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Env. Sustainability Costs of Nickel Laterite v Sulphide

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WHAT?!
YOU WANT A
FRIDGE
AS WELL AS
A RADIO?



A GREENHOUSE NIGHTMARE...

Nickel: A Vital Infrastructure Metal

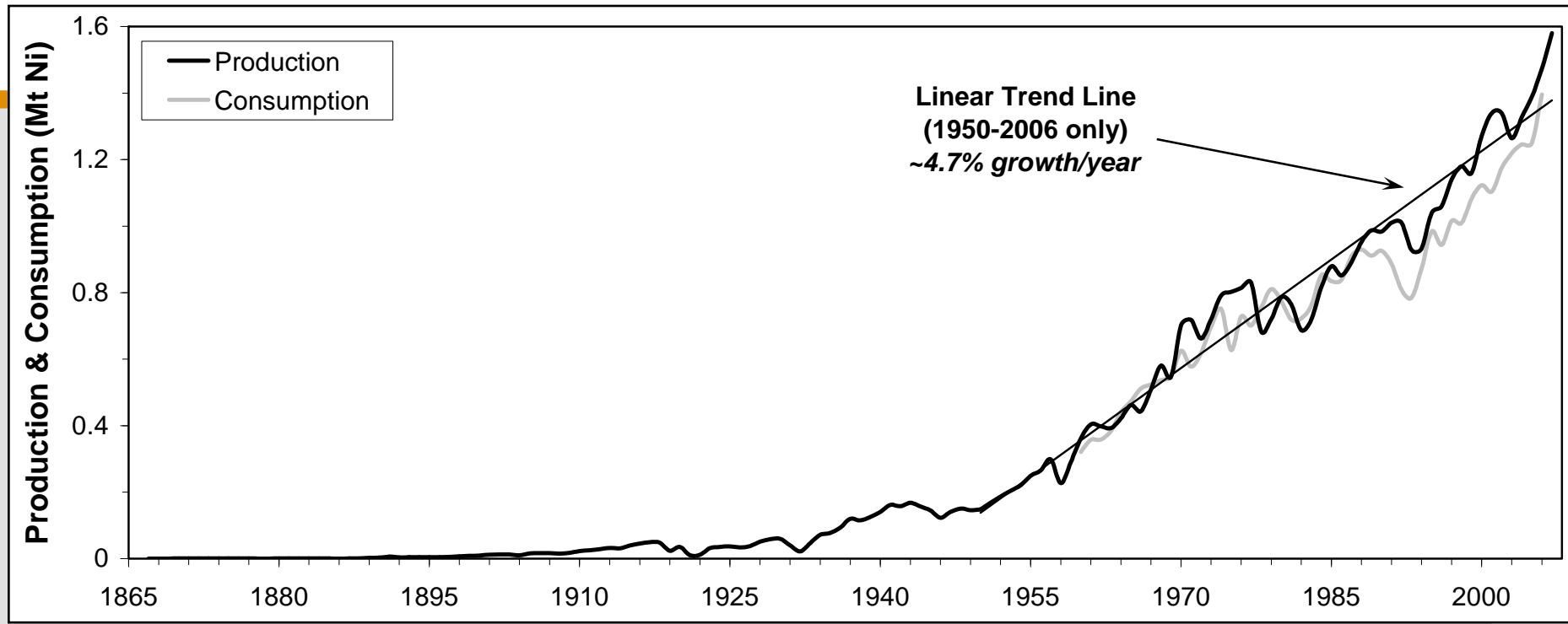
Overview

- **Nickel Resources and Ore Types**
 - *Sulphide versus Laterite*
- **Current Global Nickel Mining**
- **Environmental Sustainability Costs**
- **Implications for the Future ?**

Nickel: Sulphide v Laterites

- Nickel is a reasonably abundant known metal resource, found in mainly in sulphide or laterite (oxide) deposits
 - Ni sulphides: eg. pentlandite, $(\text{Fe,Ni})_9\text{S}_8$
 - Ni laterites: eg. garnierite ('NiO' – complex!)
- In general, Ni is more difficult to process than copper, especially Ni laterites
- Historically, most Ni came from sulphides, with increasing Ni now from laterites ...
- Major uses: **stainless steel**, alloys, etc ...

Nickel Mining v Industrial Growth



kt Ni

Country	Production
Russia	322
Canada	258
Australia	180
Indonesia	145
New Caledonia	119
Colombia	100
Philippines	88
China	80
Cuba	77

Country	Total Reserves [†]
Australia	51,000
Cuba	28,600
New Caledonia	22,100
Canada	19,900
Indonesia	16,200
Russia	15,800
South Africa	15,700
Brazil	12,800
China	8,700

Enviro. Sustainability Costs of Ni ?

- **Given the continuing demand for Ni, and abundance of resources, what are the ‘environmental sustainability’ costs of Ni ?**
 - *energy, water and greenhouse costs of sulphide versus laterite Ni*
- **Since Ni mining is dominated by a handful of major mining companies, most of which report on their sustainability performance, it is possible to analyse Ni costs**

Nickel Miners & Producers #1

- **Vale Ltd – The Big Brazilian**
 - through takeover of Inco Ltd (major Ni sulphide in Ontario), plus Ni laterites in Pacific (New Cal., Indo.)
- **BHP Billiton – The Big Australian**
 - takeover of WMC Ltd (major Ni sulphide in WA), plus new Ravensthorpe Ni laterite (WA)
- **Xstrata Ltd – The Big Cheese (Swiss/SA)**
 - takeover of Falconbridge Ltd (major Ni sulphide in Ontario), interest in Koniambo Ni lat., New Caledonia
- **Eramet Ltd – The Big Frenchmen**
 - mainly Ni laterite mines, New Caledonia

Nickel Miners & Producers #2

	Operation	Mt/yr	%Ni	%Cu	%Co	kt Ni	kt Cu	kt Co	Mine	Process
sulphides	Inco Sudbury, Canada [§]	7.69	1.40	1.51	~0.04	81.1	103.8	-	UG/OC	Pyro.
	Thompson, Canada	2.13	2.11	~0.13	-	46.6	~2.3	-	UG/OC	Pyro.
	Mt Keith [†] , Australia	~10.9	0.62	-	-	45.0	-	-	OC	Conc.
	Leinster [†] , Australia	2.6	2.08	-	-	40.4	-	-	OC/UG	Conc.
	Kambalda [†] , Australia	~0.8	~3.4	~0.22	~0.05	~30	~2	~0.6	UG	Conc.
	Kalgoorlie [†] , Australia	-	-	-	-	~92.6	-	-	Smelter	Pyro.
	Kwinana [†] , Australia	-	-	-	-	~58.1	-	-	Refinery	Pyro.
	Taimyr, Russia [#]	13.49	1.66	3.02	-	124.3	356.9	-	UG/OC	Pyro.
laterites	Murrin Murrin, Aust.	2.69	1.32	-	0.09	28.9	-	1.94	OC	HPAL
	Sorowako, Indonesia	~5.1	1.88	-	-	70.0	-	-	OC	Pyro.
	Doniambo, New Cal.	~2.9	~2.6	-	-	59.7	-	-	OC	Pyro.
	Yabulu, Australia	<i>NR</i>	<i>NR</i>	-	<i>NR</i>	~30 [‡]	-	~1.8 [‡]	-	Caron

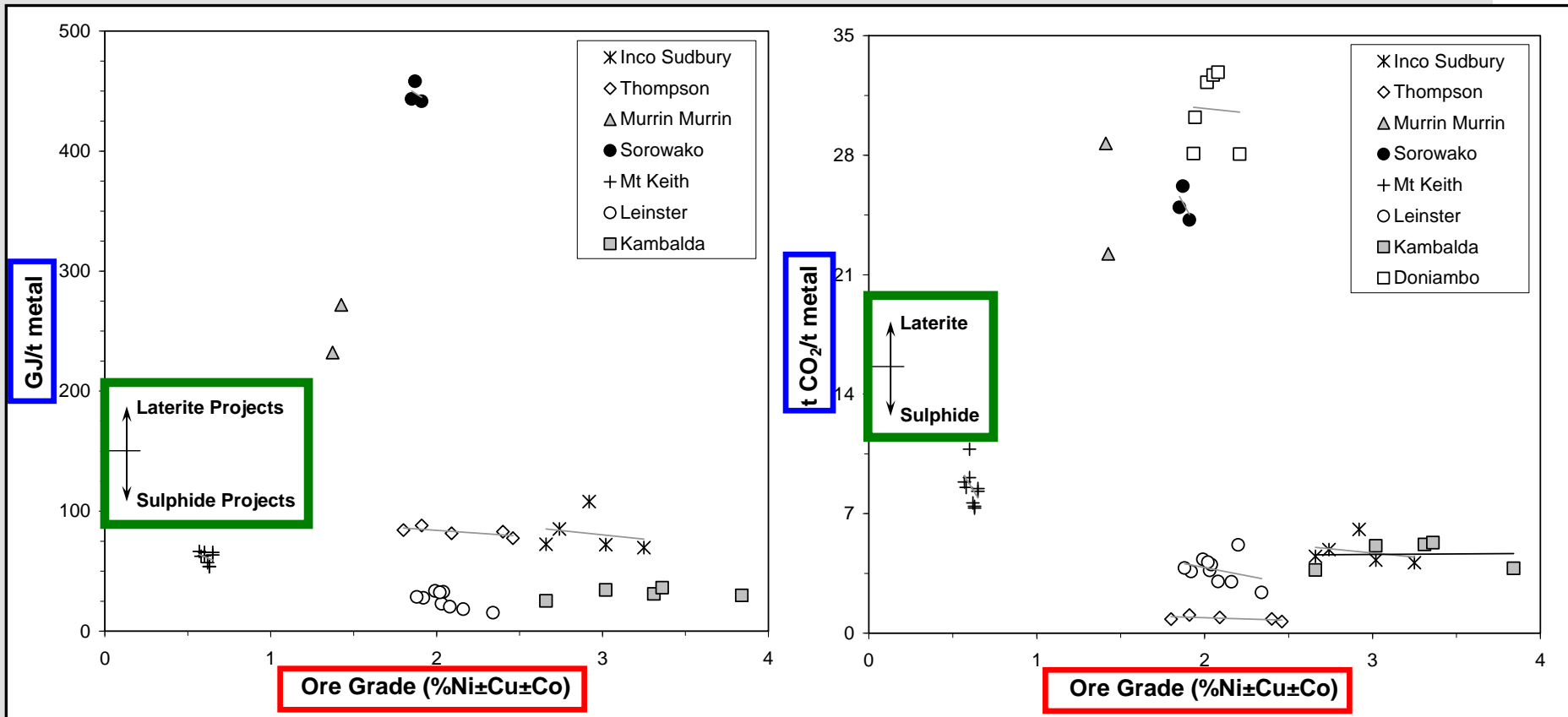
[†]No production or environmental data reported by BHP Billiton since their takeover of WMC in August 2005. [‡]Approximate annual capacity before recent Ravensthorpe expansion. [§]Platinum group metal grades ~1.51 g/t PGM. [#]~9.3 g/t PGM.

UG – underground, OC – open cut; Pyro – pyrometallurgical; HPAL – high pressure acid leach; Conc – concentrator; NR – not reported.

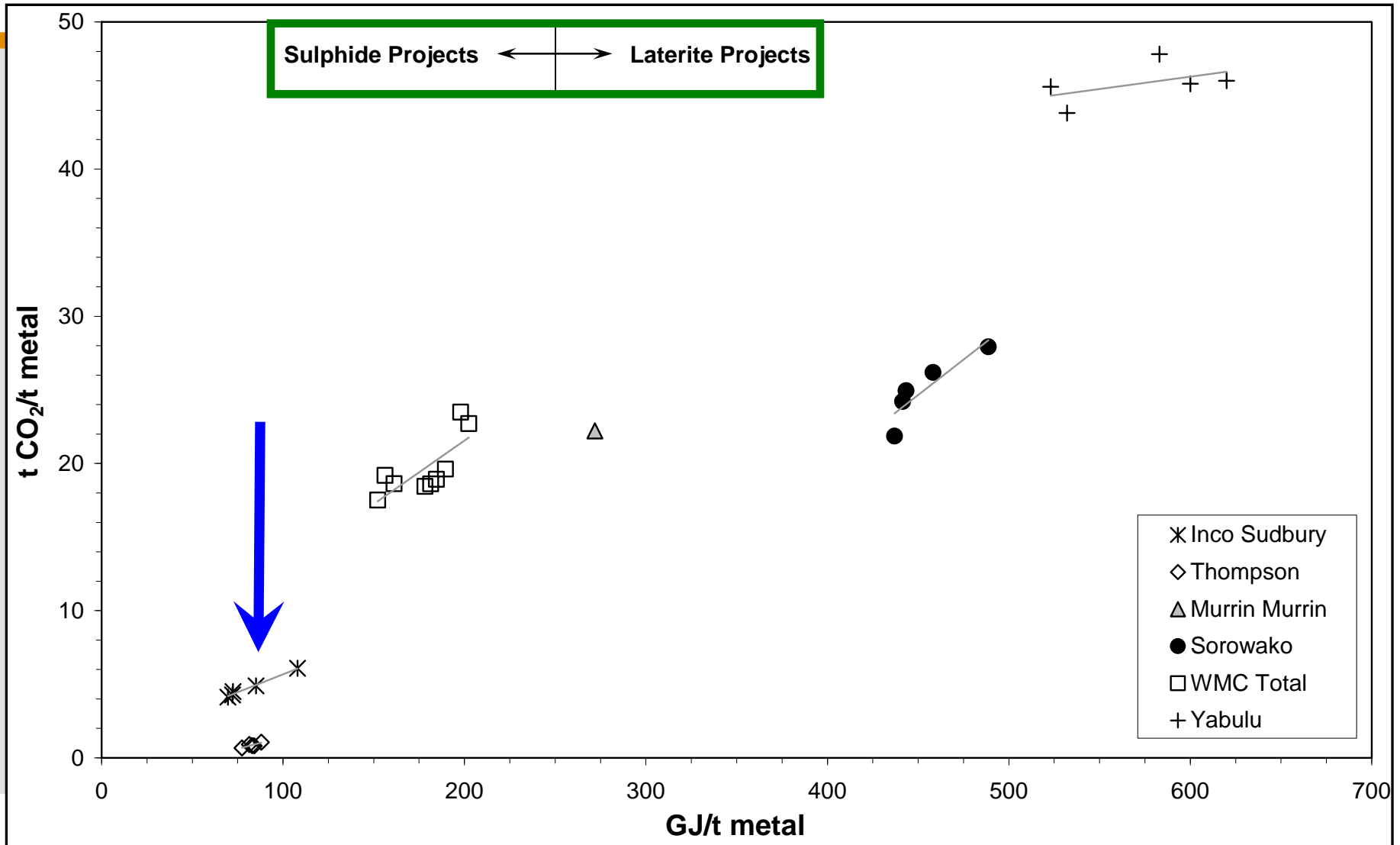
Ni Laterite Mining, New Caledonia



Results : Energy & Greenhouse



Results : Energy V Greenhouse



Implications & Ni Future ?

- Nickel will continue to be a critical metal in infrastructure (*no real alternatives ...*)
- Need for improved sustainability reporting
- Although there are relatively abundant resources compared to consumption:
 - most Ni is in lateritic ores
 - most new Ni mines are laterite
 - Ni from laterites is clearly more environmentally costly than sulphides
- **Env. costs for Ni will grow rapidly in future**