

Overview

Overview of mineral exploration in Western Australia for 2007–08

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Overview

Significant observations for the Western Australian mineral industry during 2007–08 include:

- Mineral exploration expenditure in Western Australia rose by 45% from \$868 million in 2006–07 (in 2007–08 dollar terms) to \$1260 million* in 2007–08. Expenditure has now surpassed the level of previous booms in 1996–97 and in 1987–88 (Fig. 1).
- Australian mineral exploration expenditure rose by 39% from \$1773 million in 2006–07 (in 2007–08 dollar terms) to \$2461 million in 2007–08.
- Western Australia's share of the national exploration expenditure for minerals (excluding petroleum) increased from 49% in 2006–07 to 51% in 2007–08, but is still below the level of around 60% experienced during the late 1990s and early 2000s (Fig. 1).
- Quarterly mineral exploration data shows that the exploration boom continued unabated for the June quarter of 2008 in Western Australia, but for the rest of Australia the first signs of weakening activity were evident (Fig. 2).
- Iron ore was the key commodity for 2007–08, of which the main highlight was Fortescue Metals Group making its first shipment (180 000 t) of iron ore from the Cloudbreak mine. In addition, work advanced on large-scale magnetite projects with several at the final feasibility or early development phase, including Southdown, Balmoral Central, and Karara.
- Production of nickel commenced from several new, small sulfide nickel mines and the large-scale nickel laterite mine at Ravensthorpe, but the State's overall nickel production declined by about 1.5%. Nickel prices peaked in late 2007 and dropped substantially during 2008.
- The gold price reached a 25-year high (in US\$ terms), but the gold industry in Western Australia remained subdued in 2007–08. In addition, high costs in the mining sector

Abstract

During 2007–08, Western Australia continued to experience growth in the minerals industry, with the value of mineral production in the State increasing by 6% to a new record of \$39 billion (excluding petroleum). This was despite a fall in production for some commodities including nickel, gold, manganese, chromium, and lead.

Mineral exploration expenditure in Western Australia also boomed during 2007–08 and set a new record, surpassing the peak levels experienced in 1987–88 and 1996–97 (in 2007–08 dollar terms). However, the five-year recovery in non-ferrous mineral exploration in Western Australia during this boom phase has lagged behind the recovery compared with the rest of Australia and overseas.

Western Australia accounts for the major proportion of exploration dollars expended in Australia for iron ore (94%), nickel–cobalt (92%), gold (59%), diamond (59%), heavy mineral sands (40%), and lead–zinc–silver (30%). Both mining and exploration in Western Australia are now dominated by iron ore, which has surpassed gold. During 2007–08, exploration expenditure for iron ore exceeded that for nickel, the first time that this has occurred in Western Australia for at least 30 years.

The continuing mining and exploration boom in 2007–08 resulted in further takeovers of small- and medium-sized Australian mining companies by large overseas companies.

For many commodities, prices peaked in late 2007 and early 2008, and by June 2008 there were already signs of a weaker capital market, with fewer initial purchase offers on the share market.

generally flowed through to the gold industry, and 2007–08 saw several mine closures and companies placed into receivership. There was good news of further impressive gold intersections at brownfields sites, along with the first gold pour from the high-grade Trident deposit near Higginsville. In greenfields areas, the highlight was undoubtedly the initial resource estimate for Tropicana, with an estimated four million ounces of contained gold.

* 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.

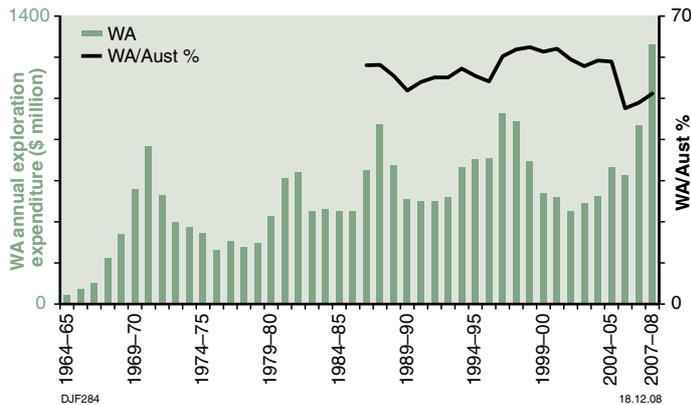


Figure 1. Mineral exploration expenditure in Western Australia, by year (2007–08 dollars)

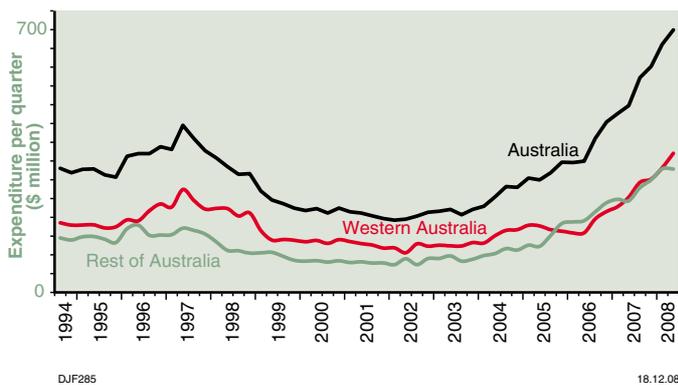


Figure 2. Mineral exploration expenditure in Australia, Western Australia, and rest of Australia (seasonally adjusted, 2008 June dollars)

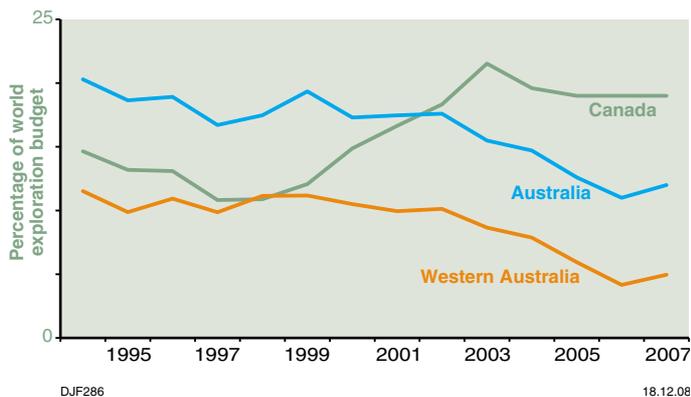


Figure 3. Non-ferrous mineral exploration expenditure — comparative market share of Canada and Western Australia since 1994

- Other highlights include initial development work at the Mount Weld REE mine and advancement of the Moly Mines Spinifex Ridge porphyry Mo–Cu project.

The continuing mining boom has resulted in the takeover of, and joint venturing with, numerous small- and medium-sized mining companies by large overseas mining companies. Some of these acquisitions and joint ventures include:

- BHP Billiton's takeover bid for Rio Tinto Ltd.
- Xstrata's acquisition of Jubilee Mines NL, which owns the Cosmos and Sinclair nickel projects.
- The Russian-owned Norilsk acquisition of LionOre Mining International Ltd's Lake Johnston nickel operation (which has the Emily Ann and Maggie Hays mines), and also the Honeymoon Well nickel project, 35 km south of Wiluna. Norilsk also acquired OMG's Cawse laterite nickel operation near Kalgoorlie.
- Palmary Enterprises Ltd acquisition of Consolidated Minerals Ltd, which operates nickel mines near Kambalda, the Woodie Woodie manganese operation, and the Coobina chromite project.
- The Brazilian company Vale Inco Ltd is in joint venture with a number of projects in Western Australia, including the Kalgoorlie laterite nickel project with Heron Resources Ltd.
- Hunan Nonferrous Metals Holdings Group Co. (the largest integrated nonferrous metal producer in China) announced its intention to take 70% of the shares in Abra Mining Ltd.
- Hong Kong-based CITIC Pacific Ltd bought the Sino Iron magnetite project in the Pilbara from Mineralogy Pty Ltd.

During the last decade, the proportion of the world's non-ferrous mineral exploration expenditure in Australia has dropped from 17% to 12%, of which Western Australia's share has dropped from 10% to 5% (Fig. 3; based on data compiled by the Metals Economics Group of Halifax, Canada, <<http://www.metalseconomics.com>>). The sharp decline since 2002 in both Western Australia and Australia as a whole appeared to have bottomed in 2006 with a marginal rise in 2007. From 2002 to 2007, other jurisdictions have increased their non-ferrous mineral exploration expenditure by an average of about 525%, whereas expenditure in Western

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Australia has increased by only about 200% (Fig. 4; based on data compiled by the Metals Economics Group of Halifax, Canada, <<http://www.metalseconomics.com>>).

Developments and mineral exploration highlights by commodity

During 2007–08, exploration expenditure for iron ore, nickel, and copper–lead–zinc reached record highs, but gold exploration expenditure has now fallen behind iron ore, the first time this has occurred in Western Australia for at least 30 years (Figs 5 and 6).*

Gold

Trends in the gold industry in Western Australia during 2007–08 include:

- In 2007–08, the international gold price rose to a 25-year high, reaching US\$968/oz (\$A1045) in March 2008, but declined to US\$887/oz (\$A931) in June 2008.
- Gold production fell by 14% to 140 t, and the value decreased by 4% to \$4.1 billion.
- Gold exploration expenditure in 2007–08 increased by 22%, continuing the positive trend that began last year, but expenditure is still well below the historical 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 (and reached levels of around 75% of the total mineral exploration expenditure in the mid-1990s), its proportion of total exploration expenditure declined to 28% during 2007–08 (Fig. 5). As a result, gold has fallen behind iron in terms of exploration expenditure (Fig. 6), and also lags behind the total exploration expenditure for nickel and base metals. Despite this, in 2007–08 exploration expenditure for gold actually increased by 22% to \$347.8 million (Fig. 7). Gold production in Western Australia has continuously declined over the last ten years (Fig. 8), and the record increase in annual expenditure since late 2006 may curb this trend.

The high cost of extracting gold has led to a number of gold operations going into care and maintenance, including Davyhurst (Monarch Gold Mining Co. Ltd) and Mount Magnet (Harmony

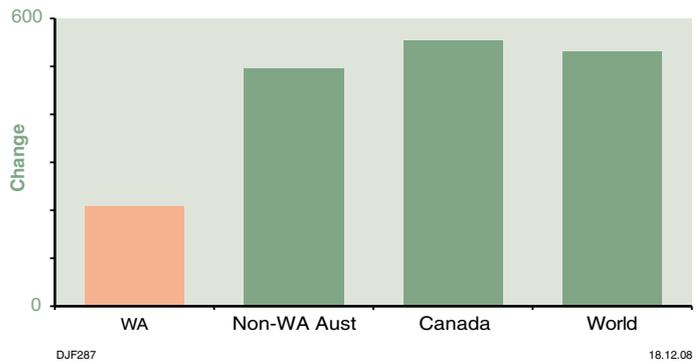


Figure 4. International comparison of non-ferrous mineral exploration: % change from last recession 2002 to 2007

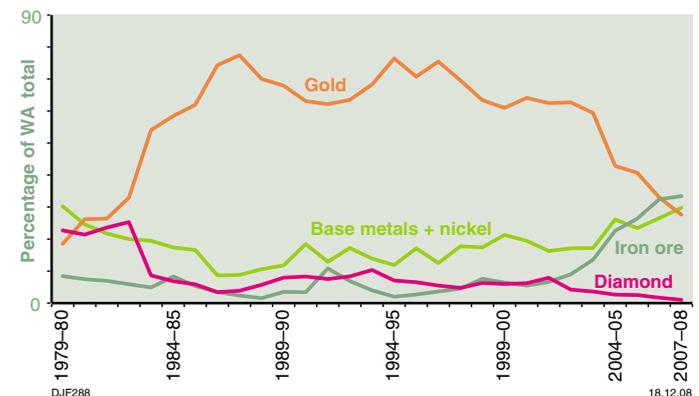


Figure 5. Exploration expenditure in Western Australia since 1979–80 (% of total, by commodity)

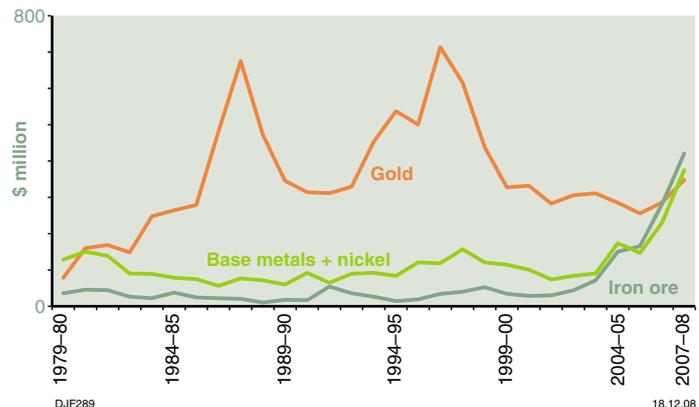


Figure 6. Gold, base metals + nickel, and iron ore exploration expenditure in Western Australia since 1979–80 (2007–08 dollars)

* For location information on the sites/places mentioned here see Cooper et al. (2007).

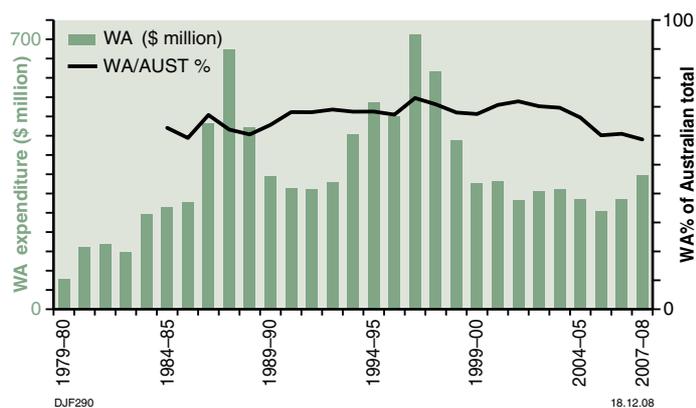


Figure 7. Gold exploration expenditure in Western Australia since 1979-80 (2007-08 dollars)



Figure 8. Gold exploration expenditure and gold production in Western Australia (2007-08 dollars)

Gold (Australia) Pty Ltd). Bronzewing, north of Leinster, was reopened and then reverted to care and maintenance as View Resources Ltd went into receivership. In addition, operational problems led to Crescent Resources Ltd suspending operations at its Laverton project.

The most significant highlight for 2007-08 was development of the Boddington gold-copper project, where production is expected in early 2009 (joint venture of Newmont Mining Corporation and AngloGold Ashanti Ltd). The planned annual production rate is an average 850 000 ounces of gold and 30 000 tonnes of copper for more than 20 years.

Other new mine developments during 2007-08 included the reopening by Mercator Gold of the Surprise-Bluebird pit at Meekatharra, plans by Apex Resources to restart 100 000 ounces per

annum gold production by 2009 from its Wiluna gold project, Avoca's first gold pour from the Trident deposit at Higginsville, and Focus Minerals Ltd recommencement of mining at Perseverance Underground, south of Coolgardie.

In other developments, the AngloGold/Independence Group joint venture estimated a total indicated and inferred resource of 62.8 Mt at 2.01 g/t Au for 4.05 million ounces of gold for the greenfields Tropicana gold project, 400 km northeast of Kalgoorlie. Tropicana was discovered during 2003-05 and is the most important discovery in Western Australia since Thunderbox about seven years ago. Carrick Gold has boosted its global resources for the Halfway Hill deposit within the Kurnalpi project to more than 4 million ounces of contained gold. Kalgoorlie-Boulder Resources announced a 53% increase in indicated and inferred resources to 25.8 Mt at 1.7 g/t Au for 1.4 million ounces of gold at its Selene deposit in the Eastern Goldfields.

A number of companies had impressive gold intersections from many regions of the Yilgarn Craton. These include:

- 2 m at 561 g/t Au from 88 m including 1 m at 1114 g/t Au at Wattle Dam, 25 km southwest of Kambalda (Ramelius Resources Ltd).
- 50 m at 3.7 g/t Au, 33 m at 4.2 g/t Au, and 10 m at 10.7 g/t Au at Tower Hill in Leonora (St Barbara Mines Ltd).
- 54 m at 8.1 g/t Au from 243 m and 21 m at 12.2 g/t Au at Jaccoletti, approximately 1.5 km from Marvel Loch (St Barbara Mines Ltd).
- 4.7 m at 462 g/t Au including 0.21 m at 10 300 g/t from 248 m at Burbanks mine near Coolgardie (Barra Resources Ltd).
- 21 m at 10.2 g/t Au from 342 m at Henry5 North and 29.5 m at 9.1 g/t Au from 197.6 m at Burgundy lode, 4 km south-southeast of Wiluna (Apex Minerals NL).
- 9 m at 53 g/t Au from 19 m and 12 m at 10.4 g/t Au from 8 m at the Cardinia gold system in Leonora (Navigator Resources Ltd).
- 51 m at 7.63 g/t Au from 45 m, 10 m at 137 g/t Au from 3 m, and 78 m at 5.77 g/t Au at Salt Creek deposit, Randalls project, 50 km southeast of Kalgoorlie (Integra Mining Ltd).
- 16 m at 25.66 g/t Au, including 1 m at 374.6 g/t Au and 4 m at 97.62 g/t Au, at

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the Brilliant prospect, 90 km northeast of Kalgoorlie.

- 1 m at 75.3 g/t Au from 14 m and 12 m at 2.1 g/t Au from 76 m at the Thompson bore prospect, Duketon gold project, 123 km north-northwest of Laverton (South Boulder Mines Ltd).
- 27 m at 36.4 g/t Au including 3 m at 114.8 g/t Au, 2 m at 121.8 g/t Au, and 2 m at 85.2 g/t Au at Halleys East, Barlee gold project, 200 km north of Southern Cross (Beacon Minerals Ltd).
- 16.4 m at 12.4 g/t Au, including 0.19 m at 390 g/t Au at the Bells deposit, near Laverton (Crescent Gold Ltd).
- 67 m at 2.2 g/t Au and 52 m at 1.5 g/t Au at the Wonder North deposit, 65 km north-northwest of Leonora (Terrain Minerals Ltd).
- 108 m at 2.59 g/t Au from 177 m at Two Mile Hill, 10 km south of Sandstone (Troy Resources NL).

Iron

Highlights in Western Australia during 2007–08 include:

- Another year in which records were set for production quantity, production value, and exploration expenditure.
- Unprecedented price increases meant that the value of Western Australian iron ore production increased by 30% to \$20.5 billion, although production quantity increased by only 13% to 291 Mt.
- Western Australian iron ore exploration expenditure has continued its six-year rise, climbing by 50% (to \$421 million) in 2007–08 compared with 2006–07, and by more than 857% over the last six years (Fig. 9).
- The level of iron ore exploration in Western Australia has, for the first time, surpassed that of gold (Figs 5 and 6), accounting for nearly one-third of the total exploration dollars spent in Western Australia. At present, over 100 companies are exploring for iron ore in Western Australia.
- Numerous mines targeting zones of supergene enrichment were being developed or are at an

advanced feasibility stage. The State has also 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.
- Overseas companies continued to greatly increase their direct ownership or involvement (e.g. through long-term off-take agreements) in the Western Australian iron ore industry, with 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 rapidly by expanding their operations at existing projects and planning new projects. The high iron ore prices have greatly assisted the capital-raising capabilities of junior companies, and have also resulted in the emergence of significant producers, for example, Fortescue Metals Group Ltd (FMG), and foreign companies such as CITIC Pacific Ltd (potential producer), thus ending the historical duopoly of Rio Tinto and BHP Billiton in the Pilbara.

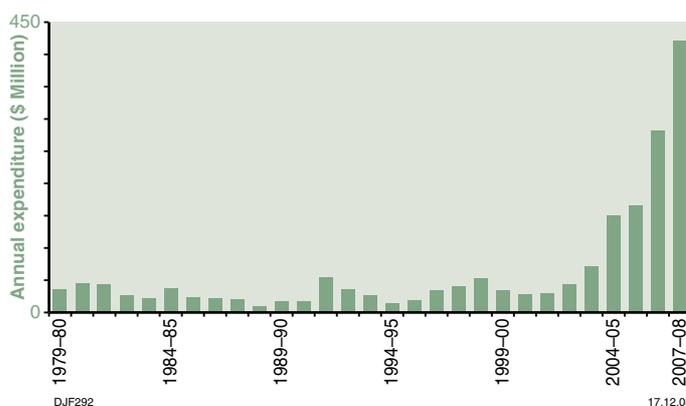


Figure 9. Western Australian iron ore exploration expenditure (2007–08 dollars)

The most conspicuous corporate activity during 2007–08 was the takeover bid by BHP Billiton Ltd of Rio Tinto Ltd, which would lead to a highly integrated iron ore industry in the Pilbara (in subsequent developments, BHP Billiton withdrew the bid in November 2008).

The most significant mining development during 2007–08 was FMG's first shipment of 180 000 t of iron ore from Cloudbreak mine, making the company the third major iron ore producer in Western Australia. FMG is initially targeting 55 Mtpa from its operations, which will be further expanded to 100 Mtpa and then to 200 Mtpa once its next major iron ore region, Solomon, is developed.

In other developments, Rio Tinto has approved US\$667 million to finance infrastructure and mine expansions at its Pilbara operations to increase the output to 320 Mt by 2012. Of this expenditure, US\$149 million will be for a new iron ore mine on the Western Turner Syncline, near Tom Price, and \$518 million will be for infrastructure works and the acquisition of long-lead items such as heavy mobile equipment. Rio Tinto also plans to carry out a \$71 million feasibility study to assess the Hope Downs 4 project in the Pilbara as a possible extension of the existing Hope Downs iron ore project.

In the magnetite sector, Hong Kong-based CITIC Pacific Ltd launched its US\$4.6 billion Sino Iron magnetite project, southeast of Karratha, and plans production of 27.6 Mt of iron pellets and concentrate in 2009, with a mine life of some 25 years. Also in the magnetite iron-ore sector, Grange Resources took another step toward development of the Southdown magnetite project near Albany with the Albany port expansion proposal progressing to the public environmental review stage. Gindalbie Metals has launched a six-month feasibility study into a 50% production increase at its Karara magnetite project in the Midwest region. Aurox Resources, with its Fe–Ti–P project (titanomagnetite in cumulate-layered mafic–ultramafic intrusive rocks) at Balla Balla in the Pilbara Craton, signed another iron ore off-take deal with the Chinese company RockCheck Steel for 3–7 Mtpa. Cape Lambert Iron Ore announced a new resource estimate of 1.56 billion tonnes at 31.2% Fe for its Cape Lambert magnetite project in the Pilbara.

Companies exploring for iron ore in Western Australia continue to target a range of mineralization styles including:

- channel iron deposits (CID)
- supergene-enriched hematite over Archean (Marra Mamba) to Paleoproterozoic (Brockman) banded iron-formations (BIF)
- primary magnetite in BIF of the Pilbara and Yilgarn Cratons
- titanomagnetite in cumulate-layered mafic–ultramafic intrusives in the Pilbara Craton at Balla Balla
- magnetite in BIF within the Mesoproterozoic gneiss terrane of the Albany–Fraser Orogen
- clastic hematite in Paleoproterozoic–Mesoproterozoic sedimentary rocks of the Kimberley Basin (Cockatoo Island, Koolan Island)
- hematite iron-ore mineralization in the Midwest region
- granular iron-formation deposits in the Paleoproterozoic Earraheedy and Yerrida Basins.

There was ongoing interest by many companies in primary magnetite mineralization within BIF horizons throughout the Yilgarn Craton.

Some of the iron-ore exploration successes include:

- direct shipping ore projects at Pardoo and Abydos in the Pilbara (Atlas Iron Ltd)
- Marra Mamba iron ore-related mineralization at Davidson Creek and Robertson Range in the East Pilbara (FerrAus Ltd)
- bedded iron deposit at Hardy west-northwest of Paraburdoo (Aquila Resources Ltd)
- channel iron-formation mineralization near Nullagine (BC Iron Ltd) and at Solomon East area near Tom Price (FMG)
- hematite iron-ore mineralization at Jack Hills (Midwest Corporation) and at Beebyn – Weld Range (Giralia Resources) in the Midwest region.

Nickel

Significant aspects in Western Australia during 2007–08 include:

- The price of nickel showed a steady decline, from a high of \$49 529 per tonne in June 2007 to \$27 121 per tonne in May 2008, a 45% drop in 12 months.
- The decrease in nickel price has resulted in a significant fall (by 34%) in the value of nickel production to \$5.3 million, although the production fell by only 2% to 171 kt.
- Nickel exploration expenditure in Western Australia increased by an impressive 71% to

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\$280 million, continuing the positive trend that began in 2006–07 (Fig. 10). Nickel exploration in the State was mainly focussed in the Forrestania, Kambalda, Leinster, Leonora, and Kalgoorlie regions in the Yilgarn Craton, Karratha region in the Pilbara Craton, Halls Creek region in the Halls Creek Orogen, and around Wingellina in the Musgrave Complex.

- Nickel exploration expenditure is set to fall during 2008–09 in Western Australia as the full impact of the falling world nickel price flows through to the local industry.

Key developments in the nickel-laterite sector include:

- BHP Billiton Ltd's Ravensthorpe nickel-laterite operation commenced production of a nickel hydroxide product in late 2007. The operation has a planned production rate of about 50 000 tpa of nickel and 1400 tpa of cobalt.
- Vale Inco Ltd continued with the prefeasibility study of the Kalgoorlie Nickel Project, and has now reached Step 3, which involves confirmation of the mineral resources, flowsheet, and products. The project has a potential production rate of 50 000 tpa of contained nickel.
- Heron Resources Ltd is now focusing on atmospheric leaching at the Jump-Up Dam project as a processing option in preference to heap leach process. Heron has plans to produce about 10 000 tpa of contained nickel.
- GME Resources Ltd has decided to proceed with a small scale demonstration trial for its NiWest nickel project, based at the Hepi site. The company plans a development strategy delivering 30–35 000 tpa nickel metal.
- The Cawse nickel project was placed in care and maintenance in June 2008 following the decline in nickel prices and disruptions to the gas supply, in the wake of the Varanus Island gas explosion.

Key developments in the sulfide nickel sector include:

- Western Areas NL discovery of the high-grade Spotted Quoll nickel deposit and T6 and T7 zones related to the T5 deposit at Forrestania. The company is planning an initial four-year openpit at Spotted Quoll with production expected in mid-2009.

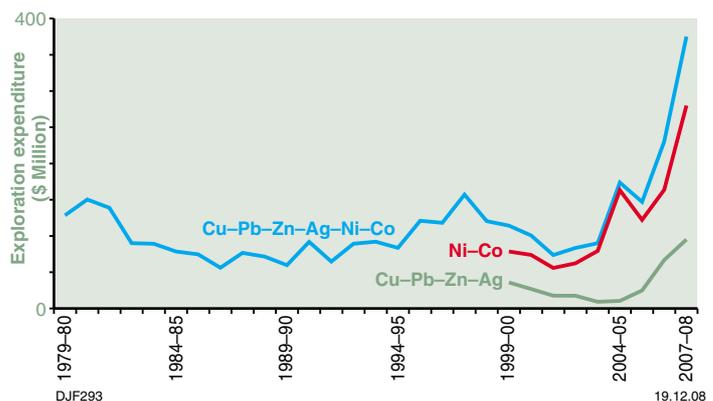


Figure 10. Western Australian nickel, cobalt, and base metal exploration expenditure (2007–08 dollars)

- Western Areas began development work on a nickel concentrate plant at Cosmic Boy near the Flying Fox nickel deposit at Forrestania.
- In mid-2007, BHP Billiton approved the development of the Cliffs nickel project, 60 km north of Leinster, with a budget of US\$139 million.
- Mincor Resources NL commenced development of the Carnilya Hill deposit, 30 km northeast of Kambalda, to recommence mining. Mincor also began development work at the McMahon deposit, 3 km north of Kambalda.
- Panoramic Resources Ltd commenced nickel production from the Deacon and Winner deposits of the Lanfranchi project, 35 km southeast of Kambalda. The company also commenced openpit mining at the Copernicus deposit, 70 km northeast of Halls Creek.
- Xstrata's Prospero, Tapinos, and Alec Mairs mines, near Cosmos and Sinclair mine (200 km south of Cosmos), are scheduled to commence production in the near future.
- Focus Minerals Ltd began trial mining at the Nepean nickel project, 50 km west of Kambalda.
- Poseidon Nickel Ltd began dewatering and other development work to recommence underground mining at Mount Windarra.

Other exploration successes include:

- Fox Resources Ltd discovery of a new copper–nickel prospect at Bertram, 12 km south of Radio Hill.

- Regis Resources Ltd had significant nickel intersections (19 m at 1.36% Ni from 48 m) at the Beltra prospect in its Collurabbie project (190 km northeast of Leinster).
- Kagara Ltd's report of an intersection of 41.14 m at 2.1% Ni at Lounge Lizard, located along strike of the Flying Fox nickel mine.
- Mincor's exploration successes at Mariners, Wannaway, and Redross deposits, all within 50 km south of Kambalda.
- Breakaway Resources Ltd's discovery of The Horn deposit, 40 km southeast of Leinster, and successful exploration results at Spargoville 1A and Andrews nickel mines near Kambalda.
- Jubilee Mines NL (now owned by Xstrata) continues to have exploration success at Alec Mairs near Cosmos in the Leinster region.

Base metals (copper–lead–zinc–silver)

Broad trends in the base metal sector in Western Australia during 2007–08 include:

- Copper–lead–zinc–silver exploration expenditure in the State showed an impressive increase of 43% from \$67 million (2007–08 dollars) in 2006–07 to \$95 million in 2007–08 (Fig. 10).
- Base metal exploration expenditure soared, but base metal prices (particularly zinc and lead) reached their peaks in September–October 2007 and dropped by about 50% to the end of June 2008. It is likely that base metal exploration expenditure in Western Australia will fall during 2008–09.
- Copper production in the State in 2007–08 increased by 7% (from 115 983 t in 2006–07 to 124 498 t in 2007–08), while the value increased by 3% to \$1081 million. The increased copper production was largely due to the output from the Nifty mine in the Paterson Orogen.
- Lead production in the State decreased significantly (by 64%), from 70 473 t in 2006–07 to only 25 706 t in 2007–08 due to the halt in production at the Magellan lead mine in April 2007. With the closure of the Pillara mine, lead production is likely to decrease further, unless Magellan is re-opened with exports of bagged/containerised lead via Fremantle. The only other producing mine is Golden Grove. The value of lead production decreased by 44% to \$81 million.
- Although zinc production in the State increased by 39% (from 142 176 t in 2006–07 to 197 129 t in 2007–08) the value decreased by 14% to \$578.3 million. The production increase was due to the recommencement of mining at Pillara (Teck Cominco Ltd/Xstrata joint venture, 76 km southeast of Fitzroy Crossing), but this was again halted in August 2008 following the drop in the international price of zinc in 2007–08 by 38% to an average of \$2901 per tonne.

Highlights during 2007–08 for base metal projects in Western Australia include:

- The estimated indicated and inferred resources at the Abra deposit increased to 93 Mt at 4% Pb in the lead domain, with an additional total indicated and inferred resource of 14 Mt at 0.62% Cu and 0.49 g/t Au in the copper–gold domain. The Chinese company Hunan Nonferrous Metals Holdings Group Co. plans to acquire 70% of the shares in Abra Mining Ltd.
- Kagara Ltd announced an initial inferred resource estimate of 72 Mt at 3.1% Zn, 2.9% Pb, 11% Ba, and 18 g/t Ag for the Admiral Bay deposit.
- Prairie Downs Metals Ltd commenced a bankable feasibility study of the Prairie Downs zinc project, 60 km southwest of Newman, to design a 300 000 tpa processing plant with the capability to expand to 1 Mtpa. The company has also discovered new areas of lead and copper mineralization within 3.5 km of the Prairie Downs deposit.
- CBH Resources Ltd approved development of its Sulphur Springs zinc–copper deposit in the Pilbara. The project is due to commence in mid-2009 with a planned production of 80 000 tpa of copper and 90 000 tpa of zinc concentrate for a mine life of more than seven years.
- Jabiru Metals Ltd began shipment of zinc concentrate from its Jaguar mine to China. The mine development work at Jaguar began in late 2005.
- Newmont Mining Corporation and AngloGold Ashanti Ltd joint venture has begun

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development work at the Boddington project with gold–copper production expected in early 2009. The planned production is an average 850 000 ounces of gold and 30 000 tonnes of copper a year for more than 20 years.

In other developments Western Australia's Environmental Protection Authority has conditionally recommended the shipment of lead concentrate from the Magellan lead mine, 30 km northwest of Wiluna, through Fremantle port. The mine was placed in care and maintenance in April 2007 due to environmental problems associated with transportation of loose lead concentrate through the port of Esperance.

Diamond

Diamond production (strictly sales production rather than mine production) in Western Australia in 2007–08 was 28 Mcts, which is an increase of 54% compared to the 2006–07 production of 18.2 Mcts. There was a similar increase in the value of diamond sales, up by 40% to \$611 million.

The estimated diamond exploration expenditure for Western Australia in 2007–08 was \$12.8 million, which is a fall of about 10% from the \$14.2 million spent in 2006–07 (Fig. 11). Diamond exploration expenditure is now only 1% of the total Western Australian mineral exploration expenditure. This is the sixth 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 completion of the underground feasibility study.

Rio Tinto owns and operates the Argyle diamond mine in Western Australia. Production from Argyle's AK1 openpit mine is expected to continue through 2008, and an openpit cutback is in progress. This reduced mine production for 2007–08 was 16.02 million carats, substantially down from the 24.24 million carats produced in 2006–07. Development of the underground mine is still in progress (about 50% complete at June 2008), consisting overall of 34 km of tunnels and excavations. Full production from the underground mine is scheduled to be achieved in December 2010, and should (along with the openpit cutback) extend the mine life out to about 2018.

In December 2007, Gem Diamonds Ltd, a global diamond company, acquired Australian-listed

Kimberley Diamonds which owns the Ellendale mine, 135 km east-southeast of Derby. Since acquisition, Gem Diamonds has modified the processing plant at the mine, increasing the processing capacity. The production of diamond from Ellendale in 2007–08 was 487 416 carats, an increase of 29% compared with the 2006–07 production of 378 000 carats.

Blina Diamonds NL, exploring five alluvial diamond projects under an agreement with Gem Mining over their Ellendale Mining Lease, recovered an outstanding diamond weighing over 11 carats from the Ellendale 9 North (E9N) alluvial project. This fetched a record price of \$106 424 (US\$88 332), which is the most valuable diamond ever recovered by Blina. A second parcel of 3500 carats has been recovered from the E9N Western Channel gravels. The Ellendale 12 alluvial system has now been traced over a strike length of 1.2 km and exploration is continuing upstream.

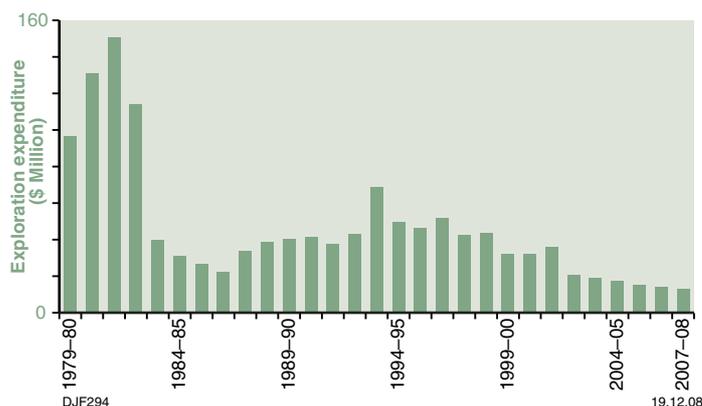


Figure 11. Western Australian diamond exploration expenditure (2007–08 dollars)

Heavy minerals (Ti–Zr–other)

The production of heavy mineral sands (garnet, ilmenite, rutile, leucoxene, zircon, and other) in Western Australia in 2007–08 decreased by 5% to 1.4 Mt, with the value decreasing by 3% to \$768 million.

Exploration expenditure in 2007–08 for heavy minerals decreased by 13% to \$15 million (Fig. 12). With 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 has recovered in recent years and was 40% in 2007–08, little changed from the previous year.

Highlights in the heavy minerals sector include:

- Iluka Resources Ltd, the main player in the heavy minerals industry in Western Australia, continued exploration in the Midwest region focusing on resource evaluation at the North Mine Remnants deposit near the Newman wet concentrator plant at Eneabba. Exploration work also continued to target resource delineation for near-mine extensions in the Southwest and Midwest regions. A high-resolution aeromagnetic survey over Iluka's tenements in the Eneabba Embayment was completed for a total of 1286 line kilometres at a 400 metre line spacing. In the Southwest, commissioning of mining operations at Waroona and Cloverdale was completed.
- Gunson Resource announced that the Coburn Zircon Development Project was fully approved for construction, but the project remains at a final feasibility stage. China Triumph International Engineering Company (CTIEC) has taken a 40% participating interest in the project.
- The Gwindinup mine (15 km south of Bunbury), now owned by Cristal Australia Ltd, commenced full production after plant commissioning in early 2008.
- Environmental impact studies for the Happy Valley deposit (near Gwindinup mine), also owned by Cristal Australia Ltd, have been completed. Assessment of the project by the Environmental Protection Authority will commence in the second half of 2008.
- Olympia Resources Ltd announced that the company has received Environmental Protection Authority approval for development of the Keysbrook mineral sands project, 50 km south of Perth.
- Detailed ground magnetic surveys and extensive drilling by Image Resources at Cooljarloo North (North Perth Basin) has outlined substantial resources (a total of 261 Mt averaging 2.4% heavy minerals) at the Hyperion, Helene, Titan, Calypso, Bidamina and Telesto deposits. Mine scoping studies were in progress in mid-2008.
- Exploration continues in the Western Australian portion of the Eucla Basin, where the target is zircon-rich beach strand lines and barrier dunes in a geological setting similar to the world-class zircon-rich Jacinth and Ambrosia deposits on the eastern margin of the Eucla Basin in South Australia. Reconnaissance aircore drilling continued through 2007–08 and the most advanced prospect is Cyclone (Wanna Lakes), 300 km north of Eucla (Diatreme Resources Ltd and Minerals Corporation Ltd). At Cyclone, the initial inferred resource estimate is 60 Mt at 3.1% heavy minerals, with zircon and leucoxene making up 41% and 42% in the heavy mineral fraction respectively.

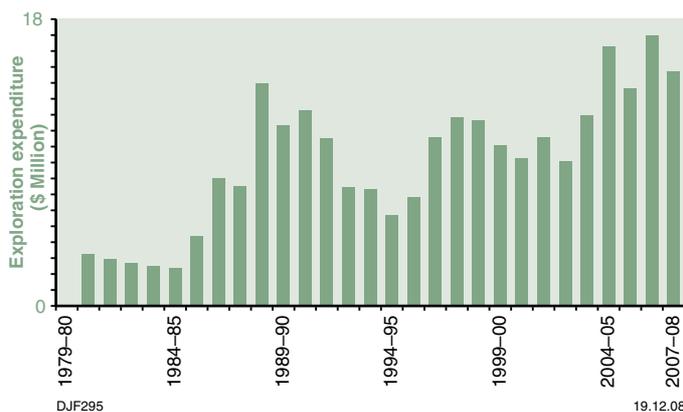


Figure 12. Western Australian heavy mineral sand (Ti-Zr) exploration expenditure (2007–08 dollars)

Other commodities

Exploration expenditure for other mineral commodities in Western Australia in 2007–08 was 7% of the total and has increased by an impressive 132% (\$50 million) to \$87 million. 'Other commodities' includes all industrial minerals, alumina, construction materials, uranium, platinum group elements, molybdenum, tantalum, manganese, chromium, vanadium, rare earth elements, and coal–lignite. Commodities attracting particular exploration attention during 2007–08 were uranium, molybdenum, vanadium, manganese, phosphate, and even potash. Highlights during 2007–08 in these commodities include:

- Moly Mines Ltd plans to produce 24 million pounds of molybdenum concentrates and 27 million pounds of copper concentrates from the proposed Spinifex Ridge porphyry Mo–Cu mine in the Pilbara, on an annualised

Overview



basis, for an initial 10 years starting from 2010. The company has signed a 10-year off-take agreement with ThyssenKrupp Metallurgie GmbH of Germany for all molybdenum produced.

- Exploration expenditure for uranium during 2007–08 has jumped to \$26.7 million, compared with negligible expenditure during the last decade. This increase was despite the then government's anti-uranium policies, which included a clause on all newly issued mining leases that prevented mining and exploration of uranium.*
- During 2007–08, Lynas Corporation Ltd completed the first mining campaign at the Mount Weld REE deposit, 30 km south-southeast of Laverton. Mount Weld is perhaps the world's richest REE deposit and is currently the only commercially viable mine outside of China. During the year, about 2.04 million cubic metres of overburden had been removed from the openpit and 773 000 t of ore had been stockpiled. The plan is to mine 2.8 Mt of proved and probable reserves at 15.5% rare earth oxides in the first 14 years of mine life. At year end, Lynas also received all approvals necessary to build its concentrator plant on site, and work was progressing on the advanced materials treatment plant in Malaysia, with the latter scheduled for commissioning in late 2009 (Fetherston, 2008).
- Western Australia moved much closer to resumption of vanadium mining. In June 2008, the Windimurra vanadium project was under construction, with initial mining forecast for late 2008 and initial production of a ferrovandium alloy in early 2009. Windimurra is a cumulate-layered mafic–ultramafic intrusive, with resources over a strike length of 6 km totalling about 177 Mt at 0.46% V_2O_5 . Mineralization is economic along the weathered zone, about 40 m thick, with mining possible mostly by rip and push techniques. Windimurra Vanadium Ltd (formerly Precious Metals Australia) plans to produce about 5700 tpa of vanadium contained within a ferrovandium alloy, representing about 8% of the world market (Windimurra Vanadium Ltd, 2008a,b).
- With high phosphate prices during 2007–08, there was interest in this sector shown by

exploration licences targeting this commodity, but few exploration results were available. A highly prospective deposit is at Balla Balla in the Pilbara Craton, where phosphate is enriched in the disseminated zone immediately overlying the main massive titanomagnetite horizon in a cumulate-layered mafic–ultramafic intrusive. The disseminated zone, which has to be mined anyway, contains drill intersections of about 20% Fe, 2.5–4% P_2O_5 , and 6–7.5% TiO_2 (Aurox Resources Ltd, 2008).

Drilling activity

Exploration drilling activity throughout Australia has been gradually rising over the last five to six years (along with general exploration expenditure) after the big slump from 1996–97 to 2001–02 (Fig. 13). Metres drilled during 2007–08 in Australia increased by 15% (1.301 million metres) to a total of 9.756 million metres. The estimated mineral exploration drilling in Western Australia followed a similar trend with metres drilled during 2007–08 increasing by 21% (0.8 million metres) to a total of 5.0 million metres (based on Western Australia's proportion of total Australian exploration expenditure for each year).

Although exploration expenditure has reached appreciably higher levels in 2007–08 than the previous peak activity of 1996–97, exploration drilling is still at levels significantly below the 1996–97 peak (Fig. 13). Reasons for this include an apparent shortage of drill rigs, increased drilling costs, and possibly less grid-style RAB drilling.

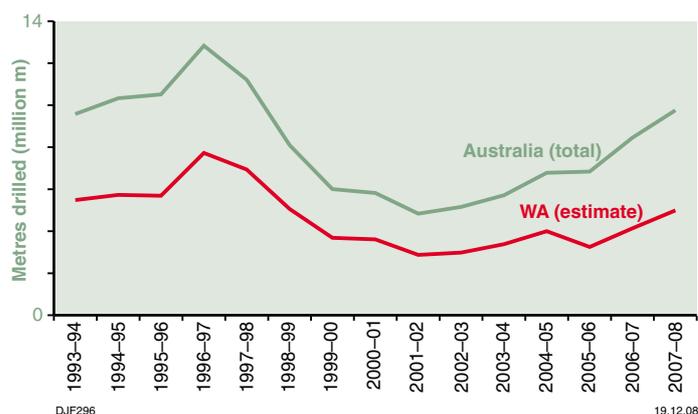


Figure 13. Mineral exploration drilling in Australia and Western Australia

* The pro-uranium mining policy stance of a new Western Australian Government elected in September 2008 is expected to result in increased uranium exploration activity in Western Australia.

Mining tenement activity

Tenement statistics clearly demonstrate the current boom conditions in the exploration industry (Fig. 14). The area under granted tenure has, like mineral exploration expenditure, risen sharply for the third year in a row, with no sign of peaking. However, the increase in the number of granted tenements in force has been much more modest. Clearly the trend is for larger tenements and for more exploration licences, which is typical for an exploration boom phase. During the last three boom phases (peak activity in 1987–88, 1996–97 and 2007–08), the rise in the number of granted tenements in force has been more subdued with each successive boom, indicating the very slow and limited turnover of mining titles. The details of these are:

- The increase in the number of granted tenements (in force) in Western Australia during 2007–08 was by 10% (1867) from a total of 19 043 in force at 30 June 2007 to 20 910 at 30 June 2008.
- The area under granted tenure increased by 27% (12.4 Mha) from a total of 45.8 Mha at 30 June 2007 to 58.2 Mha at 30 June 2008.

The distribution of tenements, both granted and under application at 30 June 2008, 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.

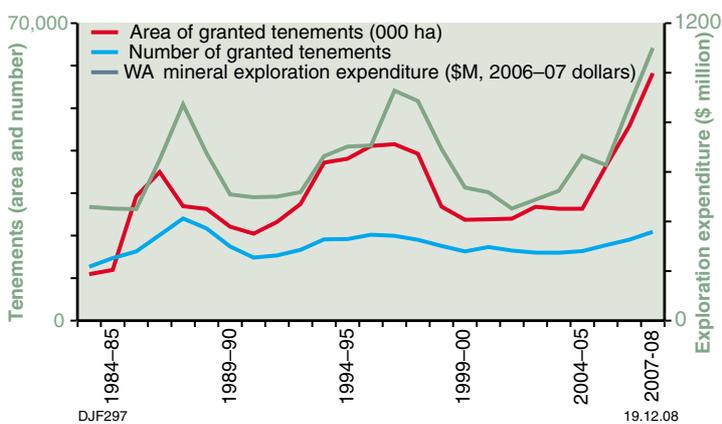


Figure 14. Trends in exploration expenditure and tenement activity (1904 and 1978 Mining Acts) since 1983–84 (source: DoIR)

Overview

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Figure 15 (top right). Distribution of mining and exploration tenements, granted and pending, in Western Australia as at 30 June 2008

Figure 16 (bottom right). Distribution of mining leases and State Agreement Act areas in Western Australia as at 30 June 2008

