

# Overview

## Overview of mineral exploration in Western Australia for 2006–07

by PB Abeyasinghe and DJ Flint

### Overview

Throughout 2006–07 the boom in commodity prices continued, leading to big increases in the value of mineral production in Western Australia, even though some commodities (e.g. nickel and gold) experienced falls in production. Despite five years of general increases in exploration activity, mineral exploration expenditure in Western Australia has only just returned to the peak levels experienced in 1987–88 and 1996–97. Both mining and exploration in Western Australia are now dominated by, and increasingly reliant upon, a single commodity — iron ore. If current trends continue, iron ore exploration in Western Australia will surpass that for gold in 2007–08. The recovery in (non-ferrous) mineral exploration in Western Australia has lagged behind other jurisdictions, including the rest of Australia, our main competitor Canada, and the world average.

Western Australia accounts for the major proportion of exploration dollars expended in Australia for iron ore (95%), nickel–cobalt (87%), gold (61%), diamond (53%), heavy mineral sands (44%), and copper–lead–zinc–silver (17%).

Some notable observations for the Western Australian mineral industry during 2006–07 are:

- Mineral exploration expenditure in Western Australia rose by 39% from \$606 million in 2005–06 (in 2006–07 dollar terms) to \$839 million\* in 2006–07;
  - Expenditure is now close to the levels of the last boom in 1996–97 and the previous boom in 1987–88 (Fig. 1);
  - Australian mineral exploration expenditure rose by 35% from \$1274 million in 2005–06 to \$1715 million in 2006–07;
  - Western Australia's share of the national exploration expenditure for minerals (excluding petroleum) increased marginally from 48% in 2005–06 to 50% in 2006–07, but is well below the level of around 60% experienced during the late 1990s and early 2000s (Fig. 1);
  - Western Australia continues to experience unprecedented growth in the minerals industry
- with the value of mineral production in the State during 2006–07 increasing by 32% to a new record of \$37 billion (excluding petroleum);
  - Drilling at a number of gold projects near Kambalda, Laverton, Southern Cross, and Wiluna in the Yilgarn Craton, and near Nullagine in the Pilbara Craton, produced impressive gold intersections and some economic discoveries;
  - Steady progress in the magnetite iron ore sector with a 3.3 – 6.6 Mtpa (million tonnes per annum) project planned at Southdown near Albany, and a bankable feasibility study nearing completion for the Karara project in the Mid West region;
  - Production of sulfide nickel commenced from new mines near Leinster and Forrestania, and production is planned from a number of deposits near Leinster and Kambalda;
  - Mine development at BHP Billiton's Ravensthorpe laterite nickel project is well advanced, with production of nickel expected to commence in early 2008;
  - The Pillara Pb–Zn mine near Fitzroy Crossing recommenced production in early 2007, and the Jaguar zinc mine near Leonora commenced production in mid-2007;

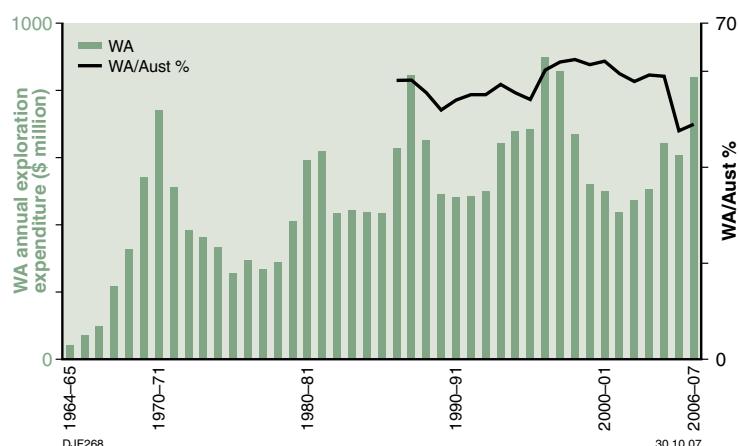
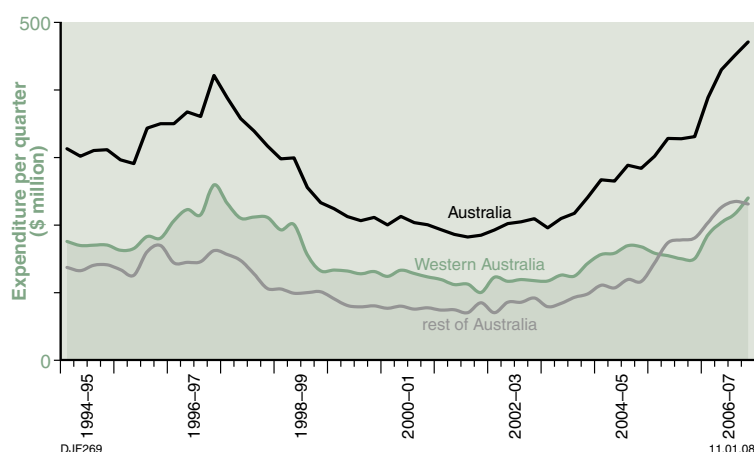
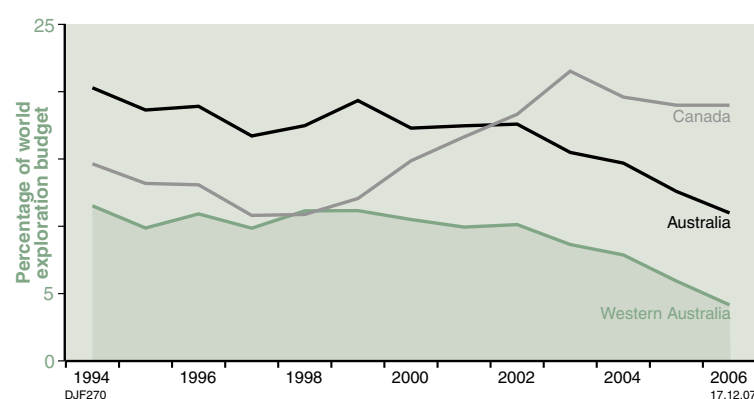


Figure 1. Mineral exploration expenditure in Western Australia, by year (2006–07 dollars)

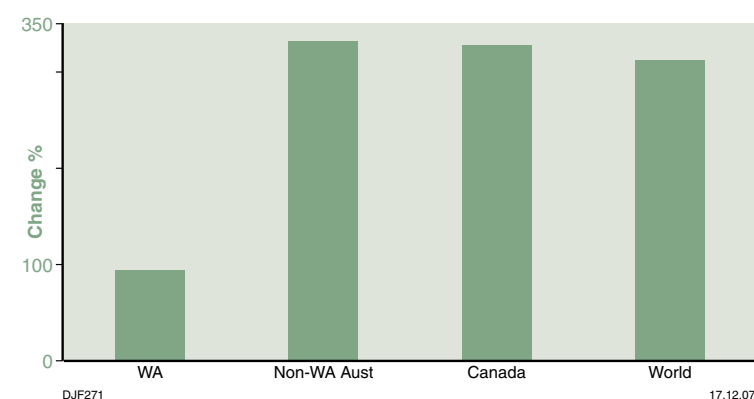
\* All \$ figures are in Australian dollars unless otherwise specified. All exploration expenditure figures and drilling statistics are compiled by the Australian Bureau of Statistics (ABS) unless otherwise specified



**Figure 2. Mineral exploration expenditure in Australia, Western Australia, and rest of Australia**



**Figure 3. Non-ferrous mineral exploration expenditure — comparative market share of Canada and Western Australia since 1994 [source: Metals Economics Group (Canada), ABS, and DoIR]**



**Figure 4. National and international comparison of non-ferrous mineral exploration: % change from last recession 2002 to 2006**

- New copper–zinc–gold–silver mineralized zones were discovered at the Golden Grove mine (near Yalgoo) increasing its mine life and annual capacity;
- Moly Mines Ltd increased the design capacity of their proposed molybdenum–copper–silver mine at Spinifex Ridge (35 km northeast of Marble Bar) from 15 Mtpa to 20 Mtpa of ore, with production planned for mid-2009.

Quarterly mineral exploration data highlight the diverging trend in mineral exploration between Western Australia and the rest of Australia, with Western Australia showing signs of gaining momentum (Fig. 2).

Australia and Western Australia have both continued to lose market share in the expanded world-wide pool of exploration capital (Fig. 3; based on data compiled by the Metals Economics Group of Halifax, Canada, <[www.metalseconomics.com](http://www.metalseconomics.com)>). During the last decade, the proportion of the world's non-ferrous mineral exploration expenditure in Australia has dropped from 17% to 11%, whereas Western Australia has dropped from 10% to 4%.

Despite significant increases in non-ferrous exploration expenditure in Western Australia during the last four years (2002 to 2006 inclusive, corresponding to the first four years of an exploration boom), Western Australia has still lagged behind its competitors. From 2002 to 2006, other jurisdictions have increased their non-ferrous mineral exploration expenditure by an average of around 300%, whereas that in Western Australia has increased by only about 100% (Fig. 4; based on data compiled by the Metals Economics Group of Halifax, Canada, <[www.metalseconomics.com](http://www.metalseconomics.com)>).

## Developments and mineral exploration highlights by commodity

During 2006–07, exploration expenditure for iron ore, nickel, copper–lead–zinc–silver, and heavy mineral sands reached record levels. Gold exploration remained the area of greatest expenditure, but is still well below the levels in 1996–97.

# Overview

## Gold

In 2006–07 the international gold price rose to a 24-year high, reaching US\$679/oz in April 2007. Trends in the gold industry in Western Australia during 2006–07 include:

- Gold production fell by 5.7% to 157 t, but value increased by 10% to \$4.1 billion. Gold production fell despite a significant contribution from Telfer;
- Gold exploration expenditure increased by 12%, reversing the declining trend of the last three years. However, expenditure is still well below the historic peaks of 1987–88 and 1996–97.

Although gold exploration has been the backbone of the mineral exploration industry in Western Australia since the early 1980s (reaching levels of around 75% of total mineral exploration expenditure in the mid-1990s), its proportion of total exploration expenditure during 2006–07 declined to 33% (Fig. 5). However, gold retains its number one position in terms of exploration dollars expended (Figs 5, 6) which, in 2006–07, increased by 12% to \$267.9 million (Fig. 7). This increasing exploration expenditure will hopefully lead to further discoveries and halt falling gold production in the State, which has shown a continuous decline over the last nine years (Fig. 8). An inadequate level of greenfields mineral exploration remains an ongoing concern for the future of gold mining in the State.

New mine developments during 2006–07 include Wattle Dam (25 km southwest of Kambalda) by Ramelius Resources Ltd; Boddington redevelopment (110 km southeast of Perth) by Newmont Australia Ltd/Anglogold Ltd joint venture; Trident mine at Higginsville (60 km south of Kambalda) by Avoca Resources Ltd; and Laverton by Crescent Gold Ltd. Mines to be developed in the near future include BrightStar (35 km southeast of Laverton) by A1 Minerals Ltd, and Davyhurst (55 km southwest of Menzies) by Monarch Gold Mining Company Ltd. Carrick Gold Ltd has increased its gold resources to more than three million ounces at its Lindsay and Kalpini projects in the eastern Goldfields.

The Anglogold/Independence Group joint venture is investigating two openpit mining areas and plans to release an initial resource for the greenfields Tropicana gold project (400 km northeast of Kalgoorlie) by late 2007. This gold discovery, made in 2003–04, is the most important in Western

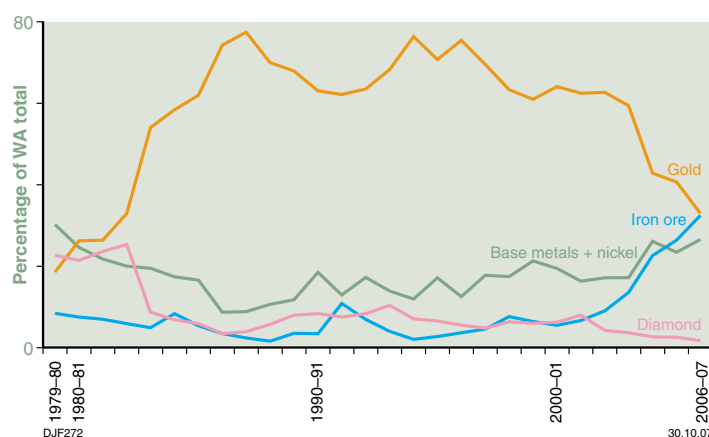


Figure 5. Exploration expenditure in Western Australia (% of total, by commodity)

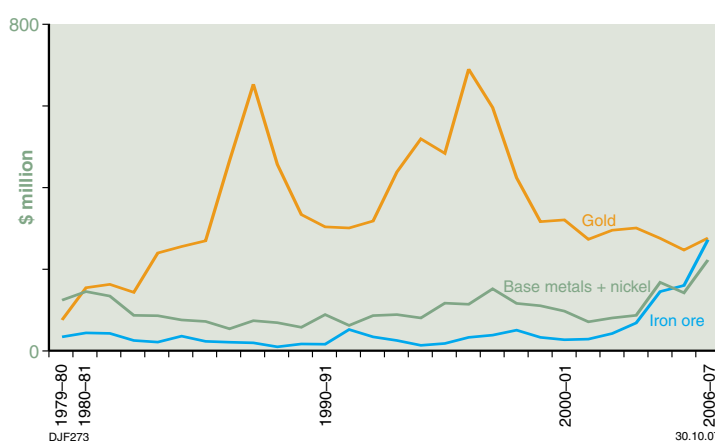


Figure 6. Gold, nickel-cobalt, and iron ore exploration expenditure in Western Australia since 1979–80 (2006–07 dollars)

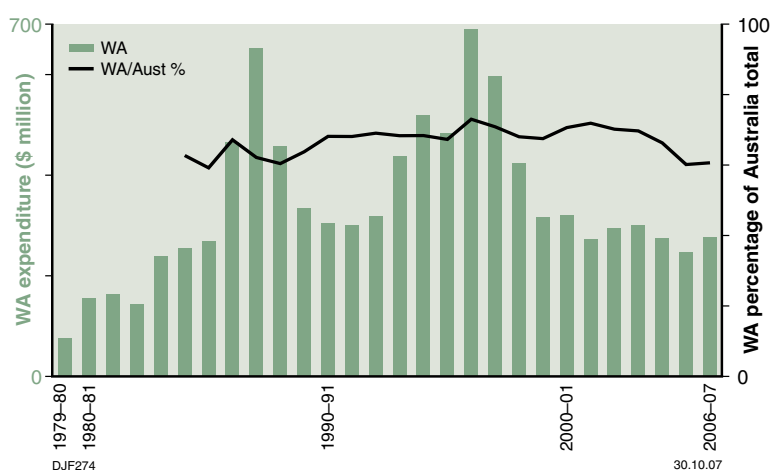
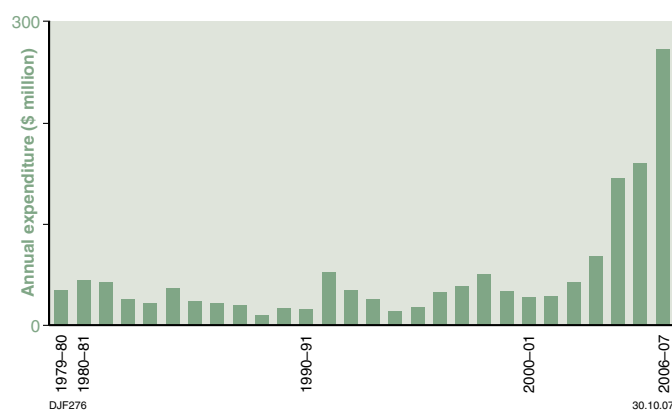


Figure 7. Gold exploration expenditure in Western Australia (2006–07 dollars)



**Figure 8. Gold exploration expenditure and gold production in Western Australia (2006–07 dollars)**



**Figure 9. Western Australian iron ore exploration expenditure (2006–07 dollars)**

Australia since the discovery of Thunderbox about seven years ago.

Highlights of significant gold intersections in Western Australia during 2006–07 are:

- 16 m at 482 g/t Au from 123 m, including 1 m at 6770 g/t Au at Wattle Dam, 25 km southwest of Kambalda (Ramelius Resources Ltd);
- 25 m at 31.8 g/t Au at Burbanks, 10 km south of Coolgardie (Barra Resources Ltd);
- 11.5 m at 13.4 g/t Au at Blue Spec, 20 km northeast of Nullagine (Northwest Resources Ltd);
- 27 m at 88 g/t Au including 10 m at 229 g/t Au at Athena lode at Trident mine,

Higginsville, 60 km south of Kambalda (Avoca Resources Ltd);

- 6 m at 11.8 g/t Au, which includes 2 m at 31.2 g/t Au at Julius prospect, 80 km southeast of Wiluna (Echo Resources Ltd);
- 28 m at 4.1 g/t Au, which includes 8 m at 10.6 g/t Au at Halleys East prospect – Barlee, 175 km north of Southern Cross (Beacon Minerals Ltd);
- 12 m at 13.1 g/t Au at Quartz Circle, 25 km northeast of Nullagine (Graynic Metals Ltd);
- 28 m at 4.56 g/t Au and 36 m at 3.42 g/t at Salt Creek near Randalls gold project, 50 km southeast of Kalgoorlie (Integra Mining Ltd);
- 8 m at 11.12 g/t at Maxwells deposit at Aldiss project, 130 km east of Kalgoorlie (Integra Mining Ltd);
- 8 m at 22.3 g/t Au at Jimblebar project, 50 km east-southeast of Newman (Warwick Resources Ltd);
- 8 m at 22.58 g/t at Pennys Find, 50 km northeast of Kalgoorlie (Empire Resources Ltd);
- 8 m at 22.15 g/t at Mertons Reward, 33 km northeast of Leonora (Navigator Resources Ltd).

## Iron

Highlights in Western Australia during 2006–07 include:

- A year of records for production quantity, production value, and exploration expenditure;
- Unprecedented price increases meant that the value of Western Australian iron ore production increased by 24% to \$15.8 billion despite production increasing by only 6% to 258 Mt;
- Western Australian iron ore exploration expenditure has continued its five-year stellar rise, climbing by 70% (to \$272 million) in 2006–07 and 540% over the last five years (Fig. 9). This level of iron ore exploration in Western Australia is, for the first time, matching that of gold (Fig. 6). At present, more than 70 companies are exploring for iron ore in Western Australia;
- Numerous mines targeting zones of supergene enrichment were being developed or were at

# Overview

an advanced feasibility stage, and Western Australia moved significantly closer to developing its first iron ore mine with a magnetite concentrate product;

- Following several years of intense capital investment in expansion projects in the Pilbara, Western Australia's iron ore production is set to increase significantly over the next 5–10 years;
- Foreign-owned companies (from China, Japan, and Korea) continued to greatly increase their direct ownership or involvement (e.g. through long-term off-take agreements) in the Western Australian iron ore industry, all seeking to secure long-term supplies at lower than current prices.

The unprecedented iron ore boom of the past three years continued, driven by extremely strong customer demand for iron ore, particularly from China, concomitant with a world-wide supply shortage. The major producers in the Pilbara are responding by rapidly expanding their operations at existing projects and planning new projects. The high iron ore prices have greatly assisted the capital raisings of junior companies, opening up the industry to juniors, and will result in ending the historical duopoly of Rio Tinto and BHP Billiton in the Pilbara.

The most conspicuous development during 2006–07 was Fortescue Metals Group's Pilbara iron ore and infrastructure project, which is nearly 50% complete. Other iron ore projects under development or near completion include those at Pardoo in the north Pilbara (Atlas Iron Ltd), Mount Gibson in the south Murchison (Mount Gibson Iron Ltd), Koolan Island in the west Kimberley (Mount Gibson Iron Ltd), Brockman No. 4 in the Hamersley region (Rio Tinto), and Hope Downs in the Hamersley region (Rio Tinto and Hancock Prospecting Pty Ltd). Rio Tinto also plans to mine Mesa A/Warramboe (Pilbara), and the Nammuldi and Yandi Expansions (Hamersley area) within the next five years. In other developments, a feasibility study is being carried out by Murchison Metals Ltd for the Jack Hills deposit in the north Murchison region to increase annual production capacity to 25 Mtpa by late 2010; and Midwest Corporation Ltd plans to start the second phase of mining to produce lump and fines at the Koolanooka and Blue Hills direct shipping ore operations in the west Murchison.

In the magnetite iron ore sector, Grange Resources Ltd commenced detailed mine planning for the Southdown project near Albany, Gindalbie Metals

Ltd has begun a bankable feasibility study for the Karara project in the Mid West region, and Macarthur Minerals Ltd commenced a scoping study for the Lake Giles magnetite project in the Southern Cross region. Australasian Resources Ltd, Mineralogy Pty Ltd, and CITIC Pacific Ltd jointly plan to proceed with the Balmoral and Balmoral South projects in the west Pilbara, and Aurox Resources Ltd is carrying out a bankable feasibility study for the Balla Balla project north of Whim Creek in the Pilbara.

Iron ore exploration targeted several mineralization styles including channel iron deposits (CID); supergene-enriched hematite over Archean (Marra Mamba) to Paleoproterozoic (Brockman) banded iron-formations (BIF); supergene-enriched hematite in the north Pilbara BIF; primary magnetite in BIF of the Pilbara and Yilgarn Cratons; magnetite in BIF within the Mesoproterozoic gneiss terrane of the Albany–Fraser Orogen; clastic hematite in Paleoproterozoic sedimentary rocks of the Kimberley Basin (Cockatoo Island, Koolan Island); and hematite iron ore mineralization in the Mid West region. Numerous companies maintained their interest in primary magnetite mineralization within BIF horizons throughout the Yilgarn Craton, as far north as Wiluna (Golden West Resources Ltd) and as far south as Ravensthorpe (Traka Resources Ltd).

Some of the iron ore exploration successes include hematite projects at Mungada (Gindalbie Metals Ltd) and Beebyn – Weld Range (Giralia Resources NL) in the Mid West region, BIF-related mineralization at Abydos project south of Port Hedland (Atlas Iron Ltd), BIF and hematite/goethite-related mineralization at Johnston Range, Evanston, and Copper Bore north of Southern Cross (Transit Holdings and Polaris Metals NL), Marra Mamba iron ore-related mineralization at Davidson Creek in the east Pilbara (FerrAus Ltd), Poondano CID project near Port Hedland (Polaris Metals NL), a bedded-iron deposit at Hardy west-northwest of Paraburdoo (Aquila Resources Ltd), and CID mineralization southwest of Nullagine (BC Iron Ltd).



## Nickel

Highlights in Western Australia during 2006–07 include:

- The international price of nickel nearly doubled from US\$26 586/t in July 2006 to US\$52 179/t in May 2007;
- The value of nickel production in Western Australia increased by an astounding 110% to \$8 billion, despite production falling by 5% to 173 kt of contained nickel;
- Nickel exploration expenditure in Western Australia increased by an impressive 34% to \$158 million, reversing last year's (2005–06) negative trend. However, the nickel sector is a less significant component of the exploration industry than it was in the late 1970s and early 1980s;

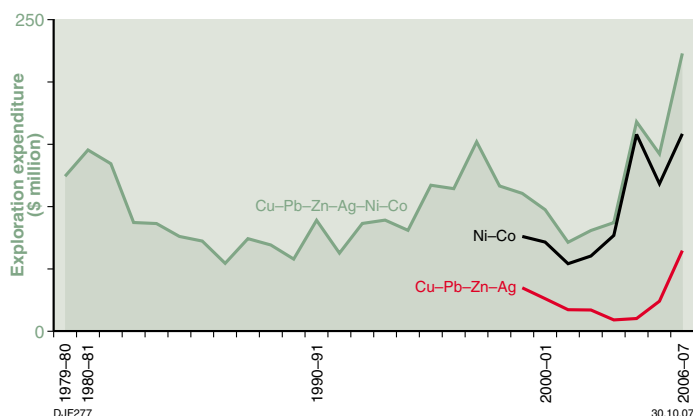


Figure 10. Western Australian nickel, cobalt, and base metal exploration expenditure (2006–07 dollars)

Nickel production in Western Australia is set to rise in the near future with the completion of a number of new sulfide and lateritic nickel projects:

- In the sulfide nickel sector, production from new mines commenced in the latter part of 2006 from the Waterloo mine southeast of Leinster, and Flying Fox mine at Forresteria. Production will soon commence from the Tapinos, Sinclair, and Alec Mairs deposits in the Leinster region; from the Winner, Deacon, and Dordie Rocks North deposits in the Kambalda region; and the Copernicus mine northeast of Halls Creek. There are also plans to start sulfide nickel mining at the Mount Windarra deposit near Laverton, at the Carr Boyd deposit southeast of Menzies, at Carnilya Hill near Kambalda, and at Nepean south of Coolgardie;

- In the lateritic nickel sector, BHP Billiton has already started mining at the Ravensthorpe project, and plans to produce about 50 000 tpa of contained nickel. In the longer term, Heron Resources Ltd and CVRD Inco Ltd plan to produce about 50 000 tpa of contained nickel from the Kalgoorlie nickel laterite project, with a bankable feasibility study for the project expected to be completed by 2011. Heron also plans to produce 10 000 tpa of contained nickel in 2009 from a heap-leach operation at Jump-Up Dam, about 120 km southeast of Leonora. Metals X Ltd has completed a scoping study on the Wingellina laterite project and GME Resources Ltd has made advances in the NiWest nickel laterite project near Murrin Murrin.

The new record high of \$158 million expended on nickel exploration in 2006–07 (Fig. 10) accounted for 19% of the total Western Australian exploration expenditure for that year. This was an increase of 163% over the last five years. Most of the nickel exploration activity in the State was within the Leinster, Forresteria, Kambalda, Kalgoorlie, Norseman, and Ravensthorpe regions of the Yilgarn Craton, near Halls Creek in the Lamboo Complex, and at a number of areas in the Pilbara Craton.

Significant exploration successes in the nickel sector include:

- Discovery of the Alec Mairs 2 and 5 deposits, near Cosmos Deeps mine near Leinster, and the Skye prospect near the Sinclair deposit south of Leonora (Jubilee Mines NL);
- Extensions to known nickel mineralization at the Blair Deeps deposit (Australian Mines Ltd), the South Miitel, North Miitel, Mariners, and Redross deposits (Mincor Resources NL), the McLeay deposit (Independence Group NL) all within 50 km south of Kambalda, and new extended mineralized zones at Carnilya Hill (Mincor Resources NL);
- Discovery of extended mineralization below the T5 deposit at Flying Fox, Forresteria (Western Areas NL);
- Discovery of two zones of significant mineralization in a previously untested area, 150 m from the main orebody at Sally Malay (Sally Malay Mining Ltd);

There were also significant exploration successes from drilling in the Yilgarn Craton at GSP (65 km north of Kalgoorlie) and Roe (122 km

# Overview

east-northeast of Kalgoorlie, Magma Metals Ltd), Bulong South (28 km east-southeast of Kalgoorlie, Southern Gold Ltd), St Andrews (80 km north-northwest of Kalgoorlie, Breakaway Resources Ltd), Grey Dam (70 km northeast of Kalgoorlie, Carrick Gold Ltd), Gillet (34 km south of Kambalda, Consolidated Minerals Ltd), Mount Thirsty (20 km northwest of Norseman, Barra Resources Ltd), Denny Bore (10 km southeast of the Mount Windarra, Poseidon Nickel Ltd), and Marriott (65 km south-southeast of Leinster, Australian Mines Ltd).

Exploration successes in the Pilbara Craton include Razerline (15 km south of Karratha, Fox Resources Ltd), Cookes Creek (40 km northeast of Nullagine, Hazelwood Resources Ltd), and Pardoo (100 km east-northeast of Port Hedland, Segue Resources Ltd).

## Base metals (copper–lead–zinc–silver)

Western Australian highlights during 2006–07 include:

- The international high prices for base metals during 2006–07 resulted in substantial increases in the value of copper, lead, and zinc production in the State by 70%, 30%, and 84% respectively;
- Copper–lead–zinc–silver exploration expenditure in the State has more than doubled from \$24 million (2006–07 dollars) in 2005–06 to \$65 million in 2006–07 (Fig. 10);
- Lead and zinc production in the State is set to increase with the Pillara mine on the Lennard Shelf having recommenced production in early 2007;
- CBH Resources Ltd approved the development of the Sulphur Springs zinc–copper project in the Pilbara area. The project will produce high-quality concentrates containing approximately 50 000 tpa of zinc and 20 000 tpa of copper;
- A disappointing note for 2006–07 was the loss of production when the Magellan lead mine was placed on care and maintenance due to environmental problems at the port of Esperance associated with transportation and handling of the lead ore.

Copper production in the State in 2006–07 increased by 38% (from 81 202 t in 2005–06 to 112 280 in 2006–07), whereas the value increased

by 70% to \$952.6 million. This increase was largely due to the increased production from the Nifty mine in the Paterson Orogen and from new mines at Whim Creek and Whundo in the Pilbara region. Despite the halt to production from the Magellan lead mine in April 2007, lead production in the State decreased by only 3% (from 58 739 t in 2005–06 to 56 927 in 2006–07), reflecting production from the newly opened Pillara mine on the Lennard Shelf from early 2007. The value of lead production increased by 30% to \$112.2 million. Magellan and Golden Grove were the only lead-producing mines in the State till the end of 2006. Zinc production in the State increased by 17% (from 110 523 t in 2005–06 to 129 276 t in 2006–07) with the value increasing by 84% to \$618.9 million. The production increase is due to the recommencement of mining at Pillara. The only other zinc producer in the State is the Golden Grove operation.

The improved exploration expenditure for copper–lead–zinc–silver in Western Australia can be attributed to:

- Exploration and development of Jabiru Metals Ltd's Jaguar deposit and Oxiana Ltd's Golden Grove mine in the Yilgarn Craton. Drilling at Golden Grove leading to the discovery of new mineralized zones (e.g. 51 m at 6.1% Cu, 1.8% Zn, 1.1 g/t Au, 52 g/t Ag) increasing its mine life and annual capacity;
- Development of Teck Cominco Ltd's Pillara mine and related exploration in the Lennard Shelf area of the Canning Basin;
- Exploration in the central Canning Basin by Kagara Zinc Ltd for zinc and lead at the deep-seated Admiral Bay deposit, which returned significant mineralized intersections including 20 m at 8.3% Zn and 4.9% Pb but from a depth of 1321 m;
- Successful exploration drilling in the Pilbara region with 20 m at 13.7% Zn and 0.2% Cu from 112 m at Panorama (CBH Resources Ltd/Sipa Resources Ltd joint venture); 22 m at 4.05% Cu from 39 m at Whundo (Fox Resources Ltd); and 21 m at 2.05% Zn and 1.10% Pb from 21 m at Orchard Well (De Grey Mining Ltd);
- Exploration drilling in the Halls Creek Orogen — 52 m at 1.8% Zn from 125 m at Eastman (Navigator Resources Ltd), 61 m at 1.32% Zn from 38 m at Emull (Northern Star Resources Ltd), 41.6 m at 10.89% Zn from 182 m at

Koongie Park (Anglo Australian Resources NL), and 16 m at 11.48% Cu at Mount Angelo North (3D Resources Ltd);

- Exploration in the Edmund Basin — at Abra, where drilling has identified an inferred resource of 50.3 Mt at 4% Pb in the lead domain and an additional inferred resource of 9.8 Mt at 0.2% Pb in the copper–gold domain (Abra Mining Ltd), at Copper Chert, a 14 m interval averaging 1.1% Cu from 44 m (Abra Mining Ltd), and at Prairie Downs, 16 m at 4.9% Zn from 60 m and 22 m at 4.3% Zn, 3.5% Pb from 37 m (Prairie Downs Metals Ltd);
- Exploration in a number of areas within the Yilgarn Craton including at Manindi, 18.15 m at 10.72% Zn (Metals Australia Ltd) and at Erayinia, 6 m at 6.65% Zn (ABM Resources NL/Great Gold Mines NL joint venture).

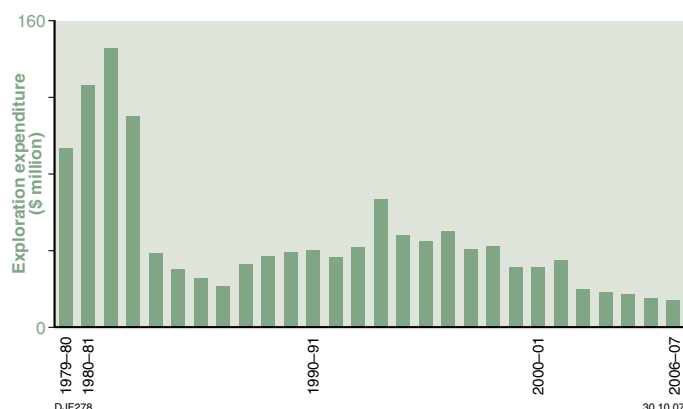


Figure 11. Western Australian diamond exploration expenditure (2006–07 dollars)

## Diamond

Notable downward trends during 2006–07 in Western Australia include:

- Diamond production fell nearly 38% to around 18 Mct (million carats);
- Diamond exploration expenditure in 2006–07 was \$14.2 million, \$1 million less than the estimated figure of \$15.2 million in 2005–06 (Fig. 11).

Diamond production (strictly sales production rather than mine production) in Western Australia in 2006–07 was 18.2 Mct, a decrease of 38%

(11.1 Mct) compared to 2005–06 production of 29.3 Mct.

Diamond production at Argyle in the east Kimberley remained constrained due to continued low-grade feed. Rio Tinto is spending about \$190 million on a new cut-back in the openpit, which will reach the end of its economic life in 2008. Underground mining, which is currently being developed, is scheduled to continue until at least 2018. Production from underground is expected to average around 20 Mct/pa, compared with the current average of some 34 Mct/pa achieved by openpit mining since Argyle opened.

In 2006–07, diamond production at the Ellendale project owned by Kimberley Diamond Company NL was 378 000 carats, more than double the production of 152 000 carats achieved in 2005–06.

Mining operations recommenced at Ellendale in the west Kimberley (by Blina Diamonds NL), on the Western Channel at the Ellendale 9 North alluvial project with 35 000 t of diamondiferous gravels mined by June 2007. Samples have returned grades of up to 25.29 carats per hundred tonnes (cpht). Exploration bulk sampling at the A-Channel alluvial project to the north of Ellendale 4 has returned grades of up to 21.5 cpht. A bulk sample from the Terrace 5 paleochannel to the south of Ellendale 12 lamproite pipe returned a grade of 15.85 cpht and an average stone size of 1.08 carats. The largest diamond recovered from the sample weighed 6.03 carats.

In the west Pilbara some 2320 diamonds, weighing 163.89 carats, have been recovered by Tawana Resources NL from the Blacktop Kimberlite, 90 km south of Karratha.

Expenditure on diamond exploration is estimated to have decreased by about 7% during 2006–07 to \$14.2 million (Fig. 11), which is only 2% of the total Western Australian mineral exploration expenditure. This is the fifth year in a row that diamond expenditure in Western Australia has declined, reflecting the general lack of exploration success and hence investor interest. The decline was primarily due to reduced resource–reserve drilling activities at Argyle, with the openpit approaching the end of its estimated mine life and the underground feasibility study being completed. Although exploration expenditure at Ellendale increased, this was not sufficient to outweigh the decrease at Argyle.



# Overview

## Heavy minerals (Ti–Zr–garnet)

The production of heavy mineral sands (ilmenite, synthetic rutile, rutile, leucosene, zircon, and garnet) in Western Australia in 2006–07 increased by 14% to 2.4 Mt, whereas the value increased by 8% to \$932 million. Exploration expenditure in 2006–07 increased by 24% to \$16.4 million, the highest in about two decades (Fig. 12). Following the switch in exploration focus to the Murray Basin in Australia's eastern states in the mid-1990s, Western Australia's share of Australian exploration expenditure for heavy minerals fell from nearly 70% of the total in the mid-1990s to only 29% in 2002–03, but this has now recovered to 44% of the total.

Highlights in the heavy minerals sector include:

- Iluka Resources Ltd, the main player in the heavy minerals industry of Western Australia, plans to increase the life of its operations in the Eneabba area. The area has significant exploration potential that could lead to over 20 years of additional mine life. Already, multiple targets have been identified close to the Newman concentrator near Eneabba. However, in the South West region, Iluka plans to reduce concentrators from four to two, and to cease mining operations south of Perth by 2014 instead of 2026 as originally planned;
- By 2009 Tiwest (Exxaro Resources Ltd/Tronox Incorporated joint venture) plans to increase the annual production capacity of titanium dioxide pigment from its plant at Kwinana by 40 000–50 000 tpa from the plant's current capacity of 110 000 tpa;
- A definitive feasibility study by Gunson Resources Ltd for the Coburn zircon project south of Shark Bay is close to completion, with Gunson entering into a memorandum of understanding with China National Building Materials, a subsidiary Company of China Triumph International Engineering Co. Ltd (CTIEC);
- Olympia Resources Ltd's Keysbrook mineral sands project (50 km south of Perth) has continued to advance, with significant progress in securing project finance;
- Bemax Resources Ltd commenced development of the new Gwindinup mine (15 km south of Bunbury);
- Happy Valley heavy mineral deposits (near Gwindinup mine) continue to be assessed by

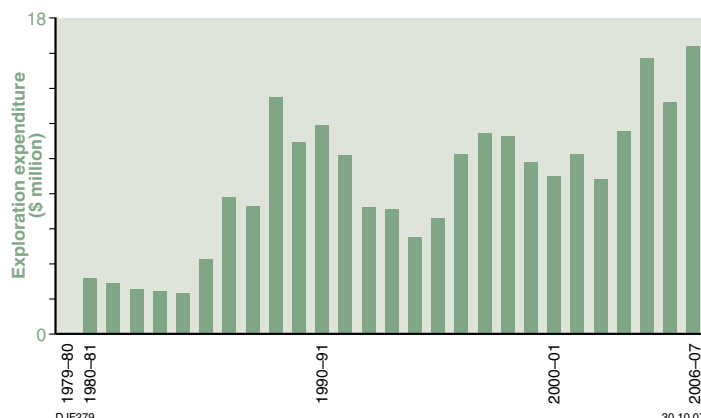


Figure 12. Western Australian heavy mineral sand (Ti–Zr) exploration expenditure (2006–07 dollars)

Bemax Resources Ltd, with an environmental impact assessment and management plan scheduled for completion in early 2008;

- Drilling of magnetic targets at Cooljarloo North by Image Resources NL has identified at least four continuous strand lines. A total strike length of at least 28 km of high-grade shallow strand lines has been delineated.

## Other commodities

Exploration expenditure for other mineral commodities in Western Australia in 2006–07 was 4% of the total and has increased by an impressive 34% (\$9.4 million) to \$37 million. 'Other commodities' includes all industrial minerals, as well as construction materials, platinum group elements, molybdenum, tantalum, manganese, chromium, vanadium, rare earth elements, uranium, and coal–lignite. Commodities attracting particular exploration attention during 2006–07 were molybdenum and uranium. Some of the highlights during 2006–07 include:

- Moly Mines Ltd has increased the design capacity of its proposed molybdenum–copper mine at Spinifex Ridge from 15 Mtpa to 20 Mtpa, where the deposit is estimated to contain a measured, indicated, and inferred resource totalling 500 Mt at 0.06% Mo, 0.09% Cu, and 1.7 g/t Ag. Production is planned for mid-2009;
- Exploration expenditure for uranium during 2006–07 has gone up noticeably to \$9.2 million (excluding 2006 December quarter, where ABS data are not available)

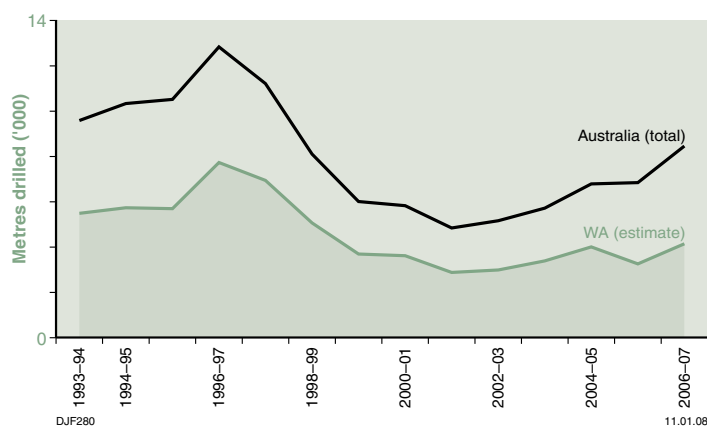


Figure 13. Mineral exploration drilling in Australia and Western Australia

## Drilling activity

Exploration drilling activity throughout Australia has been rising over the last five years (along with general exploration expenditure), partially recovering from the huge decline over the previous five years (Fig. 13). The metres drilled during 2006–07 in Australia increased by 24% (1.618 million metres) to a total of 8.455 million metres. The estimated mineral exploration drilling in Western Australia follows a similar trend, with metres drilled during 2006–07 increasing by 27% (0.885 million metres) to a total of 4.138 million metres (estimation is based on Western Australia's proportion of total Australian exploration expenditure for each year).

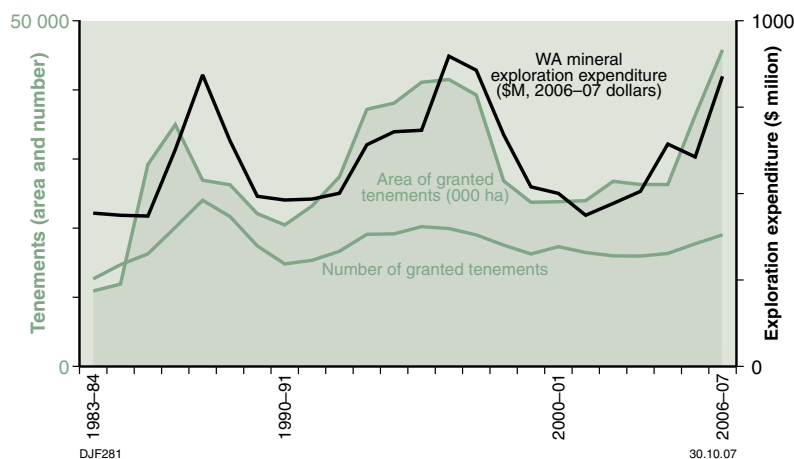


Figure 14. Trends in exploration expenditure and tenement activity (1904 and 1978 Mining Acts) since 1983–84 (source: DoIR)

The strong increases in drilling activity for Western Australia and Australia during the last year tend to mask the poorer long-term situation. Although exploration expenditure in 2006–07 has reached levels that are equal to or higher than the previous peak activity of 1996–97, exploration drilling is still at levels that are significantly below the 1996–97 peak (Fig. 13). Reasons for this include an apparent shortage of drill rigs, increased drilling costs and, possibly, a decrease in grid-style RAB drilling.

## Mining tenement activity

Tenement statistics clearly demonstrate the current boom conditions in the exploration industry. By comparison with previous booms, there is no evidence that peak activity has yet been reached (Fig. 14). The key indicators — tenements granted, area under granted tenure, and mineral exploration expenditure — all sharply increased in 2006–07.

There was an increase in the number of granted tenements (in force) in Western Australia during 2006–07, with the number of granted tenements (all tenement types combined) increasing by 7.24% (1285) from a total of 17 758 in force at 30 June 2006 to 19 043 at 30 June 2007. The number of tenement applications follows a similar trend. The area under granted tenure increased by 9.6 million hectares (Mha) or 26%, from a total of 36.3 Mha at 30 June 2006 to 45.8 Mha at 30 June 2007.

The distribution of tenements, both granted and under application at 30 June 2007, is shown in Figure 15. The distribution of mining leases, exploration and prospecting licences (granted and under applications) and State Agreement Act areas is shown in Figure 16.

compared with negligible amounts expended during the last decade. Due to the State government's policy on uranium mining, the increase in uranium exploration expenditure in Western Australia has been subdued compared to other Australian states and territories;

- The production of alumina in the State in 2006–07 increased by 4% to 11.98 Mt with the value increasing by 17% to \$4.8 billion. Notably, alumina production is now worth more than Western Australian gold production (which is at \$4.1 billion);
- Lynas Corporation Ltd has commenced mining at the Mount Weld rare earth deposit near Laverton, and has signed a \$235 million five-year contract with an unnamed customer for the supply of rare earths.

# Overview

## References

Abeysinghe, PB, and Flint, DJ, in prep., Nickel–cobalt in Western Australia: commodity review for 2006: Geological Survey of Western Australia, Record.

Abeysinghe, PB, and Flint, DJ, in prep., Copper, lead, and zinc in Western Australia: commodity review for 2006–07: Geological Survey of Western Australia, Record.

Cooper, RW, Abeysinghe, PB, and Flint, DJ, (compilers), 2007, Western Australia atlas of mineral deposits and petroleum fields 2007: Geological Survey of Western Australia, 48p.

Hronsky, JMA, and Schodde, RC, in press, Exploration history of the Yilgarn Craton: from the nickel boom to today, *in* Nickel sulphide deposits of the Yilgarn Craton *edited by* SJ Barnes: Perth, CSIRO, CSIRO Explores v. 3.

Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists, and Minerals Council of Australia (JORC), 2004, The 2004 Australasian code for reporting of exploration results, mineral resources and ore reserves: Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists, and Minerals Council of Australia, December 2004, 21p.

**Figure 15 (top right).** Distribution of mining and exploration tenements, granted and pending, in Western Australia as at 30 June 2007

**Figure 16 (bottom right).** Distribution of mining leases, exploration and prospecting licences (granted and pending) and State Agreement Act areas in Western Australia as at 30 June 2007

