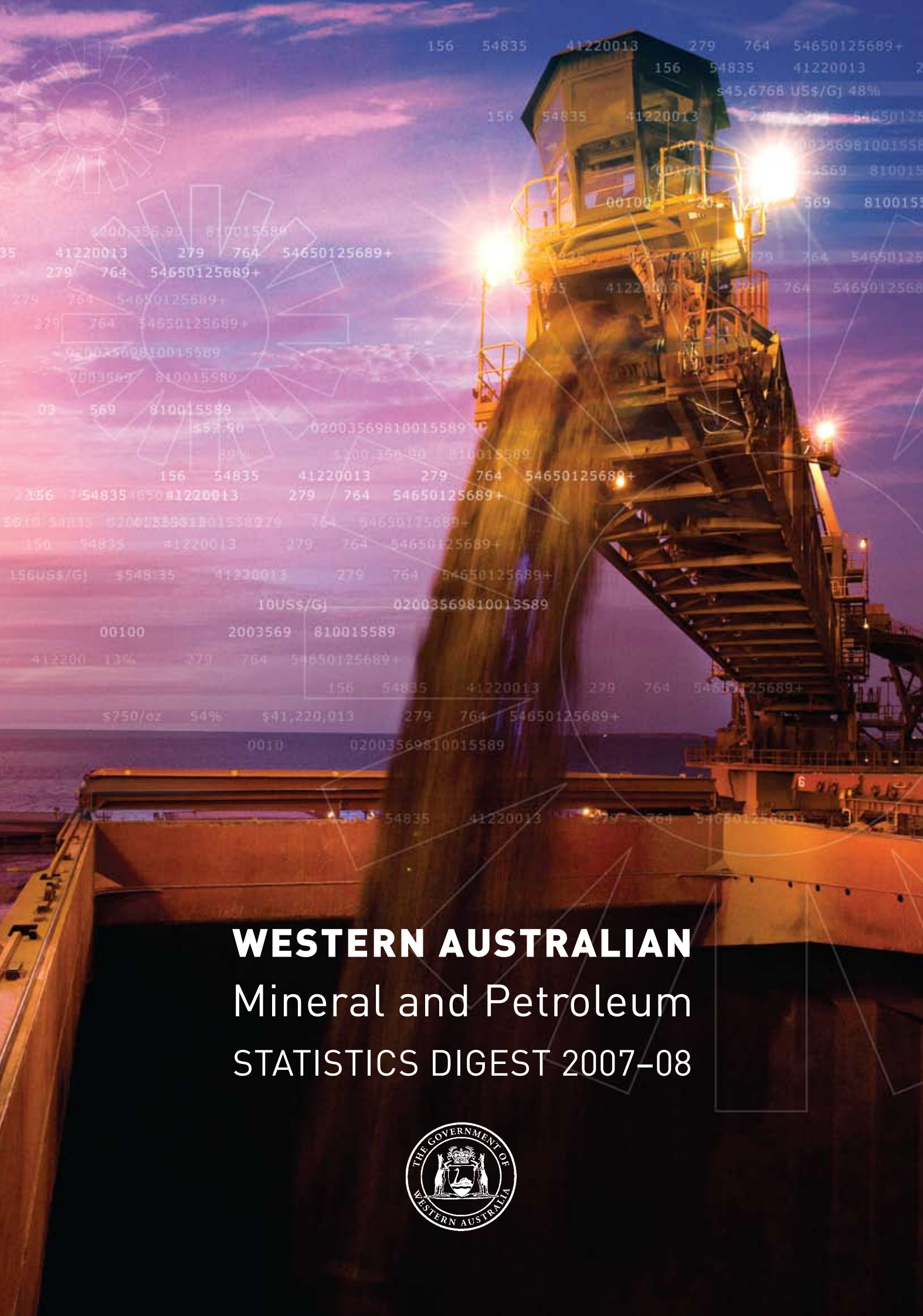

WESTERN AUSTRALIAN
Mineral and Petroleum
STATISTICS DIGEST 2007–08

THE GOVERNMENT OF WESTERN AUSTRALIA

Cover picture courtesy of Rio Tinto.

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FOREWORD

Welcome to the Mineral and Petroleum 2007–08 Statistics Digest. This publication contains the most comprehensive statistical information available on the Western Australian minerals and petroleum industry.

The statistics in this Digest show that in 2007–08 the State's minerals and petroleum sector set a new record, rising by nine per cent to reach $58.6 billion. Overall, during the last decade, the sales value of Western Australia's minerals and petroleum industry has grown at an annual average growth rate of twelve per cent.

The record result in 2007–08 was driven by strong overseas demand for our resources and rising commodity prices. Despite the robust nature of the industry, the year produced many challenges and the impressive result was achieved against a background of a strong Australian dollar, adverse weather conditions, skills shortages, mining equipment supply constraints together with some shipping bottlenecks.

The minerals and petroleum sector continues to remain the engine of the State's economy, accounting for in excess of 30 per cent of Gross State Product and 83 per cent of its export income.

Western Australia is one of the great mineral provinces of the world. It hosts an impressive 531 commercial mineral projects, embracing 1032 operating mine sites which produce over 50 different minerals. In 2007–08, there were also 62 operating oil and gas fields.

To maintain Western Australia's position as one of the world's prominent players in international resource markets, it is important that the State continues to build on its existing advantages. This is particularly significant given the uncertain outlook for global economic growth. Readers of this Digest will therefore hopefully find the publication of particular use in analysing the State's resources industry in a global context.

It is not possible to prepare such a comprehensive range of information without assistance from outside this Department. I would like to thank the various resource companies, Australian Bureau of Agricultural and Resource Economics (ABARE), Australian Bureau of Statistics (ABS) and the Western Australian Treasury Department for their cooperation and help during the preparation of this Digest.

Anne Nolan
Director General
Department of Industry and Resources

1. EXPLORATION AND INVESTMENT

1.1 PETROLEUM EXPLORATION

In 2007–08, total petroleum exploration expenditure in Australia grew by 27 per cent to $3034.9 million. The majority of this expenditure, 84 per cent, was spent offshore.

Expenditure on petroleum exploration in Western Australia during the same period grew by nearly 47 per cent to $2174.9 million. This represented 72 per cent of the national total, an increase on 2005–06 when the share was 47 per cent. Listed below is a breakdown of the various states and Northern Territory's share of petroleum exploration expenditure for 2007–08:

- Western Australia 72%
- Northern Territory 9%
- South Australia 6%
- Queensland 5%
- Victoria 4%
- Tasmania 3%
- New South Wales 1%

The cornerstones of growth in the petroleum industry are exploration and investment. The past year has seen a record number of new companies apply for petroleum exploration acreage in Western Australia. This new exploration and potential investment reflects the growing interest in Western Australia as a destination for capital expenditure from both interstate and overseas investors.

There is potential for ongoing exploration success in Western Australia with many under-explored but highly prospective areas existing both onshore and offshore. Hydrocarbon accumulations have been discovered both onshore and offshore in the coastal zone of western and northwestern Australia, however most petroleum exploration, investment and development is taking place in offshore areas of the State.

In contrast, the majority of Western Australia's onshore areas are under-explored despite the potential for vast quantities of petroleum resources to be found.

Onshore exploration is often logistically difficult and expensive to undertake resulting in explorers preferring to develop in offshore areas close to existing infrastructure. Western Australia's offshore basins have already proven to be extremely rich with hydrocarbons, and profitable, resulting in explorers preferring to develop projects in those areas.

Therefore, most petroleum exploration, investment and development is taking place in offshore areas of the State, from which Western Australia receives no fiscal benefit with government revenues accruing to the Commonwealth. Conversely, the majority of Western Australia's onshore areas are under-explored and relatively untouched, despite the potential for huge resources to be found.

It is encouraging to see the recent renewed interest in onshore exploration north of Perth and now in the Canning Basin. This gives hope for new discoveries of oil and gas fields and further onshore development.

Further information on petroleum exploration activity in Western Australia can be found in the Department of Industry and Resources' publication "Petroleum in Western Australia". This publication contains a comprehensive overview of petroleum exploration activities in this State together with details on the award of petroleum exploration permits.

1.2 MINERALS EXPLORATION

Mineral exploration in Western Australia expanded significantly compared to 2006–07 by $421 million or 50 per cent in 2007–08 to reach $1.26 billion. Of these funds, 57 per cent were spent on existing deposits with the remaining 43 per cent spent on new ground. It should also be remembered that although the added spending is significant, the cost of exploration has increased considerably.

Western Australia attracted 51 per cent of the total Australian mineral exploration budget of $2.46 billion in 2007–08. This percentage share is still short of the highs of the last boom during the mid to late 90's when the State share was around 62 per cent. Nonetheless, it demonstrates the attractive mineral potential the State offers to explorers compared with other states within Australia. The following list shows the order of state and territory share:

- Western Australia 51%
- Queensland 16%
- South Australia 14%
- New South Wales 8%
- Northern Territory 6%
- Victoria 4%
- Tasmania 1%

National expenditure in 2007–08 increased 44 per cent ($746.8 million) with Western Australia's share of this increase a little over 50 per cent.

Nationally the number of metres drilled during 2007–08 increased some 15 per cent over 2006–07 to 9756 metres. A total of 60 per cent was drilled on existing deposits whilst the remaining 40 per cent was drilled on new ground.

For nearly thirty years, gold has accounted for the majority of exploration expenditure in Western Australia accounting for around 65 per cent annually. In 2007–08 however, it is really no surprise that iron ore now claims first place accounting for 33 per cent ($420.7 million) of the total exploration expenditure in the State. Nevertheless, gold did increase some 26 per cent over the 2007–08 year to $347.9 million, claiming second place. Iron ore and gold combined account for 61 per cent ($768.6 million) of the total exploration expenditure in the State.

Nickel has maintained an average share of around 15 per cent over the past fifteen years and in 2007–08 reached 22 per cent or $280 million. Constrained supply and strong demand pushed nickel prices to record levels and has been the driving force behind increased nickel exploration.

With the ban on uranium mining in Western Australia, exploration for uranium has been virtually non-existent. However in 2007–08 a total of $26.7 million was spent in Western Australia, or around 12 per cent of the total amount spent on uranium exploration in Australia.

1.3 INVESTMENT

The ABS private new capital expenditure statistics in Western Australia show a very significant rise in the value of new capital expenditure over the past three years increasing some 47 per cent since 2005–06. In 2007–08 the amount of capital expenditure on mining in Western Australia alone amounted to $17.1 billion, which was a 26 per cent increase compared to the previous financial year. This also represented 74 per cent of Western Australia's total ($23.2 billion) new capital expenditure in 2007–08.

Total national mining investment in 2007–08 amounted to $27.3 billion, an increase of 24 per cent compared to the previous financial year. In 2007–08, Western Australia accounted for 63 per cent of the total national mining investment.

It is important to note that the figures reported above do not capture all mining investment as the ABS uses classifications specified in the 1993 edition of the Australian and New Zealand Standard Industrial Classification (ANZSIC) (ABS catalogue number 1292.0). Accordingly, mining is broadly defined as the extraction of minerals occurring naturally as solids such as coal and ores, liquids such as crude petroleum and natural gas. Downstream mining activities such as smelting of minerals or ores (other than preliminary smelting of gold) or refining are classified as manufacturing activities under the ANZSIC. Products such as coke and alumina are also included in the ANZSIC manufacturing category.

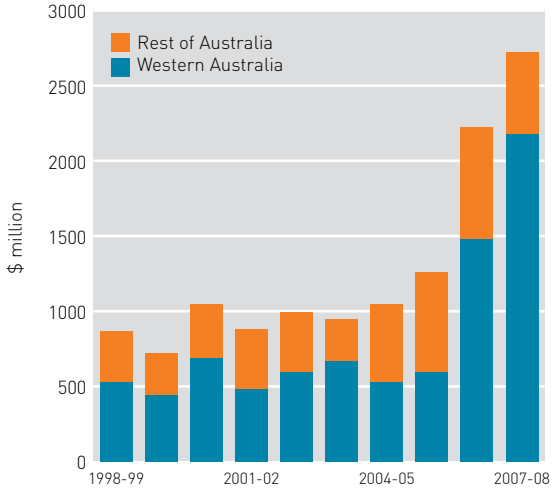


Figure 1 | **Petroleum Exploration Expenditure**
Source: ABS

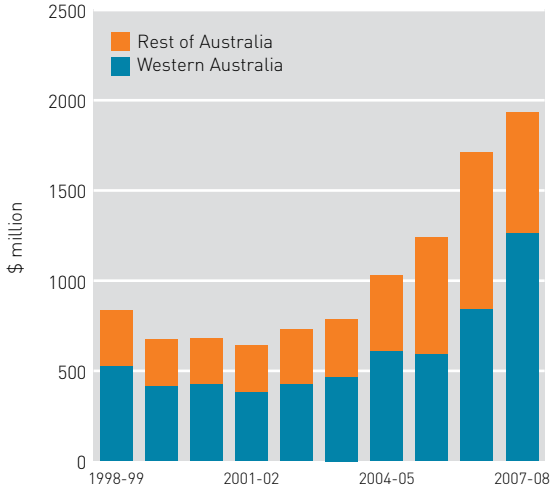


Figure 2 | **Mineral Exploration Expenditure**
Source: ABS

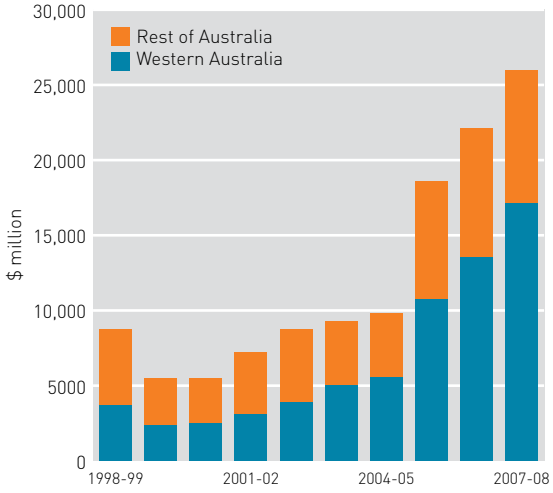


Figure 3 | **Mining Investment**
Source: ABS

2. MINERAL AND PETROLEUM INDUSTRY 2007–08 REVIEW

2.1 OVERVIEW

In 2007–08 the value of Western Australia's mineral and petroleum industry reached $58.6 billion, representing a nine per cent increase compared to the previous year. Strong overseas demand for the State's mineral and petroleum commodities, increased output and high commodity prices combined to deliver this record result.

During 2007–08 the Australian dollar strengthened against the US dollar by 14 per cent which is estimated to have had the effect of reducing mineral and petroleum export revenue by around $9 billion. Therefore, the net result of a $4.9 billion overall increase in the value of mineral and petroleum sales in 2007–08 is quite remarkable.

This outcome was achieved with the resources industry continuing to experience ongoing difficulties with equipment supplies, rising costs and skills shortages. These factors hampered expansion programs designed to meet shortfalls in resource commodity supplies.

Most of the increase in value for 2007–08 came from the iron ore and petroleum sectors. Together, these two sectors accounted for 68 per cent ($39.9 billion) of total sales value of the State's resources industry.

In 2007–08 there was a huge 30 per cent increase in the value of iron ore sales out of Western Australia, with 290 million tonnes exported at a value of $20.5 billion. This established the iron ore industry as the largest resource sector, representing 35 per cent of the total value of the State's resources industry.

High oil prices also maintained the petroleum industry's prominence in the State. In 2007–08 the State's petroleum industry grew in value by almost 19 per cent to $19.4 billion. The total sales value of this industry which includes crude oil, gas and LNG represents a third of the total value of Western Australia's resource industry. Western Australia's petroleum industry also now accounts for 70 per cent of national oil and gas production.

Overall, during the past ten years the value of Western Australia's mineral and petroleum industry has grown on average by an impressive 13 per cent per annum. Also highlighting the importance to both the State and national economies, the mining and petroleum sectors contributed 83 per cent ($56.6 billion) towards the total Western Australian merchandise exports in 2007–08.

Western Australia leads all other states contributing a little under 40 per cent ($68.1 billion) towards the total Australian merchandise exports for 2007–08, an increase of two per cent on the previous year. The other states remained virtually unchanged at Queensland with 20 per cent, then New South Wales with 17 per cent and Victoria contributing about 12 per cent.

Some additional salient indicators of Western Australia's significance in the national resource industry are that the State accounts for:

- approximately 53 per cent of Australia's total value of mineral and petroleum sales (based on DoIR and ABARE published data*);
- 70 per cent of Australia's oil and condensate production (based on published data by ABARE); and
- 40 per cent of Australia's total merchandise exports in 2007–08 (sourced from ABS).

Western Australia's GSP for 2007–08 was $157 billion in current prices and Australia's GDP in 2007–08 was $1,037 billion.

The magnitude of the State's mining developments is demonstrated in the latest ABS investment figures for 2007–08. The amount of capital expenditure on mining in Western Australia alone amounted to $17.1 billion, which was a 26 per cent increase compared to the previous financial year. This also represented 74 per cent of Western Australia's total ($23.2 billion) new capital expenditure in 2007–08.

Western Australia topped all the other states contributing 40 per cent ($68.1 billion) towards the total Australian merchandise exports for 2007–08, an increase of four per cent from the previous year. Queensland followed with 20 per cent, then New South Wales with 17 per cent and Victoria contributing about 12 per cent.

The Western Australian mining and petroleum sectors contributed a massive 83 per cent ($56.6 billion) toward the State's merchandise exports in 2007–08 which highlights the importance these sectors have not only to the State's economy, but also to that of Australia.

* ABARE Australian Commodities March Quarter 2008 page 23.

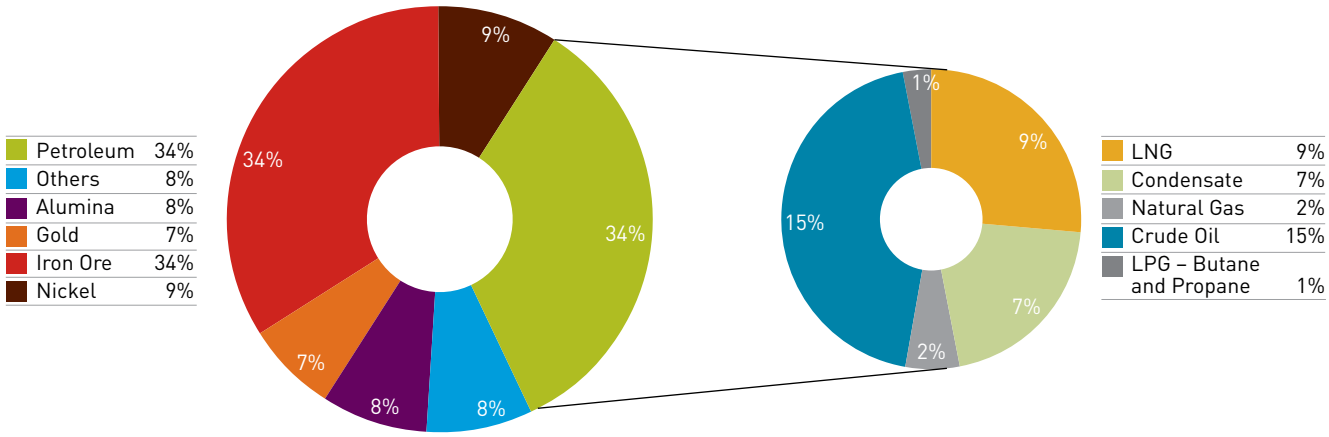


Figure 4 | **Value by Commodity 2007–08**
$58.6 billion Source: DoIR

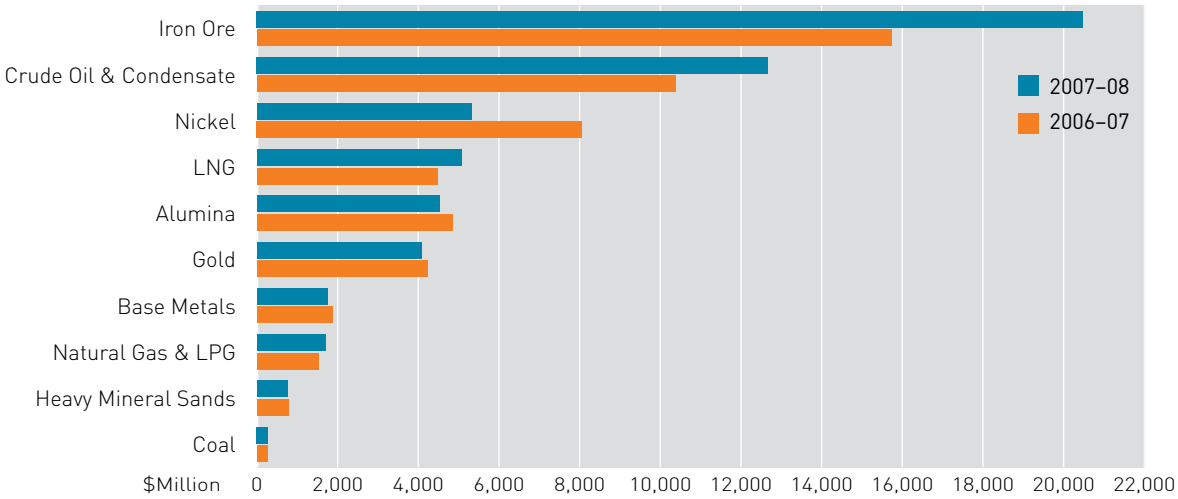


Figure 5 | **Major Commodities by Value**
Source: DoIR

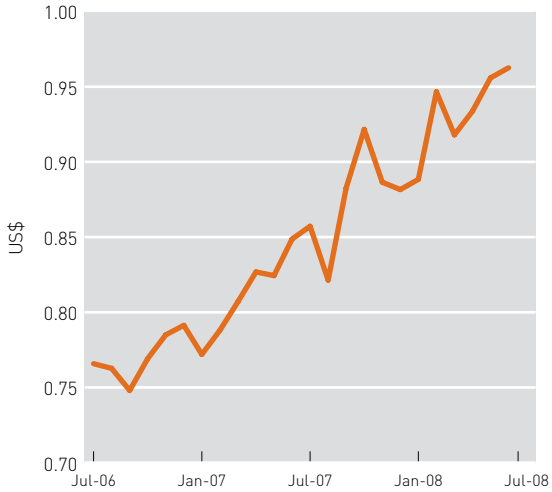


Figure 6 | **Exchange Rate US$/A$**
Source: Reserve Bank of Australia

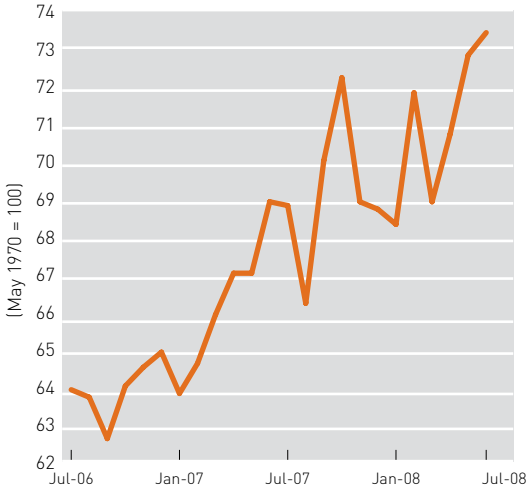


Figure 7 | **Exchange Rate**
Trade Weighted Index
(units of foreign currency per A$)
Source: Reserve Bank of Australia

Definition: "Trade weighted index" is the average value of A$ in relation to the currencies of Australia's major trading partners.

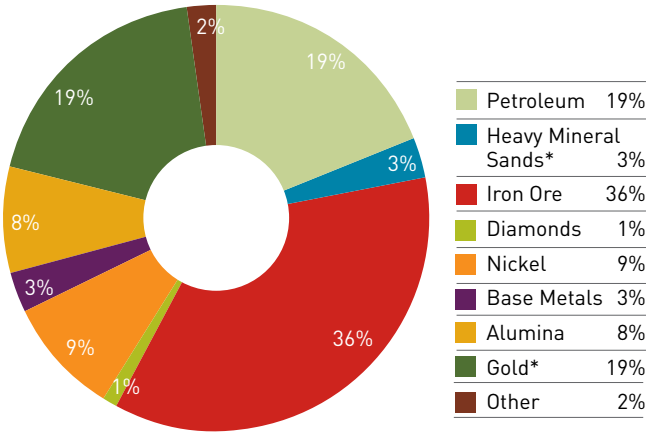


Figure 8 | **Western Australian Mineral and Petroleum Exports 2007–08**
Total Value $56.6 billion Source: DoIR

** Includes $7.94 billion of gold and $38 million of heavy mineral sands refined/processed and exported from Western Australia, but produced from mining operations in other States, Territories and overseas.*

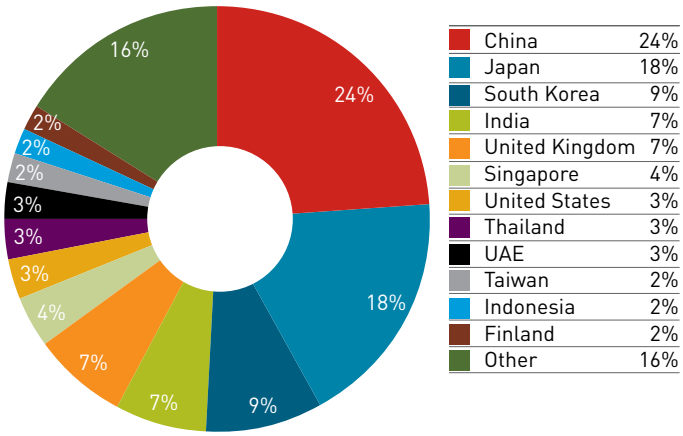


Figure 9 | **Western Australian Merchandise Exports 2007–08**
$61.3 billion Source: ABS

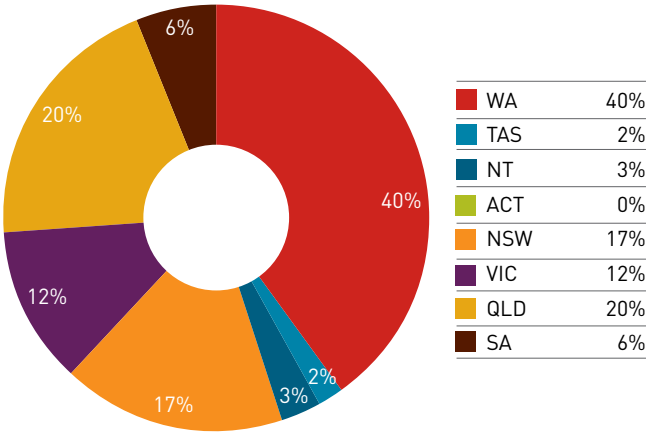


Figure 10 | **Australian Merchandise Exports 2007–08**
$179.578 billion Source: ABS

Note: These percentages are based on $172.036 billion which exclu $7.542 billion of exports of unidentified origins and re-exported goo

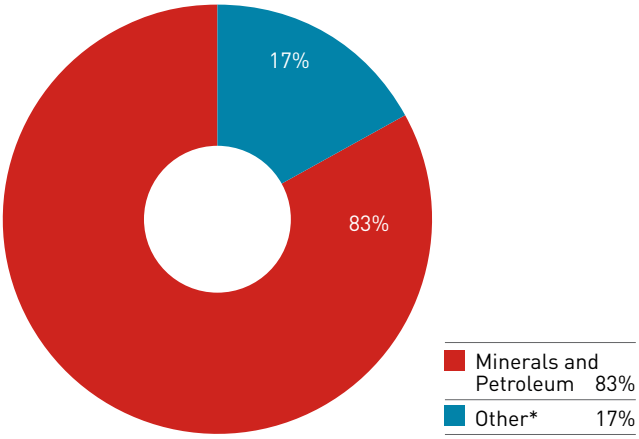


Figure 11 | **Western Australian Merchandise Exports 2007–08**
$68.1 billion Source: DoIR and ABS

** Other includes wheat, wool, live animals, seafood, meat, pearls and other agricultural and manufactured items.*

HIGHLIGHTS IN 2007–08

High world commodity prices played an important role in pushing up the value of Western Australian mineral and petroleum sales. Strong demand and constricted supply saw record prices being reached for oil, iron ore, gold, cobalt and lead. Liquefied Natural Gas (LNG) returns were also boosted by the higher oil price. However, after previous massive increases, nickel and zinc prices underwent downward price corrections of 34 per cent and 38 per cent respectively (in Australian dollar terms).

Several commodities recorded decreased levels of physical output, notably lead, gold, crude oil, LPG and salt with LNG and nickel down marginally. However the strong oil price translated to the value of crude oil, LPG butane and propane and LNG rising despite these production falls.

Iron ore is now the largest individual mineral sector by value and accounted for 35 per cent of the value of the overall mineral and petroleum sector's output in 2007–08. On the back of strong demand from China, continued support from traditional markets, a 13 per cent increase in output and price increases, iron ore reached a record sales value of $20.5 billion. This was a 30 per cent rise from 2006–07. The quantity sold also broke records in 2007–08, increasing by nearly 13 per cent to reach 291 million tonnes.

The Tapis oil price peaked in June at US$148.17 per barrel and averaged US$101.46 per barrel in 2007–08, up 47 per cent from 2006–07. **Crude oil** output fell by nine per cent to 80.3 million barrels, however high oil prices saw value of sales increase by around 18 per cent to reach $8.7 billion. **Condensate** increased output by six per cent to reach 37.6 million barrels and sales value increased by 34 per cent to reach just under $4 billion.

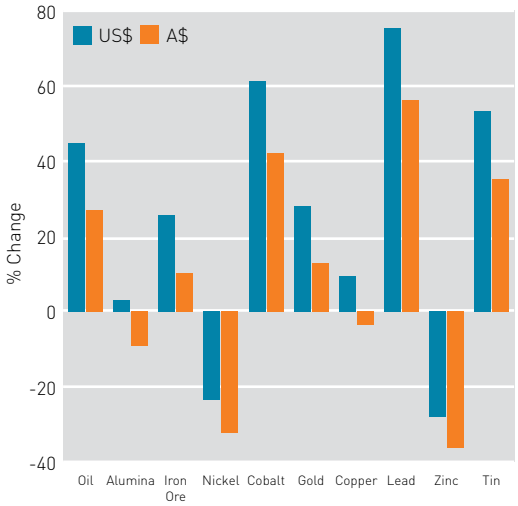


Figure 12 **Average Price Comparison 2006–07 and 2007–08**
Source: LME, Kitco, TEX Report, Metal Prices

Nickel, in third place, contributed $5.3 billion to the total value of the State's resources in 2007–08. Whilst sales quantities dropped marginally by just under two per cent to 171 thousand tonnes, a strong Australian dollar and a drop in the US dollar nickel price of 25 per cent saw the value of nickel sales plummet by 34 per cent.

LNG output remained almost static, down just half a per cent, however the influence of high oil prices saw the sales value increase by 13 per cent for a value of $5.1 billion. This resulted in LNG holding the position of fourth most valuable individual commodity in the State.

Alumina's steady performance continued through 2007–08 to claim fifth place. A modest output increase of about three per cent resulted in a record 12.3 million tonnes being shipped. An increase of just under four per cent in the US dollar price for alumina was not enough to offset the effects of the strengthening Australian dollar and resulted in the value of alumina sales in 2007–08 falling by seven per cent to $4.5 billion.

Gold output fell by 14 per cent in 2007–08 to 4.5 million ounces (139 511 kilograms) due in part to producers processing lower grades. This sector remains in sixth place with a value of $4.1 billion, down a little under four per cent from 2006–07. Whilst gold averaged US$823 per ounce for 2007–08, in January 2008 prices broke through the previous record of US$850 per ounce set in 1980. In March 2008 the gold price achieved new highs of US$1033 per ounce, averaging US$925 per ounce for the quarter.

Base metals were down in terms of overall value by seven per cent to $1.7 billion in 2007–08.

Zinc's sales volume increased by nearly 39 per cent to reach 197 thousand tonnes, however an average 30 per cent fall in the US dollar price of zinc saw sales values drop by 14 per cent to $578 million.

The value of **copper** rose by just under three per cent to $1.1 billion even though the price of copper fell by nearly four per cent in Australian dollar terms. This was due to the increased quantity of copper produced in 2007–08, rising seven per cent to 124 thousand tonnes.

A mine closure resulted in **lead** production being reduced considerably from 70 thousand tonnes to only 26 thousand tonnes. Lead prices soared by 70 per cent in US dollar terms however this was not enough to counteract the drop in output. The value of lead sales for 2007–08 fell 44 per cent to $81 million.

Domestic **natural gas** sales increased by five per cent to 9.2 billion cubic metres in 2007–08 and the sales value of this gas rose by 12 per cent to $1 billion. **LPG butane and propane** output fell almost nine per cent, however the strong prices helped to return a sales value of $683 million which is a 13 per cent increase on the previous year.

The total value of **mineral sands** sales value fell by a little under three per cent to $768 million. Volume of sales was mixed, with ilmenite, leucoxene and zircon being down and synthetic rutile and rutile up.

Cobalt sales volume increased by eight per cent and on average cobalt prices increased 63 per cent in US dollar terms to return an overall increase in sales value of 63 per cent or $449 million.

Diamond sales volumes increased by 53 per cent to reach 28 million carats whilst sales values increased by 40 per cent to $611 million.

Coal output increased by five per cent to 6.3 million tonnes and included several export shipments and sales revenue increased marginally by just over one per cent to $275 million.

The volume of **salt** sales fell by 12 per cent in 2007–08 to just over nine million tonnes. Increased prices were not enough to offset the strengthening Australian dollar and the value of these salt sales also fell by a similar amount (15 per cent) in 2007–08 to $200 million.

The State's resources in order of value for 2007–08 are:

	BILLION
IRON ORE	$ 20.48
CRUDE OIL AND CONDENSATE	$ 12.67
NICKEL	$ 5.32
LNG	$ 5.06
ALUMINA	$ 4.52
GOLD	$ 4.07
OTHERS	$ 6.49

RESERVE BANK OF AUSTRALIA (RBA) COMMODITY PRICE INDEX

The Reserve Bank of Australia Commodity Price Index is based on the price of 19 major commodities exported by Australia. These commodities collectively account for around two-thirds of total commodity exports. The index is apportioned into three sections – rural, non-rural and base metals.

The non-rural index comprises base metals (which consist of aluminium, copper, nickel, zinc and lead), gold, coking coal, steaming coal, iron ore, alumina and LNG. The index is compiled monthly and is expressed in US dollars, Australian dollars and Special Drawing Rights (SDR).

The RBA's index, expressed in US dollar terms, is useful because most commodities traded in world markets are in US dollars. However such an index is subject to changes in the US dollar exchange rate (as it is based on spot prices). In this respect, the SDR index is a better indication of underlying supply and demand for commodities than the US dollar index.

SDR is a unit of account used by the International Monetary Fund (IMF). Its value is based on a basket of currencies comprising the euro, Japanese yen, English pound and US dollar. Weights are assigned to each of these currencies to reflect their relative importance in world terms. The RBA expresses the SDR component of its index in US dollar terms, with commodity prices derived from the London Metal Exchange and Bloomberg and converted to monthly averages of daily data.

Alternatively, the Australian dollar index is useful for gauging the domestic currency price received by Australian commodity exporters as it reflects the interrelation between world commodity prices and the Australian exchange rate. For example, if prices in foreign currency terms remain unchanged but the Australian dollar depreciates, this will be recorded as a favourable upward shift in the index, which would not be evident in either the SDR or US dollar index.

The RBA index is a fixed-weight Laspeyres index, using 2001–02 as the base year and excludes crude oil. The index is re-based every five years in order to make long-run reliable comparisons, unlike the national accounts that are re-based annually to track short-run movements. Base-period weights indicate the relative importance given to individual commodities. They are based on gross exports thus explaining the omission of crude oil (for which Australia is a net importer) and correspond to the export value of each commodity as a share of total exports. These weights change over time to reflect changes in the composition of commodity exports. Movements in the index from one period to the next reflect underlying price movements and do not take into account changes in volumes.

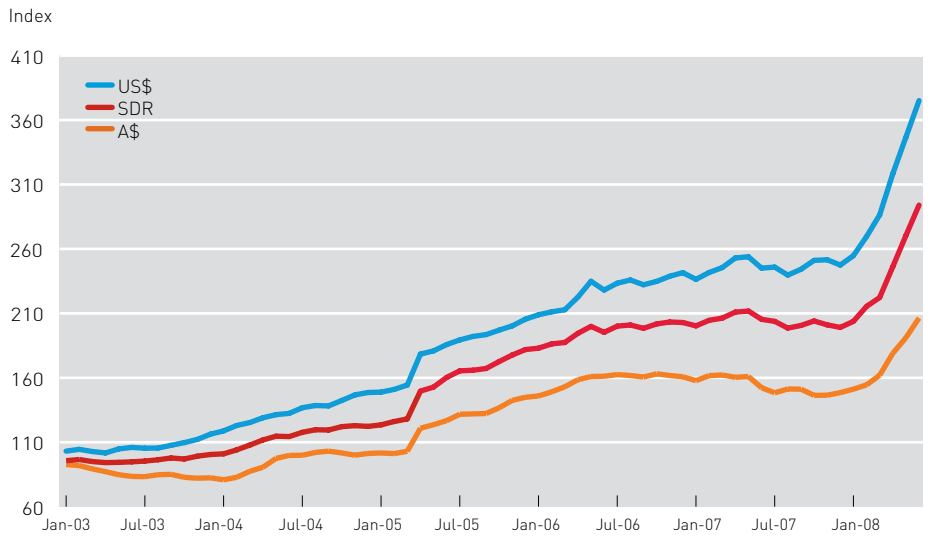


Figure 13 | **Non-Rural Commodity Price Index** (2001–02 = 100)
Source: Reserve Bank of Australia

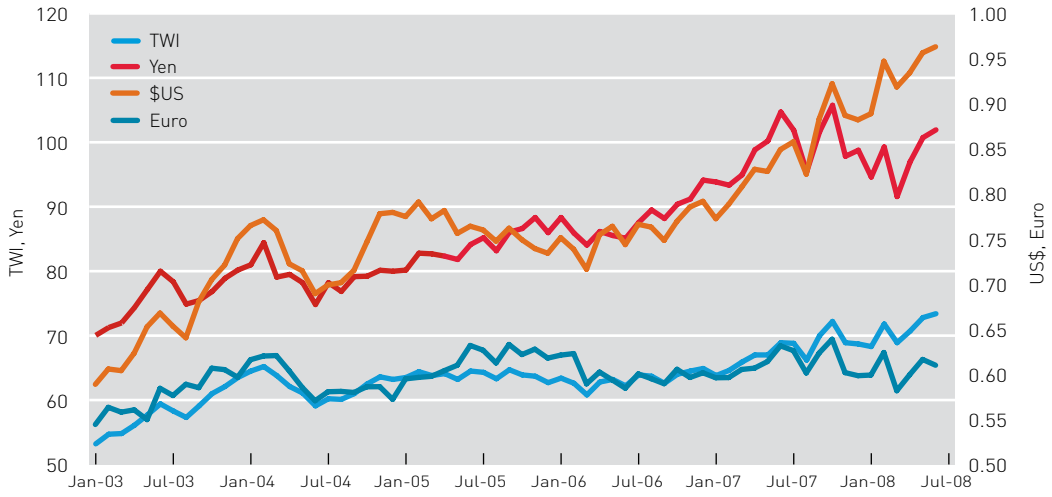


Figure 14 | **Australian Dollar Exchange Rate Against Major Currencies**
Source: Reserve Bank of Australia

TENEMENTS IN FORCE 1978 ACT

	2001–02		2002–03		2003–04		2004–05		2005–06		2006–07		2007–08	
	Number	000 ha	Number	000 ha	Number	000 ha	Number	000 ha	Number	000 ha	Number	000 ha	Number	000 ha
Prospecting Licences	4,964	634	4,566	575	4,561	568	4,665	586	5,056	638	5,376	682	6,260	800
Exploration Licences	2,899	18,556	2,855	21,123	2,917	20,896	3,066	22,215	3,966	30,822	4,766	40,031	5,427	51,790
Mining Leases	4,820	1,774	4,770	1,762	4,713	1,716	5,172	1,805	5,118	1,806	5,090	1,824	5,475	2,036
Other	3,618	3,002	3,629	3,299	3,590	3,115	3,258	2,982	3,432	3,037	3,629	3,248	3,678	4,119
Mineral Claims & Other 1904 Act	186	22	186	22	186	22	186	22	186	21	186	21	186	21
Total	**16,487**	**23,988**	**16,006**	**26,781**	**15,967**	**26,317**	**16,347**	**27,610**	**17,758**	**36,324**	**19,047**	**45,806**	**21,026**	**58,766**

Source: DoIR

2.2 IRON ORE

The State's iron ore industry has experienced a period of unprecedented growth fuelled by the burgeoning economy across Asia, particularly China. In 2007–08 the iron ore industry again broke new records in terms of output to reach 291 million tonnes and $20.5 billion in sales which makes iron ore the most valuable resource sector in Western Australia. This is a remarkable result given the past year has seen a 13.4 per cent strengthening of the Australian dollar against the US dollar. Producers have also faced the frustration of insufficient labour and skills, shortages of materials, rising capital and operating costs and time delays.

The iron ore industry plays a pivotal role in Western Australia's export-driven economy, contributing $20.5 billion or 35 per cent of the total value of mineral and petroleum sales for 2007–08. This equates to around $2.3 million per hour and accounts for 30 per cent of the State's merchandise exports. Supported by Chinese demand, iron ore sales reached record volumes for an eighth consecutive year, increasing by 13 per cent to 291 million tonnes.

China dominates Western Australia's iron ore exports, accounting for 58 per cent or $12 billion of the total amount shipped for 2007–08. Japan received 26 per cent during 2007–08 whilst other markets were South Korea (11 per cent), Taiwan (four per cent) and Europe (one per cent).

IRON ORE PRODUCERS

Whilst the larger iron ore operations are based in the Pilbara region of Western Australia, there are also three mines in the Mid West region, two in the Kimberley region and one in the Wheatbelt. Rio Tinto Limited (with its wholly owned subsidiary Hamersley Iron Pty Ltd, and its 53 per cent shareholding in Robe River Mining Company Pty Ltd) together with the 50:50 joint venture between Rio Tinto Iron Ore and Hope Downs Iron Ore (HDIO) and BHP Billiton (BHPB) dominate the industry in Western Australia and account for around 95 per cent of the State's iron ore production.

Hamersley Iron owns six mines (Brockman, Marandoo, Mt Tom Price, Paraburdoo, Yandicoogina and Nammuldi) and also operates the 60 per cent owned Channar mine, a joint venture with an Australian subsidiary of the China Iron & Steel Industry and Trade Group and the 54 per cent owned Eastern Range mine, a joint venture with Shanghai Baosteel Group Corporation.

BHPB operate seven mine sites including one of the largest single-pit, open-cut ore mines in the world – the massive Mt Whaleback mine in Newman. Nearby are the satellite ore bodies 18, 23, 25, 29, 30 and 35, Jimblebar, Yandi, Area C and Yarrie.

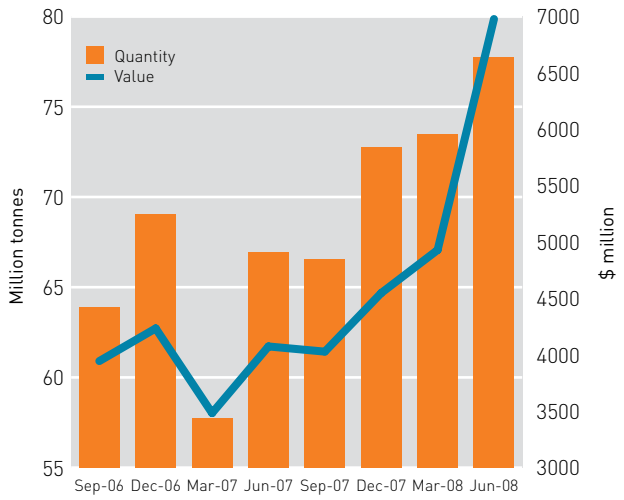


Figure 15 **Iron Ore Quantity and Value by Quarter** Source: DoIR

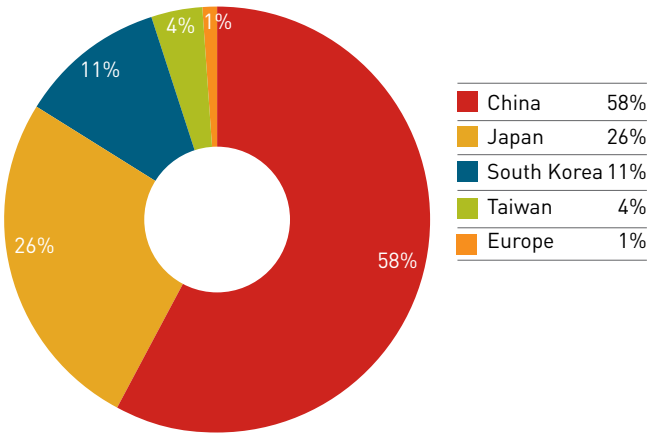


Figure 16 **Iron Ore Exports Total Value $20.4 billion** Source: DoIR

Robe River operates the Pannawonica mine and West Angelas mine.

Rio Tinto Iron Ore operations expanded to include the recently commissioned Hope Downs mine in joint venture with (HDIO). The US$1.2-billion development of the Hope Downs iron ore mine and a 58-kilometre railway line connecting into the Pilbara Iron rail system near West Angelas commenced operations in the March quarter of 2008. The rail link has the capacity to carry up to 30 million tonnes per annum of Marra Mamba ore to either Dampier or Cape Lambert for export.

The latest newcomer to the Pilbara iron ore sector is the Fortescue Metals Group (FMG) with their Chichester Range Iron Ore Cloud Break mine. The $2.4-billion project commenced shipments in May 2008 transporting ore along their new 260-kilometre multi-user railway and loaded a ship destined for China from FMG's open-access Herb Elliott port in Port Hedland.

The smaller producers consist of:

- Portman Limited with its Koolyanobbing operation about 50 kilometres northeast of Southern Cross and its smaller operation at Cockatoo Island, around 140 kilometres north of Derby.
- Mount Gibson Mining Ltd with its Tallering Peak operation, 50 kilometres north-northeast of Mullewa, and its recently acquired Koolan Island hematite mine, located in Yampi Sound off the Kimberley coast.
- Midwest Corporation Limited with its Koolanooka – Blue Hills operation, 200 kilometres east-southeast of Geraldton. Midwest commenced shipment of iron ore fines from stockpiles in February 2006 and expects to commence mining and crushing in the latter part of 2008.
- Crosslands Resources Ltd's (a 50:50 joint venture by Murchison Metals Ltd and Mitsubishi Development Pty Ltd) Jack Hills mine, located 140 kilometres northwest of Meekatharra and 380 kilometres northeast of Geraldton.

All of the State's iron ore producers have made a significant contribution to this year's impressive performance. Western Australian producers continue to develop a holistic utilisation of their ore bodies by blending a wide range of ore types, using complementary chemical and physical characteristics to reduce product variability. These new products will provide greater stability over the long term and reduce customer stockpiling requirements.

PROJECT EXPANSIONS

Since China first sent market signals in 2002–03 that it was rapidly growing its infrastructure needs and thus its intensity of steel demand, producers have been doing their utmost to capitalise on the current strong market by increasing supply through investment in expansions and exploration. However, the recent financial turmoil and uncertain outlook for global economic growth may have the potential to slow some expansions and developments in the iron ore industry.

Some of this expansion work committed in 2007–08 includes:

- BHPB's $1.53-billion Rapid Growth Project 3 (RGP 3) which will increase the capacity of its Pilbara iron ore operations to approximately 129 million tonnes per annum. The key elements of RGP 3 comprise the expansion of Area C mine by 20 million tonnes per annum, additional sidings on the Newman railway and port works at Nelson Point and Finucane Island. Initial production began in the last quarter of 2007 with full production anticipated by 2008–09.
- BHPB's $1.85-billion Rapid Growth Project 4 (RGP 4) was approved in March 2007 which will increase its Western Australian operations to 155 million tonnes per annum. Key elements include development of a new crushing and screening plant, additional stockyards, car dumping facilities and train-loading facilities at Mt Whaleback. At Yandi there is to be a new ore processing handling facility. Upgrades are to be also made at Jimblebar and Yandi along with infrastructure improvements at Nelson Point and Finucane Island.
- BHPB's next expansion plans comprise increasing installed capacity to more than 200 million tonnes per annum during calendar year 2011. Work will include the duplication of the railway track between the Yandi mine and Port Hedland and expansion of the inner harbour at Port Hedland.

  In parallel with this project, BHPB is advancing studies on the outer harbour development at Port Hedland.
- Rio Tinto is planning to complete its US$1.55 billion port expansions at Dampier and Cape Lambert to increase shipping capacity to 220 million tonnes per annum. The Dampier port expansion has been completed and Cape Lambert was scheduled for completion in 2008.
- In support of the Yandicoogina and Dampier port expansions, Rio Tinto is investing a further US$113 million in additional rolling stock and associated infrastructure to support the increased levels of production.
- Rio Tinto will develop and construct the Mesa A (Waramboo) mine and related infrastructure. The mine is forecast to be completed by 2010 with progressive ramp-up to a projected 25 million tonnes per annum by 2011. Mesa A (Waramboo) is located 48 kilometres west of Pannawonica. Production from this new mine will replace current production from the Mesa J deposit now nearing the end of its mine life.

  Rio Tinto will also develop the Brockman 4 mine 62 kilometres west of the Mt Tom Price townsite. The first phase (which will take two years to construct and commission) will see an output from this new mine of 22 million tonnes per annum with a potential for further expansion. Production is planned to begin in early 2010.

  The combined investment in these two mines will be around $3 billion.

- Rio Tinto is investing in more sustainable power generation and transmission infrastructure near Karratha worth US$503 million to supply electricity to its port and mine operations. It will use natural gas turbines, resulting in a significant reduction in emission rates compared with the two, steam-power stations currently in operation at the Cape Lambert and Dampier ports, which will be decommissioned.
- In December 2007, the Hope Downs Joint Venture approved a $71-million feasibility study to expand the Hope Downs 4 project which is located 35 kilometres northwest of Newman and 45 kilometres east of the Hope Downs 1 mine.
- In July 2008, FMG awarded an $84-million contract for 44-kilometre rail earthworks, associated drainage, road deviation and road underpass works between the Cloud Break mine and the company's Christmas Creek prospect which is currently undergoing a feasibility study. Plans include construction of additional passing loops on the rail line, procurement of additional stackers, reclaimers and ship loaders, dredging additional berths and installing further train unloaders and conveyor systems to feed the port stockpile.

While the importance of the major iron ore producers such as BHPB and Rio Tinto/Robe River continues to grow in the marketplace, this recent period of strong demand and healthy prices has created a frenzy of new developers on a rapid development schedule to establish themselves. FMG's Cloud Break mine is the latest of these developments to come on-stream.

For the past 40 years, all iron ore mined in Western Australia has been hematite ore, however the State has massive resources of magnetite ore which has long been considered the poor cousin to hematite. The advantage of hematite ore is that it does not have to undergo costly concentration to make it saleable. Chinese steel producers have long used magnetite with well established technology and have been behind an unprecedented push to develop a string of magnetite projects in Western Australia.

The past few years have seen large Chinese (and more recently Russian) companies enter into joint ventures and invest in Western Australian projects in an effort to secure a foothold in the supply chain for raw materials and to capitalise on reducing input costs for their steel-making.

PILBARA PROJECT DEVELOPMENTS

In addition to the extensive expansions being carried out on existing mines in the Pilbara, there are a host of new projects either being developed or on the drawing board. Some of these are:

- CITIC Pacific Ltd (the largest specialist steelmaker in China) has acquired mining rights from Mineralogy to two billion tonnes of magnetite ore with rights and options to a further four billion tonnes.

  CITIC Pacific's Australian operation is developing the Sino Iron project on a fast-track basis with Major Project Facilitation status granted in December 2006. It is located about 100 kilometres southwest of Karratha and, when operational, plans to export 27.6 million tonnes per annum of a mixture of high grade iron ore concentrate and pellets for 25 years. Production is planned to commence in early 2009.

  Total investment in the project is estimated to be $5.2 billion and would include the construction of:

  - production and processing facilities
  - port and materials handling facilities
  - 25-kilometre slurry pipeline
  - accommodation infrastructure and an airport.

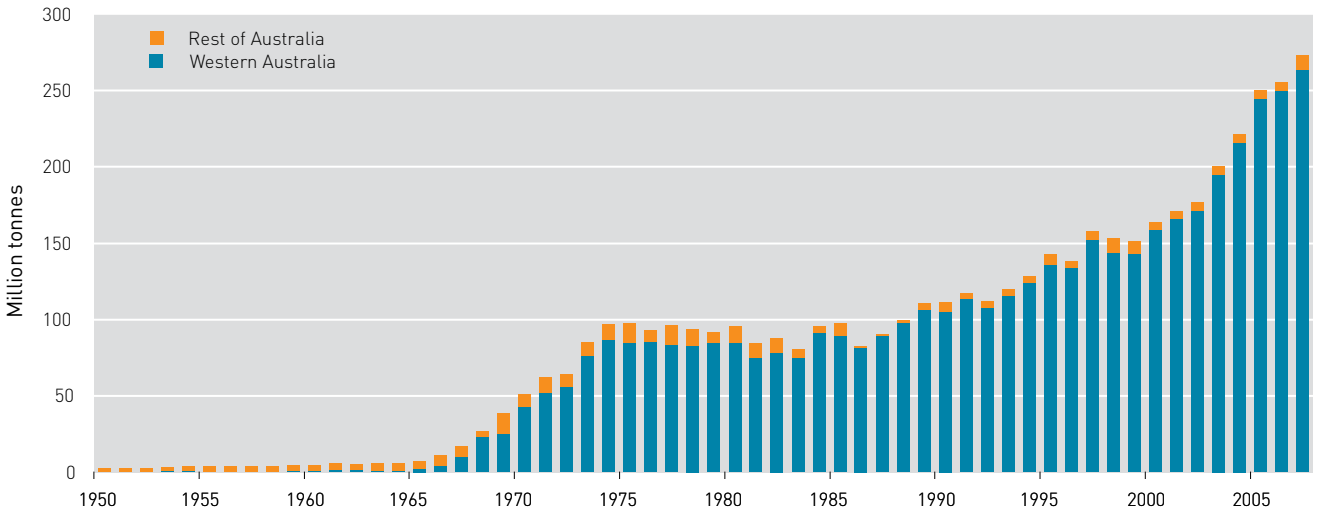


Figure 17 | **Iron Ore Quantity** Source: DoIR and ABARE

CITIC Pacific will build a 450-MW gas-fired power plant and accompanying transmission lines near its production plants as well as a desalination plant near its port development to supply water for the project.

- Atlas Iron Limited's Pardoo hematite project is targeted to commence production around December 2008. Pardoo lies 75 kilometres east of Port Hedland by road and will initially produce one million tonnes of direct shipping grade ore annually before ramping-up to three million tonnes per annum by 2010.

  In August 2008, Atlas signed a binding Heads of Agreement with FMG for access to FMG's Port Hedland port facility.

  Atlas Iron was also planning to move their 853 million tonne Ridley magnetite project into pre-feasibility this year. Capital costs could be in the vicinity of $1.5 billion plus a further $500 million project contingency.

Other potential iron ore projects in the Pilbara include:

- Australasian Resources Ltd's Balmoral South Iron Ore project.
- Aquila Resources Limited and AMCI Holdings Australia Pty Ltd 50:50 joint venture's West Pilbara Iron Ore Project.
- MCC Mining (Western Australia) Limited's Cape Lambert Magnetite Project.
- Aurox Resources Limited, with its Balla Balla magnetite iron ore project.
- Iron Ore Holdings Ltd's Phil's Creek deposit.
- Brockman Resources Limited's Marillana iron ore project.
- BC Iron's Nullagine iron ore project.

MID WEST DEVELOPMENTS

Oakajee is the Western Australian Government's preferred site for a new privately funded deep-water port to accommodate existing and potential iron ore operations in the Mid West region of the State.

In July 2007, the government announced Oakajee Port and Rail (OPR) had been selected as the preferred proponent to develop the $1.5-billion Oakajee Port. OPR is a 50:50 joint venture between Murchison Metals and Japan's Mitsubishi Development. The port and rail infrastructure is expected to cost in the vicinity of $3 billion and project feasibility is expected to be completed by the middle of 2009 with the port becoming operational as early as 2012.

OPR will develop common-use infrastructure, including the breakwater, channel and turning basins, which will be transferred to the ownership of the Geraldton Port Authority upon completion. Third party access to private use infrastructure, such as berths and loading equipment will be available on a commercial basis.

Listed below are some mining projects which were under development or consideration in the Mid West area:

- Mount Gibson Iron Limited's (MGI) $88.1-million Extension Hill hematite project, located 260 kilometres southeast of Geraldton, has completed a detailed feasibility study for a three million tonnes per annum hematite mining operation. Mining had been scheduled to commence in late 2008 or early 2009 with ore being transported via road to a rail siding near the town of Perenjori and then railed to the Port of Geraldton for export.
- Gindalbie Metals Ltd's Mungada hematite project and Karara magnetite project (located 45 kilometres east of Koolanooka) in a 50:50 joint venture with Anshan Iron and Steel Group Corporation (AnSteel), one of the largest iron ore miners and steel producers in China.
- Crosslands Resources Ltd proposes to develop the Jack Hills project in two stages. Stage 1 is already in production and Stage 2 will involve increasing annual production of up to 25 million tonnes per annum.
- Midwest Corporation Limited and Sinosteel joint venture's Weld Range hematite project.
- Asia Iron Holdings Limited's Extension Hill magnetite project.
- Ferrowest Limited's Yalgoo Iron Project.
- Golden West Resources Limited's Wiluna West project.

WHEATBELT DEVELOPMENTS

Polaris Metals NL is considering developing Stage 1 in 2010 of their Yilgarn Iron Ore Project (YIOP) located 60 kilometres north of Koolyanobbing in the Wheatbelt region of Western Australia. A recently completed pre-feasibility study confirmed the viability of the project and as a base case, assumed export of iron ore through Fremantle Port's Kwinana bulk handling facilities. In early August 2008, Polaris signed a memorandum or understanding with the Port of Fremantle focused on finalising the best option for exporting ore from the YIOP.

In an associated development, Polaris has agreed to take an option of eight hectares of Landcorp ground adjacent to the proposed new Berth-5 at the Kwinana Bulk Jetty to secure sufficient stockpile and storage space to suit the proposed iron ore export requirements.

GREAT SOUTHERN DEVELOPMENTS

In May 2007, Grange Resources Limited entered into a joint venture agreement with the Japanese trading house Sojitz Corporation, for a 30 per cent stake in Grange's Southdown magnetite project, located 80 kilometres northeast of Albany. Sojitz will bring its expertise in pelletising to the venture which is expected to produce up to 6.8 million tonnes of pellets per annum over 22 years. The project is significantly advanced with key infrastructure in place and its proximity to rapidly growing markets in South-East Asia and the Middle East provides for significant freight advantages over the current supply from Brazil. The capital costs for the project are expected to be in the range of US$1.175 billion, are subject to government approvals, and production of iron ore pellets is expected to commence in 2010.

INNOVATION

The success of the State's iron ore industry rests critically on reliability, competitiveness and quality control in a demanding trading environment. Since its inception in the sixties, the industry has continued to improve its competitiveness in mining practices, technological innovation and management processes.

In the early 1980's, Rio Tinto commenced developing its HIsmelt technology, a direct iron-making process in which iron ore fines and non-coking coals are injected directly into a molten iron bath to produce a quality molten pig iron. In 2002, Rio Tinto formed an unincorporated joint venture for the purpose of constructing and operating an 800 000 tonnes per annum HIsmelt plant. Parties to the joint venture are:

- HImet Corporation Pty Limited, a wholly owned subsidiary of Rio Tinto Limited – 60%
- Nucor Australia, LLC, a wholly owned subsidiary of Nucor Corporation – 25%
- MC Iron and Steel Pty Ltd, a wholly owned subsidiary of Mitsubishi Corporation – 10%
- China Shougang International Trade and Engineering Corporation, a wholly owned subsidiary of Shougang Corporation – 5%.

Construction of the first commercial facility, at a cost of over $400 million, commenced in 2003 with hot commissioning beginning in the second quarter of 2005. Focus continues to be on improving equipment reliability and production rates. Full ramp-up of its name-plate hot metal production rate of 105 tonnes per annum with a coal consumption rate of 700 kilograms per tonne of hot metal was scheduled for the last quarter of 2008.

Production of pig iron to date has been:

2005	9000 tonnes
2006	89 000 tonnes
2007	114 870 tonnes
2008	82 218 tonnes (up to 30 June)

The HIsmelt technology, a potential replacement for the blast furnace and as a new source of low-cost feedstock for the electric arc steelmaking industry, is poised for worldwide licensing, offering low operating costs, low capital intensity, lower environmental impact, with greater raw material and operational flexibility. At the time of writing there are two licensees, who have signed a HIsmelt Process Licence, the Laiwu Steel Group Ltd and the Nanjing Iron and Steel Group Jiangsu Huaigang Corporation Limited, both of China.

In January 2008, Rio Tinto unveiled their vision for their "mine of the future" with integrated and automated mining and transport for their Pilbara iron ore operations. Major components include:

- Mine operations in the Pilbara to be controlled 1300 kilometres away at a new centre in Perth;
- Driverless trains to carry iron ore on most of the 1300 kilometres of track;
- Driverless 'intelligent' truck fleet; and
- Remote control 'intelligent' drills.

Commissioning of these major components commenced in 2008, however the defining work began over a decade ago. The Remote Operations Centre is expected to be completed in 2009, house 320 employees and will be built near Perth Airport.

In July 2007, Rio Tinto in partnership with the University of Sydney's Australian Centre of Field Robotics undertook a $21-million partnership to develop and implement a fully autonomous, remotely operated mine. In January 2008, in partnership with Western Australia's Curtin University, Rio Tinto has established a Centre for Materials and Sensing in Mining with a funding package of $10.5 million over five years. These advancements place Western Australia in the forefront of future technologies for mining.

IRON ORE PRICE, SUPPLY AND DEMAND

The world's big three iron ore producers' (Companhia Vale do Rio Doce [now known as Vale], Rio Tinto and BHP Billiton) case for a price increase for the contract year commencing 1 April 2008 was again based upon ongoing high demand and constrained supply. Vale concluded negotiations early in the year in February 2008 with a rise of 65 to 71 per cent. However Australian producers stood firm asking for a higher increase to take into account the freight differential between iron ore from the Pilbara (which is closer to Asian markets) and from Brazil. It was not until late June 2008 that Rio Tinto reached agreement with China's Boasteel (which negotiates on behalf of the Chinese mills) on the price for their Hamersley iron ore deliveries for the contract year that commenced 1 April 2008. The increase is, on average, 85 per cent higher than for the previous contract period and took effect on shipments from 1 April 2008.

This comes as the sixth consecutive rise in iron ore prices. In September 2008, Chinese industry officials reported receiving letters from Vale requesting a mid-cycle increase of between 13 and 20 per cent from 1 September 2008 (on top of the February 2008 increase).

However, with the recent global economic uncertainty, analysts are now forecasting iron ore prices to remain flat through 2009 and 2010.

Globally, nearly 130 million tonnes of new iron ore mining capacity was brought into operation in 2007. The United Nations Conference on Trade and Development (Unctad) reported that the focus for new developments is changing from Australia to Brazil and West Africa. With freight rates having retreated from recent highs, this reduces the competitive advantage that Western Australian iron ore producers have over new producers elsewhere.

Since major producers have succeeded in introducing modifications to the benchmark system for negotiating iron ore prices, it appears likely that trade in iron ore will become more diverse and will involve a more varied range of pricing methods.

The State's iron ore industry's long-term outlook is positive, with some short-term market adjustments likely. It is an industry diversifying into new automated technology, new mines and a changing product mix with the major iron ore companies continuing to improve product quality and infrastructure.

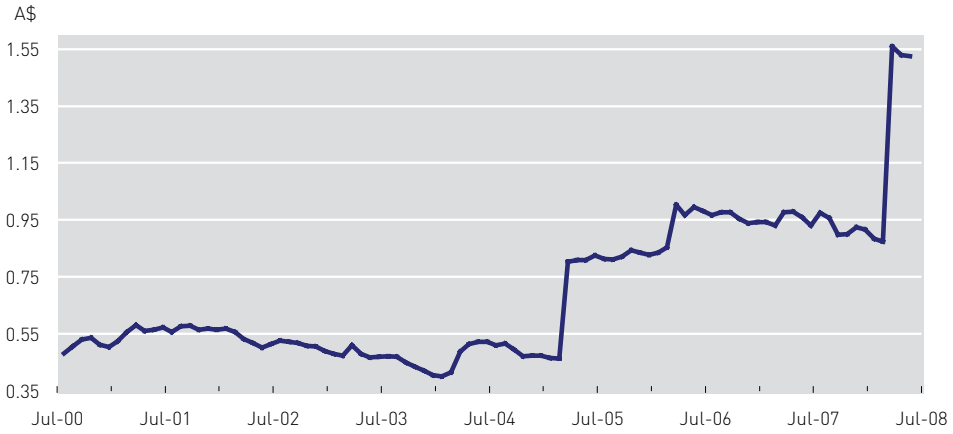


Figure 18 | **Iron Ore Price A$/Fe unit**

Source: Tex Report, High Grade Fine Ore Prices

Note: Price is per 1%. An 'Fe unit' is equivalent to each 1% of iron ore. Hence, ore shipped at 63% Fe commands a price of 63 x 'Fe unit price'.

2.3 PETROLEUM

OIL AND CONDENSATE

Western Australia is the nation's premier petroleum producer, accounting for 70 per cent of natural gas, crude oil and condensate production. The Western Australian petroleum industry is the State's second most valuable resource sector after iron ore.

International oil prices during 2007–08 escalated to record highs which not only bolstered the value of production, but has also provided an incentive for further investment in the industry. For example, the average value of crude oil (based on a combination of West Texas Intermediate, Brent and Tapis) in 2007–08 was US$98.08 per barrel, an increase of 50 per cent over the previous year. Prices escalated progressively during 2007–08 from an average in July 2007 of US$87.79 per barrel to US$142.30 per barrel in June 2008. However, detracting from returns to local producers was a 14 per cent appreciation of the Australian dollar against its US counterpart during 2007–08.

Crude oil prices in the short-term are likely to remain sensitive to geopolitical tensions and uncertainty of demand due to global financial instability and unexpected changes in world economic growth. Added to this is the influence that the Organisation of Petroleum Exporting Countries (OPEC) has on world oil prices.

OPEC cut production in September 2008 (which could take about 520 thousand barrels a day off the market) with a hope to return to 2007 output targets in an effort to stabilise the oil price at around US$100 per barrel. This action was prompted when oil prices fell from US$148 per barrel on 11 July 2008 to US$100 per barrel on 9 September 2008.

Non-OPEC countries contain less than one-fourth of the world's proven oil reserves but produce nearly 60 per cent of the world's oil. They also possess most of the world's capacity for refining crude oil into petroleum products such as gasoline and heating oil. Because non-OPEC countries have smaller reserves which are being depleted more rapidly than in OPEC countries, their overall reserves-to-production ratio – an indicator of how long proven reserves would last at current production rates – is much lower (about 14 years for non-OPEC and 73 years for OPEC). In the future, non-OPEC production is expected to increase less rapidly compared to OPEC and, as a result, shrink to less than 50 per cent of total world oil production by 2015.

Most OPEC oil is produced for export and many non-OPEC countries, such as the United States, produce oil primarily to meet their domestic demand for petroleum.

The strong price of oil combined with production increases in condensate and natural gas resulted in the total value of Western Australian petroleum production increasing by more than 11 per cent in 2007–08 to an all-time high of $19.4 billion. This impressive outcome has been achieved against a difficult background of not only declining liquids production from mature fields, but also adverse weather conditions in the early stages of 2008 and the aforementioned strengthening in the Australian currency. In addition, Mutineer–Exeter was shut in for electrical repairs in the first quarter of 2008 and Enfield experienced some technical problems early in 2008 reducing production.

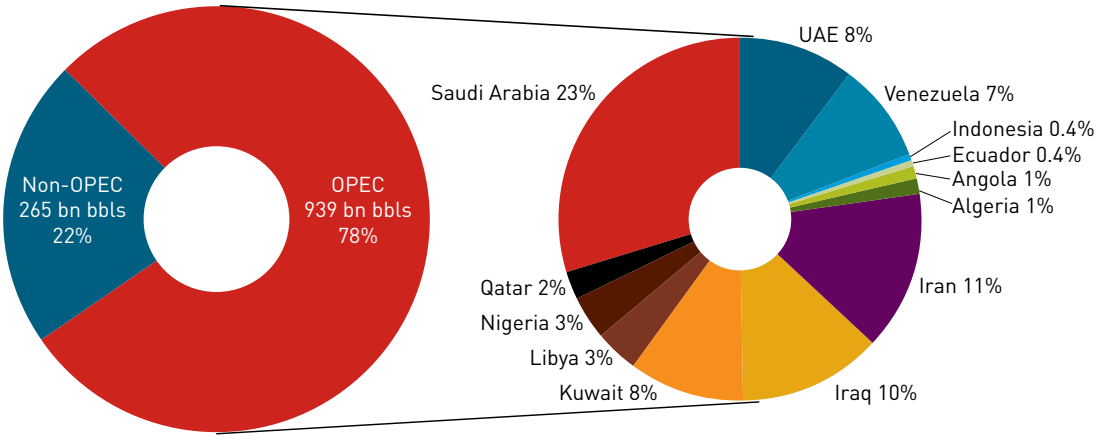


Figure 19 | **OPEC Share of World Crude Oil Reserves (2007)**
Source: BP World Energy Statistics 2008

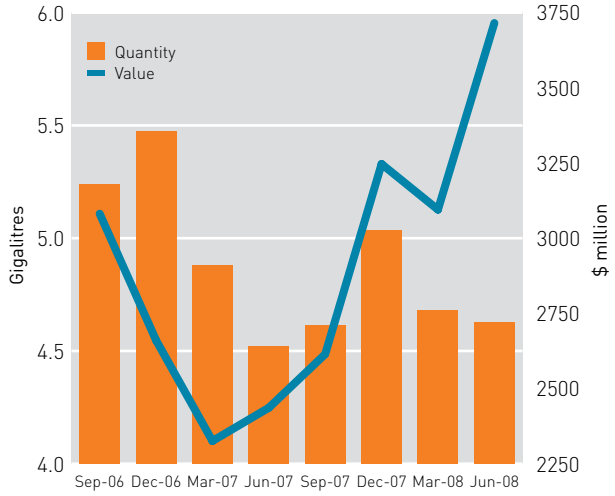


Figure 20 | **Crude Oil and Condensate Quantity and Value by Quarter**
Source: DoIR

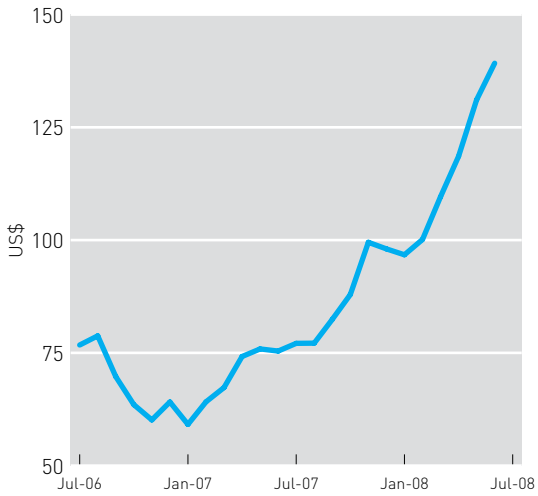


Figure 21 | **Tapis Crude Oil Price US$/bbl**
Source: WA Treasury Corporation

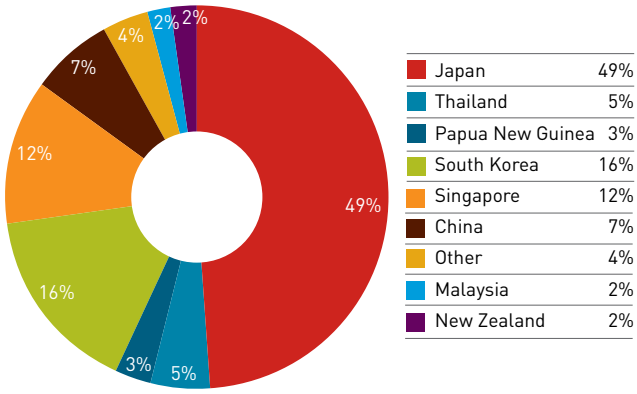


Figure 22 | **Petroleum Exports**
Total Value $10.7 billion Source: DoIR and ABS

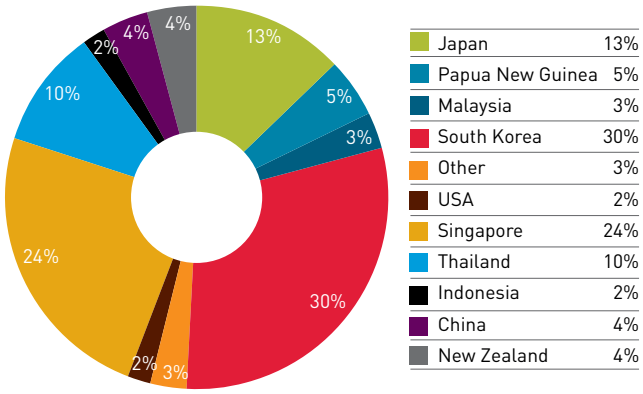


Figure 23 | **Crude Oil and Condensate Exports**
Total Value $5.46 billion Source: DoIR and ABS

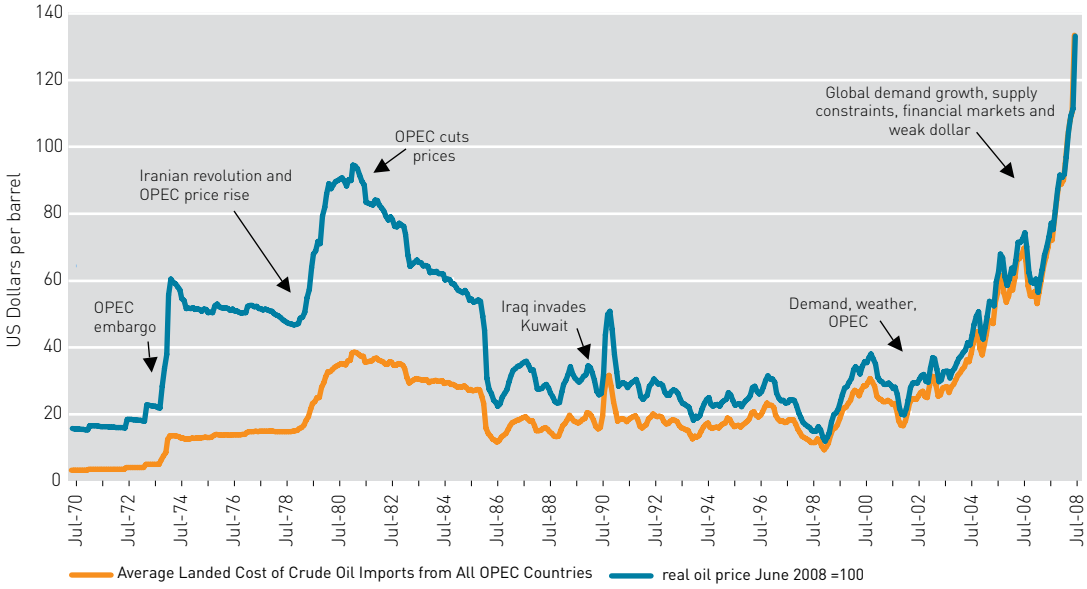


Figure 24 | **Historic Oil Prices** Source: Energy Information Administration, US Department of Energy; DoIR

Although the State's crude oil production in 2007–08 fell almost nine per cent to 80 million barrels (12.8 million kilolitres), strong international oil prices increased the value by almost 18 per cent to $8.7 billion, making crude oil the second most valuable single commodity in Western Australia after iron ore. Against a Western Australian landscape of general decline in output from mature oil fields, output was boosted with an increase from BHP Billiton's (BHPB) new Stybarrow project which produced 14.5 million barrels in 2007–08.

Crude oil output in the near future should receive a boost with the Vincent–Van Gogh project development due to start-up in the second half of 2008. The Vincent field contains two permits, one held by Woodside and the other by Apache Northwest Pty Ltd (operator) and Inpex Alpha Ltd. Woodside is developing the Vincent project and Apache is developing the Van Gogh project. Later, production should also come from BHPB's Pyrenees oil development in the Exmouth Sub-basin. This development is to comprise a floating production, storage and offloading (FPSO) vessel capable of producing about 96 000 barrels of oil per day that will be tied into 13 subsea wells in the Ravensworth, Crosby and Stickle fields in WA-12-R. Production is expected to start in the first half of 2010.

Associated with higher volume of gas sales, the amount of condensate sold during 2007–08 likewise climbed, to 38.9 million barrels (6.2 million kilolitres), representing a six per cent increase compared to the previous financial year. In sales value terms this was worth just under $4.0 billion, representing a 34 per cent increase on the previous financial year. The volume of LPG butane and propane sold fell by nine per cent to 818 390 tonnes. However, value jumped by 13 per cent to reach $683 million.

NATURAL GAS

As expected, strong demand for natural gas in Western Australia saw the volume of domestic sales increase by five per cent during 2007–08 to a total sales volume of 9.2 billion cubic metres. This equates to 348 million gigajoules or 954 terajoules per day. The summed value of this gas amounted to just over $1 billion which represented a 12 per cent increase on 2006–07. This value is based on the summation of total domestic gas sales values at the point of entry into the Dampier to Bunbury natural gas pipeline (DBNGP), or where applicable, the Parmelia pipeline. The graph included showing the price of domestic gas in Western Australia is calculated on this value and the aforementioned total volume of sales. In the current energy climate, as expected, the average price of gas sold in Western Australia continues to climb, with an average price of $2.94 per gigajoule recorded for 2007–08.

Auguring well for a potential increase to the State's gas supply as well as added exports have been new discoveries and developments. The North West Shelf joint venture's $1.6 billion Angel gas and condensate project is poised to commence production in the fourth quarter of 2008 and is the third major offshore production platform off the North West Shelf. The remotely operated Angel processing platform will be in 80 metres of water about 49 kilometres east of Woodside's existing North Rankin production facility and will be tied to the North Rankin platform via a new subsea pipeline. Hydrocarbons will be produced through one processing unit with a capacity of up to 800 million standard cubic feet a day and up to 50 000 barrels of condensate a day.

Partners in the Reindeer field, Apache (operator) and Santos announced the go-ahead in April 2008 for the development of the Devil Creek project comprising:

- An offshore gas production platform;
- A 105-kilometre offshore gas supply pipeline connected to;
- An onshore processing plant at Devil Creek; and
- A sales gas pipeline tied into the DBNGP.

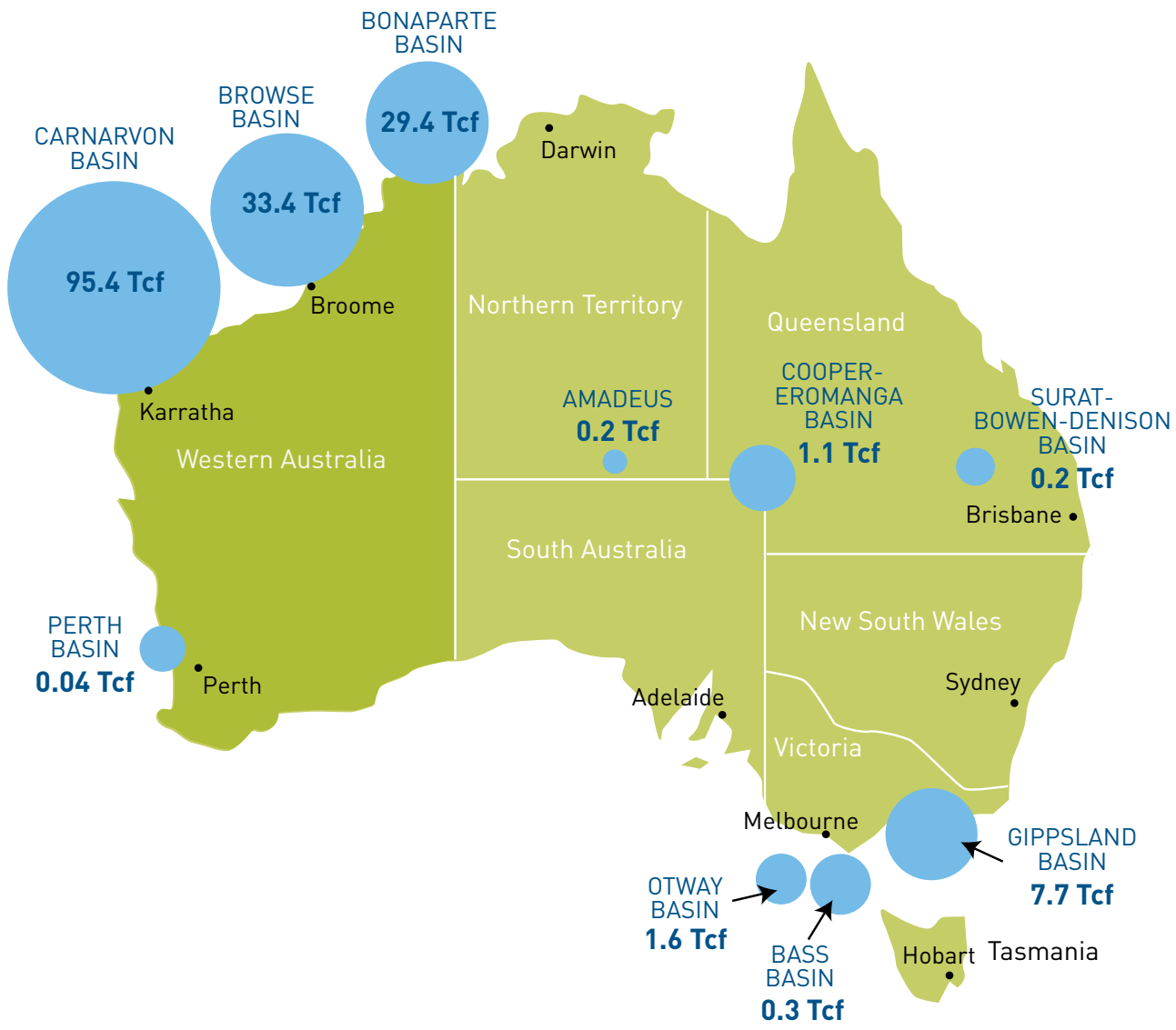
Reindeer is located in permit WA-209-P offshore in the Carnarvon Basin. The proposed production capacity is approximately 110 terajoules per day of sales gas. Project construction could commence in late 2008 with production by 2011.

A little further into the future is the North Rankin 2 project which will recover remaining low pressure gas from the North Rankin and Perseus gas fields. The project will include the installation of a second platform (North Rankin B) which will be connected by a 100-metre bridge to the existing North Rankin A platform. The project will also include necessary tie-ins and refurbishment of North Rankin A and upon completion both platforms will be operated as a single integrated facility.

LNG

All LNG from Western Australia emanates from the NWS joint venture project in Karratha which comprises five LNG production unit trains. Commissioned in September 2008, the 4.4 million tonnes per annum fifth train is Australia's largest single LNG production unit and boosts the NWS's total annual capacity to 16.3 million tonnes. It is also one of the largest LNG trains in the world.

LNG output remained almost static, down just half a per cent, however the influence of high oil prices saw the sales value increase by 13 per cent for a value of $5.1 billion. This resulted in LNG holding the position of fourth most valuable individual commodity in the State.



Australian Natural Gas Resources

Source: DoIR. Current as at end 2007.

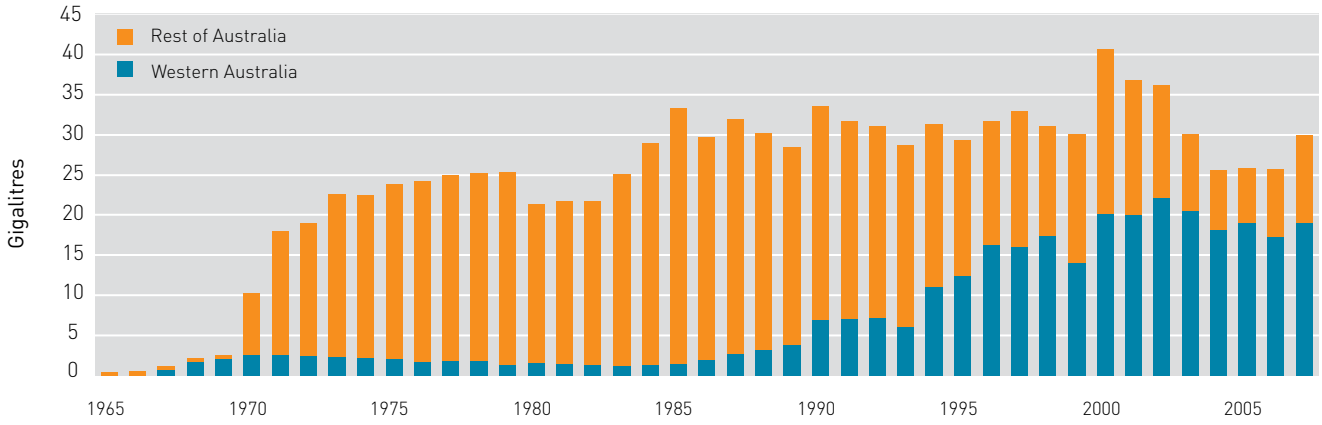


Figure 25 | **Crude Oil and Condensate Quantity** Source: DoIR and ABARE

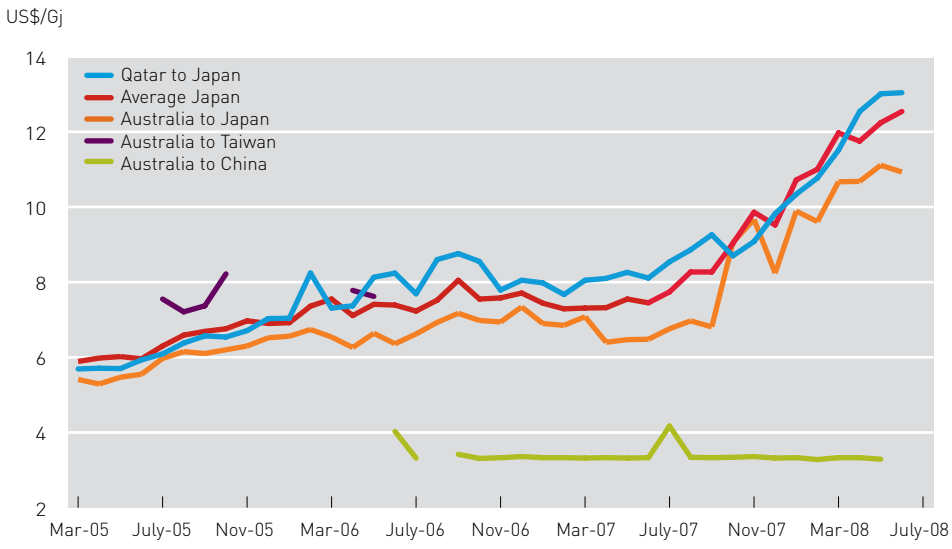


Figure 26 | **LNG Import Prices** Source: Argus Monthly LNG (Prices include freight and regassing)

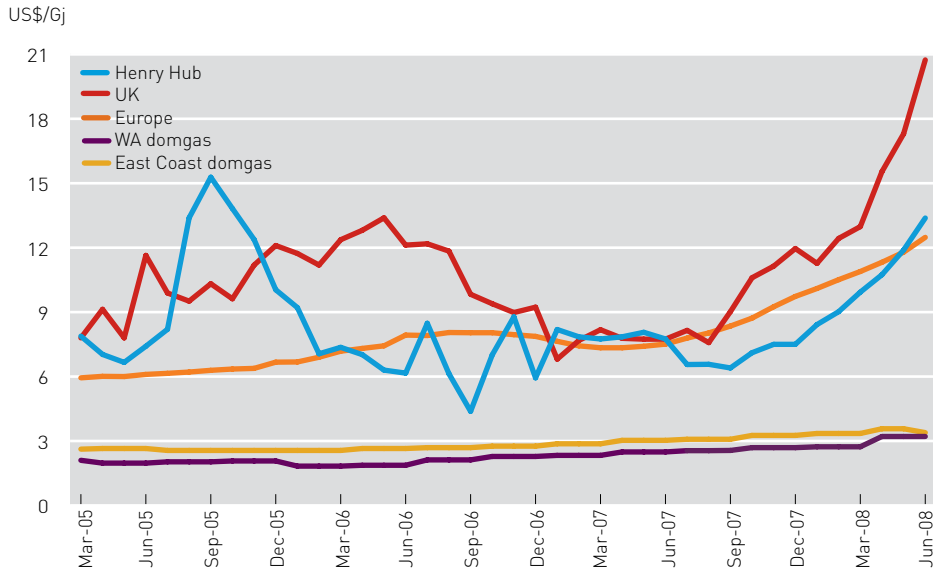


Figure 27 | **Average Natural Gas Prices** Source: Argus Monthly LNG, EnergyQuest, DoIR

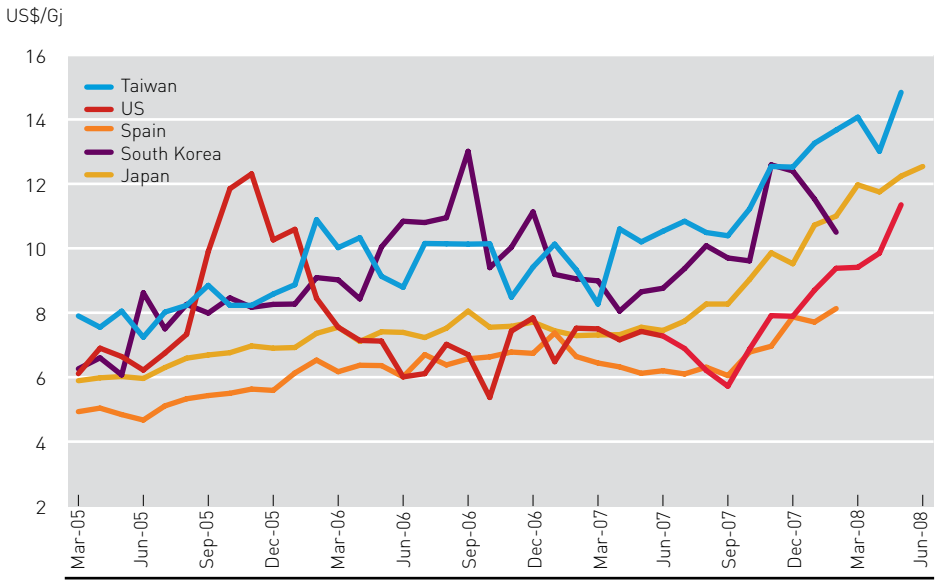


Figure 28 | **Average LNG Import Prices** Source: Argus Monthly LNG

The LNG quantity published in this Digest is sourced from Woodside's quarterly Australian Stock Exchange reports. A value is obtained by multiplying this quarterly figure by an LNG price. This price is an average published import price for a given quarter, converted at the average exchange rate for that quarter. The import price includes transport and re-gasification.

Western Australia is no longer the nation's sole LNG producer with ConocoPhillips and its partners commissioning the 3.5 million tonnes per annum Darwin LNG plant in 2006.

Whilst Darwin LNG has become Australia's second LNG hub, after the NWS, it is not the last. In July 2007, the Woodside Board approved additional funding of up to $11.2 billion and development of the Pluto LNG Project, subject to receipt of final environmental and other regulatory approvals. Preliminary site works for the onshore facilities for the Pluto LNG project began in January 2007. The project is based on Woodside's Pluto and Xena gas fields located about 190 kilometres northwest of Karratha in permit WA-350-P. It is estimated that these two fields contain a total recoverable reserve volume of 5.1 trillion cubic feet of gas.

The initial phase is to include a single LNG train, forecast to produce 4.3 million tonnes per annum. It will be connected by a 180-kilometre, 36-inch offshore pipeline to a platform in 85 metres of water. The platform will be connected to five subsea wells in the Pluto field, with first gas to be produced in late 2010. The LNG facility itself is to be based on the Burrup and later, with expansions, produce five to seven million tonnes per annum of LNG. Included in the project plan is funding towards additional infrastructure to facilitate future expansion for other Woodside or third party gas, allowing the onshore plant to operate as an open-access facility with additional LNG trains.

The project is to be underpinned by an integrated package of LNG Sale and Purchase Agreements, project equity and shipping arrangements with Tokyo Gas and Kansai Electric of Japan. This includes a 15-year sales agreement with Tokyo Gas and Kansai Electric totalling up to 3.75 million tonnes per annum of LNG.

Tokyo Gas and Kansai Electric will also each construct and operate an LNG ship to transport a combined 2.6 million tonnes per annum of LNG to Japan. An additional ship is to be constructed at Samsung Heavy Industries in South Korea by AP Moller Maersk and leased to Woodside on a long-term basis to transport LNG to Japan.

In addition, a joint venture has been formed with Tokyo Gas and Kansai Electric, with each of them taking a five per cent equity in the Pluto permit (WA-350-P) and the Pluto Train 1 infrastructure, reducing Woodside's ownership to 90 per cent. Tokyo Gas and Kansai Electric also have options to participate in two additional Pluto trains and three Woodside exploration permits (WA-347-P, WA-348-P and WA-353-P).

Woodside is also appraising its extensive gas reserves in the Browse Basin, which includes the Torosa (formerly known as Scott Reef), Brecknock and Calliance (formerly known as Brecknock South) discoveries. Combined, these could hold an estimated resource exceeding 18 trillion cubic feet of gas and 300 million barrels of condensate.

Options for an LNG development to process gas from these fields cover both offshore and onshore concepts.

Chevron is also considering an LNG and domestic gas development based on Barrow Island, sourcing gas from its Gorgon and Jansz fields and a project based on the Wheatstone field. Another potential LNG project is BHPB's Exxon Mobil's Pilbara LNG project based on the Scarborough field.

There have also been major advances in liquefaction technology, making small-scale LNG an increasingly viable proposition. In Kwinana, south of Perth, Wesfarmers' $138 million, 175 tonnes per day domestic LNG project will be producing fuel for heavy trucks and regional power generation.

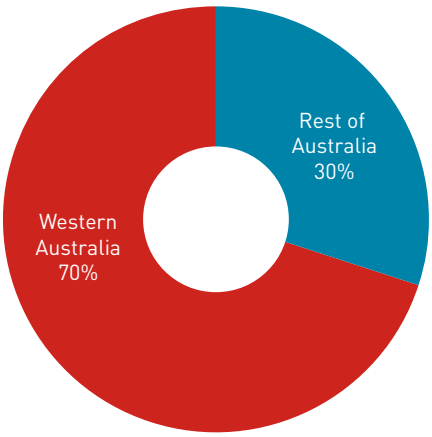


Figure 29 | **Natural Gas, Crude Oil and Condensate Production 2007–08**
Source: ABARE

2.4 NICKEL

The State's nickel producers spent the 2007–08 year watching record nickel prices sliding down to June 2006 levels and at the same time experiencing the double effect of a strengthening Australian dollar.

In November 2005, nickel prices rose from an average US$12 115 per tonne (US$5.50 per pound) to record levels in May 2007 of US$54 200 per tonne (US$24.58 per pound). Since May 2007 prices have been on the decline to end the 2007–08 year at an average of US$28 518 per tonne (US$12.94 per pound). This represented a 25 per cent drop in US dollar terms from 2006–07 and a 34 per cent drop in Australian dollar terms.

In October 2008 prices reached their lowest levels since 2004 and have dropped to US$11 000 per tonne.

Sales revenue for the 2007–08 period fell accordingly to $5.3 billion with quantities sold only marginally down by 1.5 per cent to 171 thousand tonnes placing nickel third in order of value behind iron ore and petroleum.

With around 60 per cent of nickel going into stainless steel production, the demand for this commodity is highly leveraged to the rapidly growing industrialising nations in Asia. The recent boom in stainless steel production created a shortage of nickel, thereby pushing prices to record highs. In response, China developed a different technology for processing low grade nickel ores to produce nickel pig iron. However, the higher production costs of nickel pig iron mean that it is not a sustainable source of long-term supply, but it does act as a floor on the nickel price near US$10 per pound.

Nickel pig iron is a low purity ferronickel with 1.5 to 8 per cent nickel grade being produced from blast furnaces and 10 to 25 per cent nickel grade from electric furnaces (much lower than conventional ferronickel, which averages 25 to 40 per cent nickel content) with iron accounting for the balance. Other impurities include silica, phosphorus, sulphur, chromium and carbon, etc.

In 2005, the Chinese Government mandated that blast furnaces producing pig iron with a capacity of less than 200 cubic metres must close permanently. However, only ferro-alloy furnaces with less than 100 cubic metres needed to close. 100-200-cubic metre blast furnaces have switched to nickel pig iron (a "ferro-alloy") to survive and it is estimated there are over 100 currently producing this product.

Nickel pig iron is now widely produced in China and imported into China from the Philippines, Indonesia and New Caledonia. China has also been exporting nickel pig iron to Japan and India.

With the price of nickel plummeting and because of the high cost of nickel pig iron, the economics of nickel pig iron supply is becoming less attractive. Some analysts are forecasting that nickel pig iron is here to stay but perhaps not at the same levels as the past twelve to eighteen months.

Western Australian nickel exports in 2007–08 saw China taking 33 per cent, Finland 19 per cent, the Netherlands 13 per cent, Japan 8 per cent, the USA 6 per cent, Belgium 4 per cent and the balance being taken by South Korea, the United Kingdom, Italy, Canada and others.

CURRENT PRODUCERS

The Western Australian nickel industry remains heavily concentrated with the top five producers accounting for around 80 per cent of all nickel sales. The largest of these is BHP Billiton's Nickel West with concentrators at Mount Keith, Leinster and Kambalda, the Kalgoorlie smelter and the Kwinana refinery. Nickel West is the world's third-largest producer of nickel in concentrate.

With the acquisition of LionOre Mining International Ltd and OM Group's Nickel Business early in 2007, Norilsk Nickel is now the second-largest nickel producer in Western Australia. Norilsk now operate:

- Black Swan–Silver Swan underground and open pit mines located 53 kilometres northeast of Kalgoorlie;
- Lake Johnston operations (incorporating the Emily Ann and Maggie Hays underground mines) located 125 kilometres southeast of Marvel Loch;
- The Waterloo underground nickel mine, located 35 kilometres south of Leinster. Waterloo exploits an ore body between 100 to 400 metres below the surface with ore being toll treated at BHPB Leinster concentrator under a treatment and purchase agreement;
- Cawse open pit mine and ore leaching facility, located 50 kilometres northwest of Kalgoorlie.

The Murrin Murrin Joint Venture (Minarra Resources Ltd 60 per cent and Glenmurrin Pty Limited 40 per cent) is the third-largest producer with its laterite project located between Leonora and Laverton. Based on current estimates, Murrin Murrin operations have a mine life of at least 30 years. The current slump in nickel prices and soaring prices of sulphur prices have resulted in Minarra looking closely at cost-saving measures, including putting their $300 million heap leach project on hold.

Figure 30 | **Nickel Price A$/tonne**
Source: LME Cash, Monthly Average

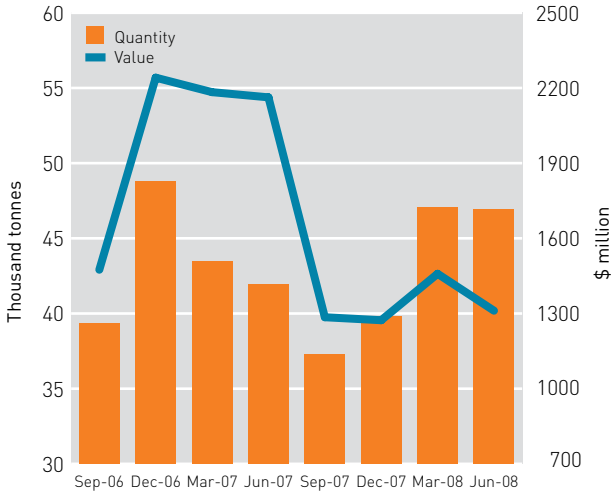


Figure 31 | **Nickel Quantity and Value by Quarter** Source: DoIR

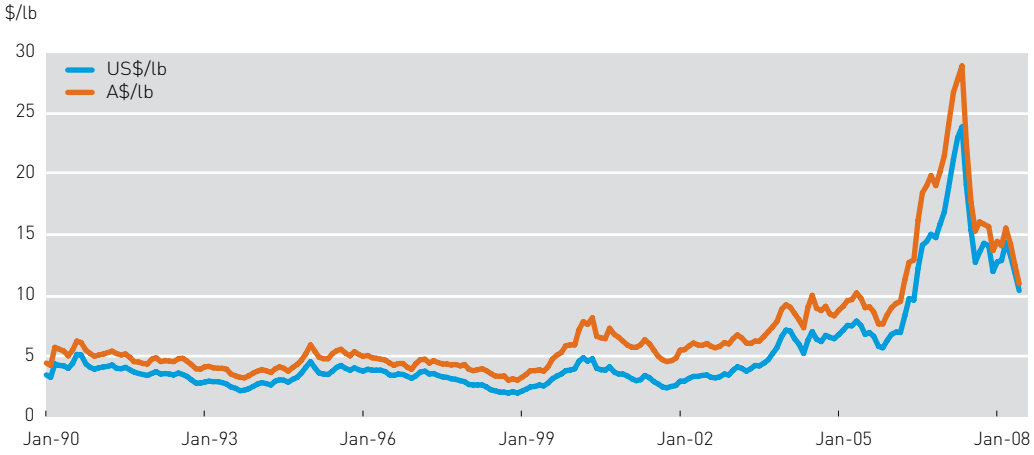


Figure 32 | **Historic Nickel Prices** Source: LME

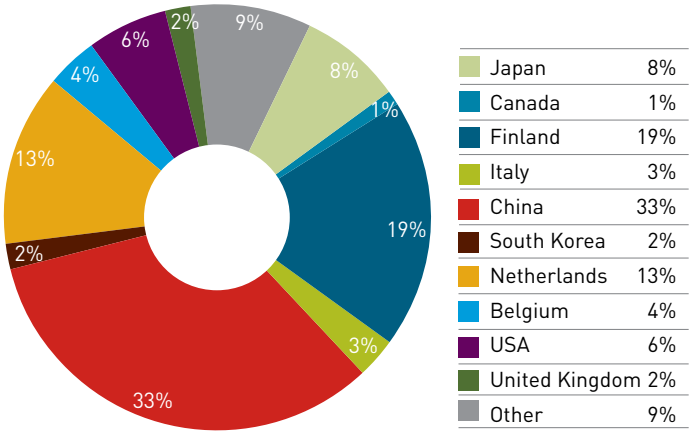


Figure 33 | **Nickel Exports**
Total Value $5.07 billion Source: DoIR

BHPB's US$2.2-billion Ravensthorpe nickel laterite project commenced shipments in the December quarter 2007 to its Yabulu refinery near Townsville in Queensland. The Ravensthorpe operation is located approximately 155 kilometres from the Port of Esperance. It is envisaged the project will produce around 145 000 tonnes per annum of nickel–cobalt hydroxide and have an expected mine-life of around 25 years. The Ravensthorpe operation may rival Murrin Murrin as Western Australia's largest lateritic nickel mine.

Other sulphide producers in 2007–08 include Panoramic Resources Ltd (name changed from Sally Malay Mining Limited in June 2008) with its Savannah project located 120 kilometres north of Halls Creek in the Kimberley and its Lanfranchi mine located 42 kilometres south of Kambalda.

As operator of the Copernicus Nickel Project (Panoramic Resources Ltd 60%, Thundelarra Exploration Ltd 40%) Panoramic has commenced operations with a view to mining ore in the last half of 2008. Copernicus is located around 70 kilometres north-northeast of Halls Creek and will have its ore processed at the nearby Savannah concentrator.

Mincor Resources' Miitel (which includes Mariners, Redross and Wannaway) nickel operation and is located 13 kilometres southeast of Widgiemooltha. The remnant mining operations at the Wannaway mine came to a close in early August 2008 and have been placed on care and maintenance.

Mincor also operates the recently recommissioned Carnilya Hill project (70 per cent Mincor and 30 per cent View Resources Limited Administrators Appointed) located 25 kilometres northeast of Kambalda. Like its Miitel project, Carnilya Hill ore is toll treated and sold to BHPB under long-term off-take agreements. In July 2008 Mincor announced that production had commenced at its newest operation, the McMahon nickel mine situated just two kilometres out of Kambalda.

Xstrata Nickel Australasia (previously Jubilee Mines) with their Cosmos multi-mine operations located 450 kilometres north of Kalgoorlie. Sinclair, approximately 100 kilometres south of the Cosmos operation, commenced construction in late 2007 and first production is expected in the last half of 2008. Sinclair is projected to produce 5500 to 6000 tonnes per annum.

Western Areas NL Forrestania project with its Flying Fox mine located 400 kilometres east of Perth is the first of a planned five mines at the Forrestania project by 2011. Flying Fox is one of the highest grade nickel mines in the world. Ore is currently being toll treated at Norilsk's Lake Johnston concentrate plant (located about 90 kilometres to the east), however construction of a nickel concentrate plant on their Cosmic Boy deposit in the centre of the Forrestania project commenced in April 2008.

Consolidated Minerals' (now owned by Palmary Enterprises Ltd) Widgiemooltha North Nickel Project commenced mining in the September quarter 2007 and represents the first phase of a proposed staged mine development strategy with the overall objective of establishing at least two mines over the next eighteen months. The Widgiemooltha North mine is just 14 kilometres north-northwest of the town of Widgiemooltha. The other mine operated by Consolidated Minerals is their Beta Hunt, East Alpha deposit.

Independence Group NL's Long nickel mine and Australian Mines Limited's Blair nickel mine are both located close to Kalgoorlie whilst Fox Resources Limited's Radio Hill nickel–copper operation is further to the north, 27 kilometres south of Karratha.

A range of nickel sulphide producers also have toll treatment and concentrate purchase agreements in place with Nickel West, trucking ore to be concentrated at their Kambalda concentrator. These operations include:

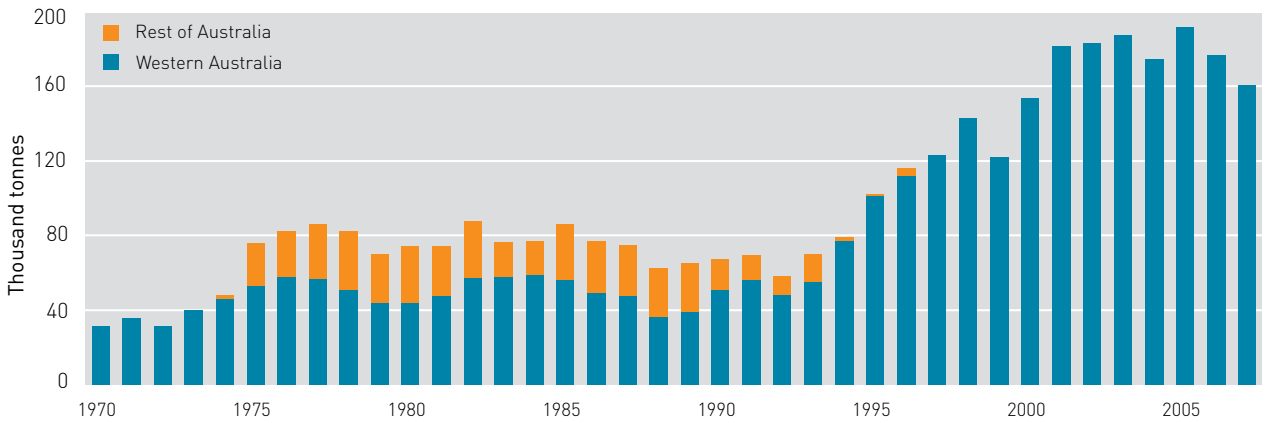


Figure 34 | **Nickel Quantity** Source: DoIR and ABARE

- Australian Mines Limited's Blair nickel operation;
- Independence Group NL's Long mine;
- Consolidated Minerals Limited's Beta Hunt, East Alpha deposit and Widgiemooltha North;
- Mincor Resources' Miitel–Wannaway and Carnilya Hill projects; and
- Panoramic Resources Ltd's Lanfranchi Tramways operation.

OTHER PROJECTS UNDER CONSIDERATION

- After receiving all the necessary approvals, in the March quarter of 2008, Poseidon Nickel Limited commenced trial rehabilitation of the historic Windarra nickel mine located 17 kilometres north-northwest of Laverton. Dewatering has commenced which will allow access to the nickel ore bodies and enable underground mine rehabilitation to be completed and further underground drilling to be carried out. Poseidon aim to complete a pre-feasibility study and options by the end of 2008. The Windarra nickel mine originally operated from 1971 to 1990.
- Another historic nickel mine receiving attention is Focus Minerals Ltd's Nepean nickel mine located 25 kilometres south of Coolgardie. Trial mining has commenced as part of an ongoing feasibility study into the re-commissioning of the mine. Focus is encouraged by the fact that Nepean is one of the few nickel ore bodies in the region yet to be tested at depth. Other geologically similar deposits have extensive high-grade mineralization at deeper levels, most notably the Flying Fox deposit operated by Western Areas.
- Braemore Resources plc is in the final stages of testing their nickel sulphide tailings project at BHPB's Leinster nickel operations. This project involves the production of a high-grade intermediate product in the form of nickel sulphide containing 61 to 65 per cent nickel from the reclamation and processing of sulphide nickel tailings from BHPB's Nickel West operations at Leinster, Mt Keith and Kambalda. During the past 40 years, these operations have accumulated an estimated 163 million tonnes of tailings, containing approximately 500 000 tonnes of nickel. It is also estimated that a further 522 000 tonnes of nickel will be added to tailings from current processing to the completion of mining activities at Leinster and Mt Keith.
- Should Braemore's project prove feasibile, 10 to 20 000 tonnes of nickel per year will be produced in a nickel sulphide product, increasing production to 30 to 50 000 tonnes of nickel by further plant development at Kambalda and/or Mt Keith.
- Heron Resources' Goongarrie laterite nickel project, located about 85 kilometres north of Kalgoorlie.
- Australian Mines Ltd's Marriott's nickel project is undergoing a mining scoping study to determine the best approach of mining the orebody.
- A bankable feasibility study is due for completion on Norilsk's Honeymoon Well project. Amongst one of the world's largest undeveloped nickel deposits, Honeymoon Well is located 53 kilometres northeast of Kalgoorlie.
- Several laterite heap leaching studies currently underway include Nickelore Limited's Canegrass nickel–cobalt project, Heron Resources Yerilla study and GME Resources Limited's Niwest project.

OUTLOOK

Western Australian nickel producers will continue to adjust to falling demand for stainless steel, as consumers slow spending and stainless steel distributors delay restocking until the market stops sliding. Recent changes to nickel operations include:

In June 2008, BHPB shut down its 100-thousand-tonne-per-year Kalgoorlie smelter for four months of repair effectively removing 20 thousand tonnes of supply from the market.

Norilsk Nickel's Cawse operations have been suspended until current market conditions improve and Australian Nickel Mines has put the Blair nickel mine on care and maintenance. In August 2008, Fox Resources shut the Radio Hill mine.

In August 2008, Xstrata plc suspended its Falcondo ferronickel operations in the Dominican Republic and Chinese nickel pig iron producers are suffering with an estimated one-third cut in production.

Western Australian nickel producers and those who have expansions and developments on the drawing board will be closely monitoring events in both Europe and Asia throughout the coming year.

Western Australia is also likely to continue to account for all of Australia's nickel mining in 2007–08.

2.5 ALUMINA

The State's alumina industry is the fourth-largest sector in terms of sales after iron ore, petroleum and nickel accounting for eight per cent of total mineral and petroleum sales. During 2007–08, the total quantity of alumina sold continued to break records increasing by almost three per cent to 12.31 million tonnes in 2007–08, compared to 11.98 million tonnes in 2006–07.

Alumina had a sales value of $4.5 billion in 2007–08, down seven per cent from the previous year. Output increased by nearly three per cent and had an increase of a similar amount in US dollar prices, it was not enough to offset the strengthening Australian dollar. The average annual alumina price in Australian dollar terms fell nine per cent from $404 per tonne in 2006–07 to $368 per tonne in 2007–08. In terms of aluminium, 2007–08 prices averaged US$2668 per tonne, a fall of one per cent on the previous year.

Australia is the world's largest bauxite and alumina producer. In 2007, Western Australia produced 15 per cent and 65 per cent of the world's and Australia's alumina respectively. The State's total alumina production has demonstrated an average annual growth rate of four per cent per annum during the past ten years. Reserves of currently mined bauxite ore are sufficient to last more than 50 years at current production levels. In addition, there are also extensive undeveloped bauxite deposits on the Mitchell Plateau in the State's far north.

The total value of alumina exports in 2007–08 was nearly $4 billion. Western Australia's markets for its alumina are very diverse with China taking 18 per cent, Bahrain 16 per cent, South Africa and the United Arab Emirates each accounting for 15 per cent, Mozambique nine per cent, Canada six per cent, the United States five per cent and others making up the 16 per cent balance.

Alumina exports reflect global aluminium market conditions with around 98 per cent of the world's alumina being used for aluminium production. Alumina feedstock is the largest single component of the cash cost of producing primary aluminium metal. Some two tonnes of alumina are required to produce one tonne of aluminium and the industry is very competitive, with the world's major aluminium-producing companies also playing key roles in both bauxite mining and alumina refining.

Western Australia currently has two alumina producers, Alcoa World Alumina Australia and Worsley Alumina Pty Ltd (BHP Billiton Limited 86 per cent, Japan Alumina Association (Australia) Pty Ltd ten per cent and Sojitz Alumina Pty Ltd four per cent). Both producers' refineries are located within close proximity to their bauxite mines and shipping facilities which allow economical processing of relatively low-grade bauxite.

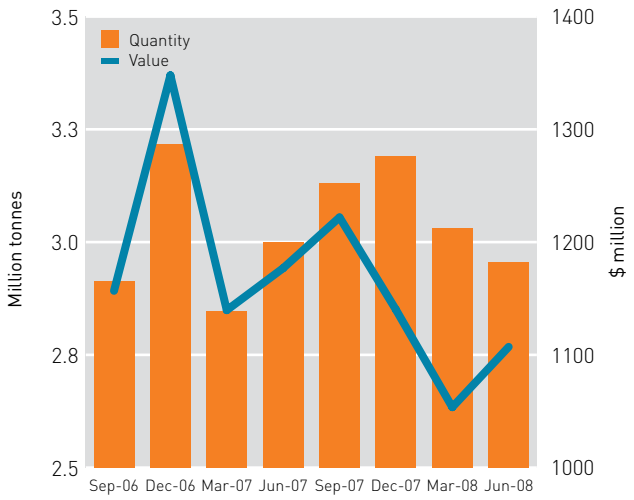


Figure 35 **Alumina Quantity and Value by Quarter** Source: DoIR

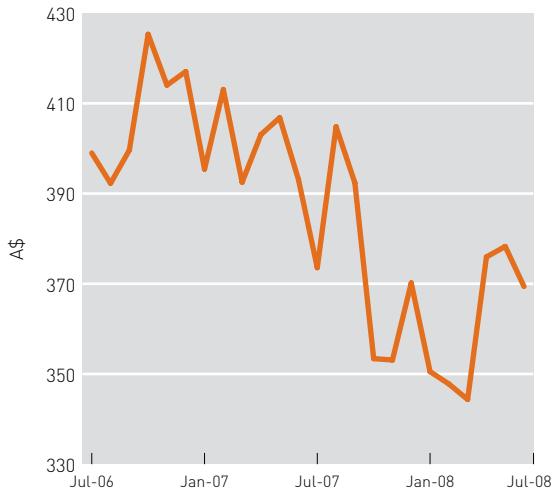


Figure 36 **Alumina Price A$/tonne** Source: ABS

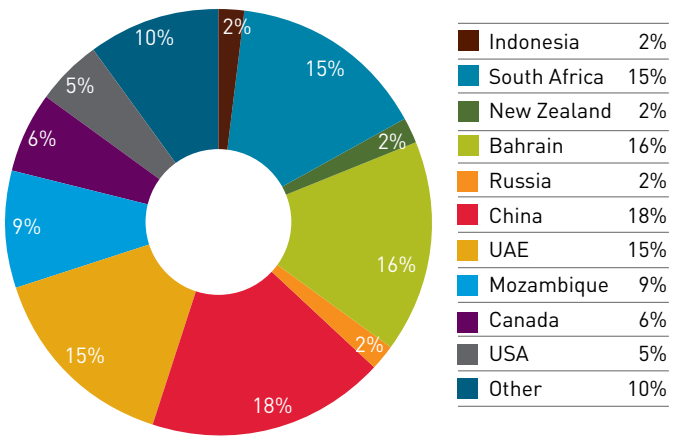


Figure 37 **Alumina Exports Total Value $3.99 billion** Source: DoIR

Alcoa mines bauxite at its Huntly (the largest bauxite mine in the world) and Willowdale mines south of Perth and extracts alumina at the Kwinana, Pinjarra and Wagerup refineries. The recently completed upgrade of the Pinjarra refinery which included new emissions control technology makes this one of the most efficient alumina refineries in the world. Combined, the three Alcoa refineries have a production capacity of 8.8 million tonnes of alumina per year. The alumina is shipped to aluminium smelters in Victoria and overseas.

Government approvals have been received for the construction of a third production unit at the Wagerup refinery to increase alumina capacity from 2.6 million tonnes per annum to 4.7. It is estimated that the project will cost in the vicinity of $1.5 billion. Approval for the project's expansion is subject to 42 conditions, including that Alcoa funds air quality testing and health surveys in addition to purchasing land. The project is expected to create 1500 jobs during construction and 260 permanent jobs.

In April 2007, Alcoa unveiled their 'Carbon Capture' system developed by their Technology Delivery Group in Kwinana. The technology, which has the potential to revolutionise greenhouse emissions in the aluminium industry, locks up carbon dioxide (CO_2) in a greenhouse sink. Since January 2007, the Kwinana carbonation plant has been operating at full capacity, treating all residue produced by the refinery, reducing CO_2 emissions by 70 000 tonnes annually. The plant also treats CO_2 produced from the nearby CSBP ammonia plant which would otherwise be emitted into the atmosphere. Alcoa plans to deploy the technology across its operations in Australia and worldwide. In Australia alone, this technology could potentially save 300 000 tonnes of CO_2 a year being released into the atmosphere (the equivalent of removing 75 000 cars).

Worsley's bauxite mine is located approximately 120 kilometres southeast of Perth at Boddington and the crushed ore is transported 35 kilometres to the refinery via overland conveyor to Worsley near Collie. The Worsley refinery produces more than 3.1 million tonnes of alumina each year. Alumina is then carted a further 50 kilometres by rail and exported through the Port of Bunbury.

Worsley Alumina's $2.5-billion Efficiency and Growth expansion project was announced on 1 May 2008. This project is one of the largest single industrial investments in Western Australia's South West region and will create approximately 4000 jobs over the life of the project. The expansion to existing mining, refinery and ship-loading operations will increase production from 3.5 to 4.6 million tonnes per year. Construction has already commenced with first production expected in 2011.

In May 2007, Norwegian giant Norsk Hydro (43 per cent owned by the Norwegian Government) signed a Memorandum of Understanding with Australian mining company United Minerals Corporation (UMC) to form a joint venture to assess the feasibility of developing an integrated bauxite mine and alumina refinery in the Kimberley region of Western Australia. Following results from the exploration and trial drilling, Norsk Hydro and UMC extended this agreement and formally set up a joint venture with the aim of recovering bauxite and producing alumina. The joint venture is with Hydro Aluminium AS (a wholly owned subsidiary of Norsk Hydro) which is one of the world's largest integrated aluminium producers (75 per cent share) and UMC (25 per cent share). The formal agreement will see Hydro Aluminium fund the majority of a US$7.4 million exploration drilling program through to the end of 2009.

Norsk already has a major presence in Western Australia through Yara International, a partner in the Burrup Fertiliser plant near Karratha. UMC holds more than 7000 square kilometres in the region, including tenements previously held by the Russian-backed Aldoga which are estimated to contain at least 40 million tonnes of bauxite.

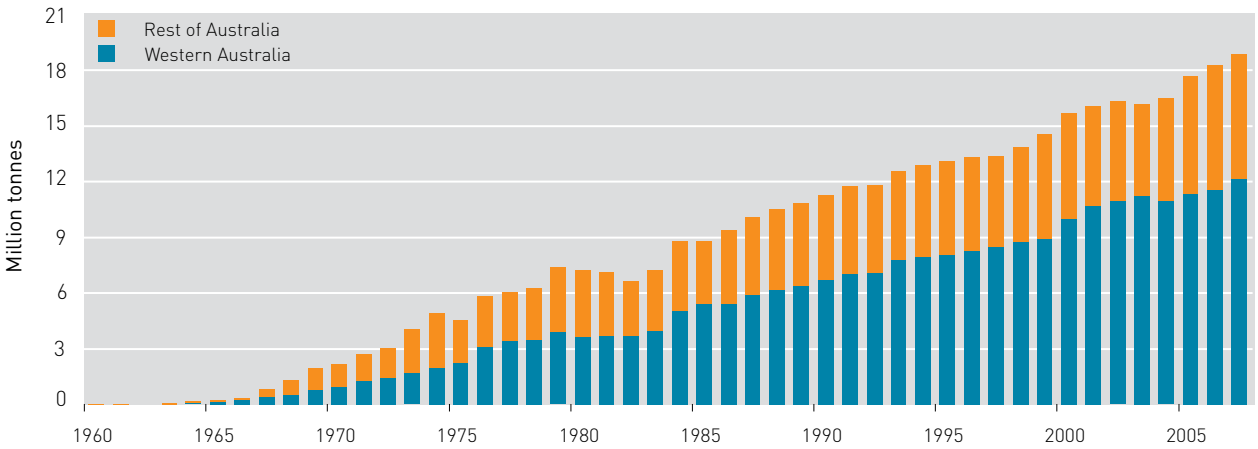


Figure 38 | **Alumina Quantity** Source: DoIR and ABARE

Being about 40 per cent lighter than steel and consumers seeking lighter, more economical cars, the transport sector has embraced aluminium. Experts predict that by 2009 more cylinder blocks, wheels and cylinder heads will shift to aluminium. 14 per cent of China's consumption of aluminium is linked to the transport sector and for 2008 the National Development and Reform Commission has set a production target of 10 million motor vehicles (up from 8 million in 2006). Currently, an average car contains around 125 kilograms of aluminium.

China is the largest consumer and major producer of aluminium and remains the growth engine for the global aluminium industry. For the past few years, China's demand for aluminium has outstripped domestic supply which has been driven by rapid industrialisation and urbanisation.

Power supply problems have and will continue, for the short-term at least, to affect world aluminium production. China, South Africa and New Zealand were all operating below capacity during 2007–08 due to power disruptions.

The Golden Mile Super Pit in Kalgoorlie

2.6 GOLD

In 2007–08, the gold industry, at $4.1 billion, ranked as the fifth-largest commodity sector in Western Australia, accounting for seven per cent of the State's total mineral and petroleum sales. On a national scale, in 2007–08, Western Australia accounted for around 62 per cent of Australia's gold production. Statistics show that Australia's gold production fell almost nine per cent to 227 tonnes (7.3 million ounces) in 2007–08 compared to 2006–07.

Western Australia's gold sales in 2007–08 amounted to 4.49 million ounces (140 tonnes), representing a 14 per cent decrease compared with the previous year. This result is the lowest output for gold in Western Australia since 1988–89 when sales were 4.1 million ounces (130 tonnes).

However, higher gold prices have partly counteracted the effect of reductions in output and resulted in the value only falling by 3.5 per cent over the 2006–07 year to $4.07 billion in 2007–08.

In 2007–08, the average international price of gold was US$823 per ounce, up 29 per cent compared to the previous financial year. The gold price has remained in the spotlight following its upward trend in the last half of 2005, peaking in March 2008 at US$1033 per ounce.

In mid-March 2008, gold hit an all-time record in Australian dollar terms of $1092.28 per ounce. In Australian dollar terms, the average gold price was 13 per cent higher, up from an average of $813 per ounce in 2006–07 to $915 per ounce in 2007–08. Escalating production costs per tonne are putting pressure on local operations and with disruptions to gas supply from Varanus Island in the last month of the financial year have taken the edge off record prices.

With global financial uncertainty, the past financial year has seen investor interest in gold increase. More of the world's major gold miners are buying out their hedge books in the expectation that the gold price will continue to strengthen. In July 2007, Newmont closed out its last remaining hedging contracts allowing the company to claim it is now the world's largest unhedged gold producer. Hedging, the practice of locking in future revenues by promising to sell a fixed volume of unmined gold at a certain point in the future at an agreed price, is no longer the preferred option for most of the world's major gold miners. It does provide a degree of certainty and some banks insist on sufficient hedging to cover loans taken out to develop new operations. Opponents to the practice argue that it weighs down the gold price by suggesting the miner believes future gold prices will fall and robs miners of their appeal to investors seeking direct exposure to the gold price.

In 2007, an estimated 446 tonnes of gold was reduced from outstanding hedge positions of gold producers, primarily as a result of de-hedging from Newcrest Mining, Barrick Gold and Newmont Mining. The size of remaining hedge books is forecast to fall to 320 tonnes in 2008 and 200 tonnes in 2009.

Western Australia's ten largest projects accounted for 74 per cent of the State's gold output in 2007–08. These projects comprised:

- Golden Mile (Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM)) – 17.9 tonnes
- Telfer Gold (Newcrest Mining Limited) – 17.5 tonnes
- Sunrise Dam (AngloGold Ltd) – 17.1 tonnes
- St Ives (Gold Fields Ltd) – 13.0 tonnes
- Jundee Nimary (Newmont Mining Corp) – 11.6 tonnes
- Agnew (Gold Fields Ltd) – 6.4 tonnes
- Kanowna Belle (Placer Dome Inc.) – 5.6 tonnes
- Marvel Loch (St Barbara Limited) – 5.0 tonnes
- Plutonic (Barrick Gold Corp) – 4.8 tonnes
- Granny Smith (Placer Dome Inc.) – 4.3 tonnes.

Exports of gold from Western Australia totalled $12.01 billion for 2007–08, however only 34 per cent of this amount ($4.1 billion) can be attributed to being sourced from Western Australian mines (see Gold Export update 2007–08 in this section). The United Kingdom has overtaken India as Australia's top gold export destination with 34 per cent of total exports. India was second with 33 per cent, followed by the United Arab Emirates with eight per cent, Switzerland with six per cent, Vietnam with five per cent with others making up the 14 per cent balance.

Although the United Kingdom is credited with taking 34 per cent of exports in 2007–08, a huge jump from 18 per cent in the previous year, it should be noted that with London having a central role in the gold market, it is often used as a shipping destination to be on-sold from London accounts.

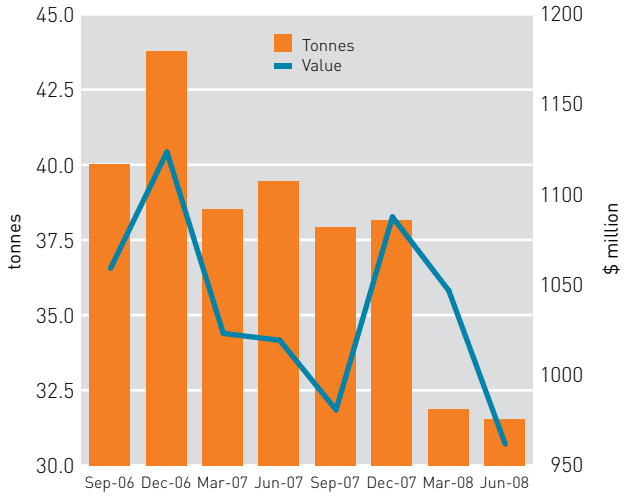


Figure 39 | **Gold Quantity and Value by Quarter** Source: DoIR

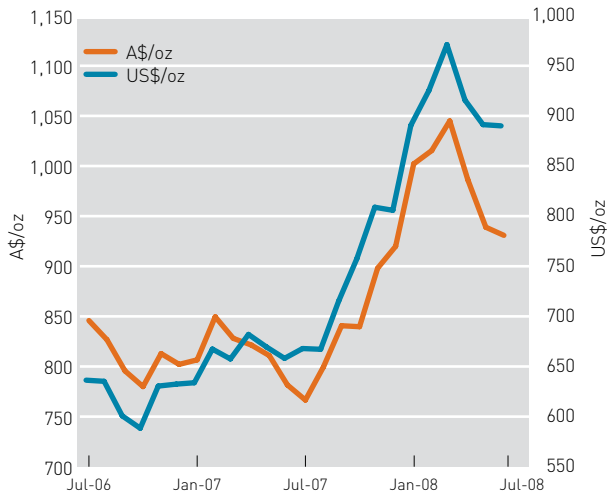


Figure 40 | **Gold Price** Source: Perth Mint and London Fix

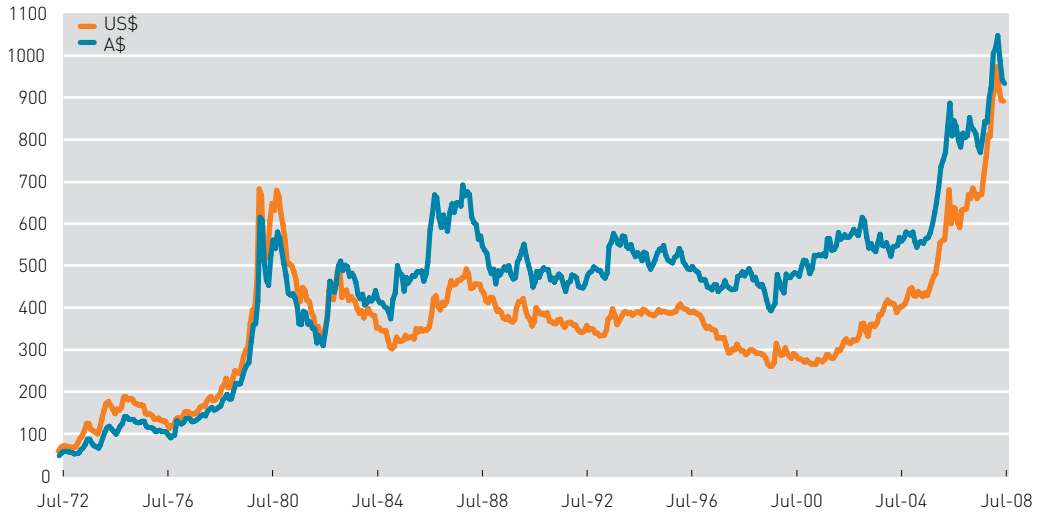


Figure 41 | **Historic Gold Price US$/A$ per ounce** Source: World Gold Council, Perth Mint and London PM Fix

GOLD EXPORT UPDATE 2007–08

The Australia Bureau of Statistics (ABS) released trade data that indicated a significant rise in Western Australian gold exports. However, this apparent increase in gold exports from Western Australia has been due to a restructuring of Australia's gold refining industry.

In October 2002, AGR Matthey was formed. This is a partnership between Johnson Matthey (Aust) in Victoria, WA Mint (The Perth Mint) and the Australian Gold Alliance. As a result of the merger, all Australian gold is now refined in Western Australia. The Victorian refinery still refines silver and jewellery products.

Gold export data published by the ABS from Western Australia must therefore be interpreted with some caution. It includes gold produced in other States and Territories, in addition to production from overseas operations, namely Papua New Guinea and Asia, which is refined and exported from Western Australia. This export figure is therefore larger than Western Australia's own level of gold production from its own mines.

The ABS estimates that gold exports from Western Australia in 2007–08 amounted to approximately $12.01 billion. Approximately 34 per cent or $4.07 billion was gold produced in Western Australia. The remaining 66 per cent (approximately $7.94 billion) can be attributed to gold refined and exported from Western Australia but produced from mining operations in other States, Territories and overseas.

Overseas imported gold also includes scrap which is refined in Western Australia and exported.

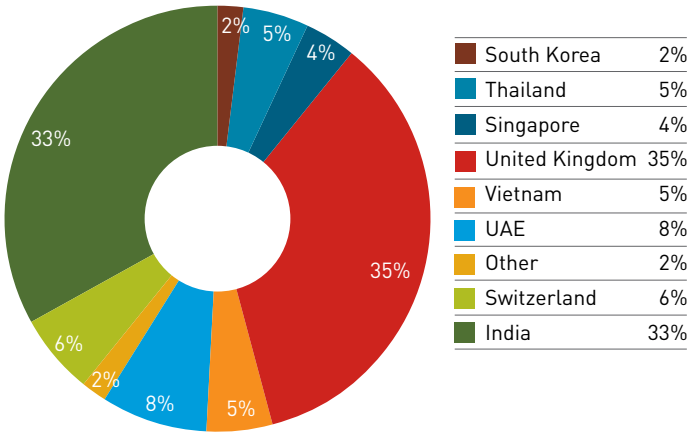


Figure 42 | **Gold Exports**
Total Value $12.01 billion Source: ABS and DoIR

Note: Includes gold refined/processed and exported from Western Australia, but produced from mining operations in other States, Territories and overseas.

Global mine production of gold peaked in 2001 at 2600 tonnes. It has been constrained for several years since then. In 2007, 2475 tonnes was produced globally. South Africa produced 253 tonnes, China 250 tonnes, USA 240 tonnes and Australia 227 tonnes.

In terms of the State's gold production outlook, there are several gold projects looking at re-opening and some current producers looking to expand, as well as new projects planned, due to the higher gold price. The two-year price graph on the previous page demonstrates the widening gap between US dollar prices and Australian dollar prices.

Listed below are some of the projects still proceeding with either development or expansions:

- Newmont Mining Corporation in Joint Venture with Anglo Gold Ashanti Limited's expansion of the Boddington gold mine (Wandoo South and Wandoo North). Boddington is located 130 kilometres southeast of Perth. Production will be up to 600 000 ounces per annum of gold and about 20 000 tonnes per annum of copper in concentrates over a 15-year life. Initial production is not expected until late 2008 or early 2009. The project remains on schedule and at August 2008 was 77 per cent complete. The capital cost for the project is US$2–2.3 billion.
- Kalgoorlie Super Pit – Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) plans to extend the life of its open-cut mine by five years to 2017 with the Golden Pike Cutback. KCGM received government approval to proceed in June 2008. The Super Pit is located three kilometres southeast of the town of Kalgoorlie and is the largest gold open pit operation in Australia. What was once the Golden Mile was named the Fimiston Open Pit, which in turn has become known as the Super Pit. This now famous landmark will eventually stretch 3.8 kilometres in length, be 1.35 kilometres wide and go down to a depth of more than 500 metres.
- Independence Group NL (30 per cent) and AngloGold Ashanti Ltd's (70 per cent) Tropicana JV pre-feasibility study will be completed in the first quarter of 2009. The discoveries at Tropicana, located 400 kilometres northeast of Kalgoorlie, are reported to have multi-million ounce potential. Subject to government approvals and the outcome of the pre-feasibility study, construction could commence late 2009.

  AngloGold has confirmed the Tropicana gold project could cost up to $1 billion to develop. The remote location of Tropicana will be challenging to develop, with the cost of water, fuel, transport and power at a premium.

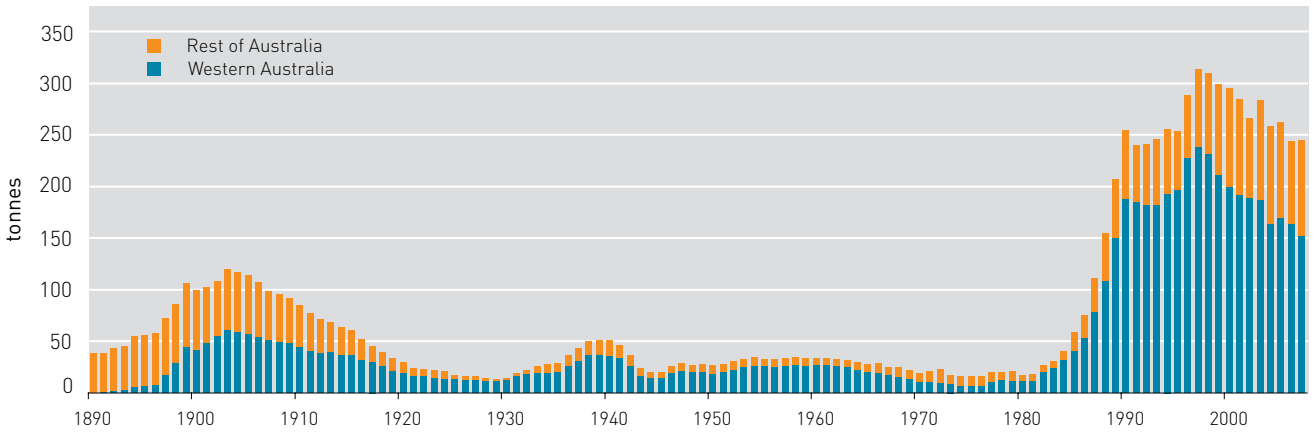


Figure 43 | **Gold Production** Source: DoIR and ABARE

- Apex Minerals NL's refurbishments at the Wiluna underground mine remain on schedule to be completed at the end of October 2008 ahead of the proposed re-commencement of processing in November 2008. Apex expects to achieve an initial production rate of 100 000 ounces per annum, from Wiluna underground and East Pit (open pit) ramping-up to 150 000 ounces from the Wilsons deposit.
- Kalgoorlie–Boulder Resources Ltd is conducting a pre-feasibility study into the development of its Norseman gold project which is located 30 kilometres south of the prolific gold producing centre of Norseman. Studies so far indicate production is capable of commencing in 2010 at an average of 100 000 ounces of gold per annum for around seven years. Initial capital costs are expected to be approximately $75 million.
- Integra Mining Ltd has completed a pre-feasibility study into its Randalls gold project which is located130 kilometres east of Kalgoorlie. The study was based on the development of three open pit sources (Salt Creek, Maxwells and Cock-eyed Bob) feeding a central gold processing plant located at Salt Creek with an annual production rate of 120 000 ounces and a mine-life of almost five years. The capital cost of the project is estimated to be around $85 million.
- Navigator Resources Ltd's pre-feasibility study into the 950 000 ounce Leonora gold project will be completed in the third quarter of 2008 with gold production targeted for late 2009. The Leonora project is located just 30 kilometres from the town of Leonora. The preferred development option is the three large open pits of Cardinia, Mertondale South and Tonto with ten smaller pits providing additional production.
- In May 2006, revised mineral resource estimates announced by Saracen Mineral Holdings Limited at its Carosue Dam project have revealed significant increases in resources. In August 2007, Saracen were progressing the project through a definitive feasibility study. Carosue Dam is located 110 kilometres northeast of Kalgoorlie. St Barbara Limited approved the development and mining of Gwalia Deeps in February 2007 and forecast reserves will sustain production for at least eight years. The Gwalia Deeps project is located four kilometres southeast of Leonora. Gold production will be at the initial rate of 100 000 ounces per annum in 2008–09 building up to 200 000 ounces during 2009–10 and is scheduled to begin in the September quarter of 2008.
- Avoca Resources Limited has completed developing their Trident gold project within the historical mining centre of Higginsville which lies midway between the world-class mines of St Ives and Norseman in the Eastern Goldfields of Western Australia. First gold was poured on the 8 July 2008 and by the end of the June quarter, 22 371 tonnes of material was milled at about 2 grams per tonne gold. With the new high grade ore discovery of Apollo, adjacent to Trident, it is expected to provide a ten-year plus mine life. Production is expected at the annual rate of 160 000 to 190 000 ounces.
- A1 Minerals Ltd is continuing the feasibility study into the development of its BrightStar gold project near Laverton. The area is host to a number of world-class gold deposits including Sunrise Dam, Wallaby and the Granny Smith ore bodies. The purchase of a gold plant has been agreed which will enable the company to achieve a production strategy. High grade and near-surface ore will be mined in the initial two years of operation with a target production rate of 300 000 tonnes per annum.

2.7 BASE METALS

The overall value of the Western Australian base metals sector fell by seven per cent to reach $1.74 billion during 2007–08. The decrease was attributed to the suspension of production from the Magellan lead mine together with the effects of the strong Australian dollar and plummeting zinc prices. On average, throughout 2007–08, in Australian dollar terms, zinc prices fell 38 per cent; however it should be remembered that in the previous year zinc prices rose an amazing 64 per cent. Copper also fell four per cent whilst lead rose 51 per cent. Nevertheless, in value terms, the base metals sector is now ahead of heavy mineral sands.

The overall largest producer of base metals by value (around 30 per cent of the total value) in Western Australia is Oxiana Limited (now merged with Zinifex with a change of name to Oz Minerals Limited) with its Golden Grove project located 55 kilometres south of Yalgoo. Golden Grove consists of the Scuddles and Gossan Hill zinc and copper mines and the Scuddles concentrator. The Golden Grove project produces zinc concentrate and copper concentrate which also contains silver, gold and lead. Product is exported to China, South Korea, Thailand and India.

Coming a close second to Oz Minerals is Birla Minerals Pty Ltd with their Nifty mine, then Newcrests Mining Limited's Telfer gold–copper operation, with Teck Comminco–Xtrata's Lennard Shelf lead–zinc operation fourth.

COPPER

Copper production in Western Australia may be split into three categories comprising copper concentrate, copper cathode and copper by-product (mainly from nickel mining). During 2007–08, the total quantity of copper sold increased by around seven per cent to 124 798 tonnes whilst the value rose three per cent to $1.08 billion. On average during 2007–08 the US dollar copper price rose ten per cent, however with the strengthening Australian dollar it fell nearly four per cent in Australian dollar terms.

Aditya Birla Minerals Ltd operates the Nifty copper mine, 350 kilometres east of Port Hedland. Nifty currently has a capacity of 25 000 tonnes per annum of copper cathode from their open pit operation. Cathode production is under contract of sale to Glencore. Although open pit mining operations ceased in mid-2006, copper extraction through heap leaching is expected to continue for a further five years.

Aditya Birla also has a large copper sulphide resource estimated to be around 1.9 million tonnes of copper equivalent. The commissioning of their sulphide operation, an underground mine with a copper concentrate plant, commenced in early 2007 and ramped-up to full capacity through 2007. The mine will have a capacity of 2.3 million tonnes per year. During the 2007–08 financial year Aditya Birla reported producing a total of 56 995 tonnes of copper. The concentrate product is trucked to Port Hedland for shipping (under contract) to Hindalco Copper's Dahej smelting and refining facilities in India.

Straits Resources Limited operates the Whim Creek and Mons Cupri copper cathode projects located midway between Karratha and Port Hedland. After mining, oxide copper ore is trucked to a processing facility located midway between the two ore bodies. The lengthy process of heap leaching (which can take from six to twelve months to recover most of the copper from the oxide ore), then solvent extraction and electrowinning follows (taking around a week). During the 2007–08 period, Straits produced a total of 13 547 tonnes of copper cathode; however not all of this production is reported to DoIR, as the Whim Creek tenements are not covered by the *Mining Act 1978*.

Newcrest Mining Limited's Telfer copper–gold project, 310 kilometres northeast of Newman, reported producing a total of 26 772 tonnes of copper in concentrate during 2007–08.

Golden Grove reported producing 13 053 tonnes of copper concentrate for the period whilst Jabiru Metals Limited produced 2877 tonnes of copper in concentrate. In a recent announcement, Oz Minerals plans to reduce zinc production by approximately 35 to 40 per cent of their 2008 production levels in 2009 in favour of copper. Golden Grove is a polymetallic mine, meaning Oz Minerals has the capability to vary the mix of copper and zinc produced to suit market demand and price.

Of the fourteen nickel operations which produce copper as a by-product in concentrate, Panoramic Resources Limited's Savannah nickel project contributed around 36 per cent of the total 11 254 tonnes for the 2007–08 financial year.

A potential newcomer is CBH Resources Limited's Panorama project located 160 kilometres by road from Port Hedland. The Panorama project is based on the development of the Sulphur Springs copper–zinc ore body. A bankable feasibility study has been completed and environmental approvals are being finalised for a 1.5 million tonne per annum open-cut mine and ore processing plant to produce 80 thousand tonnes per annum of copper concentrate (25 per cent copper) and 90 thousand tonnes per annum of zinc concentrate (53 per cent zinc). Construction was planned to commence in the second half of 2008 and first production in late 2009.

LEAD

Lead prices surged, peaking at US$1.80 per pound during October 2007 to reach an average for 2007–08 of US$1.31 per pound, an increase (in US dollar terms) of 70 per cent. Since January 2008, prices have been generally in decline and in August 2008 averaged just US$0.87 per pound.

The only current stand-alone lead producer in Western Australia is Ivernia's Magellan lead operation, located 30 kilometres west of Wiluna. It is considered amongst the top five lead-producing mines in the world (when in full production). It has a mine life of approximately ten years.

Temporary suspension of operations at the Magellan mine in early April 2007 resulted from problems associated with lead contamination. Shipments are scheduled to recommence pending regulatory approval for containerised shipments. The bulk of Magellan's shipments have been made to smelters in China, with Belgium, South Korea and Thailand receiving smaller quantities.

Golden Grove's reported production of lead for the 2007–08 period was 9642 tonnes in concentrate.

The Lennard Shelf (Pillara mine) operations in the Kimberley, which is the second mine producing lead in concentrate as a by-product, produced around 16 064 tonnes of lead for the 2007–08 period.

ZINC

Zinc prices were trading at around US$1.63 per pound at the end of June 2007 and had collapsed to around US$0.84 per pound by the end of June 2008, striking an average for the year of US$1.17 per pound. This average price (in US dollar terms) represented a fall of some 30 per cent over the previous year.

Golden Grove, together with the Lennard Shelf project and recently opened Jabiru Metals Limited's Jaguar mine, currently produce all of Western Australia's zinc in concentrate. Oz Minerals reported production of 127 041 tonnes for 2007–08 with all of Golden Grove's zinc being sold to smelters in Asia under long-term supply contracts. With the depressed price of zinc, Oz Minerals plan to reduce production of zinc in favour of copper in 2009. Lennard Shelf reported production of 53 944 tonnes and Jabiru produced 16 144 tonnes.

In July 2008, Xstrata and Teck Cominco agreed to close the Lennard Shelf operations because of the falling metal prices and strong Australian dollar.

2.8 MINERAL SANDS

Western Australia remains the nation's dominant producer of heavy mineral sands accounting for over 75 per cent by total value sold in 2007–08. During 2007–08, the value of Western Australian mineral sands fell by almost three per cent ($20 million) when compared with 2006–07. Only product covered by the *Mining Act 1978* and relevant State Agreement Acts are included in these calculations. Product mined from land titled prior to 1 January 1899 and product mined in other States and overseas are excluded.

Quantities sold were up with the exception of ilmenite which fell by around 12 per cent; however some of this shortfall was accounted for in the rise in feedstock for synthetic rutile of nearly five per cent. Rutile was up by 22 per cent, zircon up 12 per cent with leucoxene remaining almost the same with a small rise of one per cent.

Prices received by Australian producers of heavy mineral sands during 2007–08 were on average down in line with the strengthening Australian dollar although ilmenite fared better than the others dropping only five per cent.

Export markets for Western Australian heavy mineral sands are very diverse and in 2007–08 the United States took 17 per cent, China 14 per cent, Japan and the United Kingdom taking nine per cent each and the balance (51 per cent) being shared between a host of buyers from across Europe and Asia. It should be noted that these exports include some product mined from private land and product produced from mining operations in other States as well as overseas and exported from Western Australia.

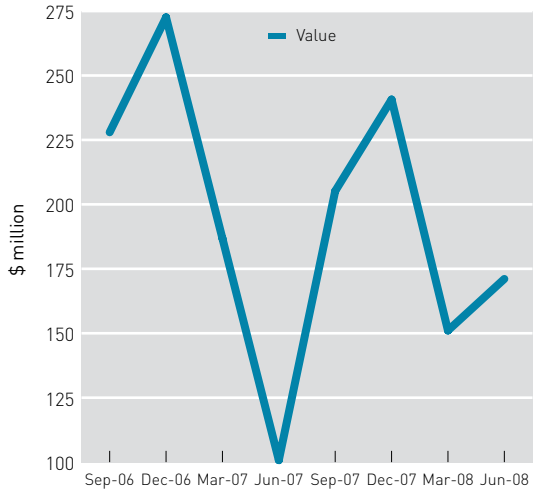


Figure 44 | **Heavy Mineral Sands Value by Quarter** Source: DoIR

Western Australia is dominated by two major producers, Iluka Resources Ltd and the Tiwest Joint Venture, which is a joint venture between Tronox Western Australia Pty Ltd, a subsidiary of Tronox Incorporated, and the subsidiaries of Australian-based Ticor Resources Pty Ltd. These two producers account for around 80 per cent (by value) of all Western Australian heavy mineral sands sold in 2007–08.

Iluka's operations include Cloverdale, Waroona and the Wagerup mines as well as two dry separation plants and a synthetic rutile processing plant located at North Capel and Capel in the southwest of the State. Capel is about 200 kilometres south of Perth and processed product is shipped through the nearby Port of Bunbury.

Narngulu is the processing centre for Iluka's operations in the Mid West and is located on the outskirts of Geraldton, 410 kilometres north of Perth. Titanium minerals and zircon from the Eneabba (275 kilometres north of Perth) and Gingin (85 kilometres north of Perth) mine sites are processed at Narngulu before they are exported through the Geraldton Port. The Gingin operation is currently expected to cease production in late 2008. The processing facilities at Narngulu consist of a dry separation plant, zircon finishing plant and a synthetic rutile processing plant.

In August 2007, Iluka announced that after more than 50 years association with mining in the South West, the company will be winding-up its operations in the area in 2014. This comes 12 years ahead of schedule. This announcement comes after decisions to close businesses in Florida and Georgia. Iluka will maintain its operations in the Mid West and focus on the Murray Basin in Victoria and the Eucla Basin in South Australia.

Tiwest has operations at six locations in Western Australia. Tiwest's Cooljarloo mine, is situated approximately 170 kilometres north of Perth. Ore is processed through concentrators before being transported from the mine site at Cooljarloo to the dry mill, 110 kilometres to the south, at Chandala.

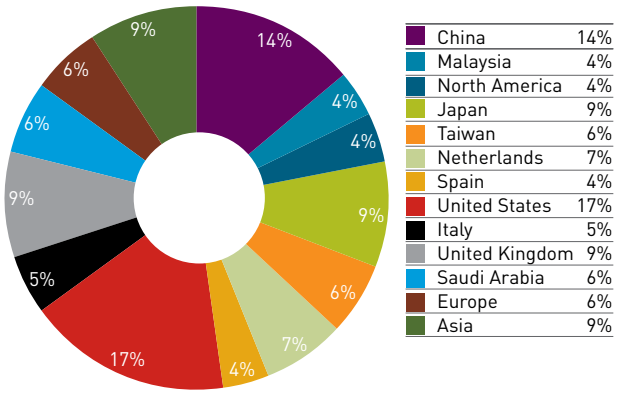


Figure 45 | **Heavy Mineral Sands Exports**
Total Value $806 million Source: DoIR

Note: Exports include titanium dioxide and product sourced from private land, overseas and other States and processed in Western Australia

The Chandala complex includes three major plants – a dry mill, which separates the minerals, a synthetic rutile plant, which upgrades ilmenite into high quality titanium dioxide pigment feedstock, and a waste management plant. Using technology developed in Western Australia – the Improved Becher Process – Tiwest upgrades the titanium dioxide content in ilmenite from an average 61 per cent to at least 93 per cent in synthetic rutile.

Not all synthetic rutile from Chandala is exported. Of the 230 000 tonnes produced, about half is railed to Tiwest's Kwinana pigment plant where it is transformed into pure white pigment, TiO_2, which is used as a commercial colouring agent and coating material. The Kwinana facility is a cogeneration plant, where a gas turbine generates electricity and the exhaust gases, which would in the past have been vented into the atmosphere, are used to raise steam for use in the pigment plant. The plant generates all of Tiwest's power requirements, plus surplus electricity for the South West Interconnecting Grid.

Bemax Resources Limited through its wholly owned subsidiaries that make up the Cable Sands Group are the next largest operator with its Ludlow, Tutanup

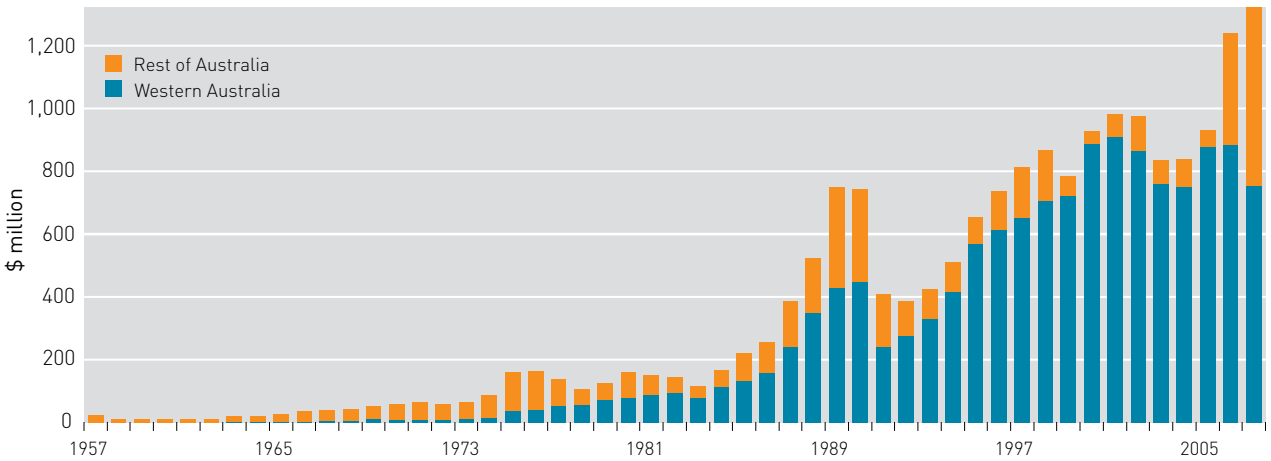


Figure 46 | **Heavy Mineral Sands Value of Production**
Includes Ilmenite, Leucoxene, Upgraded Ilmenite, Rutile, Zircon and Monazite. Source: DoIR and ABARE

South and Gwindinup mines. Cable Sands' Bunbury Mineral Separation Plant (MSP) treats feedstock from the company's own mines as well as on a toll treatment basis for a number of customers. During 2005, the MSP underwent a $6-million upgrade to allow it to simultaneously process feedstock from both its Western Australian and Murray Basin operations in South Australia.

Doral Mineral Sands Pty Ltd is the smallest of the Western Australian mineral sands producers located at Dardanup and Picton. The company is a wholly owned subsidiary of Perth-based Doral Mineral Industries Limited, itself an unlisted public company owned by Iwatani International Corporation of Japan. Ore at Dardanup is concentrated and trucked nine kilometres to the continuously operated Picton dry separation plant. Product is then exported from the nearby Port of Bunbury.

It should be noted that not all heavy mineral sands mined comes under the *Mining Act 1978*. Some product is mined from land granted to private individuals prior to 1899 and as such is not reported to this Department.

The Argyle mine is famous for its pink diamonds ©WATC

2.9 DIAMONDS

Rio Rinto's Argyle mine, 112 kilometres south-southwest of Kununurra, accounts for the bulk of diamond production in Western Australia and in 2007–08 produced 16.02 million carats, a drop of some 8.22 million carats from the previous year.

Argyle commenced mining its main ore body in 1985 and has since produced over 678 million carats of diamonds worth a combined US$11 billion (A$14.3 billion). The open pit resource is projected to be exhausted by around the end of 2008 when plans are in place to go underground with first production expected in 2009. The construction of an underground block cave operation is currently underway to extend the life of the operation to 2018. The challenging ground conditions, increased construction and labour costs, has pushed the value of this project up to US$1.5 billion. The semi-automatic block cave will be one of the world's most sophisticated mines, using remotely operated machinery.

Variability in feed grade and production rates will continue as the open pit operation approaches the end of its life and transitions to the underground operation. Adverse conditions during the wet season also hampered production in the March quarter of 2008.

The Argyle mine is famous for its pink diamonds and accounts for around 90 per cent of the world's production of this type of diamond (though they represent less than one per cent of the mine's output). The colour range also includes white and champagne. Argyle production consists of five per cent gem and 70 per cent near-gem with the remaining 25 per cent of the volume being industrial diamonds. The entire gem and near-gem diamonds are polished and account for more than 95 per cent of the value of Argyle's rough diamond sales.

The Kimberley Diamond Company with its Ellendale mine, 100 kilometres east of the coastal town of Derby, is the State's only other producing diamond mine. In December 2007, Gem Diamonds acquired 100 per cent of the Ellendale mine when it acquired the Kimberley Diamond Company. Production has subsequently been ramped-up and processing capacity enhanced. The Ellendale mine is expected to reach 10.5 million tonnes per annum in 2009 with an associated diamond production of over 700 000 carats.

During 2007–08, the Ellendale mine produced around 488 thousand carats.

Ellendale produces predominantly gem and near-gem quality diamonds, including some fancy and vivid yellow stones. Since mining began in mid-2002 the mine has recovered some 1.2 million carats of diamonds.

2.10 OTHER

COAL

In the past all of Western Australia's coal supplies have been sold domestically by two producers from coal mines in Collie to Verve Energy and other large local energy users, mainly in the mineral-processing sector. Collie is located 50 kilometres inland from the coastal city of Bunbury.

The two producers are Wesfarmers Premier Coal Limited and the Griffin Group.

In 2007, Griffin Coal (part of the Griffin Group) commenced trial export shipments. In the period up to June 2008, a total of 11 cargoes had been exported to India and China through the Kwinana port.

In 2007–08, the quantity of coal sold from Collie increased by five per cent to 6.3 million tonnes whilst the value remained almost static, rising a little over one per cent, to $275 million.

About 90 per cent of Collie coal is used as thermal coal, mostly in power stations and the majority of the remainder is used metallurgically by the mineral sands industry to reduce ilmenite to synthetic rutile. A small quantity is used to reduce silica sand to silicon metal.

In August 2005, Wesfarmers Premier Coal Limited was successful in its bid to supply Verve Energy with its long-term coal requirements from 2010 to 2030 for its coal-fired power stations at Collie in Western Australia. This contract will underpin the long-term future of the Premier coal mine for Wesfarmers.

Early in 2006, Griffin Energy (part of the Griffin Group) commenced construction on the State's first privately funded, owned and operated coal-fired power station, Bluewaters I. This is the first of two coal-fired power stations being built at the Coolangatta industrial estate 4 kilometres from Collie. The $400-million, 208-megawatt (MW) Bluewaters I plant was expected to be completed in late 2008. Whilst Bluewaters II (also $400-million) is expected to be completed some time in 2009.

Coal supplies will be sourced from Griffin coal mines located within two kilometres of the plants.

Griffin has signed a contract to supply 150-MW for the $2.4-billion Boddington Gold Joint Venture mine located 130 kilometres southeast of Perth. A further long-term operation and maintenance contract with a joint venture between Worley–Parsons and Transfield Services has also been signed.

Griffin is proposing an expansion of its Bluewaters power projects at the Coolangatta industrial estate by incorporating a further two new coal-fired, base-load generators, each capable of producing 208-MW, bringing the facility's total output to approximately 830-MW. The expansion project will use modern, efficient emissions-control technology throughout and is working towards developing and adopting carbon capture technology.

Western Power Corporation commenced work in October 2006 to connect Griffin Coal to the South West Interconnected System and upgrade the distribution line between Collie and Boddington. This upgrade is scheduled to be completed in 2008, the same year the mine is expected to open and the Bluewaters I power station will become operational.

Both coal producers are also examining other areas where they can expand the market for coal with coal-carbonising projects whereby coal is transformed into a higher value product known as carbonised coal or char.

- The commissioning of a 50 000 tonnes per annum Research and Development Char Plant by Wesfarmers commenced in the June quarter 2007 with char being produced to specification.
- Carpenter Mine Management (CMM), a member of the Griffin Group of companies, is considering two sites for their char plant in the Collie region. The Mungalup Road site located approximately two kilometres southwest of the town of Collie and the Ewington site located within one of Griffin's existing mining leases. It is proposed to build (subject to government approvals) a 200 thousand tonnes per year charring operation (fed by 400 thousand tonnes of coal per year from the Ewington mine).

With new resource projects under consideration or development in the Mid West region of Western Australia, Aviva Corporation Ltd has signed a Joint Development Agreement with AES Power, one of the world's largest global power companies and is progressing the development of a $1-billion 2x200-MW base-load power station to be known as the Coolimba Power Project (Centauri I). The project will be fuelled by Aviva's Central West coal deposit 20 kilometres south of Eneabba Western Australia where open pit mining is planned to a depth of only 100 metres. Coolimba Power will also incorporate the latest carbon-capture technology.

In addition, Aviva is also seeking approval for 330-MW of gas turbine generation at Coolimba as well as the coal project making it the largest power generation centre in Western Australia apart from Collie.

Arc Energy has agreed to a partnership with Aviva to study the potential for sequestration of carbon dioxide in depleted oil and gas reservoirs in the North Perth Basin. ARC will join the existing study commissioned by Aviva and being conducted by CO2CRC Technologies. The study is investigating sequestration sites for future emissions from Aviva's planned 400-MW Coolimba Power Project.

Early in 2008, research was undertaken on gasification of Collie coal by the Cooperative Research Centre for Coal in Sustainable Development (CCSD) through its participant, CSIRO Energy Technology, in Brisbane. Part of the study was conducted at the Siemens Gasification Test Facility in Freiberg, Germany. The results of the study support the proposal to use clean coal technologies in power generation in Western Australia.

SALT

Western Australia accounts for approximately 80 per cent of the nation's salt production and is the country's dominant exporter. In 2007–08, Western Australian salt sales fell by 12 per cent to 9.1 million tonnes, and although prices were relatively strong, the exchange rate saw the value fall by 15 per cent compared to last year to reach $200 million. Japan accounts for around 35 per cent of the State's exported salt, Taiwan 24 per cent, Indonesia 14 per cent, South Korea 12 per cent, China imports 8 per cent and others 7 per cent.

Dampier Salt Limited, with its Dampier, Port Hedland and Lake MacLeod operations located in the Pilbara region, accounts for around 70 per cent of the total salt produced in Western Australia. Production involves solar evaporation of seawater (Dampier and Port Hedland) and underground brine (Lake MacLeod). The Port Hedland expansion project has been put on hold with priority being given to completing repairs to site from damage caused by Cyclone George in March 2007. The expansion project is currently undergoing reassessment and redesign to counter escalating costs. However, the Lake MacLeod salt expansion project was successfully completed during the year and will increase annual output by up to 1.9 million tonnes per annum.

Onslow Salt Pty Ltd's operation at Onslow is the next largest operation. The Shark Bay Joint Venture at Useless Loop (which commenced operations in 1968) and the WA Salt Supply's Lake Deborah East (at Koolyanobbing) and Pink Lake (at Esperance) operations make up the smaller producers.

Salt is primarily used as a feedstock for the production of chemicals, glass and plastic. In the context of growing demand from Asia, demand for salt is likely to continue to increase. Western Australian salt producers are therefore well placed, due to their proximity to the Asian markets, particularly in the context of rising freight rates for low-value bulk commodities.

TIN, TANTALUM AND LITHIUM

Tantalum is a rare, grey-blue metal used primarily in the electronics industry in the manufacture of capacitors and therefore found in many everyday devices such as mobile phones, lap-top computers and video cameras. Another increasing application for tantalum is as a "superalloy" in the manufacture of turbine blades for power stations and jet engines, where tantalum improves the structural integrity of blades at high temperatures, enabling turbines to operate at higher temperatures, thereby improving fuel efficiency.

Talison Minerals Pty Ltd was formed in August 2007 following the sale of Sons of Gwalia's Advanced Minerals Division to a consortium of investors led by the Denver-based mining specialist Resource Capital Fund. All Talison's assets are in Western Australia and include the Wodgina tantalum mine, the Greenbushes lithium and tantalum mine as well as a number of exploration tenements near Wodgina.

The Wodgina mine is located 120 kilometres southeast of Port Hedland. The Greenbushes mine (located 210 kilometres south of Perth) was discovered in 1886 and started mining two years later, making it the oldest continuously operating mine in Western Australia. Both mines have a projected life in excess of 25 years.

Talison is the world's largest producer of tantalite concentrate, providing between a quarter and a third of global supply from the Wodgina operation alone. Tantalum operations at the Greenbushes mine are on care and maintenance and if reactivated, these two mines could produce up to 50 per cent of the world's tantalite concentrate supply.

Greenbushes also contains the largest hard rock, lithium mineral resource in the world and is the world's largest producer of spodumene, accounting for around two-thirds of the world's supply of lithium minerals. Lithium minerals are used in the glass and ceramics industries and increasingly in the production of lithium chemicals for the battery market. Lithium production at Greenbushes continues at capacity.

A potential new additional tantalum–lithium producer may be Galaxy Resources' Mt Cattlin project which is located near Ravensthorpe.

MANGANESE AND CHROMITE

Consolidated Minerals Limited's Woodie Woodie mine is the State's sole producing manganese mine. During 2007–08 estimated production was 885 709 tonnes.

In January 2008, ownership of Consolidated Minerals changed when Palmary Enterprises Ltd took over.

Woodie Woodie is recognised worldwide as a supplier of reliable high-grade, low impurity manganese ore. Located 400 kilometres southeast of Port Hedland in the Pilbara region, the open cut mine was first established in 1954. It continued operating until 1982 when it closed for seven years. The mine re-opened again in 1989 and currently exports to world markets.

Consolidated Minerals is also the State's sole producer of chromite ore and in 2007–08 produced 247 030 tonnes. The Coobina chromite project is located 80 kilometres southeast of Newman. The mine has an operating capacity of 250 000 tonnes per annum of high grade ore, which represents around 2.5 per cent share of the world market.

Globally, chromite production is dominated by South Africa, Kazakhstan, Turkey, India and Pakistan, which together account for 80 per cent of world mine production.

VANADIUM

Windimurra Vanadium Limited (WVL) is in the process of rebuilding the Windimurra vanadium mine and processing facilities. The project is based on one of the world's largest known vanadium deposits. The mine is located 600 kilometres northeast of Perth near the town of Mt Magnet in the Mid West region of Western Australia.

The Windimurra mine is expected to be commissioned in 2009. Once operational the mine will produce approximately 5700 tonnes per annum of vanadium as ferrovanadium, which represents approximately eight per cent of the world market. The mine is expected to have a life of around 20 years.

Windimurra has a strategic alliance and offtake agreement with Hong Kong based global supply chain manager, Noble Group Limited. Noble has agreed to purchase the total vanadium output of the Windimurra mine, at prevailing market prices for the life of the mine.

Interruption to global supply created by power supply issues in South Africa (which are forecast to continue for some years) have seen vanadium prices in 2008 trading at 20-year highs. Robust vanadium demand, driven by growth in steel demand primarily from developing countries including Brazil, Russia, India and China, coupled with production constraints, has resulted in the current historically high price levels of US$60 per kilogram.

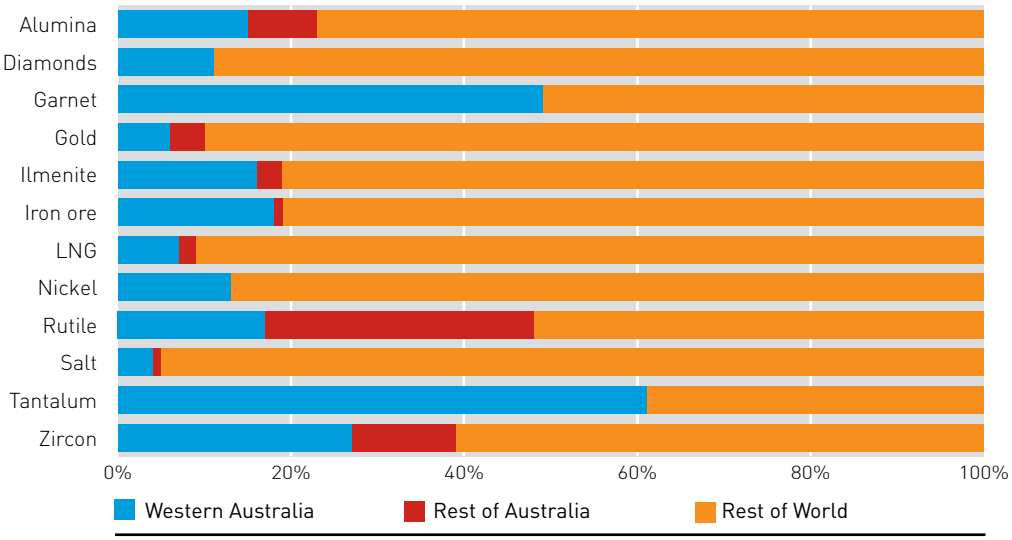


Figure 47 | **Selected WA Commodities Relative to World Production Ending 2007 by Quantity** Source: DoIR, ABARE, USGS

The latest comparable data show that the Western Australian share (by quantity) of the world's output of the following products was: alumina 15%, gold 6%, garnet 49%, ilmenite 16%, iron ore 18%, LNG (sea-borne trade) 7%, nickel 13%, rutile 17%, salt 4%, tantalum 61%, zircon 27% and 11% of diamonds (mainly industrial grade).

RARE EARTHS

June 2007 saw the commencement of mining operations at Lynas Corporation Ltd's Mt Weld Rare Earths project located 18 kilometres southeast of the town of Laverton. The Mt Weld deposit comprises world-class Rare Earths Oxide (REO) and niobium–tantalum deposits. Rare earths ore will be mined, crushed and blended at Mt Weld, trucked to Leonora, then railed to the Port of Esperance for export to the Gebeng Industrial Area, Pahang on the east coast of Malaysia where Lynas is in the process of establishing a processing operation.

The first twelve months' production is estimated to be around 120 000 tonnes. The mine is expected to have at least a 20-year mine-life.

Rare earths are not found as free metals in the Earth's crust, rather within a mixed 'cocktail' of rare earth elements that need to be separated for their individual or combined commercial use. Despite their name, rare earths are relatively abundant in the Earth's crust, however they are often of low quality and rarely presented in economic concentration.

Rare earths have unique properties that make them indispensable for many technological applications. A range of unique chemical, catalytic, electrical, magnetic, metallurgical and optical properties enable them to play a major role in the advancement of materials technology.

China currently supplies approximately 95 per cent of the global rare earths market and is the dominant processor and user of refined compounds. This has evolved as processors in the rest of the world transfer production bases to China. In addition, more than 70 per cent of light rare earths are supplied from one mine in China and Mt Weld, (with its very high grade, contains light rare earths and is also high in Europium, a heavy rare earth), is currently the only commercially viable resource of significant size outside China.

Recent changes to Chinese Government regulations will reduce the amount of rare earths being extracted from within China and the supply of high demand elements will require the exploitation of other sources. China also introduced an export tariff of ten per cent in late 2006 on rare earths and in January 2008 increased this tariff to 15 and 20 per cent.

The rare earths market is currently growing at 15 per cent per annum and is forecast to continue to do so for the next five years. This, combined with three supply contracts (worth a combined estimated US$310 million), strategically places the Mt Weld project in an advantageous position in a time of restricted supply and rising prices.

MOLYBDENUM–COPPER DEVELOPMENTS

Molybdenum is a high melting-point alloying metal used in iron, steels and super alloys to enhance hardness, strength, wear and corrosion resistance. High nickel prices have seen an increased usage of molybdenum in stainless steel.

Moly Mines Limited is developing their $1 billion Spinifex Ridge molybdenum–copper project. Spinifex Ridge is located approximately 50 kilometres northeast of Marble Bar. Production is scheduled to commence in early 2010 and the mine is projected to have a mine-life of some 20-plus years.

The Spinifex Ridge project is to comprise an open pit mine with an output of 20 million tonnes per annum with an average annual production of 24 million pounds of molybdenum in concentrate and 27 million pounds of copper in concentrate for an initial 10 years. Processing will be through a conventional crush, grind and flotation processing plant.

Global consumption of molybdenum has increased 70 per cent since the mid-1990s to over 400 million pounds per annum. From mid-2003 the price steadily climbed from around US$5 per pound to reach a 25-year high of just over US$40 per pound in May 2005. Current levels are at around US$34 per pound. This is a significant increase on prices of US$3 to US$5 per pound paid during the 1990's.

The distribution of molybdenum reserves and production is concentrated in only a few countries. China, the USA, Chile and Canada hold nearly 85 per cent of reserves. The main three producers are the USA (29 per cent), China (26 per cent) and Chile (21 per cent).
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World molybdenum supply is constrained by decreasing by-product production from the major South American copper producers, the imposition of export tariffs and export quotas in China and lack of new molybdenum mining developments. Spinifex Ridge therefore represents a significant potential new supply source for the global market.

In July 2008, Moly Mines Limited announced some very positive drilling results from two areas of outcropping hematite mineralisation on its Spinifex Ridge leases and hope to fast-track the delineation of a JORC-compliant resource for iron. Should the exploitation of the iron ore be viable, it will enhance the synergies of the nearby molybdenum mine and infrastructure. Recent analysis indicates that the current resource includes a significant zone of tungsten mineralisation which falls within the planned pit and the company is evaluating methods for extraction of this valuable by-product metal from the tailings.

3. ROYALTIES

Over the past ten years, royalties received by the Western Australian Government from Western Australian mineral and petroleum producers have increased 280 per cent from $600 million in 1988–89 to around $2.3 billion collected during the 2007–08 financial year. This represents royalties paid into the Western Australian Government Consolidated Revenue Fund. It includes Western Australia's share of royalties paid by petroleum projects, royalties collected in the Territorial Sea subsisting permit areas, Barrow Island and the North West Shelf (where the State receives approximately 65 per cent of royalties) that are shared with the Commonwealth.

The bulk of collections for 2007–08 (almost three-quarters) attributed directly to the State came from the iron ore (42 per cent) and petroleum (35 per cent) industries.

In addition, an estimated $1.7 billion was received by the Commonwealth in 2007–08 from petroleum resource rent tax (PRRT). This tax is applied to operating projects within designated Commonwealth waters off the Australian coast.

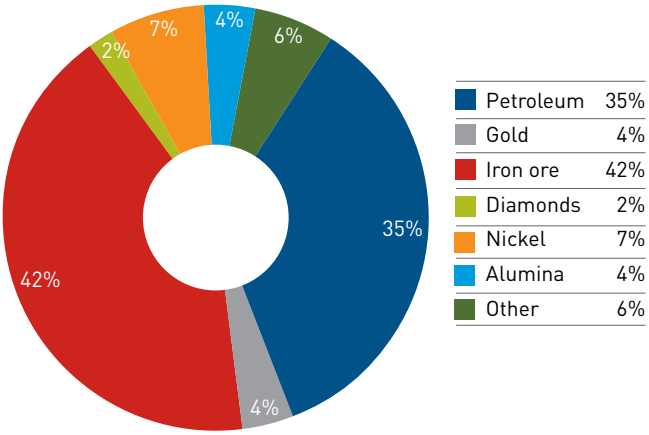

Figure 48 | **Royalty Receipts 2007–08 $2.3 billion** Source: DoIR

Woodside's Karratha Gas Plant, North West Shelf Venture, Western Australia © Woodside

TABLE 1. ROYALTY RECEIPTS 2006-07 AND 2007-08

COMMODITY	2006–07 Total A$	2007–08 Total A$	2007–08 Growth A$	2007–08 Growth %
ALUMINA	83,444,014	80,535,398	-2,908,616	(3)
DIAMONDS	20,969,209	43,436,045	22,466,836	107
GOLD	104,885,111	99,481,977	-5,403,134	(5)
HEAVY MINERAL SANDS	31,922,003	21,110,828	-10,811,175	(34)
IRON ORE	851,069,611	964,429,941	113,360,330	13
NICKEL (Includes, cobalt, palladium and platinum)	184,491,190	158,404,647	-26,086,543	(14)
PETROLEUM	714,091,067	811,026,024	96,934,957	14
OTHER	101,802,328	118,234,147	16,431,819	16
TOTAL REVENUE	**2,092,674,533**	**2,296,659,007**	**203,984,474**	**10**

Note: All Royalty Receipts above are only those paid into the State's Consolidated Revenue Fund during the period. It does not include royalty receipts collected on behalf of the Commonwealth.

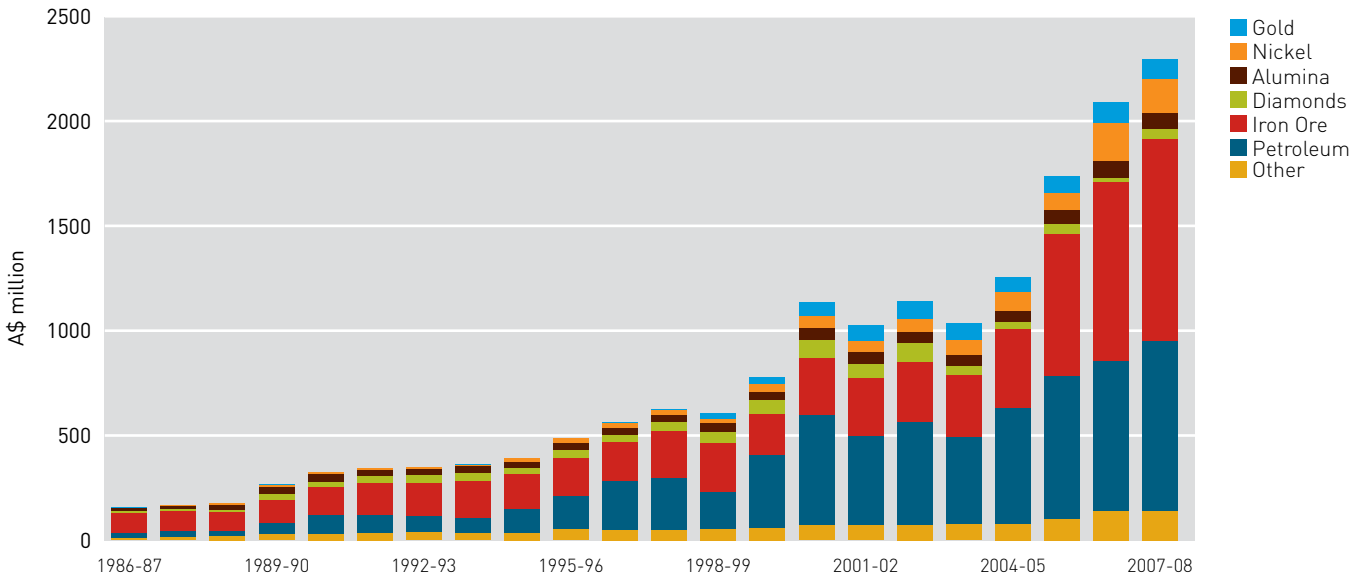

Figure 49 | **Royalty Receipts by Commodity** Source: DoIR

TABLE 2. QUANTITY AND VALUE OF MINERALS AND PETROLEUM

COMMODITY	UNIT	FINANCIAL YEAR 2006–07		FINANCIAL YEAR 2007–08	
		QUANTITY	VALUE	QUANTITY	VALUE
ALUMINA	t	11,978,698	4,847,032,758 (r)	12,307,608	4,522,136,447
BASE METALS					
Copper Metal	t	115,983 (r)	1,052,482,476 (r)	124,498	1,080,815,203
Lead Metal	t	70,473 (r)	146,072,892 (r)	25,706	81,391,253
Zinc Metal	t	142,176 (r)	675,749,725 (r)	197,129	578,310,585
TOTAL BASE METALS			1,874,305,093 (r)		1,740,517,041
CHROMITE	t	106,063	52,281,337	83,059	57,769,566
CLAYS			1,502,794		1,802,716
COAL	t	6,017,626	271,523,233 (r)	6,315,245	274,924,963
CONSTRUCTION MATERIALS					
Aggregate	t	1,102,665	28,307,131	1,723,489	43,420,168
Gravel	t	176,724	1,303,316	159,123	1,142,753
Rock	t	389,748	2,084,403	1,324,798	22,107,533
Sand	t	4,220,897 (r)	22,705,249 (r)	3,308,044	20,426,008
TOTAL CONSTRUCTION MATERIALS			54,400,099 (r)		87,096,461
DIAMONDS	ct	18,222,045	435,318,495	27,968,098	610,674,805
DIMENSION STONE		1,976	342,863	492	157,224
GEM & SEMI-PRECIOUS STONES	kg	329,689 (r)	260,083 (r)	240,606	192,110
GOLD	kg	161,775	4,222,906,523 (r)	139,511	4,074,590,506
GYPSUM	t	1,550,168 (r)	26,936,294 (r)	716,132	11,007,735
HEAVY MINERAL SANDS					
Garnet	t	265,550 (r)	n/a	327,521	n/a
Ilmenite	t	821,345 (r)	90,896,795 (r)	720,106	82,048,259
Leucoxene	t	61,458 (r)	22,397,826 (r)	60,722	17,137,786
Zircon	t	323,560 (r)	282,183,620 (r)	286,430	274,007,335
Other			392,584,849 (r)		394,779,067
TOTAL HEAVY MINERAL SANDS			788,063,090 (r)		767,972,447
IRON ORE		257,635,972 (r)	15,732,595,441 (r)	290,512,349	20,480,171,760
LIMESAND–LIMESTONE–DOLOMITE		3,805,018	23,091,619 (r)		18,419,385
MANGANESE ORE	t	902,052	153,320,702 (r)	885,709	284,127,680
NICKEL INDUSTRY					
Cobalt	t	4,699 (r)	275,284,956 (r)	5,078	448,645,387
Nickel	t	173,659 (r)	8,059,379,171 (r)	171,049	5,325,661,159
Palladium and Platinum By-Product	kg	714	9,693,188	948	13,213,845
TOTAL NICKEL INDUSTRY			8,344,357,315 (r)		5,787,520,391

TABLE 2. QUANTITY AND VALUE OF MINERALS AND PETROLEUM

COMMODITY	UNIT	FINANCIAL YEAR 2006–07		FINANCIAL YEAR 2007–08	
		QUANTITY	VALUE	QUANTITY	VALUE
PETROLEUM					
Condensate	kl	5,860,393 (r)	2,970,818,438 (r)	6,187,492	3,971,793,728
Crude Oil	kl	13,992,356 (r)	7,398,308,590 (r)	12,769,119	8,697,919,277
LNG	t	12,211,051	4,481,788,825 (r)	12,148,060	5,064,332,962
LPG - Butane and Propane	t	898,606	605,084,727	818,390	683,352,217
Natural Gas	'000m^3	8,714,911 (r)	919,485,832 (r)	9,159,074	1,025,195,256
TOTAL PETROLEUM			16,375,486,413 (r)		19,442,593,439
SALT	t	10,423,586 (r)	236,151,569 (r)	9,137,288	200,045,042
SILICA-SILICA SAND		630,536	6,016,582	675,112	11,283,531
SILVER	kg	86,017 (r)	53,701,299 (r)	104,976	53,463,741
TIN–TANTALUM–LITHIUM					
Spodumene	t	290,432	n/a	227,063	n/a
Tantalite	t	552 (r)	n/a	587	n/a
Tin Metal	t	419	6,245,046	93	1,200,322
TOTAL TIN–TANTALUM–LITHIUM			182,923,696 (r)		169,361,586
OTHER (Includes Feldspar, Red Oxide, Spongolite, Talc and Vanadium)			20,264,482 (r)		13,684,502
TOTAL VALUE			**53,702,781,780 (r)**		**58,609,513,081**

Note: Quantities used in this table only apply to Minerals and Petroleum covered by the *Mining Act 1978*, the *Petroleum Act 1967*, the *Petroleum (Submerged Lands) Act 1982* and relevant State Agreement Acts.
(r) Revised from previous edition
n/a Breakdown of feldspar, garnet, red oxide, talc, spodumene and tantalite not available

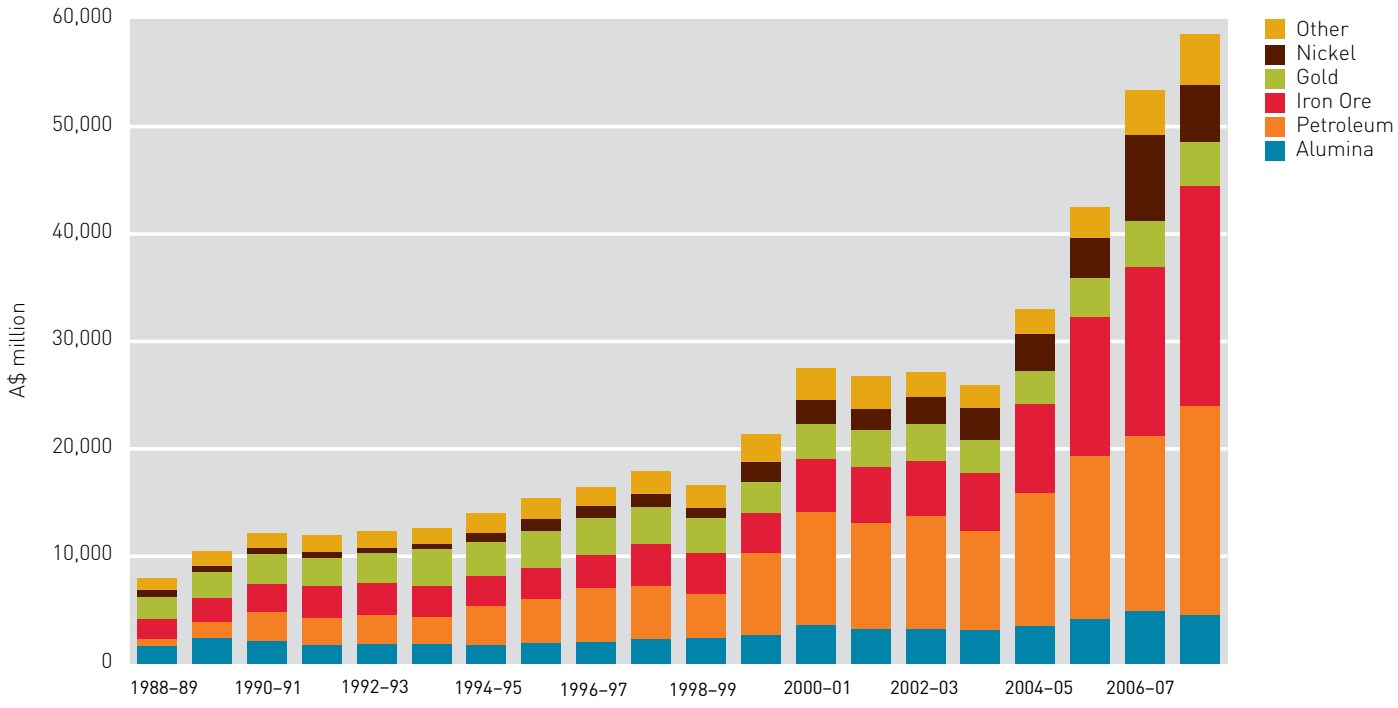

Figure 50 | **Value of Minerals and Petroleum by Commodity** Source: DoIR

TABLE 3. VALUE OF MINERALS AND PETROLEUM BY REGION BY LGA 2007–08

Region	2007–08 Value
Pilbara Region	
Roebourne	276,942,144
East Pilbara	13,862,046,976
Ashburton	7,263,436,236
Port Hedland	87,179,287
Karratha and Marble Bar	217,129
Total	**21,489,821,772**
Offshore Petroleum	**19,287,397,368**
Goldfields–Esperance Region	
Coolgardie	2,556,950,672
Leonora	2,135,730,251
Kalgoorlie–Boulder	1,688,254,755
Laverton	898,511,758
Dundas	263,478,455
Menzies	21,112,890
Ravensthorpe	271,013,386
Esperance	598,933
Total	**7,835,651,100**
Peel Region	
Waroona	3,248,558,343
Boddington	1,273,578,104
Total	**4,522,136,447**
Mid West Region	
Wiluna and Three Springs	603,053,636
Yalgoo	590,092,108
Irwin	152,113,323
Carnamah and Coorow	291,961,431
Morawa, Mullewa and Mt Magnet	295,195,533
Meekatharra	228,052,808
Northampton, Perenjori and Sandstone	88,772,061
Cue	598,518
Total	**2,249,839,418**
Kimberley Region	
Halls Creek	343,125,630
Wyndham-East Kimberley	511,420,702
Derby-West Kimberley	683,657,825
Broome	6,318,889
Total	**1,544,523,046**

Region	2007–08 Value
South West Region	
Bridgetown–Greenbushes and Capel	594,872,954
Collie	
Bunbury, Dardanup and Manjimup	45,683,601
Total	**640,556,555**
Wheatbelt Region	
Yilgarn	616,551,940
Dandaragan	226,792,881
Dalwallinu and Kondinin	106,227,926
Corrigin and Moora	1,898,427
Gingin and Wyalkatchem	1,138,137
Mukinbudin, Northam and Nungarin	758,008
Lake Grace	537,063
Total	**953,904,382**
Gascoyne Region	
Carnarvon	35,183,350
Exmouth, Shark Bay and Upper Gascoyne	21,135,310
Total	**56,318,660**
Perth Metropolitan Region	
Kalamunda, Swan and Wanneroo	16,099,226
Cockburn, Kwinana and Rockingham	7,940,589
Total	**24,039,815**
Great Southern Region	
Albany, Kent and Plantagenet	**5,324,518**

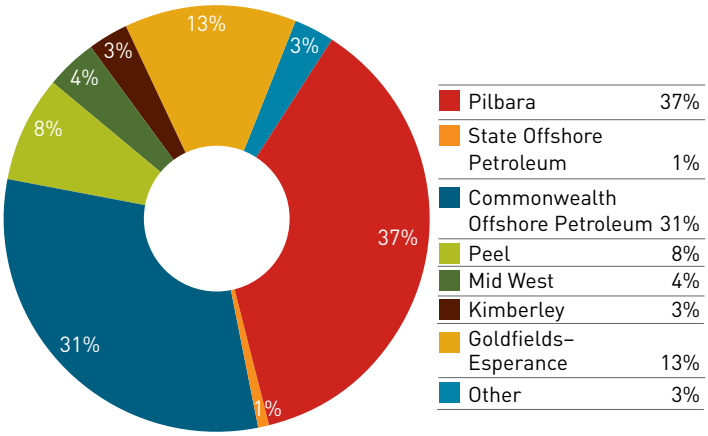

Figure 51 | **Value of Minerals and Petroleum by Region 2007–08 Total $58.6 billion**
Source: DoIR

TABLE 4. VALUE OF MINERALS AND PETROLEUM BY REGION BY COMMODITY 2007–08

Region	2007–08 Value
Pilbara Region	
Iron Ore	19,460,546,588
Copper	869,714,013
Gold and Silver	604,648,751
Manganese and Salt	429,782,562
Other	125,129,858
Total	**21,489,821,772**

Offshore Petroleum	
Crude Oil and Condensate	12,546,217,864
Liquefied Natural Gas	5,064,332,962
Natural Gas	993,494,325
LPG Butane and Propane	683,352,217
Total	**19,287,397,368**

Goldfields–Esperance Region	
Nickel	4,699,237,208
Gold	2,594,779,564
Cobalt	401,223,462
Copper and Zinc	98,698,757
Silver	15,813,988
Construction Materials	5,689,372
Gypsum and Limesand	5,398,678
Other	14,810,071
Total	**7,835,651,100**

Peel Region	
Alumina	**4,522,136,447**

Mid West Region	
Gold	707,873,638
Copper, lead and zinc	522,248,327
Crude Oil, Condensate	122,038,865
Heavy Mineral Sands, Chromite	403,493,370
Nickel and Cobalt	226,211,088
Iron ore	190,302,604
Natural Gas	31,700,904
Silver	30,763,654
Construction Materials, Talc and Other	15,206,968
Total	**2,249,839,418**

Region	2007–08 Value
Kimberley Region	
Nickel and Cobalt	281,824,832
Diamonds	610,674,805
Copper, Lead, Zinc, Silver and Gold	276,073,406
Iron Ore	366,510,630
Other	9,439,373
Total	**1,544,523,046**

South West Region	
Heavy Mineral Sands	196,016,686
Coal	274,924,963
Tin, Tantalum and Spodumene	169,361,586
Other	253,320
Total	**640,556,555**

Wheatbelt Region	
Iron Ore, Gold and Silver	609,844,171
Gypsum and Heavy Mineral Sands	228,416,713
Nickel, Copper and Salt	111,650,007
Other	3,993,491
Total	**953,904,382**

Gascoyne Region	
Salt and Gems	47,577,718
Gypsum and Limesand-Limestone	8,106,608
Other	634,334
Total	**56,318,660**

Perth Metropolitan Region	
Construction Materials, Silica Sand, Limesand-Limestone	**24,039,815**

Great Southern Region	
Spongolite and Construction Materials	**5,324,518**

TABLE 5. QUANTITY AND VALUE OF SELECTED MAJOR COMMODITIES

		1998–99		1999–00		2000–01		2001–02	
	Unit	Quantity	Value $M	Quantity	Value $M	Quantity	Value $M	Quantity	Value $M
ALUMINA	Mt	8.86	2,367.03	9.35	2,657.89	10.48	3,600.67	10.86	3,584.38
BASE METALS									
Copper Metal	kt	24.44	43.71	30.73	64.62	42.62	111.12	53.50	122.57
Lead Metal	kt	51.55	17.25	64.47	20.24	82.33	37.31	75.08	36.72
Zinc Metal	kt	194.90	170.73	232.59	251.01	236.01	280.24	223.67	173.82
TOTAL BASE METALS			231.69		335.87		428.67		333.11
COAL	Mt	5.80	256.74	6.50	271.53	6.10	252.28	6.16	258.13
COBALT	kt	1.09	55.27	2.07	86.26	4.19	174.38	4.43	127.36
DIAMONDS	M ct	51.23	610.44	50.98	703.67	25.42	614.45	25.69	489.34
GOLD	t	219.26	3,219.52	204.96	2,951.26	201.21	3,245.06	185.00	3,279.50
HEAVY MINERAL SANDS									
Ilmenite	Mt	1.32	158.59	1.16	151.66	1.10	168.75	0.80	128.75
Rutile	kt	119.71	90.97	98.49	72.78	127.21	110.04	122.61	106.74
Upgraded Ilmenite (Synthetic Rutile)	kt	475.54	275.23	552.51	324.65	643.27	409.19	585.91	380.21
Zircon	kt	284.53	136.07	348.11	153.27	343.08	198.84	317.77	218.84
Other HMS			19.44		28.85		18.08		19.78
TOTAL HEAVY MINERAL SANDS			680.30		731.20		904.90		854.32
IRON ORE	Mt	141.03	3,898.53	151.16	3,722.12	161.77	4,912.70	164.63	5,207.61
MANGANESE ORE	kt	27.40	3.42	212.38	25.68	401.36	58.50	474.27	68.62
NICKEL	kt	125.77	876.62	143.93	1,806.29	167.45	2,238.74	179.46	2,002.07
PETROLEUM									
Condensate	Gl	5.55	743.91	6.35	1,583.94	5.81	1,984.53	6.33	1,680.03
Crude oil	Gl	9.16	1,189.64	12.05	3,144.77	13.96	4,792.05	15.09	4,198.78
LNG *	Btu 10^{12} & t	391.90	1,434.42	393.61	1,971.06	429.54	2,695.53	386.08	2,970.61
LPG - Butane **	kt	388.69	90.62	443.58	190.90	428.90	221.97	482.20	193.71
LPG - Propane	kt	259.21	57.63	334.57	145.94	333.47	187.54	374.32	167.87
Natural Gas	Gm^3	6.44	549.83	6.55	578.76	7.63	630.36	7.53	643.28
TOTAL PETROLEUM			4,066.65		7,615.37		10,511.98		9,854.28
SALT	Mt	8.57	199.64	8.81	208.58	8.30	233.08	8.60	227.95
OTHER			189.73		229.26		371.67		409.47
TOTAL			16,655.58		21,344.98		27,547.08		26,696.14

* Expressed in million tonnes from 2004–05 onwards
** LPG Butane and Propane combined from 2004–05 onwards

2002–03		2003–04		2004–05		2005–06		2006–07		2007–08	
Quantity	Value $M	Quantity	Value $M	Quantity	Value $M	Quantity	Value $M	Quantity	Value $M	Quantity	Value $M
11.13	3,204.65	11.17	3,085.11	11.16	3,461.63	11.47	4,111.25	11.98	4,847.03	12.31	4,522.14
59.45	138.78	53.29	155.82	61.93	243.73	81.20	559.85	115.98	1,052.48	124.50	1,080.82
70.02	31.85	29.45	10.57	2.32	0.31	58.74	86.55	70.47	146.07	25.71	81.39
206.45	173.19	108.04	79.55	48.40	42.42	110.52	336.65	142.18	675.75	197.13	578.31
	343.82		245.95		286.46		983.05		1,874.31		1,740.52
6.32	272.89	5.98	274.28	6.28	271.72	6.71	297.37	6.02	271.52	6.32	274.92
4.92	124.18	4.55	213.14	4.50	202.38	5.02	183.98	4.70	275.28	5.08	448.65
38.89	773.32	32.50	519.72	22.80	467.81	29.26	693.80	18.22	435.32	27.97	610.67
187.47	3,445.34	177.01	3,109.56	167.35	3,016.38	166.17	3,715.05	161.77	4,222.91	139.51	4,074.59
0.96	136.51	0.76	91.03	0.71	79.55	590.24	65.92	0.82	90.90	0.72	82.05
113.57	82.53	138.77	84.57	101.71	63.02	n/a	n/a	n/a	n/a	n/a	n/a
597.27	353.10	592.18	307.00	652.94	336.37	n/a	n/a	n/a	n/a	n/a	n/a
411.15	255.81	433.14	251.97	420.04	298.37	402.42	357.34	323.56	282.18	286.43	274.01
	16.86		20.53		23.58		442.71		414.98		394.78
	844.81		755.10		800.89		865.97		788.06		767.97
188.52	5,205.27	202.04	5,331.53	233.15	8,302.34	242.63	12,699.09	257.64	15,732.60	290.51	20,480.17
619.65	75.38	584.97	81.78	606.94	116.32	888.43	117.97	902.05	153.32	885.71	284.13
191.89	2,482.47	182.21	3,031.04	180.42	3,503.20	183.56	3,815.11	173.66	8,059.38	171.05	5,325.66
6.93	2,046.37	6.18	1,747.51	5.63	2,203.11	5.63	2,791.73	5.86	2,970.82	6.19	3,971.79
14.00	4,258.12	13.22	3,773.64	12.80	5,146.61	11.16	5,935.12	13.99	7,398.31	12.77	8,697.92
403.83	3,130.83	404.94	2,775.88	11.04	3,953.10	11.68	4,625.22	12.21	4,481.79	12.15	5,064.33
460.47	221.47	383.92	154.13	77.17	421.74	871.98	654.42	898.61	605.08	818.39	683.35
346.60	172.39	311.35	128.02	**							
8.12	661.92	8.06	694.07	7.64	678.72	7.71	703.28	8.71	919.49	9.16	1,025.20
	10,491.10		9,273.25		12,403.29		14,709.77		16,375.49		19,442.59
9.61	227.95	9.88	179.85	11.58	221.25	10.83	229.85	10.42	236.15	9.14	200.05
	366.48		316.87		820.06		1,113.02		866.73		437.45
	27,857.66		26,417.17		33,405.91		42,841.48		53,702.78		58,609.51

TABLE 6. PRINCIPAL MINERAL AND PETROLEUM PRODUCERS EFFECTIVE 1 SEPTEMBER 2008

BASE METALS

COPPER–LEAD–ZINC

Birla Nifty Pty Ltd,
Level 3, 256 Adelaide Terrace,
Perth WA 6000,
(08) 9366 8800
Nifty.
www.adityabirla.com/our_companies/international_companies/birla_nifty.htm

BHP Billiton (Nickel West)
191 Great Eastern Highway,
Belmont WA 6104,
(08) 9479 0500,
Kambalda.
www.bhpbilliton.com

Fox Resources Ltd,
Suite 1 and 2,
614 Newcastle Street,
Leederville WA 6007,
(08) 9318 5600
Whundo,
www.foxresources.com.au

Jabiru Metals Limited,
Ground Floor,
1205 Hay Street,
West Perth WA 6005,
(08) 9426 8300
Jaguar.
www.jabirumetals.com.au

Magellan Metals Pty Ltd,
96 Welshpool Road,
Welshpool WA 6106,
(08) 9267 7000,
Magellan,
www.ivernia.com

Newcrest Mining Ltd
Level 2, 20 Terrace Road
East Perth WA 6004
(08) 9270 7070
Telfer.
www.newcrest.com.au

Oz Minerals Limited,
Second Floor,
16 Ord Street,
West Perth WA 6005
(08) 9216 5800,
Golden Grove.
www.ozminerals.com

Straits Resources Limited,
Level 1, 35 Ventnor Avenue,
West Perth WA 6005,
(08) 9480 0500,
Mons Cupri,
www.straits.com.au

BAUXITE–ALUMINA

ALUMINA

Alcoa World Alumina Australia,
181–205 Davy Street,
Booragoon WA 6154,
(08) 9316 5111,
Del Park, Willowdale, Huntly,
www.alcoa.com.au

Worsley Alumina Pty Ltd,
PO Box 344,
Collie WA 6225,
(08) 9734 8311,
Boddington,
www.wapl.com.au

CHROMITE

CHROMITE ORE

Pilbara Chromite Pty Ltd,
28 Ventnor Avenue,
West Perth WA 6005,
(08) 9321 3633,
Coobina,
www.consminerals.com.au

CLAY

ATTAPULGITE

Hudson Resources Ltd,
2 Kemp Street, Narngulu,
Geraldton WA 6530,
(08) 9923 3604,
Lake Nerramyne,
www.hudsonresources.com

CLAY SHALE

The Griffin Coal Mining Company Pty Limited,
28 The Esplanade,
Perth WA 6000,
(08) 9261 2800,
Collie
www.griffincoal.com.au

FIRE CLAY

Midland Brick Company Pty Ltd,
102 Great Northern Highway,
Middle Swan WA 6056,
(08) 9273 5522,
Bullsbrook North,
www.midlandbrick.com.au

SAPONITE

Watheroo Minerals Pty Ltd,
PO Box 353,
Dunsborough WA 6281,
(08) 9756 6121,
Watheroo Clays,
www.bentoniteproductswa.com.au

COAL

The Griffin Coal Mining Company Pty Limited,
28 The Esplanade,
Perth WA 6000,
(08) 9261 2800,
Collie
www.griffincoal.com.au

Wesfarmers Premier Coal Ltd,
Premier Road,
Collie WA 6225,
(08) 9780 2222
Collie
www.wesfarmers.com.au

CONSTRUCTION MATERIALS

AGGREGATE

Cemex,
Technology Park,
18-20 Brodie-Hall Drive,
Bentley WA 6102
(08) 9212 2000,
Boodarrie, Burrup–Dampier,
www.cemex.com.au

GRAVEL

Boral Resources (WA) Ltd,
63-69 Abernethy Road,
Belmont WA 6104,
(08) 9333 3400,
Grosmont,
www.boral.com.au

WA Limestone Co.,
41 Spearwood Avenue,
Bibra Lake WA 6163,
(08) 9434 2299,
Pickering Brook

SAND

Boral Resources (WA) Ltd,
63-69 Abernethy Road,
Belmont WA 6104,
(08) 9333 3400,
Grosmont,
www.boral.com.au

Rocla Quarry Products,
130 Fauntleroy Avenue,
Redcliffe WA 6104,
(08) 9475 2555,
Gnangarra,
www.rocla.com.au

Cemex,
Technology Park,
18-20 Brodie-Hall Drive,
Bentley WA 6102
(08) 9212 2000,
Various sites,
www.cemex.com.au

TABLE 6. PRINCIPAL MINERAL AND PETROLEUM PRODUCERS EFFECTIVE 1 SEPTEMBER 2008

Tuma Holdings Pty Ltd,
T/as Action Sand Supplies
42 Noel Road,
Gooseberry Hill WA 6076,
(08) 9275 1100
Mobile: 0408 923 801
The Lakes, Mundaring

DIAMONDS

Argyle Diamonds Australia,
2 King's Park Road,
West Perth WA 6005,
(08) 9482 1166,
Argyle,
www.argylediamonds.com.au

Kimberley Diamond Company,
Level 3, 52 King's Park Road,
West Perth WA 6005,
(08) 9426 9888,
Ellendale,
www.gemdiamonds.com

DIMENSION STONE

GRANITE

Fraser Range Granite NL,
Eyre Highway,
Norseman WA 6443,
(08) 9039 3442,
Fraser Range Granite

FELDSPAR

Unimin Australia Ltd,
26-28 Tomlinson Road,
Welshpool WA 6106,
(08) 9362 1655,
Pippingarra, Mukinbudin,
www.unimin.com.au

GOLD

Agnew Gold Mining Co. Pty Ltd,
PMB 10,
Leinster WA 6437,
(08) 9088 3822,
Agnew,
www.goldfields.co.za

AngloGold Australia Ltd,
Level 13, St Martin's Tower,
44 St Georges Terrace,
Perth WA 6000,
(08) 9425 4600,
Sunrise Dam,
www.anglogoldashanti.com

Barra Resources Limited,
Level 3, Mercury House,
33 Richardson Street,
West Perth WA 6005,
(08) 9481 3911,
Burbanks,
www.barraresources.com.au

Barrick Gold of Australia Limited,
Level 10, 2 Mill Street,
Perth WA 6000,
(08) 9212 5777,
Darlot, Lawlers, Plutonic, Granny Smith,
Kanowna Belle, East Kundana.
www.barrick.com

Crescent Gold Limited,
Level 5, 89 St Georges Terrace,
Perth WA 6000,
(08) 9322 5833,
Laverton–Barnicoat,
www.crescentgold.com

Dioro Exploration NL,
Level 2, 45 Stirling Highway,
Nedlands WA 6009,
(08) 9389 8799,
South Kal Mines–New Celebration,
www.dioro.com.au

Kalgoorlie Consolidated Gold Mines Pty Ltd,
Private Bag 27,
Kalgoorlie WA 6433,
(08) 9022 1100,
Golden Mile Fimiston Super Pit
www.superpit.com.au

Lihir Gold Limited,
Level 9, AAMI Building,
500 Queen Street,
Brisbane Qld 4000,
(07) 3318 3300,
Kirkalocka,
www.lglgold.com

Monarch Gold Mining Company Limited (Administrators Appointed),
Level 1, 23 Ventnor Avenue,
West Perth WA 6005,
(08) 9481 6422,
Davyhurst, Mt Isa.
www.monarchgold.com.au

Newcrest Mining Ltd
Level 2, 20 Terrace Road
East Perth WA 6004
(08) 9270 7070
Telfer.
www.newcrest.com.au

Newmont Australia,
PO Box 1652,
Subiaco WA 6904,
(08) 9983 7000 (site)
Jundee-Nimary,
www.newmont.com

Norseman Gold Plc,
Level 2, Canning Highway,
Victoria Park WA 6979,
(08) 9473 2201,
Norseman,
www.norseman goldplc.com

Nustar Mining Corporation Limited,
Level 2, 34 Colin Street,
West Perth WA 6005
(08) 9346 0000,
Paulsens,
www.nustarmining.com.au

Paddington Gold Pty Ltd,
Menzies Highway,
PO Box 1653,
Kalgoorlie WA 6430,
(08) 9080 6800,
Paddington,
www.nortongoldfields.com.au

Ramelius Resources Limited,
GPO Box 1373,
Adelaide SA 5001,
(08) 8373 6473,
Wattle Dam,
www.rameliusresources.com.au

Range River Gold Limited,
15 Queen Street,
Melbourne Vic 3000,
(03) 8614 1500,
Indee Gold,
www.rangeriver.com.au

St Barbara Mines Ltd,
1205 Hay Street,
West Perth WA 6005
(08) 9476 5555,
Marvel Loch–Southern Cross,
www.stbarbara.com.au

St Ives Gold Mining Co Pty Ltd,
POB 359
Kambalda WA 6442,
(08) 9088 1111,
Kambalda–St Ives,
www.goldfields.co.za

Tanami Gold NL,
Level 4, 50 Colin Street,
West Perth WA 6005,
(08) 9212 5999,
Coyote,
www.tanami.com.au

TABLE 6. PRINCIPAL MINERAL AND PETROLEUM PRODUCERS EFFECTIVE 1 SEPTEMBER 2008

Troy Resources NL,
44 Ord Street,
West Perth WA 6005,
(08) 9481 1277,
Sandstone,
www.try.com.au

View Resources Limited (Administrators Appointed),
Level 12, London House,
216 St Georges Terrace,
Perth WA 6000,
(08) 9226 4611,
Bronzewing,
www.viewresources.com.au

GYPSUM

Cockburn Cement Ltd,
Lot 242 Russell Road East
East Munster WA 6166,
(08) 9411 1000,
Lake Hillman.

Dampier Salt Pty Ltd,
37 Belmont Avenue
Belmont WA 6104
(08) 9270 9270,
Lake MacLeod
www.dampiersalt.com.au

Gypsum Industries,
PO Box 952,
Canning Bridge WA 6153
(08) 9364 4951,
Lake Cowcowing.
www.aglime.com.au

Lake Hillman Mining Pty Ltd,
PO Box 1,
Kalannie WA 6468,
(08) 9666 2045,
Lake Hillman.

HEAVY MINERAL SANDS

GARNET SAND

GMA Garnet Pty Ltd,
PO Box 188,
Geraldton WA 6531,
(08) 9923 3644,
Port Gregory,
www.garnetsales.com

ILMENITE, LEUCOXENE, RUTILE AND ZIRCON

Cable Sands (WA) Pty Ltd,
PO Box 133,
Bunbury WA 6231,
(08) 9721 0200,
Jangardup, Sandalwood,
Ludlow, Tutunup,
www.cablesands.com.au

Doral Mineral Sands
Lot 7 Harris Road
Picton WA 6229
(08) 9725 4899,
Dardanup,
www.doral.com.au

Iluka Resources Ltd,
Level 23, 140 St Georges Terrace,
Perth WA 6000,
(08) 9360 4700
Capel, Eneabba, Yoganup,
www.iluka.com

TiWest Pty Ltd,
1 Brodie-Hall Drive,
Bentley WA 6102,
(08) 9365 1333,
Cooljarloo,
www.tiwest.com.au

IRON ORE

BHP Billiton Iron Ore (Goldsworthy) Ltd,
225 St Georges Terrace,
Perth WA 6000,
(08) 9320 4444,
Mining Area C, Nimingarra–Yarrie,
www.bhpbilliton.com

BHP Billiton Iron Ore Ltd,
225 St Georges Terrace,
Perth WA 6000,
(08) 9320 4444,
Jimblebar, Newman, Yandicoogina,
www.bhpbilliton.com

Channar Mining Pty Ltd,
152 St Georges Terrace,
Perth WA 6000,
(08) 9327 2327,
Channar.

Fortescue Metals Limited,
Level 2, 87 Adelaide Terrace,
East Perth WA 6004,
(08) 9218 8888,
Cloud Break.
www.fmgl.com.au

Hamersley Iron Pty Ltd,
152 St Georges Terrace,
Perth WA 6000,
(08) 9327 2327,
Brockman, Hope Downs, Marandoo,
Paraburdoo,
Tom Price, Yandicoogina,
www.hamersleyiron.com

Midwest Corporation Limited,
Suite 2, 32 Kings Park Road,
West Perth WA 6005,
(08) 9226 2033,
Koolanooka,
www.midwest.com.au

Mt Gibson Iron Limited,
1st Floor,
7 Havelock Street,
West Perth WA 6005,
(08) 9426 7500,
Tallering Peak, Koolan Island,
www.mtgibsoniron.com.au

Murchison Metals Ltd,
Level 2, 18 Richardson Street,
West Perth WA 6005,
(08) 9483 0500,
Jack Hills,
www.mml.net.au

Portman Iron Ore Ltd,
Level 11, 1 William Street,
Perth WA 6000,
(08) 9426 3333,
Cockatoo Island, Koolyanobbing,
www.portman.com.au

Robe River Iron Associates
Level 27 Central Park
152-158 St Georges Terrace
Perth WA 6000,
(08) 9327 2800,
Pannawonica, West Angelas,
www.roberiver.com.au

LIMESAND–LIMESTONE

Cockburn Cement Ltd,
Lot 242, Russell Road East,
East Munster WA 6163,
(08) 9411 1000,
Cockburn, Dongara, Wanneroo
www.cockburncement.com.au

Limestone Resources Australia Pty Ltd,
Unit 1, 7 Guthrie Street,
Osborne Park WA, 6017,
(08) 9445 3433,
Wanneroo, Moore River, Carabooda
www.limestone-resources.com.au

Loongana Lime Pty Ltd,
PO Box 808,
Kalgoorlie WA 6430,
(08) 9021 8055,
Loongana.

TABLE 6. PRINCIPAL MINERAL AND PETROLEUM PRODUCERS EFFECTIVE 1 SEPTEMBER 2008

WA Limestone Co.,
41 Spearwood Avenue,
Bibra Lake WA 6163,
(08) 9434 2299,
Postans.

Gypsum Industries of Australia,
PO Box 952,
Canning Bridge WA 6153,
(08) 9364 4951,
Dongara–Denison, Cervantes, Lancelin, Jurien.

MANGANESE

Pilbara Manganese Pty Ltd,
28 Ventor Avenue,
West Perth WA 6005,
(08) 9321 3633,
Woodie Woodie,
www.consminerals.com.au

NICKEL

Australian Mines Limited,
Level 1, 681 Murray Street,
West Perth WA 6005,
(08) 9481 5811,
Blair,
www.australianmines.com.au

BHP Billiton (Nickel West),
191 Great Eastern Highway,
Belmont WA 6104,
(08) 9479 0500,
Kambalda, Leinster, Mt Keith,
www.bhpbilliton.com

Consolidated Minerals Limited,
28 Ventnor Avenue,
West Perth WA 6005,
(08) 9321 3633,
Beta Hunt,
www.consminerals.com.au

Fox Resources Ltd,
Suites 1 and 2,
614 Newcastle Street,
Leederville WA 6007,
(08) 9318 5600
Radio Hill
www.foxresources.com.au

Glenmurrin Pty Ltd
30 The Esplanade,
Perth WA 6000,
(08) 9226 1099,
Murrin Murrin,
www.glencore.com

Minara Resources Ltd,
Level 4, 30 The Esplanade,
Perth WA 6000,
(08) 9212 8400,
Murrin Murrin,
www.minara.com.au

Independence Group NL,
PO Box 893,
South Perth WA 6951,
(08) 9367 2755,
Long Nickel,
www.independencegroup.com.au

Mincor Resources NL,
Level 1, 1 Havelock Street,
West Perth WA 6005,
(08) 9321 7125,
Miitel, Wannaway, Redross, Mariners, Carnilya Hill
www.mincor.com.au

Norilsk Nickel Australia Pty Ltd,
Level 3, 88 Colin Street,
West Perth WA 6005,
(08) 9426 0100
Black Swan, Waterloo,
Cawse, Lake Johnson,
www.nornik.ru/en/

Panoramic Resources Ltd,
Level 22, Allendale Square,
77 St Georges Terrace,
Perth WA 6000,
(08) 9225 0999,
Sally Malay, Lanfranchi Tramways
www.panoramicresources.com

Xstrata Nickel Australasia,
3rd Floor, 24 Outram Street,
West Perth WA 6005,
(08) 9213 1588,
Cosmos,
www.xstrata.com

Western Areas NL,
Level 1, 11 Ventnor Avenue,
West Perth WA 6005,
(08) 9486 7855,
Flying Fox,
www.westernareas.com.au

PALLADIUM

BHP Billiton (Nickel West),
191 Great Eastern Highway,
Belmont WA 6104,
(08) 9479 0500,
Kambalda,
www.bhpbilliton.com

PETROLEUM

Apache Energy Ltd,
Level 3, 256 St Georges Terrace,
Perth WA 6000,
(08) 9422 7222,
Agincourt, Albert, Artreus, Bambra, Campbell, Double Island, Endymion, Gipsy, Gudrun, Harriet, Hoover, Legendre, Linda, Little Sandy, Mohave, Monet, North Alkimos, North Pedirka, Pedirka, Rose, Simpson, Sinbad, South Plato, Stag, Tanami, Victoria, Wonnich,
www.apachecorp.com

Buru Energy Limited,
Level 3, Suite 32,
IBM Building,
1060 Hay Street, Street,
West Perth WA 6005,
Free Call: 1800 337 330,
Blina, Dongara, Evandra,
Hovea-Eremia, Mt Horner,
Xyris, Woodada,
www.buruenergy.com.au

BHP Billiton Petroleum (North West Shelf) Pty Ltd,
Level 42, Central Park,
152-158 St Georges Terrace,
Perth WA 6000,
(08) 9278 4888,
Chinook–Scindian, Griffin, Stybarrow,
www.bhpbilliton.com

ChevronTexaco Australia Pty Ltd,
Level 24, QV1 Building,
250 St Georges Terrace,
Perth WA 6000,
(08) 9216 4000,
Barrow Island, Cowle, Crest,
Roller-Skate, Saladin, Yammaderry,
www.chevron.com

TABLE 6. PRINCIPAL MINERAL AND PETROLEUM PRODUCERS EFFECTIVE 1 SEPTEMBER 2008

ENI Australia Limited,
Level 3, 40 Kings Park Road,
West Perth WA 6005,
(08) 9320 1111,
Woollybutt.

Origin Energy Resources Ltd,
34 Colin Street,
West Perth WA 6005,
(09) 9324 6111,
Beharra Springs, Jingemia, Tarantula
www.originenergy.com.au

Santos Limited,
Ground Floor Santos Centre,
60 Flinders Street,
Adelaide SA 5001,
(08) 8116 5000,
Mutineer–Exeter,
www.santos.com.au

Woodside Energy Ltd,
240 St Georges Terrace,
Perth WA 6000,
(08) 9348 4000,
Athena, Cossack, Echo-Yodel, Goodwyn,
Hermes, Lambert, Laminaria,
North Rankin, Perseus, Wanaea,
www.woodside.com.au

PLATINUM

BHP Billiton (Nickel West)
191 Great Eastern Highway,
Belmont WA 6104,
(08) 9479 0500,
Kambalda.
www.bhpbilliton.com

SALT

Dampier Salt Pty Ltd,
37 Belmont Avenue
Belmont WA 6104
(08) 9270 9270,
Dampier, Lake MacLeod, Port Hedland,
www.dampiersalt.com.au

Onslow Salt Pty Ltd,
PO Box 23,
Onslow WA 6710,
(08) 9184 9000,
Onslow Salt,
www.onslowsalt.com

Shark Bay Salt Joint Venture,
Level 16, 2 The Esplanade,
Perth WA 6000,
(08) 9265 8000,
Useless Loop.

WA Salt Supply Ltd,
Cockburn Road,
Hamilton Hill WA 6163,
(08) 9430 5495,
Lake Deborah East, Pink Lake,
www.wasalt.com.au

SILICA–SILICA SAND

SILICA

Simcoa Operations Pty Ltd,
PO Box 1389,
Bunbury WA 6231,
(08) 9780 6666,
Dalaroo,
www.simcoa.com.au

SILICA SAND

Kemerton Silica Sand Pty Ltd,
PO Box A283,
Australind WA 6233,
(08) 9720 0022
www.ksspl.com.au

Rocla Quarry Products,
180 Fauntleroy Avenue,
Kewdale WA 6105,
(08) 9475 2555
Gnangarra,
www.rocla.com.au

Austsand Pty Ltd,
PO Box 1373,
Albany WA 6330,
(08) 9846 1288,
Mindijup.

SPONGOLITE

Australian Diatamaceous Earth Pty Ltd,
GPO Box 4188,
Sydney NSW 2001
Woogenellup,
www.supersorb.com.au

TALC

Luzenac Australia Pty Ltd,
Level 22,
152–158 St Georges Terrace
(08) 9327 2277,
Three Springs,
www.luzenac.com

Unimin Australia Ltd,
26 Tomlinson Road,
Welshpool WA 6106,
(08) 9362 1655,
Mt Seabrook,
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TIN–TANTALUM–LITHIUM

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TANTALITE–TIN

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ABBREVIATIONS

A$	Australian Dollar	km	kilometres
ABARE	Australian Bureau of Agricultural and Resource Economics	km^2	square kilometres
ABS	Australian Bureau of Statistics	LME	London Metal Exchange
AFR	Australian Financial Review	Mbbl	thousand barrels of oil
ANZ	Australia and New Zealand bank	MMbbl	million barrels of oil
bbl	barrels of oil	Mct	million carats
Bcm	billion cubic metres	Moz	million ounces
BMR	Bureau of Mineral Resources	Mt	million tonnes
cons	concentrates	Mt/a	million tonnes per annum
CSO	Central Selling Organisation	n/a	not applicable
ct	carat	oz	ounce
DRI	Direct Reduced Iron	RBA	Reserve Bank of Australia
ECB	European Central Bank	t	tonnes
f.o.b.	free-on-board	t/a	tonnes per annum
f.o.t.	free-on-truck	Tcf	trillion cubic feet
GDP	Gross Domestic Product	US$	United States Dollar
HBI	Hot Briquetted Iron	WTI	West Texas Intermediate
IMF	International Monetary Fund		

UNITS AND CONVERSION FACTORS

	Metric Unit	Symbol		Imperial Unit
Mass	1 gram	g	=	0.032151 troy (fine) ounce (oz)
	1 kilogram	kg	=	2.204624 pounds (lb)
	1 tonne	t	=	1.10231 United States short ton [1 US short ton = 2,000 lb]
	1 tonne	t	=	0.98421 United Kingdom long ton [1 UK long ton = 2,240 lb]
	1 tonne LNG	t	=	52,000,000 British Thermal Units (Btu)
Volume	1 kilolitre	kl	=	6.28981 barrels (bbl)
	1 cubic metre	m^3	=	35.3147 cubic feet (ft^3) [1 kilolitre (kl) = 1 cubic metre (m^3)]
Energy	1 kilojoule	kj	=	0.94781 British Thermal Units (Btu)

	Energy Content	Prefix	
Coal	19.7 GJ/t	kilo (k)	10^3
Condensate	32.0 MJ/L	mega (M)	10^6
Crude oil	37.0 MJ/L	giga (G)	10^9
LNG	25.0 MJ/L	tera (T)	10^{12}
Natural gas	38.2 MJ/m^3	peta (P)	10^{15}
LPG-butane	28.7 MJ/L (1tonne LPG-butane = 1,720 litres)		
LPG-propane	25.4 MJ/L (1tonne LPG-propane = 1,960 litres)		

DATA SOURCES

Quantities and values for minerals and petroleum in this publication are collected from a variety of sources including:

The Department's royalty returns, various company annual reports and quarterly Australian Stock Exchange reports, State port authority statistics, the ABS and ABARE.

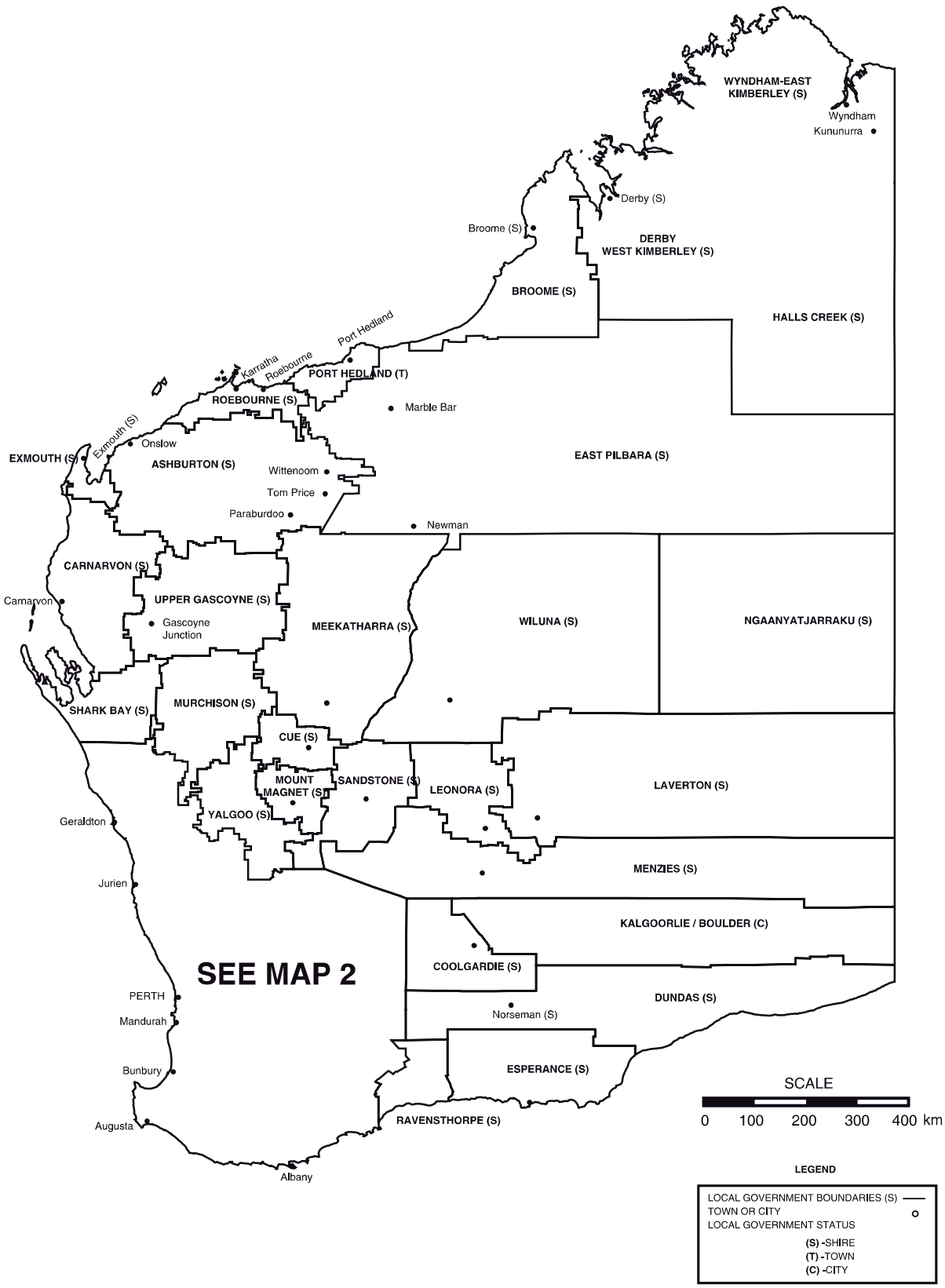
Quantities specified relate to either mine production or sales as listed below for each commodity.

Mine Production
Clays
Coal
Construction Materials
Dimension Stone
Gold
Gypsum
Limesand–Limestone–Dolomite
Silica–Silica Sand
Talc
Sales
Alumina
Base Metals (Copper, Lead and Zinc)
Chromite
Diamonds
Gem and Semi-Precious Stones
Heavy Mineral Sands
Industrial Pegmatite Minerals
Iron Ore
Manganese
Nickel Industry (Nickel, Cobalt, Platinum and Palladium)
Petroleum
Pigments
Salt
Silver
Spongolite
Tin–Tantalum–Lithium
Vanadium

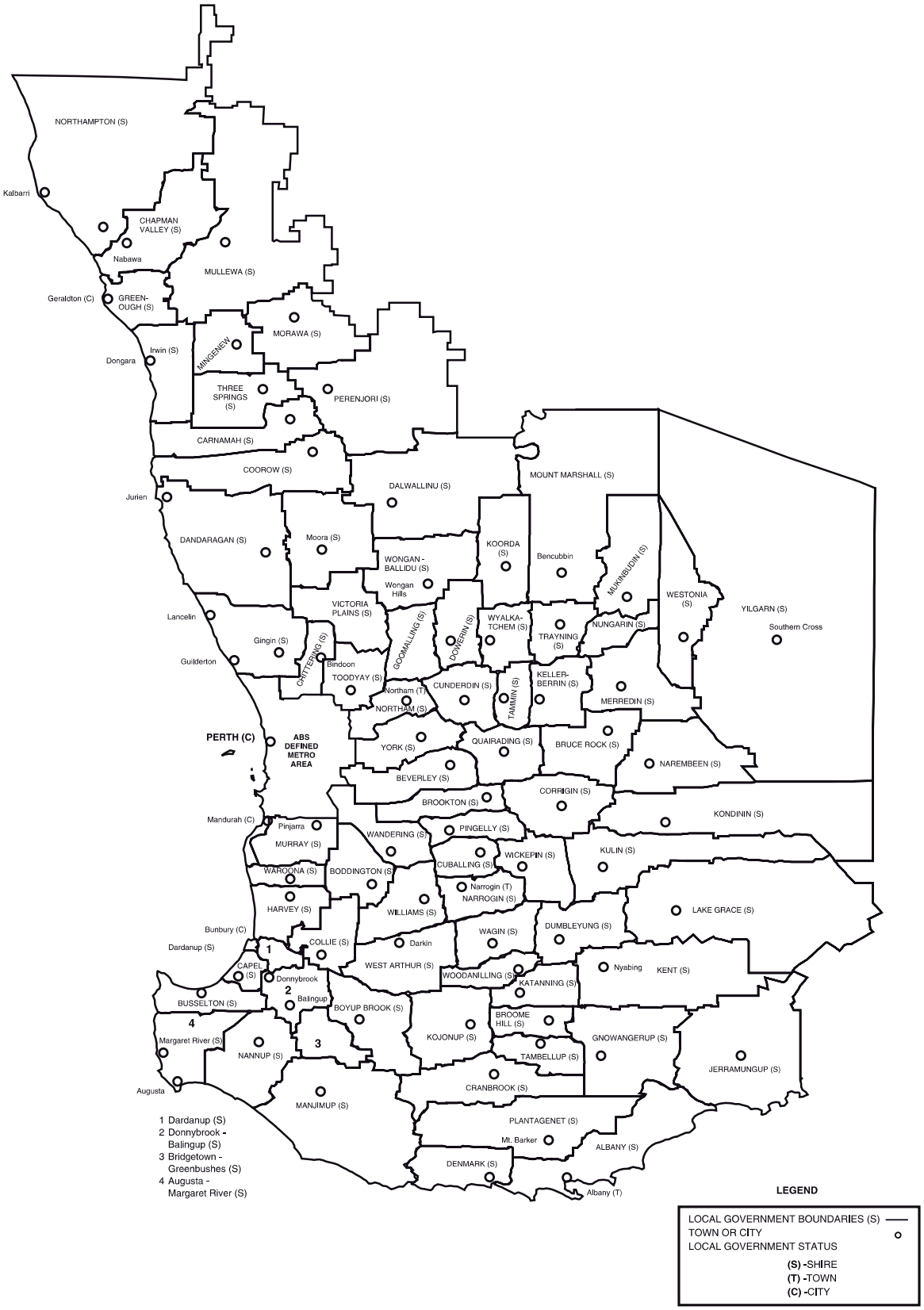
CLASSIFICATION OF COUNTRIES

Euro area[1]/ European Union	
Austria	*Italy*
Belgium	Latvia
Cyprus	Lithuania
Czech Republic	*Luxembourg*
Denmark	Malta
Estonia	*Netherlands*
Finland	Poland
France	*Portugal*
Germany	Slovakia
Greece	Slovenia
Hungary	*Spain*
Ireland	Sweden
	United Kingdom
Non-Japan Asia	
Afghanistan	Myanmar
Bangladesh	Nepal
Bhutan	Newly industrialised Asia
Brunei Darussalam	Pakistan
Cambodia	Papua New Guinea
China	Philippines
Fiji	Samoa
India	Solomon Islands
Indonesia	Sri Lanka
Kiribati	Thailand
Lao PD Republic	Tonga
Malaysia	Vanuatu
Maldives	Vietnam
Mongolia	
Newly Industrialised Asia	
Hong Kong	Singapore
Republic of Korea	Taiwan

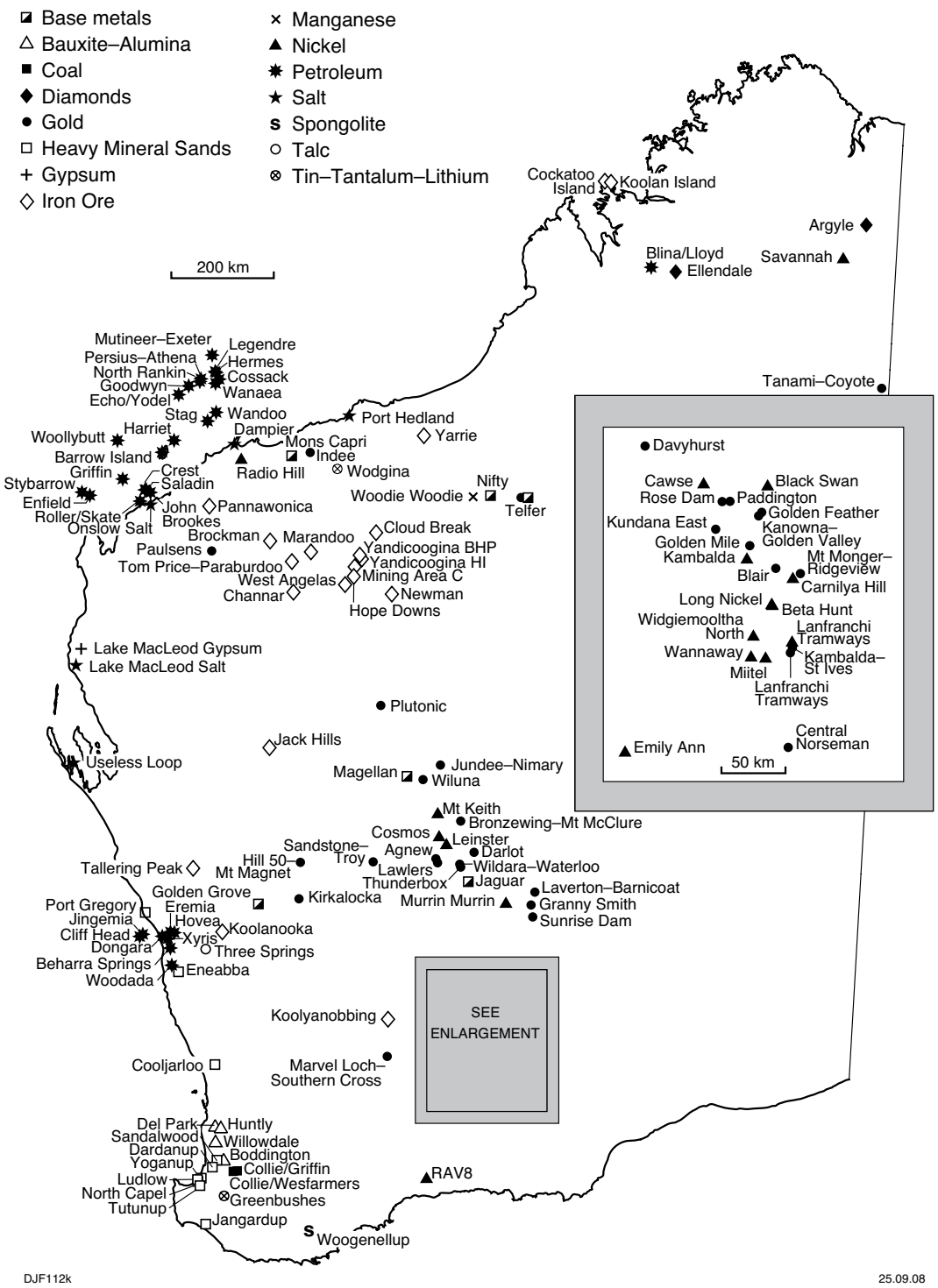
[1]Italics indicate countries that are members of the euro area.



Map 1 **Local Government Boundaries**



Map 2 **Local Government Boundaries**



Map 3 **Major Mineral and Petroleum Projects in Western Australia**

This publication is available on our website

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