AUSTRALIA

Department of Resources & Energy

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1987 / 4

EXTENDED ABSTRACTS

PETROLEUM & MINERALS REVIEW CONFERENCE 1987

CANBERRA, 18-19 MARCH

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World petroleum overview

G.G. Harvey, BP Petroleum Development Australia Pty Ltd

Last year was a traumatic one for the oil business. The far-reaching impacts of the dramatic fall in world oil prices will be felt for some years to come.

Industry observers are not optimistic that there will be a rapid demand rise in response to the price fall; the conservation gains resulting from 1973/74 and 1978/79 price hikes were once-and-for-all irreversible shifts; world growth is generally slowing in the major energy consuming nations; and in many countries, taxation on petroleum products (often to replace dwindling upstream revenues) is further damping the demand response.

On the supply side, the incentive to explore for, and develop, high-cost frontier oil is now removed. Non-OPEC oil sources have thus been the most severely impacted by the oil price fall, and this will therefore hasten the re-emergence of OPEC members as the dominant world suppliers.

The 1986 collapse of oil prices had a number of effects which conspired to produce a substantial cut in the overall level of exploration activity. First and foremost, lower oil prices meant reduced cashflows for the oil industry. Given the existing debt levels of many of the players in the industry, and the general pressure to maintain dividends, these reduced internal cashflows were largely reflected in capital expenditure cutbacks. The need to meet long-term commitments exacerbates the squeeze on 'optional' new exploration. Secondly, the industry perceived that it had entered a new era of lower, and probably more volatile, oil prices, reducing the attractiveness of exploration relative to other projects. Thirdly, banks and others have become markedly less eager to make new loans to oil explorers.

These factors together added up to a very bleak 1986 for upstream activity. Salomon Bros. estimate that the total upstream capital expenditure outside OPEC and the Centrally Planned Economics (CPE) fell by 35 percent or some US$17 billion over 1985. Further cuts planned for 1987 are likely to produce another 5 percent fall in this year alone.

However there are still robust segments of the international oil industry which have the right perspective and capacity to pursue exploration in new prospective areas. It follows that there is an increased onus on national governments to see that such companies are not disadvantaged relative to shorter-term players in

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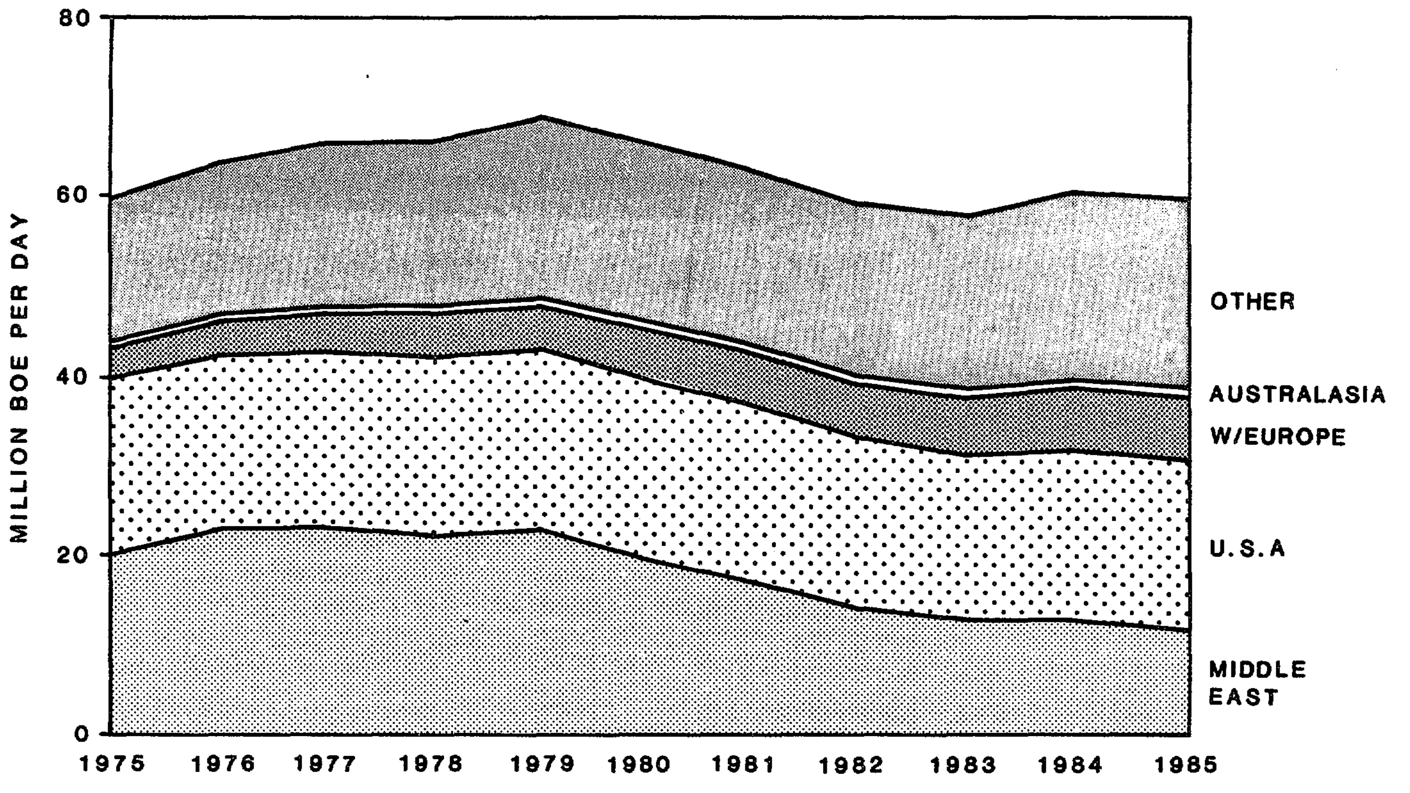
the exploration industry whose main interests really lie in trading opportunities for exploration rights.

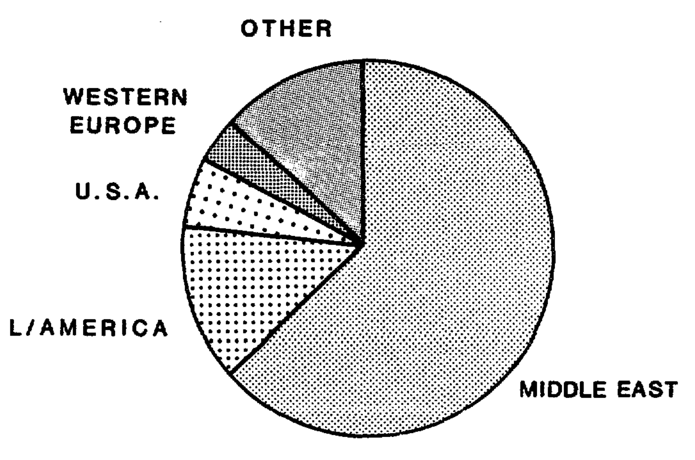
A further consequence of the general cutback on upstream investment is that oil companies are becoming more selective about where they go looking for oil and where they spend their scarce exploration dollars. In this new, leaner environment Australia must compete for that investment. BP estimates Australia's yet-to-be discovered reserves are very low, at little more than one-half percent of the Non-Communist World's (NCW) 300 billion barrel yet-to-find oil reserves. Given this prospectivity, Australia needs to pay close attention to all factors influencing oil exploration and development costs. On the relative attractiveness of the tax regime Australia is moving in the right direction but other policies which influence the 'on-costs' of exploration, such as labour work practices, domestic industry protection and investment guidelines, must all receive close attention.

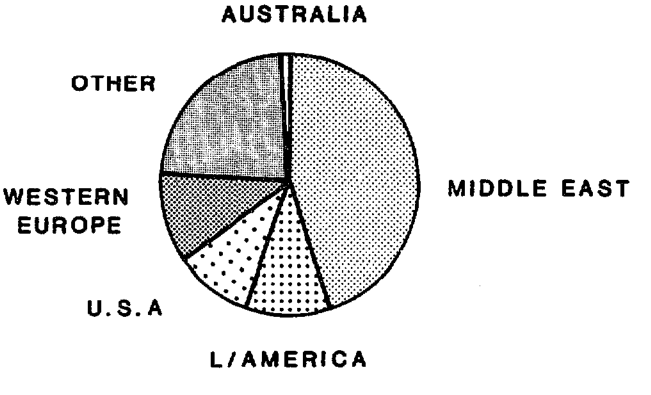
NCW OIL AND GAS PRODUCTION



NCW PROVED OIL AND GAS RESERVES

END 1985





OIL

626 BILLION BARRELS

GAS

1923 TRILLION CU. FT.

(320 BILLION BARRELS)

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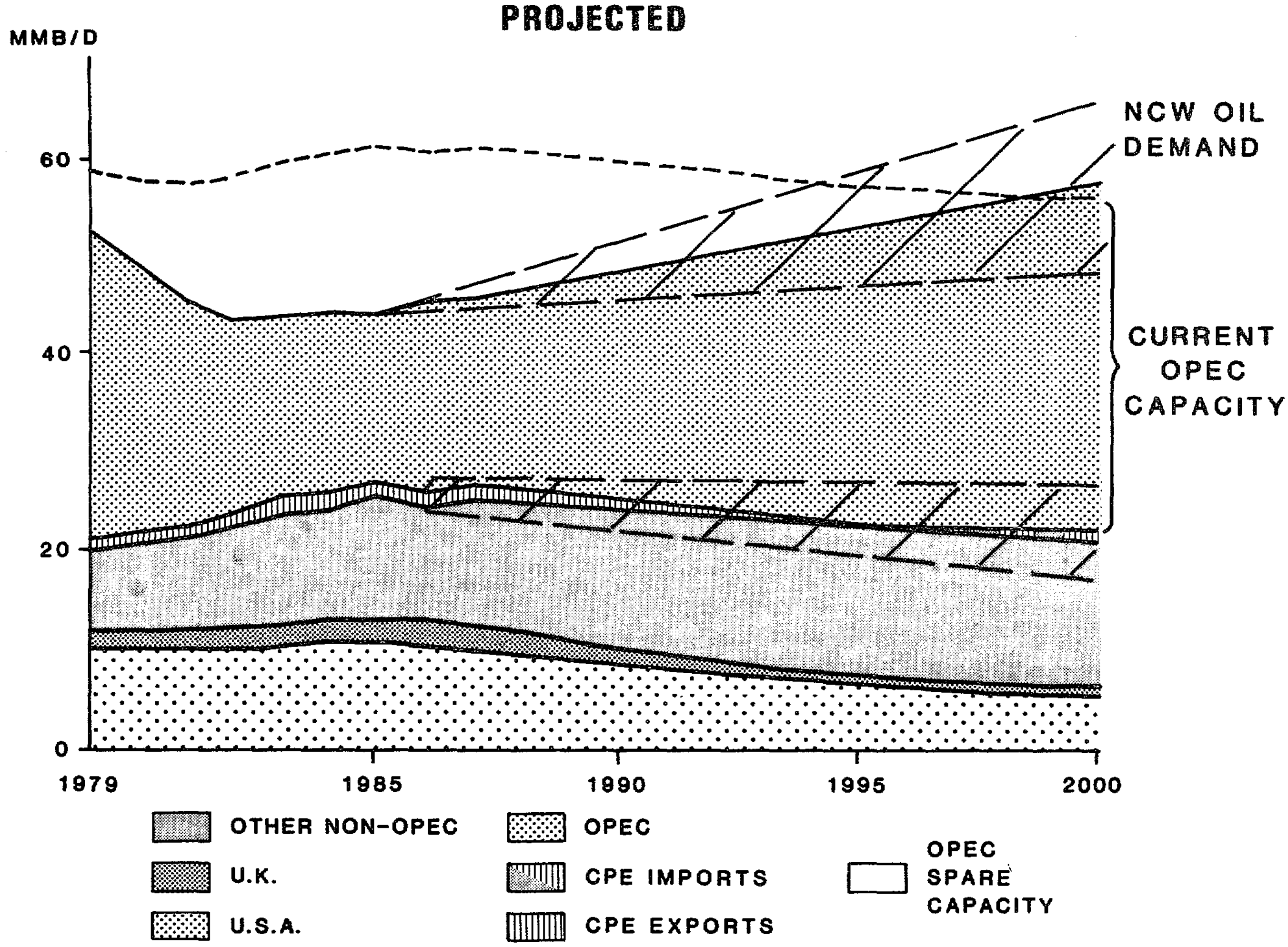
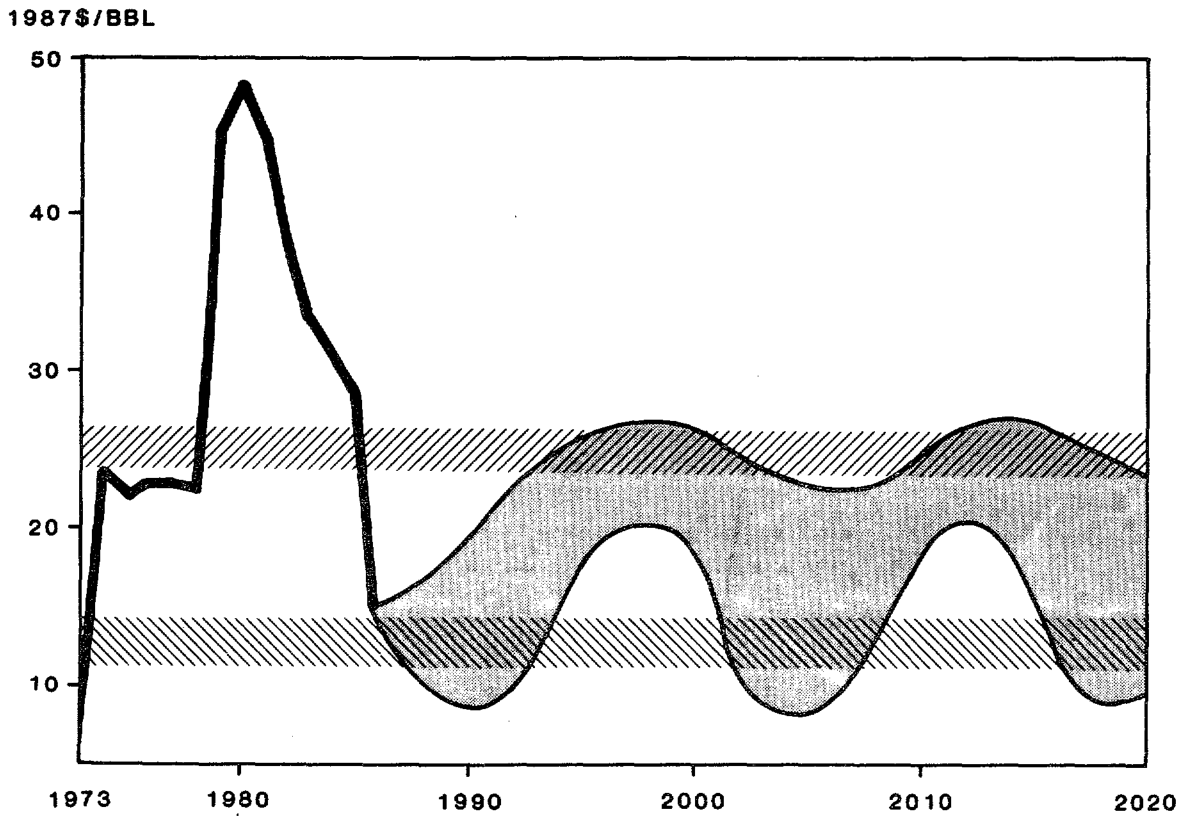
NCW OIL SUPPLY

PROJECTED



OIL PRICE PROJECTION



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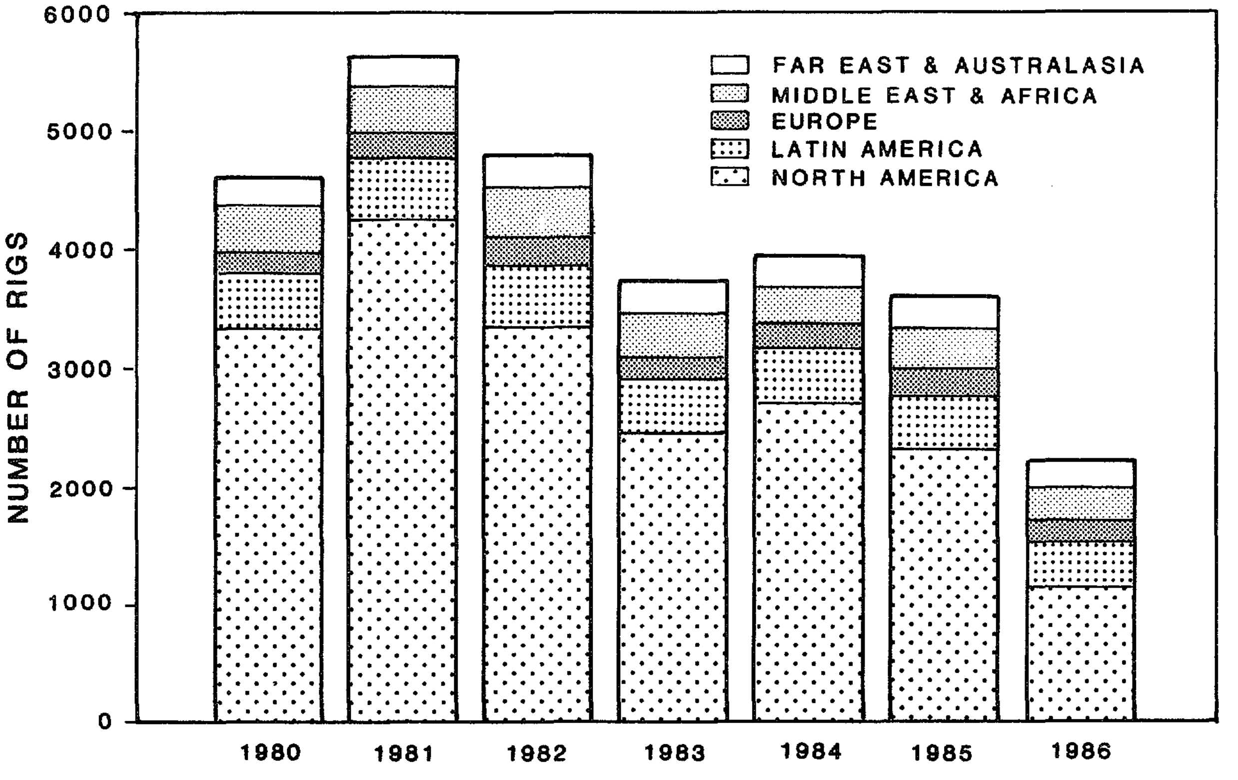
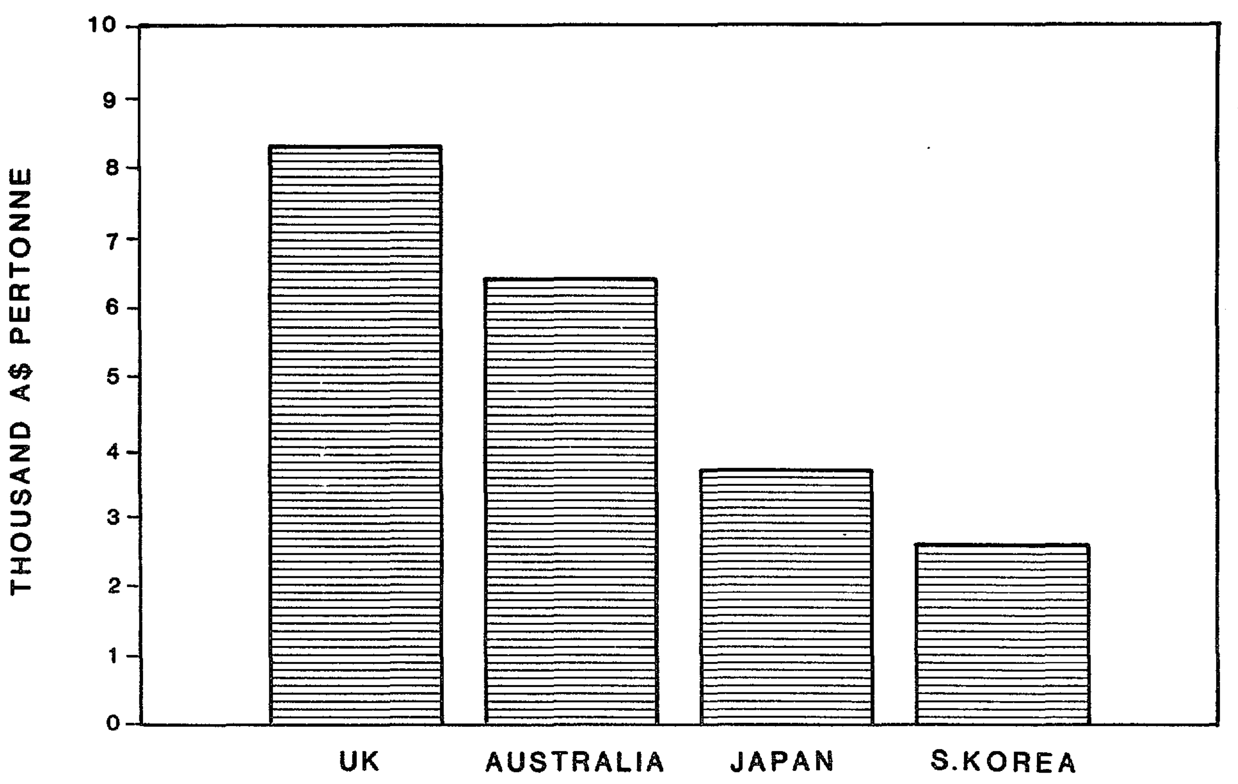
EXPLORATION ACTIVITY 1980–86
DRILLING RIG COUNT



MATERIAL AND FABRICATION COSTS
OF A 15,000 TONNE JACKET



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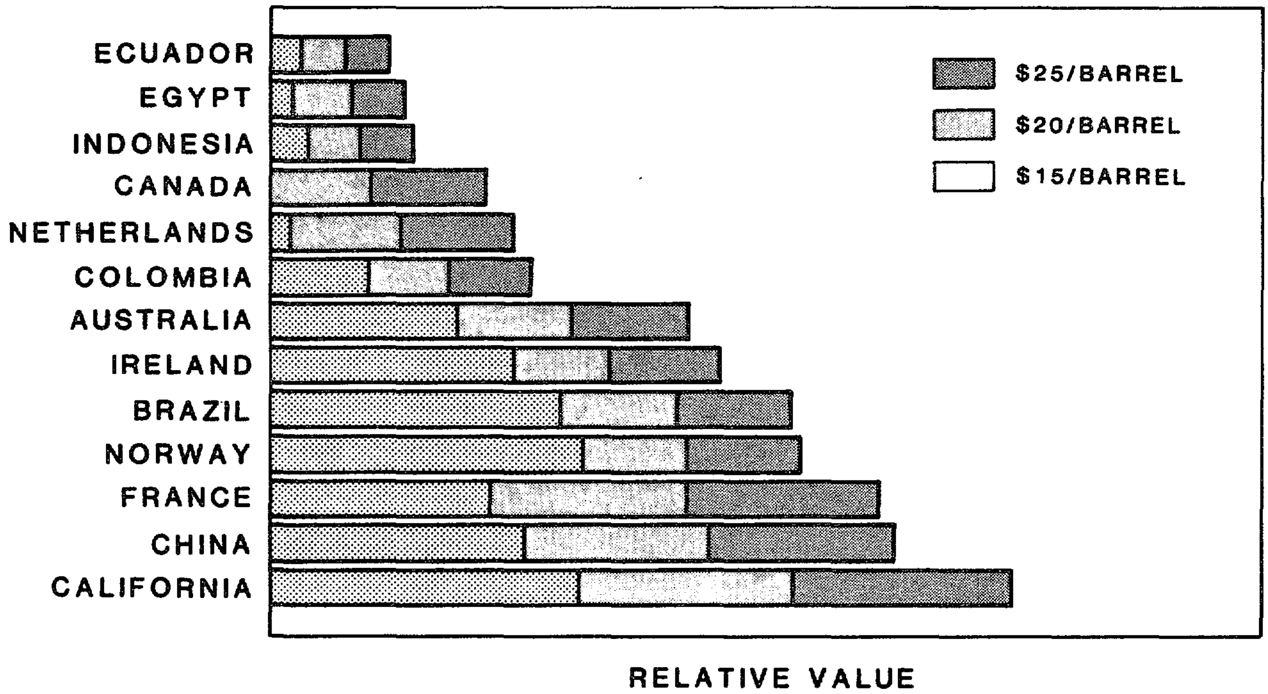
FISCAL COMPARISON – SMALL OFFSHORE FIELD



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Recent developments in Australian petroleum policy

D.J. Ives, Department of Resources and Energy

Fluctuations in the international petroleum market over recent years have challenged both industry and Government to be flexible and imaginative in responding to new situations in a manner which will attempt to ensure that the longer-term development of Australia's petroleum resources proceeds. The conundrum facing governments is how to frame policy which reflects long-term objectives and provides a stable investment environment, yet is sufficiently flexible to respond to often unforeseen fluctuations in the world's petroleum markets.

Events over the last 12 months have led to calls for adjustments to existing policies, particularly petroleum taxation policies which are currently under review. These events have also focused greater attention on the Energy 2000 policy review and the scheduled review of the crude-oil-marketing arrangements.

The paper examines the events that have led to some of these policy changes and the way in which the Government has demonstrated its preparedness to modify policies in response to changing circumstances. It argues that while some changes will always be necessary, the established policy framework of the Government should not be discarded lightly in response to short-term fluctuations.

Current policy reviews - Energy 2000, marketing arrangements for indigenous crude oil, taxation arrangements - will be discussed.

Petroleum exploration and development in Australia, 1986

J A W White, BMR

1986 was a year of dramatic change for the petroleum exploration and development industry in Australia. The sharp drop in the world price of crude oil during the first quarter of the year caused a severe reduction in both exploration and development.

Exploration wells drilled totalled 140, of which 112 were onshore and 28 offshore; development wells totalled only 35, of which 15 were drilled onshore and 20 offshore. Total wells drilled amounted to 175 compared with 364 in 1985. Seismic survey activity decreased to about half that in 1985.

Several important new petroleum discoveries were made during the year, but the volume of crude oil found was markedly less than the volume produced in the same period.

The most significant new production development was the construction and commissioning of a natural gas pipeline in the Northern Territory, from Palm Valley, in Central Australia, to Darwin. Other production initiatives undertaken included a condensate-stripping gas-recycling project at North Rankin (Northwest Shelf) and the supply of natural gas to the Warrnambool area, Victoria, from one of two small nearby gas fields.

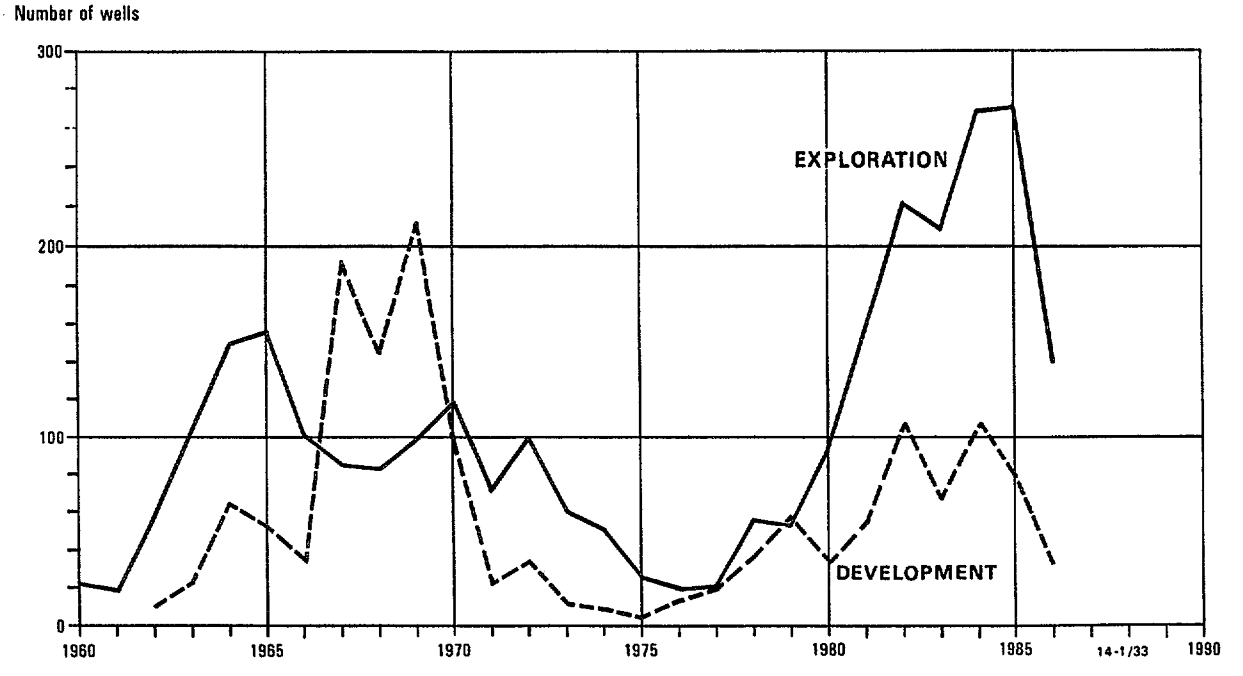
Crude oil production developments are in the offshore Gippsland Basin with the construction of a new production platform to be located on the Bream structure, and new production wells are planned to drain untapped reserves of oil from the Snapper platform.

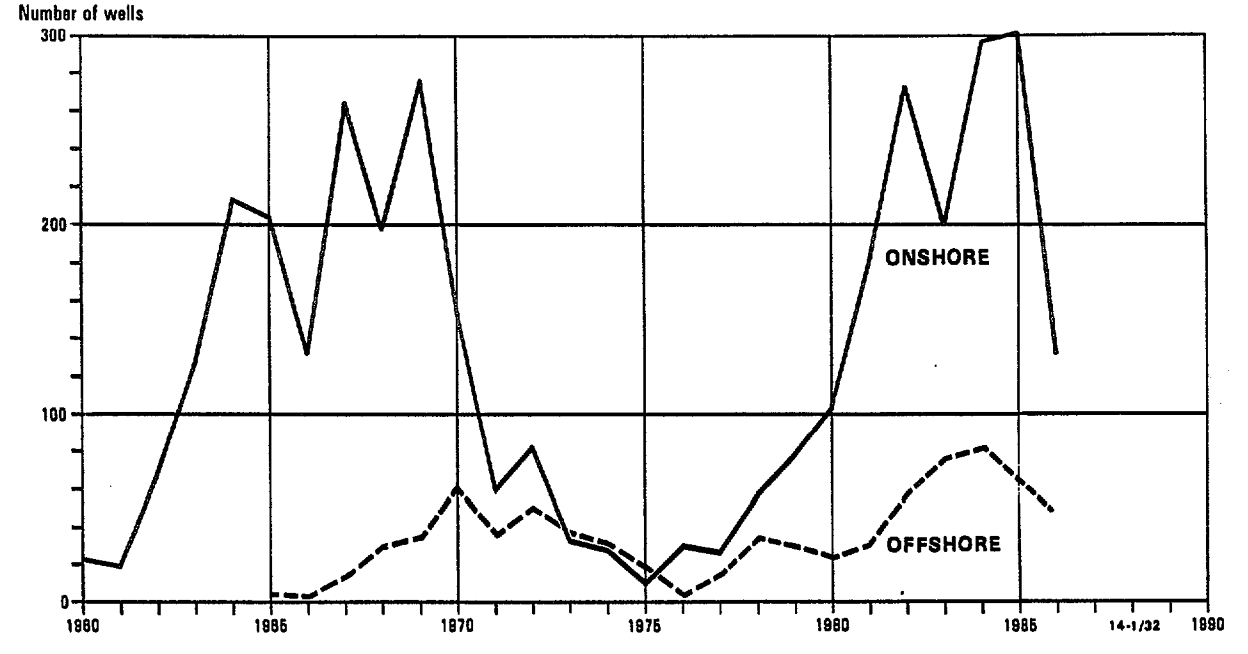
Work has commenced on Australia's first enhanced oil recovery project at Tirrawarra, South Australia, using ethane miscible flooding techniques.

Marine geophysical surveys carried out by BMR's chartered research vessel, 'Rig Seismic', have provided valuable new knowledge regarding the petroleum potential of some of Australia's more remote sedimentary basins.

BMR considers that the level of petroleum exploration and activity in 1987 will continue at about the same level as 1986 but with an increase in onshore exploration drilling and decreases in offshore exploration drilling and development drilling both onshore and offshore.

PETROLEUM WELLS DRILLED IN AUSTRALIA 1960-1986
EXPLORATION AND DEVELOPMENT, ONSHORE AND OFFSHORE





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AUSTRALIA - WELLS DRILLED - HISTORICAL

Year	Exploration Onshore	Exploration Offshore	Exploration Sub-total	Development Onshore	Development Offshore	Development Sub-total	Totals for year	Totals Cumulative
To 1970	1 396	87	1 483	768	59	827	-	2 310
1971	54	18	72	4	18	22	94	2 404
1972	62	38	100	21	12	33	133	2 537
1973	29	31	60	5	6	11	71	2 608
1974	20	31	51	8	-	8	59	2 667
1975	6	19	25	4	-	4	29	2 696
1976	16	3	19	13	-	13	32	2 728
1977	8	13	21	18	2	20	41	2 769
1978	33	22	55	24	13	37	92	2 861
1979	31	21	52	48	9	57	109	2 970
1980	77	17	94	26	7	33	127	3 097
1981	142	16	158	41	14	55	213	3 310
1982	177	44	221	95	13	108	329	3 639
1983	160	49	209	40	26	66	275	3 914
1984	221	43	264	71	38	109	373	4 287
1985	227	43	270	76	18	94	364	4 651
1986*	112	28	140	15	20	35	175	4 826

* Preliminary figures subject to revision

AUSTRALIA - METRES DRILLED - HISTORICAL

Year	Exploration Onshore	Exploration Offshore	Development Onshore	Development Offshore	Totals Yearly	Totals Cumulative
To 1970	1 794 911	272 994	776 656	148 654	-	2 993 215
1971	108 683	59 860	9 359	46 453	224 355	3 217 570
1972	107 002	117 429	47 365	23 643	295 439	3 513 009
1973	50 301	80 616	11 347	9 644	151 908	3 664 917
1974	37 206	84 078	15 531	-	136 815	3 801 732
1975	12 579	35 658	10 351	-	58 588	3 860 320
1976	32 393	15 119	24 863	-	72 375	3 932 695
1977	23 675	36 827	44 508	6 419	111 429	4 044 124
1978	52 709	56 900	56 332	42 493	208 434	4 252 558
1979	59 635	76 424	44 110	36 612	216 781	4 469 339
1980	137 296	62 012	41 337	27 142	267 787	4 737 126
1981	277 258	45 126	77 602	34 473	434 459	5 171 585
1982	324 288	128 213	154 030	28 379	634 910	5 806 495
1983	273 571	137 472	82 019	86 425	579 487	6 385 982
1984	403 329	113 486	147 294	137 645	801 754	7 187 736
1985	406 967	105 145	125 190	59 816	697 118	7 884 854
1986*	208 012	60 983	24 059	72 364	365 418	8 250 272

* Preliminary figures subject to revision

Helium resources and developments in Australia

B A McKay, BMR

Helium is a lesser known by-product of the petroleum industry. Although it is derived from the natural radioactive decay of heavy elements deep in the Earth, it is commonly associated with natural gas deposits in the Earth's sediments where it is trapped while migrating to the surface. However, in most cases the helium concentration in these deposits is too low (< 0.3%) to be of commercial significance.

The unique properties of helium, including its low solubility, low density, very low liquid boiling point, and inertness, make it an ideal commodity for certain industrial and research applications including laboratory and medical usage.

Globally, helium production occurs in only a few countries, notably USA, Poland and USSR. Production is mostly dependent on cryogenic separation of helium from well-head gas in commercially-produced natural gas fields; however research into alternative methods of extraction appears promising.

Currently Australia has no indigenous production of helium and all of our needs are met by imports which are rising substantially (Table 1). However, encouraging indications of helium are known to occur in gas in several of our gas fields, and there is increasing interest by the Australian natural gas industry in local helium production. The main areas of interest are in the Perth, Carnarvon, Canning, Amadeus, Cooper and Gunnedah Basins. The Amadeus Basin, in particular, with helium occurring in both the Mereenie and Palm Valley fields, and with commercial natural gas production, has excellent potential for the first domestic extraction plant.

In USA, helium in excess of market demand has been stored for some years in a depleted subsurface natural gas reservoir in West Texas, with both government and industry using this storage. This stockpile has helped to stabilise international helium prices. However, it appears likely that the future price of helium will rise as current strategic stocks (especially those in the USA) are depleted; this should act as a stimulus for helium production in Australia to supply our domestic market, and possibly export to the Pacific area.

Table 1. AUSTRALIAN IMPORTS OF HELIUM AND RARE GASES

Year	Quantity (Kg)*	Approximate volume of helium ($\times 10^6 m^3$)
1980/81	29 222	0.082
1981/82	70 365	0.197
1982/83	116 989	0.327
1983/84	113 406	0.317
1984/85	66 411	0.186
1985/86	194 422	0.543

* Approximately 50% helium

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Factors affecting the availability of Australia's undiscovered crude oil resources

D J Forman & A L Hinde, BMR

Over the last nine months BMR has assessed Australia's undiscovered resources of crude oil (Fig. 1), sales gas, and condensate (Fig. 2) using a new method called the trap-by-trap creaming method (Forman, 1986; Forman & Hinde, 1986). The assessment of undiscovered crude oil is now being analysed to try to estimate the rate at which the undiscovered fields may be discovered and brought into production up to the year 2000.

The new assessment has provided us with systematic estimates of the undiscovered petroleum resources in many areas of Australia. Some of these areas have hardly been explored and are overlain by deep water. The occurrence of oil in them is speculative and any oil that may occur (Fig. 3) is unlikely to be discovered and brought into production by the year 2000. When these speculative resources are removed from the total, we are left with an estimate of Australia's hypothetical undiscovered oil resources (Fig. 4).

A proportion of these hypothetical resources is subeconomic at current prices, and some may even be subeconomic at the higher prices that might prevail in the 1990s. The price of oil will be reflected in the minimum size of field that may be produced in an area and hence in the magnitude of the undiscovered resources that could be brought into production. Figure 5 shows how the assessment of Australia's hypothetical crude oil resources varies with the assumptions made regarding the minimum size of field that potentially could be brought into production in each area.

BMR's assessments of potential petroleum provinces throughout Australia provide detailed information on the likely sizes of the undiscovered fields, their order of discovery, and the exploration effort required to find them. Efforts are now being made to include this information within a computer program called SEAPUP, which is an acronym for Simulated Exploration and Production of Undiscovered Petroleum. As implied by the name, SEAPUP will be designed to estimate future levels of crude oil production taking into account a range of possible future exploration patterns.

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The first problem we have in setting up SEAPUP lies in estimating the amount of drilling likely to be carried out each year in Australia. We have attempted to do this by assuming that future new-field wildcat-drilling patterns will be the same as those that can be identified in Australia's drilling statistics.

Next, SEAPUP uses the data and the computer program for the trap-by-trap creaming method to simulate drilling the prospects within each trap-type within each petroleum province. After the discoveries have been simulated and their sizes determined, they are placed in possible order of discovery and their year of discovery is estimated. Finally, future production is estimated by assigning to each field a lead time and a production profile, both selected from distributions based on historic data.

It is concluded that the size and geographic distribution of Australia's oil resource base, oil prices, exploration levels, and the order in which the petroleum provinces are drilled, will place constraints on the rate at which undiscovered crude oil will be brought into production. When it is completed, program SEAPUP will enable us to examine the consequences of variations in these unknown factors.

References

Forman, D.J., 1986 - Australia's potential for further petroleum discoveries. Bureau of Mineral Resources, Australia, Record 1986/34.

Forman, D.J., & Hinde, A.L., 1986 - Examination of the creaming methods of assessment applied to the Gippsland Basin, offshore Australia. In RICE, D.D., (Editor) - Oil and gas assessment - methods and applications. AAPG Studies in Geology, No. 21, 101-110.

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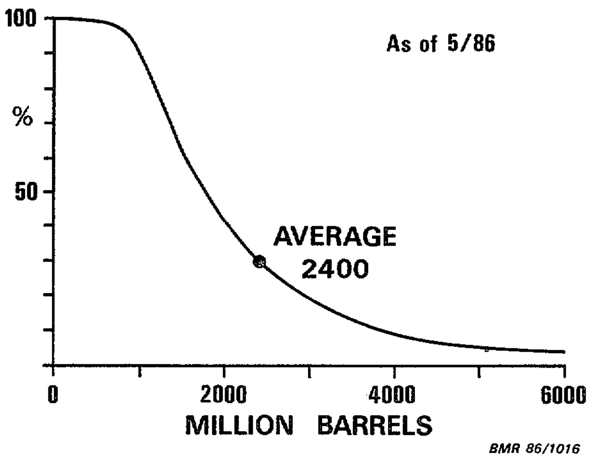

Fig.1 Australia's undiscovered oil resources, as at May 1986.

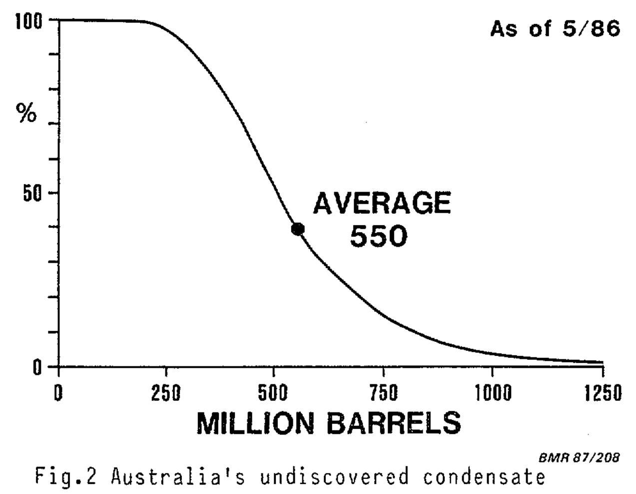

Fig.2 Australia's undiscovered condensate resources, as at May 1986.

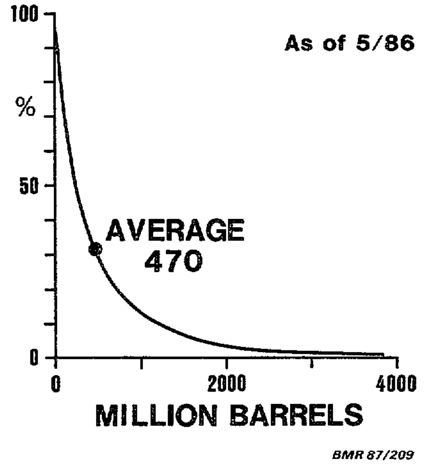

Fig.3 Australia's speculative undiscovered oil resources, as at May 1986.

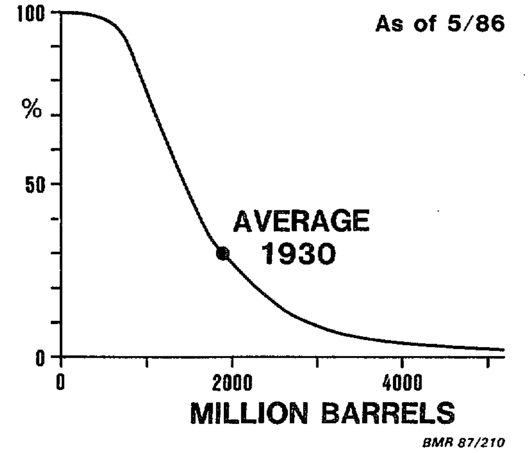

Fig.4 Australia's hypothetical undiscovered oil resources, as at May 1986.

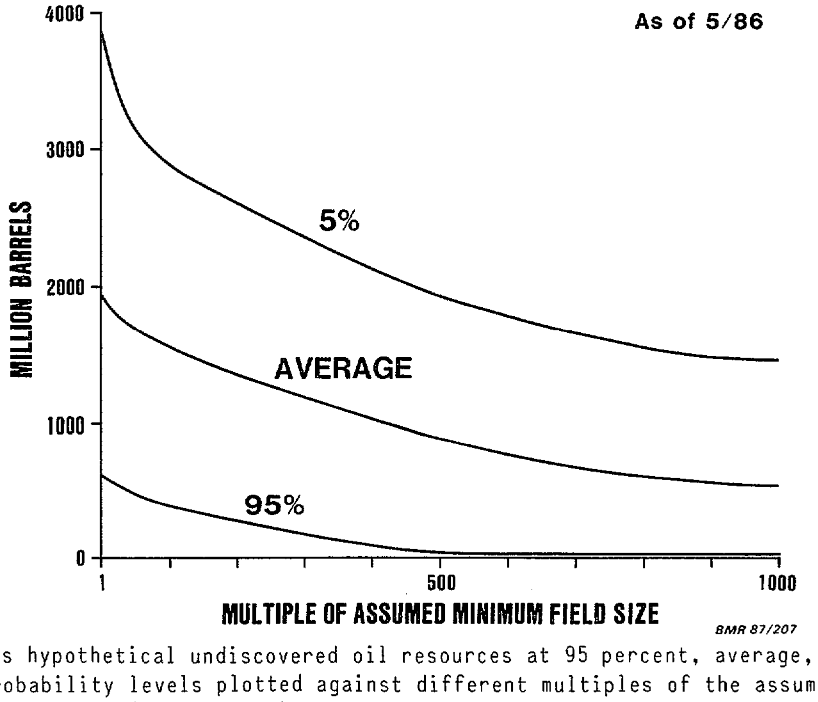

Fig.5 Australia's hypothetical undiscovered oil resources at 95 percent, average, and 5 percent probability levels plotted against different multiples of the assumed minimum economic field size (preliminary).

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Australian mineral industry overview

J Ward, BMR

In 1986 the Australian mining industry operated with an international backdrop of falling or stagnant metal prices and in the shadow of continuing high stock levels, sluggish demand, and real or potential excess production capacity. Little wonder, then, that expansion in the industry, a feature of the last quarter century, plateaued-out with ex-mine value of output down 10 percent on 1985, and the value of mineral exports barely holding the line at 1985 levels. With the notable exception of aluminium and gold, refined metal production fared no better, and data produced for AMIC's Annual Summary of the Minerals Industry for 1985-86 indicate a sharp increase in losses sustained by the smelting and refining sector of the industry.

Nevertheless, the year was not without its successes. In the face of fierce international competition, Australia maintained its position in the world as a leading producer and source of a wide spectrum of minerals, and recorded some notable gains particularly in

- coal - production, domestic consumption and exports of black coal achieved record levels of 168 Mt (raw coal), 43 Mt and 90 Mt respectively
- aluminium - Australia maintained its position as the world's leading bauxite and alumina producer and produced record tonnages of alumina and aluminium
- gold - production increased for the sixth successive year to about 72t, the highest since 1913
- diamonds - mining of the AK-1 pipe established Argyle as the world's largest individual diamond producer, contributing about one-third of total world output of natural diamonds
- mineral sands - strong upward pressure on prices for mineral sand concentrates helped restore profitability to the industry and provided a solid basis for major processing projects which should add considerable value to the industry's output.

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Overall, the world supply/demand position in metals has shown little improvement in the early months of 1987 despite some reduction in stock levels and a conscious freezing or liquidation of active production capacity. No major economic upswing is predicted, rather, steady economic progress, and there seems little justification for increased metal prices in real terms, except for a few individual commodities.

In recent years the Australian mining industry has achieved considerable reductions in production costs by rationalisation and increased efficiency. Not surprisingly, some of our competitors have made similar progress and it is imperative that our domestic industry now capitalises on its own hard-won gains, for instance, by channelling some of its improved productivity into new areas of demand opened up by particular consumer preference. I suggest that we take advantage of our strength in mineral resources' endowment, and our expertise in mining, smelting and refining. We should carefully select those projects involving value-adding mineral treatment and high-technology development which can be demonstrated to be economically feasible and consistent with sound industrial development, and which take account of Australia's general comparative advantage in the minerals field.

Because of high world gold prices enhanced by the relatively-low-parity value of the $A, ease of marketing, and inelasticity of gold prices with respect to supply, there has been a strong trend, both locally and internationally, to direct increasing effort and capital towards the exploration for and development of viable gold deposits. This is reflected in increasing expenditure on gold exploration and the impact that gold production and shipments are making on both value of mine output and export revenue. Positive achievements by the gold mining industry have afforded welcome relief in a relatively gloomy mining-industry scene and the success of gold exploration and development has, to some extent, cushioned the effects of the relatively poor performance of other mineral commodities. While this emphasis on gold is no doubt justified in the shorter term, a broader strategy for mineral exploration and development is called-for in the longer term if we are to maintain and improve our position in relation to the supply of minerals and mineral products. Continued heavy reliance on any one commodity would be unwise, having regard to the vagaries of international metal prices and the uncertainty associated with the volatility of currency exchange rates.

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TABLE 1. MINE PRODUCTION OF PRINCIPAL MINERALS

	Unit of quantity	1983	1984	1985	1986
Bauxite	'000 t	24 372 (d)	31 537	31 839	31 800 (e)
Coal, black, raw	'000 t	120 482	139 094	158 256	168 113 (e)
Coal, brown	'000 t	34 191	35 166	36 985	38 000 (e)
Copper (a)	t	261 476	235 671	259 765	239 001
Diamonds	carat	6 200 227	5 692 193	7 070 062	29 210 764
Gold (a)	kg	30 591	40 309	58 521	72 800 (e)
Iron ore and concentrate (b)	'000 t	71 037	94 406	92 859	90 000 (e)
Lead (a)	t	480 626	440 620	497 954	434 487
Manganese ore, metallurgical	t	1 370 233	1 848 889	2 002 960	1 648 921
Nickel (a)	t	76 625	76 923	85 757	78 000 (e)
Petroleum (c)					
Crude oil and condensate	$10^3 m^3$	23 907	28 915	33 377	29 766
Natural gas	$10^6 m^3$	11 581	12 600	13 464	14 708
LPG	$10^3 m^3$	3 070	3 392	4 124	3 929
Silver (a)	kg	1 032 895 (d)	972 303	1 085 933	1 017 000 (e)
Tin (a)	t	9 275	7 939	6 374	8 631
Titanium					
Ilmenite concentrate	t	892 570	1 493 171	1 418 867	1 314 300 (e)
Leucoxene concentrate	t	13 358	32 110	13 809	16 500 (e)
Rutile concentrate	t	163 374	170 424	211 615	212 400 (e)
Tungsten (W)(a)	t	2 015	1 733	1 970	1 500 (e)
Uranium (U_3O_8)	t	3 786	5 099	3 781	4 899
Zinc (a)	t	699 032	676 532	759 083	662 258
Zircon concentrate	t	382 005	457 599	501 440	401 700 (e)

(a) Total metallic content of minerals produced. (b) Excludes iron oxide not intended for metal extraction. (c) Data collected by Bureau of Resource Economics, DRE. (d) Excludes Victoria.

TABLE 2. SMELTER AND REFINERY PRODUCTION OF PRINCIPAL METALS

	Unit of quantity	1983	1984	1985	1986
Alumina	'000 t	7 231	8 781	8 792	9 423
Aluminium	t	478 190	757 798	851 286	881 910
Blister copper (a)	t	173 619	179 822	167 669	168 855
Copper	t	168 533	171 180	163 833	159 565
Gold, newly won					
Australian origin	kg	27 551	33 897	49 184	68 723
Overseas origin	kg	2 095	3 106	5 039	13 463
Lead (b)	t	196 335	198 847	200 147	151 510
Lead bullion (a)	t	182 593	179 491	183 161	188 277
Pig iron	'000 t	5 045	5 329	5 607	5 889
Raw steel (c)	'000 t	5 657	6 303	6 578	6 705
Silver	kg	329 357	302 482	329 024	294 602
Tin	t	2 913	2 899	2 683	1 302
Zinc	t	298 451	301 940	288 686	305 654

(a) Metallic content. (b) Includes lead content of lead alloys from primary sources.
(c) Includes recovery from scrap.

TABLE 3. OVERSEAS TRADE IN MINERAL PRIMARY PRODUCTS

	Unit of quantity	1984 Quantity	1984 Value f.o.b. ($'000)	1985 Quantity	1985 Value f.o.b. ($'000)	1986 Quantity	1986 Value f.o.b. ($'000)
EXPORTS (a)							
Alumina	'000 t	6 905	1 276 389	7 169	1 432 501	7 687	1 426 669
Aluminium (ingot metal)	t	419 063	661 694	563 716	861 918	579 124	968 918
Coal, black	'000 t	76 002	3 911 640	89 194	5 112 753	92 262	5 332 286
Copper	t	146 197	225 648	156 453	274 450	140 093	247 567
Diamonds, gem	carat	2 682 585	25 896	2 670 546	29 827	1 562 764	28 286
Diamonds, industrial	carat	903 480	6 014	561 451	3 684	1 813 194	10 263
Gold	kg	31 617	418 143	49 879	668 130	59 495	947 685
Ilmenite concentrate (b)	t	1 172 986	33 859	1 151 921	39 746	1 034 209	48 454
Iron ore and pellets	'000 t	85 480	1 615 188	86 914	1 997 225	79 661	1 937 707
Iron, ingot steel, ferroalloys	'000 t	411	81 266	685	155 491	598	163 366
Lead	t	427 177	357 684	429 722	357 781	412 041	361 122
Nickel	–	n.a.	374 759	n.a.	496 933	n.a.	438 801
Petroleum							
Crude oil	$10^3 m^3$	3 162	638 091	6 822	1 642 387	4 331	654 870
LPG	'000 t	1 441	376 304	1 609	491 935	1 495	298 262
Rutile concentrate	t	191 507	58 018	211 723	83 473	229 665	116 412
Salt	'000 t	4 783	74 723	5 166	97 439	5 330	104 094
Silver	kg	813 822	50 589	776 065	50 028	957 807	53 455
Tin	t	6 577	83 790	5 667	87 165	7 326	57 767
Tungsten concentrate	t	3 160	19 253	3 300	22 762	2 526	13 482
Uranium oxide	t	3 259	312 079	3 424	314 749	4 164	372 604
Zinc	t	660 963	468 860	633 472	514 802	662 394	489 061
Zircon concentrate	t	437 770	51 819	495 891	63 881	445 590	74 313
Other minerals	–		301 148		462 938		864 556
Total			11 422 854		15 261 998		15 010 000
IMPORTS							
Aluminium	t	709	1 893	1 079	3 370	910	3 920
Asbestos, all types	t	14 432	12 145	12 194	11 386	8 790	7 430
Clay (excl. activated)	t	61 695	8 288	63 187	9 965	48 000	8 450
Diamonds, gem	carat	96 966	36 141	117 921	48 155	120 300	63 200
Diamonds, industrial	carat	1 471 714	5 255	1 787 148	7 927	2 206 700	8 860
Gold	kg	3 527	38 670	7 972	89 303	4 740	57 820
Ingot steel, ferroalloys	t	36 472	26 413	62 502	39 039	69 080	39 040
Nickel, matte and metal	t	1 134	5 898	858	6 075	3 740	8 150
Oil, crude	$10^3 m^3$	5 330	1 071 883	3 305	766 634	3 320	481 460
Phosphate rock	'000 t	1 606	82 095	1 810	94 207	1 750	100 300
Potassium fertiliser	t	259 628	28 158	204 633	28 464	228 740	30 300
Sulphur, elemental	t	470 795	39 642	392 344	57 863	447 300	79 940
Other minerals	–		711 374		862 208		600 000
Total			2 067 855		2 024 596		1 489 000

(a) Quantities refer to total metallic content of all ores, concentrates, intermediate products, or refined metal; value of metals contained in host mine and smelter products (e.g. silver in lead concentrate or lead bullion) is not separately available and is included in the value of the mineral product or metal in which it is exported.
(b) Excludes leucoxene and beneficiated ilmenite.

Australian mineral industry financial overview and outlook

B.J. Davies, Coopers & Lybrand

As in the past years, this paper is based on data gathered by Coopers & Lybrand in connection with the Minerals Industry Survey 1986 conducted on behalf of the Australian Mining Industry Council (AMIC).

Revenue and production

After the welcome 26% growth in operating revenue in 1984/85, the Australian minerals industry showed a much lower rise in operating revenue for 1985/86 of under 10%. This was despite an average depreciation of the Australian dollar against the US dollar (in which the majority of minerals are priced) of some 9% and an increase in production volumes for many commodities. These favourable factors were offset by tight market conditions and low world-wide commodity prices, and which together resulted in depressed Australian dollar prices. This situation seems unlikely to change in the near-term.

The effect on prices, expressed in Australian dollar terms, is shown in the accompanying graphs for various significant commodities. A number of prices showed significant declines during 1985/86 and, while others show an average for the year which exceeded those of 1984/85, most commodities finished 1985/86 at , or below, the level at which they started the year. Gold was a notable exception.

Foreign exchange differences

In my paper last year, I observed that "unrealised exchange losses on overseas borrowings of some one billion dollars continue to hang over the head of the Australian minerals industry". In 1985/86, some of those losses were realised. In addition, a number of companies recognised that exchange rates were unlikely to return to anywhere near the levels at which the respective borrowings had been drawn down, and so they took the conservative view that those losses should be recognised now, rather than spread over the remaining term of the respective borrowings. This action had a detrimental effect on profits for the year. Unrealised foreign exchange losses at the end of 1985/86, however, were still over one billion dollars and will continue to impact on the industry for some time to come.

Profits

The net profits of the Australian minerals industry in 1985/86 were adversely affected by the foreign exchange losses referred to above, many of which were classified as extraordinary times. As a result, profits fell, and for the fifth consecutive year net profits, as a percentage of average shareholders' funds, were below 6% with the 1985/86 figure being only 4.9%, as shown by the following table:

	1982	1983	1984	1985	1986
Net profit ($ millions)	177	379	462	640	535
Net profit to average shareholders' funds (%)	2.2	4.1	4.4	5.7	4.9

Profits before extraordinary times, however, did show some improvement. This appears to be due to the continuing program of cost containment by the industry and some progress in the elimination of restrictive work practices. Nevertheless there still seem to be opportunities for further efficiencies in these areas compared to what is achieved in other areas of the world. Interest increased at a faster rate than other costs, growing by 26%, mostly as a reflection of higher levels of debt.
Revenue rose by almost 10%, but production appears to have risen almost 13%. Nevertheless, cost increases were limited to under 8% and so profits before tax increased by almost 24%. The extraordinary times referred to earlier, however, absorbed all of this gain, with final net profits showing a down-turn of 16% compared to 1984/85.

Rates of return

The rate of return for the Australian minerals industry remains dismal, with a further downturn from the minor improvements shown in 1984/85.

A comparison of the net profit returns of the Australian minerals industry with other financial and industrial enterprises is instructive. When it is recognised that the minerals industry should be perceived to have a higher risk profile than most others, it could be expected that, other things being equal, a higher rate of return might be anticipated.

The following tabulation is taken from the Reserve Bank of Australia Bulletin of January 1987. The "mining" figures given by the Bank are slightly different to the AMIC Survey due to a different population, but the trends are the same.

Net profit return on average shareholders' funds

	1982	1983	1984	1985	1986
Financial	16.3	14.8	15.6	15.1	13.5
Industrial	9.4	7.7	10.0	11.2	12.7
Mining	1.4	4.6	5.4	4.9	5.9
AMIC	2.2	4.1	4.4	5.7	4.9

Investment in the Australian minerals industry

This continued lack of an adequate return is limiting further shareholder investment in the industry. While there is a huge asset base of over $28 000 million, much of this investment was made many years ago or is due to decisions taken some years back when prospects may have looked better. Assets increased at the lowest percentage rate in the history of the AMIC survey. One result is the divestment of shareholders' funds from the Australian mineral industry, either to overseas opportunities, to other sectors of Australian industry, or by mine closures, with a far greater reliance now on borrowed funds. In 1985/86, shareholders' funds fell by $777 million, while borrowings rose by $1313 million to $13 277 million. As a result, the "debt to equity" ratio increased to an all time high of 1.27. Five years ago this ratio was only 0.83, and the deteriorating trend is shown by the following table:

	1982	1983	1984	1985	1986
Debt (borrowings)	7 431	9 639	10 275	11 964	13 277
Equity	8 916	9 955	10 967	11 226	10 449
Total ($millions)	16 347	19 594	21 242	23 190	23 726
Ratio	0.83	0.97	0.94	1.07	1.27

The main area of the Australian minerals industry which has continued to attract investment in 1986 has been gold. The decision by the Federal Government to continue the exemption from income tax of gold mining operations seems likely to encourage this trend while gold prices remain relatively high. However, after 1

July 1987 when the Dividend Imputation system comes into force, gold mining profits will remain taxable when distributed to shareholders while most other dividends will become effectively exempt in the hands of shareholders.

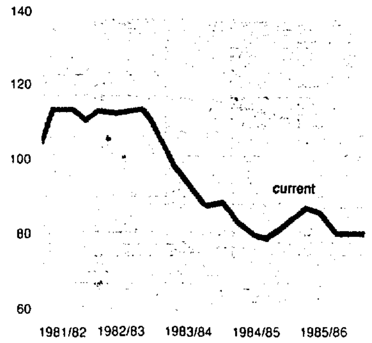
The one encouraging factor is that exploration is expected to be greater in 1986/87 than it was in 1985/86 - the first increases in five years. While the forecast increase is only marginal in real terms, it is one positive sign in relation to the future lifeblood of the industry.

Dividend Imputation

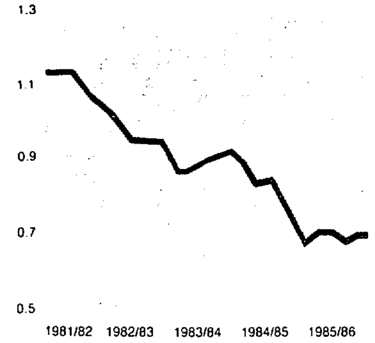
		Gold Profits	Other Profits
Company			
Profit before tax		100	100
Company tax	(A)	Nil	49
Profit after tax		100	51
Dividend paid		100	51
Individual Shareholder			
Dividend received		100	51
Gross-up for company tax		-	49
Taxable income		100	100
Tax at 49%		49	49
Imputation credit		Nil	(49)
Tax payable	(B)	49	Nil
Combined			
Total tax	(A+B)	49	49

Price Data

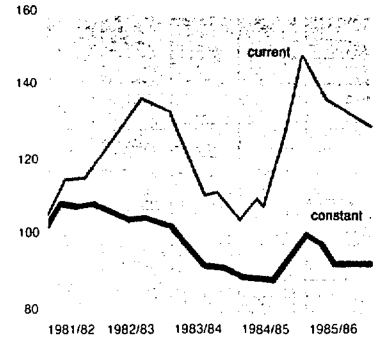
AMIC Mineral Price Index $US
1979/80 = 100



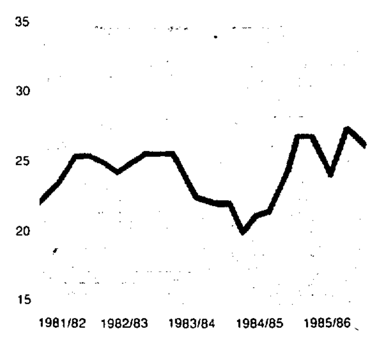
$US: $A Exchange Rate
Quarterly average



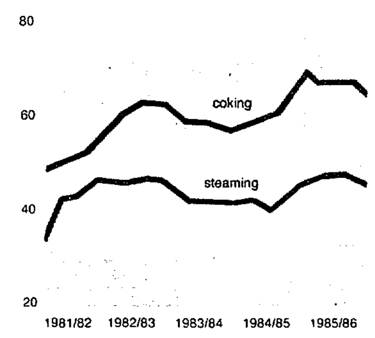
AMIC Mineral Price Index $A
1979/80 = 100



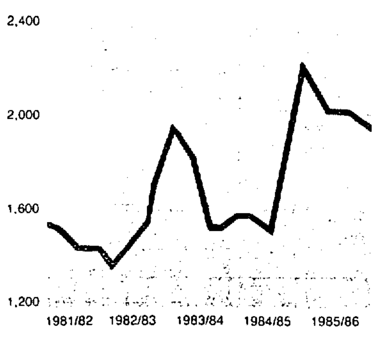
Iron Ore
$A/tonne



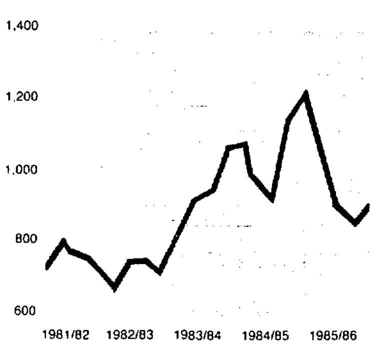
Coal
$A/tonne



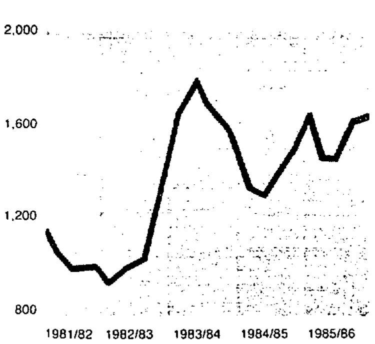
Copper LME
$A/tonne



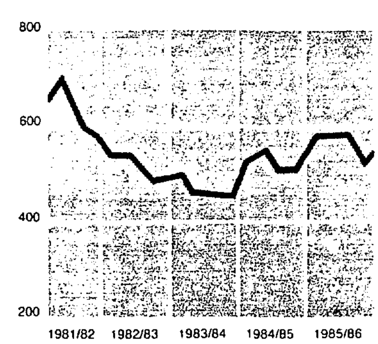
Zinc LME
$A/tonne



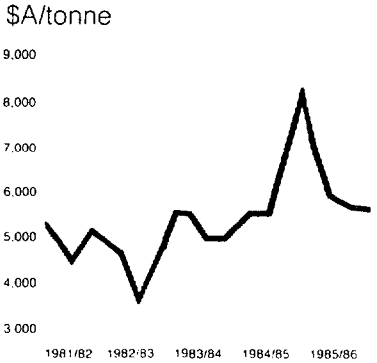
Aluminium LME
$A/tonne



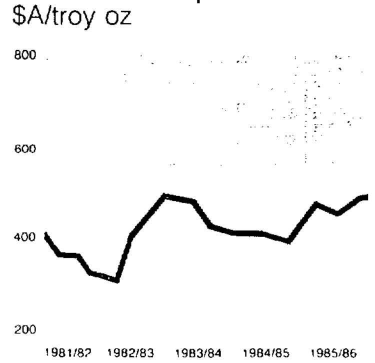
Lead LME
$A/tonne



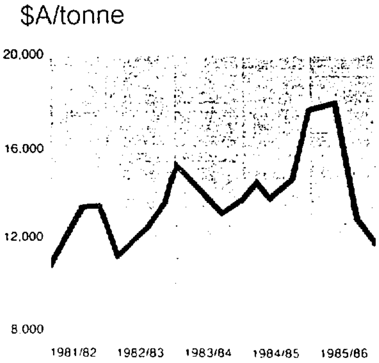
Nickel LME
$A/tonne



Gold London Spot
$A/troy oz



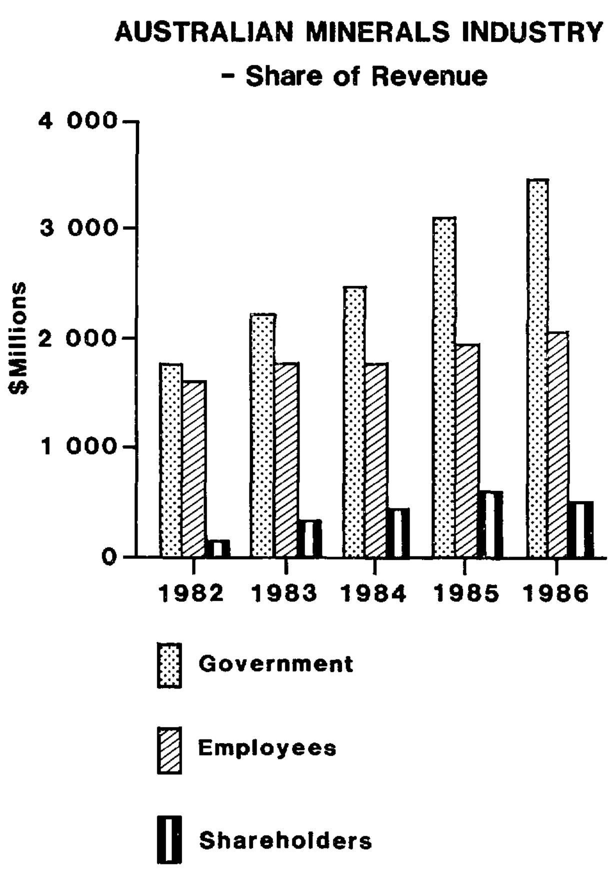
Tin
$A/tonne

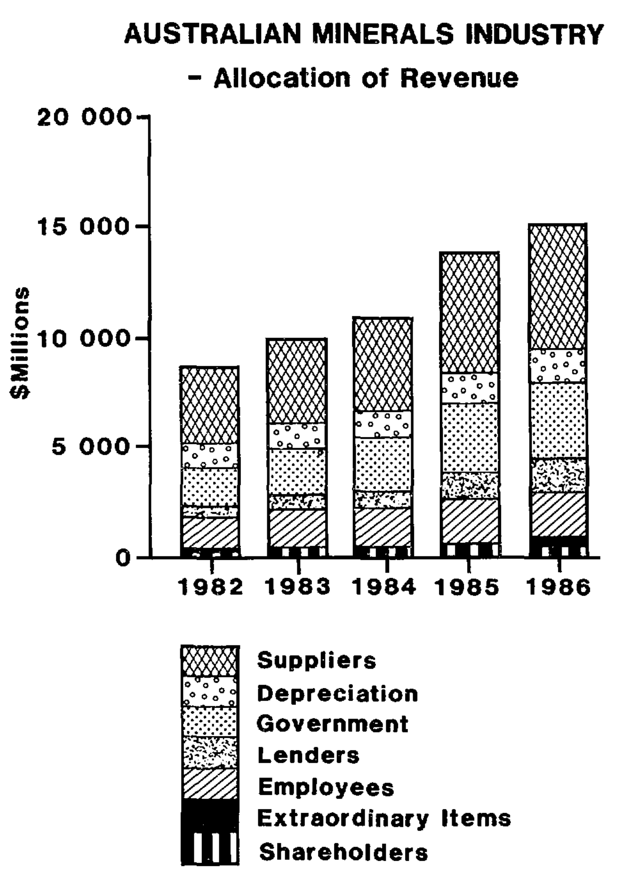


Survey Highlights

Items of Interest	1983/84	1984/85	**1985/86**
Operating Revenue ($ Million)	10748	13500	**14799**
Total Assets at Year End ($ Million)	25401	27662	**28359**
Borrowings at Year End ($ Million)	10275	11964	**13277**
Interest Expense ($ Million)	748	964	**1216**
Net Profit ($ Million)	462	640	**535**
Net Profit Return on Average Shareholders' Funds (%)	4.4	5.7	**4.9**
Effective After-Tax Return on Average Funds Employed (%)	4.4	5.5	**6.7**
Effective After-Tax Return on Average Assets Employed (%)	3.7	4.6	**5.6**
Direct Taxes on Pre-impost Profit (%)	63	58.3	**56.6**
Expenditure on Fixed Assets ($ Million)	2075	1793	**1993**
Exploration Expenditure ($ Million)	287	254	**231**
Employees at Year End	78923	79609	**78610**
Debt to Equity Ratio	0.94	1.07	**1.27**
No. of Responses	118	121	**129**

Forecasts	**1985/86 Actual**	1986/87 Forecast	Percentage Change
Expenditure on Fixed Assets ($ Million)	**1993**	2011	0.9
Exploration Expenditure ($ Million)	**231**	257	11.3
Employees at Year End	**78610**	78607	0.0





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Industrial relations and the mining industry

P. Ryan, Department of Resources & Energy

Against a background of depressed commodity prices, a situation likely to prevail for the foreseeable future, industry profitability will be heavily dependent upon containment of costs and improved productivity. Industrial relations and the related issue of work practices are both an "Archilles heel" and a key to improved productivity if the industry's problems in this area can be addressed constructively.

Over recent years the mining industry has been the major contributor to industrial disputes in the economy and has had by far the worst record in terms of working days lost per thousand employees. The overall impression is one of a volatile industrial relations environment with a sustained high level of disputes contrasted with a much lower and declining level of disputes for the economy as a whole.

Within these broad parameters, the Department of Employment and Industrial Relations' weekly records of industrial disputes (from 1983 to June 1986) provide a good indicator of the industrial relations climate facing the mining industry. Aggregating the data indicates a predominance of 'work practices' disputes, rather than ones provoked by wage-related or employment issues. Further, if one examines the duration of disputes, there is a large proportion of very short disputes (less than 2 days), which one would assume did not involve intractable issues. This inevitably raises questions about the conduct of industrial relations in the mining industry.

The industrial relations performance of the mining industry has vital implications for its competitiveness through its impact on costs and on Australia's reliability as a supplier. There are special features of the industry which make for a more difficult industrial relations climate compared with other industries - dangerous occupation, isolated locations and, given finite resources, the question of job security. However, these difficulties appear to have been exacerbated by a failure to address the industrial relations issue in the past. In these hard times confrontation seems to have become the norm, yet many unacceptable work practices presently under question were conceded by companies in easier times.

Nevertheless, there are indications that a change in attitudes is taking place in response to the imperative of the present economic situation - cases of Mt Isa, Cobar, Broken Hill, Robe River and Invincible where necessary changes to work practices, in most cases to keep the enterprises viable, have been effected. It is also heartening that a recent issue of the Mining Review could instance four case-studies of successful co-operative approaches to industrial relations, involving workers and unions in decisions about the organisation of work.

The development of a more conciliatory, site-specific approach to industrial relations appears to hold the prospect of a much improved industrial relations climate and hence a more favourable environment for addressing the work practices issue, which is essentially one of developing a flexible attitude to the ongoing problem of change in the industry.

Although this is predominantly a problem for the companies and unions to jointly resolve, the Government has acted at an industry level in the cases of the Western Australian Iron Ore Industrial Consultative Council and the Australian Coal Consultative Council to facilitate improved communication on industrial relations issues. These bodies have served to promote some awareness that the workforce and management are partners and a more co-operative approach is needed to issues affecting the future of the various segments of the industry.

One-off victories achieved through confrontation may well win the battle but, in the longer run, lose the war. We have an increasingly well-educated workforce that is becoming more attuned to the commercial realities that will dictate the industry's future.

Changed economic circumstances have thrust the issues of industrial relations and work practices to the forefront. Change is inevitably an ongoing process and we need to question our attitudes and approaches to these issues if the industry is to effectively respond to this challenge, both now and in the future. If we cannot do so, the competitiveness of many of our mining operations may be seriously eroded.

Australian coal in a world perspective

R. Austen, A.O., Austen & Butta Limited

Australian coal reserves and production

Australia's coal reserves rank about 9th in the world and account for at least 5% of the known economically recoverable reserves. Most reserves of "black coal" are concentrated in New South Wales and Queensland, whilst Victoria has the majority of the "brown" coal reserves.

Australia's domestic coal market is relatively small (in 1985/86 domestic consumption was 36.3 million tonnes thermal coal, 6.2 million tonnes coking coal and 36.5 million tonnes "brown" coal). The small domestic market, coupled with large reserves has enabled Australia to become a major exporter of both coking and thermal coal. In 1985/86 Australia was the world's leading coal exporting country, with 89.9 million tonnes exported. These exports earned around $5.3 billion in 1985/86 which made coal Australia's largest single export commodity.

The development of major projects in New South Wales and Queensland in the late 1970s and early 1980 enabled the rapid expansion in the export trade.

Australia's current competitive position

Australia occupies the dominant position in internationally-traded coking coal, on a cost basis. The export growth has now flattened with 1985/86 exports being 48.8 million tonnes and it is anticipated that the growth rate previously seen will no longer continue.

Although a major supplier of competitively-priced export thermal coal, Australia has higher cash costs than both South Africa and Colombia. Exports have enjoyed a rapid rise in the 1980s, and in 1985/86 41.4 million tonnes of thermal coal was exported.

World outlook

The markets for internationally-traded coking and thermal coal are currently oversupplied. Among the many factors influencing this are changing inter-fuel economies, production of marginal tonnage, new exporting countries, political influences, switching of coal usage and low expectation of economic growth.
It is believed that these factors will continue to influence the markets and in addition future pattern of supply and demand will be further influenced by trade imbalance considerations, restructuring of some domestic coal industries and changing world patterns of industry and manufacturing.

Australian outlook

The Australian coal industry, in line with the international coal industry, is currently undergoing a period of rapid change in terms of supply, demand, price and trade patterns. The uncertainty this has created has been exacerbated in Australia by exchange rate volatility and the actions of trade unions and governments.

The industry in Australia does enjoy some inherent competitive advantage over many of its international counterparts. The advantages are derived principally from resource quality and geographic location, as well as political stability and now well-established infrastructure.

However, the ability of the industry to maintain its competitive position, and thus make a positive contribution to Australia's export earnings and balance of trade is of critical concern.

A key determinant in current ability to compete is the exchange rate. The depreciation of the Australian dollar over the last few years has enabled the Australian coal industry to maintain its prominent position. However, a return towards historic levels of the Australian dollar versus the US dollar would represent a real threat, if not offset by savings in Australian dollar costs.

Thus it is essential that to ensure a long-term competitive position in international trade, the Australian coal industry must become extremely cost-conscious. This must be achieved in production costs, transport costs and other charges. Producers must take initiatives to control and reduce costs wherever possible at the technical and operational level.

However, the major areas in which the Australian coal industry suffers compared to its overseas competitors are industrial relations and government charges. The inflexible industrial relations system has allowed work practices to develop in a way that burdens the industry unduly. (eg The Australian Bureau of Statistics reports that for the 12 months to October 1986, the Australian coal industry accounted for approximately 20% of total days lost in industrial action, and this despite the fact that the industry employs less than 1% of the workforce). The Australian coal industry is focussing, and will continue to focus, on the question of government take, especially via rail freight charges, port charges and royalties. The industry maintains that these charges should be related to actual cost, which in turn should be competitive in world terms, rather than being used as a revenue-raising mechanism by State Governments.

In summary, it is essential that the coal industry, Australia's largest single export earner, be able to preserve the position it has in the world market so that it can contribute positively to Australia - especially in terms of decentralised employment opportunities, export earnings and balance of trade. To do so it must strive for continued technical and operational improvement and have the co-operation of unions and government to ensure that its cost structures are competitive in the world arena.

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The outlook for the resources sector to 2000

A.G. Christie, Bureau of Resource Economics

A major focus of current concern about the Australian economy is its export performance. The resources sector (including energy and mineral commodities in both raw and processed form) provides approximately half of the total export earnings today. The performance of the sector over the years to 2000 will have a major influence on the economy.

BRE has undertaken a study of the outlook for each of the major export-earning resource commodities to the year 2000. The intention has been to identify the potential areas of opportunity into the 1990s rather than to provide precise forecasts for price and volume over the next few years.

The methodology employed involves consideration of both demand and supply. The patterns of demand (relative to world economic growth) and price for each commodity were examined over a 30-50 year time-frame, depending on data availability. Appropriate interpretation of the relationships between demand and economic growth at different periods in the past (eg, pre- and post-1973) has been given careful attention.

Our assessments suggest that the major influences which are most likely to affect the resource outlook over the period are world economic growth, changes in technology of resource commodity usage, energy prices, exchange rate realignments, trade policies, and the ability of Australian resource companies to react to emerging opportunities.

The study attempts to highlight and to account for the inherent uncertainties in an outlook exercise by developing scenarios involving these major influences. In brief, the scenarios, and <u>notional</u> probabilities of their being representative of the actual future, are:

<u>Muddle Through</u> - the world economy continues to exhibit modest growth (at about 3% pa), similar to that of the past decade (say 40% probability).

<u>Restructured World</u> - an initial slow growth period(of about 1.5% pa for about 4-5 years) involving restructuring of various national economies is followed by a boom (of about 4.5% pa) in the 1990s (say 30% probability).

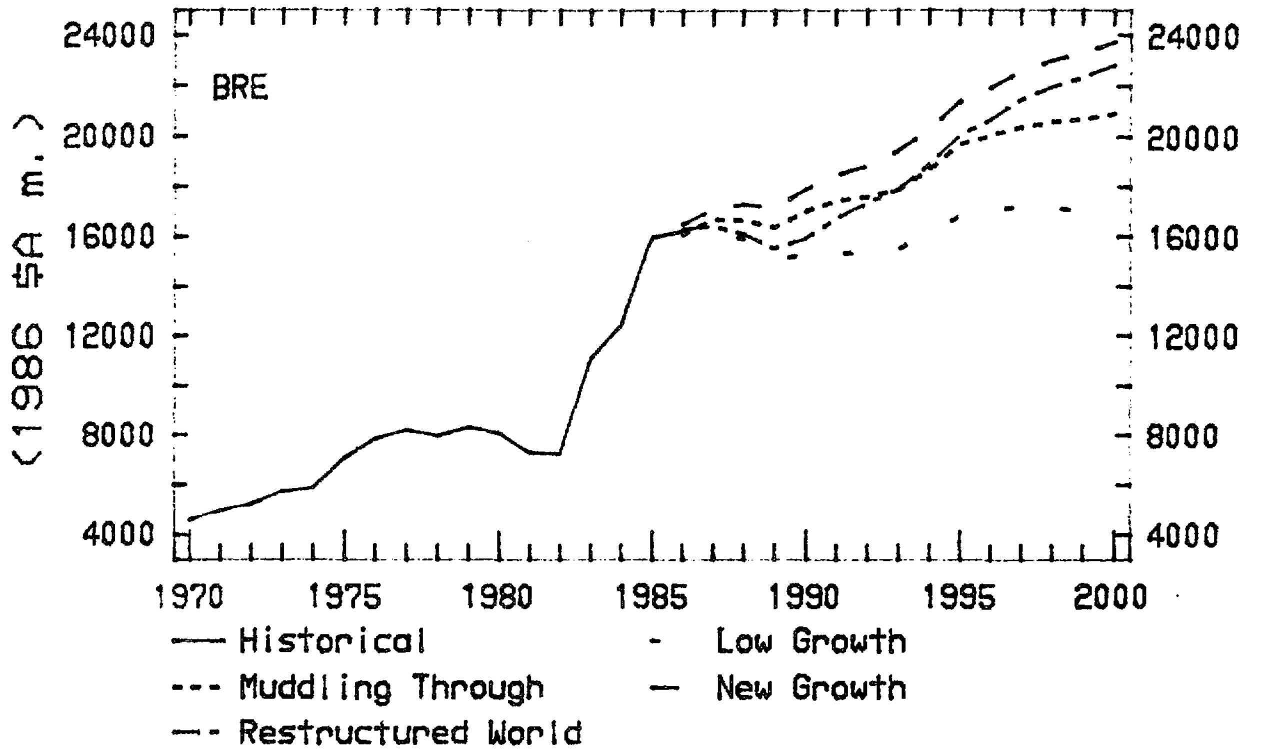
<u>Lower Material Demand</u> - slow economic growth (at about 2% pa) accompanied by improved technology leads to slower growth in resource commodity requirements (say 20% probability).

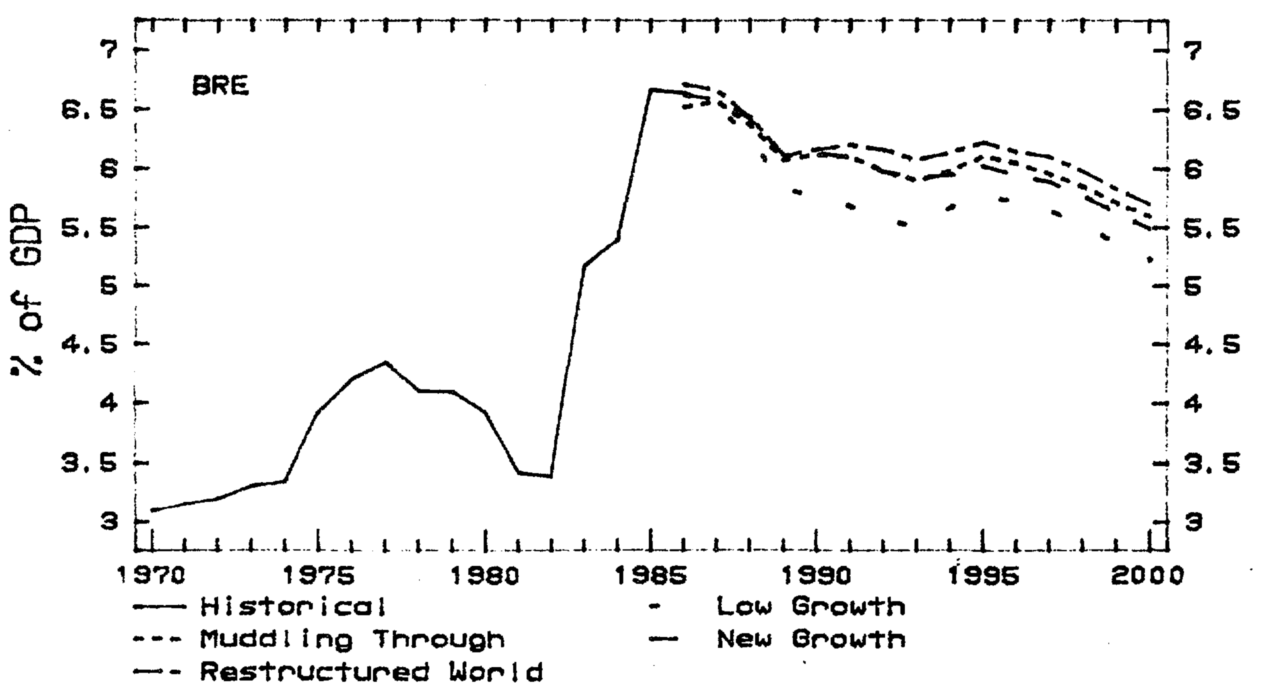
<u>New Growth Era</u> - a period of relatively rapid growth (at about 4.0% pa), and rising metal metal intensity (say 10% probability).

The results of our study provide an indication of resources sector prospects in the 1990s. The nature of the methodology ensures that our results are influenced by the long-term trends of the relationship between commodity demand and GDP which are appropriate for a medium-long term outlook. Consequently, even though we have chosen cautious or conservative assumptions wherever possible the results tend to be more optimistic than those of studies whose methodology is dominated by more recent trends.

Demand for resource commodities generally over the past decade has been remarkably weak compared with earlier periods, and the prices trend is now substantially below the trend for most other commodities. Our analysis suggests that this situation is reversible, at least in part, and that the situation with respect to both demand and price for most resource commodities which Australia exports should improve into the 1990s. The sector is expected to continue to make an important contribution to export earnings and there should be large increases in the real value of exports.

Australian Resource Exports
1970-2000





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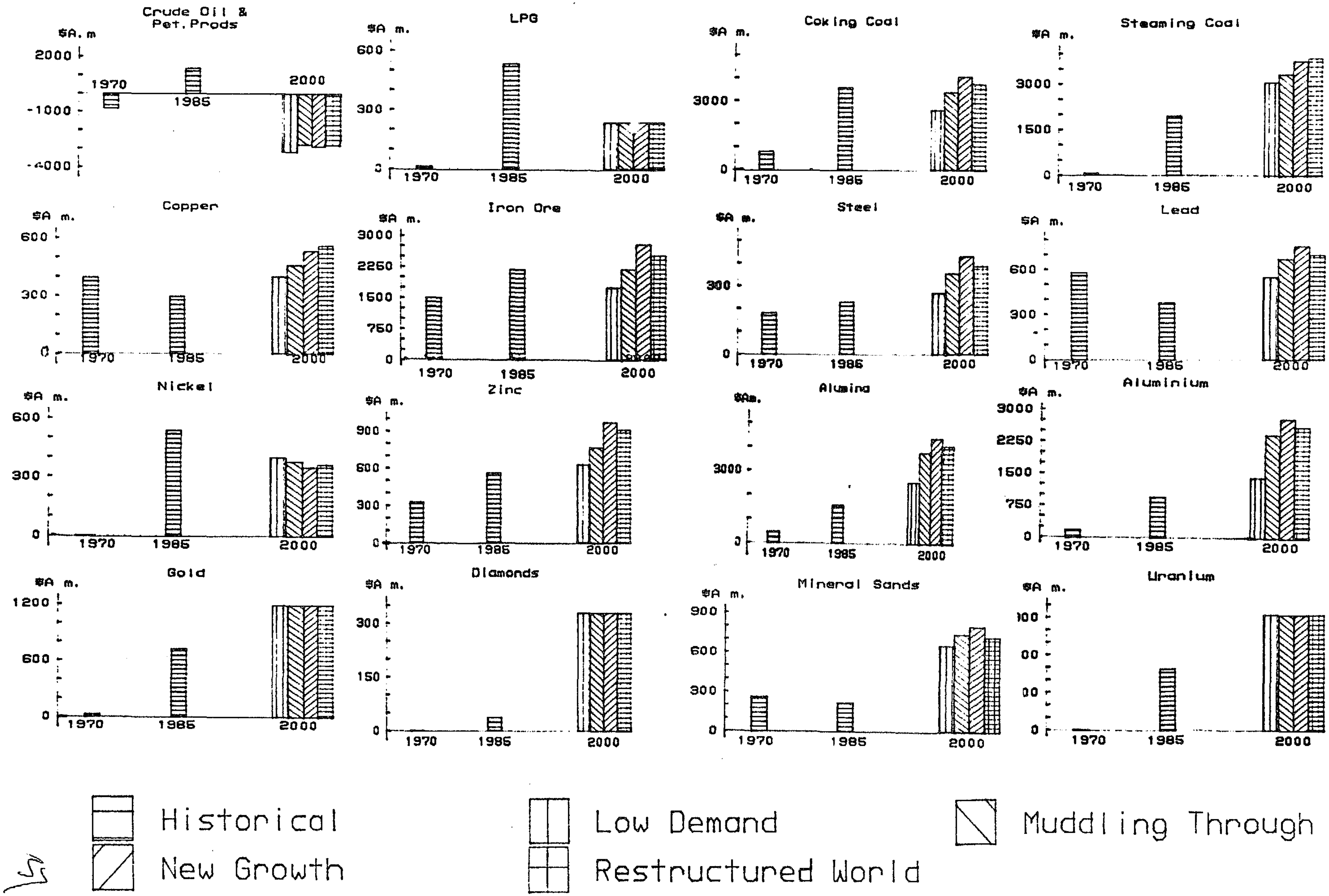
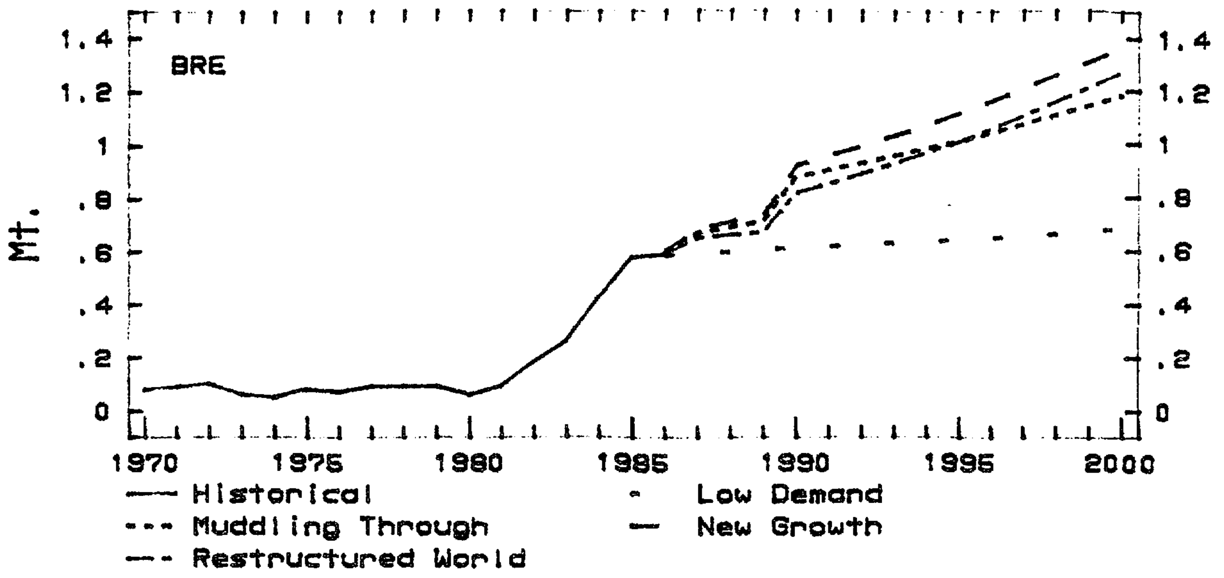
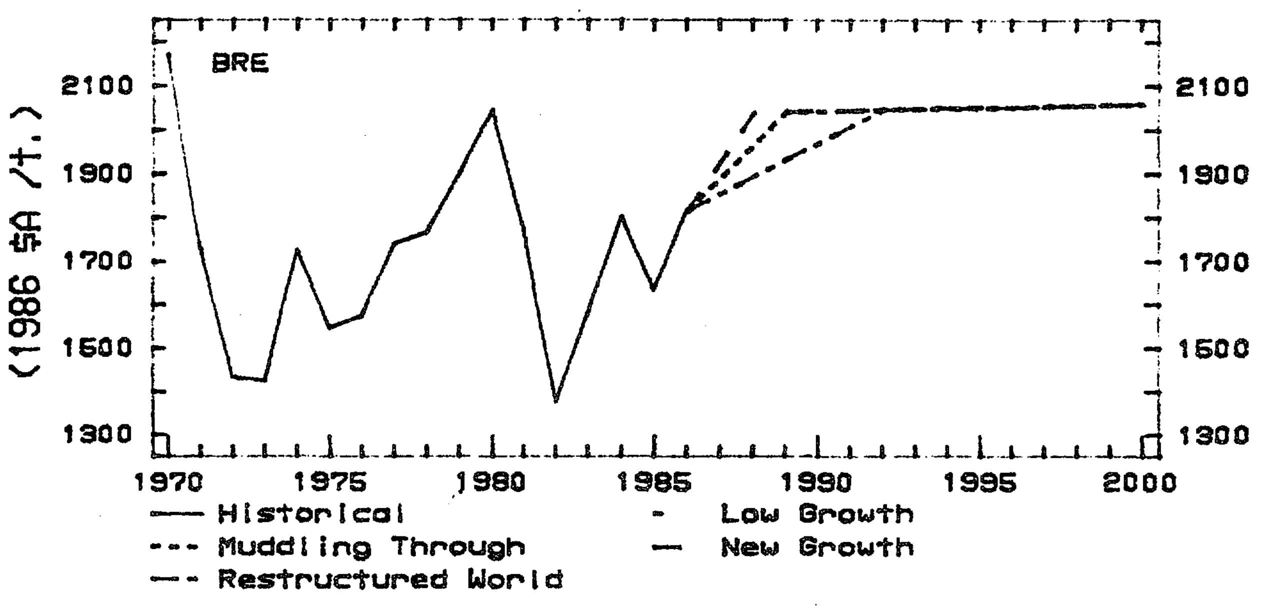
Australian Resource Exports 1970-2000 ($1986)



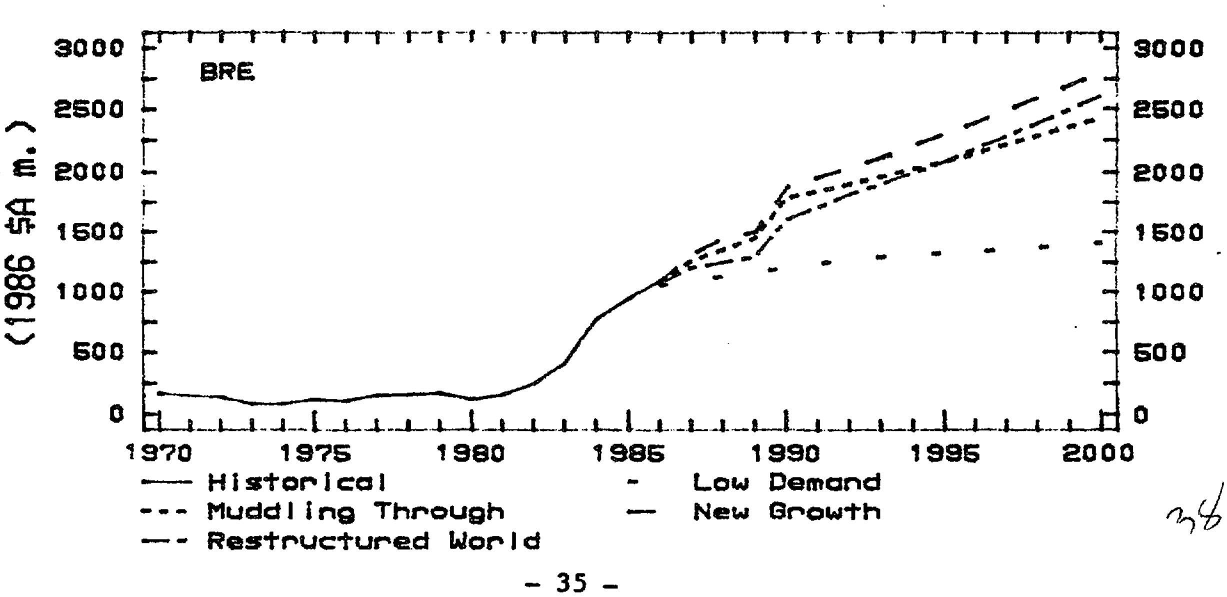
Aluminium:Aust.Exports(Volume)



Aluminium:Aust.Exports(Prices)



Aluminium:Aust.Exports(Value)



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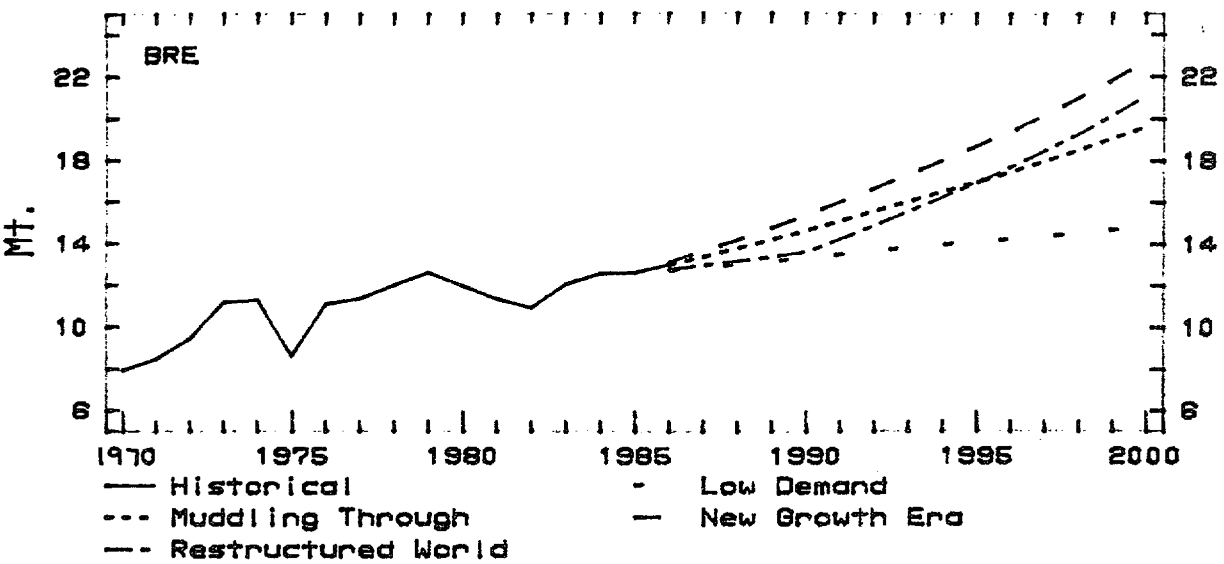
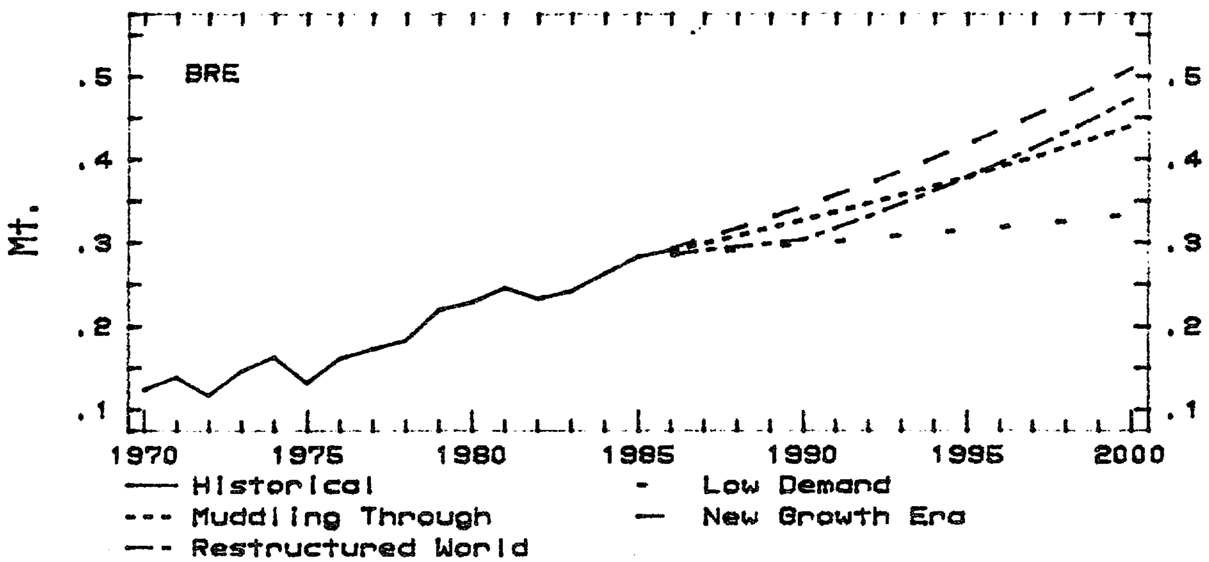
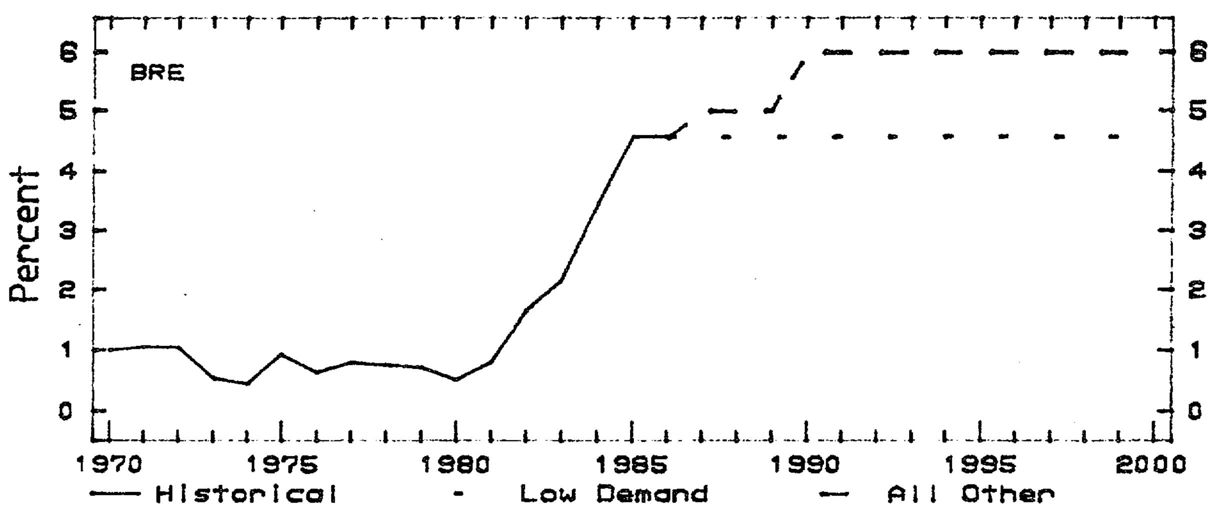
Aluminium:WOCA Primary Demand



Aluminium:Aust. Primary Demand



Aluminium:Aust. Exports (percentage of Woca demand)



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Mineral exploration and mining developments in Queensland during 1986 and outlook for 1987

J.D. Sawers, Geological Survey of Queensland

In keeping with global trends, gold continued to completely dominate exploration for non-fuel minerals in Queensland during 1986. The new gold rush, already fuelled by profitability, rising production, and a succession of new discoveries was given added impetus by the complete collapse of the tin mining industry. A rapid exodus to the goldfields of many of the smaller-scale tin miners followed, rapidly exhausting the availability of suitable shallow alluvial ground. By the end of the year, some three-quarters of current Authorities to Prospect (M) titles were held primarily for gold.

When rated in terms of dollar value of production for all minerals produced in the State, gold moved into fourth place ahead of bauxite, in consequence of which it now ranks second only to copper in the metals sector. Kidston, the largest gold mine in Australia was by far the major producer followed in importance by tailings re-treatment operations at Mount Morgan and Cracow. The relative importance of these tailings projects will decrease in 1987 as new comparatively-large hard rock mines are brought into production. Mining commenced in 1986 at Red Dome near Chillagoe and at Mount Leyshon south of Charters Towers, and construction of facilities to enable large-scale heap leaching of ore was completed at both projects.

Prospects for 1987 are also enhanced by proposals to resume mining operations at Croydon, commence open-cut mining of the old Golden Plateau mine at Cracow, west of Bundaberg and to bring the Starra gold-copper deposit, south of Cloncurry, into production. Amongst other projects, work will be undertaken to allow production from the rich Pajingo deposit south of Charters Towers to commence in 1988.

Release of resource estimates for substantial deposits scattered throughout the State includng the Disraeli deposit south of Charters Towers, deposits on Horn Island in Torres Strait, and at Cracow, also helped engender optimism among explorers. Additionally, the search for large low-grade epithermal gold deposits continues to provide encouragement, more particularly in the Hodgkinson Basin, the Mount Coolon area and at Woolgar.

Alluvial workings are predominantly small and of widespread occurrence. Amongst the larger of these are operations at Kilkivan, west of Gympie and in the Gilbert and Palmer River areas of North Queensland.

Activity in base metals remains restricted to several known deposits. Plans are proceeding for trial mining during 1987 at the Hilton lead-zinc deposit north of Mount Isa; development work has proceeded at the Lady Loretta lead-zinc deposit further north. Additions were made to reserves at the Thalanga zinc-copper deposit near Charters Towers.

The sudden collapse of the tin industry severely affected mining in north Queensland during 1986. Exploration for tin deposits also effectively ceased although further underground investigations were carried out at the Collingwood deposit, south of Cooktown, before suspension of operations.

The depressed state of the tungsten market led to the Mount Carbine mine, northwest of Cairns, being placed on care-and-maintenance towards the end of the year, prior to completion of the underground access decline. Active exploration and testing of the large Watershed scheelite prospect in the same area was discontinued.

Interest in heavy mineral sand deposits continued, and exploration proceeded at Byfield north of Rockhampton. Production from established operations on Stradbroke Island, near Brisbane, increased.

Industrial minerals became increasingly important. Late in 1986 a modern kaolin treatment plant was opened at Weipa and the first bulk clay shipment made to Japan. Continuing exploration of extensive sedimentary nodular magnesite deposits in the Marlborough area north of Rockhampton has revealed an extremely large high-grade resource. A new dry treatment plant at Cape Flattery, north of Cooktown, was commissioned and construction of a loading wharf commenced to enable increased production of high-grade silica sand. Granting of leases this year over silica sand deposits at Shelburne Bay, further to the north, heralds increased production in the future.

TABLE 1: PRINCIPAL AND POTENTIAL GOLD PRODUCERS IN QUEENSLAND

Deposit	Mining operation	Production status	Annual production	Resource estimates
CRACOW	Tailings	Started early 1985	7459 oz (232 kg) Au, 26 205 oz (815 kg) Ag	To finish early 1987
	Open-cut	Expected start early 1987	46 000 oz (1430 kg) projected	1.5 Mt x 5.2 g/t to 84 m
	Underground	-	-	1.5 Mt x 5.5 g/t
CROYDON	Open-cut	Expected start late 1987	350 000 tpa ore projected	1.3 Mt x 3.8 g/t
DISRAELI	Open-cut	Expected start mid 1987	200 000 tpa ore projected	0.6 Mt x 4.6 g/t
HORN IS.	Open-cut	Final planning	250 000 tpa ore projected	0.6 Mt x 3.3 g/t
KIDSTON	Open-cut	Commenced March 1985	238 380 oz (7270 kg) in 1986	39.2 Mt x 1.82 g/t proved (Jan. 1986)
MT LEYSHON	Open-cut	Mining started, plant completed end 1986	46 000 oz (1430 kg) projected	6.3 Mt x 1.8 g/t
MT MORGAN	Tailings	Started Dec. 1982	53 600 oz (1669 kg)	22.5 Mt x 1.08 g/t June 1986
PAJINGO	Open-cut	Expected start 1988	75 000 oz (2300 kg) projected	1.4 Mt x 12.6 g/t Au, 40 g/t Ag
RED DOME	Open-cut	Mining start plant trials completed 1986	62 000 oz (2000 kg) projected	8.6 Mt x 2.5 g/t mineable
STARRA	Open-cut	Expected start 1987	50 000 oz (1550 kg) rising to 90 000 oz (2800 kg) projected	2.24 Mt x 4.8 g/t Au & 0.8% Cu
	Underground	-	-	2.47 Mt x 7.6 g/t Au & 3.0% Cu

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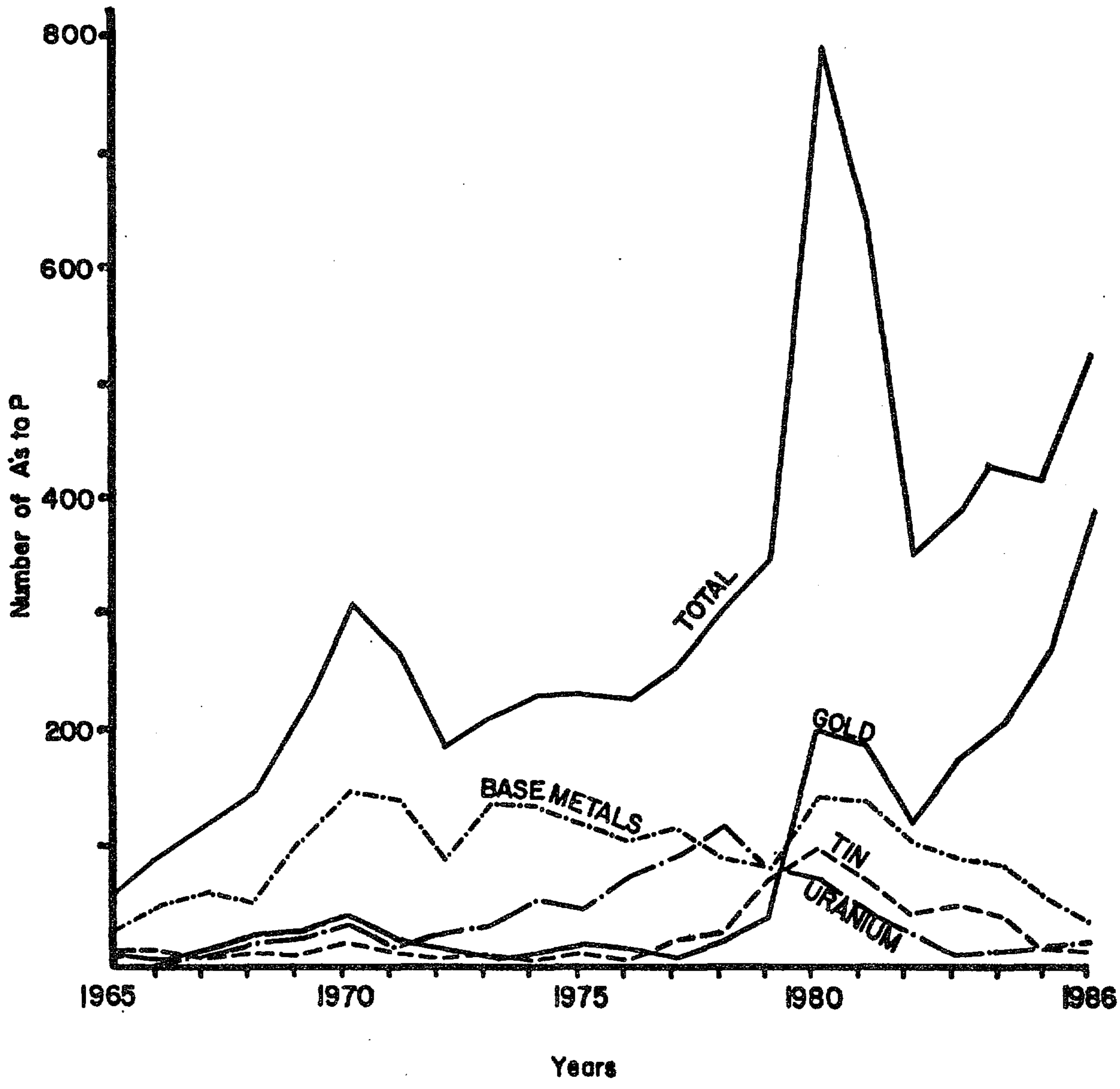
EXPLORATION UNDER AUTHORITIES TO PROSPECT QUEENSLAND 1965-86



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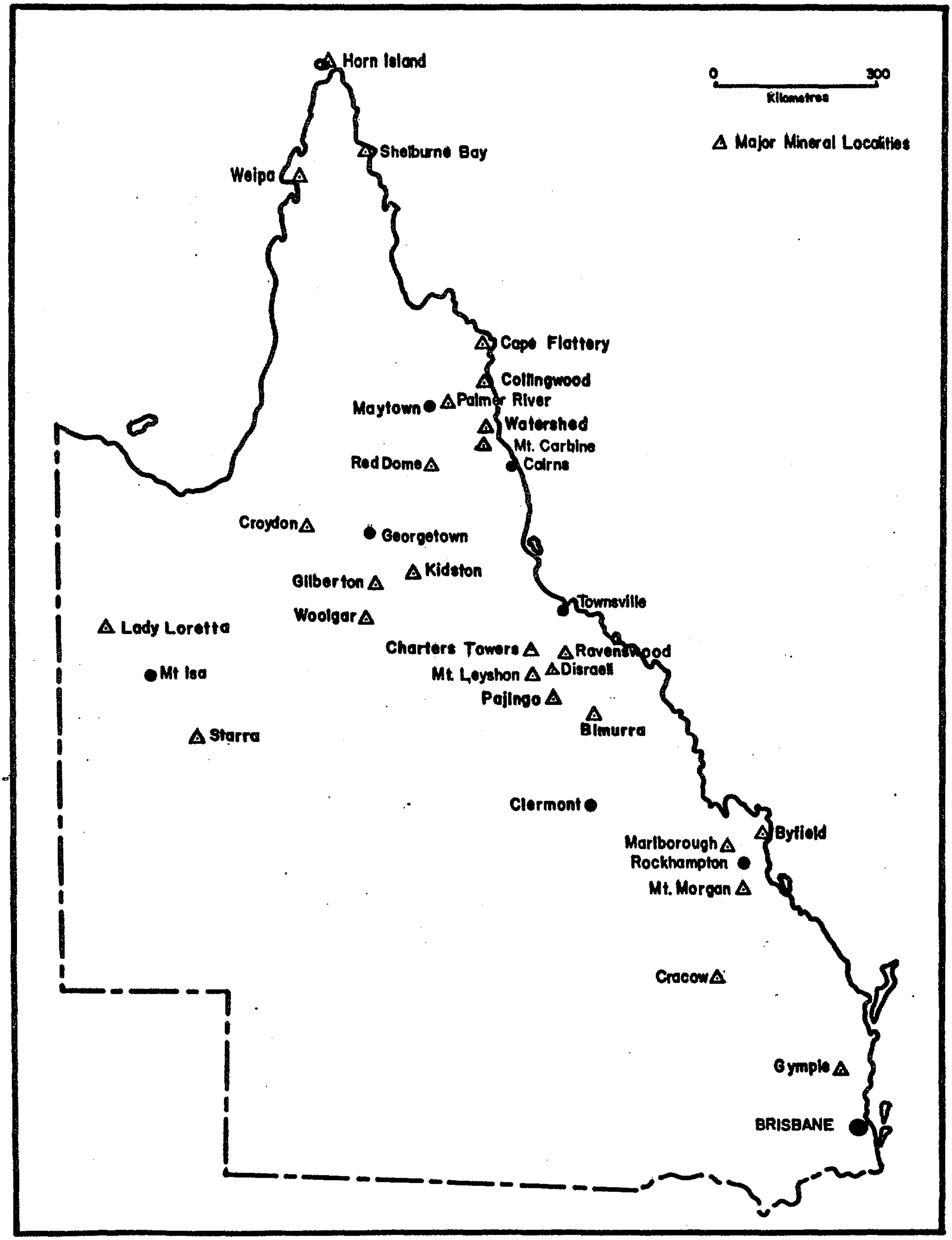

Major Mineral Localities

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Queensland Mineral Industry
1985-86

COAL	METALLIC AND INDUSTRIAL MINERALS
Percentage of Total Production:	Percentage of Total Production:
66.6%	**23.3%**
Market Value:	Market Value:
$2668.5 Million	**$933** Million
No. of Producers:	No. of Producers:
28	**326**

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NSW mineral exploration and mining: 1986 in review
and outlook for 1987

F.W. Cook, Geological Survey, New South Wales

Exploration. Exploration expenditure in New South Wales during 1985-86 amounted to $56.5 million (up from $55.1 million in 1984-85) with the most active region being the Lachlan Region on which $21.1 million was spent. $11.8 million was recorded for coal exploration in the State, an increase of $4.4 million over 1984-85. Base metals exploration expenditure fell by $2.9 million to $17 million and gold was steady at $17.5 million.

The number of current mineral exploration licences has fluctuated around 380 whilst other titles have been reduced in number by design through monitoring of conditions.

Regionally, coal exploration was, not surprisingly, restricted to the Sydney-Gunnedah Basin and comprised almost all exploration in that region. The Lachlan Region exploration was mostly directed at gold targets in several well-defined belts, viz, the Temora epithermal gold province, Blayney, Parkes and Peak Hill areas.

In general, base metals exploration was divided between the Broken Hill Region (65%) and the Lachlan Region (35%). Tin exploration expenditure fell by $0.5 million but heavy mineral sands exploration increased markedly from a low base and was directed at targets in the Murray Basin and also onshore along the central and north coast.

During the year, a routine core sampling program by the Geological Survey highlighted the exploration potential of the Fifield area for platinum group metals. Encouraging results continue to be returned by the licence holder.

Mineral Production. Preliminary statistics for mineral production from New South Wales for 1985-86 indicate a total value around $2980 million, comprising coal $2250 million, metallic minerals $349 million, non-metallic $66 million, and construction materials estimated to be around $315 million.

Coal's dominance of the value of NSW production is well-known and in 1985-86 it improved by 15.5% over the previous year.

Record raw coal production of 80.2 Mt (saleable 66.4 Mt) was achieved during 1986, but exports fell marginally to 40.4 Mt. 46

Non-metallic production value was up by 5% in 1985-86 but metallics declined by 9.2%. The latter's decline can be attributed mainly to the zinc concentrate value being down by $48 million. Values of lead and tin concentrates were also down.

The fall in base metals prices, industrial action at Broken Hill and the depletion of open-cut ore at Woodlawn caused a decline in zinc and lead concentrate production, whilst the collapse of the international tin market in 1985 was reflected in the tin concentrate production downturn (down by $3.3 million).

The largest two New South Wales tin producers, Ardlethan and Gibsonvale, both ceased production late in 1986 and currently there is no significant New South Wales tin output. However, the value of copper production increased during 1985-86.

Rutile and zircon production values improved in 1985-86 largely due to expansion of production at the Tomago mineral sands operation, and gold output increased from a low base through expansion at Canbelego, Forbes and Browns Creek, and a number of smaller operations.

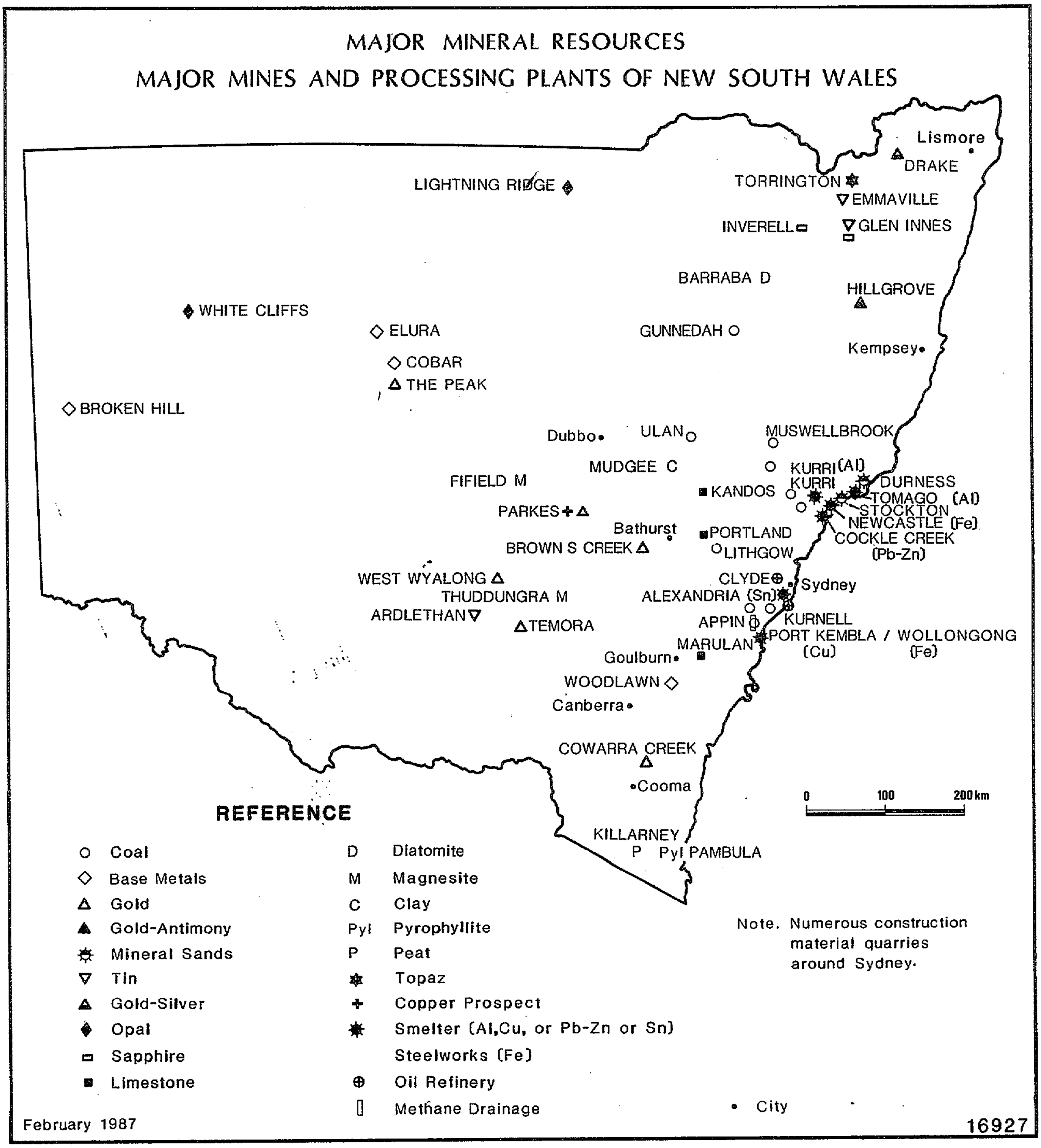
Two new developments, the Durness heavy mineral sands operation (Near Tea Gardens - 30 000 tpa each of rutile and zircon), and the Cowarra Creek gold mine (16 000 oz pa) were commissioned late in 1986 and their impact will be seen in the 1986-87 statistics. The third major mineral development which reached an advanced stage of construction in 1986, and was commissioned in January 1987, the Temora gold mine, now ranks as the State's largest gold producer (45 000 oz pa).

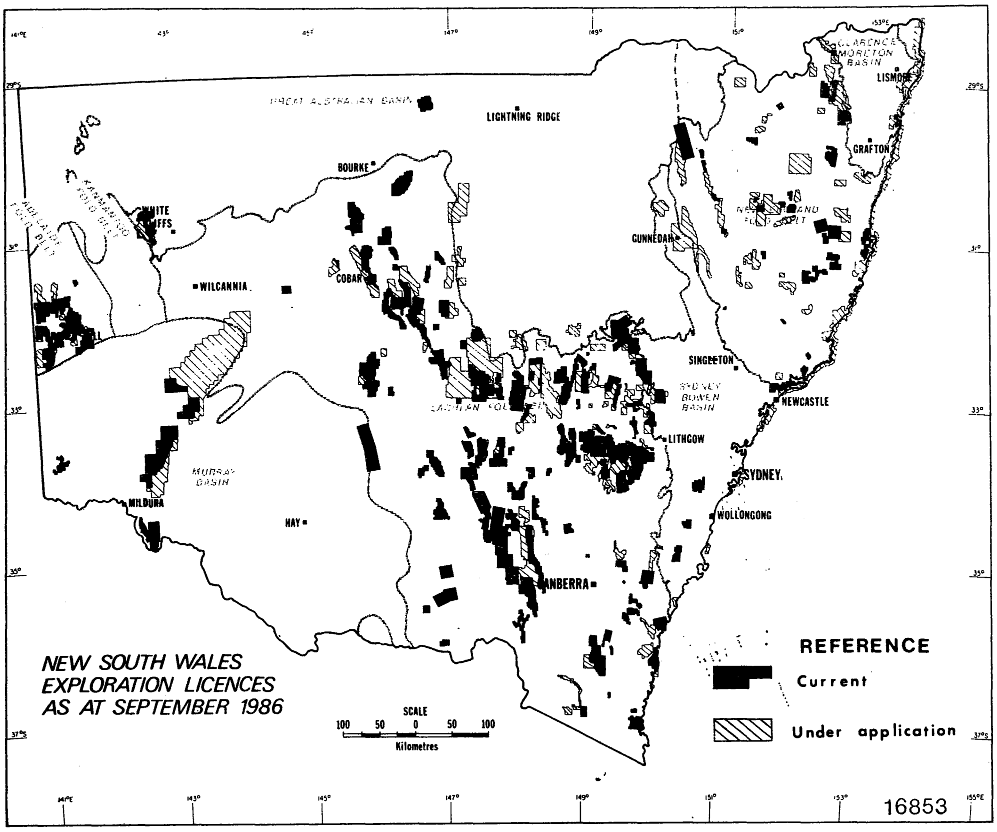
New coal developments during 1986 were the commissioning of Baal Bone and expansion at Charbon mines in the Lithgow area.

Outlook. The outlook for 1987 is for expanded exploration effort directed towards previous metals and mineral sands (onshore, and perhaps offshore). Gold exploration in the Temora epithermal province may lead to further developments. The most interesting potential gold developments are The Peak prospect near Cobar, and the Goonumbla gold-copper deposit near Parkes. Base metals production will be increased if and when the Woodlawn underground mining operation is brought into full production at an anticipated 500 000 tpa.

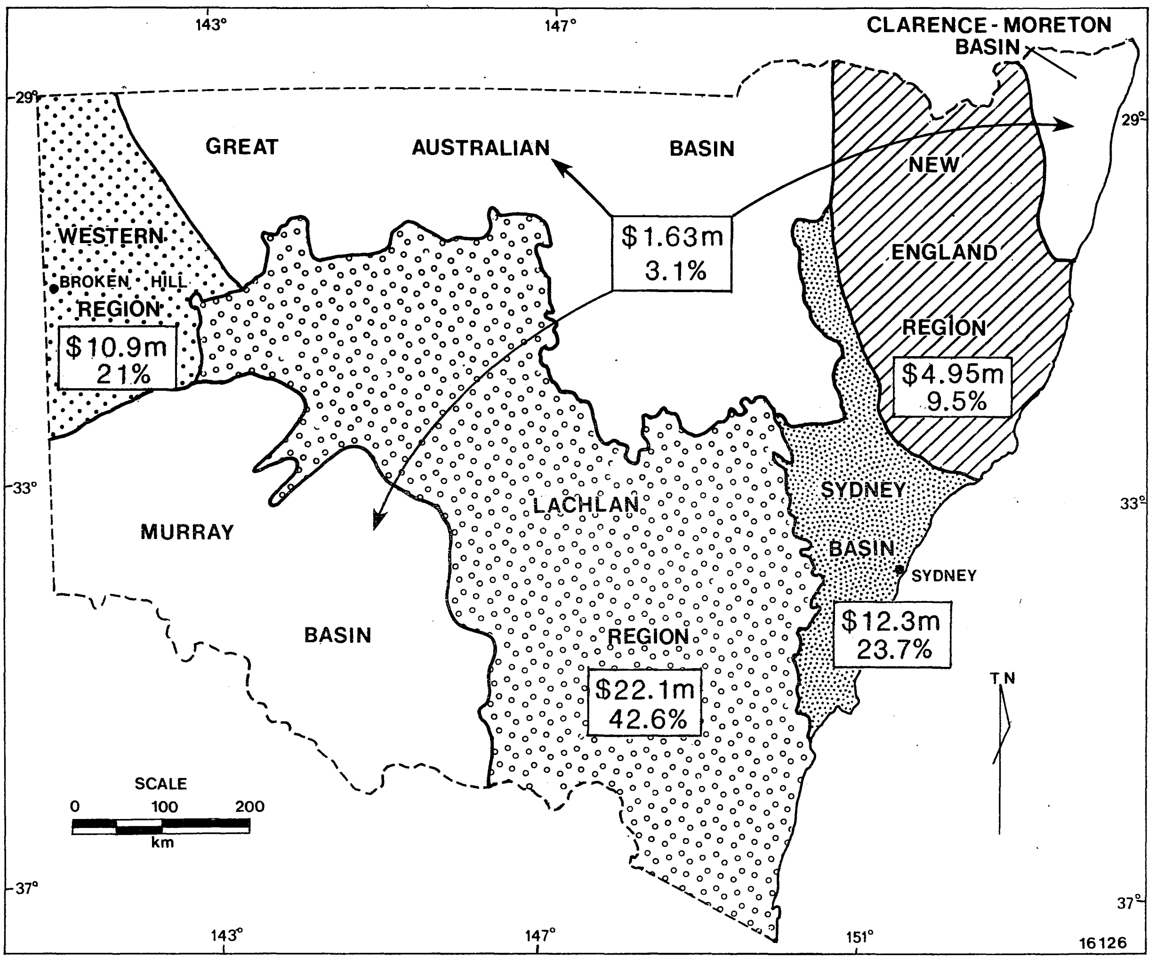
Other projects to watch are Browns Creek (gold) now under BHP management (likely expansion), Sheahan-Grants near Blayney, Peak Hill, and Wellington (alluvial gold). Also a number of tailings retreatment projects are likely to be brought into production in 1987.

In the coal industry, the existing coal operations at Bayswater, Ravensworth II Ulan (with its 200 m longwall) and Wambo are likely to expand into new coal-lease areas. Development of projects such as Vickery, United, and Glendell will only proceed should new markets (domestic and/or export) become available.





N.S.W. EXPLORATION EXPENDITURE BY REGION 1985/86



NEW SOUTH WALES

TOTAL VALUE OF MINERAL PRODUCTION

($'000)

	Coal	Metallics	Non-Metallics	Construction Materials	Total
1981/82	1,585,023	300,028	79,701	232,136	2,196,886
1982/83	1,906,970	326,256	58,644	212,514	2,504,384
1983/84	1,733,358	320,385	61,584	229,466	2,344,792
1984/85	1,948,608	384,661	62,812	287,523	2,683,604
1985/86(P)	2,250,000	349,000	66,000	315,000	2,980,000

NEW SOUTH WALES

ROYALTY INCOME ON MINERALS

YEAR ENDED 30-6-1986

($'000)

Clay	142
Coal	115,439
Copper, Lead, Zinc Silver	792
Gold	53
Granite	53
Limestone, Marble	451
Magnesite	11
Mineral Sands	812
Quartzite	62
Sapphire	145
Shale Ash	20
Tin	508
Others	81
Total	**118,569**

Highlights of mineral exploration and mining development in Victoria, 1986

C.R. Dalgarno, Geological Survey of Victoria

In the current gold boom Victoria has seen modest development and steadily increasing gold exploration during 1986. Much of the activity has been focussed on the old gold mining centres of Ballarat, Bendigo, Stawell and Walhalla.

Since 1983 gold exploration and development at Stawell by WMC have been based mainly on the Wonga Open Cut, with some production from old tailings and the Magdala decline and underground operations. Pending final approvals, a new operation is about to commence involving enlargement of the old Davis and Hampshire open cuts. This will involve three to four years mining for up to 400 000 tonnes of medium to low-grade ore for treatment in the existing standard gold ore treatment plant.

At Bendigo WMC are refurbishing the Williams United Shaft. Some 1500 m of underground drives and cross-cuts will be dewatered and developed along the New Chum lines of reef for bulk sampling and underground drilling access. A mill and gravity separation plant have been erected north of the city and evaporation ponds have been constructed to control mine water discharge.

At Ballarat, Ballarat Goldfields has negotiated areas for continued exploration and working proposals are under discussion. Drilling on the First Chance Anticline has established gold mineralisation paralleling the anticlinal axis, with a possible spur on "leather jacket" branching from it. Both the Bendigo and Ballarat activities have been defined as projects of major economic importance because of the complexities of operating in urban areas where mining is prohibited. This facilitates the granting of areas for exploration.

Almost every auriferous area in Victoria is being investigated. The following short notes give recent highlights of exploration/development - they are not exhaustive.

At Bethanga east of Wodonga, Pan Australian Mining is attempting to rehabilitate old mine workings in order to undertake sampling and geological investigations of the gold-silver-copper mineralisation.

At Walhalla, the Mining Lease over the Cohen line of reef is held by Walhalla Mining Co. in a joint venture with Australian Anglo American. The old Walhalla inclined shaft is being refurbished. In surrounding areas work is continuing under an Exploration Licence partnership with CRA.

At Maldon, Triad Minerals are expected to commence open-cut mining at Union Hill. Planning hurdles have been cleared and the Mining Area Licence for the treatment plant is granted. Mineralisation at Union Hill consists of quartz veins in hornfels. Reserves which could be mined as open cuts are 0.6-0.7 million tonnes with an average grade of 3.5 g/t. Following open-cut mining, Triad Minerals is proposing to go underground through a decline.

At Dunolly-Inglewood, alluvials are under test by Bendigo Mining NL, and New Resources Pty Ltd (a subsidiary of Ballarat Goldfields Ltd) whilst at Landsborough, Ashton Mining announced reserves which could be dredged of 47.5 million m^3 in the Landsborough deep-lead with 10 000 kg of recoverable gold. More detailed drilling is underway to confirm this reserve estimate.

In base-metal activities the Wilga and Currawong copper-zinc-silver deposits in the Benambra area are undergoing pre-feasibility studies by Roche Bros. Bulk sampling for metallurgical testing is planned.

CRA have progressed with their Wimmera heavy-mineral program and have defined areas of potential near Horsham. The Preliminary Environmental Report has been submitted and planning schemes have been amended.

Although trailing some other States in the current gold boom, Victoria saw some 30% increase in gold production in 1986 over 1985 and exploration activity expenditure on Exploration Licences of $10 m with a further $3.5 m prospecting areas and Mineral Licences.

We have in Victoria three or four different models of gold occurrence from a greenstone association in the west through the vein systems of the central slate belts to breccia pipe and epithermally-altered systems in the east. The Geological Survey will put in renewed effort to develop these models and provide support mapping and metallogenetic studies in selected areas.

Brown coal resources of the State have been the subject of major studies and in May 1986 the report entitled "Latrobe Region: Framework for the Future" was released jointly by the Minister for Industry, Technology and Resources (Mr Robert Fordham) and the Minister for Planning and Environment (Mr Jim Kennan).

This report develops the energy policy and social and environment issues based on future development of the coalfields of the Latrobe Region. The State Electricity Commission of Victoria is extending the Yallourn North open cut into the "East Field" north of Morwell, and continues to develop the Morwell and Loy Yang open cuts.

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Tasmanian mineral exploration and mining developments in 1986

M.R. Hargreaves, Tasmanian Mines Department

During the year mineral exploration in Tasmania has been maintained at a high level with an over-riding emphasis on gold and polymetallic massive sulphide deposits. The process has probably been accelerated by the requirements to reduce long-established Exploration Licence areas by 50% and the impending termination of existing licences in late 1987 and early 1988.

These important highly-prospective areas - largely occurring within the Mount Read Volcanic Belt - will be awarded under the work program tender system which was implemented in 1984.

To provide a geological, geophysical and geochemical overview of the Mount Read Volcanic Belt, the Tasmanian Government allocated $2 million of Federal Government funds from compensation paid for the curtailment of the Gordon-below-Franklin power development in 1985. Further State funds ($344 000) have been made available to sustain the Project until 30 June 1987 and continued funding is hoped-for in the 1987/88 financial year.

Various geological, geophysical and geochemical data packages are now available to the private sector and hopefully will facilitate the exploration process.

Meanwhile, the Hellyer development continues with completion of the 1.1 km adit and development incline and decline. Ore is being produced at a rate of 250 000 tonnes per annum and processed at the modified Cleveland tin-mine mill. A feasibility study is being completed on the estabishment of a 1 million tonne per annum operation with construction of a new mill at Hellyer. A decision on development is expected in 1988.

With the collapse of the International Tin Agreement and abandonment of the quota system, the Renison Bell tin mine has increased its workforce and gone into full production.

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South Australia: highlights of mineral exploration and mining development, 1986

J.G. Olliver, SADME

Exploration. Total expenditure on mineral (including coal) exploration reported in 1986 was $28.4 million which is 47% down on 1985. The fall reflects cessation of exploration reporting from Olympic Dam in May 1986 and a general downturn elsewhere. Metal exploration other than Olympic Dam was down 26%, coal down 36%, diamonds down 35%, uranium down 48% and non-metallic, etc, down 43%. The area held under Exploration Licences remained at about 220 000 km². Notable discoveries announced during 1986 were:

- a significant tin lode at Prospect Hill in the northern Flinders Ranges
- discovery of plaster-grade gypsum at two sites on Eyre Peninsula
- one million tonnes of 40% wollastonite at Ethiudna in the northeast.

Gold is the main target for current explorers.

The arcuate Ooldea Sand Range on the edge of the Nullabor Plain has been taken up by BHP in the search for heavy minerals. Industrial minerals being sought include celestite, kaolin, palygorskite and sulphur. Results of Departmental investigations for base metals in the Flinders Ranges National Park were released during 1986. Four prospects with features diagnostic of MVT lead-zinc deposits have been delineated.

Development. The value of mineral production in 1986 is expected to remain similar to 1985 at $228 million (Fig. 3) compared to $922 million from oil, natural gas, condensate and LPG. Mineral production comprises $73 million - construction materials, $65 million - coal, $35 million - metallics, $33 million - opal, and $21 million - industrial minerals (Table 1).

Copper production ceased following the closure of Mount Gunson in June 1986. Coal from Leigh Creek will increase to provide additional feed for the new Northern Power Station. The current rate of production of 2.5 million tonnes per year will reach 3.5 million tonnes by 1990. Ultimately up to 100 million tonnes of coal will be mined, requiring removal of 750 million m³ of overburden. Open cuts will extend over 15 km, be up to 1 km wide, with maximum depth of 200 m. Because of the depths proposed for future mining and the steep dip of the coal seams, the dragline operation has been phased out in favour of the truck/shovel operation and a study is underway to determine the most feasible method for future production. Excavation of the trial pit at Lochiel is in progress to determine mining parameters and obtain bulk samples of coal.

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The Olympic Dam project entered the construction and development stage following commitment to the initial project in December 1985, with copper-uranium-gold production expected to start in early 1988. Underground development to the end of 1986 totalled:

- 15 km of driving (increasing at the rate of 550 m per month)
- 2.2 km of raise boring
- 0.5 km of shaft sinking

The development of the 3.3 km surface decline commenced and should be completed by mid 1987. Townsite, infrastructure and metallurgical plant construction commenced during 1986. Under the indenture, the Minister of Mines and Energy is the Approving Authority for the project, including infrastructure, and is the focus for any application from Roxby Management Services requiring State agency approval.

The establishment of an open cut at Iron Duke-Iron Duchess in the South Middleback Ranges to replace Iron Baron as a source of high-grade ore for the Whyalla Steel-works was postponed as a result of improved recoveries and the extension of mineable reserves near Iron Baron. A trial pit is planned to evaluate mineralisation in the Iron Knob Racecourse area in early 1987.

In early 1987, ACI opened their new glass sand pit and treatment plant at Mount Compass. In 1986, Ausmintec Corp. Ltd was floated as a major new industrial minerals mining and processing company. Acquisitions included Williamstown open cut - Australia's only source of sillimanite, mica and export kaolin.

The first shipments were made to the UK of pigment grade micaceous hematite from Warrakimbo, Flinders Ranges. The natural building stone industry is buoyant. Quarries at Black Hill (black norite), Calca (red granite), and Sienna (brown granite) are working at capacity. There are now 10 producing slate/flagstone quarries.

During 1986, opal mining increased dramatically. In December, Precious Stones claims have increased to 1506, almost double that in May 1982. Mintabie is now the world's no. 1 producer of opal.

The nephrite jade deposits at Cowell were revalued from a 1974 estimate of $20 million to $226 million. This was the catalyst for the formation of the Australian Gemstone Corporation which will specialise in the processing and marketing of Australian gemstones.

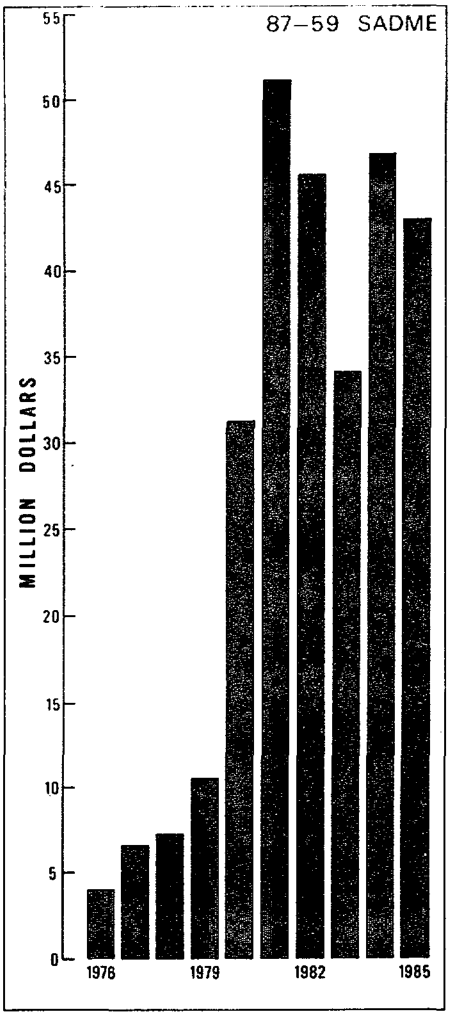

FIG. 1 Company expenditure on exploration in South Australia

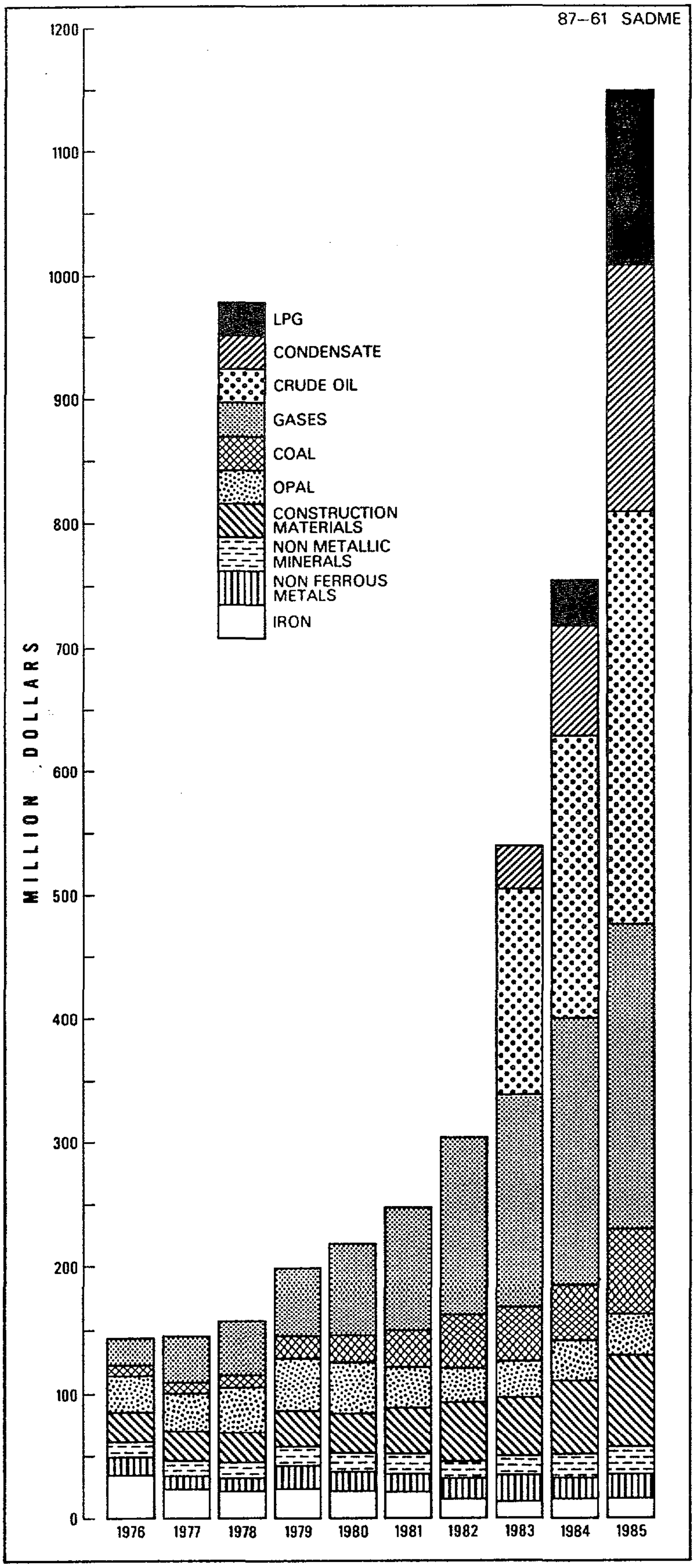

FIG. 3 Value of South Australian mineral production

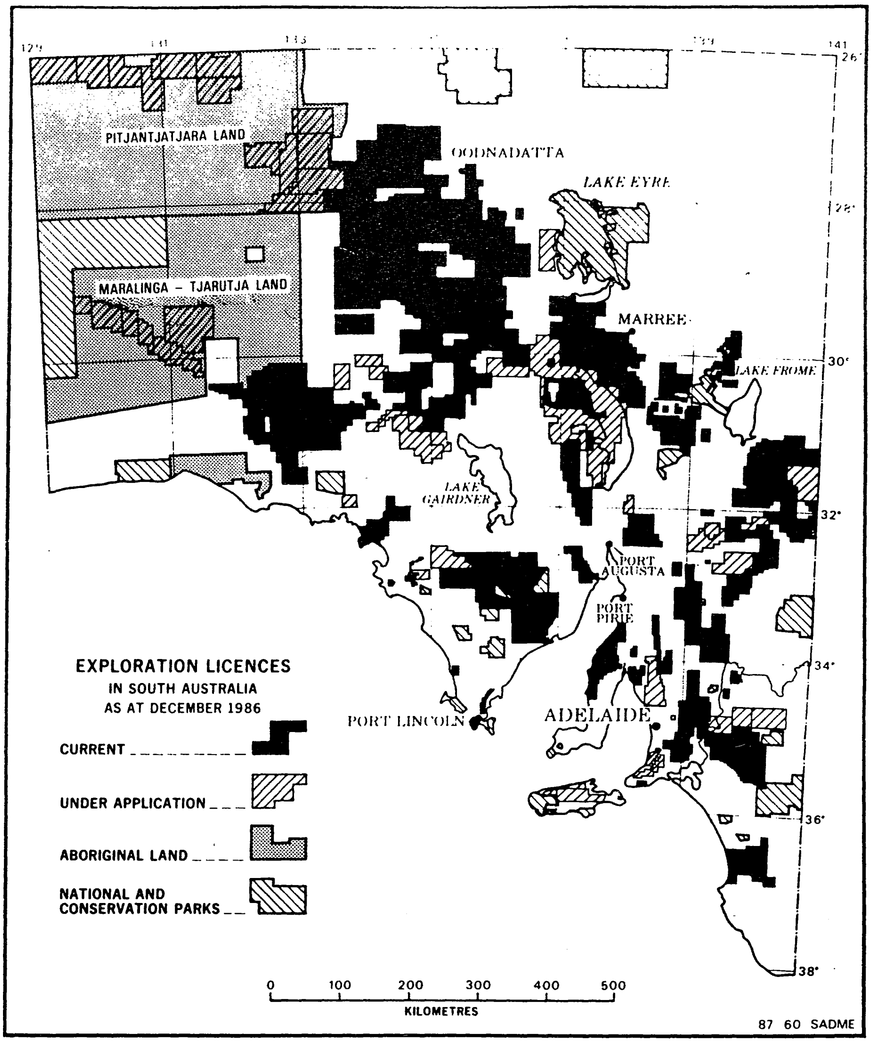

FIG. 2 Exploration Licences in South Australia as at December 1986

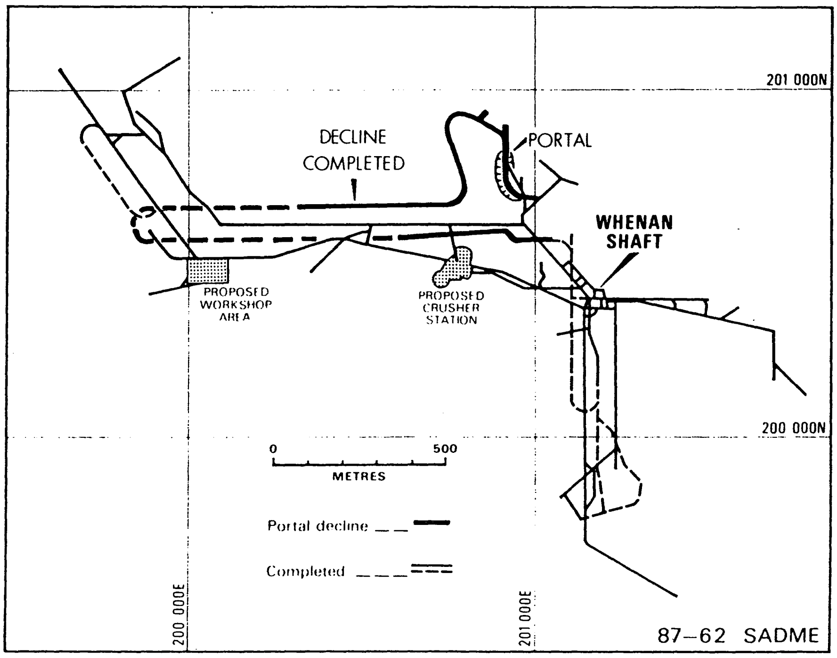

FIG. 4 Underground development at Olympic Dam

TABLE 1

SOUTH AUSTRALIAN MINERAL PRODUCTION

	1985 Quantity	1985 Value ($)	1984 Quantity	1984 Value ($)
Energy Minerals	(tonnes)		(tonnes)	
Natural gas (m^3) (a)	4·843 x 10^9	245 531 000	4.5 x 10^9	214 786 000
Condensate (kl)	827 587	199 040 000	430 187	88 297 000
Crude oil (kl)	1 262 070	333 451 000	1 050 270	229 188 000
LPG (tonnes)	467 189	143 919 000	142 644	36 921 000
Coal (b)	2 058 358	65 463 000	1 323 783	45 009 000
Metallic Minerals				
Iron ore	1 726 304	15 537 000	1 752 582	15 773 000
Jaspilite	—	—	375	1 000
Copper (metal content)	11 032	16 743 000	10 500	11 895 000
Zinc ore	30 566	3 112 000	46 397	4 925 000
Gold (gm)	3 831	42 000	4 466	44 000
Silver (gm)	16 000	3 000	7 700	1 000
Lead	15	6 000	11	4 000
Non-metallic Minerals				
Limesand (agricultural)	2 351	5 000	—	—
Limesand (flux)	15 029	248 000	—	—
Limestone	1 784 921	6 315 000	1 469 302	5 548 000
Gypsum	1 001 919	2 728 000	1 018 205	3 173 000
Salt	738 733	3 233 000	702 422	2 617 000
Dolomite	586 046	2 266 000	547 566	2 234 000
Clay (c)	866 043	2 332 000	796 953	2 362 000
Silica Sand	76 913	1 109 000	124 431	1 483 000
Silica Rock	66 535	266 000		
Talc	16 804	1 099 000	18 588	801 000
Barite	21 232	768 000	18 130	562 000
Phosphate	9 316	67 000	7 473	49 000
Magnesite	18 933	696 000	13 664	493 000
Sillimanite	428	43 000	507	50 000
Damourite	1 574	128 000	2 164	193 000
Flint (Pebbles)	12	2 000	—	—
Nephrite jade (kg)	18 000	73 000	13 000	75 000
Ornamental stones (kg)	2 585	3 000	2 822	3 000
TOTAL		$1 044 228 000		$666 487 000
CONSTRUCTION MATERIALS				
Dimension Stone				
Bluestone	230	17 000	400	21 000
Granite	5 876	896 000	4 655	647 000
Dolomite/Limestone	16 682	327 000	18 247	373 000
Quartz/Sandstone	783	35 000	1 911	52 000
Slate	10 775	724 000	9 979	583 000
Sub-Total	34 346	$1 999 000	35 192	$1 676 000
Aggregates, Ballast, etc.				
Basalt	113 374	1 054 000	117 398	1 184 000
Dolomite/Limestone	6 281 814	27 354 000	5 617 334	21 804 000
Gneiss	76 864	528 000	21 839	180 000
Granite	146 164	1 081 000	534 132	1 284 000
Gravels	2 258 182	1 828 000	284 197	257 000
Greywacke	129 179	680 000	88 684	491 000
Ironstone	53 988	41 000	19 795	22 000
Quartz/Sandstone	3 672 236	22 278 000	2 867 736	16 444 000
Sand	2 852 074	14 990 000	2 542 331	13 795 000
Clay fill	1 585 099	793 000	1 732 468	868 000
Marble	4 968	33 000	5 024	26 000
Shale	276 843	383 000	638 107	1 172 000
Slate	43 726	33 000	20 852	18 000
Sub-Total	17 494 511	71 076 000	14 489 897	57 543 000
Total construction materials	17 528 857	73 075 000	14 525 089	59 219 000
Opal production estimate		33 430 000		29 590 000
TOTAL MINERAL PRODUCTION		$1 150 733 000		$755 296 000

(a) Value of gas ex-Moomba plant includes $556 216 value of CO_2 from Caroline-1 well.
(b) Value of coal production estimated by this Department.
(c) Includes Kaolin.

Mineral exploration and mining trends, Western Australia, 1986

P.E. Playford, Geological Survey of Western Australia

The value of Western Australia's mineral production in 1985/86 was $5235 million representing a 12.3% increase compared to the 1984/85 total (Table 1). This income was principally due to strong growth in the production of diamonds, gold, mineral sands, natural gas, and zinc, offsetting reductions in coal, copper, nickel, and silver production. Expenditure on mineral exploration (excluding petroleum) in Western Australia during 1986 is estimated to have been approximately the same as in the previous year (about $190 million which represents almost 50% of total Australian expenditure). Figure 1 compares the amount of exploration drilling undertaken in the various States. Available information indicates that in Western Australia more than 60% of the expenditure on exploration was allocated to gold projects.

Gold exploration and development of new gold mines and prospects are currently a dominant feature of the State's mining industry. In 1986 a further 19 gold mines were brought into production (Table 2) and it is anticipated that an additional 25 new gold mines will commence operation in 1987 (Table 3). The most significant of the new 1986 mines are Sir Samuel, Emu, Galtee Moore, and the Sons of Gwalia (tailings retreatment), whereas the largest new producers in 1987 are expected to be Boddington and Mt Pleasant. Another potential major producer, Big Bell (4175 kg pa) may begin production in 1988.

Open-cut operations will continue to dominate the resurgence in gold mining, the only new underground mines in 1986 and 1987 being Golden Crown, Edwards Find and Sir Samuel. In addition to the 44 new mines, significant gold resources have also been indicated at 44 other prospects, many of which, with further exploration, may eventually be developed into mines.

Gold production in Western Australia during 1986 totalled about 56 tonnes (Fig. 2), which is only slightly below the State's historical maximum annual fine-gold production of 61 tonnes in 1903. Production planned for 1987 is about 73 tonnes and it is currently anticipated that the corresponding 1988 figure will be approximately 85 tonnes (Fig. 2).

Although no new iron-ore mines were brought into production in 1986, development plans or feasibility studies were announced for Deepdale, McCamey's Monster, and Yandicoogina (Table 4). Robe River Iron Associates announced that Deepdale K and J Deposits were purchased from BHP and will be brought on stream as the existing Deepdale workings are depleted. Hancock Mining Ltd hopes to develop the McCamey's

Monster deposits to supply to Romania under a barter arrangement. BHP announced that its Yandicoogina Deposit will be developed within two years to supply its domestic steel mills using the existing Newman railway, whereas CSR and CRA hope to export their Yandicoogina ore through Hamersley Iron's railway and port facilities.

Other minerals to receive attention in 1986 were base metals, uranium, diamonds, mineral sands and phosphate (Fig. 3). BHP-Billiton's Zn-Pb deposit at Cadjebut, 80 km southeast of Fitzroy Crossing, appears likely to be developed in the near future, possibly by late 1987. The promising Kintyre uranium prospect in the Paterson Province is being explored by CRA, while the Limestone Creek-Bow River alluvial diamond deposits in the Kimberleys, the Cooljarloo mineral sands deposit 250 km north of Perth, and the Mount Weld phosphate deposit near Laverton, which has reserves of 160 million tonnes of 18% P_2O_5 and unspecified rare earths, are all at the advanced feasibility planning stage. No recent announcements have been made concerning future development of the zinc-copper-silver deposits at Golden Grove.

Important secondary processing plants to produce rare earths from monazite, silicon from chert, synthetic rutile from ilmenite, zirconium products from zircon, and gallium from bauxite wastes, are in various stages of planning and construction.

An indicator of the level of exploration activity in Western Australia is provided by the fact that 39 new mining companies were floated during 1986. Most of these are seeking gold, but there is also interest in platinum, diamonds, mineral sands, and industrial minerals.

TABLE 1

W.A. MINERAL PRODUCTION 1985/86

Mineral	Quantity	Value $AM	% Value Change On 1984/85
Alumina	5.4×10^6 t	1 029.3	- 2.6
Coal	3.8×10^6 t	126.8	- 16.2
Copper in ore/concentrate	12.3×10^3 t	13.9	- 13.1
Crude Oil	1.4×10^6 kL	311.9	+ 9.5
Diamond	17.5×10^6 carats	147.6	+ 227.5
Gold	46.1 t	707.1	+ 39.0
Ilmenite	1.1×10^6 t	59.8	+ 8.0
Iron ore	85.5×10^6 t	1 965.7	+ 7.4
Monazite	18.0×10^3 t	10.4	+ 38.2
Natural gas	2.8×10^9 m^3	291.6	+ 75.8
Nickel concentrate	455.2×10^3 t	313.5	- 13.7
Petroleum condensate	293.1×10^3 t	NA	NA
Rutile	71.8×10^3 t	30.8	+ 20.8
Salt	4.8×10^6 t	95.3	+ 7.6
Silver	41.1 t	10.7	- 16.1
Zinc concentrate	31.8×10^3 t	20.0	+ 91.8
Other		100.6	+ 24.8
		-------	-------
		5 235.0	+ 12.3

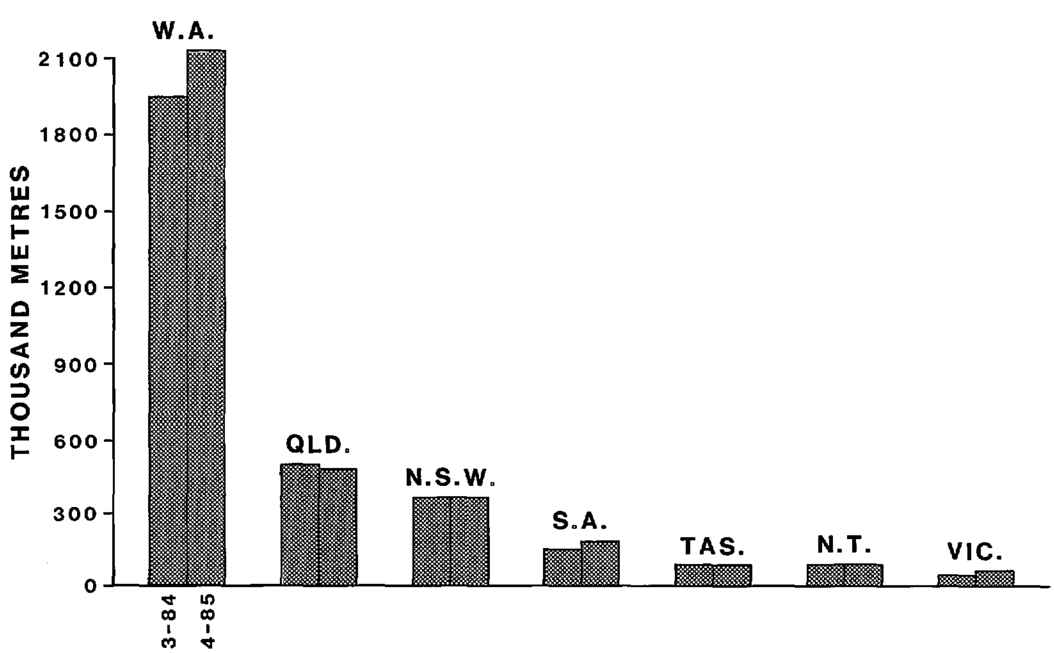

Figure 1: Mineral-exploration drilling

TABLE 2

PRINCIPAL GOLD MINES COMMENCING PRODUCTION IN 1986

Name	Ore Reserve 10^6t	Grade g/t	Capacity 10^6t pa	Gold Output t pa*
1. Bardoc	1.370	4.22	0.300	1.266
2. Cork Tree Well	3.433	2.63	0.275	0.723
3. Edwards Find	0.284	13.0	0.050	0.650
4. Emu	1.800	3.6	0.500	1.800
5. Galtee Moore	0.840	6.87	0.250	1.718
6. Golden Crown	0.303	18.6	0.051	0.949
7. Greenfields	0.620	1.7	0.250	0.425
8. Grosmont	0.390	4.5	0.150	0.675
9. Gum Creek	0.313	5.4	0.100	0.540
10. Kanowna (Ballarat-Last Chance)	0.502	3.73	0.100	0.373
11. Lady Bountiful	0.604	11.21	0.100	1.121
12. Mertondale	1.300	4.3	0.300	1.290
13. Montague	0.177	5.43	0.100	0.543
14. Mt Gibson	5.210	2.99	0.350	1.047
15. Patricia	0.180	5.40	0.130	0.702
16. Sir Samuel (Bellevue)	2.656	6.97	0.291	2.028
17. Sons of Gwalia Tailings	6.500	1.30	1.200	1.560
18. Westonia	2.821	2.60	0.500	1.300
19. Wiluna Open Cut	2.580	3.73	0.350	1.306
	31.883	3.40	5.347	20.016

* Maximum annual production (actual 1986 production generally less)

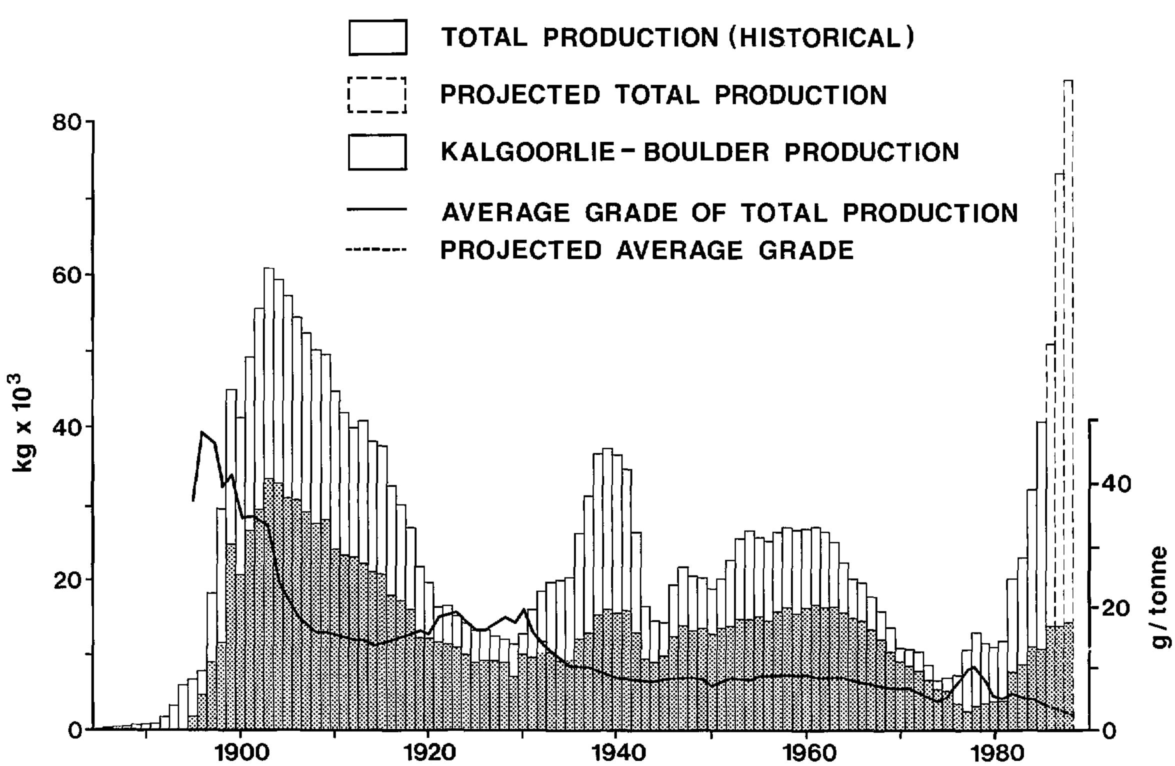

Figure 2: Gold production in Western Australia

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TABLE 3

PROPOSED GOLD MINES, 1987

Name	Ore Reserve 10^6t	Grade g/t	Status 1986	Capacity 10^6 t pa	Gold Output t pa*
1. Boddington (Worsley)	44.000	1.80	Development	2.400	4.320
2. Bottle Creek	1.600	3.50	Feasibility	0.500	1.750
3. Camperdown	0.165	4.80	Evaluation	0.125	0.600
4. Copperhead	0.160	4.00	Development	0.050	0.200
5. Cork Tree Well (Mt Morgans)	2.374	6.98	Feasibility	0.200	1.396
6. Davyhurst (WMC)	1.250	2.77	Development	0.200	0.554
7. Gabanintha	1.417	3.88	Prefeasibility	0.100	0.388
8. Gidgee	0.991	4.87	Development	0.300	1.461
9. Golden Pig-Three Boys	0.735	8.0	Development	0.100	0.800
10. Golden Spec	0.139	21.87	Development	0.025	0.547
11. Goongarrie	0.731	4.23	Feasibility	0.200	0.846
12. Jubilee	3.614	2.92	Development	0.500	1.460
13. Hannan South	0.190	7.76	Development	0.100	0.776
14. Hopes Hill	0.588	3.13	Development	0.100	0.313
15. Kanowna (N Deep Lead etc)	0.822	3.45	Feasibility	0.100	0.345
16. Karonie	1.392	3.90	Feasibility	0.300	1.170
17. Mikado	0.091	3.35	Development	0.120	0.402
18. Mt Fisher	0.220	5.30	Development	0.125	0.663
19. Mt Pleasant	3.000	5.50	Development	0.400	2.200
20. Mt Wilkinson	NA	3.30	Development	0.350	1.155
21. New Celebration	5.886	2.82	Development	0.500	1.410
22. North Morning Star	2.100	4.34	Development	0.200	0.868
23. Reedy North	2.900	2.90	Development	0.350	1.015
24. Trafalgar (Tailings)	11.132	0.92	Feasibility	0.300	0.276
25. Youanmi	1.920	5.16	Development	0.200	1.032
	87.417	2.55		7.745	25.947

* Maximum annual production (actual 1987 production generally less)

TABLE 4

NEW IRON ORE PROJECTS ANNOUNCED IN 1986

Name	Reserve in M tonnes	Grade % Fe	Status	Capacity in M tonnes/ Year
Deepdale K & J Deposits	NA	NA	Development	18
McCameys Monster	797	61.5	Feasibility	5
Yandicoogina (BHP)	NA	NA	Feasibility	4-12
Yandicoogina (CRA-CSR)	2940	58.5	Feasibility	10

* Possible resource (exploration at an early stage)

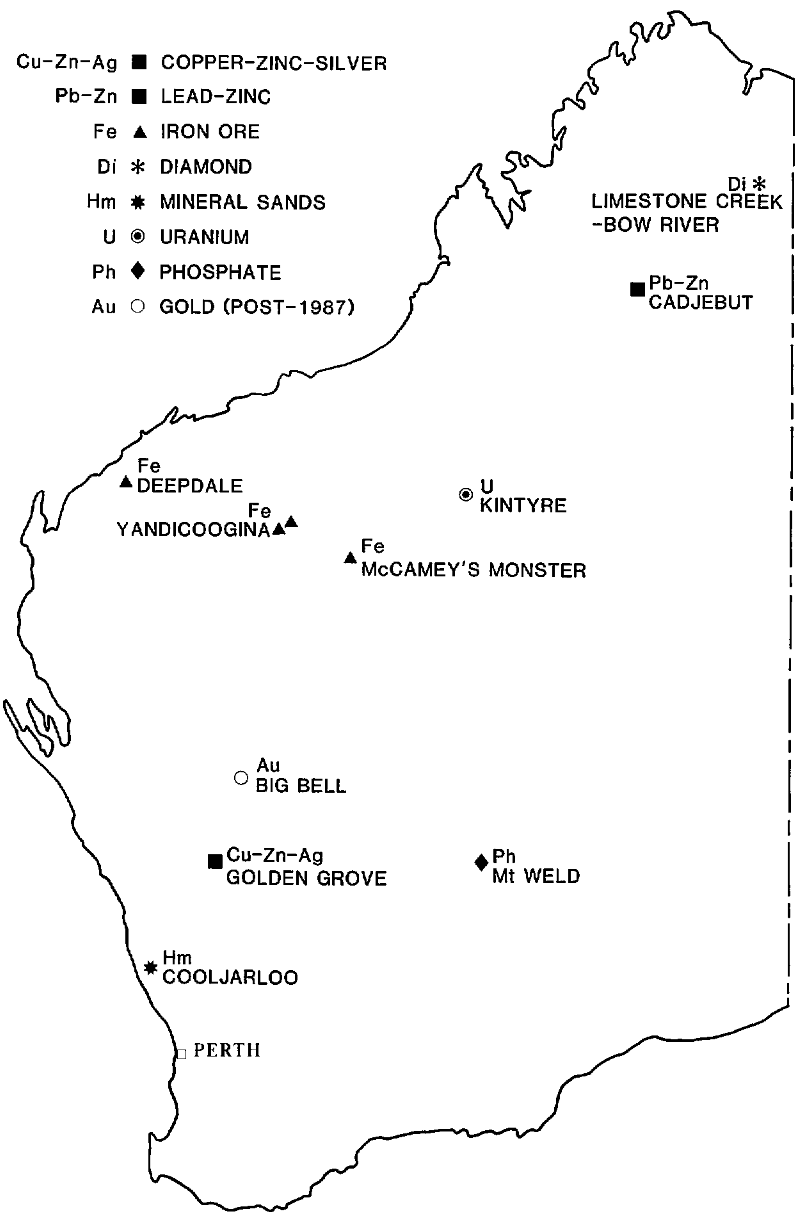

Figure 3: Other proposed mineral development projects in Western Australia

Northern Territory mineral exploration and mining developments in 1986, and the outlook for 1987

J.S. Pearson, Northern Territory Government

In both the exploration and mining sectors, significant expansion of activities occurred in the Territory during 1986, due primarily to the interest in gold. Production from Pine Creek, The Granites, Moline, Argo and TC8 Mines will substantially lift the Territory's gold production. Feasibility studies are proceeding at a number of localities in the Hayes Creek-Pine Creek area and in the Tennant Creek region.

Planned new developments combined with recent mine commissionings are estimated to increase the value of gold production from the Northern Territory in 1987 to exceed $140 million, a marked improvement on the actual 1985 figure of $37 million.

The established mines at Groote Eylandt, Gove and the Alligator Rivers region continue to provide the bulk of mineral wealth produced in the Territory. Expanded production of manganese ore at Groote Eylandt passed the 2 million tonne per year level in 1985/86.

Mineral exploration in the Territory has been concentrated in the search for gold, platinoids and diamonds, and to a lesser extent base metals, uranium and tantalum. The prime areas of exploration interest for gold have been the Pine Creek Geosyncline, the Tennant Creek and Granites/Tanami Blocks. Major reconnaissance diamond exploration programmes in the past few years have resulted in some encouragement in the Barkly Tableland region. Further evaluation of diamondiferous host rocks is proceeding. In the search for platinoid mineralisation efforts have been concentrated in the Arunta Block and the Pine Creek Geosyncline. Evaluation of the Coronation Hill gold, platinum and palladium deposit recommenced during 1986. Exploration in the Pine Creek Geosyncline for base metals, uranium and tantalum has been limited essentially, to areas outside Arnhem Land and the Kakadu National Park and its two extensions.

The Northern Territory Government and the Department of Mines and Energy has actively sought to encourage investment and development for the Territory mining industry. The broad economic benefits of a growing mining industry has emphasised the importance of Departmental support to the industry and the need for a more detailed assessment of Northern Territory resources.

Denial of access to highly prospective land due to Commonwealth legislation and policies has been countered by policy initiatives from the Territory Government to maximise utility of areas under its control.

These initiatives are aimed at encouraging further investment and streamlining administrative procedures, and include reviews of legislation relating to mining in Territory Parks, the Mineral Royalty Act and the Mines Safety Control Act.

Other initiatives for industry assistance include geological/metallogenic mapping, expanded information services and computerisation of titles. A review of policy relating to reserves has permitted exploration to proceed in certain areas under NT control which previously were closed to mining.

The value of mineral production for 1987 is expected to rise to more than $1000 million as a result of expanded gold production from new mines and increased uranium production from Ranger. The outlook for exploration is that existing commodity priorities will continue, namely that gold, diamonds and platinoids will be of prime interest. New gold mining ventures in the Territory will continue to dominate activities in this sector. Six new projects are committed to commence producing gold in 1987.

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Copper

D J Perkin, BMR

The continuing world economic recovery, albeit slight, led by Europe and North America, resulted in slightly stronger demand for copper in 1986 especially in the first half. Estimated western world copper consumption was 7.3Mt, marginally higher than in 1985. Western world refined production increased by 1.0% to an estimated 7.4Mt which resulted in a net apparent surplus of refined production over consumption of about 100 000t. World stocks declined in the first half of 1986 but began to rise by year end.

Western world mine production declined by an estimated 1% in 1986 to 6.4Mt as a result of lower output from all major producing countries except Chile and USA where production rose by 2%.

Estimated Australian mine production fell 8% to 239 000t in 1986 despite higher output from Cobar and Woodlawn in NSW, because of decreases in production from Warrego in Northern Territory and from the Mount Gunson mine in South Australia which closed around mid year. However, output from Mount Isa and from Mount Lyell remained at near record levels.

The average US producer price trended downwards from US69.41 cents/lb in January to US66.53 cents/lb in July at which level it stayed until ending the year with an average for December of US66.40 cents/lb. The average price during 1986, at US67.40 cents/lb was 0.6% higher than the US66.98 cents/lb 1985 average. However, in real terms, US copper prices in 1986 were the lowest for at least 40 years. At an average of $2113/t for the year, Australian copper prices were 2% higher than in 1985, mainly because of the relative weakness of the Australian dollar.

In 1987, Australian mine production is forecast to remain slightly below the 1986 level before increasing to about 250 000t in 1988 with the start-up around mid-year of the Olympic Dam project in South Australia where production of 30 000t refined copper annually is planned in the initial phase.

In the longer term, despite the probable cessation of operations at Mount Lyell in mid 1989, Australian mine production of copper could increase by up to 50% by the mid 1990's as a result of commissioning of new mines such as Scuddles and Nifty in Western Australia and/or because of expansion at existing mines (eg Olympic Dam in South Australia), provided relative costs and prices are favourable for their development.

Despite the lower real price for copper every year, copper producers in Australia and overseas continue to remain in business, albeit at levels of low profitability for one or more reasons:-

- by-product metals, particularly gold, tend to offset decreasing copper revenues

- devaluation of local currencies effectively boosts revenues for exported copper in some of the major producing countries
- the chronically low prices experienced in the copper industry over the last seven years has necessitated drastic cost-cutting through the introduction of high technology innovations and efficiencies to all phases of the production process, and this is mirrored by an increasing trend towards production from very low cost surface or oxidised ore-types which are amenable to heap leaching, solvent extraction and electrowinning.

On the eve of Australia's bicentenary, it may be constructive to consider what implications an analysis of the past 144 years of copper production up until 1986 could have for future levels and sources of copper output.

To date, Australia has produced about 7Mt of contained copper, which is the equivalent of about one year's western world production. Of this, about 50% has come from the Mount Isa - Cloncurry area and 47% from the Mount Isa mine itself, by far the largest single producer. The largest three mines, Mount Isa (about 3.3Mt Cu), Mount Lyell (1.0Mt Cu) and Mount Morgan (0.38Mt Cu), together have produced about 70% of Australian copper output to date.

In terms of the geological age of the host rocks, the mid-Proterozoic has produced about 52% of past copper production of 6.89Mt, of which about 80% has come from Mount Isa. A further 16% was produced from the Cambrian, of which Mount Lyell contributed 90% of the output.

In terms of deposit type, the Proterozoic stratabound type of which Mount Gunson, Rum Jungle,and Kapunda are concordant examples, and the Mount Isa copper orebodies, Burra, Blinman, Wallaroo, Moonta, Mammoth and Duchess are just a few discordant examples, make up the largest proportion (about 65%). When past production is combined with currently identified economic demonstrated resources which of course includes the large Olympic Dam deposit, stratabound deposits clearly represent the single most important deposit type.

The most important metallogenic copper provinces in the past include the Proterozoic Mount Isa Trough (50%) followed by the Dundas Trough, Tasmania (18%), the Lachlan Fold Belt New South Wales (7%), and the New England Fold Belt which includes the Mount Morgan deposit, Queensland (7%). Overall, 16 basins/blocks have hosted about 50 major mines, each having produced in excess of 4,000t of contained copper.

However, it is considered that Australia's Proterozoic rift basins have the largest potential for further economic stratabound copper deposits and while several of the known rift basins have been substantial producers, many still remain with high potential and have not as yet been exhaustively explored.

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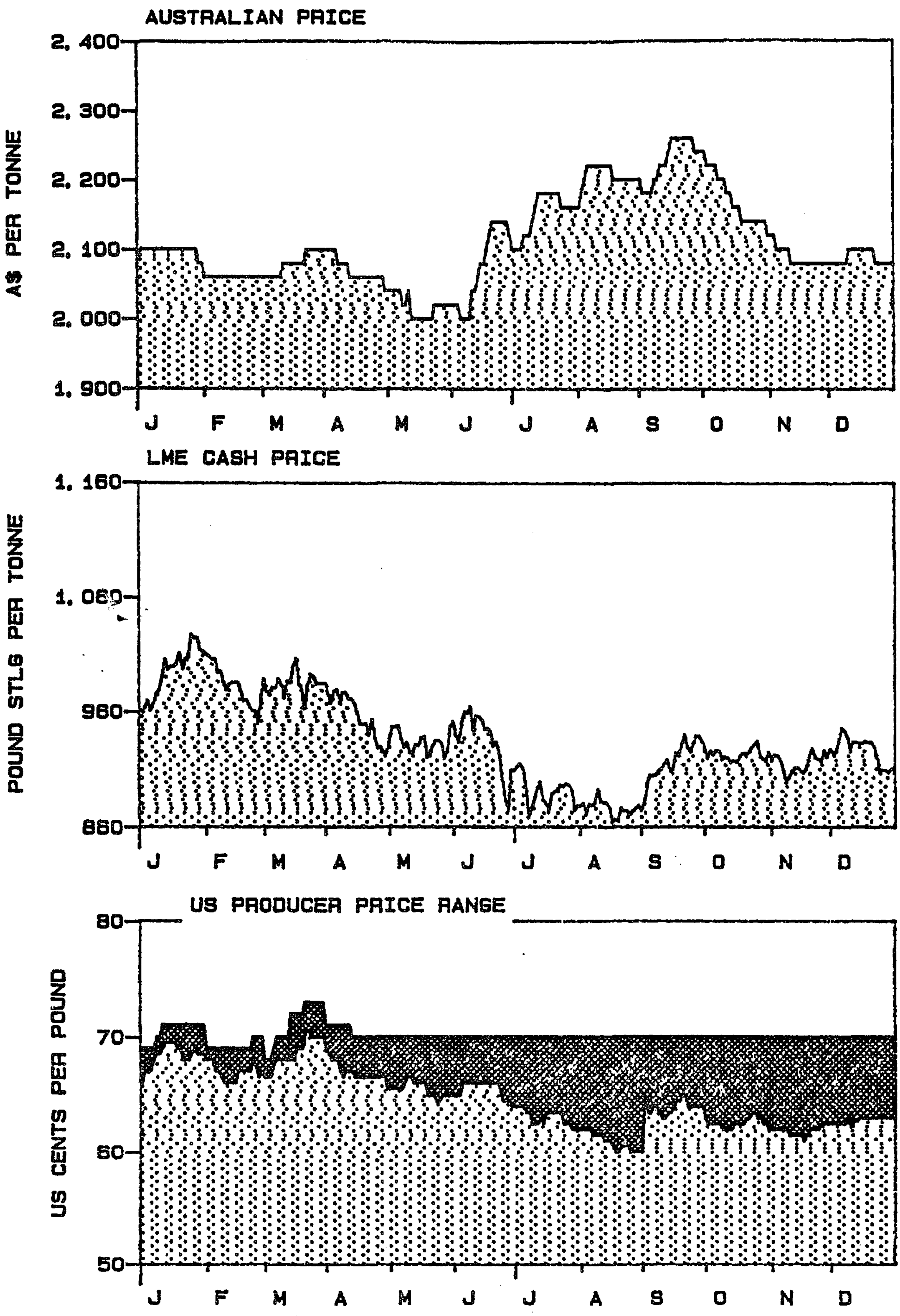

COPPER DAILY PRICES, 1986

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Development and outlook for lead and zinc in Australia - Are the fundamentals improving?

M. Roarty, BMR

The Australian non-ferrous-metal producers have been faced with depressed market circumstances over the last few years and profitability has declined substantially since 1980. In response to this the Australian producers have had to become more cost effective to stay in business.

Despite the low levels of profitability no Australian mines or smelters have been permanently closed, with the exception of Teutonic Bore (Western Australia), where ore reserves have been exhausted. In contrast a number of lead and zinc mines and lead and zinc smelting and refining complexes overseas closed either temporarily or permanently in 1986. However production at the major Broken Hill mines was disrupted in mid-1986 by industrial disputation over work practices; this caused supply shortages to Australia's only primary lead refinery at Port Pirie, which, as a result, was closed for a period in the second half of 1986.

The Australian lead-zinc industry forms an important part of the Australian economy. Export earnings for all lead and zinc primary products were $850.1 million in 1986, which was 6% of our total mineral export earnings. This share could increase when a number of new deposits come on stream in the next few years.

Although the growth rates of Western World lead and zinc consumption have declined and, in fact, were negative from 1979 to 1984, two important facts are:

- the Western World still consumes substantial amounts of lead and zinc;
- estimated world consumption of zinc increased to 4.9 Mt in 1986, which is an all-time-high, and estimated consumption of lead increased to 4.1 Mt in 1986, second only to that in 1979. Further increases in consumption of both metals are forecast for 1987.

The latter point is considered important because of the worldwide trend towards the manufacture of lighter, thinner and stronger products. What has kept a dampener on the price level has been the persistence of excess capacity, which has broken the former close link between prices and supply. The closing or suspension in 1986 of some overseas operations was more than offset by the opening or expansion of other operations. Continuation of mine and metal production has also been assisted in a number of countries including Australia by the devaluation of their currencies. Supply capacity and demand could be

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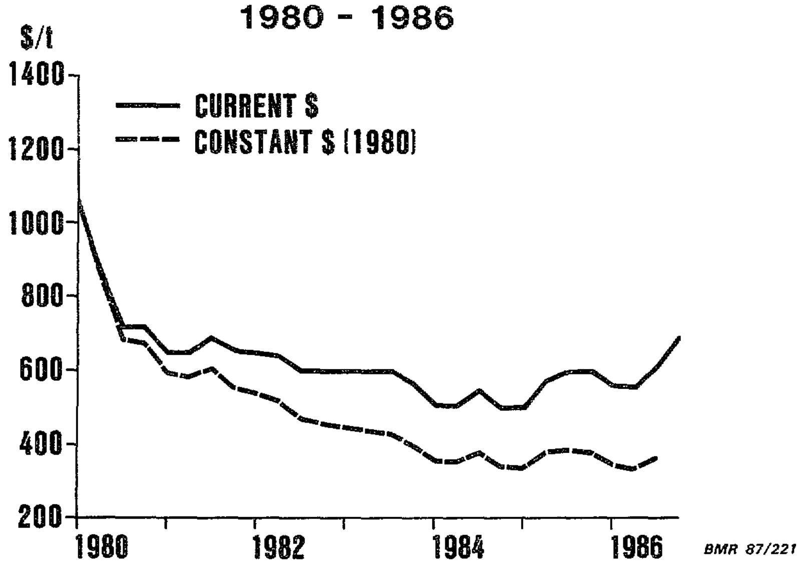
brought back into closer balance if the current low levels of profitability discourages construction of new capacity, although a number of large projects are presently under consideration for development.

The traditional uses of lead in batteries, and zinc for galvanising remain firm. The gradual phasing-out of the use of lead additives in petrol has reduced the demand for lead to some extent but a number of new applications appear to be emerging. Research is currently being conducted on the use of large lead batteries for the load management of power for essential services and in lead compounds to increase the life of bitumen used on road surfaces. Zinc die-casting has returned to favour in recent years because of the extensive use of thin-walled zinc diecasts.

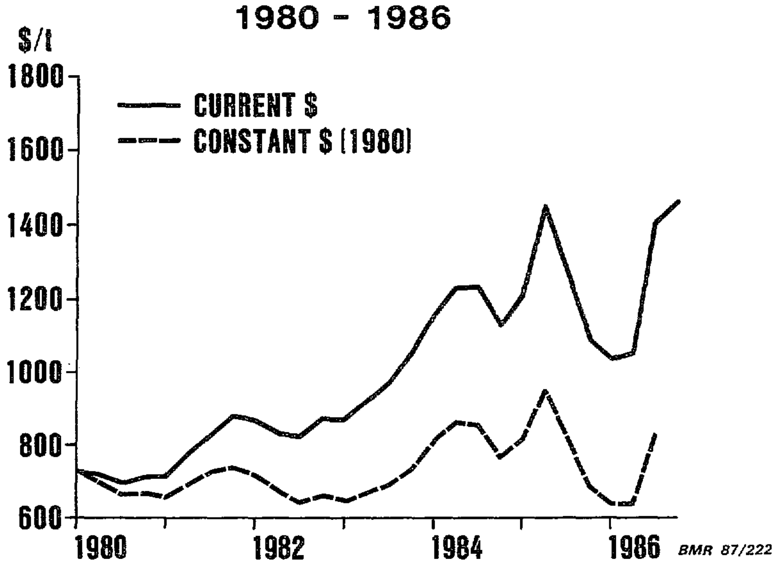
Australia's production comes from relatively-high-grade mines. Their production is expected to remain at around the current levels for the medium-term and, from some, well into the 21st century because of their substantial resources, coupled with the fact that the producers are becoming more cost-effective. In addition, production is expected to come from a number of deposits currently undergoing intensive evaluation, including Benambra (Victoria); Hellyer (Tasmania); Hilton, and Lady Loretta (Queensland); Golden Grove, Cadjebut and Blendevale (Western Australia). Apart from Hilton, where production will offset declining production at Mount Isa, these other deposits could add 340 000 t of contained zinc and 100 000 t of contained lead to Australia's production by the early 1990's if they all proceed.

In conclusion, world demand for lead and zinc has increased in 1986 and is expected to increase again in 1987. The current low levels of profitability should discourage additional investment in the world lead-zinc industry although there are still a number of projects under consideration for development. Australia is well established as a supplier and should maintain this position, because the supply comes from efficiently-run relatively-high-grade mines and smelter and refinery complexes. Mine production is expected to increase and this should increase export earnings from the lead-zinc sector. World demand is improving. However, while substantial surplus supply capacity continues to exist, and development of further prospects remains a strong probability, the possibility of any rapid improvement in the fundamentals appears unlikely.

LEAD - QUARTERLY PRICES 1980 - 1986



ZINC - QUARTERLY PRICES 1980 - 1986



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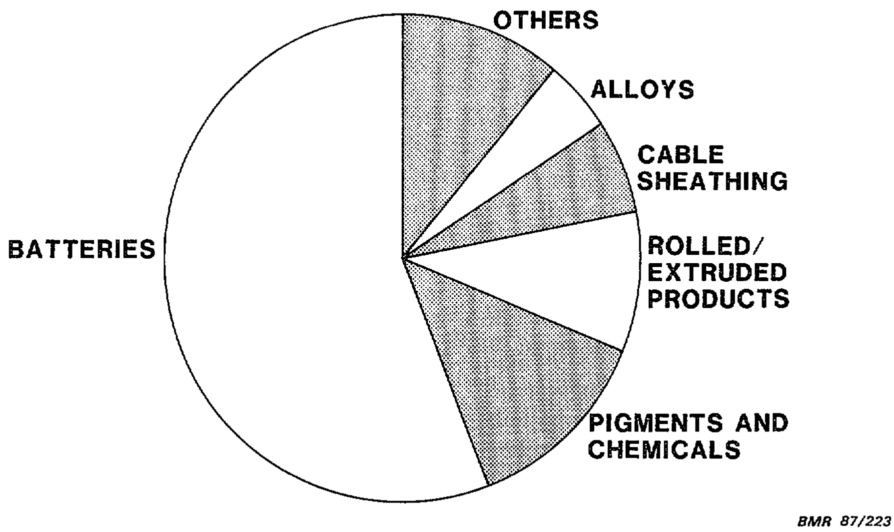
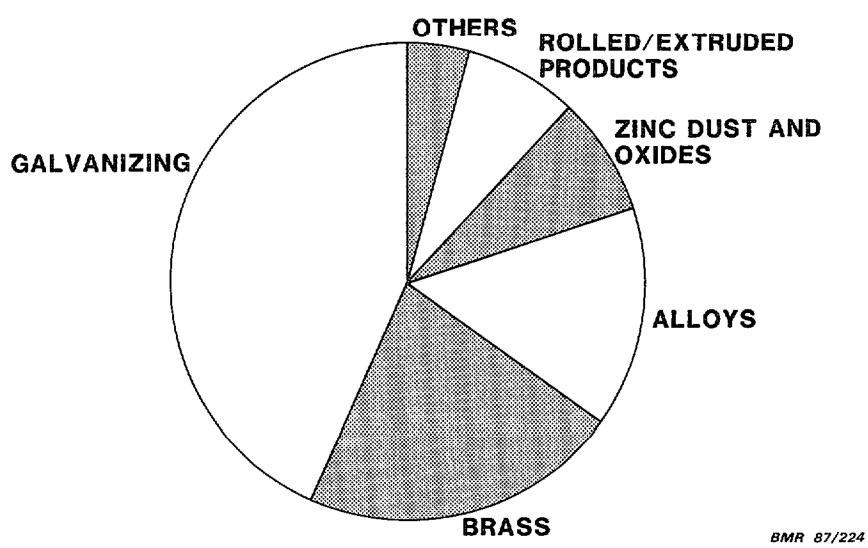
WESTERN WORLD LEAD CONSUMPTION BY MAJOR END USE 1985



WESTERN WORLD ZINC CONSUMPTION BY MAJOR END USE 1985



Ferroalloys

I.L. Gunn, BHP Minerals Ltd

Iron, manganese and silicon are essential to the production of steel. Other metals are important - Table 1 lists the functions of the alloying metals. These metals are generally added to the steelmaking process in the form of ferroalloys. Ferroalloy is a mixture of iron and a particular other metal smelted together in a furnace.

This paper will concentrate on the three most important ferroalloy metals - silicon, manganese and chromium.

Most countries possess deposits of silica of adequate purity to produce ferro-silicon; manganese, chromium and most of the other alloying metals have limited geographical distribution. Tables 2 and 3 show that South Africa dominates world reserves of manganese and chromium ore and also the production and export of ore.

The major Western World steel producers such as USA, Japan, Europe, UK, Korea and Taiwan have virtually no reserves at all of these two essential materials. Table 4 shows world crude steel production in 1985 and against each country, manganese ore, chromium ore and ferroalloy production capability.

It is interesting to note that only six countries are self-sufficient in manganese ore, six in chromium ore and only three have reserves of both; most countries have some alloy-making capacity but must import their ores. Norway, a non-steel-producing country, has neither manganese nor chromium ores but has become the World's largest manganese alloy exporter. Manufacture of ferroalloys requires large quantities of electrical energy. Countries having ore reserves, cheap electrical energy, and a large steel industry are the most likely to develop large ferroalloy capacity. Table 5 shows world production and export of manganese, chromium and silicon alloys. Table 5 shows the importance of South Africa again to the steel industry of the Western World, particularly when it is remembered that the Japanese and European ferroalloy makers import all of their manganese and chromium ores, with a large proportion coming from South Africa.

The increasing cost of power is causing a major restructure of the ferroalloy industry in the Western World. There is virtually no alloy produced in the United States and the Japanese industry is rapidly cutting back its production.

Approximately 95% of manganese ore and 70% of chromium ore production is used in the steel industry, and there is only limited growth forecast in world steel production. It is predicted that the demand for manganese and chromium ores will not increase.

Complicating the world picture even more is the emergence of new steelmaking technology, particularly in Japan. The process of adding manganese to steel by way of ferromanganese addition to the steel converter is being superceded by direct addition of manganese ore. This process was developed by the Japanese in an attempt to produce higher quality steel with less impurities and this has been successful. This new technology could result in consumption of ferromanganese being reduced by up to 60%. Within the Japanese market, this could be good news for the ferroalloy producers of the world as it could mean that the Japanese manganese alloy industry will close down and the silicomanganese used in the electric steel furnace industry will be imported. Manganese ore will still be needed for the new steelmaking process, so there should be little effect on the ore producers. However, if steel makers in other parts of the world adopt the new technology, then there will be an upheaval in the world ferroalloy industry. This new steelmaking process and other direct reduction processes are having similar effects in the chromium industry.

The ferroalloy business is thus at an extremely interesting stage with the distinct possibility of major shifts in demand and location of production facilities.

Australia is self-sufficient in manganese ore and manganese and silicon alloy production capacity. Manganese ore from BHP's world class mine on Groote Eylandt is exported to more than 50 customers around the world and, in 1986, out of a total production of 2 million tonnes, 1.5 million was exported, and 0.5 million used in BHP's ferroalloy plant in Tasmania and in the steelworks.

BHP's alloy plant is currently being expanded at a total cost of around $60 million. This will increase its capacity from 100 000 to 150 000 tonnes of manganese alloy of which 100 000 tonnes will be exported. BHP will then become the world's fourth largest manganese alloy exporter. The expansion includes the installation of an energy-recovery unit which will generate 10 Megawatts of power using gases from the furnaces as fuel. Sophisticated computer control and the latest mechanical technology is being installed in the furnaces and the Bell Bay plant will become a leader in ferroalloy technology.

Unfortunately, the very low price of ferrosilicon and unavailability of additional hydro-electric power makes expansion in that alloy production impossible.

Production of chromium alloys has been considered at Bell Bay but because there are no chromium deposits of sufficient size existing in Australia to provide low-cost suitable feed for the furnaces, ore would have to be imported. The only reason why ferrochromium and increased quantities of manganese alloys could not be made in Tasmania is that additional quantities of low-cost hydro-electric power are not available. The cancellation of the Gordon-below-Franklin hydro-electric scheme means that this position is unlikely to change.

Although it is unlikely that sales of manganese ore or alloys can be greatly increased because of the stagnant nature of the steel industry, other uses of manganese ore are being studied. The most exciting possibility is the production of electrolytic manganese dioxide (EMD). This is the basic raw material used in the manufacture of dry-cell torch batteries. It is a high-technology material produced by quite secret processes, well understood by BHP scientists.

The Japanese are the World's biggest producers of EMD, but high costs and a strong currency are giving them the same problem with EMD that they had with ferroalloy production. Because of the superior quality of Groote Eylandt manganese ore, skilled labour, reasonable cost power and the low value of our dollar, Australia has the potential to become a major producer.

TABLE 1 - ALLOY ELEMENTS ADDED TO STEEL

Element	Functional Characteristics
Aluminium	Control of grainsize and deoxidation.
Chromium	Corrosion resistance, high temperature strength and ability to harden.
Cobalt	High temperature toughness and hardness.
Columbium	For rolled strength.
Copper	Corrosion resistance.
Lead	Machinability.
Manganese	Deoxidation, sulphur removal, ability to harden.
Molybdenum	Ability to harden, high temperature hardness, temper and brittleness control.
Nickel	Surface appearance, low temperature toughness, ability to harden.
Rare earth metals	Toughness, ductility, impurity control.
Silicon	Deoxidation, electrical properties.
Sulphur	Machinability.
Tungsten	Ability to harden, and high temperature hardness.
Vanadium	High temperature hardness, grainsize control, strength, toughness.

TABLE 2 - MANGANESE ORE
WORLD RESERVES, PRODUCTION AND EXPORTS, 1985
(Estimated manganese content)

COUNTRY	RESERVES		PRODUCTION		EXPORTS		
	$tx10^6$	%	$tx10^3$	%	$tx10^3$	%	Rank
South Africa	5 715	81.7	1 372	15.8	1 367	36.9	1
USSR	681	9.7	3 026	34.9	-	-	-
Gabon	200	2.9	1 052	12.2	1 050	28.4	2
Australia	189	2.7	1 000	11.6	701	18.9	3
Brazil	73	1.0	0 900	11.4	396	10.7	4
India	38	0.5	0 385	4.5	5	0.1	7
Mexico	36	0.5	0 181	2.1	50	1.4	6
China	30	0.4	0 480	5.5	4	0.1	7
Ghana	8	0.1	0 107	1.2	95	2.6	5
Other	2.4	0.3	0 66	0.8	34	0.9	-
Total	6 994	100.0	8 659	100.0	3 702	100.0	

TABLE 3 - CHROMIUM ORE
WORLD RESERVES, PRODUCTION AND EXPORTS, 1985
(Estimated chromium content)

COUNTRY	RESERVES $tx10^6$	%	PRODUCTION $tx10^3$	%	EXPORTS $tx10^3$	%	Rank
South Africa	990	73.9	1 106	37.6	427	36.4	1
Zimbabwe	226	17.4	143	4.9	-	-	
USSR	39	3.0	756	25.7	133	11.3	3
Turkey	22	1.7	146	5.0	132	11.3	4
India	18	1.4	131	4.4	24	2.1	9
Finland	9	0.7	134	4.5	82	7.0	5
Philippines	9	0.7	77	2.6	73	6.3	6
Albania	6	0.5	272	9.2	226	19.3	2
Brazil	3	0.2	90	3.1	-	-	
New Caledonia	2	0.2	25	0.9	29	2.4	8
Madagascar	2	0.2	18	0.6	32	2.8	7
Greece	1	0.1	15	0.5	-	-	
Other	3	0.2	25	0.9	13	1.1	
Total	1 300	100.0	2 938	100.0	1 170	100.0	

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TABLE 4 - WORLD CRUDE STEEL PRODUCTION, 1985

COUNTRY	STEEL $tx10^6$	MANGANESE ORE	CHROMIUM ORE	FERROALLOYS
USSR	155.2[e]	x	x	x
Japan	105.2			x
United States	80.4			x
China	46.5	x		x
FR Germany	40.5			x
Italy	23.7			x
Brazil	20.5	x	x	x
France	18.8			x
Poland	16.1[e]			x
United Kingdom	15.7			x
Czechoslovakia	15.2[e]			x
Canada	14.7[e]			x
Romania	14.4[e]			x
Spain	14.2			x
Rep. Korea	13.5			x
India	11.1	x	x	x
Belgium	10.7			x
South Africa	8.6[e]	x	x	x
DPR Korea	8.4			x
German Dem. Rep.	7.9[e]			x
Mexico	7.3			x
Australia	6.4	x		x
Netherlands	5.5			x
Taiwan	5.1[e]			x
Turkey	5.0[e]		x	x
Sweden	4.8			x
Austria	4.7			x
Yugoslavia	4.4[e]			x
Luxembourg	3.9			
Hungary	3.7[e]			x
Venezuela	3.0			x
Bulgaria	3.0[e]			
Argentina	2.9			
Finland	2.5		x	x
Norway	-			x
Other	16.4			
World total	719.9			

[e] - estimated

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TABLE 5

WORLD PRODUCTION AND EXPORTS OF MAJOR FERROALLOYS

FERROMANGANESE AND SILICOMANGANESE

COUNTRY	PRODUCTION		EXPORTS		
	$tx10^3$	%	$tx10^3$	%	Rank
USSR	1 832	27.4	79	5.5	5
Japan	718	10.7	23	1.6	8
China	490	7.3	0		
Norway	480	7.2	422	28.1	1
South Africa	418	6.3	367	24.3	2
France	359	5.4	336	22.1	3
Germany	309	4.6	101	7.0	4
Brazil	285	4.3	21	1.5	9
Mexico	203	3.0	0		
India	168	2.5	0		
Spain	155	2.3	25	1.6	7
Poland	135	2.0	0		
Romania	128	1.9	0		
Italy	124	1.9	12	0.8	11
Canada	116	1.7	9	0.6	11
Australia	106	1.6	50	3.4	6
Czechoslovakia	100	1.5	13	0.9	10
Other	560	8.4	39	2.7	-
TOTAL	6 686	100	1 497	100	

FERROCHROMIUM

COUNTRY	PRODUCTION			EXPORTS		
	$tx10^3$	%	Rank	$tx10^3$	%	Rank
South Africa	912	31.9	1	863	63.2	1
USSR	432	15.1	2	22	1.6	6
Japan *	324	11.3	3	0		
Zimbabwe	220	7.7	4	200	14.6	2
Sweden *	145	5.1	5	98	7.2	3
Brazil	132	4.6	6	54	4.0	4
China *	120	4.2	7	0		
Yugoslavia *	87	3.0	8	5	0.4	9
Germany *	70	2.4	9	0		
Finland	59	2.1	10	8	0.6	8
Italy *	50	1.7	11	20	1.5	7
Philippines	50	1.7	11	50	3.7	5
Other	260	9.1		46	3.4	
TOTAL	2 861	100		1 366	100	

FERROSILICON

COUNTRY	PRODUCTION		EXPORTS		
	$tx10^3$	%	$tx10^3$	%	Rank
USSR	750	23.9	46	4.8	6
USA	445	14.2	7	0.7	12
Norway	410	13.1	427	44.2	1
China	195	6.2	4	0.4	13
Brazil	171	5.4	90	9.3	2
France	154	4.9	82	8.5	3
Japan	153	4.9	0		
Yugoslavia	100	3.2	46	4.8	6
South Africa	90	2.9	40	4.1	8
Canada	80	2.5	35	3.6	9
Italy	71	2.3	14	1.5	10
Iceland	63	2.3	63	6.5	5
Germany	60	1.9	80	8.3	4
Spain	60	1.9	8	0.8	11
Other	339	10.8	23	2.4	-
TOTAL	3 141	100	965	100	

The Australian aluminium industry

C.A. Kneipp, Aluminium Development Council of Australia Ltd

Although the extremely optimistic predictions made in the late 1970s and early 1980s about the future development of the Australian aliminium industry were not realised there has been a most significant growth in both the production and export of aluminium. This increase has been achieved against the background of static world production and a sharp reduction in growth of demand.

This has meant that the industry has advanced from being a largely domestic industry (apart, of course, from the bauxite and alumina sectors which have traditionally been export-oriented) to being very much a part of the world in aluminium ingot. Australia has been most successful in this trade but its markets are heavily concentrated in the Pacific Basin and most notably in Japan. Japan takes no less than 65% and the total region accounts for more than 90% of exports.

As a seller in an international commodity market, Australia is faced with a price which is set purely by market forces and these forces have, since the early 1980s, been acting to drive the price of aluminium down. The international price fell from a high of over US$2100 to a low of just on US$900 a tonne in mid-1982. At present the price is below US$1200. The industry has been assisted, however, by the exchange rate but these gains are offset by increases in loan repayments.

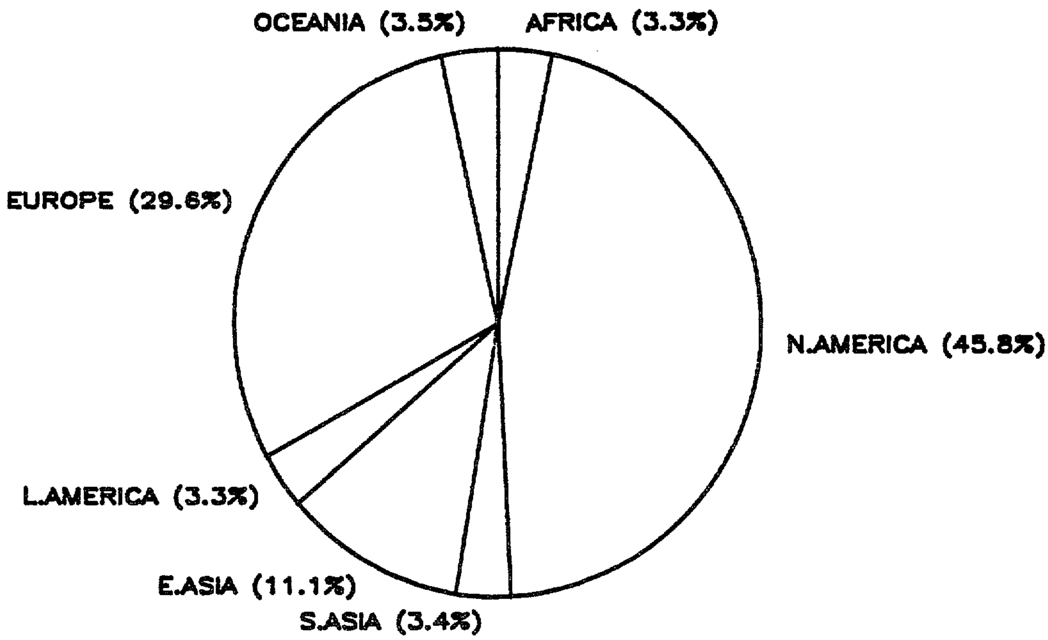
Despite the low prices, aluminium export sales are making a major contribution to Australia's balance of payments with an increasing amount coming from the sale of semi-fabricated products, particularly sheet used in the beverage-can market in the USA.

So far as the future is concerned there is little to suggest an improvement in either demand or price. The general view is that growth in the demand for aluminium is unlikely to exceed 2% per year over the next few years. Such a level of growth, while not exciting, does nonetheless provide opportunities for further development in the Australian industry. For this to be achieved, the industry must remain internationally competitive. The industry is determined to keep its costs to a minimum and looks to the Government to implement policies which will assist it to achieve this objective and thus increase the industry's contribution to the country's welfare.

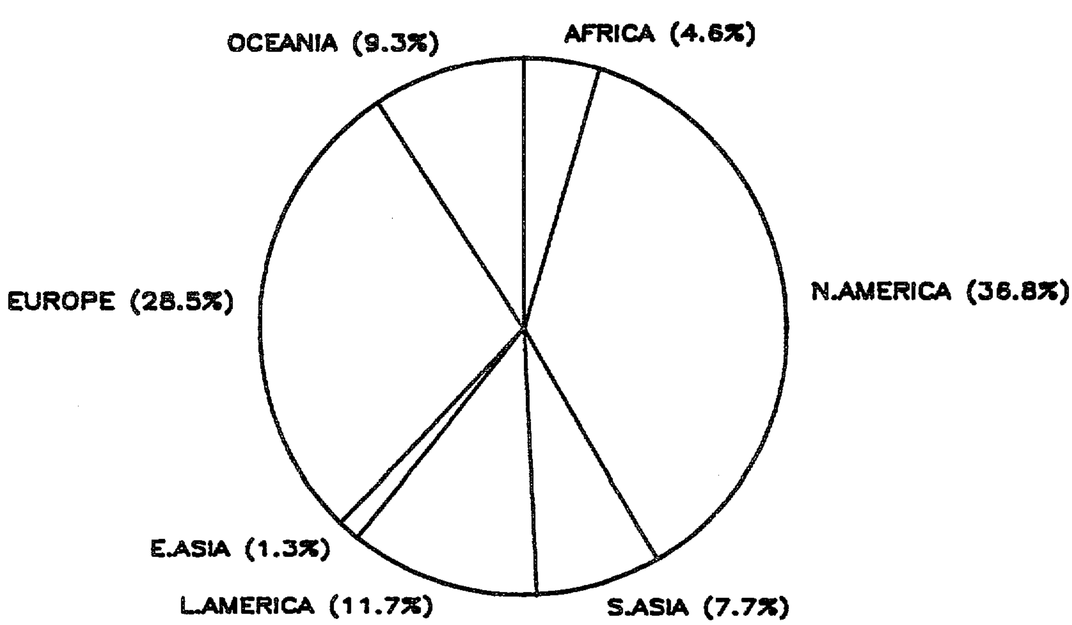
PRIMARY ALUMINIUM PRODUCTION

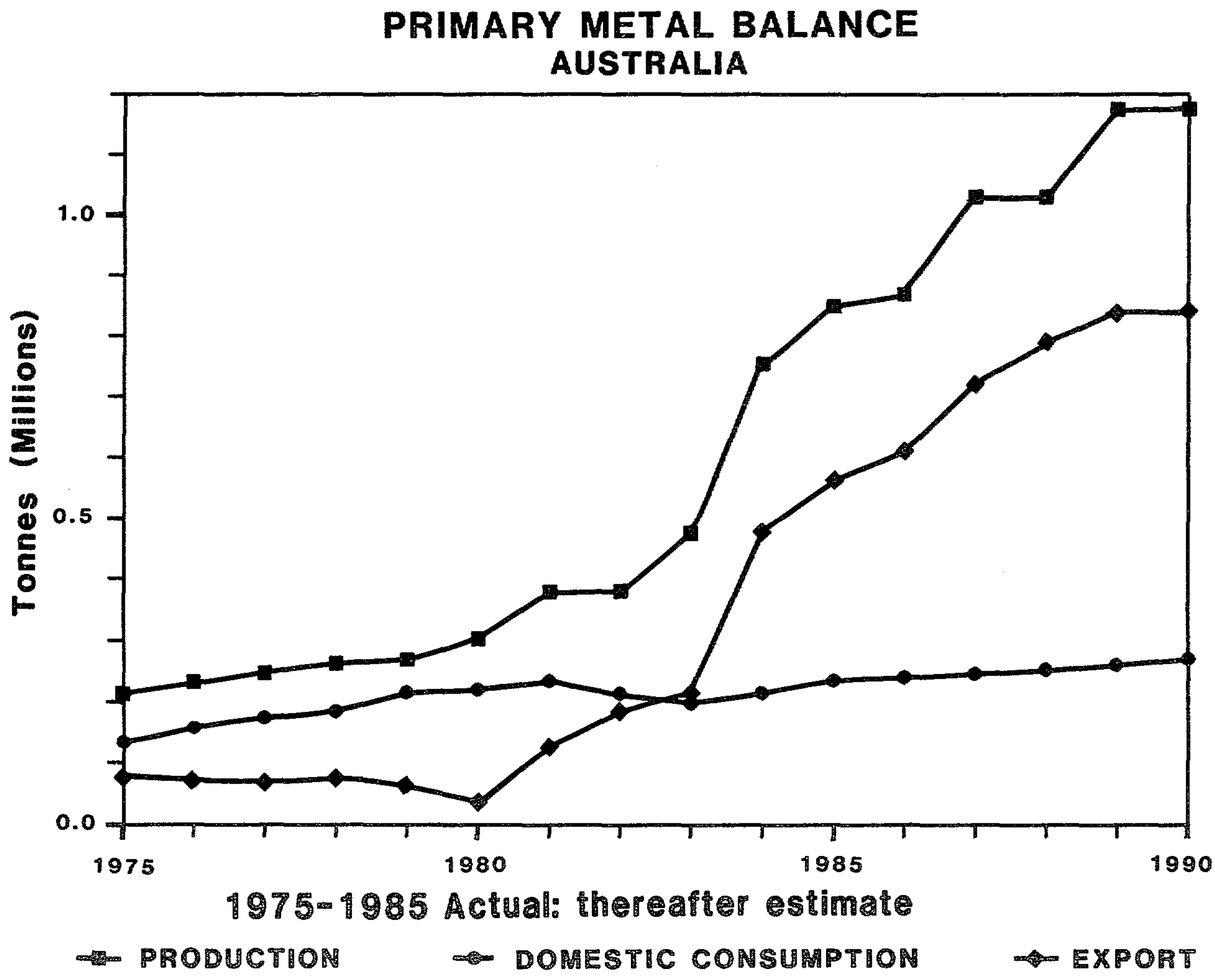
YEAR	AFRICA	NORTH AMERICA	LATIN AMERICA	EAST ASIA	SOUTH ASIA	EUROPE	OCEANIA	TOTAL
1977	367	5093	358	1235	379	3292	393	11 117
1978	336	5409	413	1126	385	3345	414	11 428
1979	401	5421	668	1084	376	3425	425	11 800
1980	437	5726	821	1168	399	3595	460	12 606
1981	483	5603	793	817	513	3551	536	12 296
1982	501	4343	795	376	627	3306	548	10 496
1983	436	4448	942	270	717	3322	700	10 835
1984	413	5327	1035	304	878	3502	998	12 457
1985	472	4781	1119	245	918	3327	1091	11 953
1986	555	4399	1396	159	915	3399	1115	11 938
% OF TOTAL								
1977	3.3	45.8	3.3	11.1	3.4	29.6	3.5	
1985	3.9	39.9	9.4	2.1	7.6	27.9	9.2	

PRIMARY ALUMINIUM PRODUCTION
BY AREA – 1977



PRIMARY ALUMINIUM PRODUCTION
BY AREA – 1986




PRIMARY METAL BALANCE
AUSTRALIA
Tonnes (Millions)
1.0
0.5
0.0
1975
1980
1985
1990
1975-1985 Actual: thereafter estimate
PRODUCTION
DOMESTIC CONSUMPTION
EXPORT

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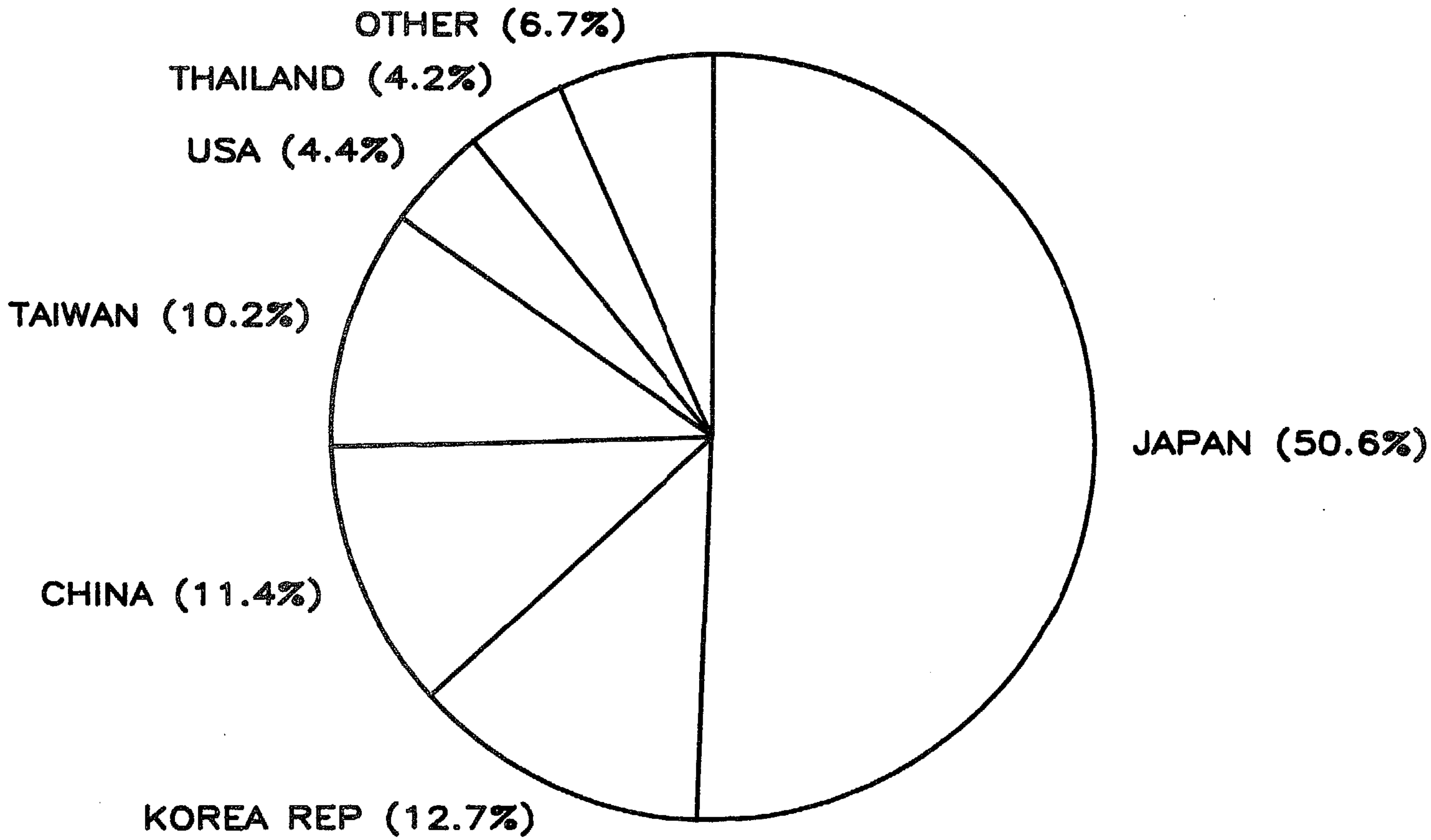
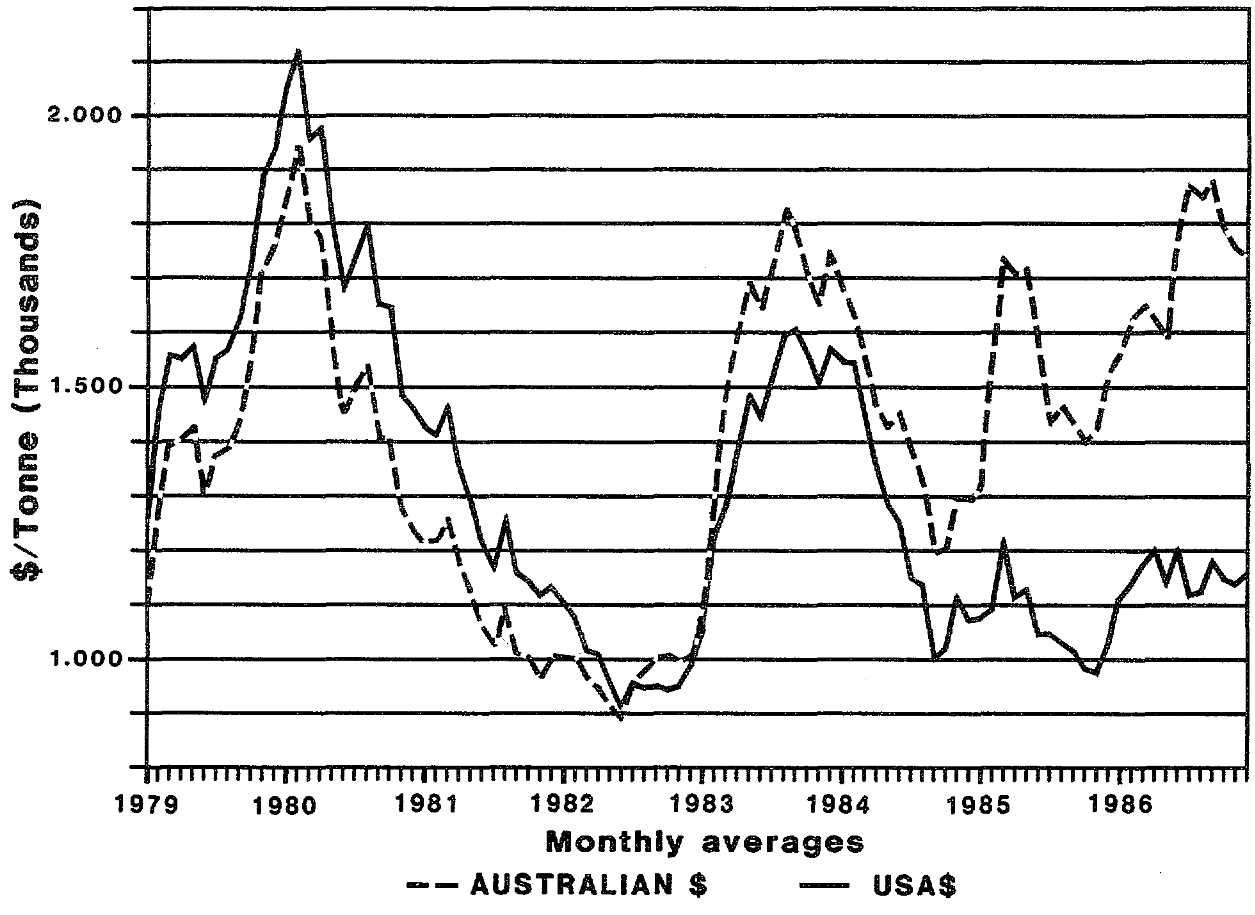
EXPORT DESTINATION – PRIMARY INGOT

YEAR 1986



LONDON METAL EXCHANGE
CASH PRICE - ALUMINIUM 99.5%



PRODUCTION (000's Tonnes)

Year	Bauxite	Alumina	Aluminium*
1974	19994.3	4899.2	219.3
1975	21003.5	5128.9	213.9
1976	24083.5	6205.8	232.3
1977	26084.4	6659.0	247.6
1978	24299.2	6775.7	263.4
1979	27583.4	7414.6	269.6
1980	27179.0	7246.5	303.5
1981	25541.7	7079.0	379.4
1982	23662.0	6630.5	381.2
1983	24372.2	7230.5	475.1
1984	32181.9	8780.7	754.8
1985	32400.0	8791.5	851.7

Source: Bauxite and Alumina — Bureau of Mineral Resource.
*Aluminium — Hot Metal Production.

DOMESTIC SHIPMENTS (000's)

Year	Ingot	Sheet and Plate	Extrusions	Foil	Total
1974	37.8	70.6	49.3	9.7	167.4
1975	28.5	62.7	42.4	7.8	141.4
1976	33.5	72.8	52.0	8.2	166.5
1977	36.6	80.4	52.6	9.0	178.6
1978	43.4	79.5	54.6	9.6	187.1
1979	49.1	89.9	64.7	11.5	215.2
1980	56.0	91.8	64.6	11.2	223.6
1981	61.0	91.8	70.0	11.6	234.4
1982	50.5	87.5	61.5	11.8	211.3
1983	46.0	84.8	61.6	11.2	203.6
1984	58.6	82.9	72.4	11.7	225.6
1985	63.6	89.7	85.3	12.0	250.6

AUSTRALIA: CONSUMPTION-SELECTED OTHER COUNTRIES

Year	Total Metal Consumed (Tonnes)	Mean Population (Millions)	Per Capita Consumption (Kilograms)	U.S.A.	Per Capita Consumption JAPAN	U.K.
1974	203.182	13.598	14.9	27.4	14.7	12.4
1975	157.744	13.771	11.5	20.4	12.2	9.8
1976	190.809	13.916	13.7	25.9	16.2	11.4
1977	199.844	14.067	14.2	27.4	16.1	12.0
1978	209.600	14.259	14.7	29.9	19.1	12.1
1979	245.697	14.417	17.0	29.8	19.3	10.0
1980	257.905	14.616	17.6	25.8	20.8	9.8
1981	278.950	14.856	18.8	25.0	19.0	9.4
1982	252.650	15.147	16.7	23.8	19.0	9.1
1983	235.750	15.371	15.3	25.9	19.4	9.9
1984	258.500	15.540	16.6	26.9 (est.)	18.0 (est.)	10.7 (est.)
1985	284.900	15.75	18.1	N.A.	N.A.	N.A.

Platinum-group metals (PGM) and Australia's potential for increasing its share of world supply

P.Coker, BMR

Australia's share of the world's PGM markets is currently very small; we account for only a fraction of 1% of world supply and demand. Although Australia is essentially self-sufficient in its palladium requirements, we are net importers of the other PGM, particularly platinum and rhodium.

The US Bureau of Mines estimated that world mine production of PGM in 1985 was 247 tonnes, with the USSR and South Africa accounting for 94% of this, and Canada most of the remainder. Australia, on the other hand, accounted for only 571 kg of recoverable PGM (palladium and platinum) in the same year.

While the USSR accounts for the largest portion of Western World primary palladium supply, South Africa dominates Western World primary supply of platinum, rhodium, ruthenium, osmium, and iridium. South Africa is virtually the only country which recovers PGM as the major product of deposits, and even then rhodium, ruthenium, osmium, and iridium can be considered by-products of platinum mining. In the USSR and Canada (and Australia) PGM are recovered as by-products of nickel-copper operations.

The start-up of the Stillwater project in the USA this year will add modestly to Western World supply (2.3 t/year palladium and 0.8 t/year platinum) but in the longer-term South Africa will probably retain its share of the market with the Northam project expected to come on-stream in 1991. The supply side of the PGM markets is likely to continue to be dominated by South Africa and, to a lesser extent, the USSR, for some time.

Japan and the USA account for more than three-quarters of Western World primary PGM demand, with Europe accounting for most of the remainder. Japanese demand is dominated by platinum for jewellery, and palladium for electrical and dental applications. USA's demand is mainly platinum for autocatalysts, and palladium for electrical and dental applications. Areas of probable demand-growth include autocatalysts in Western Europe during the next decade, and platinum for fuel cells in the longer term (more than ten years).

The promising outlook for PGM demand-growth generally, and platinum and rhodium in particular, the narrow supply base, the high PGM prices prevailing in the 1980's (particularly in Australian dollar terms), and Australia's reliance on PGM imports, have stimulated exploration for PGM in Australia.

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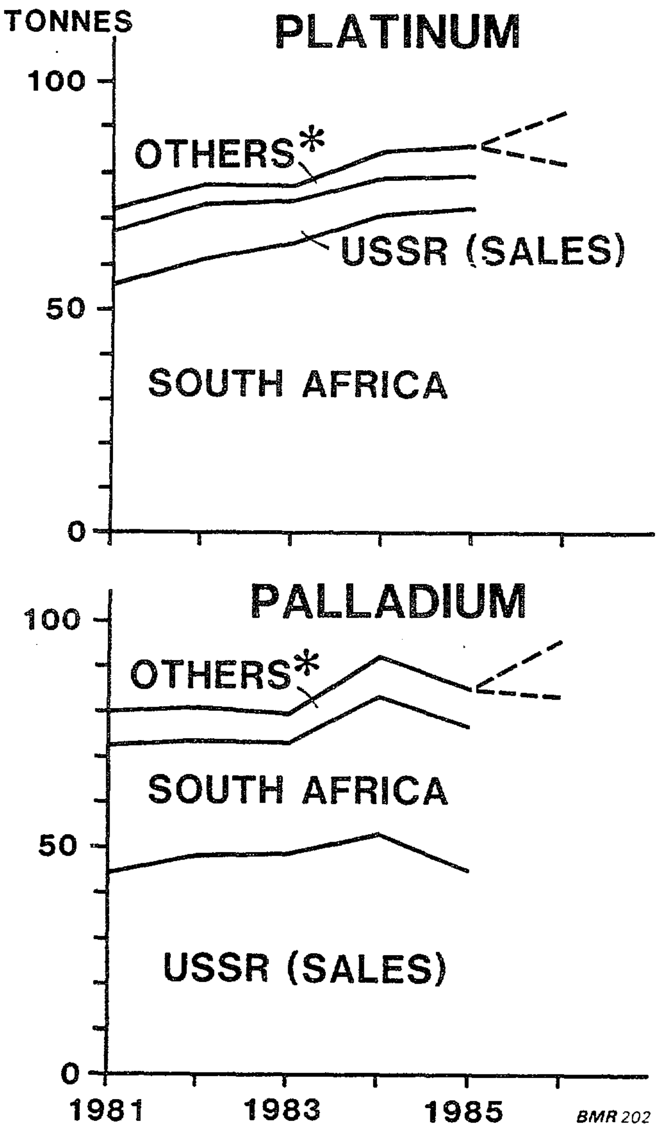
Currently, more than fifty companies are involved in PGM exploration in Australia. While some of this activity has been directed at areas where production has been recorded in the past, such as Fifield in NSW and Wilson River in western Tasmania, the prospects that appear to have the most potential are in areas with no recorded PGM production. The prospects in which investigations are more advanced of these are Munni Munni in Western Australia and Coronation Hill in Northern Territory.

PGM at Munni Munni occur within a layered mafic-ultramafic intrusion. This type of mineralisation is similar to that in the Bushveld Igneous Complex in South Africa, and is representative of the type of deposit that many exploration companies are seeking. Coronation Hill, however, does not conform to this model. PGM (and gold) mineralisation seems to be of an epithermal (low-temperature) type and is in acid volcanic, clastic sedimentary, and dioritic intrusive rocks. This mineralisation not only suggests a new PGM province but the style appears to be unique. PGM mineralisation at Coronation Hill is an example of the increasing body of evidence which suggests that PGM can be transported and concentrated in many more geological environments than previously thought. Some explorers are pursuing these ideas but it is too early to judge whether an economically exploitable 'new' type of PGM deposit will be found in Australia.

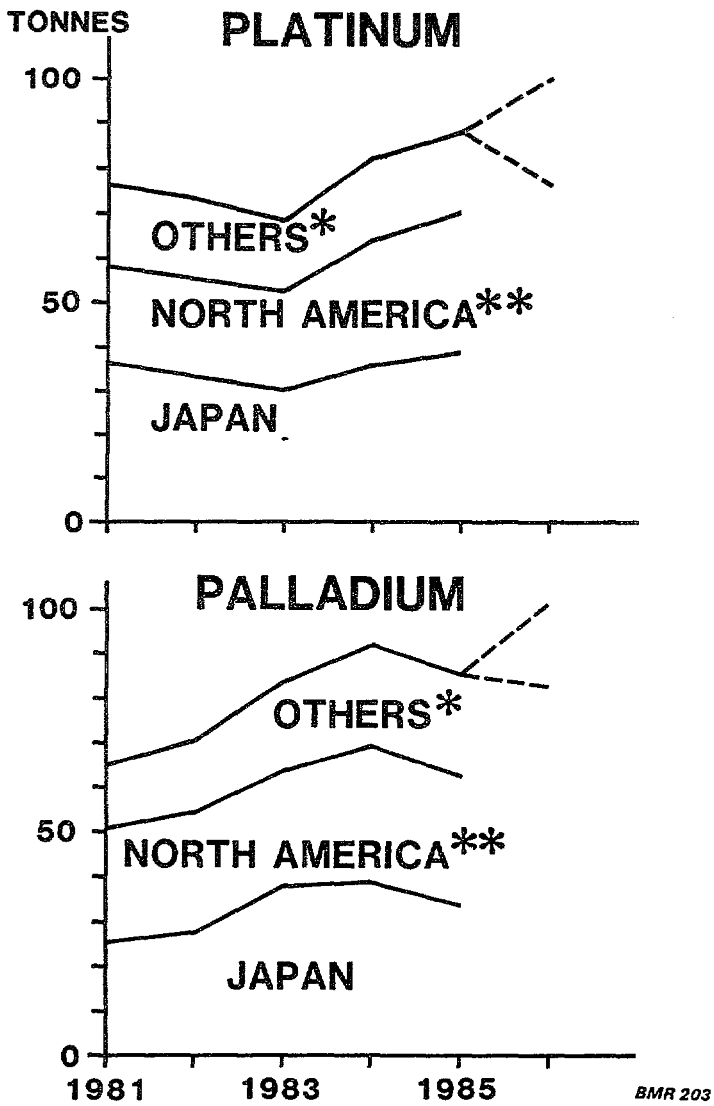
It is important to place this exploration activity in context. While significant PGM mineralisation has been intersected at some prospects, no firm plans have been announced to develop a mine. The best that can be realistically expected in the short-term (less than five years) is that Australia becomes essentially self-sufficient in its PGM needs and even a net exporter of palladium. In the longer-term Australia's prospects for increasing its share of world supply look better. There is enough evidence to be cautiously optimistic that a substantial, economically exploitable, PGM deposit could be found in Australia in the not too distant future.

WESTERN WORLD PRIMARY PLATINUM & PALLADIUM SUPPLY



* MAINLY CANADA

WESTERN WORLD PRIMARY PLATINUM & PALLADIUM DEMAND



* MAINLY EUROPE
** MAINLY USA

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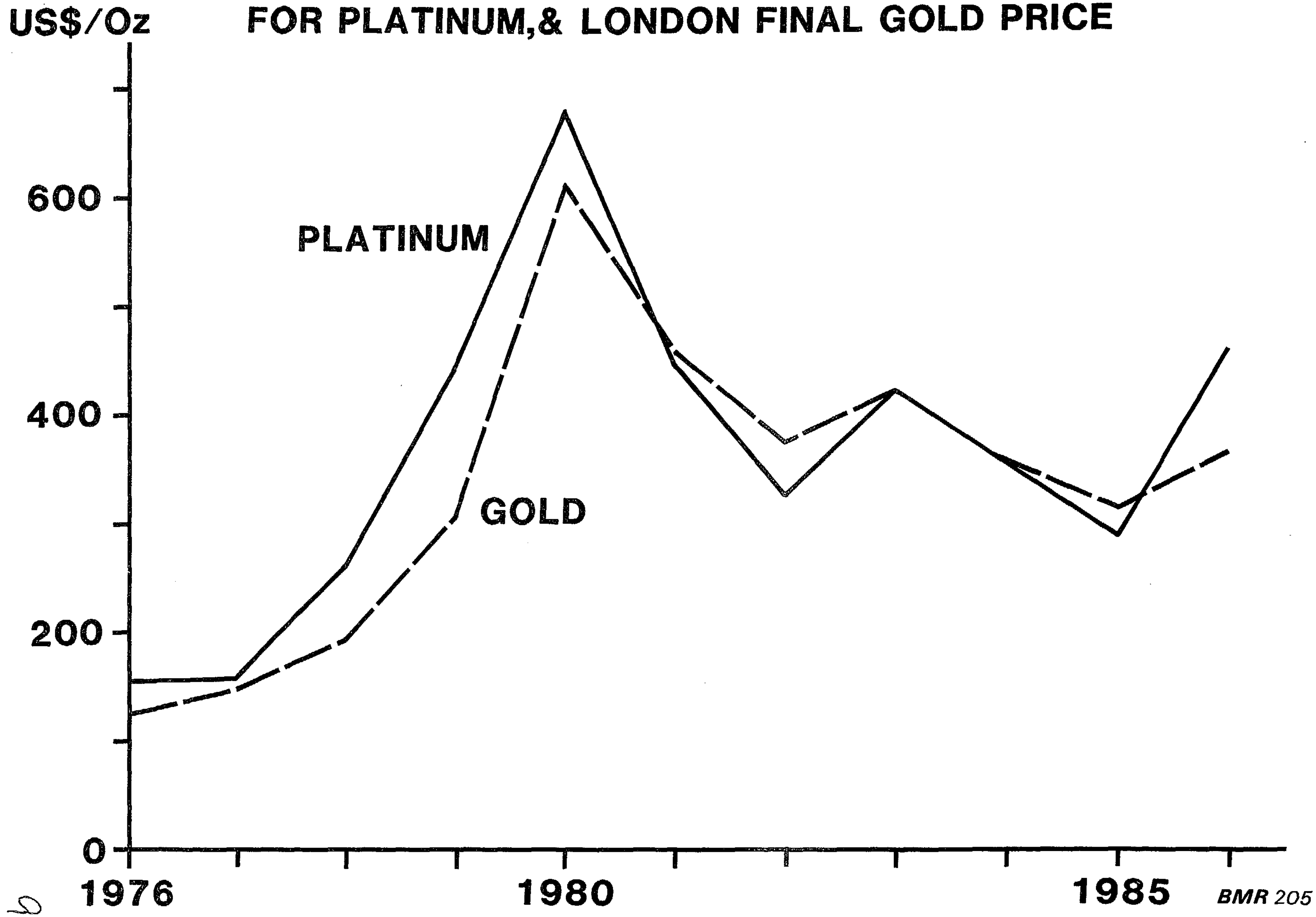
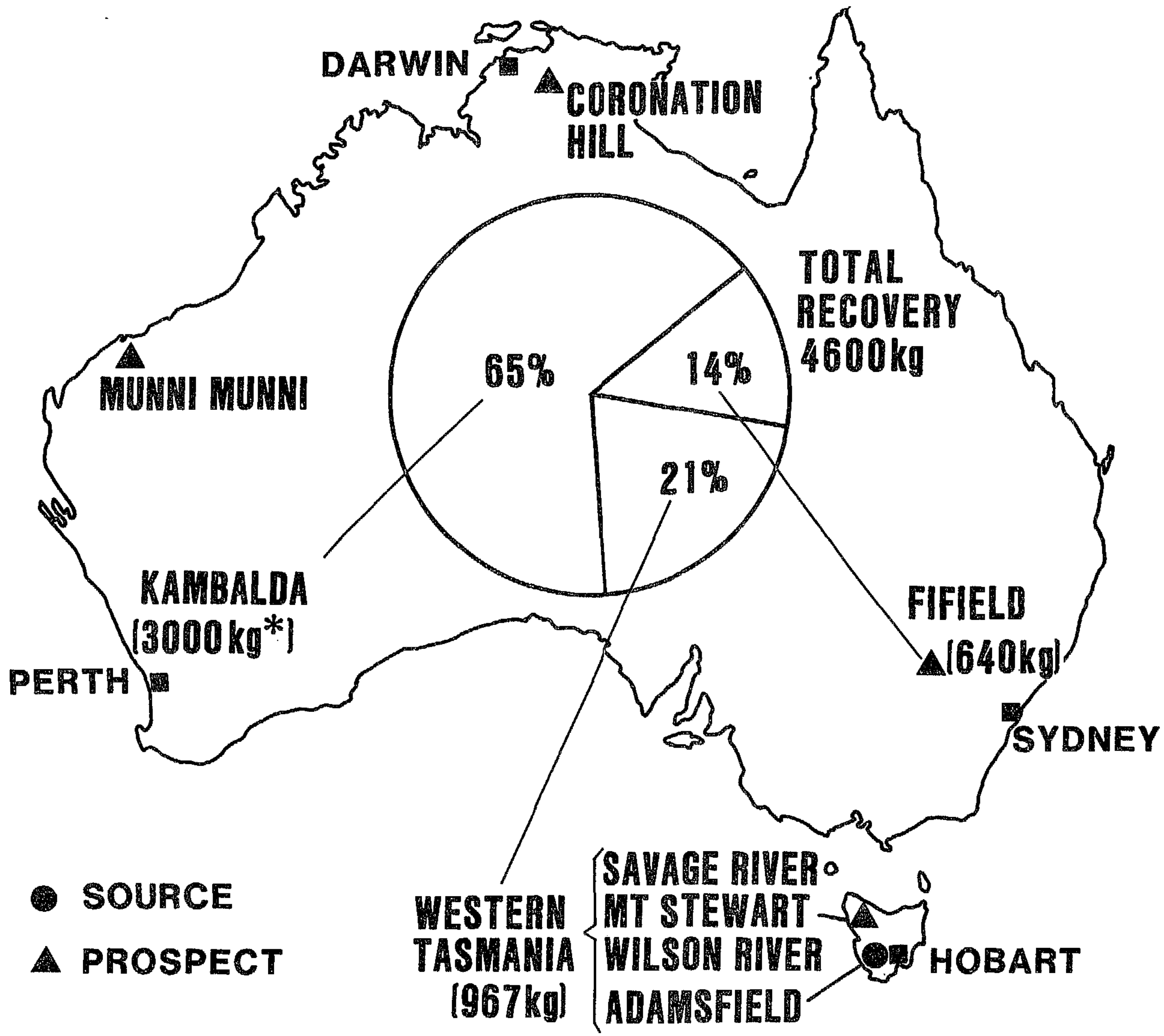
ANNUAL AVERAGE NEW YORK DEALER PRICE FOR PLATINUM,& LONDON FINAL GOLD PRICE



PGM RECOVERY & PROSPECTS



* *Includes some PGM recovered from other base-metal mines*

BMR 206

Mineral sands industry update

Roy Towner, BMR

Australian production of ilmenite, rutile, zircon and monazite all decreased in 1986, and is likely to continue to slowly decline as grades decline, especially if east coast operations continue to be restrained by environmental legislation. Nevertheless, Australia will continue to be a leading world producer of mineral sands.

Exports of mineral sands except rutile also decreased in 1986. However, the value of exports increased by over 30% to $240 million, because of much higher prices for all four mineral sands commodities. Even in constant dollar terms, rutile and zircon prices are at their highest level since the late 1960's, apart from the prices boom period in the mid 1970s, and the price of ilmenite is at its highest level since the late 1960s.

The price increases for the titanium minerals reflect sustained demand for TiO_2 pigment (rather than titanium metal), which is used mainly in paints and plastics. The increase in zircon prices reflects mainly tightening supply. However, price increases for the latter commodity are less likely to be sustained as zircon is more vulnerable to substitution in its main markets (refractories and foundry sands).

In 1986, BMR estimated economic demonstrated resources (EDR) of ilmenite, rutile, zircon, and monazite combined as about 66 Mt (about 61 Mt in 1985); the increase represents new resources in the Cooljarloo region of Western Australia. The quantity of EDR of mineral sands 'frozen' by environmental considerations, all on the east coast, is about 11 Mt, which represents about 17% of Australia's EDR and over 50% of east coast EDR of mineral sands. Inferred resources of mineral sands total about 14 Mt but most of these are presently also classified sub-economic.

On the basis of presently known EDR and current rates of production the west coast industry has a life expectancy of about 25 years. On the same basis, the life expectancy of the east coast industry is less than 20 years, which could be doubled if 'frozen' materials were made available for mining.

Exploration and evaluation of new mineral sands deposits and provinces is continuing, particularly in Western Australia, and also around Byfield, Queensland, and Horsham, Victoria.

BMR estimates that identified resources of titanium in hardrock titaniferous magnetite deposits total about 50 Mt. In the longer term these could well replace or supplement Australia's diminishing known placer resources of titanium minerals. Australia also has large resources of rare earths in hardrock deposits to succeed placer monazite, but to date no alternative sources of zircon have been identified.

Governments are encouraging industry to move towards further processing, thereby adding value to output, and in response to this and commercial incentives to maximise return on remaining resources, the Australian mineral sands industry is clearly moving in that direction, particularly in Western Australia.

Two synthetic rutile (SR) plants, both in Western Australia, are presently nearing completion. When they are commissioned this year, they will increase Australian SR capacity about four-fold to 272 000 t/year and make Australia the world's largest SR producer. Further up the technological scale, ICI Australia is constructing a high-purity zirconia powder (450 t/year) and zirconium chemicals (250 t/year) plant at Rockingham, WA, and the French-based company Rhone-Poulenc will construct a plant to extract rare-earth oxides from monazite concentrates at Pinjarra, WA. Both projects will add appreciably to Australia's export earnings.

In eastern Australia, it has been recently shown that it is now commercially feasible to produce a relatively low-chromium ilmenite fraction by selective electromagnetic separation suitable for pigment manufacture. Consolidated Rutile Ltd is constructing a separation plant at Meeandah, Queensland, to produce 175 000 t/year of low-chromium ilmenite, suitable for pigment manufacture via a synthetic rutile stage.

The outlook is for Australia to remain a major supplier of titanium and zirconium mineral concentrates and intermediate products to world markets. Ilmenite exports could decrease by about 360 000 t/year as some domestic output is diverted to Australian SR plants, and zircon exports could also decrease. Monazite exports may virtually cease, depending on the level of domestic processing achieved. Nevertheless export earnings from the mineral sands sector will increase appreciably because of higher levels of processing of the various mineral concentrates.

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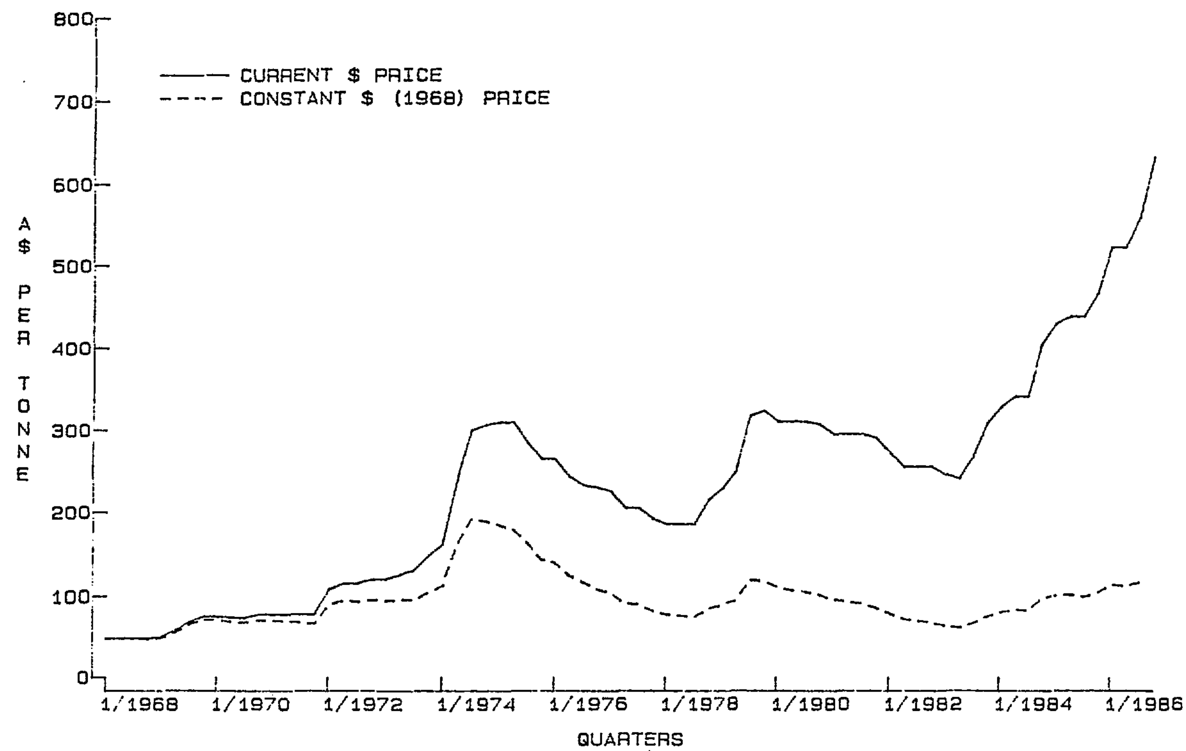
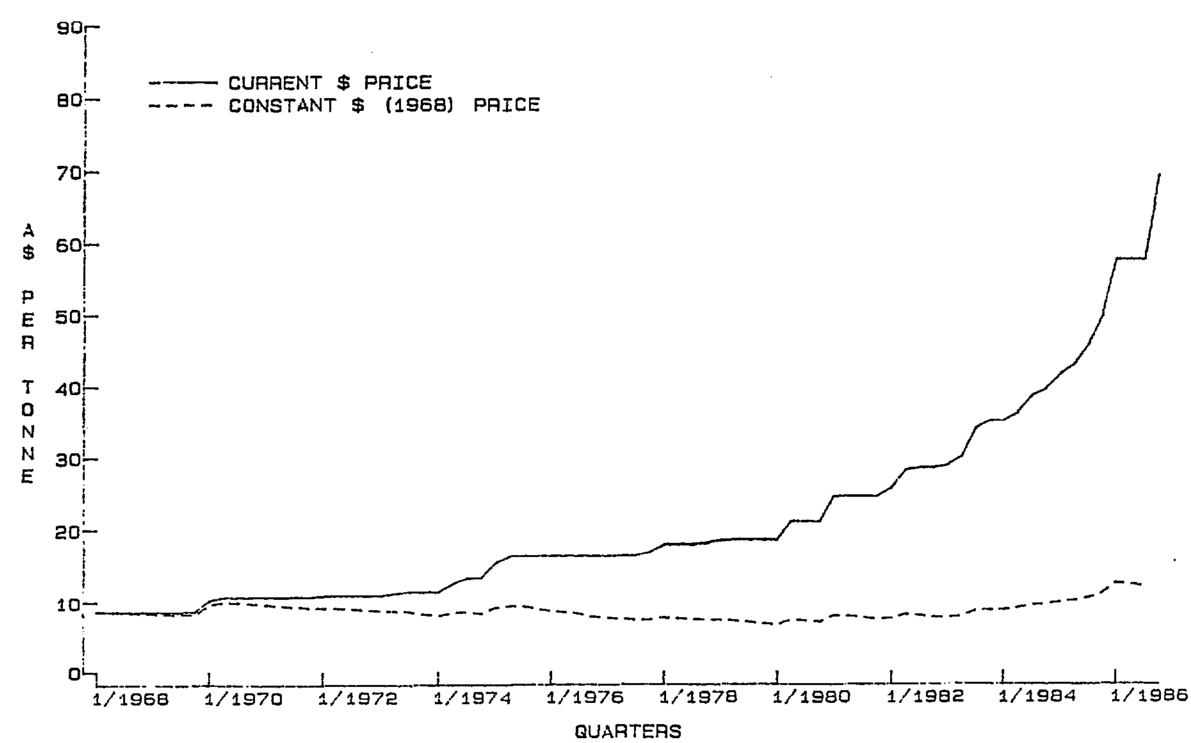
AUSTRALIAN RUTILE PRICE
1968 - 1986



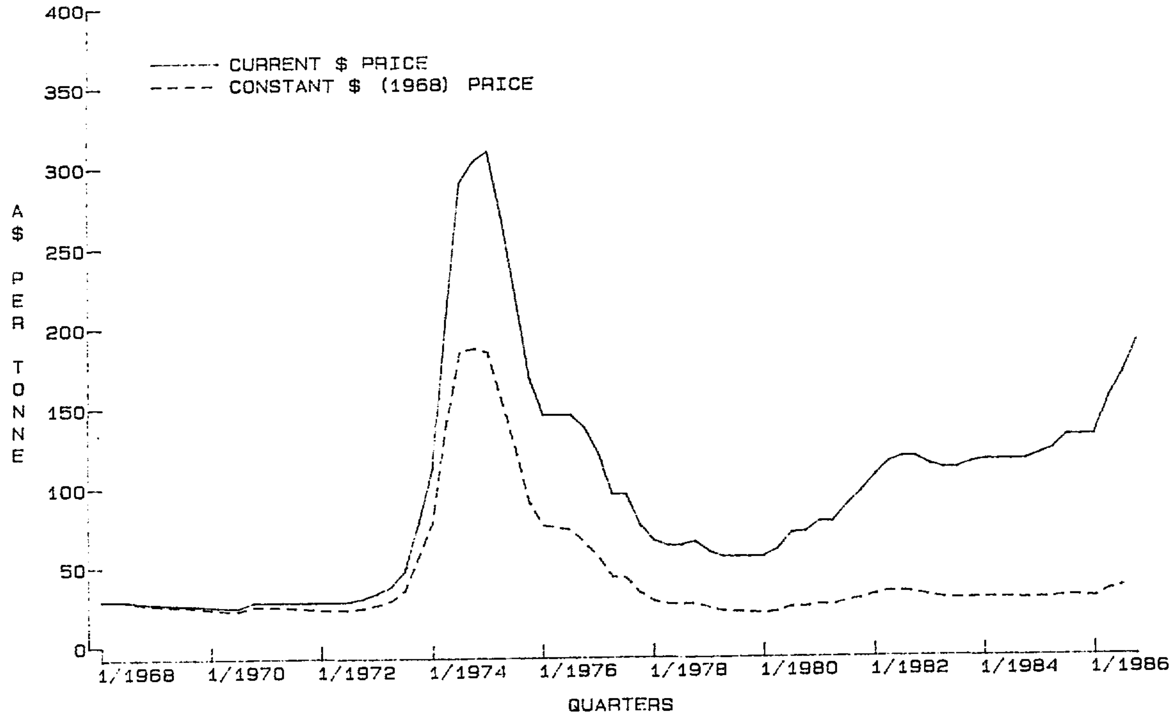
SOURCE: MINPRI AND IFS DATABASES

AUSTRALIAN ILMENITE PRICE
1968 - 1986



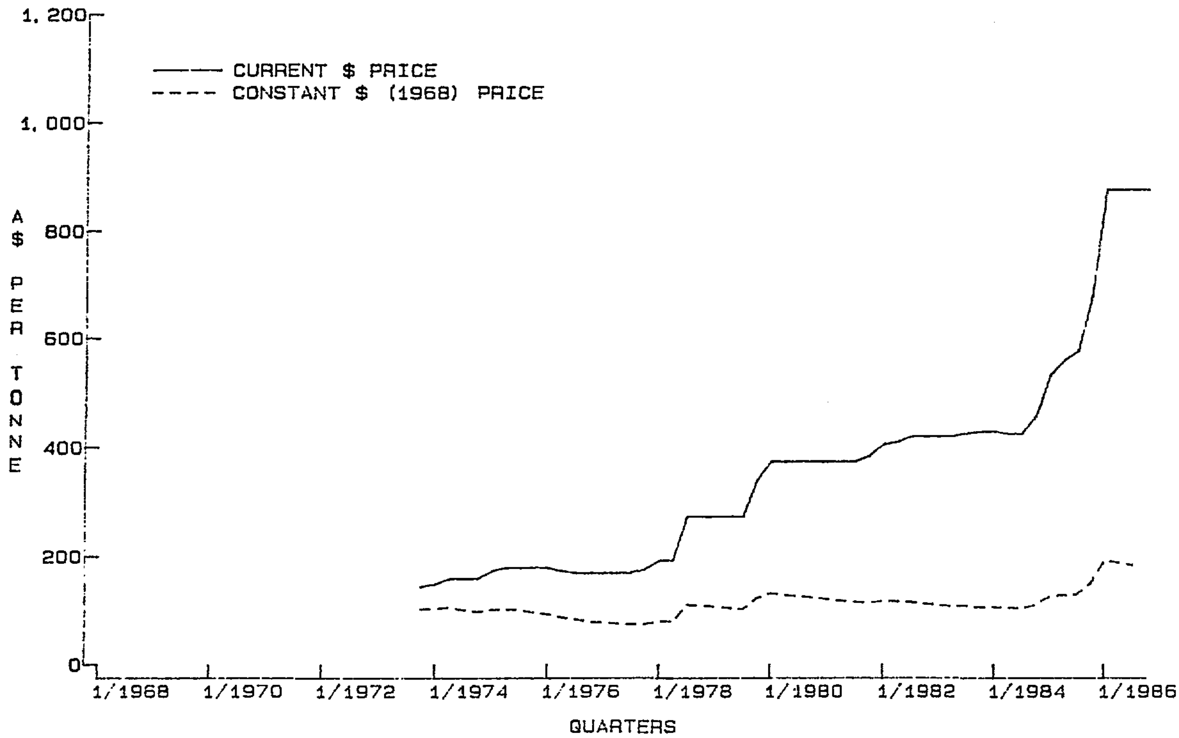
SOURCE: MINPRI AND IFS DATABASES

AUSTRALIAN ZIRCON PRICE
1968 - 1986



SOURCE: MINPRI AND IFS DATABASES

AUSTRALIAN MONAZITE PRICE
1973 - 1986



SOURCE: MINPRI AND IFS DATABASES

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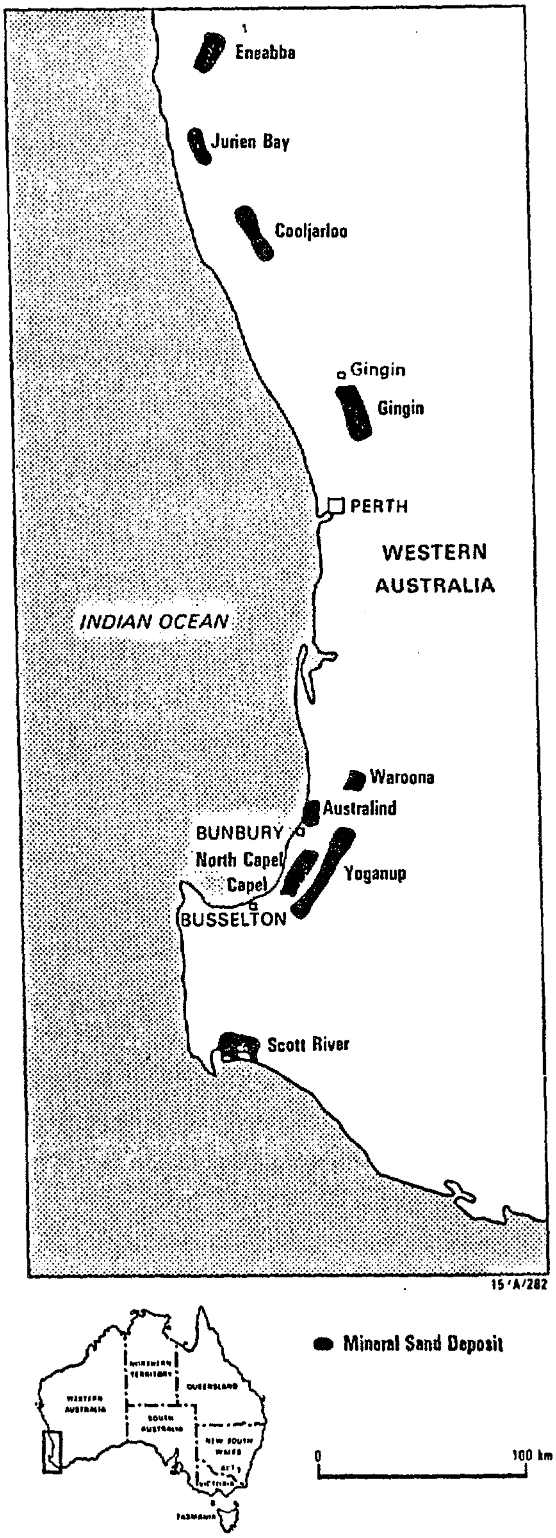
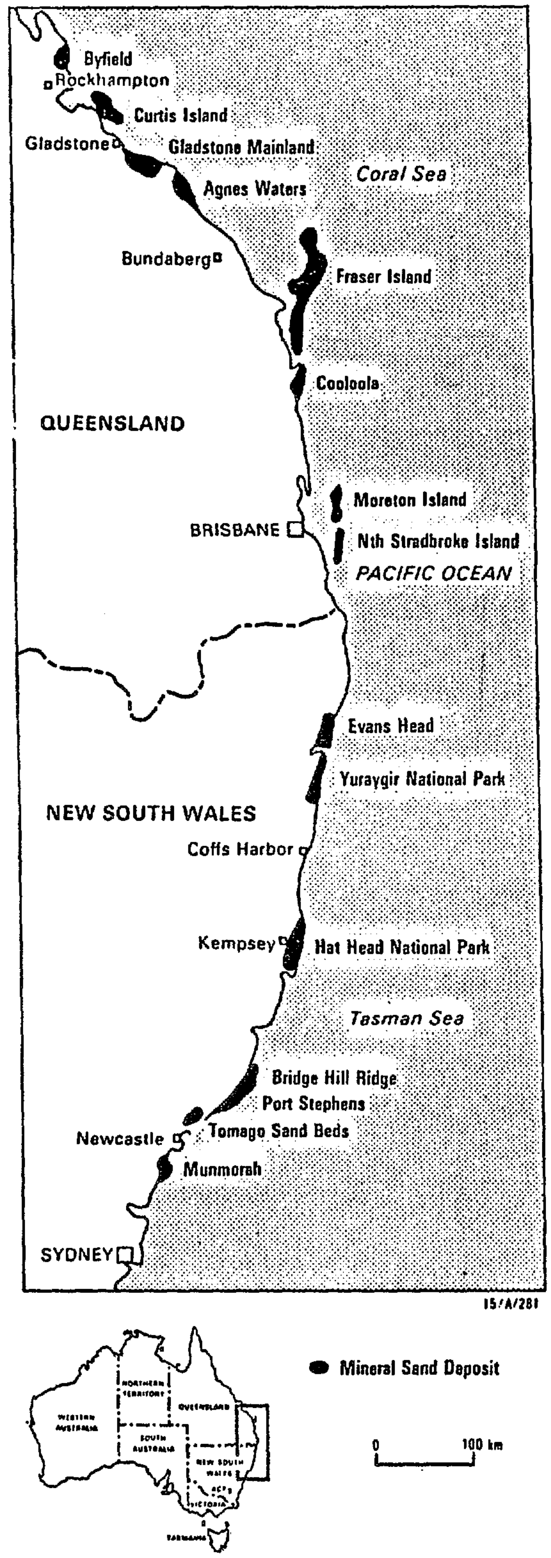


West Coast mineral sand deposits



East coast mineral sand deposits

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Australian gold industry in a world context

R. Woodall, AO, Western Mining Corporation Ltd

World supply of gold

Gold production in the Western World in 1985 was 1213 tonnes (39 million ounces) (Table 1), an increase of 267.1 tones in 10 years, and production seems set to increase almost as much again by the early 1990s. Five regions - Canada, USA, Australia, countries on the Pacific Ocean rim and Brazil - are major contributors to this increased production. The increased gold production reflects geological opportunity - i.e. natural endowment, the success of exploration, new treatment methods, and the high price of gold.

If we add production from Eastern Block countries, a possible scenario for future world gold supply is 2000 tonnes per annum sometime around the year 2000 (Table 2). South Africa is likely to remain the dominant gold producer into the 21st century.

World demand for gold

The fascination for owning gold has not been shaken off in the space age. It remains the only universally-accepted medium of exchange and the ultimate currency by which one nation, whether capitalist or communist, settles its debts with another.

There has been a fundamental shift in the character of the demand for gold over the last thirty years. Historically gold was a monetary metal, but since 1965 gold has joined diamonds, platinum, and silver as a commodity. It is a commodity with special attractions for the investor and any mining company thinking ahead for the rest of this century, and, trying to project demand, must focus principally on the application of gold as a commodity and private investment vehicle.

Price of gold

The price of gold in its new role as a commodity is now very sensitive to demand, especially by the jewellery trade, which is now the cornerstone of the market (Fig. 1). The price of gold is thus volatile and very difficult to predict.

Production is not nearly as price-sensitive as demand and the price of gold will need to fall below US250 per ounce before it will have any significant effect on primary gold supply.

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The Australian gold mining industry and the future

Australia has produced 6200 tonnes (200 million ounces) of gold.

Gold exploration has increased dramatically over the last five years. During this period, $A395 million was spent on exploration in Western Australia, and 246 tonnes of gold (8 million ounces) added to ore reserves at a discovery cost of $A50 per ounce. The majority of these new discoveries resulted from drilling around old mines. The success of this exploration has been mainly due to the high gold price and the availability of new extraction technologies.

Recently, there has been increasing interest and success with exploration for deeper ore beneath old mines.

Exploration in central, northern and eastern Australia has resulted in a number of new gold operations. The development of the large, low-grade Kidston deposit, now Australia's largest producer at 7 tonnes per annum, has highlighted the potential that now exists for economic production from large, low-grade (2 g/t) deposits.

Australia's gold production in 1985 was 57.0 tonnes (1.8 million ounces) and during the second half of 1986 was at a rate of 74 tonnes/annum (2.4 million ounces). Production could rise to 120 tonnes per annum (3.8 million ounces) by early in the 1990s. This production, whilst small in world terms, is very significant within the context of Australia's domestic economy and its terms of trade.

There are very extensive areas of deep soils, deep weathering and shallow sediments covering our goldfields and therefore great opportunity for geochemistry, geophysics and drilling to discover near-surface deposits. Excellent potential thus exists for new discoveries. Geologists and chemist are now extending our understanding of where to explore. Exploration geochemistry is an area where there have been significant advances in gold exploration technology and geophysics has a great deal to contribute to gold exploration.

With the gold price rising faster than costs, and scientific and technological expertise also increasing, most of the present operating gold mines should be able to continue producing far beyond the life of their published reserves. The mine-environment can be the most prospective of all to explore, and ore found near existing mine facilities, the most profitable of all.

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There is no evidence that Australia's gold reserves are declining due to depletion through mining. On the contrary, new exploration technologies, new scientific exploration concepts, and new production methods are more than adequately compensating for such reduction in the natural endowment that results from production. Only if exploration is hampered by poor management or government policies, or if there is a major collapse in the price of gold (which seems unlikely) will we see any decline in either Australia's gold production or gold reserves. On the contrary, an increase in both is more likely over the next 10 to 20 years.

Figure 1.

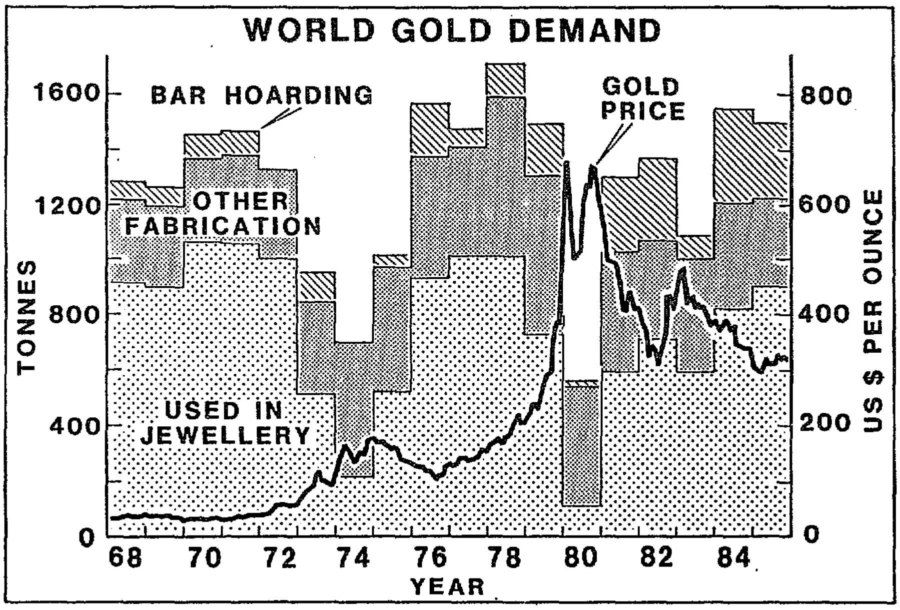

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Table 1

Gold Production in the Western World
(tonnes)

	1975[1]	1985[1]	Growth 1975-1985	Early 1990's	Growth 1985-1990's
South Africa	713.4	673.3	(40.1)	710	37
Canada	51.4	86.0	34.6	115 [2]	29
U.S.A.	32.4	79.0	46.6	140 [2]	61
Australia	16.3	57.0	40.7	120	63
Pacific Ocean Rim:					
Latin America	29.6	99.4	69.8		
Western Pacific	43.7	86.3	42.6		
Total:	73.3	185.7	112.4	230	44
Brazil	12.5	63.3	50.8	75 [3]	12
Rest of Western World	46.4	68.5	22.1	80	12
	945.7	**1212.8**	**267.1**	**1470**	**258**

Source: (1) Milling-Stanley & Green, 1986
(2) Beunderman, 1986
(3) Burnell, 1986

Table 2

World Gold Production 1985 – 2000
(tonnes)

	1985	1990	2000
Western World	1213	1470	1500
Eastern Block	390	465	590
Total	1603	1935	2090

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Metal prices in 1987

W. Davies, Metals & Minerals Research Services

Abstract to be provided separately.

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BIOGRAPHICAL NOTES ON THE SPEAKERS

R. AUSTEN, AO, AUSTEN & BUTTA LTD

Dick Austen is Chairman of Austen & Butta Limited, a company he established with Angelo Butta in 1950, and is an Officer of the Order of Australia.

He is the past Chairman of both the Australian Coal Association and the NSW Coal Association and for some years, has been one of the principal spokesmen for the Australian coal industry.

Mr Austen holds a number of appointments. He is: Chairman of the German Creek Coal Project - a $450 million undertaking in Central Queensland; Chairman of the Australian Meat & Livestock Corporation; a Director of James Howden Australia; an Australian representative on the Coal Industry Advisory Board of the International Energy Agency; as well as a Director of a number of London-based companies.

A.G. CHRISTIE, BUREAU OF RESOURCE ECONOMICS

Alastair Christie is Director of the Bureau of Resource Economics, an economic research and analysis agency formed in May 1986 to study the economics of the resource sector and its relationship with the rest of the economy.

Alastair is a graduate of Melbourne University (Mechanical Engineering) and Oxford University where he studied economics and completed a Doctorate in Operations Research in 1971.

Since joining the Public Service in 1974, from management consulting, he has been involved in regional economic aspects of industry assistance, energy research, petroleum policy and, more recently, energy policy and resource economics. He has spent the bulk of his Public Service career in the Department of Resources and Energy (and its predecessors) and has held senior positions in the Energy Research and Development Division, the Petroleum Division and Energy Policy Division. Alastair has directed the formation of the BRE since its establishment.

P.A. COKER, BMR

Paul Coker is the commodity specialist for platinum-group metals, nickel, and cobalt in the Mineral Commodities Branch, Resource Assessment Division. He graduated from the Canberra College of Advanced Education in 1977 with a B. App. Sc. Since then he has worked on a variety of exploration projects throughout Australia and New Zealand, before joining BMR in 1985.

F.W. COOK, GEOLOGICAL SURVEY OF NSW

Fred Cook graduated from the University of Melbourne B.Sc. (Geology) in 1968, holds a B. Econ. degree (University of Queensland, 1980), and is currently working towards a M. Geoscience (Mineral Economics) degree at Macquarie University.

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Fred joined The BHP Coy. Ltd. Exploration Department in 1969 as an Exploration Geologist and worked on a variety of projects including nickel sulphides (WA), porphyry copper (PNG, Queensland, NSW), gold (eastern Australia), tin (Queensland) and the Wolfang Basin coal deposit (near Clermont, Qld). From 1981 he worked with Mineral Deposits Ltd/Umal Consolidated Ltd as Senior Geologist on project evaluation and, after a period consulting with Earth Econ, he joined the Geological Survey of NSW as Principal Mineral Economist in 1985.

Fred's current interests include coal export demand forecasting, government revenue aspects of the minerals industry, and promotion of the NSW minerals and minerals processing sectors.

C.R. DALGARNO, GEOLOGICAL SURVEY OF VICTORIA

Bob Dalgarno graduated from Adelaide University in 1960 and first worked in the Regional Surveys Section of the South Australian Mines Department. From 1966-1973 he worked with Anaconda Australia Inc. on a range of base metal, gold, nickel and uranium projects. He then joined AFMECO, gaining overseas experience and supervising uranium exploration in Australia until 1979. From 1979-1981 he was Supervising Geologist, Regional Mapping Section, of the South Australian Department of Mines and Energy, and from 1981-1985 he worked with BP Minerals Australia on Stuart Shelf (South Australia) and Olympic Dam operations. Following a period of self-employment, he was appointed Director of the Geological Survey of Victoria in October 1986.

B.J. DAVIES, COOPERS & LYBRAND

Barry Davies is a partner with Coopers & Lybrand in Melbourne and is the National Specialist partner for minerals and energy for that firm of chartered accountants. He is on the Committee of the International Mining Industry Group of Coopers & Lybrand and is involved with the affairs of a number of Australia's largest mining houses.

Coopers & Lybrand are involved in audit, taxation and consulting services for many of the largest mining entities in Australia. They have also been responsible for conducting the annual Minerals Industry Survey on behalf of the Australian Mining Industry Council since its inception in 1977.

W. DAVIES, AUSTRALIAN MINERAL ECONOMICS P/L

Wyn Davies is a Founder Director of Metals and Minerals Research Services Ltd, London and Director of Australian Mineral Economics Pty Ltd, Sydney. He is a graduate of the Royal School of Mines, London and has spent over 20 years in the minerals business in various parts of the world including Africa, USA, Europe, South America and Australia.

D.J. FORMAN, BMR

David Forman graduated with a B.Sc (Hons) degree in geology from the University of Western Australia in 1958. Except for a year with the former Petroleum and Minerals Authority in 1975, he gained experience in field mapping, sedimentary basin studies, and assessment of undiscovered petroleum resources with BMR. He gained an A.M. in 1967 and a Ph.D. in structural geology in 1968 from Harvard University. He is Principal Research Scientist in the Petroleum Branch of the Resource Assessment Division, in charge of a research group responsible for the assessment of undiscovered petroleum resources and the estimation of possible future supply.

I.L. GUNN, BHP MINERALS LTD

Ian Gunn graduated in Mining at Edinburgh University before joining BHP in 1962 as a mining engineer at its Cockatoo Island iron ore mine in Western Australia. From Cockatoo he went to Iron Baron and Rapid Bay mines in South Australia, and was appointed the first Manager of the new Groote Eylandt manganese mine in 1965. After two years he was appointed first Mine Manager at the Mt Newman iron ore mine in the Pilbara. In 1978 he transferred to BHP's Head Office in Melbourne where he was responsible for the marketing of manganese ore and ferroalloys, and for the development of the manganese business.

In 1981 Ian moved again, this time to Brisbane as General Manager of the Thiess Dampier Mitsui Coal Company. In 1985 he was posted to Head Office as General Manager-Manganese, his current position, responsible for all aspects of BHP's manganese and ferroalloy business, covering mining operations on Groote Eylandt and alloy smelting at Bell Bay in Tasmania, as well as world-wide marketing of the products.

Ian is President-elect of the Manganese Centre in Paris, and President of the Victorian Chamber of Mines.

M.R. HARGREAVES, DEPARTMENT OF MINES, TASMANIA

Rod Hargreaves is the Deputy Director of Mines and Chief Government Geologist in Tasmania. Prior to joining the Department in 1984 Rod had some 18 years experience in mineral exploration. He was appointed as Chief Geologist in late 1986.

G.G. HARVEY, BP PETROLEUM DEVELOPMENT AUSTRALIA PTY LTD

Greg Harvey has held the position of Director - Exploration & Gas for The British Petroleum Company of Australia Limited since September 1986. An Arts/Law graduate of the University of Western Australia, he practised law in Perth before joining the Commonwealth Public Service in 1967. After several years with the Department of Foreign Affairs he moved to BHP as a resources project lawyer.

In 1976 he joined BP Australia as Manager, Government & Public Affairs Division and later spent three years in Perth as Manager, WA Marketing Division. Before taking his present appointment he spent several years based in London in senior positions within the BP Group.

D.J. IVES, DEPARTMENT OF RESOURCES & ENERGY

Denis Ives is Deputy Secretary of the Australian Department of Resources and Energy. Denis graduated with a B.Sc. Appl. (Hons) from the University of Queensland in 1961, and a B.A. in Economics from the Australian National University, Canberra, in 1965.

Denis has worked in numerous Departments since joining the Public Service in 1961, including the Departments of Territories, Trade and Industry, Industry and Commerce, and National Development.

He has been directly involved with mineral development policies, manufacturing industry policies and, since 1978, with the development of Australia's resources and energy policies, particularly in regard to the petroleum, electricity and mineral processing industries.

Denis has represented Australia at meetings of the Governing Board of the International Energy Agency. He has been the senior Government representative on the National Petroleum Advisory Council and Chairman of the Snowy Mountains Council, which controls the operations of the Snowy Mountains Scheme. Denis is Deputy Chairman of The Pipeline Authority.

C.A. KNEIPP, ALUMINIUM DEVELOPMENT COUNCIL OF AUSTRALIA LTD

Charles Kneipp has had experience in two major areas - the Commonwealth Public Service and the aluminium industry. He joined the Public Service in 1947, working in the Taxation Office in New South Wales and Canberra until 1956.

During this period he completed the accountancy qualifications for Associate Membership of the ASA. From 1956 to 1966 he worked in Department of Trade in areas of commodity policy and manufacturing industry. He was awarded his Economics degree by the Australian National University.

In 1967 he left the Public Service to establish the Aluminium Development Council and has worked in that area ever since. He has also participated extensively in the work of the International Primary Aluminium Institute as a member and as Chairman of that body's Statistics Committee.

B.A. McKAY, BMR

Brian McKay was a science graduate with geology majors at the University of Manitoba in 1952. His professional experience involved over a decade with the petroleum industry working in various countries on wellsite and laboratory operations. He joined BMR in 1963 and became supervisor of the Petroleum Technology Laboratory followed by administrative/management positions in the Petroleum Branch of the Resource Assessment Division. He is commodity expert for helium in BMR.

J.G. OLLIVER, SOUTH AUSTRALIAN DEPARTMENT OF MINES & ENERGY

Jeffrey G. Olliver is Chief Geologist, Mineral Resources, in the South Australian Department of Mines and Energy (SADME). He is responsible for the professional and administrative leadership of the Mineral Resources Branch of the Resources Division. The Branch is a field-orientated unit involved in the exploration and evaluation of all minerals except oil, gas and coal.

A graduate of Adelaide University, he was a geologist in the South Australian Department of Mines from 1960-1965, Senior Geologist with Newbold General Refractories Ltd based in Wollongong, NSW, from 1965-1969, and Senior Geologist, then Chief Geologist, with Emperor Gold Mines Ltd at Vatukoula, Fiji, from 1969-1972 before his return to SADME in 1973.

J.S. PEARSON, NORTHERN TERRITORY GOVERNMENT

John Pearson graduated B.Sc. from the University of New England in 1970 and worked for mineral exploration companies in Australia, USA, and Paraguay for uranium, base, and precious metals. In 1982-83 he completed his post-graduate Diploma course in Mineral Economics at Macquarie University, and in 1984 was employed by the Northern Territory Government to work in the Water and Mining Divisions. He is now the Mineral Adviser, for the Legislation and Commercial Branch.

D.J. PERKIN, BMR

Don Perkin is Principal Geoscientist in the Mineral Project Evaluation Branch, Resource Assessment Division. He graduated from the University of Sydney with a B.A. (Geology) and worked for a number of years with a range of mining and exploration companies throughout Australia. He graduated in Economics from James Cook University in 1975. Since joining BMR in 1978 he worked as the tin, uranium, and copper, commodity specialist and is now leading the Minerals Potential Section, assessing undiscovered mineral resources.

P.E. PLAYFORD, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Phillip Playford is a West Australian, who was educated at Perth Modern School, the University of Western Australia, and Stanford University. He holds a First Class Honours degree in Geology from the University of Western Australia and a Ph.D. from Stanford.

He has been employed since graduation with both Government and the exploration industry, his present position being that of Director of the Geological Survey. He is the author of many publications dealing with the geology, mineral and petroleum resources of Western Australia, and is known internationally for his research on carbonate rocks.

M. ROARTY, BMR

Mike Roarty is the lead-zinc-silver Commodity Specialist with the Mineral Commodities Branch of the Resource Assessment Division. He graduated from the University of New South Wales in Science in 1968 and has since graduated in Economics from the University of Queensland. He worked with a consultant from 1969-73 on base metal and petroleum prospects throughout Australia and Papua New Guinea, and with Amoco Minerals in the Mount Isa area in 1974. He worked for the NT Department of Mines and Energy from 1975-80 on regional geological mapping projects, and in administration, and joined BMR Mineral Economics Section in 1981.

P. RYAN, DEPARTMENT OF RESOURCES & ENERGY

Pat was originally a seafarer and following 16 years' experience in industrial relations in the stevedoring industry, has held senior positions in the Departments of Trade, Transport, Primary Industry, and Resources and Energy. In the last Department he was First Assistant Secretary (Head) of the Uranium and General Division from 1978 to 1983, and since July 1983 has been First Assistant Secretary of the Coal and Minerals Division. Pat is also Co-chairman of the Advisory Committee of the Australian Coal Consultative Council.

He holds the degree of Bachelor of Arts from the University of Queensland.

J.D. SAWERS, GEOLOGICAL SURVEY OF QUEENSLAND

Since graduation from the University of Queensland, Jim Sawers has had, through his employment, the opportunity to acquire an extensive knowledge of the non-fuel mineral resources of the State.

Currently he holds the position of Assistant Director - Economic Geology in the Geological Survey of Queensland. Major work commitments of his group include an active monitoring role with respect to exploration activity under Authority to Prospect (M) tenure, provision of mineral commodity information and specialist services and planning and implementation of a metallogenic studies program in North Queensland.

R.W. TOWNER, BMR

Roy Towner is Commodity Specialist (mineral sands and industrial minerals) in the Mineral Commodities Branch of the Resource Assessment Division. After graduating Bachelor of Science from the University of Queensland in 1971, he worked as a regional mapping geologist in the Geological Branch of BMR. In 1981 he transferred to the Mineral Commodities Branch, after graduating Bachelor of Economics from the Australian National University.

J. WARD, BMR

Jack Ward graduated in Science from the University of Queensland in the mid-1940's. He was employed by Zinc Corporation Limited in connection with the development of mineral sand deposits on North Stradbroke Island before joining BMR in charge of laboratory investigations on mineral sands along the east coast from Fraser Island to Coffs Harbour. From 1952-1957 he was engaged mainly on the assessment of uranium reserves in the Northern Territory. He also acted as Resident Geologist in Darwin and was responsible for the day-to-day planning and direction of geological services to the Northern Territory Administration before transferring to the Mineral Economics Section (BMR) in 1958. He studied economics at the Australian National University during 1960-61 and specialised in the economic aspects of tin, titanium and tungsten in which connection he travelled widely through North America, Africa and Southeast Asia. He is Assistant Director, Mineral Commodities Branch, Resource Assessment Division, whose main functions are the assessment of Australia's mineral resources and their availability through time, and the monitoring of developments and problems of the Australian minerals industry as a basis for advice to Government.

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J.A.W. WHITE, BMR

John White graduated in Oil Technology at the Royal School of Mines, Imperial College, London. After graduation he worked in many parts of the world with the Schlumberger group of companies before joining the Subsidy Section of the Petroleum Exploration Branch of BMR in 1964. During 1975 he was with the Petroleum and Minerals Authority before rejoining BMR. He is currently Assistant Director, Petroleum Branch of the Resource Assessment Division.

R. WOODALL, AO, WESTERN MINING CORPORATION LTD

Roy Woodall is Director of Exploration of Western Mining Corporation Ltd, and a Director of Western Mining Corporation Holdings Pty Ltd.

He was awarded the degree of B.Sc. (Hons) in Geology by the University of Western Australia in 1953, M.Sc. in Mining by the University of California, in 1957, and the Honorary Degree of Doctor of Science by the University of Western Australia in 1985.

He has been employed by WMC since 1953 in the exploration for gold, especially in the Kalgoorlie, Coolgardie, and Norseman Goldfields in Western Australia.

He is an Officer of the Order of Australia and has received honours and awards from numerous professional societies.