



Overview of mineral exploration in Western Australia for 2004–05

by D. J. Flint

Overview

During 2004–05 mineral exploration expenditure* (excluding petroleum) for Western Australia rose sharply by 30% (\$140.2 million) from \$465.8 million to \$606 million, which is the third year in succession where mineral exploration expenditure has risen in the State and follows a 10% increase over the previous year. However, mineral exploration is still well below (28% below) the peak level of 1996–97, when \$845 million (in 2004–05 dollar terms) was spent (Fig. 1). The most recent quarterly data show that mineral exploration expenditure was levelling off during mid-2005, the peak of the field season, suggesting that any increase next year in mineral exploration expenditure will be smaller (Fig. 2). So far, the current boom does not appear as strong as at least three others that Western Australia has experienced over the last 40–50 years; i.e. the three exploration booms of 1970–71, 1987–88, and 1996–97 were stronger in 2004–05 dollar terms (Fig. 1).

The main interest in Western Australia continues to be exploration for iron ore and for nickel, with both of these sectors easily setting new records in exploration expenditure. The dominant gold sector suffered another decline in exploration during 2004–05, as has gold production, which has now declined for the last six years.

The Western Australian trend is consistent with the Australian trend. The 2004–05 level of mineral exploration expenditure within Australia is \$1028 million, which is 27.6% (\$222.4 million) higher than during 2003–04. However, mineral exploration expenditure in Australia is still well below the peak level of 1996–97, when \$1404 million was spent (in 2004–05 dollar terms). Western Australia continues to attract the major proportion of mineral exploration expenditure in Australia (around 59%).

Unfortunately, the recovery in exploration expenditure in Australia and Western Australia has not been as strong as the worldwide recovery, and Australia and Western Australia have again both lost market share in the expanded pool of exploration capital (Fig. 3; based

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

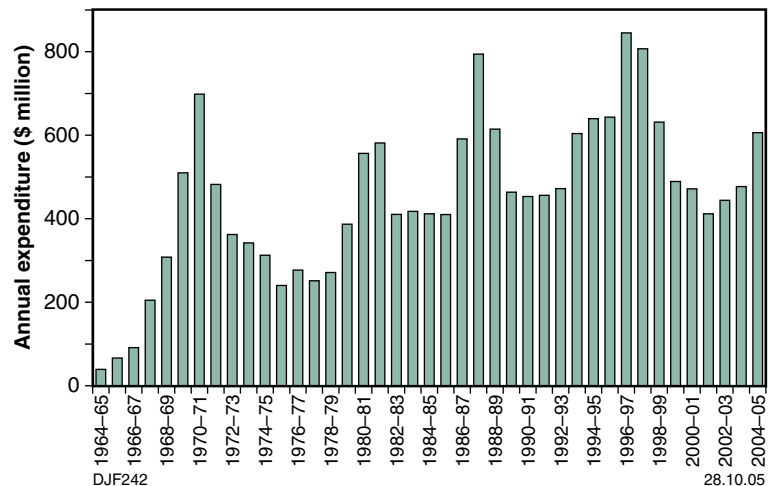


Figure 1. Mineral exploration expenditure in Western Australia, by financial year (2004–05 dollars)

on data compiled by the Metals Economics Group of Halifax, Canada, www.metalseconomics.com). During the last decade, the proportion of the world's non-ferrous mineral exploration expenditure in Australia has dropped from 23% to 15% of the total, whereas that for Western Australia has dropped from 12% to 8% of the total. The comparison with the situation in Canada is striking, with the proportion of worldwide mineral exploration expenditure spent in Canada recovering strongly after 1997, whereas the proportion has continued to fall in Australia and Western Australia (Fig. 3). This clearly illustrates what can be achieved with the combination of high-profile discoveries, ongoing exploration success, and favourable and innovative government regimes (including fiscal incentives to exploration).

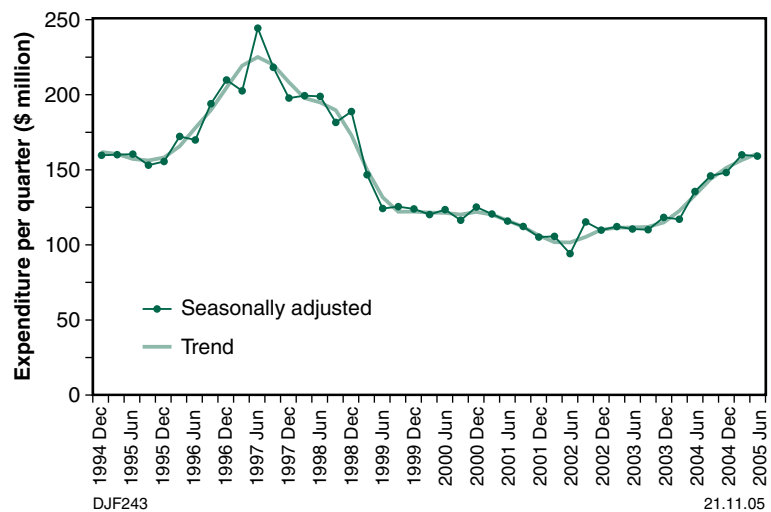


Figure 2. Mineral exploration expenditure in Western Australia, by quarter, on seasonally adjusted and trend terms (June 2005 dollars)

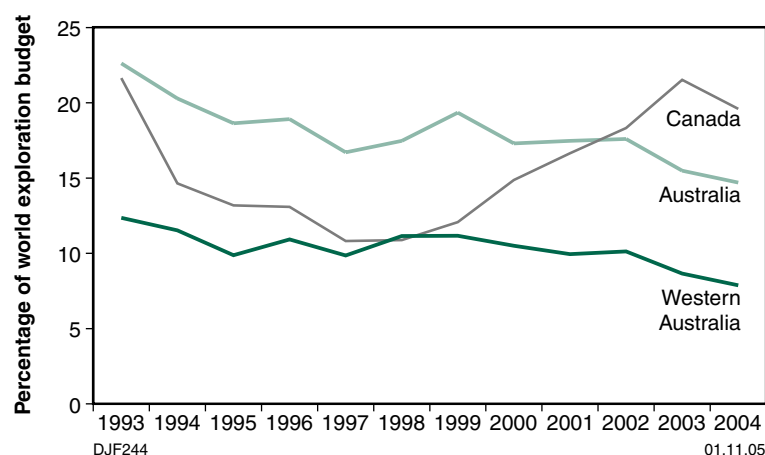


Figure 3. Non-ferrous mineral exploration expenditure — comparative market share of Canada, Australia, and Western Australia since 1993. Source: Metals Economics Group (Canada), ABS, and DoIR

Exploration and development highlights

Important gold discoveries are still being made in Western Australia, but few have been sufficiently spectacular to excite international attention. Perhaps the most newsworthy was that at Trident by Avoca Resources Ltd*, with a spectacular intercept of 27 m at 88 g/t Au, which included an intercept of the Athena lode at 10 m at 229 g/t Au. Other spectacular intercepts obtained were at Annean near Meekatharra (15 m at 45 g/t Au) by Mercator Minerals Ltd, at Burbanks near Coolgardie (25 m at 17 g/t Au) by Barra Resources Ltd, at Golden Eagle near Nullagine (29 m at 48 g/t Au) by Wedgetail Exploration NL, and at Blue Spec near Nullagine (3 m at 37 g/t Au and 1.5% Sb) by Northwest Resources Ltd. Further gold exploration success was achieved at some of the better 2003–04 projects, including Williamson–Regent (Lake Way), Sickle (Laverton), Brightstar (Laverton), and Withnell – Camel 1 and Wingina Well (Indee, Pilbara), the emerging gold province around Tropicana (southeast margin of the Yilgarn Craton), and gold–copper mineralization in the southwest Yilgarn Craton (Wongan Hills, Dominion Mining Ltd). Unfortunately, the investment market appeared to be mostly disinterested in good gold news during 2004–05.

Development highlights for gold in Western Australia are dominated by commissioning of the Telfer Au–Cu mine in the Paterson Orogen. Telfer is a world-class deposit and contains a total of about 26 Moz of gold and 950 kt of copper within its measured, indicated, and inferred resources. Gold production at Telfer during 2004–05 in the early commissioning phase was 160 000 ounces, but production during calendar 2006 is expected to be 800 000 ounces of gold. Other gold mines commissioned or being (re)developed during 2004–05 included Mungari East (85 000 ounces), Paulsens (5000 ounces; but 100 000 ounces per year expected for four years), and Lancefield (4000 ounces). Gold mines commencing production in mid-2005 were Lake Way (Calais, Williamson), Lord Henry and Lord Nelson at Sandstone, and Credo – Rose Dam.

In the nickel sector, the most notable greenfields exploration success during the last two years was at Collurabbie in the Gerry Well greenstone belt (northeast Yilgarn Craton), where Falcon Minerals Ltd and WMC Resources

* For further information on the numerous mines, deposits, or prospects mentioned in this article see the websites for the companies mentioned, which contain copies of company announcements to the Australian Stock Exchange (ASX). For location information, either see the relevant company websites, or DoIR's online databases (MINEDEX or GeoVIEW.WA) at www.doir.wa.gov.au, or Cooper and Flint (2005).

Ltd (the latter now part of BHP Billiton Ltd) announced in early 2004 a new nickel province. The discovery is a zone of combined nickel, copper, and platinum group elements (PGE) mineralization, but where the low Ni/Cu ratio and high PGE levels reported to date distinguish this mineralization from typical komatiite-hosted nickel sulfide mineralization. Significant brownfields exploration successes in the nickel sector include high-grade nickel sulfide mineralization at Prospero near Cosmos (Jubilee Mines NL), T5 at Flying Fox–Forrestania (Western Areas NL), McLeay near Kambalda (Independence Group NL), and Copernicus North in the east Kimberley region (Thundelarra Exploration Ltd). WMC Resources has successfully used an innovative deep-penetrating electromagnetic surveying technique ('Geoferrer' technology) around Mount Keith that now more effectively explores for sulfide deposits at depths from 150 to 500 m below surface.

Nickel–cobalt production in Western Australia fell slightly during 2004, but is set to rise substantially with two advanced lateritic nickel projects. BHP Billiton (BHPB) is developing the Ravensthorpe project and plans to produce about 50 000 tpa of contained nickel, commencing production in late 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 the year 2011.

In the iron ore sector, 2004–05 was a time of unprecedented exploration throughout Western Australia, targeting many mineralization styles: 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 region; magnetite in Mesoproterozoic gneiss of the Albany–Fraser Orogen; clastic hematite in Paleoproterozoic–Mesoproterozoic sedimentary rocks of the Kimberley Basin (Cockatoo Island, Koolan Island) and Carr Boyd Basin (Pompeys Pillar); and for hematite in granular iron within the Frere Formation within the Paleoproterozoic Earaheedy Basin (Giralia Resources NL). Also in the Pilbara Craton, Fortescue Metals Group Ltd (FMG) has established substantial resources (more than 2000 Mt) of Marra Mamba supergene-enriched mineralization in the Chichester Ranges. There was considerable renewed interest by numerous companies in primary magnetite mineralization within BIF horizons throughout the Yilgarn Craton — to as far north as Wiluna (Golden West Resources Ltd) and as far south as Ravensthorpe (Resource Mining Corporation Ltd, Traka Resources Ltd). Numerous iron ore projects were at the feasibility stage.

All of the existing iron ore mines have expansion plans in place, and Koolanooka is being developed. The go-ahead has been given by BHPB for development of Western 4 (four mesas of CID mineralization along Marillana Creek) and Newman Orebody 18 (Brockman supergene-enriched mineralization), Robe River proposes development of the Mesa A–Bungaroo CID mineralization, and development proposals for Hope Downs and East Angelas were lodged by Hancock Prospecting Pty Ltd with Government.

At the Argyle diamond mine in the Kimberley region, Rio Tinto Ltd completed a full feasibility study on underground mining (which included an exploratory decline costing \$70 million); negotiations with Government on the proposed development continued during 2004–05. Western Australia's second diamond mine in the Miocene lamproite pipes at Ellendale had a very successful year: mining expanded at Ellendale 9, mining commenced at Ellendale 4, trial mining started at the Terrace 5 gravels, and numerous other sites were being drill tested and bulk sampled (Kimberley Diamond Co. NL, Blina Diamonds NL). Greenfields exploration success during 2004–05 was in the west Pilbara Craton south of Karratha, where bulk sampling of the newly discovered Blacktop kimberlitic dyke and sill

complex yielded 130 diamonds (totalling 5.22 carats) from a 33 t bulk sample (De Beers Australia Exploration Ltd, Helix Resources Ltd).

In the Ti–Zr sector, the highlights were construction of new mines near Perth at Gingin and Wagerup (Iluka Resources Ltd), proposals to mine at Waroona and Cataby (Iluka Resources) and at Coburn near Shark Bay (Gunson Resources Ltd), and substantial resource upgrades to the Keysbrook deposit (Olympia Resources Ltd). At Coburn, a bankable feasibility study was completed on 600 Mt of mineralization, with mining proposed for 2006. Mining in late 2006 is also planned at Waroona (Iluka Resources). At Keysbrook (70 km south of Perth), a bankable feasibility study was completed in mid-2005 (only one year after floating of Olympia Resources on the ASX), which suggested an 11-year mine life, with mining to start in late 2006 or early 2007. For greenfields exploration during 2004–05, there was renewed interest in strandlines of the Eucla Basin in Western Australia following the discovery in late 2004 of zircon-rich heavy mineral sands in the Eucla Basin of South Australia at the Jacinth and Ambrosia prospects (Iluka Resources, Adelaide Resources Ltd).

Mineral exploration expenditure by commodity

Western Australia still accounts for the major proportion of exploration dollars expended in Australia for many of the major commodities — iron ore (99%), nickel–cobalt (94%), diamond (67%), gold (66%), heavy mineral sands (54%), silver–lead–zinc (13%), and copper (7%).

Within Western Australia, gold remains the main focus of mineral exploration, accounting for about 42% of all exploration expenditure (Fig. 4). Other target commodities for exploration are nickel–cobalt (24%), iron ore (22%), diamond (3%), heavy mineral sands (2%), copper–lead–zinc–silver (2%), and ‘others’ totalling 5%. Although there has been renewed interest in uranium during 2005, there has been nil exploration expenditure in Western Australia.

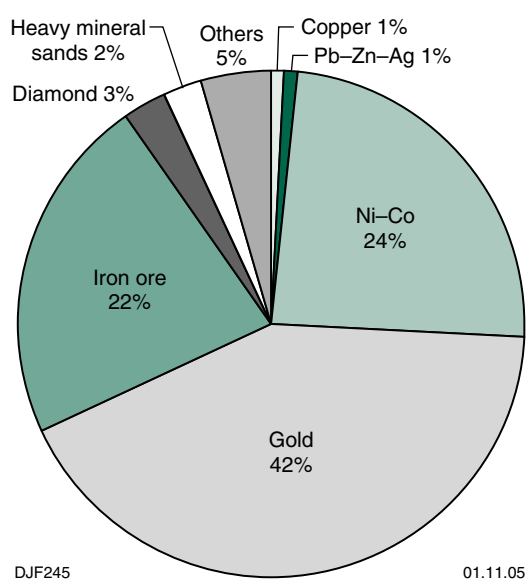


Figure 4. Mineral exploration expenditure in Western Australia, by commodity (2004–05)

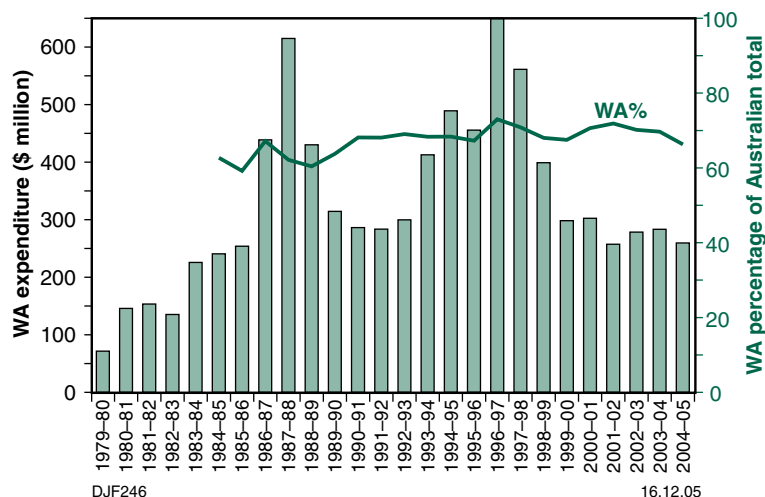


Figure 5. Gold exploration expenditure in Western Australia, by financial year (2004–05 dollars)

Commodities that attracted increased exploration expenditure in Western Australia during 2004–05 were iron ore, nickel–cobalt, heavy mineral sands, and ‘others’. Commodities that attracted decreased exploration expenditure in Western Australia during 2004–05 were gold and diamond.

During 2004–05, \$259.6 million was expended on gold exploration in Western Australia, which is a decrease of 8.4% (\$23.8 million) from the \$283.4 million spent in 2003–04 (expressed in 2004–05 dollars; Fig. 5). Gold exploration expenditure is now 60% below its peak levels experienced eight years ago during 1996–97. In addition, gold exploration expenditure in Western Australia is now at a level last experienced almost twenty years ago (2004–05 dollar terms; Fig. 5).

Gold exploration has been the backbone of the mineral exploration industry in Western Australia for many years, but the last ten years has seen it lose its shine — gold exploration expenditure was around 75% of the total mineral exploration expenditure in the mid-1990s, declining to only 42% during 2004–05. As it was in 2003–04, gold exploration companies found it easier to raise capital for nickel and iron ore exploration during 2004–05, hence there was a degree of refocusing and ‘re-inventing’ themselves (e.g. Gindalbie Metals Ltd). Gold exploration was also hindered by gold miners experiencing higher costs, a relatively stable gold price, and lower profits, resulting in several development projects (for example, Coyote in the Granites–Tanami Complex) being put on hold. In general terms, a considerable amount of exploration was in an endeavour to convert near-mine mineral resources into ore reserves, thus limiting the chances of discovering new deposits. An inadequate level of greenfields mineral exploration is of ongoing concern for the future of gold mining in this State.

Exploration expenditure for nickel–cobalt rose dramatically during 2004–05, doubling in just one year, with a rise of 106% (\$76.4 million) to \$148.7 million (2004–05 dollar terms; Fig. 6). Exploration expenditure for Ni–Co has now risen strongly over the last three years and is now probably at an all-time record, surpassing the previous peak activity in 1997–98, which coincided with the exploration and development of the phase-1 nickel laterites (Murrin Murrin, Bulong, and Cawse). The recovery during the last three years, driven by high metal prices, was led principally by junior

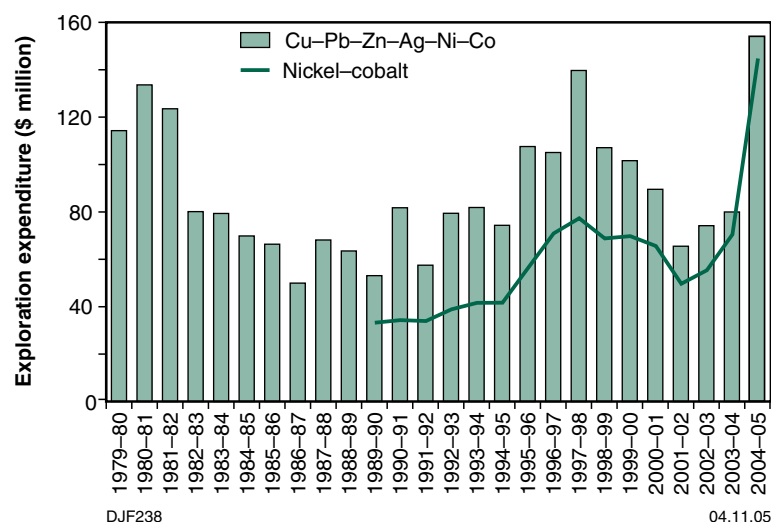


Figure 6. Base metal exploration expenditure in Western Australia, by financial year (2004–05 dollars). Base metals include copper, lead, zinc, silver, nickel, and cobalt. Note: the ABS did not separate Ni–Co data from total base metals until 1999–2000; Ni–Co data from 1989–90 to 1998–99 extracted from Hronsky and Schodde (in press)

companies exploring for and developing nickel sulfide deposits (particularly in the Kambalda area at properties previously owned by WMC Ltd) and by BHPB completing the feasibility study for the large Ravensthorpe lateritic nickel project. Ravensthorpe alone will lift the State's nickel production by 30 000 – 50 000 tpa of contained nickel. In addition, Heron Resources has been advancing its Kalgoorlie nickel laterite project, also capable of producing up to 50 000 tonnes per year of contained nickel. However, the greatest exploration successes that have captured most attention have all been for nickel sulfide mineralization — at Collurabie in the Gerry Well greenstone belt, at Prospero near Cosmos, and at the T5 deposit at Forrestania. Exploration for nickel in the Musgrave Complex was subdued after the excitement from 2000 to 2003, but WMC announced a potential resource of about 1 Mt of contained nickel and an equivalent amount of copper in the Babel deposit (in resources averaging about 0.47% Ni equivalent).

Iron ore exploration expenditure in Western Australia is now at the highest level ever recorded, with last year's record left far behind. During 2004–05 iron ore exploration expenditure jumped dramatically by 112% (\$72.3 million), from \$64.6 million to \$136.9 million (2004–05 dollar terms; Fig. 7). This unprecedented iron ore boom was driven by strong customer demand for iron ore, particularly from China, and the iron ore price increases during the year of around 70%. The major producers in the Pilbara region have been able to respond fairly rapidly by expanding their operations at existing projects and planning new projects, with these including Western 4 at Yandicoogina, Brockman 4, and Mesa A – Warrambo. In addition, FMG has explored at a frenetic pace in the Chichester Ranges, particularly at Cloud Break and Christmas Creek. There is now unprecedented interest in iron ore throughout the State, including exploration for Archean magnetite deposits in primary banded iron-formations throughout the Yilgarn Craton. The high iron ore prices have greatly assisted the capital raisings of junior companies, opened up the industry to juniors, and lessened the duopoly of Rio Tinto and BHPB. There is now the prospect of a magnetite mine within the State in the next year or two, with perhaps Southdown the most likely magnetite deposit to

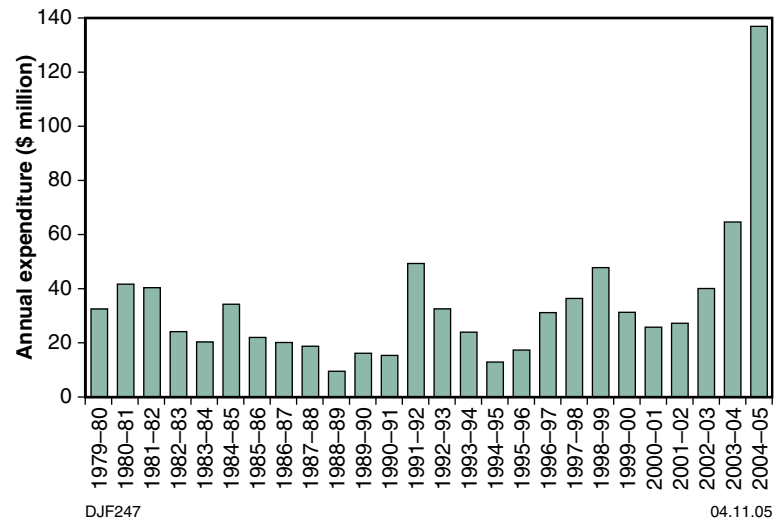


Figure 7. Iron ore exploration expenditure in Western Australia, by financial year (2004–05 dollars)

be developed first. At present over 60 companies are exploring for iron ore in Western Australia, with significant and diverse direct equity investment by Chinese, Korean, and Japanese companies — attempting to ensure long-term supplies and at lower prices than currently.

Diamond exploration expenditure in Western Australia is now at its lowest level for at least 25 years, decreasing by a further 8% during 2004–05, falling by \$1.4 million to only \$15.9 million for the year (2004–05 dollar terms; Fig. 8). This is the third year in a row that diamond exploration has declined. The fall was primarily due to reduced resource–reserve drilling activities at Argyle, with the openpit approaching the end of its estimated mine life and with the underground development option at the negotiating stage with Government. Although there were encouraging mining and exploration results in the Ellendale region, they were not sufficient to balance

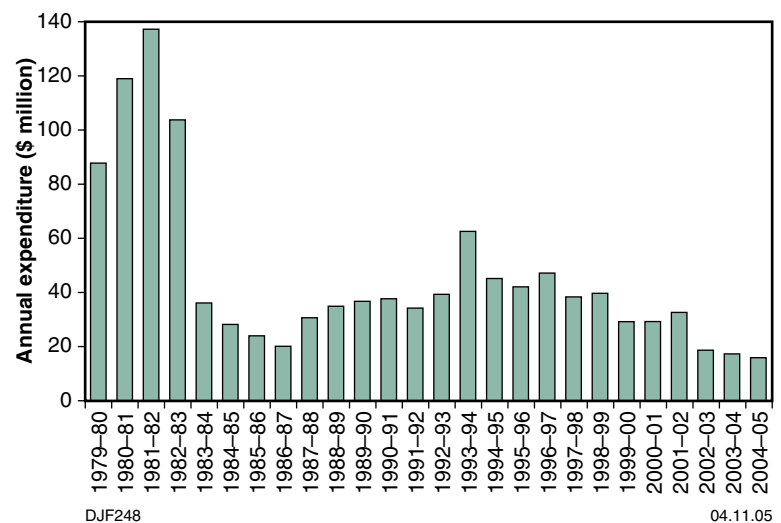


Figure 8. Diamond exploration expenditure in Western Australia, by financial year (2004–05 dollars)

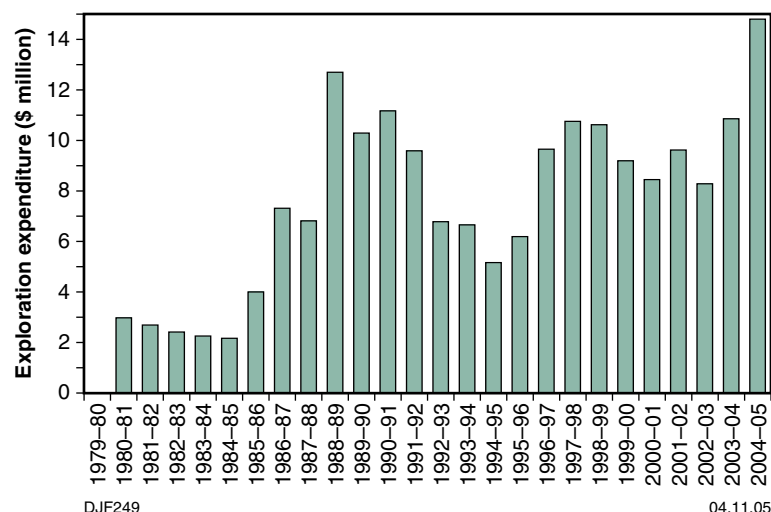


Figure 9. Heavy mineral sands (Ti–Zr) exploration expenditure in Western Australia, by financial year (2004–05 dollars)

the decreased exploration expenditure at Argyle. Diamond exploration expenditure has declined gradually over the last decade, and is now far below the peak level of \$137 million in 1981–82 (in 2004–05 dollar terms) reflecting the general lack of exploration success, hence investor interest, in Western Australia. However, there has been some greenfield exploration success in the western part of the Pilbara Craton that may reverse investor sentiment.

Exploration expenditure for heavy minerals in Western Australia recovered strongly during 2004–05, rising by 36% (\$3.9 million) to \$14.8 million for 2004–05 — the second year in a row of such increases (2004–05 dollar terms; Fig. 9). Expenditure has been sufficient to break out of the band of \$8 million to \$11 million per year that has been the trend for the last decade. Exploration expenditure for Ti–Zr in Western Australia is now at the highest level for around 30 years. 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 had fallen from around 70% of the total in the mid-1990s to only 28% in 2002–03. However, during 2004–05 its share recovered to 54% of the total. The main greenfields exploration projects are Coburn, which progressed during 2004–05 to the development phase, and Keysbrook.

Exploration expenditure directed at copper–lead–zinc–silver in Western Australia improved during 2004–05 to total \$9.5 million, attributed mainly to exploration and development of the Jaguar deposit (Archean VMS style) and the Magellan lead mine (supergene enrichment). There remains little interest in the Mississippi Valley-type Pb–Zn mineralization (sedimentary carbonate-hosted deposits) of the Lennard Shelf after Teck Cominco Ltd closed the mines in early 2004.

Exploration expenditure directed at 'other' minerals in Western Australia increased by 47% (\$8.8 million) to \$27.8 million in 2004–05. 'Others' include all industrial minerals, construction materials, PGE, tantalum, manganese, chromium, vanadium, rare earth elements, and coal–lignite. Exploration expenditure for these commodities is now at its highest level for the last 25 years; attributed to keen interest in the steel industry metals (manganese, chromium, and vanadium) and an awakening of interest in coal.

Drilling activity

Exploration drilling activity throughout Australia has now risen modestly for the third year in a row (as has general exploration expenditure), with this partially offsetting the huge decline from 1996–97 to 2001–02 (Fig. 10). The rise in metres drilled during 2004–05 for Australia was 18.8% (1.073 million metres) to a total of 6.784 million metres. The estimated mineral exploration drilling in Western Australia follows the same trend (based on Western Australia's proportion of the total Australian exploration expenditure for each year).

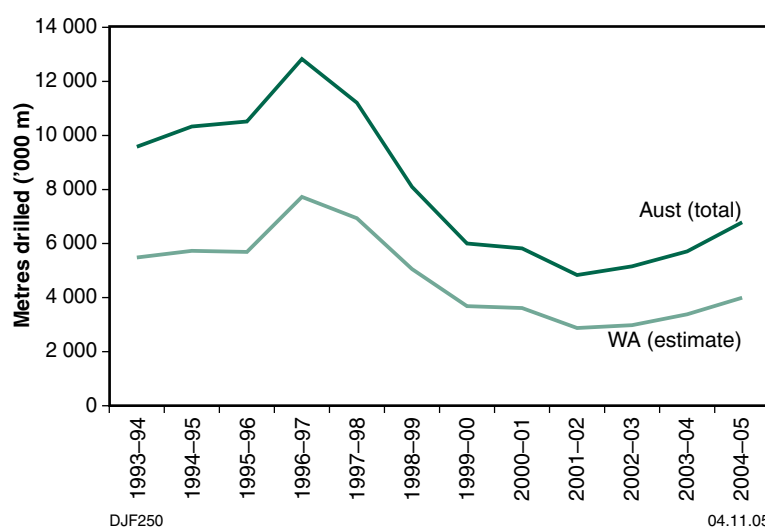


Figure 10. Mineral exploration drilling in Australia and Western Australia, by financial year (metres drilled)

However, mineral exploration drilling in Australia and in Western Australia is now at a level of around half that during the last boom of 1996–97. This highlights several factors, including the extreme severity of the five-year downturn (1996–97 to 2001–02) and that current drilling probably lacks the significant component of RAB drilling in greenfields areas, which characterized the previous exploration boom peaking in 1996–97. The data support the suggestion that Government financial incentives should be directed at stimulating more greenfields exploration.

If the current lack of drill-rig availability is partly due to a loss of drilling capacity from the Western Australian (and Australian) exploration industry then this will be a limiting factor to any immediate increase in mineral exploration expenditure.

Mining tenement activity

Despite mineral exploration expenditure during 2004–05 increasing by around 30%, the mineral tenement statistics* remain static. The number of granted tenements (all tenement types combined) increased by only 2.4% (380) from a total of 15 967 at 30 June 2004 to 16 347 at 30 June 2005 (Fig. 11). The area under granted tenure remained essentially unchanged. The distribution of tenements, both granted and under application, is shown in Figure 12.

The longer term data covering several exploration booms clearly show the link between exploration expenditure and tenement activity (Fig. 11). The

* Tenement data supplied by the Department's Mineral and Title Services Division and published in Department of Industry and Resources Annual Reports.

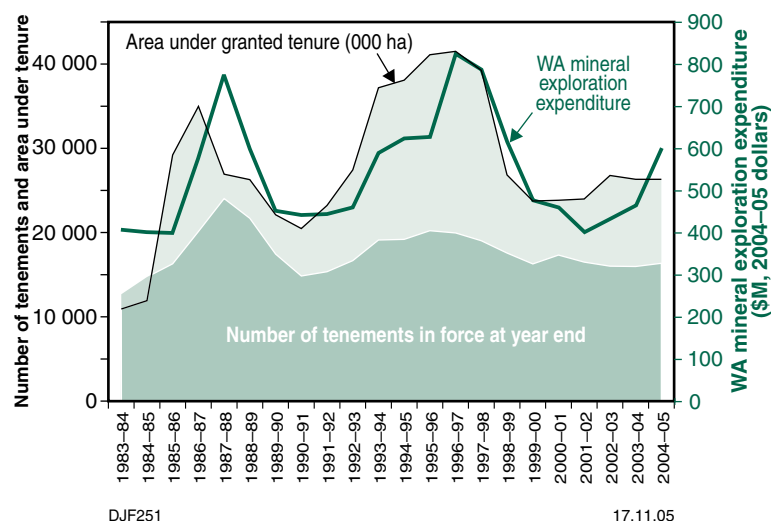


Figure 11. Tenement activity, Western Australia (1904 and 1978 Mining Acts). Source: DoIR

trend in the area under granted tenure closely follows the trend in broad mineral exploration expenditure, but the area under granted tenure is yet to rise significantly during the current boom.

Figure 11 also illustrates that the number of granted tenements is showing less volatility and hence less correlation with fluctuations in mineral exploration expenditure. Although the number of granted tenements rose sharply during the exploration boom that peaked in 1987–88, the rise in granted tenements during the boom of the mid-1990s was quite subdued. This trend persists in the current exploration boom, which so far is of smaller magnitude (Fig. 11).

The data suggest (but do not prove) that the trend towards brownfields exploration since the last boom peaked in 1996–97 has not yet been significantly reversed. The trends are also consistent with the hypothesis that Western Australia has become a ‘mature’ area for mineral exploration.

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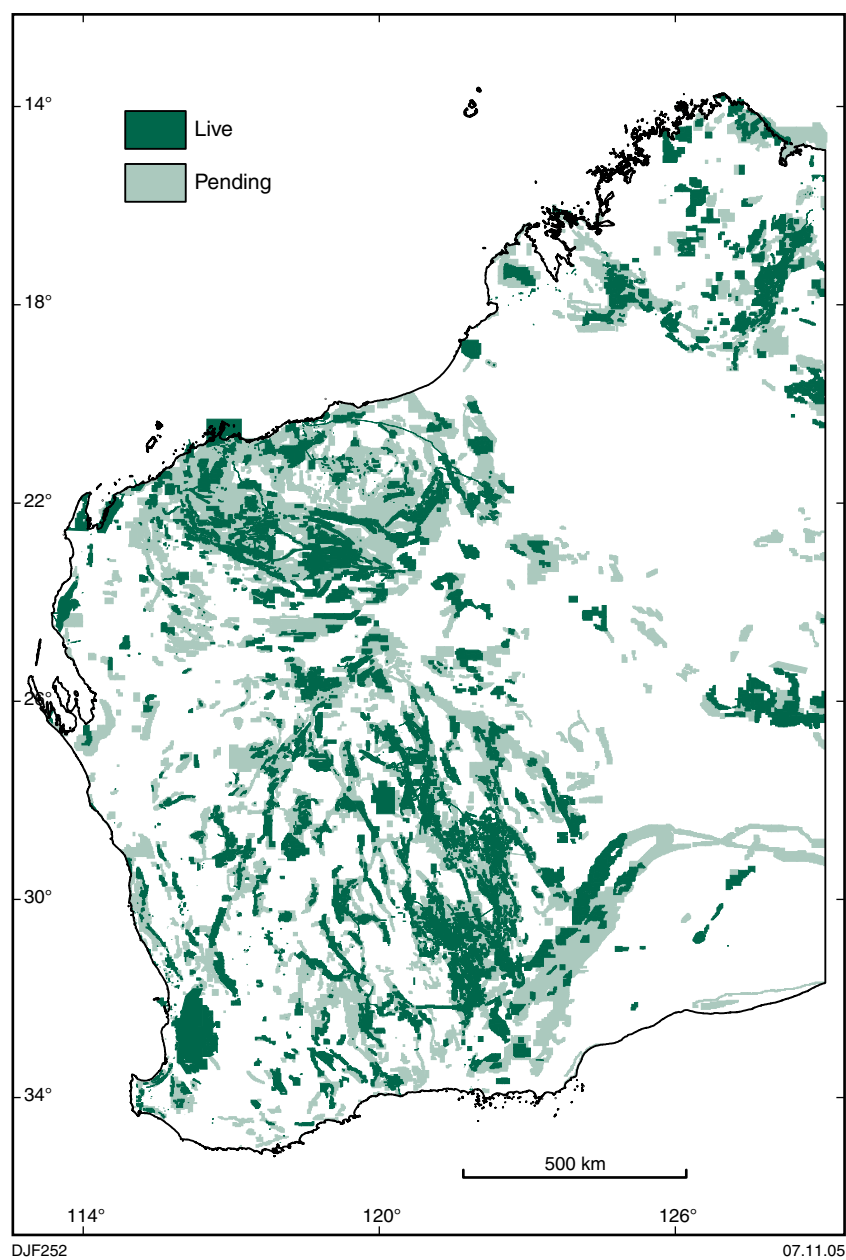


Figure 12. The distribution of mining and exploration tenements, granted and pending, in Western Australia as at 30 June 2005