Overview of mineral and petroleum exploration in Western Australia in 1999–2000

by D. J. Flint[1] and R. H. Bruce[2]

In the 1999–2000 financial year, the value of mineral production (including petroleum) rose sharply by $4611 million (27.7%) and totalled $21 266 million, making this the first year that aggregate mineral production had exceeded $20 000 million in value. The value of petroleum products rose sharply by $3584 million (88%) to a total of $7649 million, but rises were also recorded for the value of alumina, base metals, coal, diamond, leucoxene, manganese, nickel, spodumene, synthetic rutile, and tantalite. Western Australia continues to lead the country in both gas and liquid petroleum production, and it ranks fourth in the world for liquefied natural gas (LNG) production. Falls were recorded in the value of production of gold, ilmenite, iron ore, rutile, salt, and tin. In a world market context, Western Australia continues to be a very significant producer of gold, iron ore, bauxite–alumina, nickel, diamond, heavy-mineral sand products, salt, tantalite, spodumene (lithium), and LNG.

Exploration in Australia and throughout the world continued to decline during 1999–2000. This is attributed to low metal prices in general in recent years, particularly in the case of gold (the gold price reached a 20-year low point in $US terms). In recent years, companies had focused on increasing the volume of ore treated and reducing costs, but surveys have shown that mining is often a low-profit activity. Companies concentrated more on corporate return on capital during 1999–2000, and speculative venture capital was directed away from the resources sector to the information and technology sector of world stock markets (the dot.com boom). The perception existed that mining was 'old economy' and that exploration, particularly greenfields exploration, destroys shareholder value. This resulted in reduced exploration activity, less preparedness to risk funds on greenfields exploration, and a lower percentage of profits directed back as exploration expenditure. In Australia, the effect of Native Title issues on land access compounded the problems.

However, the year finished with renewed interest in the minerals sector as a result of stronger profits, a falling Australian dollar exchange rate, publicity given to exploration successes, and takeover activity (particularly from large foreign companies) targeting companies yielding acceptable rates of return on equity or with the best exploration potential. This renewed interest has flowed through to more company floats on the Australian Stock Exchange. Prospectuses released during the year that contained properties in Western Australia included Tuart Resources NL, Templar Resources Ltd, Orlando Resources NL, Bullion Minerals Ltd, Western Areas NL, Phoenix Mining Ltd, and Ausgem International Ltd.

Mineral exploration

Western Australia's prospectivity is highlighted by the continuing high proportion of Australian exploration expenditure that the State attracts. However, like the other States, Western Australia experienced a reduction in exploration activity during 1999–2000, with mineral exploration

[1] d.flint@dme.wa.gov.au
[2] Petroleum Division, Department of Minerals and Energy

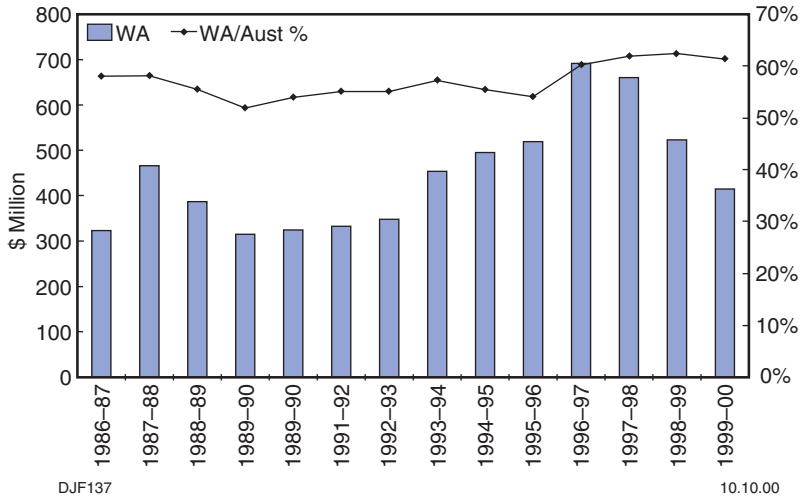

Figure 1. Mineral exploration expenditure in Western Australia, by year (dollars of the day)

expenditure (excluding petroleum) in Western Australia at $415.0 million, a decrease of $108.1 million or 20.7% on the previous year. This is the third successive substantial decline in total annual exploration expenditure after seven successive years of growth (Fig. 1), with exploration expenditure (excluding petroleum) in Western Australia having fallen by a total of 40% over the last three years. However, mineral exploration expenditure in Western Australia, on a quarterly basis, showed signs of stabilizing towards the end of 1999–2000, suggesting that the exploration slump may have bottomed out (Fig. 2).

The fall in exploration activity over the last three years, both in Western Australia and the other States, has seen Australia-wide exploration expenditure (excluding petroleum) falling well below the record levels of over $1000 million that were achieved in 1996–97 and 1997–98. Australia-wide expenditure figures showed a drop of $161.5 million (19%) to $676.3 million during 1999–2000. Most of the decrease was in Western Australia, where expenditure fell to $108.1 million (67% of the national decrease). However, Western Australia still continues to attract the greatest portion of all Australian exploration expenditure (61.4% compared to 62.4%

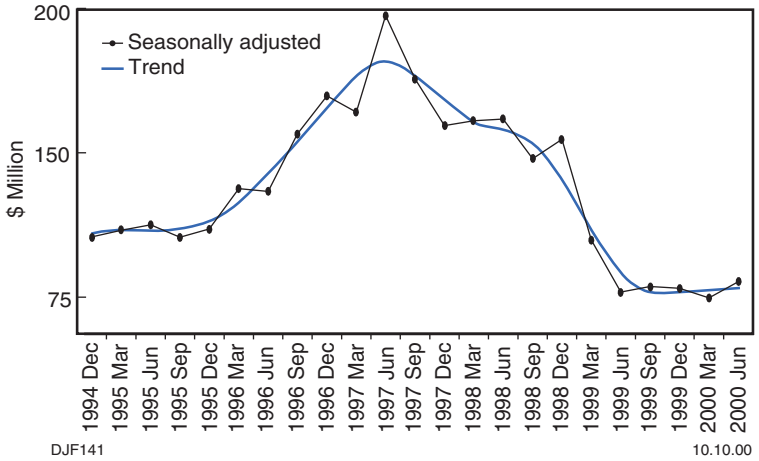

Figure 2. Mineral exploration expenditure in Western Australia, by quarter, on seasonally adjusted and trend terms (dollars of the day)

previously). This has remained relatively constant at 60–62% over the last four years throughout the large cutbacks that have occurred in exploration expenditure (Fig. 1).

Mineral exploration expenditure by commodity

During 1999–2000, gold again bore the brunt of the decline in mineral exploration in Western Australia, as it did in 1998–99. Exploration expenditure for gold fell by $77.7 million (30.7%) to $253.0 million, out of the State's total decrease of $108.1 million for 1999–2000 (Fig. 3). Over the last three years, the fall in annual gold exploration in Western Australia has been dramatic, falling by $278.7 million in annual expenditure (52.4%). That represents around a total of $500 million of investment over three years that was not spent in gold exploration in the last three years. Furthermore, there is no evidence that this shortfall in gold exploration has been redirected to other commodities. The seriousness and magnitude of the fall between 1997–98 and 1999–2000 is illustrated by comparing the recent fall with the expenditure fall in the three years following the world sharemarket crash in October 1987 — the two falls are almost identical in dollar terms (1999–2000 dollars) and in the percentage drop.

On a yearly basis, gold exploration activity (about $250 million per year) is now at levels last experienced in 1992–93 (Fig. 3). On a quarterly basis, gold exploration expenditure in Western Australia showed signs of stabilizing towards the end of 1999–2000.

The gold price did recover slightly during 1999–2000, from monthly averages of about $US261 in June 1999 to $US285 in June 2000. The gold sector was assisted by a steadily declining Australian currency during the year, which saw the gold price in Australian dollar terms rise from an average of about $A400 in June 1999 to $A480 in June 2000. Any strengthening of the Australian currency in the near future would undoubtedly have an adverse effect on gold exploration and development in Western Australia, unless the gold price in $US terms also began to rise.

Exploration for base metals (including nickel and cobalt) dropped only slightly during 1999–2000, falling by $2.6 million (2.9%) to $88.3 million. The sharper fall experienced in 1998–99 was due to the completion of major exploratory and development work on the lateritic nickel deposits at Murrin Murrin, Cawse, and Bulong, as the mines moved into the commissioning phase. During 1999–2000, there was renewed interest in other nickel projects because of the sustained high nickel price, with fresh exploration at the so-called second-generation lateritic nickel deposits. Nickel prices rose strongly during the year, reaching a ten-year high of over $US10 000/t, but have since retreated slightly. The copper price improved slightly, but this was

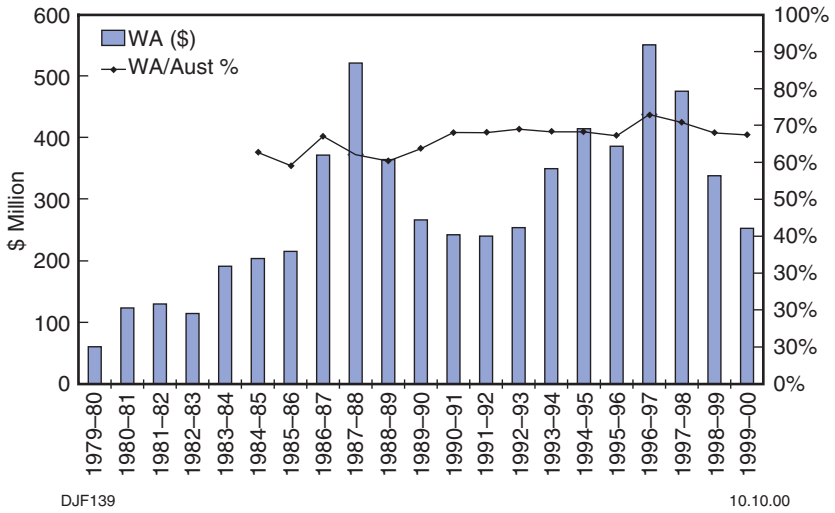

Figure 3. Gold exploration expenditure in Western Australia, by year (1999–2000 dollars)

from a very low base in mid-1999 and thus did little to encourage exploration. Zinc prices firmed by about 10% during the year, but this probably had more impact on the profitability of current producers rather than stimulating more exploration.

Diamond exploration fell by $8.1 million (24.6%) to $24.8 million during 1999–2000. This continues the steady decline from the peak in recent years of $35.8 million that was spent in 1996–97. The fall is due to the generally difficult conditions in raising equity capital, combined with the paucity of significant discoveries in recent years. However, interest in Argyle remains strong, with the competing bids of De Beers and Rio Tinto for Ashton's share in the Argyle Joint Venture. The level of diamond exploration has now fallen by 35.8% in three years, and is well below the historical peak activity in 1981–82 ($50 million) and in 1993–94 ($47 million).

Iron-ore exploration expenditure is not expected to increase significantly in the near future as a result of uncertainty over the development scenarios at West Angelas, now that Rio Tinto Ltd has control of North Ltd, and at Hope Downs where access to existing railway infrastructure is yet to be obtained. Funding for the Mid West iron and steel project moved a step closer, with Chase Manhattan Bank appointed by Kingstream Steel Ltd to assist with project development financing.

Although gold remains the main focus of exploration effort in Western Australia, its paramount lead continues to be eroded, though this may not be happening as quickly as the very large drops in gold exploration expenditure (in dollar terms) would suggest at first glance. Gold now accounts for about 61.0% (63.4% last year) of all exploration expenditure in Western Australia (other than petroleum), a sharp fall from 76% of the total in mid-1997. By comparison, the proportion spent on exploration for base metals and nickel–cobalt has increased slightly to 21.3%.

Despite the large fall in exploration activity in Western Australia during 1999–2000, Western Australia still attracts the major part of the Australian exploration dollar for iron ore (96%, estimated), diamond (83.2%), gold (67.5%), base metals including Ni–Co (56.3%), and heavy mineral sands (40%, estimated). For base metals and diamonds, the proportions of Australian exploration expenditure spent in Western Australia are now at the highest levels for those commodities since at least 1984. For example, 1999–2000 was only the second year on record when Western Australia has attracted more than 50% of the Australian base-metal exploration expenditure, although this predominantly reflects the ongoing nickel exploration. For gold, the proportion of expenditure (67.5%) is close to the average for the last decade (around 69%) and has varied little throughout that time. These statistics are encouraging because they apply at a time when companies are being very selective about where to explore, and this undoubtedly indicates that the perceived prospectivity for these commodities in Western Australia is very high.

Mineral resources and reserves

Despite the severe cutbacks in gold exploration and the strong pessimism prevailing in many parts of the gold sector, the State's inventory of measured and indicated gold resources (including any converted to reserves) increased during 1999–2000 (Fig. 4). Gold resources (measured and indicated only) increased by 256 t (7.3%) to 3752 t (Table 1). This substantial increase was double that recorded in the previous year, and was achieved with reduced exploration expenditure, resulting in significantly lower average discovery costs (Table 2). For the first time in at least seven years, gold discovery costs dropped below $A20 per ounce of measured and indicated resources; these costs are only $A15 per ounce if inferred resources are included.

For the fourth year in succession, there have been large increases in nickel resources, which have almost trebled in the last four years (Fig. 5). Nickel resources (measured and indicated) increased by 3.46 Mt (20.6%) to 20.23 Mt of contained metal. Inferred resources increased by 15.1%. Contained nickel (in measured and indicated resources) within lateritic nickel deposits eclipsed contained nickel within sulfide deposits for the first time

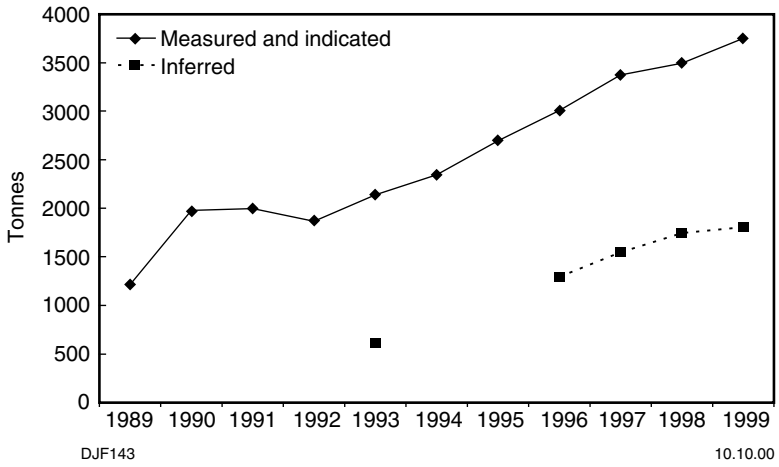

Figure 4. Estimates of gold resources in Western Australia, by year

during 1998–99 (57% versus 43% respectively of total contained nickel) and this trend has been further advanced during 1999–2000 (64% versus 36% respectively). Resources of nickel in sulfide deposits remained essentially unchanged during 1999–2000 at 7.227 Mt, whereas resources of nickel in lateritic deposits jumped by 3.4 Mt (26%) to 12.913 Mt. The 1990s has seen an unprecedented boom in nickel exploration that has been extremely successful in converting exploration effort into resources in the ground.

Resources of other commodities (high-grade iron ore, bauxite, and heavy mineral sands) have remained essentially unchanged during 1999–2000 (Table 1).

Table 1. Estimates of mineral resources of major commodities in Western Australia

Commodity	*Units*	*1996*	*1997*	*1998*	*1999*
Measured and indicated resources					
Iron ore (high grade)	Mt	21 960	22 539	22 407	22 282
Gold	t	3 009	3 376	3 496	3 752
Bauxite ore	Mt	3 359	3 386	3 387	3 387
Mineral sands	Mt	128.9	163.4	208.7	208.7
Nickel	Mt	10.73	13.41	16.77	20.23
Diamonds (industrial + gem)	Mct	140	177	534	534
Inferred resources					
Iron ore (high grade)	Mt	10 466	10 382	10 525	10 587
Gold	t	1 295	1 549	1 750	1 807
Bauxite ore	Mt	1 326	1 314	1 314	1 314
Mineral sands	Mt	52	53	73	73
Nickel	Mt	6.96	10.58	10.15	11.68
Diamonds (industrial + gem)	Mct	86	59	59	59

NOTE: Data sourced from MINEDEX database. Information nominally as at 31 December for year shown, but data extracted from MINEDEX database on 30 June in following year
For iron ore and bauxite, it is the quantity of resources that is shown. Only high-grade iron ore resources are included. High-grade iron ore is based on iron content only, but cut-off grade (55 or 60% Fe) depends on mineralization type
For heavy minerals, the total of all heavy minerals is shown
For all other commodities, the contained element/mineral in the resources is shown

Table 2. Gold discovery costs per ounce of measured and indicated resources, Western Australia

Year	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
Cost ($A) per ounce discovered	21	28	22	26	26	30	17

Mining tenement activity

In general, the reduced activity in the mineral exploration sector has also been reflected by the reduction in the number of mining tenements in force and the area held under tenure as at 30 June 2000 (by comparison with the same time 12 months previously). For all tenement types under the Mining Acts of 1904 and 1978, the area under tenure showed a decrease of 11.5% (3.1 million hectares) to 23.7 million hectares. Much of this decrease (98.7%) may be attributed to fewer and smaller exploration licences (Table 3), which dropped by 2.0% in number but dropped by 12.8% in area. These data indicate that large, greenfields-type exploration licences have continued to be reduced in area during 1999–2000.

For the three years since the boom in exploration in mid-1997, the number of granted exploration licences has dropped by 28%, and the area under tenure has dropped by 45.9%. The cutback in exploration over the last three years has also been reflected in prospecting licences, with falls of 29% in number and 32% in the area held. However, for mining leases the number and area held has gone against the trend, with figures for these having increased slightly over the last three years. These trends of reduced exploration and prospecting areas and increased mining lease areas are perhaps the most reliable available indicators of the swing from greenfields to brownfields exploration.

The number of new tenement applications also gives a guide to the general state of the mineral exploration sector (Table 3). The number of exploration licences and the area under application have dropped by 37% and 46% respectively over the last three years, whereas the number of mining leases and area under application have dropped by 51% and 60% respectively for the same period. However, the same trend is not observed with applications for prospecting licences, where applications for these have remained relatively static over the last three years, declining in number by only 4%, but increasing 5% in the area under application. There may be two explanations for this. Either prospecting licences (for gold) are

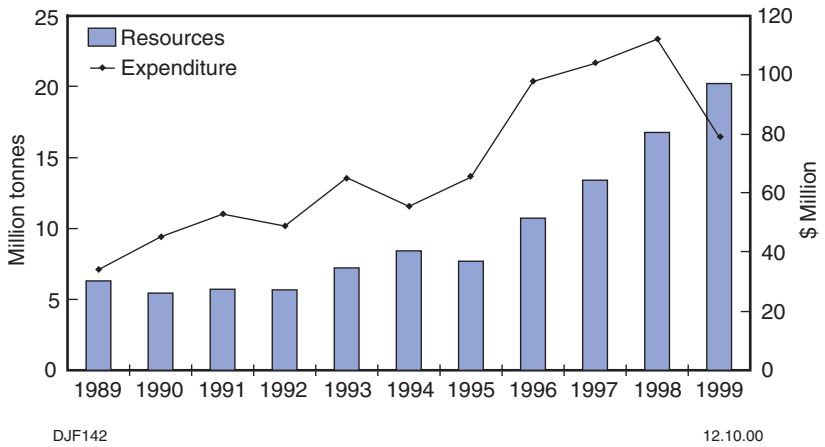

Figure 5. Nickel resources in Western Australia versus base-metal exploration expenditure, by year (dollars of the day)

being taken up over the most prospective sites in the exploration licence areas being dropped, or the level of prospecting licence activity is somehow independent of the broader commodity cycle in exploration.

Again, Native Title issues continued to cause delays to the planning of many exploration and development programs, and these issues added further to the three-year slowdown in exploration activity. Another issue affecting exploration and development is competing landuse, especially in the State's southwest and in or near national parks, but this situation remained unchanged during 1999–2000.

Statistics that highlight Native Title impacts are shown by the large number of tenement applications yet to be granted as at 30 June 2000 (Table 3). Over the last three years, the number of outstanding applications (yet to be granted) for mining leases and prospecting licences has increased each year. The trend for exploration licences is similar, although there was a slight clearance of the backlog of outstanding applications during 1999–2000. The figures clearly show the magnitude of the problem, even for greenfields exploration. Access to highly prospective land for mineral exploration is essential for new discoveries to be made and to thereby enable continuing development of the State's mineral resources to ensure the future economic well-being of the State.

Drilling activity

The trend in drilling activity since the peak of exploration in mid-1997 is clearly evident (Fig. 6). Rotary air blast (RAB) drilling was the first to be adversely affected as companies reduced expenditure and moved away from grass-roots greenfields exploration, and this was followed one year later by declining reverse circulation (RC) drilling, as expenditure cuts deepened. Exploration and resource drilling of all types declined sharply throughout 1998–99 and 1999–2000, with the exception of diamond drilling in 1999–2000. RAB drilling has plummeted by 60% over the last three years, with RC drilling declining by only 35% (but over only the last two years).

Table 3. Mining tenements current as at 30 June 2000, Western Australia

	1996–97		*1997–98*		*1998–99*		*1999–2000*	
	No.	*Area (ha)*	*No.*	*Area (ha)*	*No.*	*Area (ha)*	*No.*	*Area (ha)*
Tenements current as at 30 June 2000 (1978 Mining Act)								
Prospecting Licences	8 212	1 099 671	7 525	992 392	6 242	808 792	5 827	745 021
Exploration Licences	4 718	38 279 436	4 505	35 992 499	3 463	23 732 102	3 394	20 687 010
Mining Leases and others	6 717	2 135 806	6 717	2 238 301	7 555	2 263 145	6 866	2 297 430
Tenements current as at 30 June 2000 (1904 Mining Act)								
Mineral claims and others	310	34 133	309	34 132	307	34 130	193	21 790
Total (all tenements)	**19 957**	**41 594 046**	**19 056**	**39 257 324**	**17 567**	**26 838 169**	**16 280**	**23 751 251**
Tenement applications received for the period								
Prospecting Licences	1 239	159 719	1 146	154 769	976	124 310	1 189	167 755
Exploration Licences	2 484	26 352 760	1 764	14 484 400	1 747	14 078 400	1 557	14 158 480
Mining Leases	1 653	821 268	1 855	1 076 575	944	460 559	803	329 157
Others	169	44 186	148	424 978	1 454	729 574	138	783 789
Total	**5 545**	**27 377 933**	**4 913**	**16 140 722**	**5 121**	**15 392 843**	**3 687**	**15 439 181**
Tenement applications yet to be granted as at 30 June 2000								
Prospecting Licences	985	–	1 142	–	1 735	–	1 813	–
Exploration Licences	2 060	–	2 012	–	2 904	–	2 776	–
Mining Leases	3 167	–	4 562	–	4 944	–	5 179	–
Others	357	–	1 493	–	1 512	–	516	–
Total	**6 569**	–	**9 209**	–	**11 095**	–	**10 284**	–

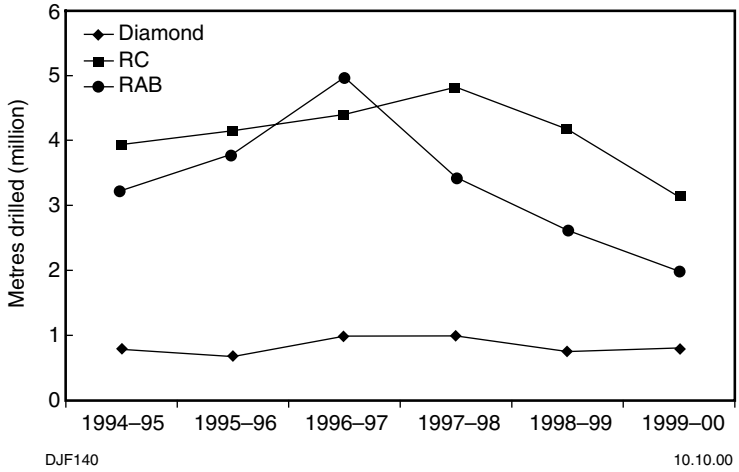

Figure 6. Mineral exploration drilling in Western Australia, by drilling type and year

Because there is a time delay in reporting statistics to the Department, further falls are anticipated in reports received after July 2000; however, the magnitude of the falls is likely to be smaller if the exploration slump is bottoming out. Diamond drilling figures have shown resilience, going against the general falling trend, with a modest rise (estimated at 7.3%) during 1999–2000. This is apparently a result of brownfields exploration where there is a need for the drilling of deep targets close to existing mine sites.

Petroleum exploration

Offshore Western Australia, and the North West Shelf in particular, continues to be recognized internationally as a premier place for new petroleum ventures based on favourable prospectivity, success rates, legislative and taxation regime, and political stability. Previous significant discoveries made on the North West Shelf continue to encourage further exploration, and offshore exploration drilling remains at near-record levels.

In this section on petroleum, the term 'Western Australia' has a broader meaning, referring to the State's onshore and offshore jurisdiction, combined with the adjacent offshore Commonwealth waters (Fig. 7). Excluded from the broad meaning of 'Western Australia' are the Territory of Ashmore and Cartier Islands, and the Zone of Cooperation.

In 1999–2000, petroleum exploration expenditure in Western Australia declined after setting successive records in the previous three years. Petroleum exploration expenditure fell by $105.9 million (20.0%) to $424.9 million. However, Western Australia has maintained its share of total Australian petroleum exploration expenditure (60–61%; Fig. 8).

The 1999–2000 financial year has seen the oil price remaining at historically high levels after dropping to very low levels in the previous financial year. However, until recently, industry has been very cautious in regard to increasing exploration expenditure.

In 1999–2000, a total of 66 petroleum wells were spudded in Western Australia, compared with 59 in 1998–99. Of the wells spudded, 40 were new-field wildcat wells, four were extension wells, and 22 were development wells. Extension and development drilling were greater than in the previous financial year, with a combined total of 26 wells compared with 18 in 1998–99. A near-record number of offshore new-field wildcat wells were drilled.

Offshore

The $3 billion North West Shelf LNG expansion moved closer during mid-2000 as additional sales contracts (letters of intent) were signed with Japanese customers. The project involves a 4.2 Mtpa facility at Burrup

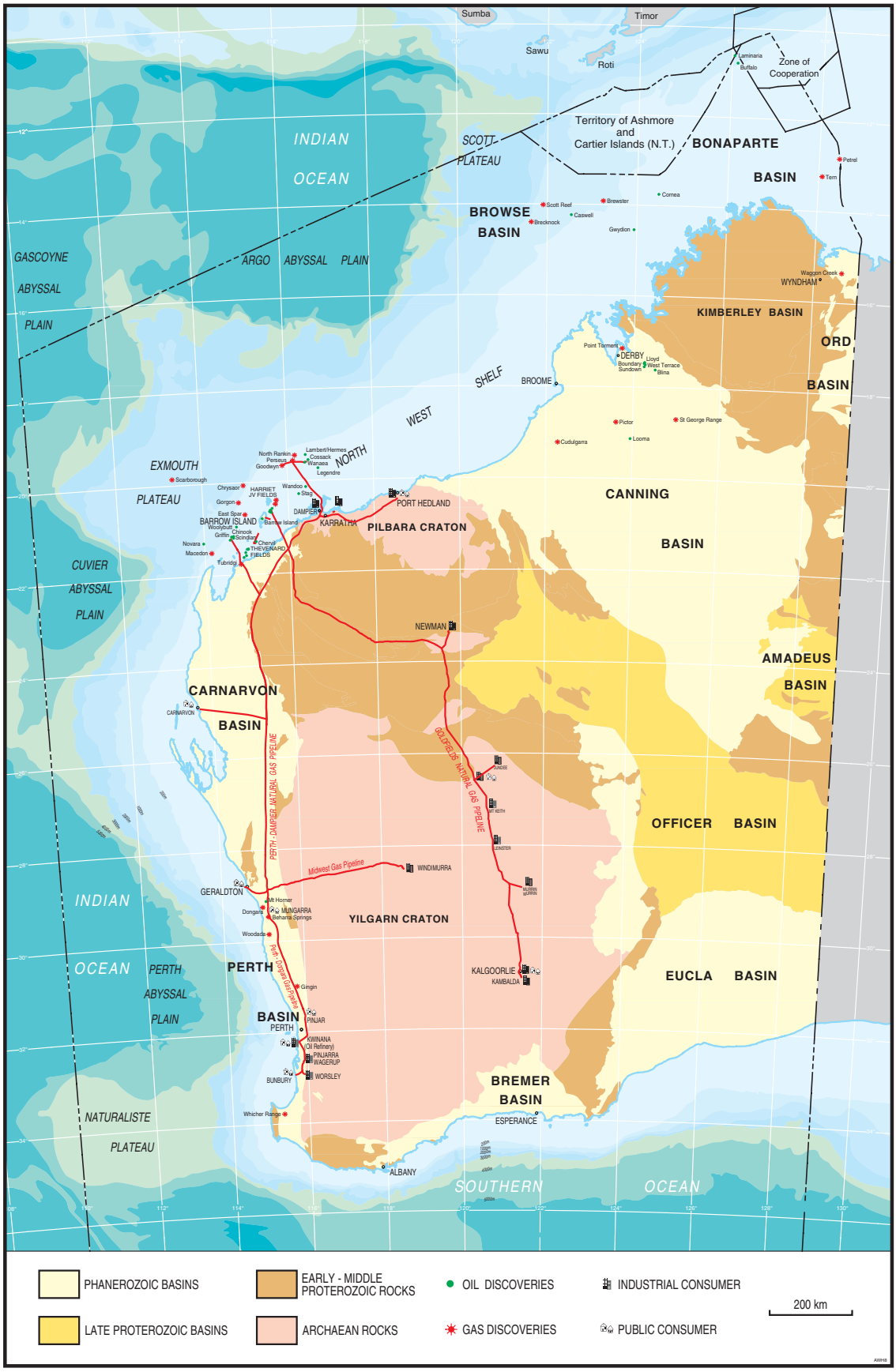

Figure 7. Location diagram of petroleum discoveries and developments in Western Australia

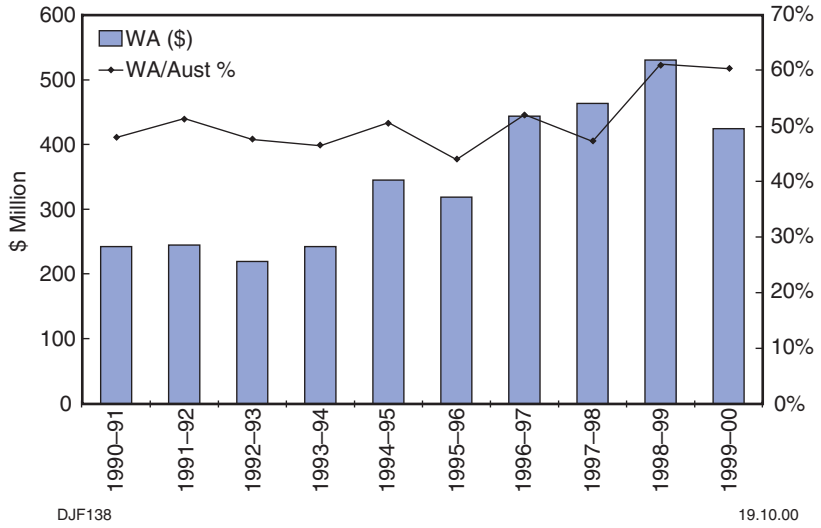

Figure 8. Petroleum exploration expenditure in Western Australia, by year (dollars of the day)

Peninsula (near Karratha), a $850 million trunk line, and additional offshore development and production work. Negotiations have been ongoing for four years, but Woodside Petroleum plans to have all the necessary contracts signed by the end of 2000. Although the project has not yet been given formal approval to proceed, the timetable is for gas delivery in mid-2004.

Offshore exploration drilling continued at near-record levels, with the primary focus of exploration being the offshore Carnarvon Basin. A total of 36 new-field wildcat wells were spudded in offshore Western Australia during 1999–2000. The corresponding total for 1998–99 was 38 wells.

The Northern Carnarvon Basin continues to be the most actively explored basin in Western Australia. During the 1999–2000 financial year, a total of one onshore and 31 offshore new-field wildcat wells were spudded in the basin. Four deep-water gas discoveries (Geryon, Maenad, Orthrus, and Urania) were drilled in succession by Chevron, proving world-class gas reserves. Numerous other hydrocarbon discoveries were made from north of North West Cape to northwest of Dampier.

Three new-field wildcat wells were spudded in the Browse Basin, two of which were gas discoveries that could contain world-class reserves and have reasonable condensate content.

In the offshore Bonaparte Basin, the Buffalo Oilfield in WA-260-P came on-stream in December 1999 and BHP expects the field to produce 3.5 million cubic metres of oil over a three-year period. In addition, two new-field wildcat wells were spudded.

No drilling took place in the offshore portion of the Perth Basin, but about 670 line km of seismic data were acquired in the northern part of the basin.

Onshore

The level of onshore new-field wildcat drilling activity in Western Australia is at its lowest level in ten years, with only four wells drilled. One extension well and ten development wells were spudded in 1999–2000, and onshore seismic data acquisition remains at very low levels compared with those of the 1980s.

The lack of activity in onshore exploration was particularly evident in the Canning Basin, which was once a highly active exploration area. The Canning Basin may be one of the most underrated basins in Australia, considering the potential of its petroleum systems. However, there is some promise for more active exploration in the future. New Standard Exploration has applied for five exploration permits in the southern Canning Basin, with one of these

granted in February 2000. Numerous prospects, some with giant potential, have been mapped by companies such as Shell and Kimberley Oil.

No wells were drilled in the onshore Bonaparte Basin.

In the onshore northern Perth Basin, 163 line km of 2D and 212 km^2 of 3D seismic data were acquired and three exploration wells were drilled.

Of concern to industry in the granting of new onshore titles is Native Title and the lengthy process required for the Right to Negotiate process, and the accompanying uncertain outcomes. Although new Commonwealth legislation has been introduced to improve the Native Title process, a number of issues remain unresolved and continue to hinder onshore exploration and development activities.

The Geological Survey of Western Australia continued with its petroleum initiatives projects that focus on the underexplored interior basins (Officer and Canning Basins) and western margin of Western Australia (onshore Southern Carnarvon and Perth Basins). Drilling of a deep stratigraphic well, Vines 1, in the Waigen area (Officer Basin) intersected gas at a depth of 1482.9 m, which was released from a fracture system while coring. The gas show at Vines 1, located 190 km east of Warburton and south of the Aboriginal communities at Blackstone and Wingellina, is thought to be a direct indication of thermogenic gas generated by petroleum source rocks in the Neoproterozoic Officer Basin. This result is regarded as very encouraging to the oil industry, which has investigated smaller hydrocarbon shows elsewhere in the Officer Basin in South Australia and in the Amadeus Basin in the Northern Territory, where both the Mereenie Oil- and Gasfield and the Palm Valley Gasfield are located. Further exploration by petroleum companies is required to determine the commercial significance of the gas show at Vines 1, but it demonstrates the importance of the work being carried out by the Geological Survey to enhance the petroleum prospectivity of the State's extensive and essentially unexplored onshore sedimentary basins.

Petroleum reserves

Petroleum reserves, at the 50% probability level, in developed and undeveloped fields increased during 1999–2000 for oil, condensate, and gas (Fig. 9). Oil reserves increased with the discovery of new fields and the

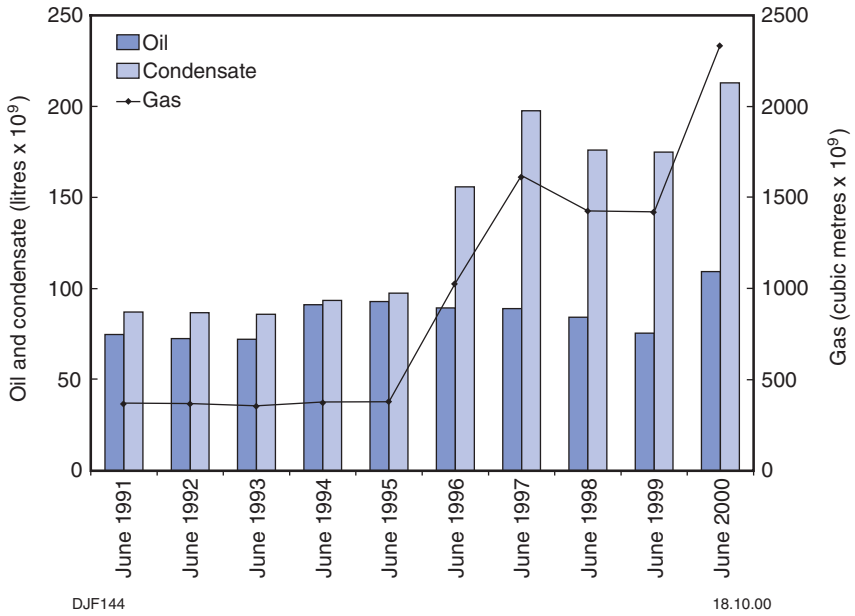

Figure 9. Inventory of petroleum reserves in developed and undeveloped fields in Western Australia, including offshore Commonwealth waters, at the 50% probability level

re-evaluation of previous discoveries, rising from 76 to 109 gigalitres. The production rate also increased significantly from an average of just over 24 000 kilolitres per day last year to over 34 000 kilolitres per day this year. Booked gas and associated condensate reserves rose substantially due to reassessment of the Brecknock, Scott Reef, and Scarborough fields and discovery of the Geryon field. The average daily gas and condensate production rates for 1999–2000 are marginally higher than for the previous year (DME Annual Report, 1999–2000).

Acknowledgements

Mineral and petroleum exploration expenditure data were compiled by the Australian Bureau of Statistics, but petroleum exploration expenditure for the periods prior to 1993–94 were compiled by the Bureau of Resource Sciences (now Australian Geological Survey Organisation).