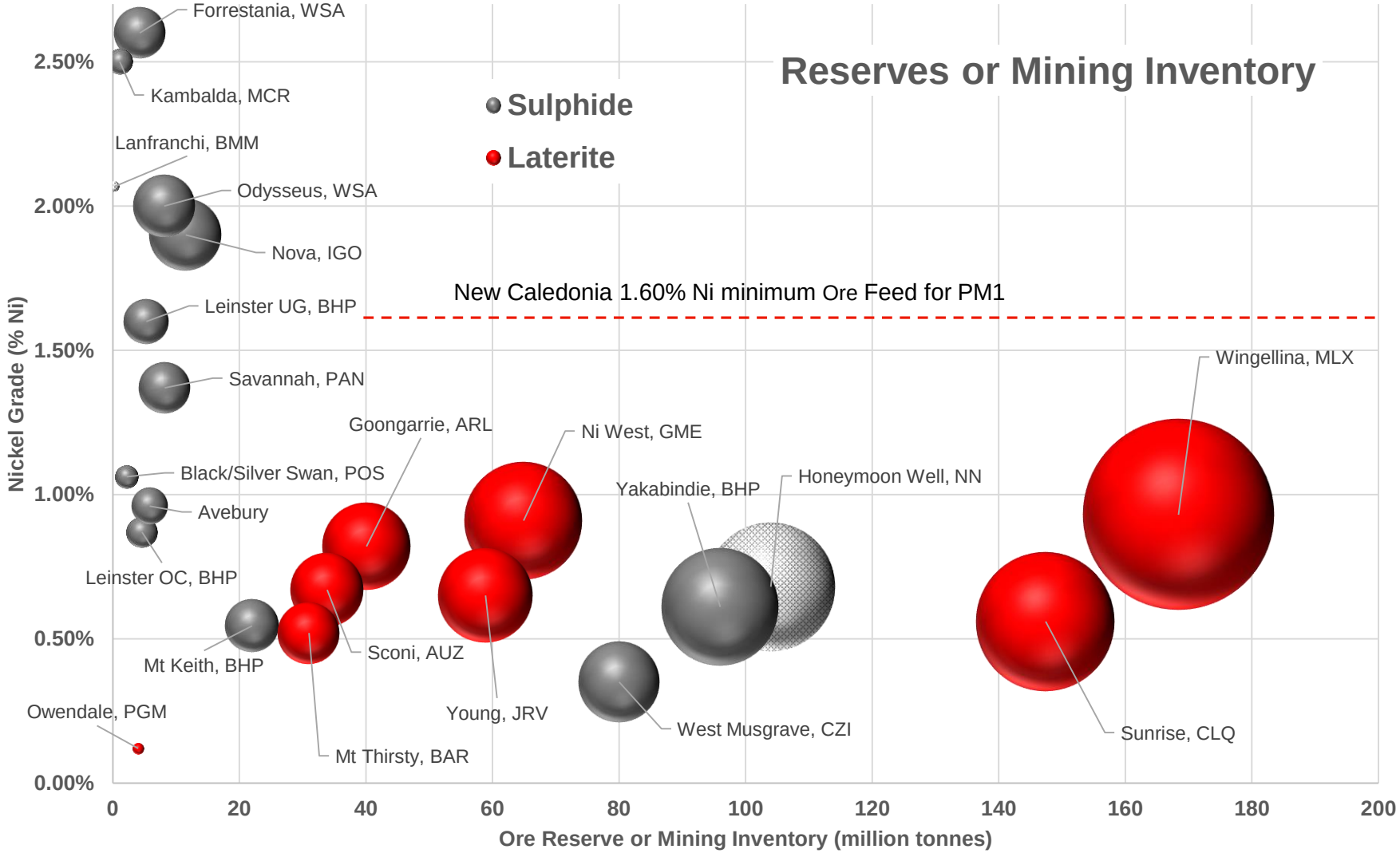
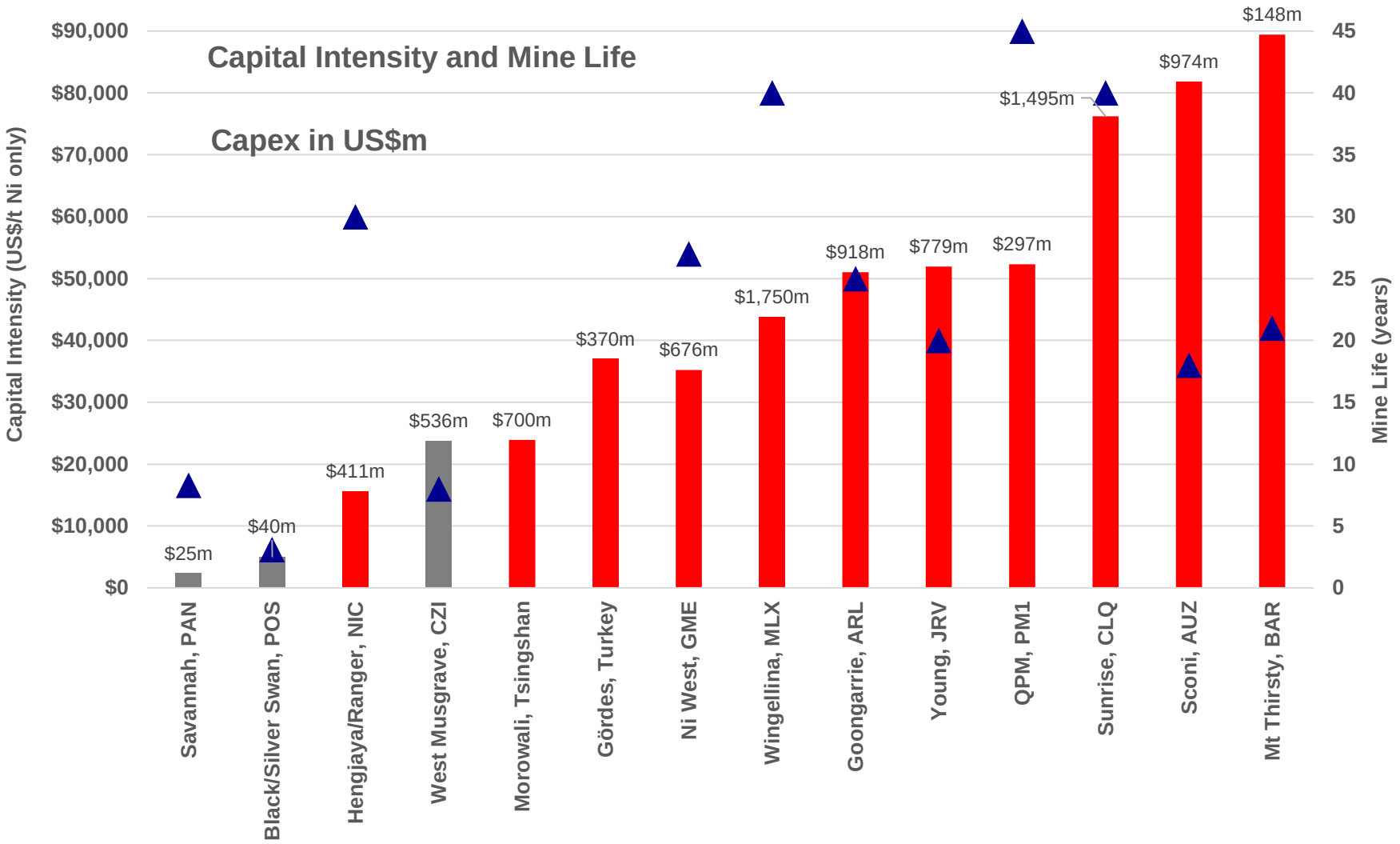
Mining Inventory or Ore Reserves



- Considering the technical risks of Australian laterite projects, the West Musgrave (Nebo-Babel) and Honeymoon Well represents alternative well worth considering.

Source: company announcements, Terra Studio

Development Capital



- Financial risk
- Sulphide competitive advantage
- HPAL cheaper elsewhere?
  - Morowali, infrastructure in place
  - Gördes, Turkey (10,000 t Ni)
- Highly competitive NPI operation in Indonesia in terms of capital, capital intensity and mine life

Source: company announcements, Terra Studio

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ASX-Listed Nickel Sector

	Code	Company	Share Price		Week	YTD	52 Week Range	Market Cap (A$m)	Type	Project
Producers	BHP	BHP Billiton Group	37.190	▼	(0%)	9%		177,800	Sulphide	Nickel West mines, WA
	MNOD	Norilsk Nickel	39.963	▼	(2%)	45%		63,239	Sulphide	Honeymoon Well project, WA
	IGO	Independence Group	6.070	▼	(1%)	59%		3,586	Sulphide	Nova mine, WA
	WSA	Western Areas	2.920	▼	(2%)	46%		799	Sulphide	Forrestania mine, WA
	NIC	Nickel Mines	0.585	▲	4%	121%		416	Laterite	Hengjaya mine + NPI, Indonesia
	PAN	Panoramic Resources	0.390	▲	10%	6%		255	Sulphide	Savannah mine, WA
	AVQ	Axiom Mining	0.025	—	0%	(60%)		13	Laterite	Isabel mine, Solomon Islands
	ZER	Zeta Resources	0.335	—	0%	16%		96	Sulp+Lat	Holding Co PAN+GME
Developers and Care & Maintenance	CLQ	Clean Teq	0.340	▼	(11%)	(37%)		175	Laterite	Sunrise project, NSW
	MCR	Mincor Resources	0.605	▼	(8%)	75%		173	Sulphide	Kambalda+Long mines, WA
	POS	Poseidon Nickel	0.050	▲	2%	19%		132	Sulphide	Lake Johnston […], WA
	JRV	Jervois Mining	0.195	▼	(5%)	(3%)		125	Laterite	Nico Young project, NSW
	ARL	Ardea Resources	0.780	▲	11%	50%		91	Laterite	Goongarrie project, WA
	AUZ	Australian Mines	0.015	▼	(12%)	(61%)		52	Laterite	Sconi project, QLD
	CZI	Cassini Resources	0.081	▼	(6%)	(4%)		34	Sulphide	West Musgrave JV with OZL
	GME	GME Resources	0.057	▼	(11%)	(19%)		29	Laterite	NiWest project, WA
	BSX	Blackstone Minerals	0.115	▼	(4%)	0%		22	Sulphide	Ban Phoc mine, Vietnam
	BAR	Barra Resources	0.022	—	0%	(35%)		13	Laterite	Mt Thirsty Co-Ni project, WA
	PM1	Pure Minerals	0.017	▲	6%	21%		6	Laterite	Qld Pacific Metals, QLD
Explorers	LEG	Legend Mining	0.041	▼	(5%)	41%		97	Sulphide	WA Fraser Range
	SGQ	St George Mining	0.140	—	0%	0%		58	Sulphide	Mt Alexander, WA
	CTM	Centaurus Metals	0.014	▼	(13%)	100%		53	Sulp + Lat	Brazil Carajas Province
	CHN	Chalice Gold Mines	0.160	▼	(6%)	19%		44	Sulphide	Kimberley project, WA
	RXL	Rox Resources	0.022	▲	5%	144%		32	Sulphide	WA Leinster area
	DKM	Duketon Mining	0.180	▲	3%	38%		21	Sulphide	WA Duketon Belt
	TLM	Talisman Mining	0.087	▼	(10%)	(60%)		16	Sulphide	Sinclair deposit, WA
	PIO	Pioneer Resources	0.013	—	0%	(19%)		20	Sulphide	WA Kalgoorlie area
	GAL	Galileo Mining	0.120	—	0%	(25%)		14	Laterite	Norseman Cobalt Project
	DRE	Dreadnought Resources	0.008	▲	14%	167%		12	Sulphide	Tarraji-Yambi project, WA

- Most companies offer significant leverage to the nickel price
- Producer: Nickel Mines growth path
- Feasibility Study:
  - Finding a strategic partner is key to development to most project
- Exploration
  - Legend Mining: great address
  - St George Mining: drilling success

Source: S&P Global Market Intelligence, Terra Studio, As at 22 November 2019

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Drill Hole Results Benchmarking

- The Mt Alexander project from St George Mining Ltd (ASX: SGQ) displays a number of high grade drill hole intercepts close to surface
- Selection criteria:
  - Minimum width: 2m
  - Minimum nickel grade: 4%
  - Minimum number of intercepts in project: 5
- Nickel equivalent grade calculated based on:
  - Nickel: $15,000t
  - Copper: $6,000/t
  - Cobalt: $30,000/t
  - No value assigned to PGE

Source: Terra Studio

Conclusions

- Nickel market growth has been accelerating while the battery market is not yet significant
- Supply growth from sulphide ore sources is very limited. New nickel sulphide projects are extremely rare
- The majority of future ore sources is laterites
- There is limited supply side response outside Indonesia, as prices are low and HPAL capex and risks are high
- So far, the supply response is largely geared towards the production of stainless steel (NPI) from Indonesia.
- The Indonesian ore export ban will cause a significant step down in the Chinese NPI production
- The battery demand segment is small, but growing rapidly and causing disruption (Ni sulphate)
- Combining supply and demand forecasts and price cycles, nickel price boom highly likely from 2021
- The new wave of Australian HPAL projects is quite risky: partner, grade, mineralogy
- Most companies should do well, but those with sulphide projects should overperform, with less risk

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