



Nickel–cobalt in Western Australia: commodity review for 2004–05

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Production

In 2004 Australia ranked third after Russia and Canada in global production of nickel, with an output of 177 kt of nickel (contained within nickel concentrate, matte, and refined nickel), which was valued at about A\$3229 million*, and 100% of this production is from Western Australia. Of the Western Australian production, 81% (143 kt) was from nickel sulfide deposits and the remaining 19% (34 kt) was from nickel laterite deposits. Table 1 gives 2004–05 nickel production figures released to the Australian Stock Exchange by a number of companies in the State. The production of cobalt (as a byproduct) in the State during calendar year 2004 was 4551 t valued at A\$262 million. Figures 1 and 2 illustrate the trends in the production of nickel and cobalt in Western Australia since 1998.

Nickel–cobalt production in Western Australia fell slightly during 2004, but is set to rise substantially with two advanced lateritic nickel projects. BHP Billiton Ltd (BHPB) plans to produce about 50 000 tpa of contained nickel from their Ravensthorpe project, commencing production by the third quarter of 2007. In the longer term, Heron Resources Ltd plans to produce about 50 000 tpa of contained nickel from the Kalgoorlie nickel project, with the bankable feasibility study for the project expected to be completed by 2011.

Development highlights — nickel sulfide projects

There are about 300 nickel sulfide mines, deposits, and exploration sites in Western Australia, distributed in the Yilgarn Craton, Pilbara Craton, Halls Creek Orogen, and Musgrave Complex. Most of the nickel sites in the State are in the Yilgarn Craton, around Kalgoorlie, Kambalda, Leinster, Murrin Murrin, Forrestania, Lake Johnston, and Ravensthorpe. The Kambalda region was the centre for much of the nickel sulfide exploration and mine development, with recommencement of mining from Wannaway, Redross, Mariners, Blair, and Zone 29 deposits. Other significant developments in the mining sector were the opening of the Sally Malay mine in the Halls Creek region, Maggie Hays mine in the Lake Johnston region, Lanfranchi nickel sulfide mine near Kambalda, and the Radio Hill mine in the Karratha region. The development of the Flying Fox deposit in the Forrestania area began in late 2004. A bankable feasibility study was completed for the Sherlock Bay deposit near Karratha and a feasibility study commenced for the Copernicus deposit at Halls Creek.

* This paper is a condensed version of Abeyasinghe and Flint (in prep.). See their original paper for a complete list of references.

Table 1. Western Australian nickel production 2004–05

<i>Project</i>	<i>Operator</i>	<i>Production Ni (t)</i>	<i>Mineralization type</i>
Leinster Nickel Operations	WMC Resources Ltd ^(a)	35 079 ^(b)	Sulfide
Mount Keith Operations	WMC Resources Ltd	31 833 ^(c)	Sulfide
Long	Independence Group NL	8 869	Sulfide
Miitel	Mincor Resources NL	6 884	Sulfide
Wannaway	Mincor Resources NL	923	Sulfide
Redross	Mincor Resources NL	1 537	Sulfide
Mariners	Mincor Resources NL	670	Sulfide
Blair (Area 57 orebody)	Australian Mines Ltd	1 457	Sulfide
Carnilya+Zone 29	View Resources Ltd	1 460	Sulfide
Cosmos	Jubilee Mines NL	11 025	Sulfide
Silver Swan	MPI Mines Ltd	6 165	Sulfide
Emily Ann	LionOre Mining International Ltd	9 882	Sulfide
RAV8	Tectonic Resources NL	1 569	Sulfide
Beta Hunt	Reliance Mining Ltd (now Consolidated Minerals Ltd)	4 758	Sulfide
Radio Hill	Fox Resources Ltd	2 109	Sulfide
Sally Malay	Sally Malay Mining Ltd	4 582	Sulfide
Murrin Murrin	Minara Resources Ltd	28 631	Laterite
Cawse	OMG Cawse Pty Ltd	5 180 ^(c)	Laterite
Total: nickel sulfide		128 802	
Total: nickel laterite		33 811	
Total: Western Australia		162 613	

NOTES: (a) WMC Resources Ltd now part of BHP Billiton Ltd
 (b) Does not include June 2005 quarter (not available)
 (c) Estimated

Development highlights — nickel laterite projects

There are about 160 nickel laterite mines, deposits, and exploration sites in Western Australia, mostly distributed in the Yilgarn Craton. The only producing nickel laterite mines were at Murrin Murrin, 60 km east of Leonora, and at Cawse, about 55 km northwest of Kalgoorlie. Heron Resources signed a joint venture agreement with Inco Australia Ltd to develop its Kalgoorlie nickel project, which has the largest resource inventory of any Australian nickel laterite project, and is estimated to contain a total measured, indicated, and inferred resource of 903 Mt grading 0.74% Ni and 0.05% Co. During 2004 work progressed well at BHPB's Ravensthorpe

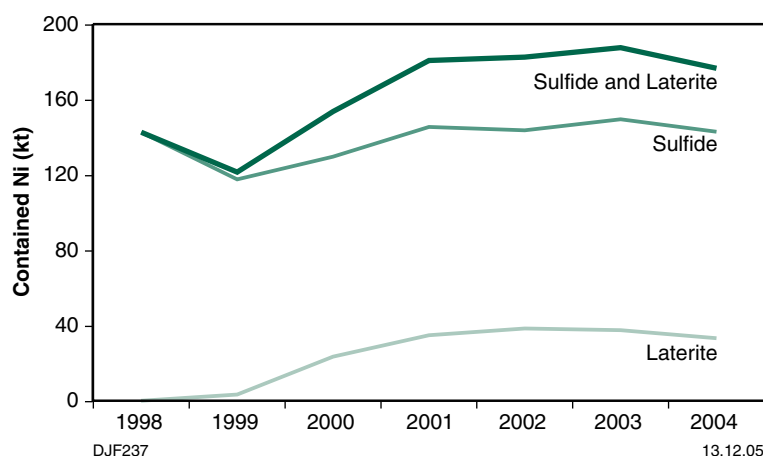


Figure 1. Western Australian nickel production, by year from 1998 to 2004

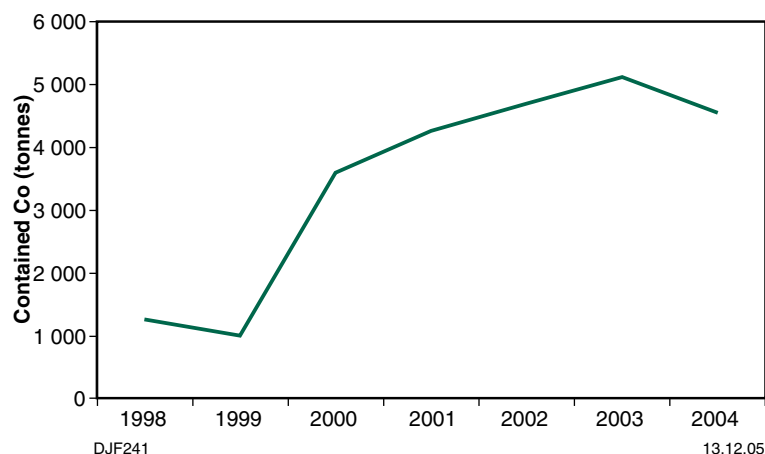


Figure 2. Western Australian cobalt production, by year from 1998 to 2004

nickel laterite project. The project involves openpit mining from three adjacent nickel laterite deposits Halleys, Hale-Bopp, and Shoemaker-Levy, which have a total proved and probable reserve of 263.3 Mt at 0.65% Ni and 0.029% Co. Mining will commence at the Halleys deposit and is expected to continue for the first 11 years of operation. The development is expected to produce a total of around 50 000 tpa of contained nickel, but, with the grade declining after the first seven years, the output will be 30 000–35 000 tpa of contained nickel from year 8 to year 28 of the project. The project at Ravensthorpe is on-track for initial deliveries of its mixed hydroxide product to an expanded Yabulu refinery in Queensland during the first half of 2007.

Exploration

During 2004–05 about 170 companies explored for nickel in Western Australia. Exploration expenditure for nickel–cobalt has risen sharply over the last three years and is now at record levels, exceeding A\$140 million per year (Fig. 3). Expenditure in 2004–05 was slightly more than double that of 2003–04.

The areas of interest for greenfields exploration were the northern parts of the Yilgarn Craton (such as Gerry Well greenstone belt), the Kimberley region, Musgrave Complex, and the west Bangemall region. In the Yilgarn Craton Kambalda-type komatiite-hosted nickel deposits in the Archean greenstone belts and Raglan-type komatiite-hosted deposits in rifted continental margins were the main targets. In the Kimberley region, Musgrave Complex, and west Bangemall region the main targets were Voiseys Bay-type deposits associated with tholeiitic intrusions, and Noril'sk-type deposits in rift- and continental-flood basalts.

The most notable greenfields exploration success was at Collurabie in the Gerry Well greenstone belt of the Yilgarn Craton, where WMC Resources Ltd (now part of BHPB) announced a new nickel province. The discovery is a zone of combined nickel, copper, and platinum group elements (PGE) mineralization extending over 7 km along strike. A number of significant drill intersections have been obtained, including 5.77 m at 3.00% Ni, 1.96% Cu, and 5.29 g/t Pt+Pd from 279.43 m in drillhole CLD159. The low Ni/Cu ratio and high PGE levels reported to date distinguish this mineralization from typical komatiite-hosted nickel sulfide mineralization.

A number of companies had brownfields exploration success near their existing operations:

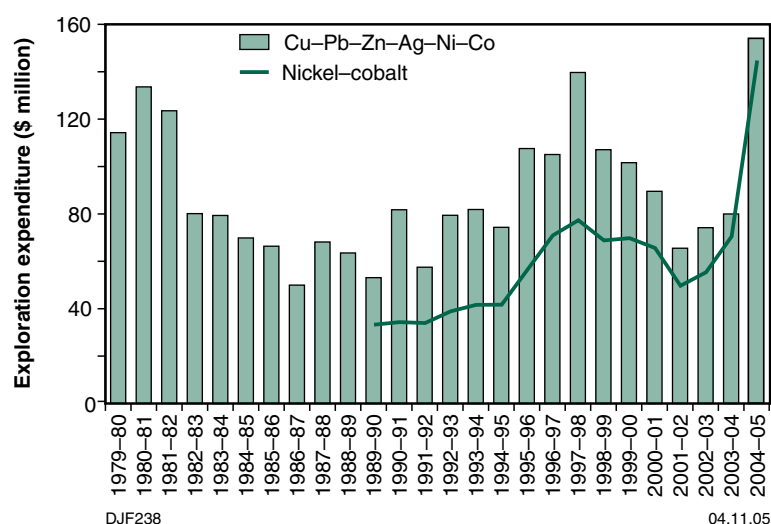


Figure 3. Western Australian base metal and nickel exploration expenditure, by financial year (2004–05 dollars), (Australian Bureau of Statistics, and Hronsky and Schodde, in press)

- WMC Resources has successfully used an innovative deep-penetrating electromagnetic surveying technique ('Geoferrret' technology) around Mount Keith, which now more effectively explores depths from 150 to 500 m below surface.
- Jubilee Mines NL discovered high-grade mineralization at Prospero near Cosmos mine, 35 km northwest of Leinster, and estimated an inferred resource of 1.06 Mt at 5.72% Ni for the deposit. Jubilee Mines also identified promising mineralization at nearby Alec Mairs and Anomalies 1 and 4, extending the considerable success around Cosmos.
- In the Forrestania belt, Western Areas NL reported considerable exploration success at Forrestania, with new resources reported for Flying Fox T5 deposit (inferred resource of 0.63 Mt at 6.9% Ni) in addition to those reported for Flying Fox T1 and Flying Fox T2 deposits.
- Independence Group NL announced the discovery of the high-grade McLeay nickel deposit south of Victor South deposit at the southerly extension of the Long nickel mine, near Kambalda.
- Drilling by Mincor Resources NL north of North Miitel mine and south of Miitel mine, about 40 km south of Kambalda, produced high-grade nickel intersections.
- In the Leinster and Wiluna regions, LionOre Mining International Ltd increased its exploration activities at Wedgetail and Harrier deposits of the Honeymoon Well project. LionOre Mining has suggested the possibility of production from Honeymoon Well by mid-2008.
- WMC Resources commenced pre-feasibility studies at the Yakabindie deposits.
- Exploration drilling by Consolidated Minerals Ltd at Beta Hunt and East Alpha near Kambalda has doubled the global resource to 2.1 Mt at 3.6% nickel, with 1.045 Mt in the measured and indicated categories.
- Thundelarra Exploration Ltd discovered the Copernicus North orebody (north of Halls Creek) that has similarities to Voiseys Bay-type nickel

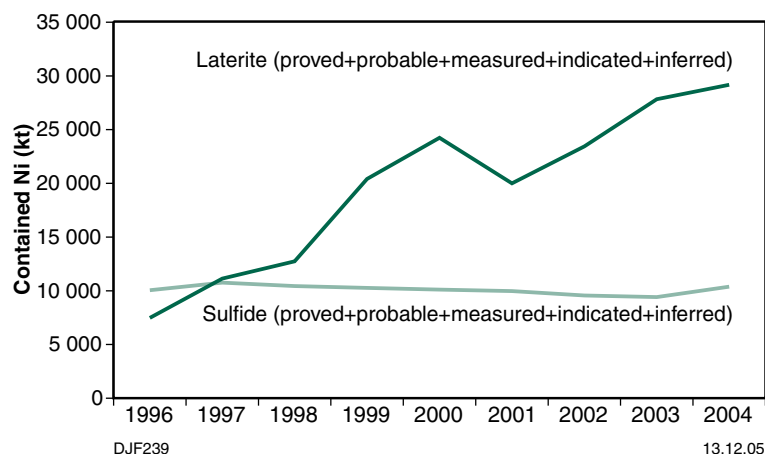


Figure 4. Western Australian nickel sulfide and nickel laterite resources, by year since 1996

mineralization. There was also significant exploration around Copernicus and Salk North deposits in the Halls Creek region and the area is proving to be highly prospective for Voiseys Bay-type nickel mineralization.

Mineral resources and ore reserves

Total resources of nickel (in all JORC categories and in all deposit styles) have increased throughout the last decade, largely due to the successful delineation of nickel laterite resources. Resources of nickel laterite have increased about fourfold over the last 10 years, whereas resources of nickel sulfide have remained almost unchanged (Fig. 4).

Figure 5 illustrates the more detailed trends for nickel laterite and nickel sulfide in all JORC categories. For nickel laterite, the increase has been relatively uniform in both inferred resources, as well as reserves and measured and indicated combined. However, for sulfide nickel, the overall long-term trend is more of resources switching classifications with no net increase or decrease. The current trend for sulfide nickel resources is most likely to be broken if and when an initial resource estimate for Babel and Nebo (West Musgrave) is compiled.

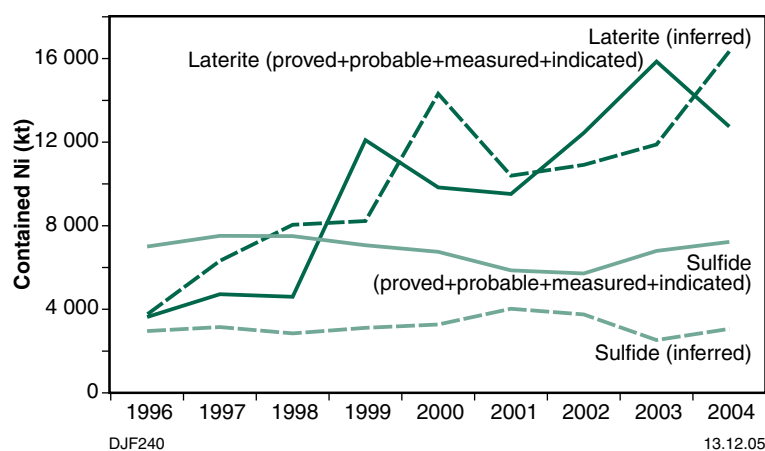


Figure 5. Western Australian nickel sulfide and nickel laterite resources (measured + indicated + inferred), by year since 1996. Measured and indicated resources also include any converted to ore reserves

Table 2. Nickel sulfide projects in Western Australia, ranked by contained nickel. Includes nickel in all resource and reserve categories

<i>Nickel sulfide deposits^(a)</i>	<i>Operator</i>	<i>Contained Ni (kt)</i>
Mount Keith	WMC Resources Ltd (BHP Billiton Ltd)	2 321
Leinster	WMC Resources Ltd (BHP Billiton Ltd)	1 726
Yakabindie	WMC Resources Ltd (BHP Billiton Ltd)	1 677
Honeymoon Well	LionOre Mining International Ltd/OM Group	1 016
Cosmos	Jubilee Mines Ltd	412
Emily Ann – Maggie Hays	LionOre Mining International Ltd	236
Jericho	WMC Resources Ltd (BHP Billiton Ltd)	207
Kambalda	BHP Billiton Ltd /Independence Group NL/Breakaway Resources Ltd	191
Sherlock Bay	Sherlock Bay Nickel Corp Ltd	162
Panton	Platinum Australia Ltd	158
Widgiemooltha North	Titan Resources NL	147
Miitil–Redross	Mincor Resources NL	127
Worthy	Westralian Nickel NL	115
Silver Swan – Black Swan	LionOre Mining International Ltd	110
Cliffs	WMC Resources Ltd (BHP Billiton Ltd)	102
		8 707

NOTES: (a) Excludes deposits of less than 100 kt

Table 3. Nickel laterite projects in Western Australia, ranked by contained nickel. Includes nickel in all resource and reserve categories

<i>Nickel laterite deposits^(a)</i>	<i>Operator</i>	<i>Contained Ni (kt)</i>
Mount Margaret	Minara Resources Ltd	3 464
Murrin Murrin	Minara Resources Ltd/GME Resources Ltd	3 441
Ravensthorpe	BHP Billiton Ltd/Traka Resources Ltd	2 530
Weld Range	Minara Resources Ltd/Dragon Mining NL/Sons of Gwalia Ltd	2 475
Wingellina	Acclaim Exploration Ltd	2 269
Honeymoon Well	LionOre Mining International Ltd/OM Group	2 250
Bulong	Heron Resources Ltd/Inco Australia Ltd ^(b)	2 099
Goongarrie	Heron Resources Ltd/Inco Australia Ltd	1 498
Siberia	Heron Resources Ltd/Inco Australia Ltd	1 358
Wiluna	Agincourt Resources Ltd	833
Highway	Heron Resources Ltd	712
Kalpini	Heron Resources Ltd	670
Pinnacles	Peninsula Minerals Ltd/Bannerman Resources Ltd	350
Ghost Rocks	Heron Resources Ltd	312
Eucalyptus Bore	GME Resources Ltd	227
Yerilla	Heron Resources Ltd/Inco Australia Ltd/Minara Resources Ltd	171
Irwin Hills	Yilgarn Mining Ltd/Minara Resources Ltd	153
Lake Rebecca	Heron Resources Ltd/Inco Australia Ltd	152
		24 964

NOTES: (a) Excludes deposits of less than 100 kt

(b) Kalgoorlie nickel project comprises deposits operated jointly by Heron Resources Ltd and Inco Australia Ltd
Cawse: figures are not available

Tables 2 and 3 indicate the ranking of nickel sulfide and nickel laterite deposits in Western Australia by contained nickel (ore reserves and resources combined).

For deposits averaging 1% Ni or greater, Western Australia has about 8% (10 Mt) of the global nickel resources (130 Mt) and about 11% (1.6 Mt) of the global cobalt resource of 15 Mt.

References

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