EXTENDED ABSTRACTS

BMR Record 1988/5

88 PETROLEUM & MINERALS REVIEW CONFERENCE

16-17 March 1988, Canberra

Bureau of Mineral Resources, Geology & Geophysics
and
Australian Bureau of Agricultural & Resource Economics

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and
Australian Bureau of Agricultrual & Resource Economics (ABARE)

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World petroleum overview and outlook

J M Despretz, Petrofina Exploration Australia

Petroleum is but one of the world's sources of energy. It is therefore necessary to consider the present position of petroleum in relation to the wider energy situation.

Cumulative production of oil to date is reported to amount to 568 billion barrels, and until recently the world's reserves were reported to be 700 billion barrels. This makes a total of 1268 billion barrels of oil discovered.

The estimate of reserves has, however, just been subject to a surprising upward revision : a 27% increase, bringing the worldwide oil reserves to 887 billion barrels, has been reported over the past year. This addition of 187 billion barrels is an event of considerable importance that deserves comments.

The bulk of the increase derives from reserves re-evaluation in seven countries, which are members of OPEC.

It is in any event clear that the increase is not due to new discoveries : the pattern of discoveries in 1987 followed the downward trend established earlier.

The question is therefore : where is to be found the 425 billion barrels, which is the amount that experts at the last World Petroleum Congress estimated remaining to be discovered?

With the declining discovery rate of new reserves and the continuously rising cost of finding what does remain, the industry has good reason to turn increased attention to finding economic ways to further enhance the discovery of oil from producing reservoirs and depleted reservoirs.

Experts at the last World Petroleum Congress have estimated that the ultimate reserves of natural gas are in the same order of magnitude as oil reserves when measured in terms of energy equivalence.

The oil supply situation in the longer term strikes us as serious, even very serious. It looks very much as if the effective oil age has less than a century left to run : by 2050 oil production will probably have sunk to the same level as it was in 1950.

The exploration for new reserves, especially for the remaining giant fields in hostile environments, the development of more advanced enhanced recovery methods, the major development schemes themselves, and the exploitation of unconventional oil resources are all long-term projects which most certainly require stable oil prices.

The declining success of exploration, especially in relation to giant fields, with its impact on world reserves, combined with the low prices that have inhibited developments that might otherwise have taken place in non-OPEC countries, will before long again give OPEC the leading position for controlling oil prices.

The oil industry recognises these underlying facts. A recent survey shows that the oil companies are concerned about replacing reserves.

Three-quarters of the companies interviewed recently considered that exploring for new reserves makes better economic sense than purchasing existing reserves, notwithstanding the effects of the recent stock market crash.

However it does seem that many companies are still active trying to buy reserves.

Petroleum exploration and development in Australia, 1987

C S Robertson, BMR

In 1987 the levels of petroleum exploration and development activity in Australia continued to reflect the downturn in industry activity following the sharp fall in world crude oil prices in the early part of 1986. Offshore exploration activity, seismic survey activity and overall expenditure in 1987 showed a further decline. This was offset to some extent by an unexpectedly large increase in the number of onshore exploration wells. There were some other signs of a partial recovery of industry confidence in 1987 as a result of some improvement of oil prices and relative price stability throughout the year.

Fifteen exploration wells were drilled offshore in 1987. This represented a decrease of 46 percent compared to 1986, and was the lowest number of offshore wells drilled since 1977. By contrast, the number of onshore exploration wells, 211, was nearly double that for 1986, and was only 7 percent below the record number in 1985.

The number of offshore development wells in 1987 (20) was the same as that in 1986 and slightly above that in 1985. The number of onshore development wells in 1987 was more than twice that in 1986. Seismic survey activity, both onshore and offshore, has declined since high levels were achieved in 1985. The overall level of seismic survey activity in 1987 was 14 percent below the level of 1986.

1987 was not a good year as far as discoveries were concerned. There was a number of small discoveries, but the total addition to Australia's oil and gas reserves from fields discovered in 1987 was insignificant compared to the decrease in reserves resulting from production.

Development drilling activity in 1987 was about 50 percent higher than in 1986 but was below that of the preceding four years. Development and production expenditure in 1987 is estimated to have been about $750 million, about twice the amount spent on exploration.

In 1987 a variety of development activities was in progress around the country, both offshore and onshore. Construction continued for the second phase of the giant North West Shelf gas project planned to supply liquefied natural gas to Japan by October 1989. Development drilling is underway on the North Herald and South Pepper oil fields south of Barrow Island, and plans were announced during the year to develop the Saladin oil field, also near

Barrow Island, and the Challis oil field in the Timor Sea. Appraisal drilling on the Jabiru oil field resulted in a second well commencing production, to bring field production to about 29 000 barrels per day.

In Bass Strait, the Bream oil and gas production platform jacket was installed in July. The 32 km pipeline linking the Bream field to the West Kingfish platform was completed. The platform will have provision for 27 wells, and the first oil is scheduled to be produced in March 1988. The producers have announced plans to proceed with the development of the small Whiting, Tarwhine and Seahorse oil fields.

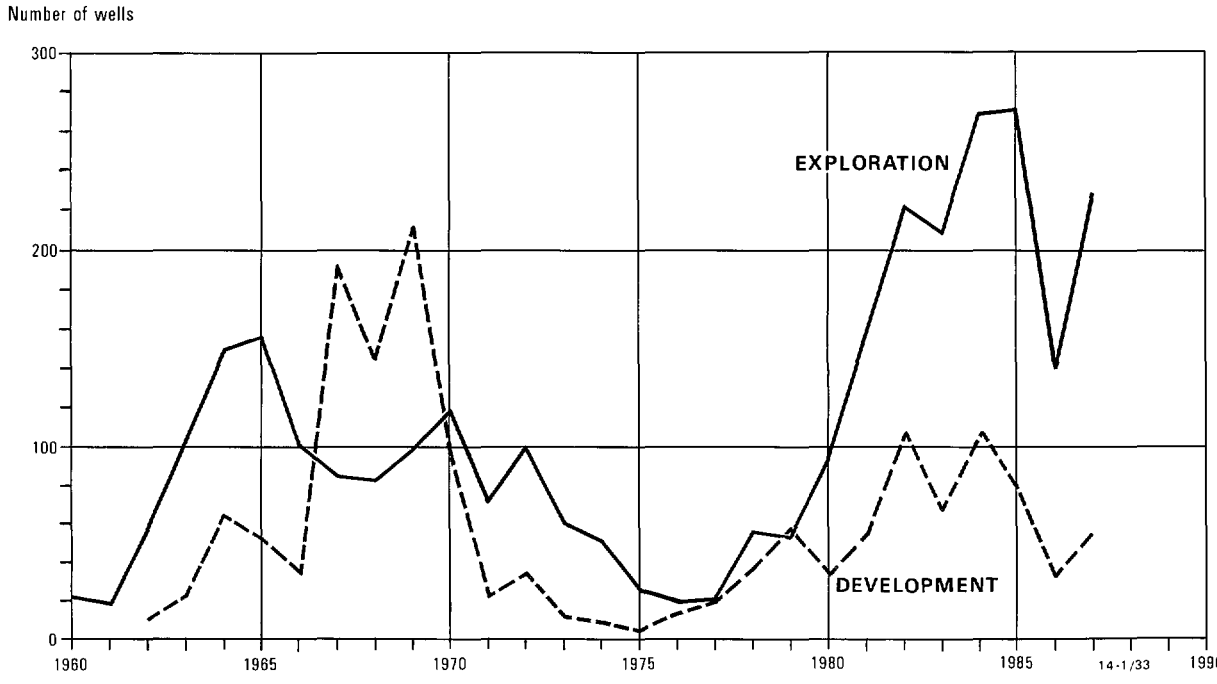
Onshore, the Queensland Government awarded a contract for project management and pipeline engineering for the planned State gas pipeline project to link the gas fields in the Denison Trough with Queensland Alumina Limited's refinery at Gladstone on the coast. In the Cooper Basin, South Australia, agreement was reached to implement an enhanced oil recovery project at the Tirrawarra and Moorari fields; construction of a 43 km pipeline linking the Bookabourdie and Bimbaya fields to Tirrawarra commenced. Plans were announced for the construction in Darwin of a gas separation plant which is expected to produce LPG and helium by the end of 1988.

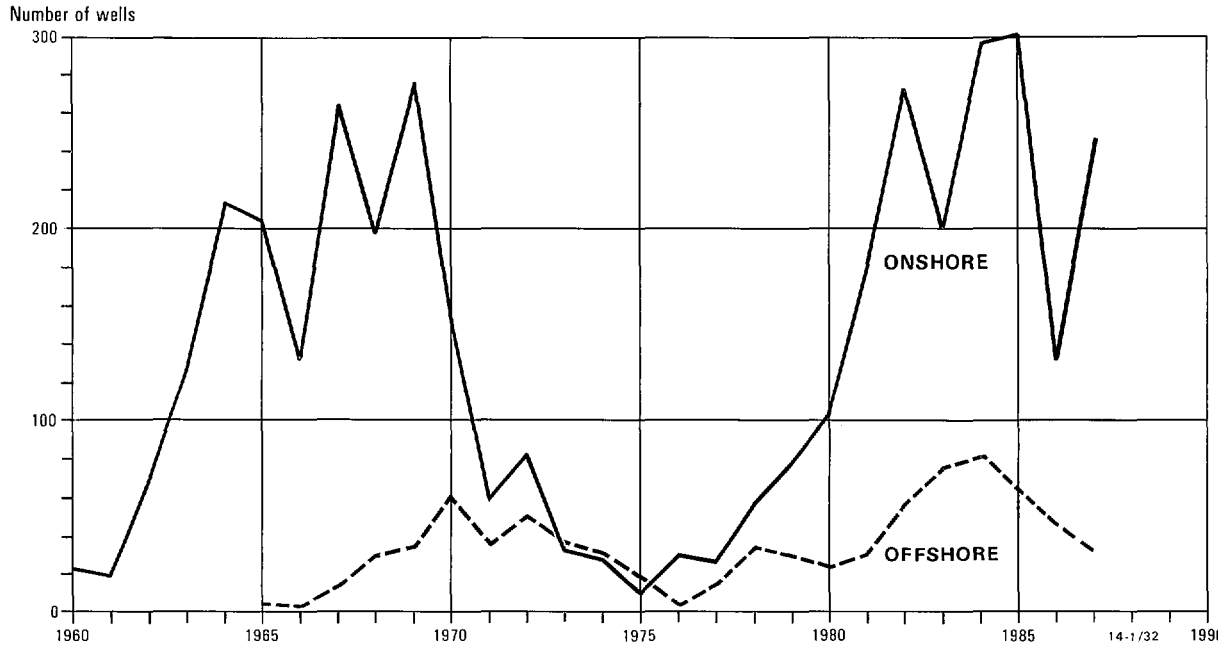
During 1987 the Commonwealth and the States continued their policy of regularly advertising vacant offshore areas for exploration. Two offshore releases were made during the year. Release No. 1 in January resulted in the granting of five new permit areas. Bids for Release No. 2 closed in December. Seventeen bids were received for six of the 11 areas offered. Details of Release No. 1 of 1988 are to be made public on 16 March 1988.

In 1987 the Research Divisions of BMR continued major projects relevant to petroleum exploration. The Division of Marine Geosciences & Petroleum Geology continued its Continental Margins Program, begun in 1985, with projects in the offshore Otway Basin, the southeastern Australian Margins, and offshore northeastern Australia. 9100 km of multichannel seismic data were collected in 1987. The Division of Continental Geology completed Stage 1 of its palaeogeography project, which has provided a complete set of 150 Phanerozoic palaeogeographic maps of Australia covering 70 time slices.

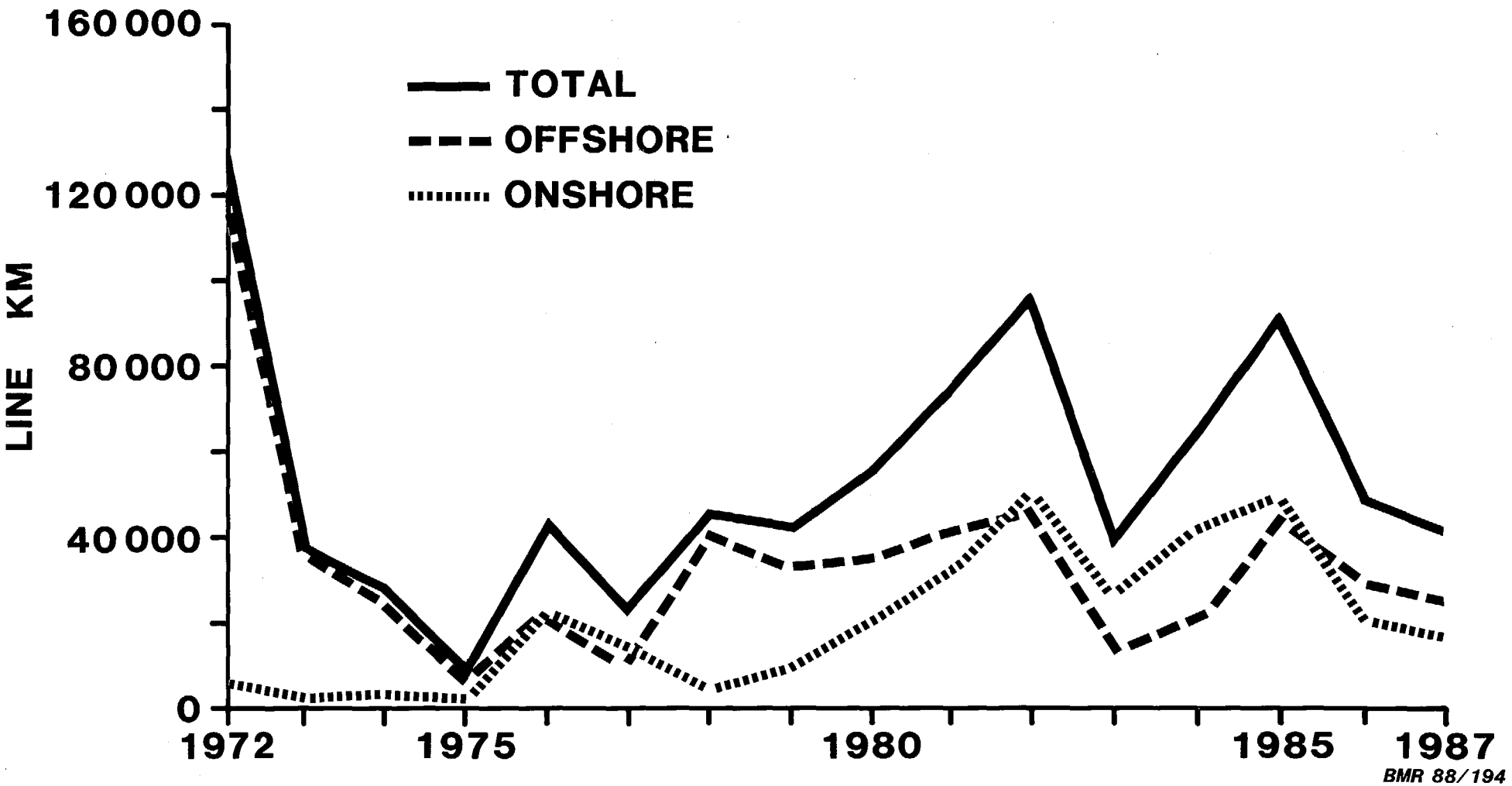
BMR estimates that the overall level of exploration and development drilling activity in 1988 will be considerably above that of 1987. The number of offshore exploration wells is expected to double, and the number of onshore exploration wells is also expected to increase substantially. However, there may be a decrease in development drilling and seismic survey activity in 1988.

PETROLEUM WELLS DRILLED IN AUSTRALIA 1960-1987
EXPLORATION AND DEVELOPMENT, ONSHORE AND OFFSHORE





SEISMIC SURVEY ACTIVITY 1972-1987



ANNUAL HISTORICAL SUMMARY

AUSTRALIA - WELLS DRILLED - HISTORICAL

Year	Exploration			Development			Totals	
	Onshore	Offshore	Sub-total	Onshore	Offshore	Sub-total	For Year	Cumulative
To 1971	1 450	105	1 555	772	77	849	-	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	111	28	139	17	20	37	176	4 827
1987*	211	15	226	36	20	56	282	5 109

* Preliminary figures subject to revision

AUSTRALIA - METRES DRILLED - HISTORICAL

Year	Onshore	Offshore	Onshore	Offshore	Yearly	Cumulative
	Exploration		Development		Totals	
Year	Onshore	Offshore	Onshore	Offshore	Yearly	Cumulative
To 1971	1 903 594	332 854	786 015	195 107	-	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	204 107	62 093	27 926	65 211	359 337	8 244 191
1987*	403 116	39 828	73 601	55 212	571 757	8 815 948

* Preliminary figures subject to revision

Notes

Australian crude oil production from new discoveries to year 2000

D J Forman & A L Hinde, BMR

Values for the median (50 percent probability) and the high (20 percent probability) estimates of production of crude oil from undiscovered resources to the year 2000 are shown in Table 1. The estimates have been produced at BMR using a computer program that simulates drilling a model of Australia's untested petroleum prospects and estimates the sizes of discoveries, the years of discovery, the lead times from discovery to production, and the annual production (Fig. 1). The information used in each part of the estimate is based on a mixture of historic data and subjective judgement as to how these data may apply to future exploration and production.

Table 1 - Comparison of BMR's latest (1987) estimate of annual crude oil production from undiscovered fields with BMR's previous (1986) estimate (thousands of barrels per day)

	1986 ESTIMATE		1987 ESTIMATE	
YEAR	HIGH	MEDIAN (50% probability)	HIGH	MEDIAN (50% probability)
1985	0	0		
1986	0	0		
1987	0	0	2.9	0
1988	0.5	0.3	6.3	2.7
1989	6.3	4.4	15	4.4
1990	27	10	27	6
1991	60	30	39	11
1992	107	60	53	17
1993	148	99	67	24
1994	186	132	83	32
1995	211	159	100	40
1996	233	181	117	47
1997	258	205	135	58
1998	274	219	150	66
1999	277	222	165	73
2000	274	208	177	81

The production estimates have been produced using BMR's most recent (September 1986) assessment of Australia's undiscovered crude oil resources; that Australia's total undiscovered crude oil resources lie between 950 million barrels at the 80 percent probability level and 3800 million barrels at the 20 percent probability level, and average 2400 million barrels. It has been assumed that onshore drilling will lie in a range of 50 to 150 new-field wildcat wells per annum, averaging 100 wells, and that offshore drilling will lie in a range of 10 to 30 new-field wildcat wells per annum, averaging 20 wells. It has also been assumed that exploration efficiency, as reflected in

average discovery rates per well drilled, will be higher than has been experienced in Australia over the last ten years, and that lead times between discovery and production will be shorter than experienced in the past. The estimate has been prepared using a suite of minimum economic field sizes relevant to different regions throughout Australia. The values chosen are based on the experience of recent developments in Australia and are consistent with oil prices within the range of $14-28 per barrel (1986 US dollars).

The new median estimate of annual crude oil production from undiscovered resources is similar to the median estimate that was published in Energy 2000 for the period 1987 to 1990, but is about 70 percent lower from 1991 to 2000. The new high (20 percent probability) estimate is similar to the earlier estimate up to about 1990, but it is about 35 to 55 percent lower from 1991 to 2000.

Apart from the improved method of estimation, the new production figures are lower than those previously prepared by BMR because:

(1) they are based on BMR's 1986 assessment of Australia's undiscovered crude oil resources which are somewhat lower than the previous assessment (1984);
(2) they are based on a lower average level of offshore drilling;
(3) they assume a lower efficiency of exploration for the larger fields; and
(4) they are based on longer lead times between discovery and production than used in the previous assessment.

The values assigned to the factors used in the new estimates of production of crude oil from undiscovered resources reflect the rather disappointing results from offshore exploration from 1984 to 1986 and the decreased expectations of activity resulting from lower oil prices and a slightly less optimistic view of Australia's undiscovered potential.

It is emphasised that the estimates of future production of crude oil from undiscovered resources are based largely on statistical analysis of historic data combined with subjective judgement. They are sensitive to a number of important assumptions, the most important being those concerning the number and size of the undiscovered oil fields and the level of exploration activity. In many areas there is at present insufficient or inadequate data on which to base a reliable estimate of the number and size of the undiscovered fields. Future exploration and research will provide the basis for improved assessments and it is possible that such work may well lead to a more optimistic view of Australia's petroleum potential.

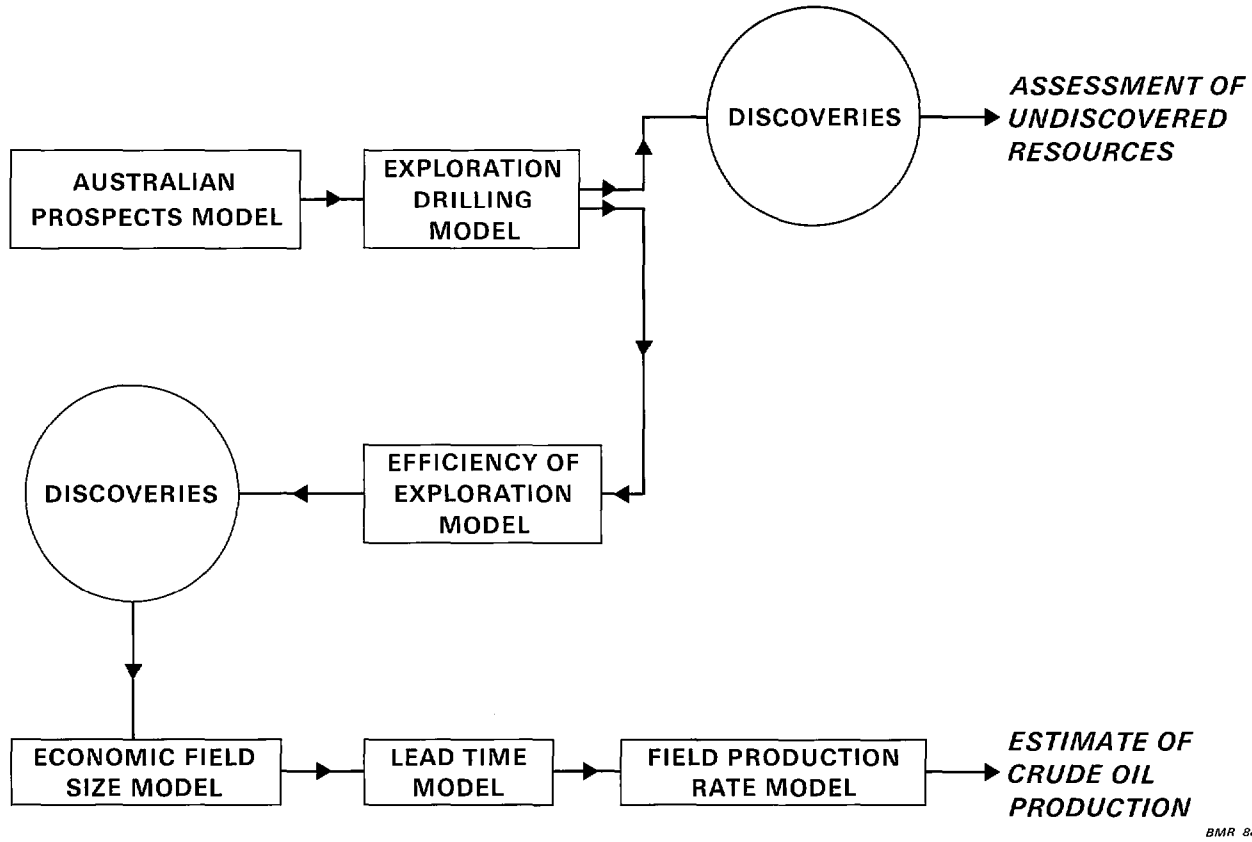


Figure 1 Diagrammatic illustration of the steps involved in assessing future discovery and production of undiscovered crude oil.

Notes

Australian mineral industry, 1987. Overview and outlook

J Ward, BMR

World economic conditions improved generally in 1987, metal stocks were reduced to more manageable levels, demand improved, base metal prices increased particularly in the latter part of the year, and despite continuing fierce competition in world mineral markets, the year proved to be one of considerable development and achievement for the Australian minerals industry. Tables 1 - 3 detail statistical performance of the industry in recent years. In particular, the ex-mine value of output increased over 1986 by about 11% to an estimated $21.9 billion; most commodities recorded positive though reduced gains, the exceptions being black coal and iron ore which were up in tonnage but down in value. The f.o.b. value of exports of mineral primary products increased by 6% to a record $16.0 billion, black coal, aluminium, iron ore, gold and petroleum being responsible for about 80% of this total. The value of imports of primary mineral products was held at about $1.8 billion, the main mineral import cost continuing to be crude oil and other refinery feedstock which accounted for about 62% of the mineral import bill in 1987.

Notable achievements were -

- gold - 21 new mines commissioned, production of 108t, 43% more than in 1986 and the highest for 80 years.
- black coal - record levels in production (saleable coal 145Mt), exports (99Mt) and domestic consumption (44.8Mt)
- aluminium - record production of aluminium (1Mt), alumina (10.1Mt) and bauxite (34Mt); exports of aluminium, alumina and bauxite valued at a record $3 billion.
- diamonds - record output of 30.3Mct, about 35% of world's natural diamond production.
- mineral sands - installed capacity for production of synthetic rutile expanded to more than one-quarter million tonnes/year establishing Australia as a world leader in this area of mineral processing.
  - major new deposit of heavy mineral sand delineated in western Victoria.

Another encouraging development in the Australian mineral industry in 1987 was renewed expansion in private expenditure on exploration for minerals other than petroleum. Preliminary data indicate an increase in 1986-87 to about $500M, the highest since the peak years of the early 1980s; a higher level of activity is predicted for the current year.

However, while the Australian mineral industry again performed impressively in 1987, some problems must be addressed and necessary action taken if the industry is to maintain its high level of performance. In particular, it needs to be recognised that

- recent growth in the industry results mainly from a major investment surge back in the early 1980s; growth in the industry is slowing, the production index for recent performance indicating growth at about the same as that in 1983.

- some growth has resulted from increased output aimed at lowering unit costs; this cannot be expected to go on indefinitely.

- return on shareholders' funds of 6.5% in 1986-87, a modest increase on returns in recent years but well below the peak of some 20% in 1980 and returns on some other forms of investment.

- while recent increases in base metal prices have been a welcome relief to producers bedevilled by depressed metal prices over the last five years, continuing downward pressure on coal and iron export prices must be regarded with considerable concern particularly as there appears to be little immediate prospect for a reversal in this trend. In 1987, coal and iron ore contributed about 34% of the total value of mineral exports, and because of the importance of this contribution the average weighted price for all mineral exports declined by about 4% during the year.

Also, while increased private expenditure on exploration reflects renewed confidence in the future of the industry , it should be recognised that more than half of this exploration effort is being directed towards gold. The comparatively high gold price, particularly in terms of the Australian dollar no doubt justifies such partiality towards gold exploration at least in the shorter term, but in the longer term exploration for a wider variety of commodities and a broader company strategy for mineral exploration and development is called for if Australia is to maintain and possibly improve its

position as a long-term source and supplier of a wide spectrum of mineral products to world markets.

The industry is cautiously optimistic about the future. After five years of depressed conditions in the world mineral industry, 1987 marked a welcome improvement in mineral demand and prices. And, notwithstanding the fact that the growth rate in the Australian minerals industry has levelled off, the industry is well positioned to conclude the 1980s on the same high note on which it entered them. Australia remains a most favourable environment for mineral exploration and development; exciting developments are in hand, substantial investment growth in the industry is forecast; and new avenues of mineral processing are being investigated and implemented. Basic to all such development is Australia's mineral resource endowment, the comparative advantage that such an endowment affords us, and the efficiency and success with which this endowment is being proved up by mineral exploration. Table 4 provides details of a ten-year trend (1977-1987) in the level of Australian economic demonstrated resources of selected mineral commodities.

However, the October collapse in world stock markets has created uncertainty in world economic growth, a growth which is expected now to be at a lower rate than previously forecast. If such proves to be the case world metal demand could well suffer and competition in world mineral markets intensify. It is therefore imperative that the Australian minerals industry consolidates the hard-won gains it has achieved in reducing production costs by rationalisation and increased efficiency, maintains its share of established markets, stakes its claim in developing markets particularly those of the Asia-Pacific Region, and pursues opportunities for substitution of mineral imports. If it can do this it will continue to play a vital role in Australia's balance of trade for years to come.

TABLE 1. MINE PRODUCTION OF PRINCIPAL MINERALS

	Unit of quantity	1984	1985	1986	1987(e)
Bauxite	'000 t	31 537	31 839	32 384	34 000
Coal, black, raw	'000 t	139 094	158 256	170 067	175 500
Coal, brown	'000 t	35 166	36 985	37 604	44 000
Copper (a)	t	235 671	259 765	248 368	223 000
Diamonds	carat	5 692 193	7 070 062	29 232 453	30 332 677
Gold (a)	kg	40 309	58 521	75 079	108 000
Iron ore and concentrate (b)	'000 t	94 406	97 447	94 015	100 000
Lead (a)	t	440 620	497 954	447 673	476 000
Manganese ore, metallurgical	t	1 848 889	2 002 960	1 648 921	1 853 279
Nickel (a)	t	76 923	85 757	76 739	74 500
Petroleum					
Crude oil and condensate	ML	28 915	33 377	29 764	31 900
Natural gas (c)	$10^6 m^3$	12 755	13 628	14 869	15 400
LPG	ML	3 392	4 124	3 929	3 900
Silver (a)	kg	972 303	1 085 933	1 022 761	1 019 000
Tin (a)	t	7 939	6 374	8 515	7 500
Titanium					
Ilmenite concentrate	t	1 493 171	1 418 867	1 237 694	1 380 000
Leucoxene concentrate	t	32 110	13 809	14 143	12 200
Rutile concentrate	t	170 424	211 615	215 774	257 000
Tungsten (W)(a)	t	1 733	1 970	1 600	1 149
Uranium (U_3O_8)	t	5 099	3 781	4 899	4 457
Zinc (a)	t	676 532	759 083	711 958	733 000
Zircon concentrate	t	457 599	501 440	451 824	439 000

(a) Total metallic content of minerals produced. (b) Excludes iron oxide not intended for metal extraction. (c) Includes ethane. (e) Estimated.

TABLE 2. SMELTER AND REFINERY PRODUCTION OF PRINCIPAL METALS

	Unit of quantity	1984	1985	1986	1987
Alumina	'000 t	8 781	8 792	9 423	10 105
Aluminium	t	757 798	851 286	881 910	1 003 947
Blister copper (b)	t	179 822	167 669	169 622	177 000 (e)
Copper	t	171 180	163 833	163 958	185 000 (e)
Gold, newly won					
Australian origin	kg	33 897	49 184	68 723	97 453
Overseas origin	kg	3 106	5 039	13 463	18 819
Lead (c)	t	198 847	200 147	156 239	201 317
Lead bullion (b)	t	179 491	183 161	188 403	197 171
Pig iron	'000 t	5 329	5 607	5 889	5 580 (e)
Raw steel (d)	'000 t	6 303	6 578	6 703	6 040 (e)
Silver	kg	302 482	329 024	336 194	309 046
Tin	t	2 899	2 683	1 399	600 (e)
Zinc	t	301 940	288 686	303 115	310 189

(a) Primary production; excludes secondary production. (b) Metallic content. (c) Includes lead content of lead alloys from primary sources. (d) Includes recovery from scrap. (e) Estimated.

TABLE 3. OVERSEAS TRADE IN PRINCIPAL MINERAL PRIMARY PRODUCTS

	Unit of quantity	1985 Quantity	1985 Value f.o.b. ($'000)	1986 Quantity	1986 Value f.o.b. ($'000)	1987(e) Quantity	1987(e) Value f.o.b. ($'000)
EXPORTS							
Alumina	'000 t	7 169	1 432 501	7 687	1 427 168	8 300	1 551 400
Aluminium (ingot metal)	t	563 716	861 918	579 528	975 088	700 000	1 357 100
Coal, black	'000 t	89 116	5 102 551	92 784	5 366 749	99 200	5 004 500
Copper (a)	t	156 453	274 450	140 133	247 567	131 800	264 900
Diamonds (c)(d)	carat	3 231 997	33 511	3 376 323	38 561	163 400	15 400
Gold (a)	kg	49 879	668 130	58 685	972 143	80 100	1 627 800
Ilmenite concentrate (b)	t	1 151 921	39 746	1 034 209	48 454	1 043 000	55 000
Iron ore and pellets	'000 t	86 914	1 997 225	79 678	1 939 009	76 860	1 656 000
Iron, ingot steel and ferroalloys	'000 t	685	155 491	607	164 938	700	149 700
Lead (a)	t	429 722	357 781	412 213	361 122	390 300	479 600
Nickel	–	n.a.	496 933	n.a	438 397	n.a.	373 300
Petroleum							
Crude oil and condensate	ML	6 822	1 642 387	4 296	655 322	5 800	934 100
Enriched crude and other refinery feedstock	ML	7	1 192	106	12 052	100	19 400
LPG	'000 t	1 609	491 935	1 495	297 909	1 400	257 100
Rutile concentrate	t	211 723	83 473	229 665	116 412	250 000	147 100
Salt	'000 t	5 166	97 439	5 213	102 470	2 695 (f)	55 500 (f)
Silver (a)	kg	776 065	50 028	957 648	53 450	892 300	58 100
Tin (a)	t	5 667	87 165	7 512	58 351	7 750	61 800
Tungsten concentrate	t	3 300	22 762	2 526	13 482	2 300	10 200
Uranium oxide (U_3O_8)	t	3 424	314 749	4 166	372 604	3 755	342 145
Zinc (a)	t	633 472	514 802	661 823	488 720	680 600	527 000
Zircon concentrate	t	495 891	63 881	445 690	74 495	456 000	96 100
Other (g)			472 111		629 460		941 955
Total value			15 262 161		14 853 923		15 985 200
IMPORTS							
Aluminium	t	1 079	3 370	736	3 113	1 200	4 200
Asbestos, all types	t	12 194	11 386	9 245	7 158	4 200	2 100
Clay (excl. activated)	t	63 186	9 965	54 221	10 365	63 100	16 100
Diamonds (c)	carat	1 905 069	56 082	2 357 013	63 884	2 462 500	73 400
Gold	kg	7 972	89 303	7 263	91 431	8 310	107 700
Ingot steel, ferroalloys	t	62 502	39 039	79 010	39 404	124 700	52 700
Nickel, matte and metal	t	858	6 075	2 952	8 627	1 400	8 300
Petroleum							
Crude oil	ML	3 305	766 634	4 026	514 877	4 100	638 900
Enriched crude and other refinery feedstock	ML	3 307	737 839	3 371	457 651	3 200	468 700
Phosphate rock	'000 t	1 810	94 207	1 698	97 330	1 650	93 500
Potassium fertiliser	t	204 633	28 464	199 395	26 516	264 000	24 400
Sulphur	t	392 344	57 863	398 101	70 559	405 000	56 700
Other			128 549		150 634		217 100
Total value			2 028 776		1 541 549		1 763 800

(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. (c) Comprises unsorted and sorted gem and industrial diamonds. (d) Excludes data for unsorted gem and industrial diamonds from May 1986. (f) Excludes common salt in bulk from 1 January to 30 June 1987. (g) Other commodities include confidential items not available separately.

CHANGES IN AUSTRALIAN IDENTIFIED MINERAL RESOURCES 1977-1987

		End 1977		End 1987		% increase	10 year depletion from
		Total	EDR	Total	EDR	in EDR	end 1987
Bauxite	Mt	6417	2703	6591	2825	5	14
Black coal (in situ)	Gt	201+	41	73.6+	70.3	71	5
(b) Brown coal (in situ)	Gt	123	41	253.4	46.5	13	1
Copper	Mt	10.4	5.6	43.4	16.9	202	18
Diamond	Mct	nil	nil	409.4	356.4	-	84
Gold	t	228	130	2725	1274	880	86
Ilmenite	Mt	75.01	48.89	80.05	49.89	2	(f)
(b) Iron ore	Gt	6435+	13.85	43.86	14.93	8	7
Lead	Mt	27.99	16.33	41.87	15.55	-5	35
(b) Manganese ore	Mt	891	490	788	192	-61	23
Monazite	kt	547.6	361.0	1072.4	237.8	-34	(f)
Nickel	Mt	7.96	1.54	9.8	1.1	-29	55
Rutile	Mt	12.72	9.79	14.47	9.12	-7	(f)
Tin	kt	772.8	169.8	993.7	184.9	9	47
Uranium (g)	kt	345	289	921	471	63	
Zinc	Mt	46.45	23.78	69.36	23.99	1	38
Zircon	Mt	20.4	14.71	21.83	13.62	-7	(f)
Petroleum							
Crude oil	Gl	(a)317	(a)247	(d) (c)262	(d)242	-2	68
Natural gas	Gm^3	(a)836	(a)316	(d) (c)2089	(d)902	185	25
Condensate	Gl	na	na	(d) (c)182	(d)116	na	35
Mineral sands							43

(a) At 30 September 1977
(b) Changes affected by major classification of resources during period.
(c) Demonstrated resources only.
(d) At 31 December 1986.
(f) See Mineral sands.
(g) Recoverable.

Economic prospects for the Australian and international economies

L P O'Mara, L I Hogan & M G Kirby, ABARE

The sharp fall in world share market prices in October 1987 has added an additional element of uncertainty to the short term outlook for the Australian and world economies. On balance, while the rate of economic growth in 1988 and 1989 is expected to be lower than had been expected prior to the share market fall, a serious world recession is not anticipated.

Large current account imbalances in Australia and the major world economies have exerted a major influence on the economic policies and performance of these countries in recent years and this is expected to continue to be the case for several more years.

In Australia, the current account deficit peaked at around 6 per cent of gross domestic product (GDP) in 1985-86, compared with a long term average of around 2 per cent. The succession of large current account deficits during the 1980s, financed primarily by overseas borrowing rather than by inflows of equity capital, contributed to a rapid rise in Australia's overseas debt relative to GDP.

If Australia's debt to GDP ratio is to be stabilised around present levels or reduced, the current account deficit will need to be reduced from around 4 per cent of GDP in 1987-88 to around 2 per cent or less over the next few years. To that end, continuing restraint on domestic expenditure will be crucial, particularly in areas other than private investment. Provided that such restraint is forthcoming to the satisfaction of financial markets, the real value of the Australian dollar could trend upward over the next few years from its present near record low level, and interest rates could decline further.

Large current account imbalances have also been a feature of the major world economies, with the United States having a large deficit and Japan and West Germany large surpluses. The United States has also had a large budget deficit during much of the 1980s. The size and persistence of these imbalances has been a major source of concern in world financial markets.

That concern contributed to the recent volatility in share prices on world markets and in the major world exchange rates.

Further significant progress in reducing the US budget deficit, with a consequent lowering of real interest rates around the world, holds out the best hope of securing reasonable economic growth over the medium term. In the short term, such a policy may have some adverse impact on world economic activity, but this would be lessened if Japan and West Germany adopted temporarily more expansionary policies. The Bureau has assumed such a scenario in preparing its forecasts for the period to 1993. Economic growth in the OECD region is expected to average a little over 2 per cent in 1988 and 1989, before recovering to 3 per cent from 1990 onwards.

If such policy action is not taken and large current account imbalances remain, protectionist pressures may increase in the United States, raising the prospect of retaliatory actions by other countries. Increased worldwide protection would lead to slower economic growth, reduced world trade, lower commodity prices and restricted access to overseas markets, all of which would be detrimental to Australia and other exporters of primary commodities.

Looking over the longer term, to the year 2000, economic growth in the OECD region is assumed to grow at around 3 per cent a year, with Japan slightly above the OECD average at around 3.5 per cent a year. The South-East Asian region is expected to record the fastest growth rate of the world's major regions, averaging around 5.5 per cent a year. While there is much uncertainty about the prospective growth rate in China, present indications are that a rate in excess of 6 per cent a year is likely.

Figure 1: STOCK MARKET PRICE MOVEMENTS

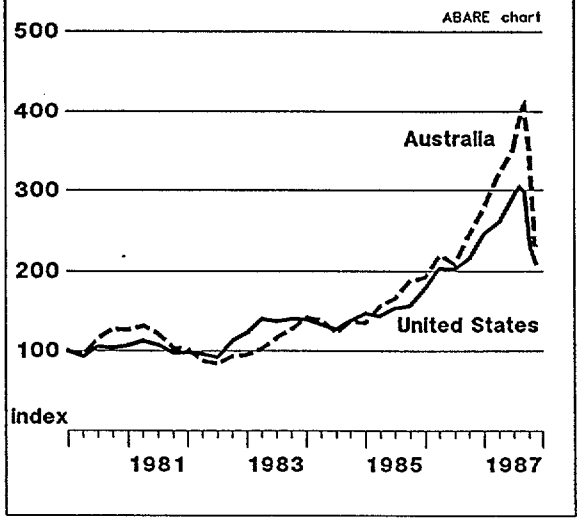


Figure 2: AUSTRALIAN CURRENT ACCOUNT DEFICIT AS A SHARE OF GROSS DOMESTIC PRODUCT

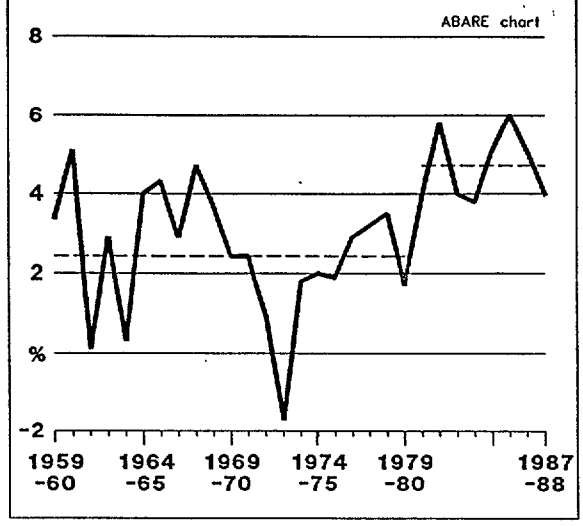


Figure 3: AUSTRALIA'S TERMS OF TRADE

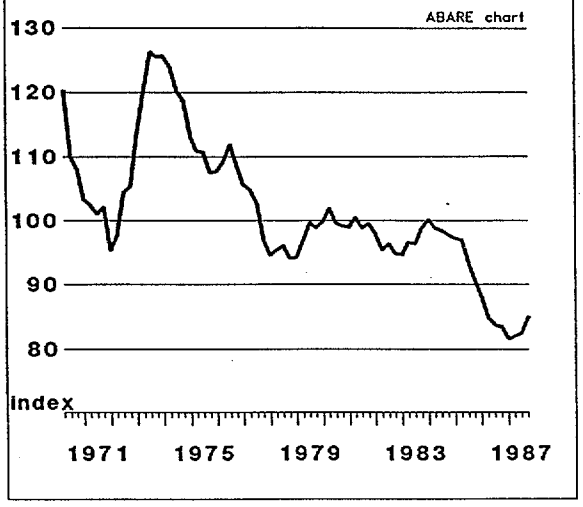


Figure 4: RATIO OF NET FOREIGN DEBT TO GDP AND DEBT SERVICE RATIO

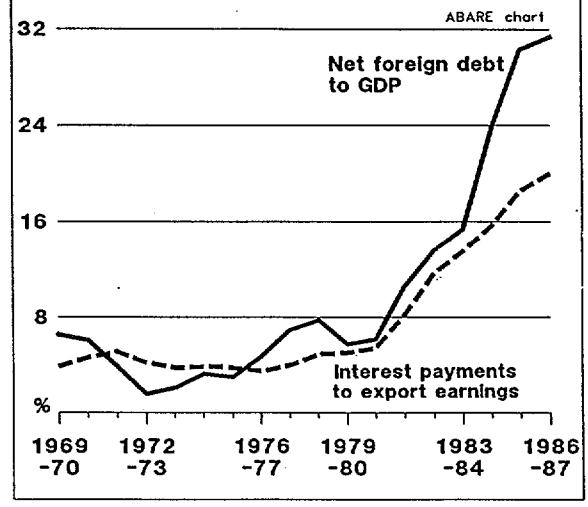


Figure 5: DIVIDEND SHARE YIELDS

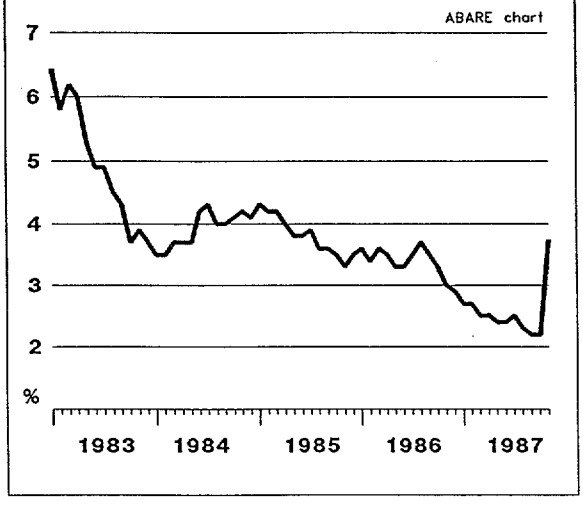


Figure 6: AUSTRALIAN REAL EXCHANGE RATE

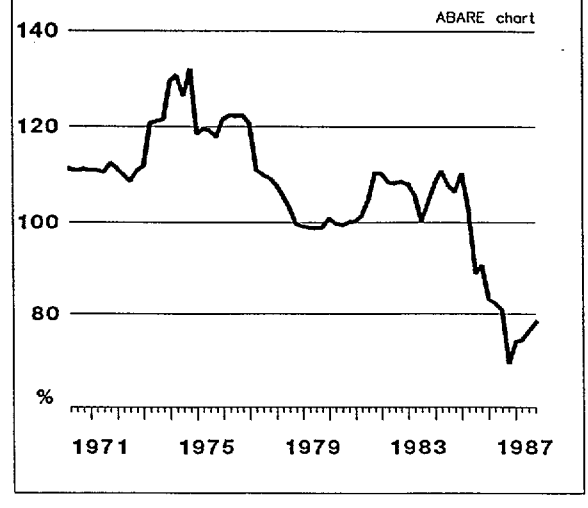


Figure 7: AUSTRALIAN INTEREST RATES: 90-day bank bill

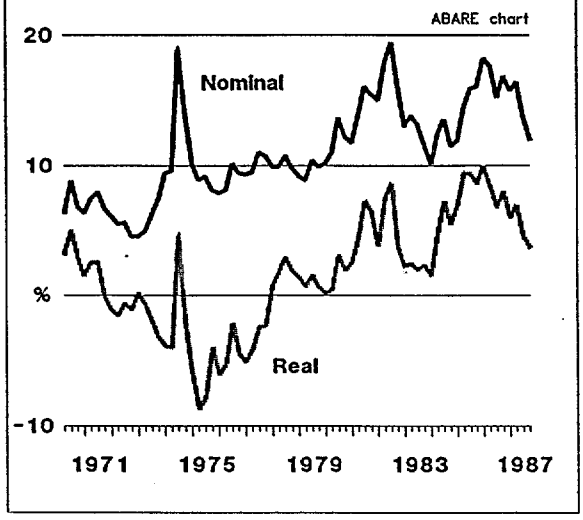


Figure 8: EQUITY AND DEBT FINANCING IN AUSTRALIA'S CAPITAL INFLOW

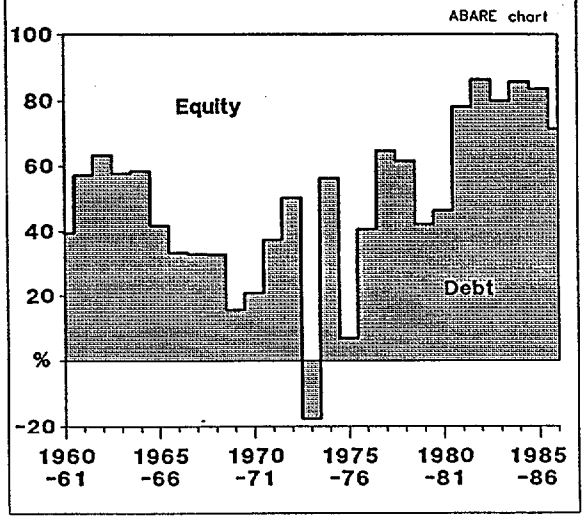


Figure 9: CURRENT ACCOUNT BALANCES

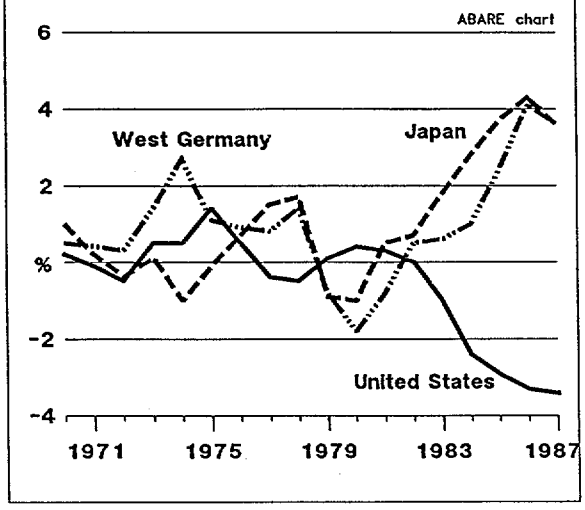


Figure 10: MAJOR REAL EXCHANGE RATES

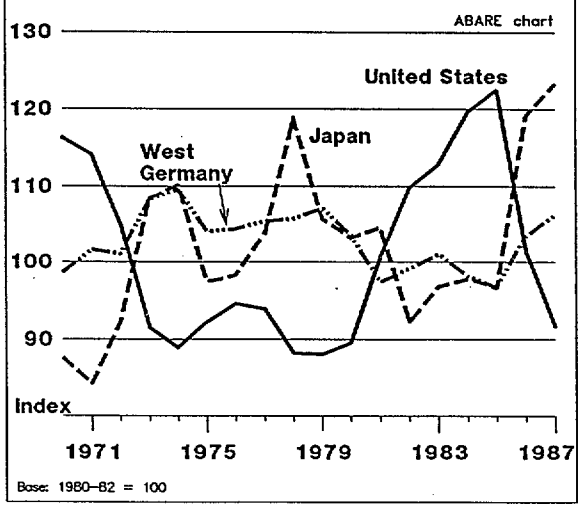


Figure 11: GENERAL GOVERNMENT FISCAL BALANCE AS A PROPORTION OF GROSS NATIONAL PRODUCT

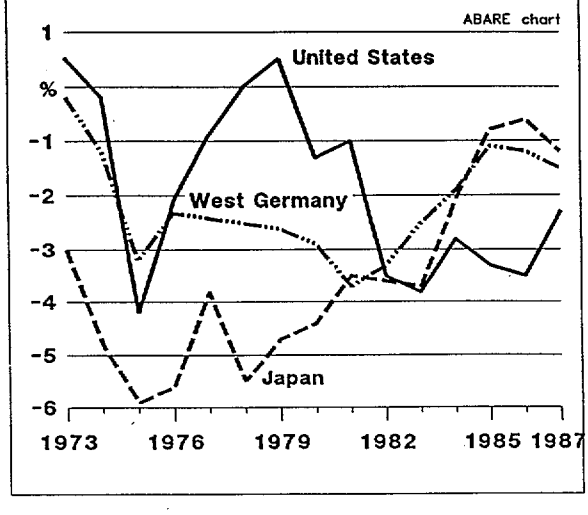
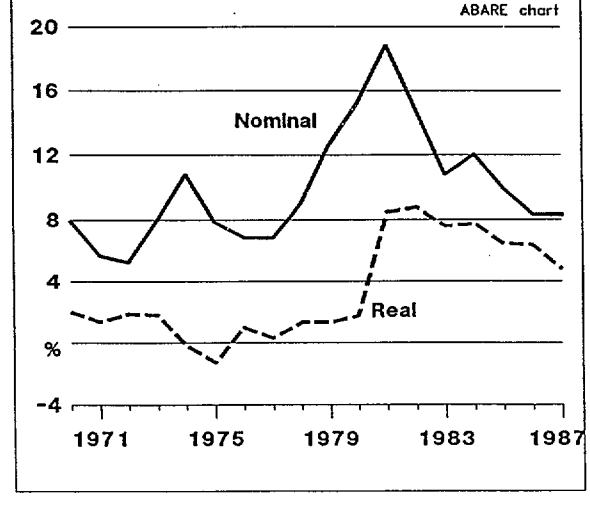


Figure 12: US REAL AND NOMINAL INTEREST RATES



Changing demand for minerals in north Asia

D J Porter, W A Nagle & B P Jones, ABARE

The economies of the north Asian region will continue to undergo significant changes during the rest of this century. Consequent changes in the industrial structures of these economies will have important implications for the Australian resource sector.

The aim of this paper is to examine the changing demands for minerals and metals in the north Asian region and to assess the effects of these changes on Australia's resource export potential. The analysis involved an examination of north Asian trends in metal consumption and economic growth, a review of the structure of the relevant economies and the composition of their industrial production and exports.

Japan has been the world's largest single importer of minerals and metals since the mid-1970's, and has been the largest single destination for Australian mineral resource exports since the 1960s. In recent years the Republic of Korea, Taiwan and China have rapidly increased their share of world mineral resource trade and also of Australian exports. Australian mineral resource exports now have a clear Asian, and particularly north Asian, orientation.

Japan has undergone rapid industrial expansion over the past 25 years, largely driven by export growth. However, the nature of Japanese industry has changed over this period, as comparative advantages have been recognised and market opportunities vigorously pursued. This has produced changes in both the export and import mix.

Further changes in the sectoral composition of Japanese industry and its import requirements are expected. To the year 2000, metal intensive industries are expected to decline, while technology intensive and higher value-added industries are expected to expand. Imports of raw materials will decline, but increasingly Japan will import processed and finished products. Regardless of the trend to relocating substantial manufacturing capacity off-shore, Japan will not 'deindustrialise' completely and will remain the dominant market for raw materials in north Asia.

The Republic of Korea and Taiwan are likely to continue to benefit directly from Japan's industrial evolution, both from the relocation of industry to within these countries and from seizing the market opportunities provided by Japan shifting its export orientation to other products. Continuation of rapid

growth in metals intensive industries in both countries is expected until at least the late 1990s, resulting in strong growth in imports of minerals and metals.

Chinese economic growth for the remainder of this century is also expected to remain strong. While China reportedly has large reserves of many minerals and metals, its comparative advantage in international trade in recent years appears to be in labour intensive industrial and agricultural goods rather than in capital intensive activities such as mining. Given this comparative advantage, its factor endowments, economic policies and constraints, the likelihood is that China will focus its efforts on the higher stages of metal processing and import its expected raw materials shortfalls in the period to 2000 at least. This expected widening of the gap between domestic demand and supply of metals and minerals in China is likely to become the basis for substantial market opportunities for Australia in future years.

Overall, Japanese structural adjustment will see some demand for minerals and metals lost, but continued growth in the Republic of Korea and Taiwan and the expected mineral and metals deficit in China will provide additional mineral demand in the region. For Australia to maintain regional market share in the face of declining sales to Japan it must accept the challenge and compete effectively with other potential supplies for the emerging markets.

To the year 2000, the outlook for mineral demand in north Asia and for Australian mineral exports to the region continues to be favourable.

Minerals processing in Australia

K S Huggan, ABARE

Australia undertakes a significant amount of mineral processing. This activity is largely underpinned by Australia's factor endowments and institutional characteristics, including access to large, high quality reserves of raw material, relatively low cost energy supplies, relatively low environmental and capital risk, established economic infrastructure and stable socio-political structures.

However, the prospects of the range of mineral processing activities undertaken in Australia vary widely with regard to their potential to contribute to economic growth and the degree to which this potential has been realised. The scope for mineral processing (as well as other export orientated activities) to contribute to sustaining economic growth has been brought more sharply into focus by changing economic circumstances in Australia and, in particular, by the deterioration in Australia's current account deficit.

Important in this context is the potential role of Australia as a supplier of processed minerals to the Asia-Pacific region, particularly as this region is expected to maintain its high economic growth rates while undergoing significant structural adjustment. The comparative advantage of the dominant Japanese economy is moving away from mineral processing, and Australia is well placed to enhance its role as a supplier of processed minerals to the region. These opportunities will, however, need to be grasped in competition with other countries, including some in the Asian region.

The consideration of location when assessing Australia's prospects for additional minerals processing necessarily focuses on Australia's comparative advantage in undertaking such activities. As a major raw materials supplier, our underlying comparative advantage in processing per se is related primarily to the transport cost savings associated with reducing volumes of raw material prior to export. However, marketing processed products from a location remote from centres of demand raises problems (costs) which tend to erode such transport cost advantages. It is

important to accept that comparative advantage is determined by the cumulative effect of positive and negative factors, extending from raw material sourcing right through to the point of final use.

Estimating Australia's net advantage from location for any export industry is difficult. There has, for example, been some concern expressed by industry that construction costs in Australia constitute a significant deterrent to undertaking mineral processing activity in Australia. Comparison of international construction costs for aluminium smelters suggests that Australia is quite competitive in this area. Data limitations preclude assessment of whether this conclusion holds true for other mineral processing industries.

It is clear that there are many factors which combine to determine the location of processing activities. A case study of plant location for titanium dioxide manufacture has been used to illustrate the influence of such factors. The overall theme is that Australia cannot expect its apparent advantages in mineral processing in particular or export activities in general to confer it naturally with increased market share for processed minerals. Comparative advantage is not a static or passive concept; the critical marketing dimension of exporting, for example, can become a positive or negative factor, according to whether planning and effort are effective and sustained. To a degree, processing may have 'fallen in the gap' between sectors. Processing requires miners to develop more of the production and marketing skills required of manufacturers and vice versa.

The main points to emerge are that strengthening the commercial relationships necessary for overseas marketing and distribution and joint production ventures with overseas partners as well as improving technology and productivity, are of major importance if Australia's mineral processing is to increase its contribution to Australia's economic growth.

Consideration of the prospects for minerals processing is by no means a new idea - somewhat intuitive views of the extent of our comparative advantage in taking abundant raw materials further down the processing chain have attracted attention over many years. Progress in broadening and accelerating this sector has been surprisingly uneven and slow relative to expectations.

It falls to government policy makers and corporate decision makers alike to give the minerals processing sector well directed and, importantly, sustained commitment if the sector is to realise its full potential.

It is also apparent that the conclusions of yesteryear need to be constantly reassessed as changes continue to occur in many factors affecting project feasibility. For instance, changes in a wide range of government policies, exchange rates, the patterns of international production and trade, attitudes, skills and performance in labour markets make a big difference.

It is clear that the nature of our claimed advantages in processing activities must be nurtured and reviewed realistically and consistent efforts should be made to address policies and cost structures which create unintended impediments to a sector which offers considerable potential for growth.

Notes

Iron ore outlook & future development

C J S Renwick, Hamersley Iron Pty Ltd

The bulk of Australia's iron ore exports are made from the Pilbara region of Western Australia (Hamersley Iron, Mt Newman Mining Co, Robe River Iron Associates, Goldsworthy Mining), with small quantities being exported from Yampi Sound in WA (BHP), Whyalla in South Australia (BHP) and from Savage River in Tasmania (Savage River Mines).

Prior to the 1960s, there was no Australian iron ore export industry. The Pilbara, in 1965, was home only to a handful of isolated cattle stations and small coastal towns servicing the needs of these stations. Twenty years later, in 1985, nine new towns had been built in the Pilbara region to service the iron ore export industry and Australian iron ore exports totalled 85 million tonnes - earning A$2.15 billion for Australia in that year (6.6% of total Australian export earnings). Today Australia is the world's second largest exporter of iron ore after Brazil.

The tremendous growth in iron ore exports came about through the equally spectacular growth of the Japanese iron and steel industry in the late 1960s and early 1970s. As Japanese ore demand plateaued and declined, it was replaced in the late 1970s and 1980s by growth in iron ore demand from Korea, Taiwan and The People's Republic of China. Australia gained a dominant share in all of these markets through a combination of: favourable geographical location; a preparedness to invest in large-scale mines, railways and ports to service the needs of our customers, active market development campaigns - including providing technical assistance to customers; and large reserves of good quality ore.

In 1985, Japan, Korea, Taiwan and The People's Republic of China absorbed about 80% of Australia's iron ore exports, while Australia's market share in each country, was, respectively, Japan-45%, Korea-40%, Taiwan-60%, PRC-75%. In total, Australian iron ore exports captured about 47% of the combined import requirement of these countries in 1985.

Although the growth in Australian iron ore exports has been impressive, the figures quoted above must be placed in perspective. Australian iron ore exports peaked at 83.7 Mt in 1974 and did not exceed this figure until 1984. The reasons for this are complex but include: slow growth in world steel consumption - due to low economic growth rates - affecting world iron ore demand; more efficient use of steel - reducing steel requirements; more efficient production of steel - requiring fewer units of iron ore per unit of finished steel produced; and substitution of steel by other materials (eg aluminium, concrete). The overall result of these factors has been an

essentially static world demand for iron ore since the late 1970s. Within the global picture, however, there have been significant changes in the regional breakdown of steel demand and supply, with growth in the developing countries partly offsetting demand declines in the industrialised countries of the world.

On the iron ore supply side, Australia was not alone in expanding capacity to meet actual demand in the 1960s and the early 1970s and the anticipated (but not realised) demand in the late 1970s and 1980s. Brazil, India and South Africa developed new export iron ore mines in the 1970s and 1980s to meet the expected increases in world traded iron ore demand, joining already well established export iron ore mines in Canada, West Africa, Sweden, Chile, Peru and Venezuela. Many of these mines - both existing and newly established - were originally designed to supply the iron ore requirements of Europe, the USA or their own domestic steel industries. However, with the stagnation, or even decline in iron ore demand in these markets, iron ore producers, worldwide, increasingly concentrated their sales efforts in the Asian region.

Iron ore is a bulk, low value commodity. Mine profitability is achieved by ensuring economies of scale through high production volumes. From the late 1970s it became apparent that traded iron ore production capacity exceeded demand. This situation was compounded by high exit costs and pressure on some producers to maintain ore exports at virtually any cost to either maintain employment or to generate foreign exchange earnings for their country. Producers worldwide, together with the world steel industry, continued to believe that the stagnation in steel consumption (and ore demand) was a temporary pause in growth only. Competition for markets intensified further in the mid-1980s as Brazil's Carajas mine - high volume, high grade, export oriented - was commissioned. The result has been declining iron ore prices since the early 1980s, and, for Australian producers, strong attacks on our previously pre-eminent position in Asian markets.

This is best illustrated by the case of Japan, where Australian market share fell from 48.5% in Japanese Fiscal Year 1984 to just over 40% in JFY1986 due to this intense competition, particularly from India. In addition, new suppliers entered the Japanese market - aided by weak freight rates which improved substantially the competitiveness of more distant suppliers - such as Sweden, Venezuela and Canada.

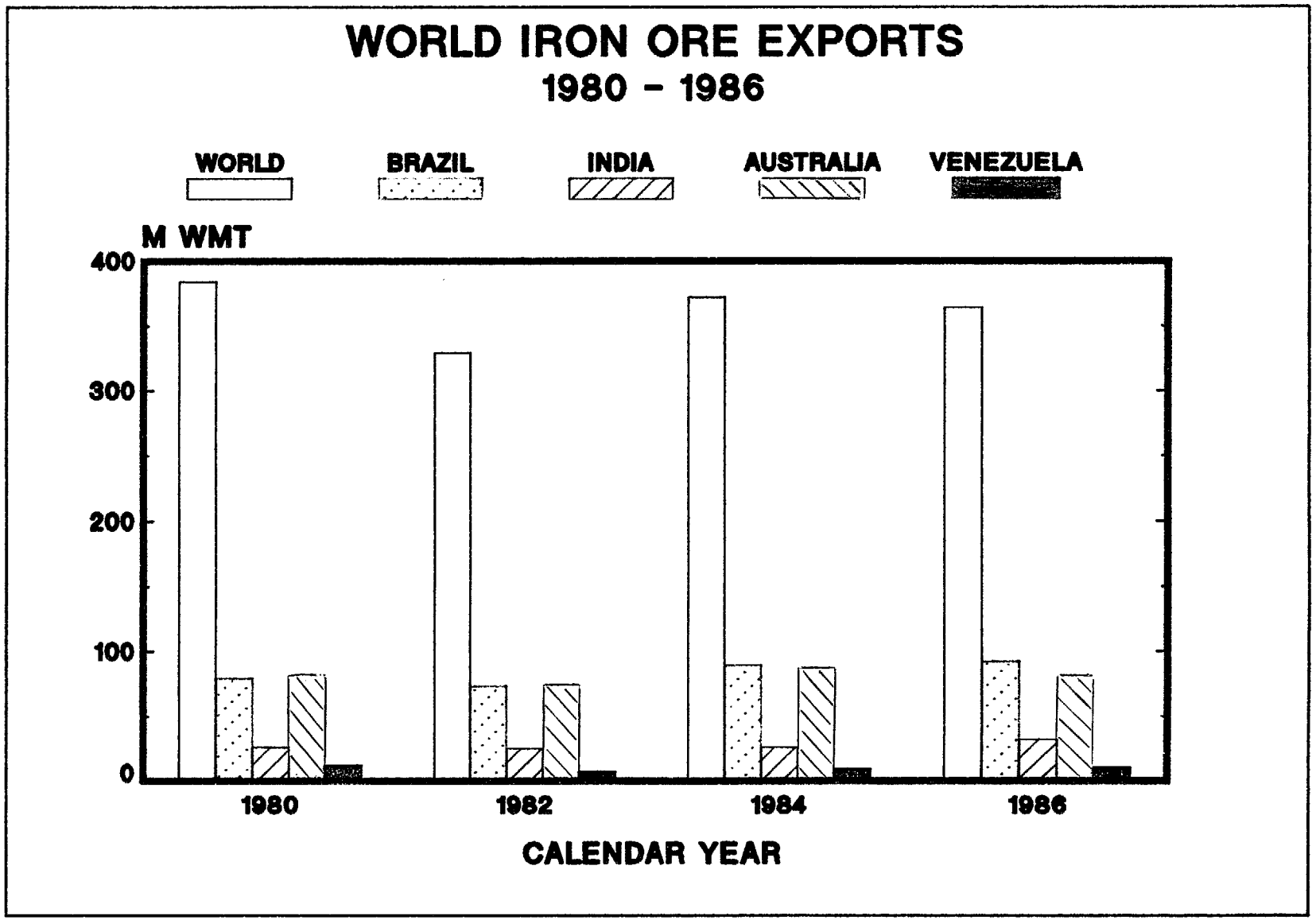
Australian suppliers have reacted strongly to these encroachments on our traditional markets and Australia's market share in Japan in JFY1988 should move back towards our more traditional market share levels. It would appear, however, that iron ore supplying countries, such as Australia, can no longer expect, as a right, a fixed percentage of a particular iron ore market. The

iron ore market today is fiercely competitive. For Australian ore exporters to succeed in the current (and likely future) market environment we must excel in each of cost, service, responsiveness to customer needs, quality control and reliability of supply - as well as maintaining an understanding of our customers' bilateral and multilateral trading considerations.

Australian iron ore producers and their work forces have responded to the intensification of competition in a number of ways: developing new markets; reducing costs and seeking productivity improvements in the work place; rationalising operations and changing organisation structures to meet more effectively the demands of the marketplace.

The Australian iron ore industry is now more productive and cost efficient than it has ever been. Accordingly the industry is in a strong position to protect current markets and to develop new markets. It would be wrong however, to expect significant market growth in iron ore over the course of 1988 or for the remainder of the decade.

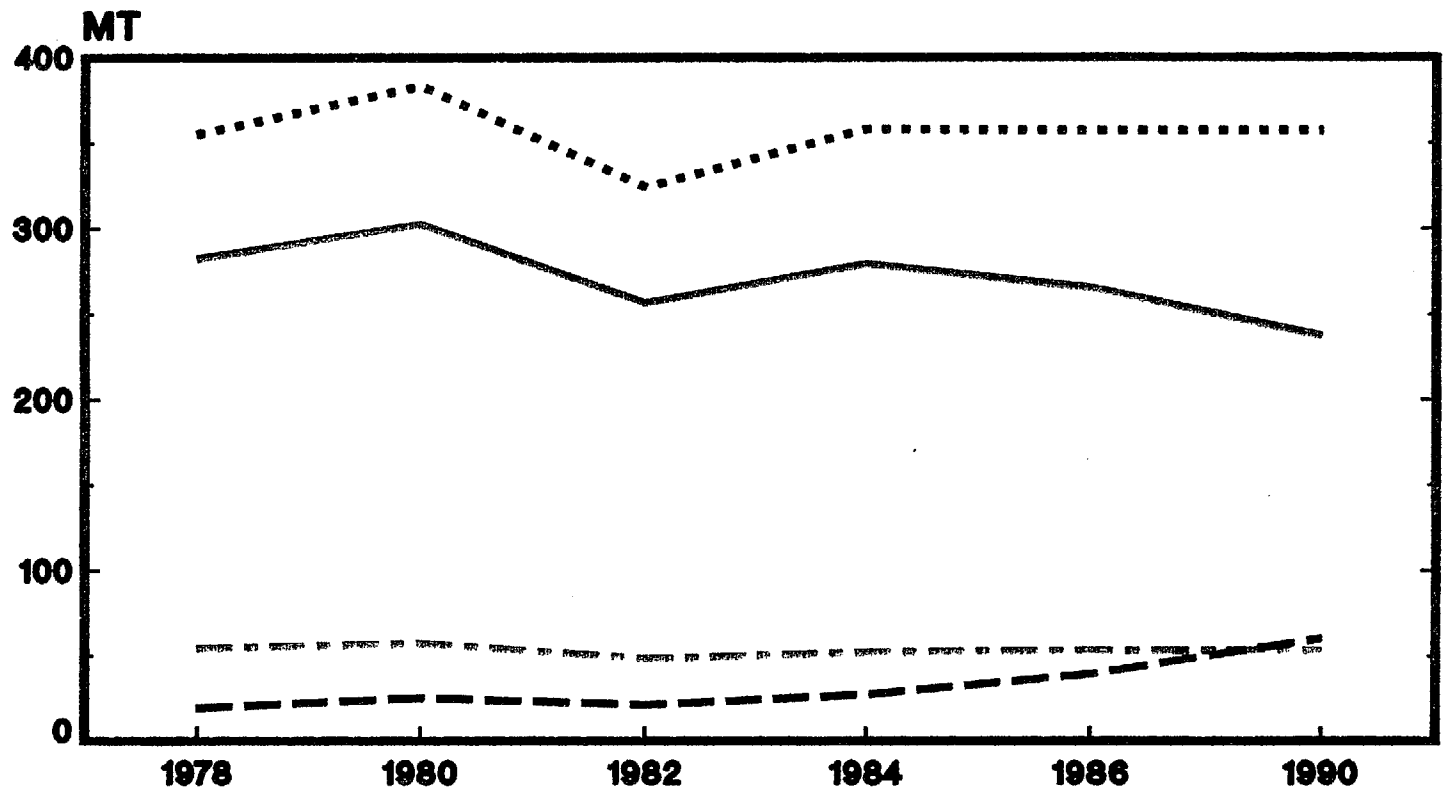
Competition will remain strong and Australian ore producers will have to remain flexible in meeting the requirements of customers and the threats of competitors, in what is now largely a mature market.


WORLD IRON ORE EXPORTS
1980 - 1986
WORLD
BRAZIL
INDIA
AUSTRALIA
VENEZUELA
M WMT
400
300
200
100
0
1980
1982
1984
1986
CALENDAR YEAR

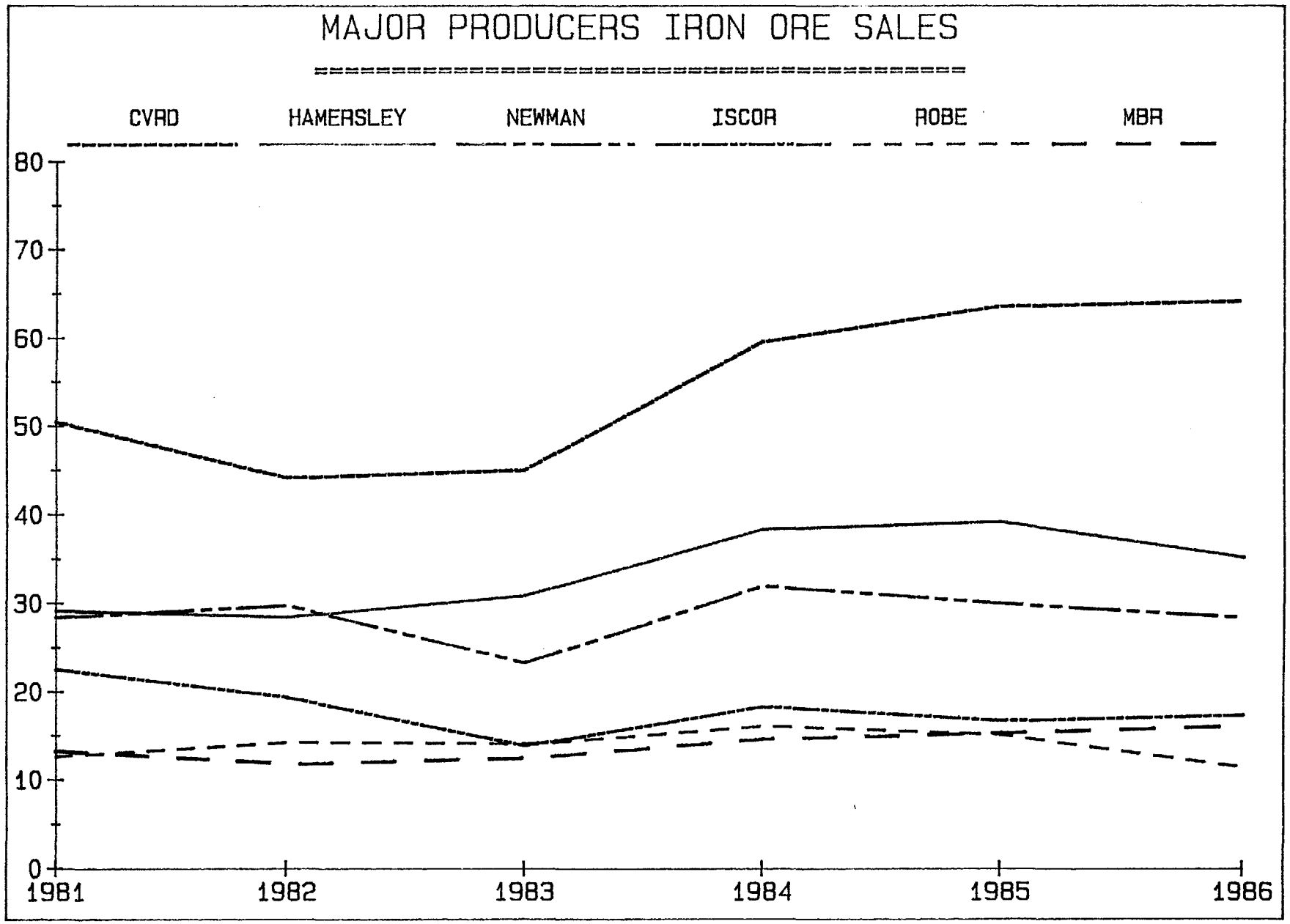
SOURCE:IISI

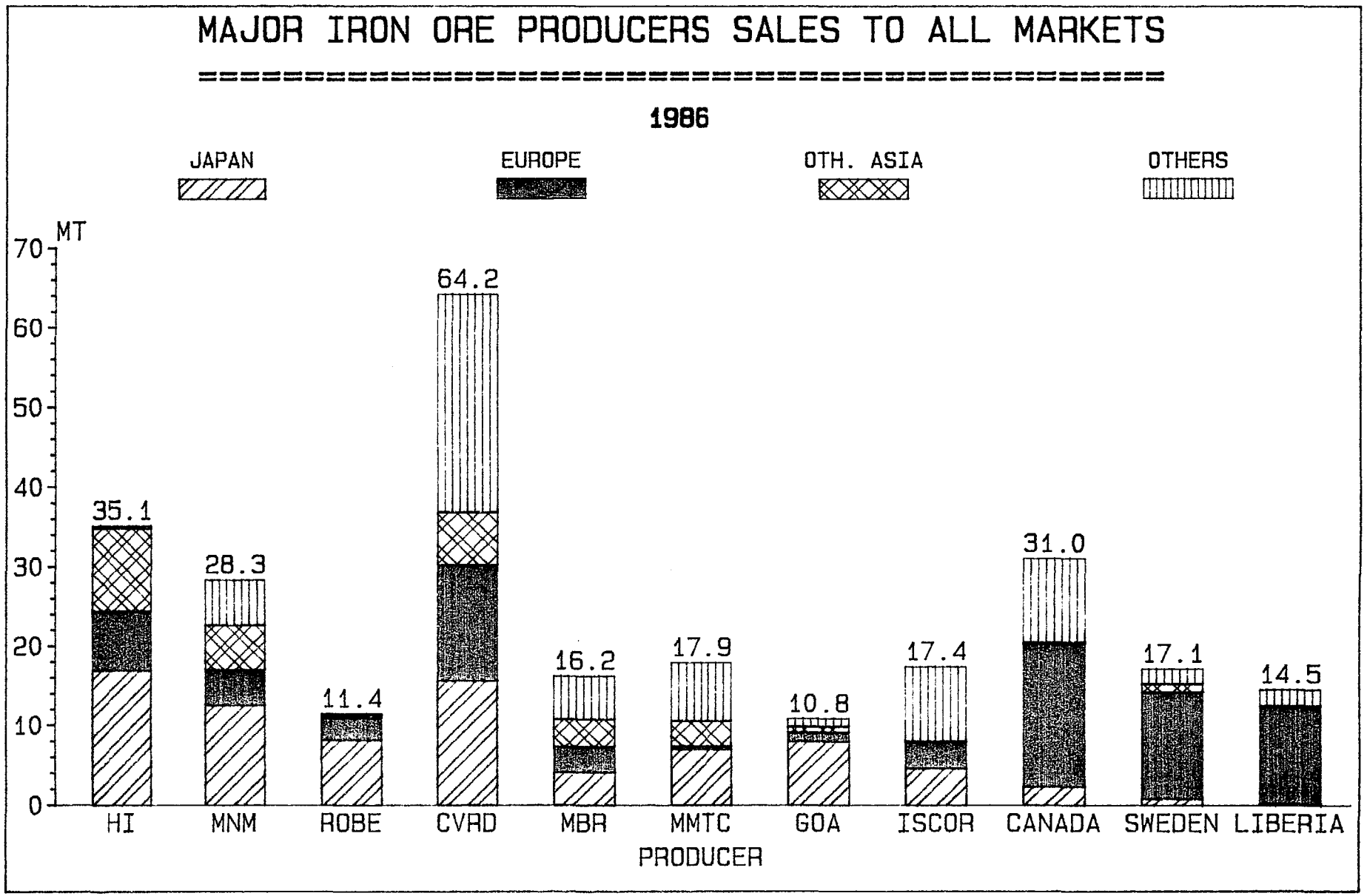
WORLD IRON ORE IMPORTS

1978 - 1990



SOURCE: ABS,FORECAST HAMERSLEY


MAJOR PRODUCERS IRON ORE SALES
CVRD
HAMERSLEY
NEWMAN
ISCOR
ROBE
MBR
80
70
60
50
40
30
20
10
0
1981
1982
1983
1984
1985
1986


MAJOR IRON ORE PRODUCERS SALES TO ALL MARKETS
1986
JAPAN
EUROPE
OTH. ASIA
OTHERS
MT
70
60
50
40
30
20
10
0
35.1
28.3
11.4
64.2
16.2
17.9
10.8
17.4
31.0
17.1
14.5
HI
MNM
ROBE
CVRD
MBR
MMTC
GOA
ISCOR
CANADA
SWEDEN
LIBERIA
PRODUCER

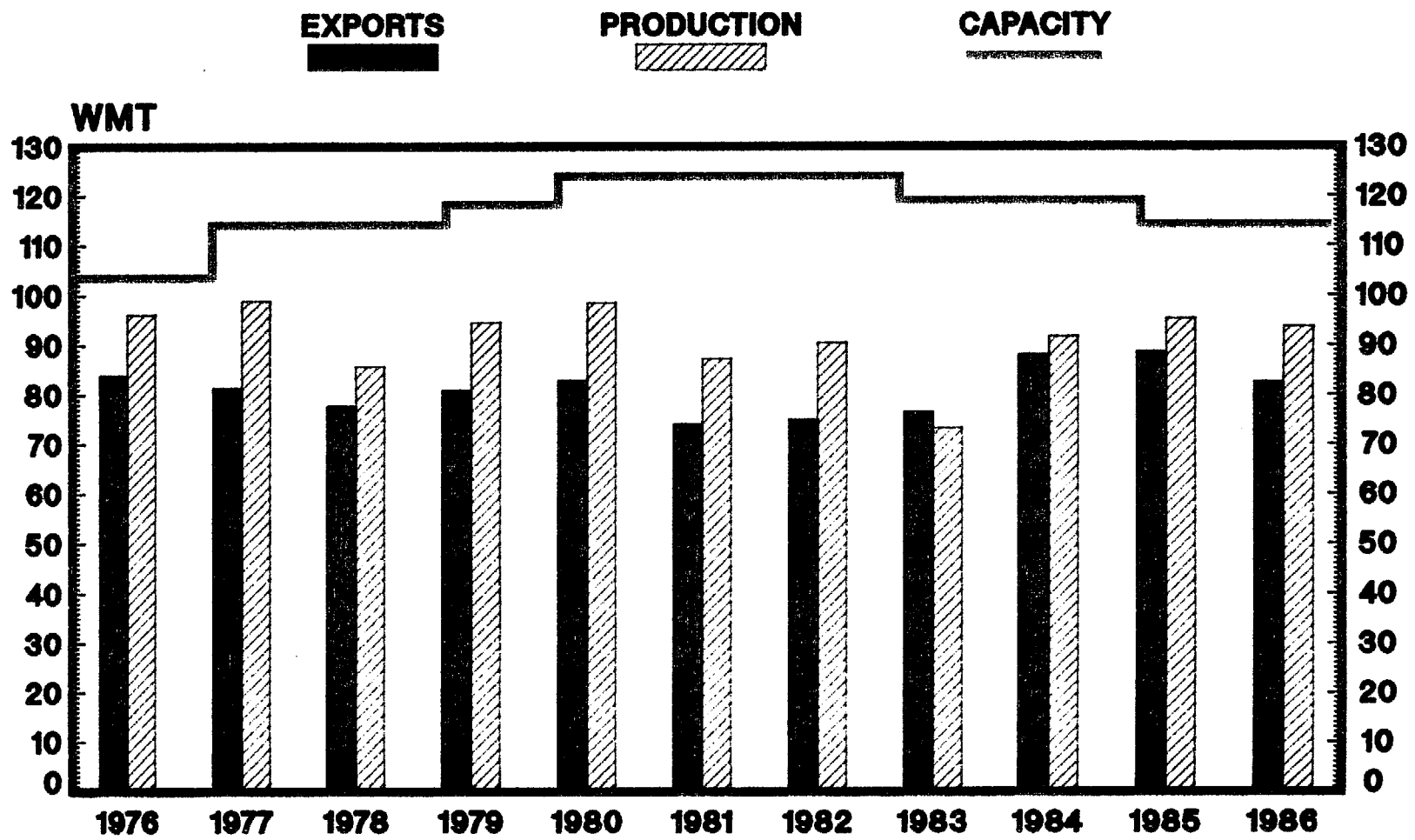
AUSTRALIAN IRON ORE EXPORTS BY MARKET (%)

JAPAN
EUROPE
CHINA
KOREA
TAIWAN

	1980	1982	1984	1986	1988
JAPAN	73	73	68	59	55
EUROPE	13	15	18	19	20
CHINA	7	3	5	11	11
KOREA	5	6	6	6	8
TAIWAN	2	3	3	4	6
OTHER	-	-	-	1	-

SOURCE: ABS,HAMERSLEY FORECAST

AUSTRALIAN IRON ORE
CAPACITY, PRODUCTION AND EXPORTS



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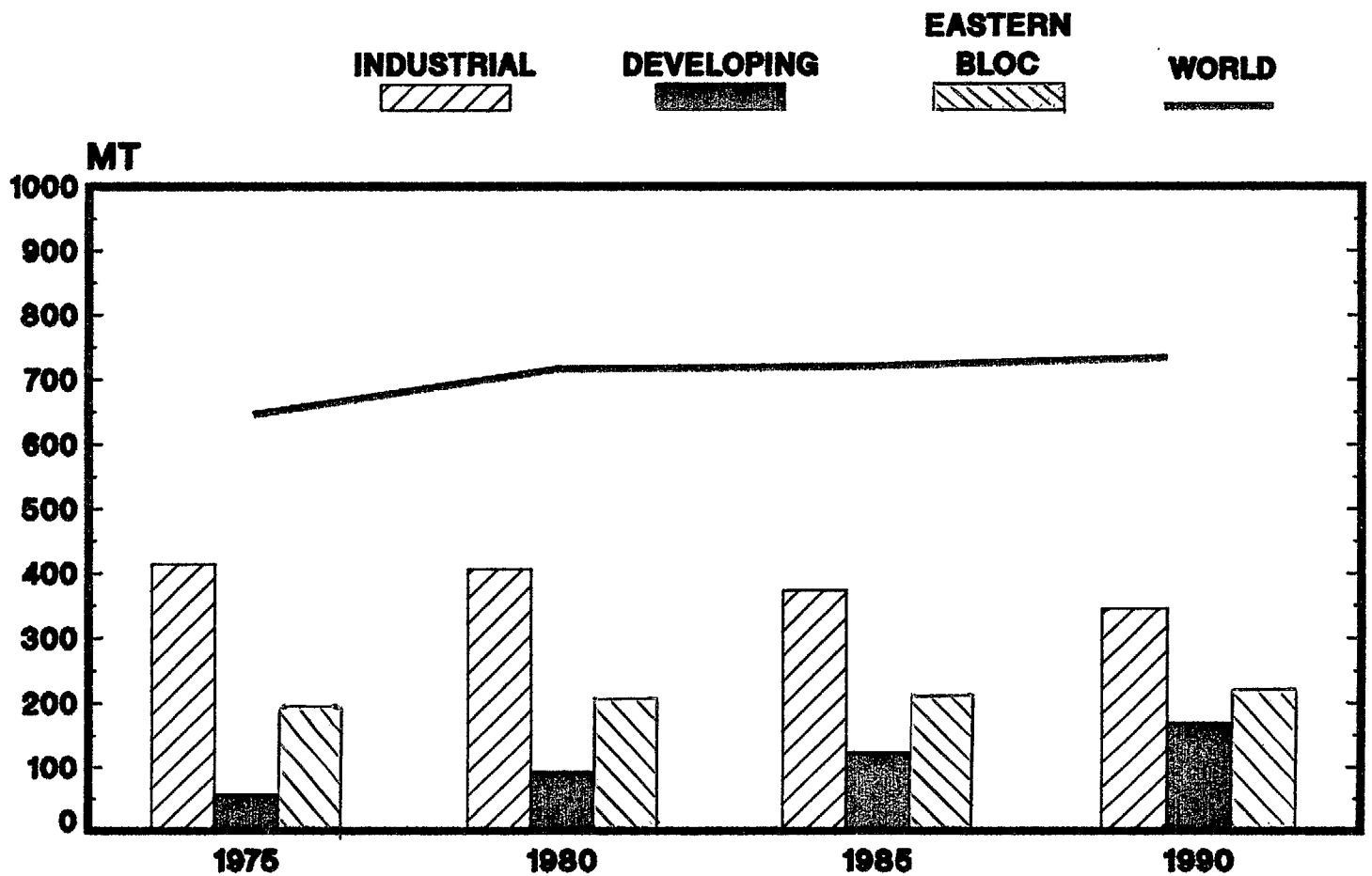
FUTURE STEEL PRODUCTION



SOURCE: IISI

The development of a strategy for the Australian coal industry: the Commonwealth perspective

P Ryan, Department of Primary Industries and Energy

In the face of difficulties which the Australian coal industry has experienced in recent years, the long-term viability of the industry is being examined.

Central to this is the question of government involvement. Overseas, coal industries tend to be highly regulated. Some government involvement is certainly needed for safety in the industry and, in Australia, State Governments perform this role. Is any further government involvement needed? Should the Commonwealth Government be involved, especially given that the States have constitutional responsibility for most of the issues which affect the coal industry?

There is no Commonwealth Government long-term strategy for other mineral industries in Australia. (The exception is uranium mining, in which the Commonwealth is involved because of its political sensitivity.)

Up to now, the Commonwealth Government has favoured a largely hands-off approach to coal mining. Under this system we have seen production, export and employment in the industry increase. In recent years, however, individual investment decisions, which may have seemed rational from an individual company's perspective, have often been disastrous when aggregated. This particularly applies to the opening of new mines.

Despite the industry's past success under limited regulation, the Commonwealth Government is committed to looking at a long-term strategy for the industry. This takes time because of the consultation processes involved.

The Commonwealth has drafted a discussion paper on a long-term strategy. This involved the Commonwealth Department of Primary Industries and Energy first analysing and assessing the industry's situation. The Department also had to consult other agencies with an interest in the industry to assess implications of strategy options. This type of consultation was necessary to ensure that the views and positions of all directly and indirectly interested players were understood. It is also the main reason for the length of time Government takes to make a decision.

Ministers then had to assess the paper's conclusions. Major questions they had to ask are 'Should general taxes be used for this specific industry' and 'What will be the benefits for the general public?'

Many issues are involved with developing such a strategy. These include the industry having a common purpose, industrial relations, government charges and controls, conservation of reserves, developing the industry, and marketing.

Following preparation of a draft discussion paper Ministers held bilateral consultations with the employers, States and unions. This was to gain a full appreciation of attitudes to the paper and to allow the Ministers to use an iterative process to develop a strategy. The final strategy (which will not necessarily be an industry consensus document) will then be taken to Cabinet.

This paper will present the issues and processes involved in developing a long term strategy for the Australian coal industry.

The development of a strategy for the Australian coal industry

J B Ritchie, Australian Coal Association

The development of the black coal export industry over the past two decades has been an achievement unsurpassed by any other Australian industry. It has been the premier foreign exchange earner for Australia, earning some $5,500 million per year, but has been overtaken recently by wool. It has grown into a highly sophisticated industry embracing some 50 major companies, including a number of the largest public companies in Australia, with highly developed management, operating, marketing and research skills.

Despite the great financial difficulty the industry is experiencing presently, overall saleable production for domestic and export purposes in the eastern States of Australia continues to increase, rising 5% to 139 million tonnes in 1987.

Australia ranks only seventh as a world black coal- producing nation, yet it is the world's premier exporter. Export volume was again a record in calendar year 1987, increasing by 10% to 101 million tonnes.

The record shows that the world coal export industry has exceeded virtually all of the significant forecasts made during the last decade, including the WOCOL study and those of the International Energy Agency. Australia has performed better than any other exporting country and consolidated its position. Australian exports compare with USA (74 million tonnes), Canada (27 million tonnes), South Africa (40 million tonnes) and China (14 million tonnes). The opportunities for Australia continue to be good with world markets continuing to grow.

It is the companies, through their own efforts, that have developed export markets in over 45 countries in a period when other Australian industries have lamented their inability to penetrate overseas markets. In world terms, the coal industry has been an outstanding achiever.

For survival in the international marketplace we must recognise that other nations will attempt to take advantage of any opportunity to enter that market. In recent years, Colombia and China have become significant competitors adding to world oversupply and correspondingly reduced prices. Other countries, such as Venezuela and Indonesia are also about to compete. Oversupply, together with low energy prices resulting from the sharp fall in oil prices in 1985, has made it increasingly difficult for Australian companies to retain market share and make a reasonable return on investment.

It is for these reasons that the Australian industry has had to undergo the difficult task of re-structuring and of convincing governments and unions that they too have to reduce their demands on the industry. There can be no escape. Future revenue for government and future security of employment can only be achieved if costs are reduced to allow companies to invest for the future. Depreciating equipment must be replaced and new mines developed, not only to replace worked-out mines but also to allow export growth in an expanding world market.

The Australian coal industry can continue its record of achievement if it is given the opportunity to do so, and it is accepted by all parties that it must be a leaner, meaner industry.

The industry is undergoing a revolution in the technology of production. Over 30 underground mines have closed since 1982, all using continuous miner techniques for operation. In NSW 40% of all underground production now comes from 15 longwall faces. In Queensland, t here has been a significant reduction in underground production from the Ipswich field, but underground production is now growing and there will be at least two longwall faces in operation by the end of 1988. This trend will continue.

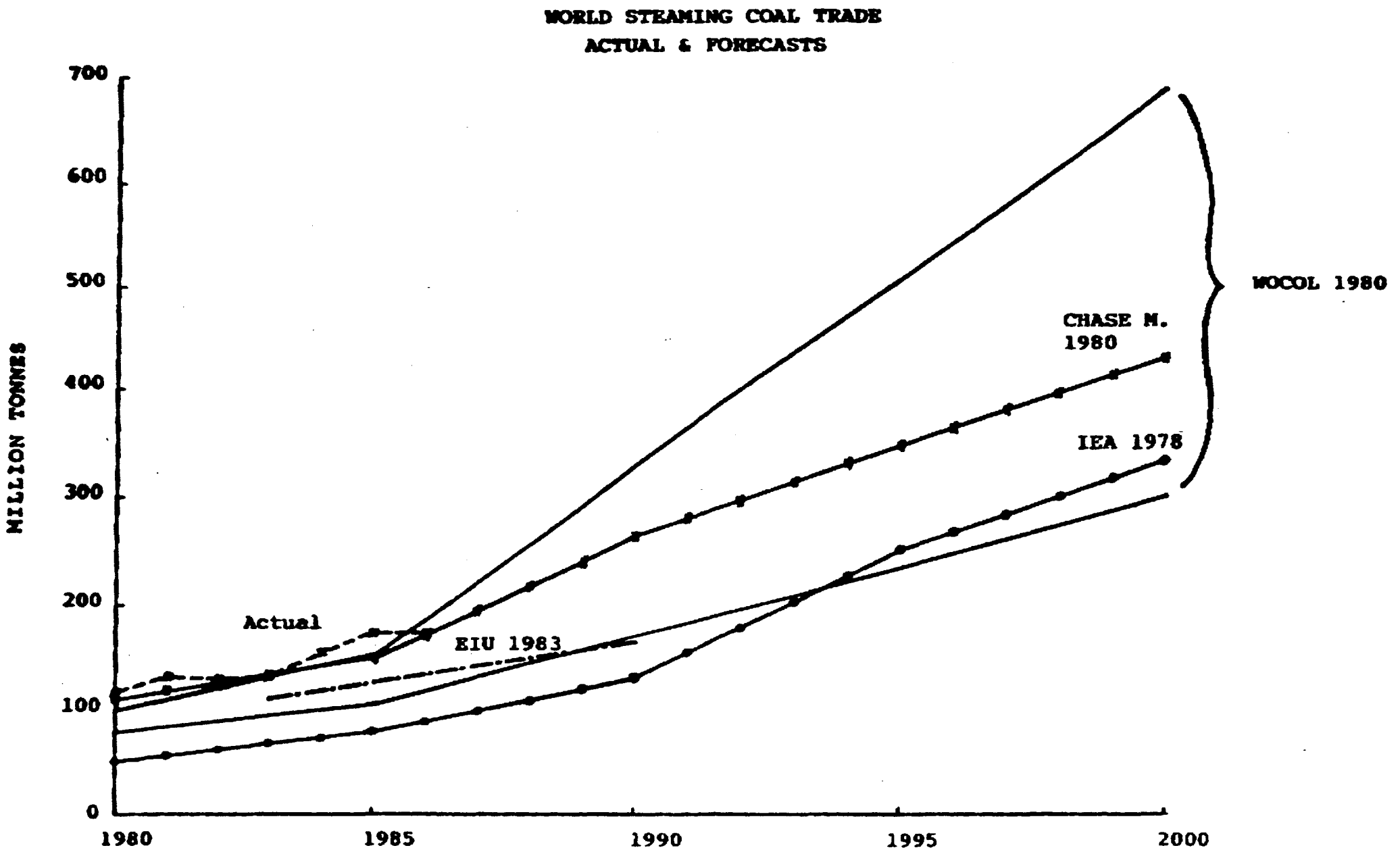
This revolution has taken place in order to make underground mining as cost competitive as open-cut mining. In addition, the introduction of longwall mining in Queensland represents the need to develop deeper coal seams not amenable to open-cut mining.

The impact of these changes on employment in the industry has, as would be expected, been marked. Employment in NSW has fallen by some 2,500 in 20,000 between October 1987 and January 1988.

The introduction of new technology represents a change toward a far more capital intensive underground industry. In addition, the cost pressures on the open-cut industry have not allowed it the luxury of continuing to under-utilise its highly capital intensive equipment. It is for these reasons that the industry must move to continuous working of equipment on a year round basis.

If the industry is allowed to expand without artificial barriers at a rate sufficient to offset productivity improvements then jobs will not decrease. The NSW Coal Association, in a paper to the unions on 29 November 1987 demonstrated that a gap would exist between productive capacity and demand if continuous working was not introduced. Further, taking up that gap would lead to a nett increase in employment. The alternative was uncompetitive companies, steady decline in capacity and loss of jobs. The JCB supported the conclusions in the Association document although it was more conservative in the impact.

There continues to hang over the coal industry the threat of government interference and control in the mistaken belief that a third party can help to resolve differences between unions and employers. A simple comparison between government policies in NSW and Queensland shows the former to be regulation oriented and the latter development-oriented. An investigation of the relative growth of the industries in each State compared with government attitude demonstrates the great danger to Australia of such interference. A much more difficult but disciplined approach is to use the good offices of third parties to assist in increasing understanding of the needs for change in a dynamic industry.


WORLD STEAMING COAL TRADE
ACTUAL & FORECASTS
MILLION TONNES
700
600
500
400
300
200
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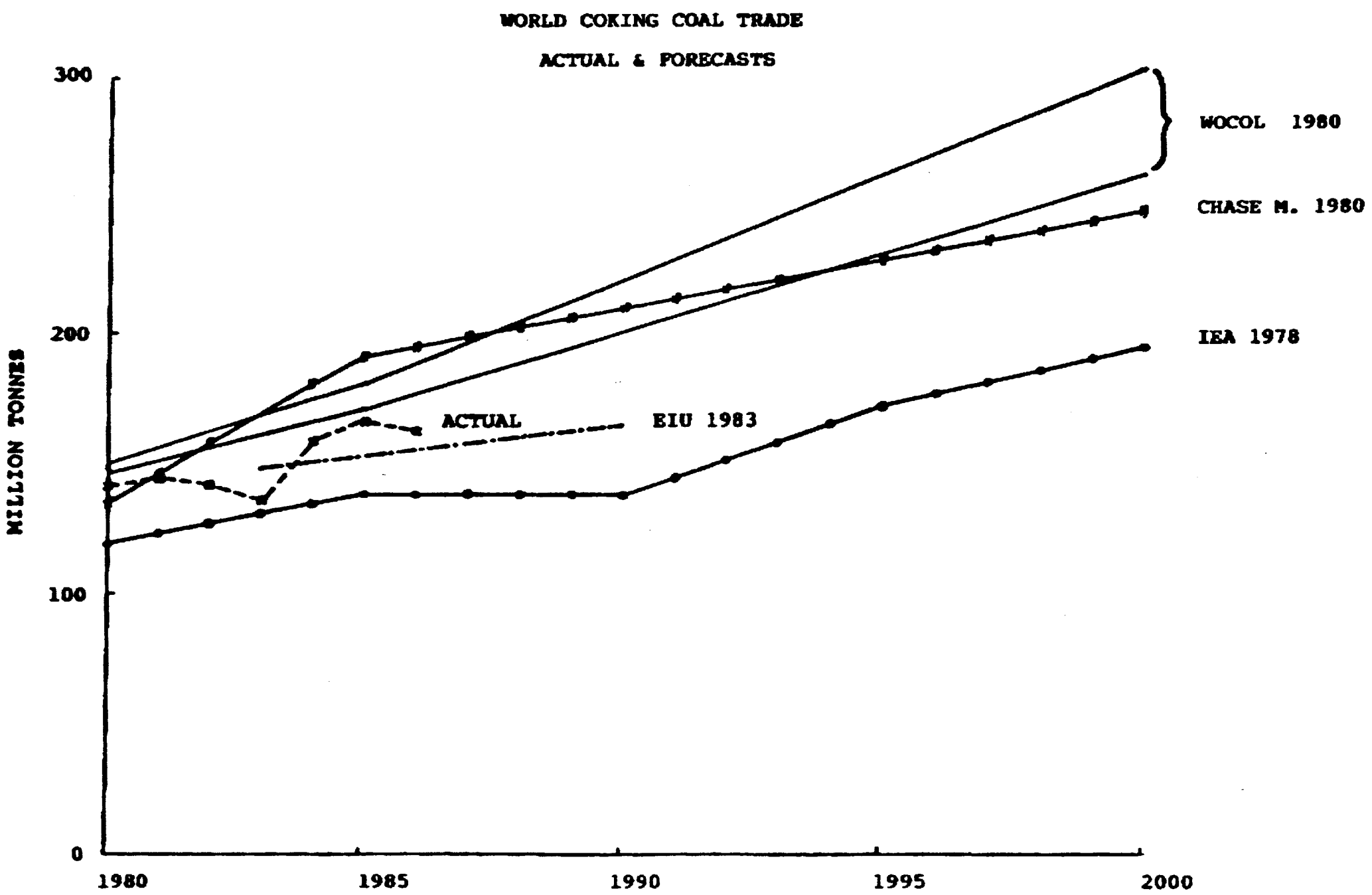
0
1980
1985
1990
1995
2000
Actual
EIU 1983
CHASE M. 1980
IEA 1978
WOCOL 1980


WORLD COKING COAL TRADE
ACTUAL & FORECASTS
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MILLION TONNES
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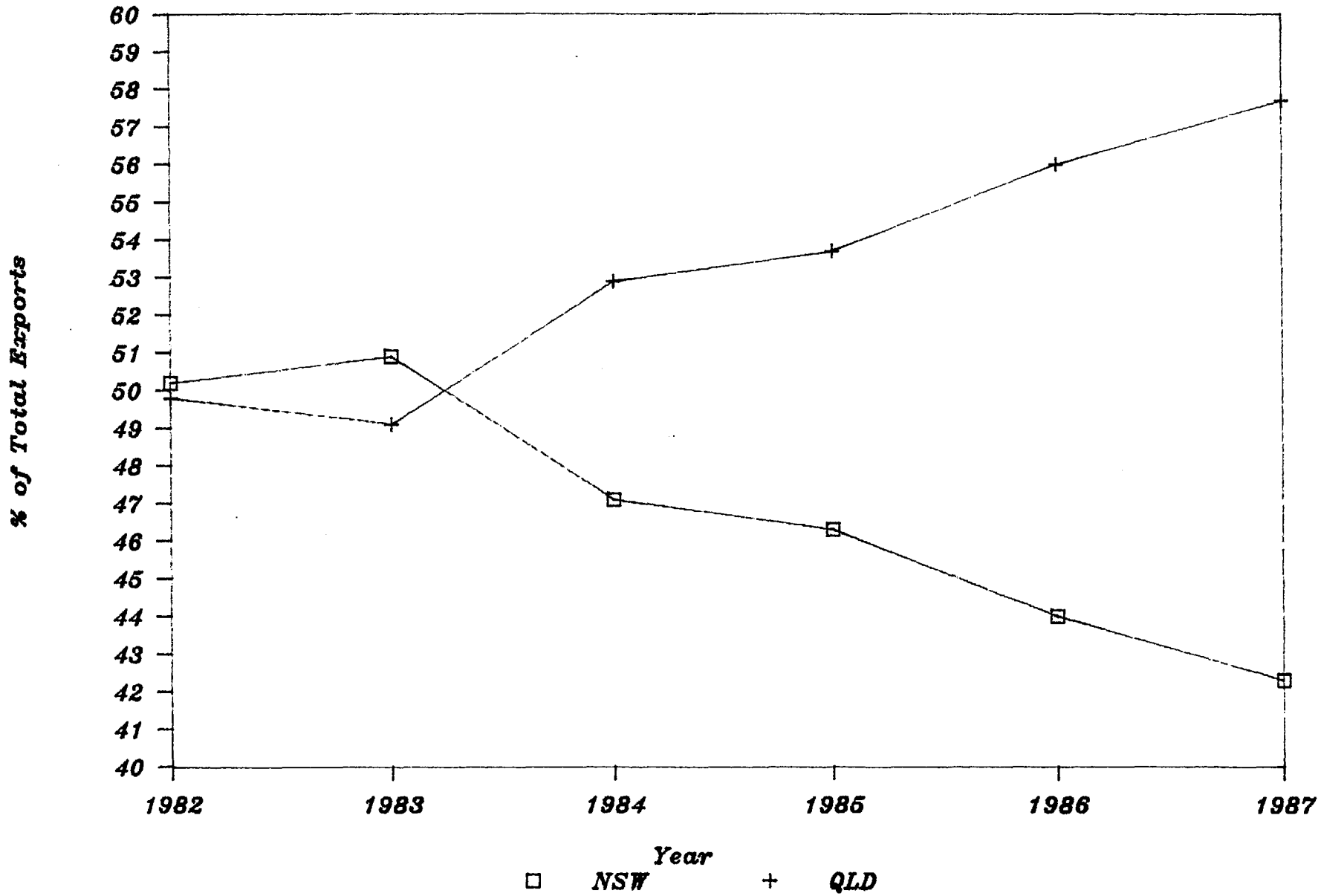
EIU 1983

COAL INDUSTRY SHARE BY STATE



Government strategies and the Australian coal industry: planning of investment in productive capacity: the Miners' Federation View

J Maitland, Miners' Federation of Australia

(No abstract available)

Notes

Resource industry outlook

W D Jarvis & B P Jones, ABARE

Prospects for Australia's mineral and energy sectors are expected to remain good over the years to 2000 according to estimates in the ABARE's publication 'Outlook for Australian Mineral Resource Exports: 1988-2000'. Although there is no evidence to suggest mineral and energy exports will grow at the very rapid rates experienced in the early 1980s, between 1986 and 2000 the sector's export earnings (measured in 1986 dollars) are projected to grow at an average annual rate of 3.4 per cent, somewhat faster than the anticipated growth of the economy (3.1 per cent).

Increasing imports of crude petroleum over the period are likely to moderate the sector's overall contribution to net foreign earnings, but even with this factor taken into account, the net export earnings of the sector are expected to grow in real terms (after allowing for inflation) by 1.8 per cent a year.

The Bureau's report focuses on Australia's most important (by export value) mineral and energy commodities. The intent of the study is to provide an up to date planning framework for those in the corporate sector, related services sectors, or government agencies who are involved in decisions with longer term implications. In particular, the study tries to identify the major medium to long term forces that are likely to affect the sector and to assess their potential influence on world and domestic markets, prices and Australian supply. While it is acknowledged that accurate prediction in these areas of great uncertainties is an impossible goal, an understanding and careful assessment of the implications of the sector's historical trends on its future prospects can still be an important tool for decision makers.

Even though the sector was buffeted by recession, weakening commodity prices, slowly growing markets and fierce competition from other suppliers, it made a major contribution to Australia's net export earnings, from growth of over 9 per cent a year in real terms between 1980 and 1986. This growth was concentrated in a few commodities. Steaming coal, aluminium, gold and net crude oil exports accounted for most of the expansion in the 1980s, just as coking coal, iron ore, nickel and alumina did in the early 1970s. By

1986, the sector's share of total Australian merchandise exports had grown to 48 per cent, from 34 per cent in 1970.

Figures 1 and 2 illustrate the projected export performance of the sector in real value terms and relative to the size of the economy. The contribution of the net crude oil account is highlighted. The strong performance in the period 1986-90 reflects principally three factors: the improvements in prices received for many commodities over the course of the past 15 months; the increases in gold production; and the bringing on stream of some major new sources of mineral and energy supply over the next few years (especially North West Shelf liquefied gas, the Olympic Dam project and the Portland aluminium project).

The growth in export value is projected to slow by the mid-1990s as gold output subsides from its peak around the turn of the decade, partially offsetting growth in sales of LNG, aluminium and coal. The point is well illustrated how the performance of one or two key commodities can influence the sector's contribution to the economy as a whole.

Over the forecast period to 2000, the key performers are expected to be:

GOLD — rapid increases to about 1990, followed by a probable easing of output, but with a high degree of uncertainty concerning levels of activity after the peak.

PETROLEUM/ LNG — expected continuing erosion of crude oil production, partially offset by the establishment, over the 1990s of LNG as a major export earner.

ALUMINA/ ALUMINIUM — strong growth based on an expected improvement in global demand and strong cost competitiveness of Australian producers.

COAL — continued growth in steaming coal exports into a highly competitive but growing market, with slower growth in coking coal.

Overall, the Bureau's assessment of the outlook is conservative. In addition to the potential for new discoveries in areas such as gold and crude petroleum, there are many possible new markets and new products that could

be developed and increases in processing that could occur - but these are difficult to quantify. By contrast, in most areas there is little downside risk as the projections are based on known reserves and reasonably assured markets.

Areas of uncertainty identified in the study include: world economic growth, to which commodity markets are particularly sensitive; commodity price fluctuations, with oil prices noted as having especially important consequences on both oil balances and other energy commodities; market share potential, where conservative assumptions were adopted although the recent performance of several of Australia's major exports has been strong; discoveries, especially in the crude oil, or gold sectors; and new products and technologies, which can have potential positive or negative effects.

Unless world economic conditions deteriorate to levels of performance significantly worse than any experienced in the post-war era, the study concludes that the minerals and energy sector will remain one of the pillars of activity and growth in Australia to the year 2000 and beyond.

Figure 1
VALUE OF MINERAL EXPORTS

Constant 1986 $A billion

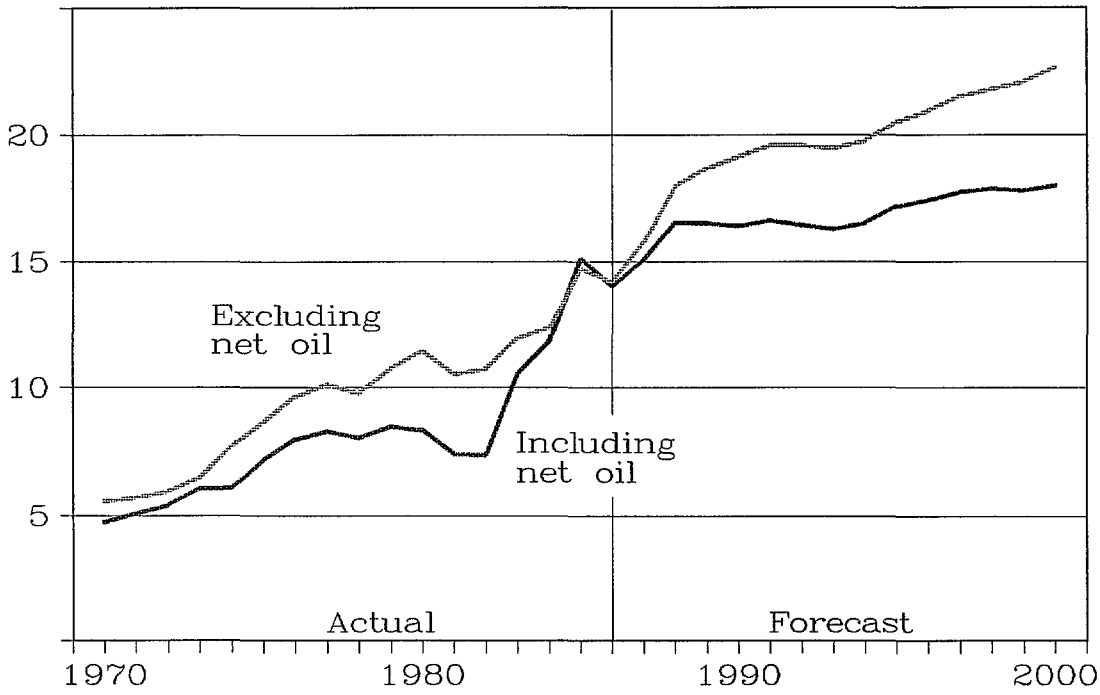
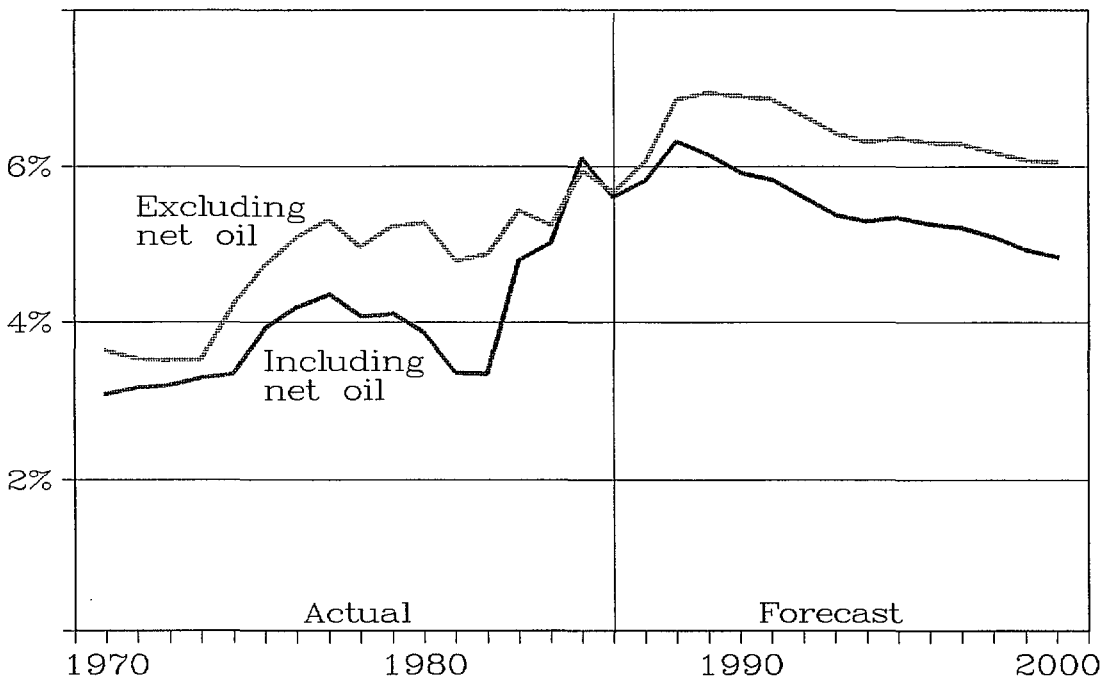


Figure 2
MINERAL EXPORTS AS A PERCENTAGE OF GDP

per cent by value



Queensland mineral exploration and mining: highlights of activity in 1987 and outlook for 1988

J D Sawers, Queensland Department of Mines

The momentum gathered by Queensland's mineral exploration and mining industries in the previous year increased dramatically during 1987, fuelled by Australia's third great gold rush. While coal remained by far the most valuable mineral produced in 1986-87, gold continued to rapidly overhaul copper as the most valuable metal. Approximately one-half of mineral exploration funds expended in the State were allocated to gold which at year's end was the primary mineral sought in over eighty percent of current Authority to Prospect (M) tenures. The mining industry in the State is no longer dominated by a few large companies.

Kidston maintained its position as the largest individual gold mine, but received increasing support from new substantial hard rock open-cut mines. The relative importance of tailings retreatment projects declined although the Mount Morgan operation remained a major producer. Attempts were made, especially by more recently listed companies, to upgrade some of the many smaller scale alluvial mines into more sizeable operations. Much of the present exploration effort, which has seen entire districts pegged out, is based on old goldfields which were not exhaustively mined. Suitable infrastructure remains in many of these areas. However, grass roots exploration is meeting with increased success, especially in the Drummond Basin southeast of Charters Towers.

Full production was achieved early in the year at Red Dome near Chillagoe and production began in January at Mount Leyshon south of Charters Towers. Both mines had been opened in 1986. Open-cut mines were brought into production at widespread localities throughout the State. These included the Agricola north of Brisbane, Lucky Break north of Clermont, the old Golden Plateau at Cracow west of Bundaberg, Pajingo south of Charters Towers, Buck Reef at Ravenswood, Mount Freda and Gilded Rose near Cloncurry and the several deposits which supply a new treatment plant at Croydon.

Substantial additions to production will occur in 1988, especially from new open-cut mines planned at Desraeli east of Charters Towers, Horn Island in Torres Strait, Starra southeast of Mount Isa and Wirralie near Mount Coolon.

Underground mining prospects are also being actively investigated. The old Gympie goldfield has attracted by far the largest and most expensive exploration program of this type. The more advanced projects include the Merriland deposit south of Charters Towers, scheduled to begin production in 1988.

Despite increases in base metals prices from the lows of 1986, significant activity was again largely restricted to known deposits. Mount Isa continued to be the State's only copper producer of any significance but substantial tonnages are expected to result in 1988 as a by-product from the Starra mine. Trial mining began during the year at the nearby Hilton lead-zinc-silver deposit to the North to provide ore to supplement Mount Isa mine production. Exploratory shaft sinking and underground drilling

were carried out at the Lady Loretta zinc-lead deposit north of Mount Isa to establish preliminary reserves. The Thalanga copper-zinc lead deposit southwest of Charters Towers was acquired by the Lady Loretta partners who hope to begin production within two years, initially by open-cutting. Exploratory drilling has intersected promising volcanogenic massive sulphide mineralisation at the Highway East prospect south of Charters Towers.

Significant hard rock tin mining ceased late in the year when the Jumna mill west of Herberton was closed and placed on care and maintenance until prices improve.

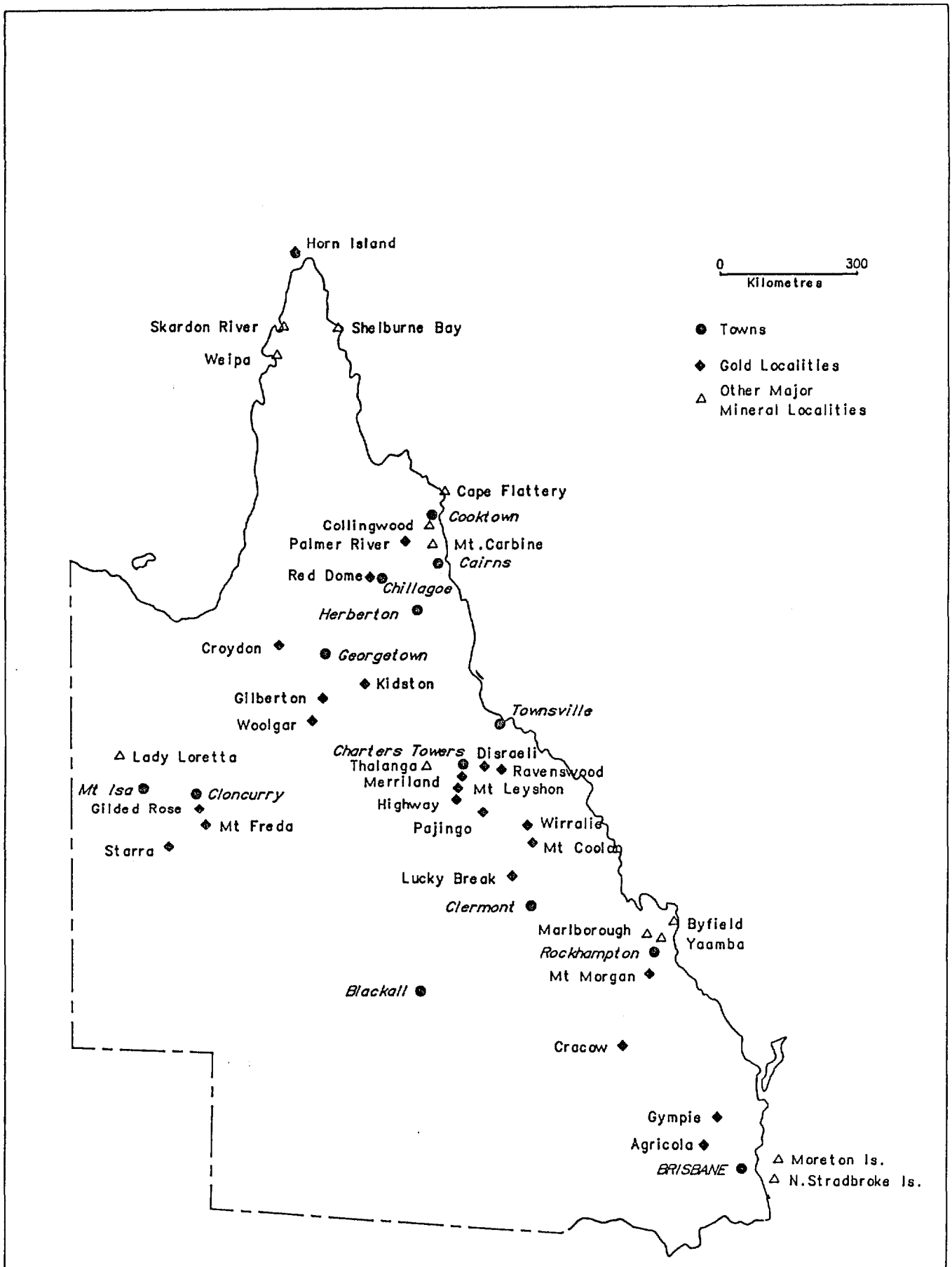
The beach sand heavy minerals industry remained buoyant. A modest increase in production was recorded from operations on North Stradbroke Island near Brisbane. The recently announced ban on mining on the adjacent Moreton Island has again focussed attention on known deposits in Central Queensland. Ongoing exploration of extensive deposits at Byfield north of Rockhampton continued to provide encouragement.

Interest in industrial minerals was maintained. Some publicity was gained by efforts to explore and develop a kaolin deposit north of established operations at Weipa. Investigations of the extremely large high grade sedimentary nodular magnesite deposits in the Yaamba-Marlborough area north of Rockhampton were advanced and construction of treatment plants in the area foreshadowed. Production of industrial salt, caustic soda and chlorine from a large underground salt deposit near Blackall is being investigated as part of a large, essentially natural gas based, chemical complex. Export to Italy of marble blocks from deposits at Chillagoe commenced through the port of Cairns in the second half of the year. Interest has been expressed in the establishment of additional marble quarries at Chillagoe and in Central Queensland.

Gold dominates the outlook for 1988 with production increasing at a faster rate than at any previous time, with a new record total in sight. The stockmarket is no longer able to supply seemingly endless equity funds and established companies are expected to gain increased access to more prospective areas.

TABLE 1: PRINCIPAL AND POTENTIAL GOLD PRODUCERS IN QUEENSLAND
(after Brooks 1987)

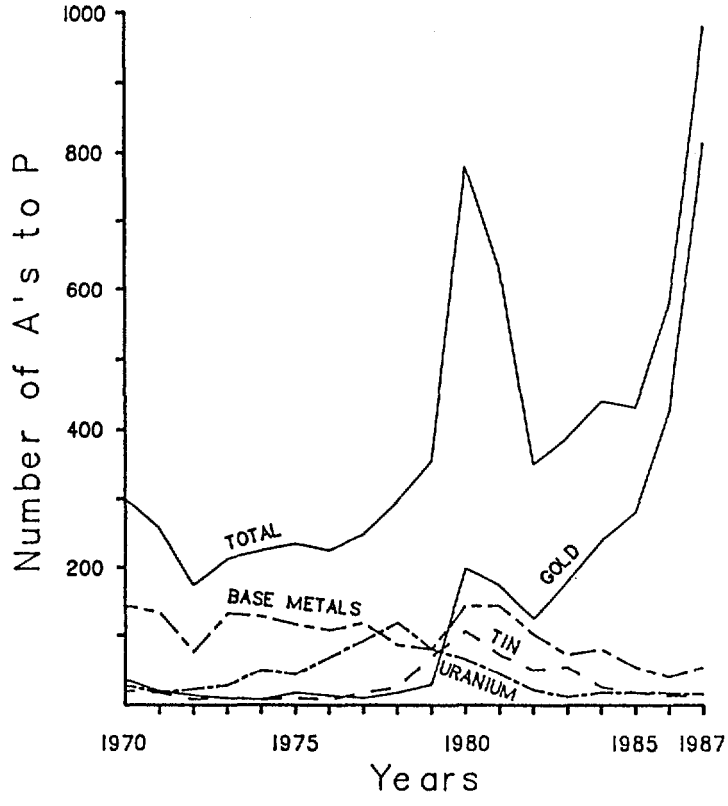
Deposit	Mining Operation	Production Status	Annual Production	Resource Estimate
AGRICOLA	Open-cut	Mining commenced July, production November 87	30 000 oz (960 kg) projected	174 000 t x 5.5 g/t proved; 82 600 t x 4.5 g/t probable
CRACOW	Tailings	Suspended March 87		0.8 Mt x 1.4 g/t
	Open-cut (Golden Plateau)	Mining commenced March 87	300 000 t ore 46 000 oz (1440 kg) projected	1.1 Mt x 6.8 g/t to depth 61 m; 1.5 Mt x 5.5 g/t possible below
CROYDON	Open-cuts (Central Coast Exploration)	Recommenced November 87	0.35 Mt ore projected To rise to 60 000 oz (1866 kg)	1.5 Mt x 3.58 g/t in situ (1 Mt x 3.39 g/t mineable)
	Open-cuts and dumps (Pancontinental Mining)			1.34 Mt x 3.29 g/t
DISRAELI	Open-cut	Production planned 1988	200 000 t ore projected	4.25 Mt x 3 g/t in situ geological (including 2.04 Mt x 4.37 g/t)
FAR FANNING	Open-cut	Commenced June 86 Primary ore 1988	300 000 t ore 22 000 oz (680 kg) projected	0.5 Mt x 2.3 g/t oxidised; 162 300 t x 4.3 g/t primary
GYMPIE	Underground	Exploration (underground)	20 000 oz (620 kg) to 30 000 oz (930 kg) projected	3 Mt x 10 g/t resource
HORN ISLAND	Open-cut and alluvials	Plant construction commenced late 87	30 000 oz (930 kg) + Ag-Pb-Zn conc. projected 1988	2.12 Mt x 2.28 g/t mineable
KIDSTON	Open-cut	Commenced March 85	228 195 oz (7079 kg) Au in 1987 165 967 oz (5160 kg) Ag in 1986	39.2 Mt x 1.82 g/t proved (January 86)
KILKIVAN	Alluvial	Commenced circa 1982	Projected to rise to 18 700 oz (582 kg)	1.2 Mm^3 x 0.5 g/t proved + 0.8 Mm^3 probable
MERRILAND	Underground	Proposed production 1988		100 000 t x 12 g/t; potential for 500 000 t
MT FREDA	Open-cut	Commenced 1987	Projected 270 000 t ore; 18 000 oz (560 kg)	300 000 t x 3.5 g/t
MT LEYSHON	Open-cut	Production commenced January 87	69 000 oz (2140 kg) projected	6.6 Mt x 1.97 g/t mineable
MT MORGAN	Tailings	Commenced December 82	59 934 oz (1864 kg) 1986-87	26.5 Mt x 1.08 g/t (at June 85)
MT RAWDON	Open-cut	Exploration in progress		20 Mt x 1.3 g/t Au; 4 g/t Ag geological in situ
PAJINGO	Open-cut	Production commenced November 87	220 000 t ore 60 000 oz (1920 kg) Au; 200 000 oz (6200 kg) Ag	1.29 Mt x 8.8 g/t Au; 33.7 g/t Ag proved and probable mineable
RAVENSWOOD	Open-cuts (x 2)	Commenced December 87	15 000 oz (480 kg) projected to rise to 35 000 oz (1088 kg)	
RED DOME	Open-cut	Full production early 1987	65 768 oz (2045 kg) in 1987	9.0 Mt x 2.35 g/t mineable open-cut to 200 m
STARRA	Open-cuts (x 4) and underground	Decline in progress 1987; production planned for early 1988	500 000 t ore open-cut; 250 000 t ore underground; 100 000 oz (3100 kg) Au, 10 000 t Cu projected	4.5 Mt x 4.5 g/t Au; 1.7% Cu defined mineable reserves
VIRRALIE	Open-cut	Mining to commence March; production by June 88	600 000 t ore 50 000 oz (1600 kg) projected	3.65 Mt x 2.75 g/t mineable



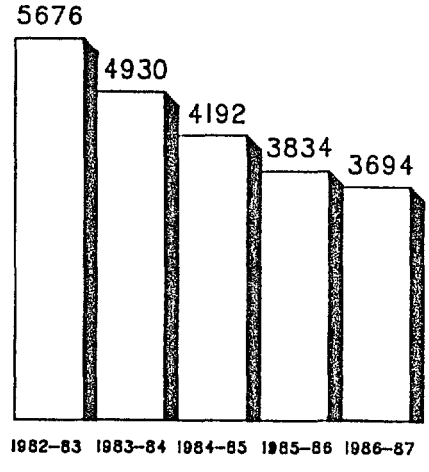
MAJOR MINERAL LOCALITIES

GCM

EXPLORATION UNDER AUTHORITIES TO PROSPECT QUEENSLAND



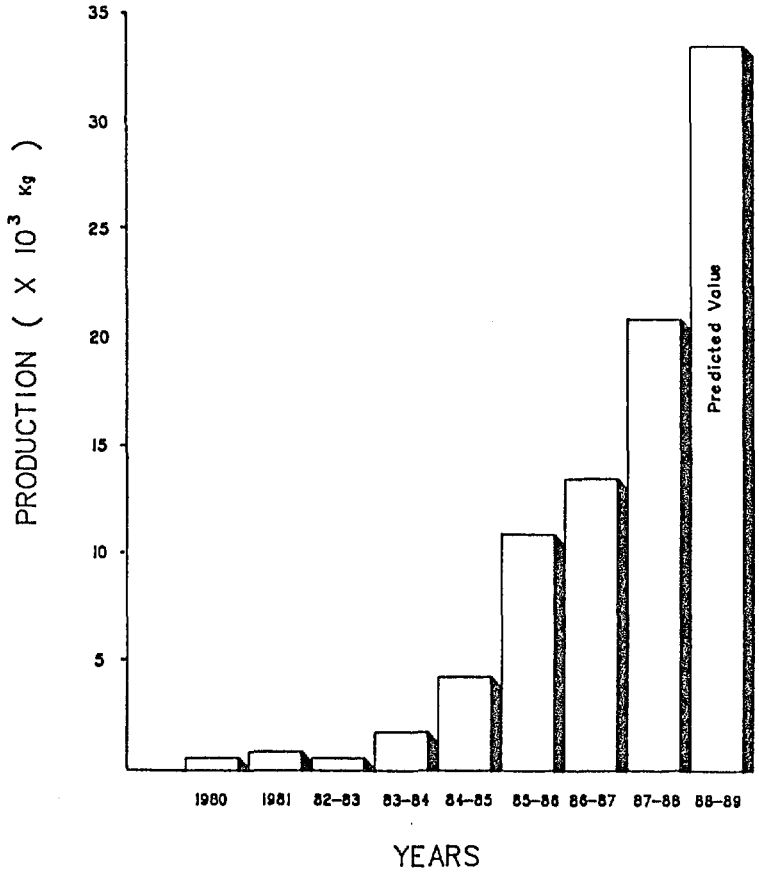
TOTAL MINING LEASES IN FORCE



GCM

QUEENSLAND GOLD PRODUCTION
ANNUAL AND ESTIMATED
1980–1989

(After Ishaq 1988)



QUEENSLAND MINERAL INDUSTRY
1986–87

COAL	METALLIC AND INDUSTRIAL MINERALS
Percentage of Total Market Value:	Percentage of Total Market Value:
69.7%	30.3%
Market Value:	Market Value:
$2672.5 Million	$1165 Million
No. of Producers:	No. of Producers:
30	404

GCM

New South Wales Mineral and Mining Developments 1987

D H Probert, Department of Mineral Resources,
Geological Survey of New South Wales

Exploration

There has been a further downturn in mineral exploration in New South Wales during 1987. Expenditure has decreased from $56.5 to $53.9 million (est.). Coal exploration expenditure decreased marginally from $11.8 to $11.1 million and base metal severely from $17 million to $12.6 million. Gold, platinum, heavy mineral sands and gemstone exploration, however, increased substantially.

Total exploration drilling fell from 377 000 to 357 000 m due largely to a decrease in exploration activity.

However the titles picture in New South Wales presents a more promising scenario. Over 2 600 titles remain in force after instigation of a deliberate policy of rationalisation of titles during the year. The number of exploration licences and applications have increased substantially. This trend is continuing and the competition for prospective ground remains high.

Mineral Production

In spite of the downturn in exploration, the total value of mineral production increased from $3 030 to $3 334 million, an increase of about 10% for the year. The increase occurred mainly in the metallics and coal areas. A 30% increase in the metallics area is due to increased gold production.

Coal

Despite difficult marketing conditions and the closure of five mines, raw coal production rose to 88.5 mt, exports increased by 7.9% to 42.2 mt and domestic consumption by 2.5% to 25.1 mt. Productivity particularly increased for those underground mines (now 18) where longwalls are operating. Although coal drilling increased by 20 000 m to 92 000 m, most was related to mine development rather than exploration and no new areas were offered to tender nor significant authorities granted to companies during the year. The Department of Mineral Resources, however, continued limited exploration to resolve conflicting land use issues related to urban expansion and rural subdivision within the Hunter Valley, Newcastle and Southern Coalfields. Methane drainage extraction prior to mining continued on the Southern Coalfields, resulting in increased production. Further research on gas release from coal measures and associated sediments is in progress.

Base Metals

Base metal production overall remained depressed although there were general increases in efficiency and production in both the Broken Hill and Cobar mines in the later part of the year. Zinc production was high due to favourable prices. Production from the Woodlawn Mine decreased on the changeover from open cut to underground mining. Tailings retreatment at this mine is programmed to commence later this year.

Confirmation of a new ore body at Elura of some 5 m tonnes was announced at the end of the year.

Gold

Though relatively modest by comparison with some States, exploration, development and production of gold continue to accelerate and gold is becoming an important component of the New South Wales mineral economy. Excluding byproduct gold, there are 14 producing mines, including five tailing retreatment and three alluvial operations. Currently the largest producer is the Temora Gold Mine at Gidginbung. Another five mines are due to come on stream within the coming year. These are Mineral Hill, north of Condoblin, London-Victoria at Parkes, Drake, east of Tenterfield, Comet, east of Armidale, and Burraga, south of Bathurst. A number of interesting prospects are under investigation, one of the most notable being The Peak, south of Cobar, where shaft sinking is in progress.

Platinum

Exploration continues at a high level as a result of encouraging results obtained from basic/ultrabasic intrusive complexes located in a belt from Derriwong, south of Fifield to Nyngan. Both hardrock and alluvial prospects show potential for future development.

Heavy Mineral sands

Production and exploration have been stimulated by high demand and favourable prices. Available coastal lands and inland basinal areas, particularly the Murray Basin, are prime exploration targets. There has been a revival of interest in offshore heavy mineral deposits and presently virtually all prospective sections of the coast are subject to exploration licences. The Department of Mineral Resources has commenced a study of marine placer minerals off the south coast of New South Wales.

Gemstones

Both sapphire and opal production in New South Wales increased by approximately 50% during the 1986/87 year.

Exploration for sapphires also has been greatly stimulated by: (1) recent theories of their volcaniclastic origin, (2) the ability now to explore for sapphires under exploration licences and (3) the release of restrictions over known sapphire-bearing areas of the New England region.

Opal mining and exploration have boomed following recent studies by the Department of Mineral Resources and later discoveries of new opan fields in the Sheepyear and Wyoming areas at Lightning Ridge.

Other Minerals and Developments

Other minerals showing high exploration activity and continued interest include zeolites, building stones and special clays.

Developments of major interest include proposals to develop a rare-earth extraction plant near Lismore and the implementation of a statewide Mineral Processing Development Strategy, the objective of which is to encourage investment in further processing of minerals and downstream manufacture.

TABLE 1

NEW SOUTH WALES VALUE OF MINERAL PRODUCTION ($000)

YEAR	**1982/83**	**1983/84**	**1984/85**	**1985/86**	**1986/87**
METALLICS	926 251	320 383	384 653	348 395	447 700
COAL	1 906 970	1 733 358	1 948 608	2 299 591	2 460 000
CONSTRUCTION MATERIALS	211 343	228 180	287 107	316 233	347 000(E)
NON METALLICS	59 888	62 870	63 235	66 065	79 000(E)
TOTAL	2 504 481	2 344 792	2 683 603	3 030 784	3 333 700
% CHANGE	14.0	-6.4	14.4	12.9	10.0

(E) = ESTIMATED

TABLE 2

PRODUCTION FROM NEW SOUTH WALES GOLD MINES DURING 1986/87

	MINE/TAILINGS PROJECT	GOLD PRODUCED (KILOGRAMS)
(1)	TEMORA GOLD MINE	449 (FROM FEBRUARY 1987)
(2)	NEW OCCIDENTAL TAILINGS, COBAR	411
(3)	COWARRA MINE, BREDBO	199
(4)	FREEHOLD MINE, HILLGROVE	184
(5)	BROWNS CREEK GOLD MINE, BLAYNEY	147
(6)	CANBELEGO TAILINGS	113
(7)	BODANGORA (MITCHELLS CREEK) TAILINGS, WELLINGTON	58 (FROM JANUARY 1987)
(8)	BINGARA MINE	49 (FROM SEPTEMBER 1986
(9)	WEST WYALONG TAILINGS	44 (FROM JANUARY 1987)
(10)	LACHLAN TAILINGS, FORBES	18
(11)	KIRKCONNELL CREEK GOLD MINE, BATHURST	1.5
(12)	ROCKY RIVER MINE, ARMIDALE	0.5
(13)	EAGLE HAWK GOLD MINE, MUDGEE	0.4
(14)	SHEAHAN GRANTS/JUNCTION REEFS	(COMMENCED FEBRUARY 1988)

TABLE 3

HEAVY MINERAL SAND PRODUCTION IN NSW - 1983-84 TO 1986-87

	1983/84		1984/85		1985/86		1986/87*	
	Quantity (t)	Value ($000)	Quantity (t)	Value ($000)	Quantity (t)	Value ($000)	Quantity (t)	Value ($000)
RUTILE	35 272	8 731	35 599	12 815	40 696	20 740	51 399	30 221
ZIRCON	59 779	7 272	47 589	6 043	54 149	8 476	50 741	11 654
MONAZITE	495	182	984	475	495	257	485	323
ILMENITE	16 780	268	15 115	244	17 929	309	19 275	376
TOTAL	112 336	16 452	99 287	19 577	113 269	29 782	121 900	42 574

* Preliminary Figures only.

TABLE 4

NEW SOUTH WALES OPAL PRODUCTION* (000)

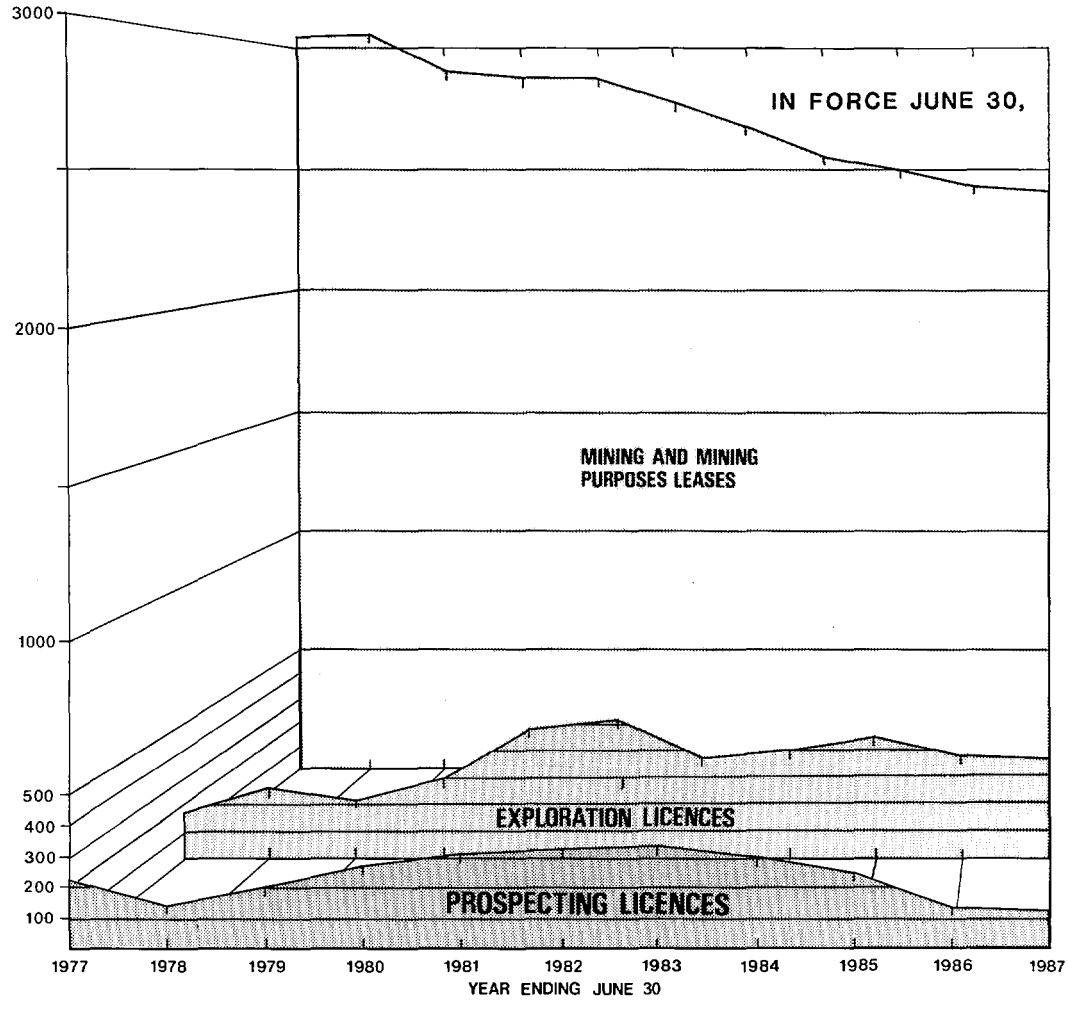
YEAR	1982/83	1983/84	1984/85	1985/86	1986/87
PRODUCTION	10 074	14 929	12 058	13 130	20 853

* ESTIMATES ONLY

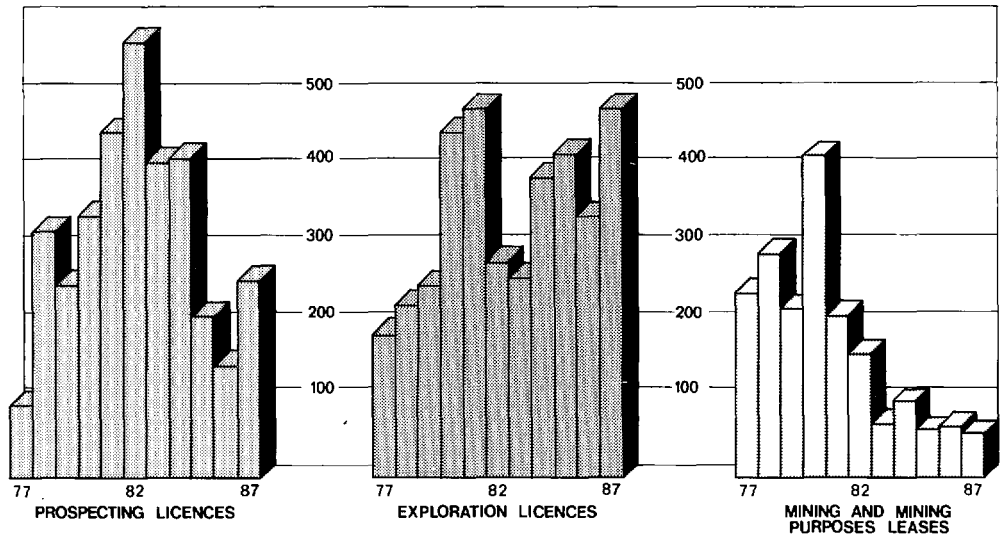
TABLE 5

NEW SOUTH WALES SAPPHIRE PRODUCTION ($000)

YEAR	1982/83	1983/84	1984/85	1985/86	1986/87
PRODUCTION ($)	6 559	4 627	3 863	6 066	8 905



APPLICATIONS RECEIVED IN THE YEAR



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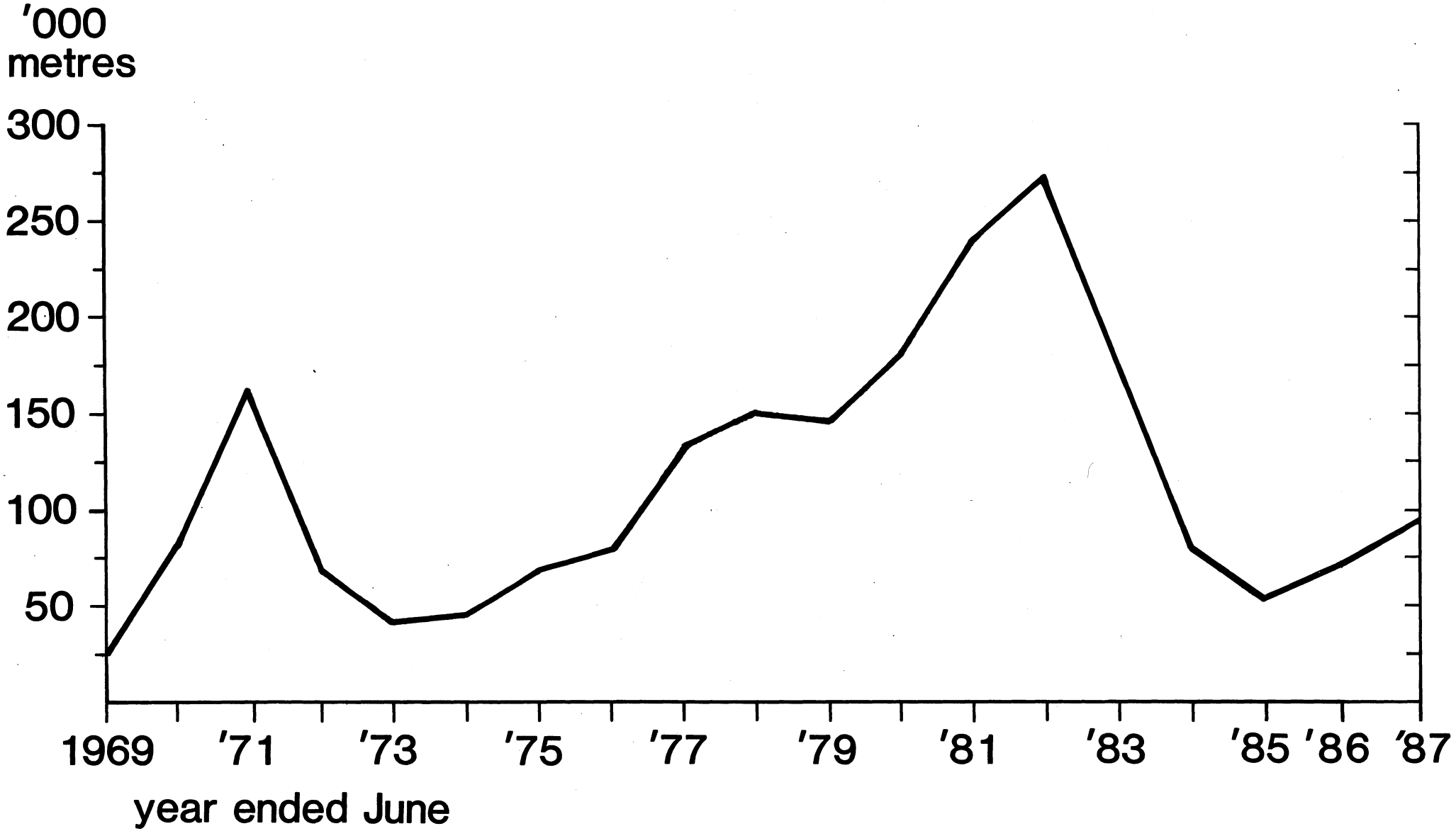
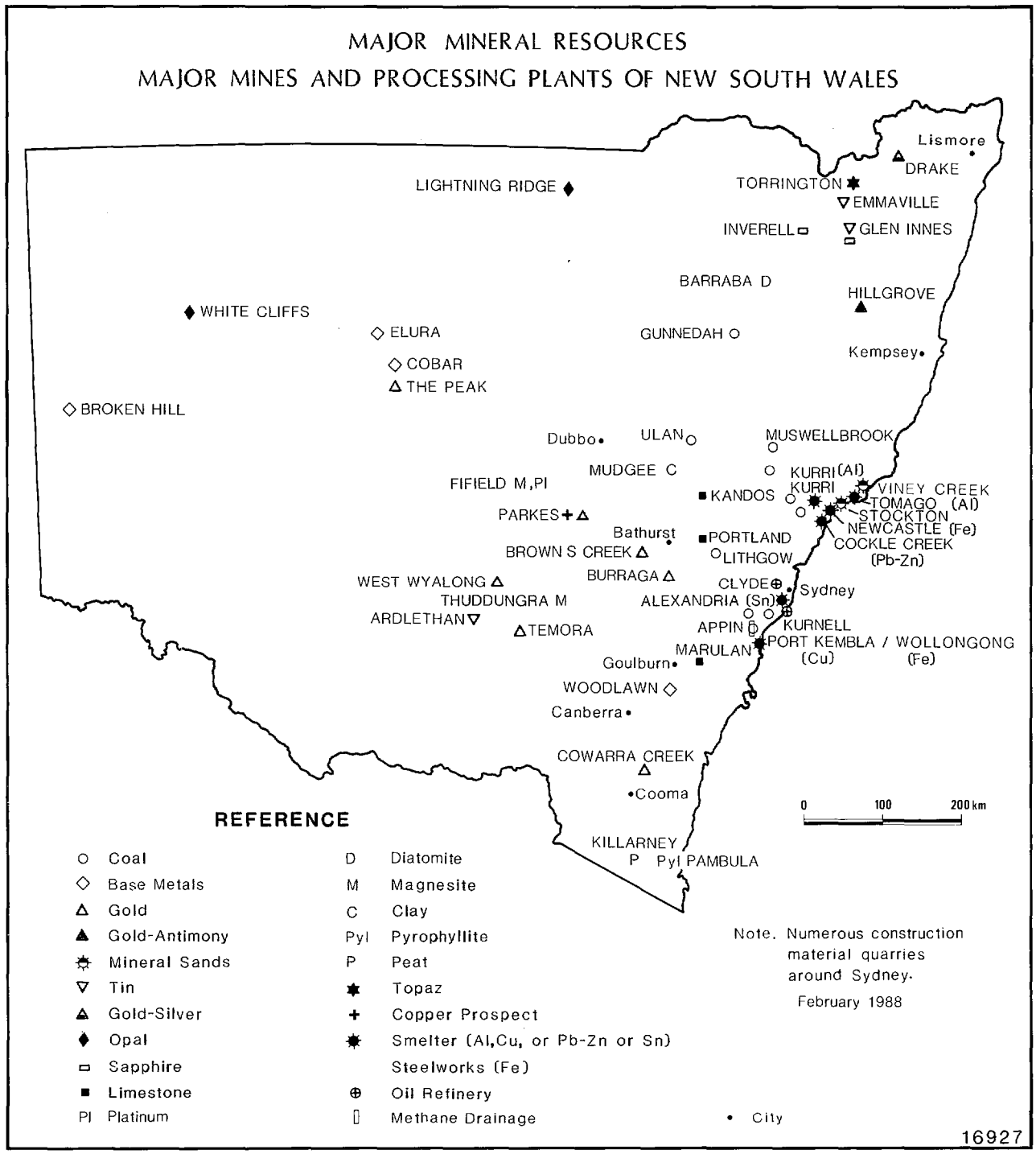
COAL DRILLING, NEW SOUTH WALES




MAJOR MINERAL RESOURCES
MAJOR MINES AND PROCESSING PLANTS OF NEW SOUTH WALES
Lismore
DRAKE
LIGHTNING RIDGE
TORRINGTON
EMMAVILLE
INVERELL
GLEN INNES
BARRABA D
HILLGROVE
WHITE CLIFFS
ELURA
GUNNEDAH
Kempsey
COBAR
THE PEAK
BROKEN HILL
Dubbo
ULAN
MUSWELLBROOK
MUDGEE C
KURRI (Al)
FIFIELD M,Pl
KURRI
VINEY CREEK
KANDOS
TOMAGO (Al)
STOCKTON
PARKES
NEWCASTLE (Fe)
Bathurst
PORTLAND
COCKLE CREEK (Pb-Zn)
BROWN S CREEK
LITHGOW
WEST WYALONG
BURRAGA
CLYDE
Sydney
THUDDUNGRA M
ALEXANDRIA (Sn)
ARDLETHAN
APPIN
KURNELL
TEMORA
MARULAN
PORT KEMBLA / WOLLONGONG
(Cu)
(Fe)
Goulburn
WOODLAWN
Canberra
COWARRA CREEK
Cooma
0
100
200 km
REFERENCE
KILLARNEY
P Pyl PAMBULA
O Coal
D Diatomite
Base Metals
M Magnesite
Gold
C Clay
Gold-Antimony
Pyl Pyrophyllite
Mineral Sands
P Peat
Tin
Topaz
Gold-Silver
Copper Prospect
Opal
Smelter (Al,Cu, or Pb-Zn or Sn)
Sapphire
Steelworks (Fe)
Limestone
Oil Refinery
Pl Platinum
Methane Drainage
City
Note. Numerous construction material quarries around Sydney.
February 1988
16927

Notes

Opportunities for mining in Victoria

T A Pratt, Department of Industry, Technology and Resources, Victoria

Victoria is a State with significant opportunities for the mining industry. It can claim Australia's two richest mineral discoveries, gold in the 1850s and oil in the 1960s. More recently, one of the world's largest single deposits of heavy minerals has been proved in the Horsham region. This contains about twice Australia's current published reserves of rare earth minerals. Victoria also has vast resources of high quality brown coal.

Despite Victoria's unusually high prospectivity, until recently the industry has not taken-up the opportunities which exist. Clearly prospectivity is not enough to attract mining investment. Opportunities for mining also require favourable economic and export conditions and a workable regulatory environment.

The industry should be aware, that since the release of the economic strategy in 1984 and its update in 1987 there have been some fundamental new directions in Government policy in Victoria, and some significant efforts to improve the opportunities for mining in the State.

The Government is well aware that Victoria must be competitive with other States to attract exploration investment. There is no doubt that we are achieving a measure of success in this regard.

Recent surveys by the Victorian Chamber of Mines show a marked change in members' perceptions of the attitude of the Victorian Government. More than one-third of members surveyed by the Chamber in October last year reported an improvement in the State Government's attitude toward the industry.

The Government has responded directly to the industry's concern that the regulatory framework in Victoria is not conducive to mining.

Both the Petroleum Act 1958 and the Mines Act 1958, which are the two main legislative controls on mining in Victoria, are currently under review. One of the central aims of the legislative review is to encourage exploration and development by creating a more conducive regulatory environment. A new Planning Act - also important for mining - was passed by State Parliament in February, and this provides increased powers for the Minister of Industry, Technology and Resources and a greater ability to manage resources on a Statewide basis.

The Mines Act review commenced in the middle of last year. The first stage of the process, a discussion paper on issues, was released in February for public consultation. A more detailed options paper is expected to be released mid-year. The Government has made a firm commitment to involve the mining industry in consultation on the principles and options underlying a new Mines Act.

One of the important factors affecting the outcome of the review will be the industry's presence and projected levels of expenditure within the State in the near future.

In addition to the legislative reviews in progress the Government has introduced new initiatives for the facilitation of major mining projects. The Department of Industry, Technology and Resources has adopted an active facilitation role and as a result major projects encounter less complexity and delays in the title approvals process.

This has proved to be a highly successful method of operating and I expect the facilitation role of the Department to increase in the future.

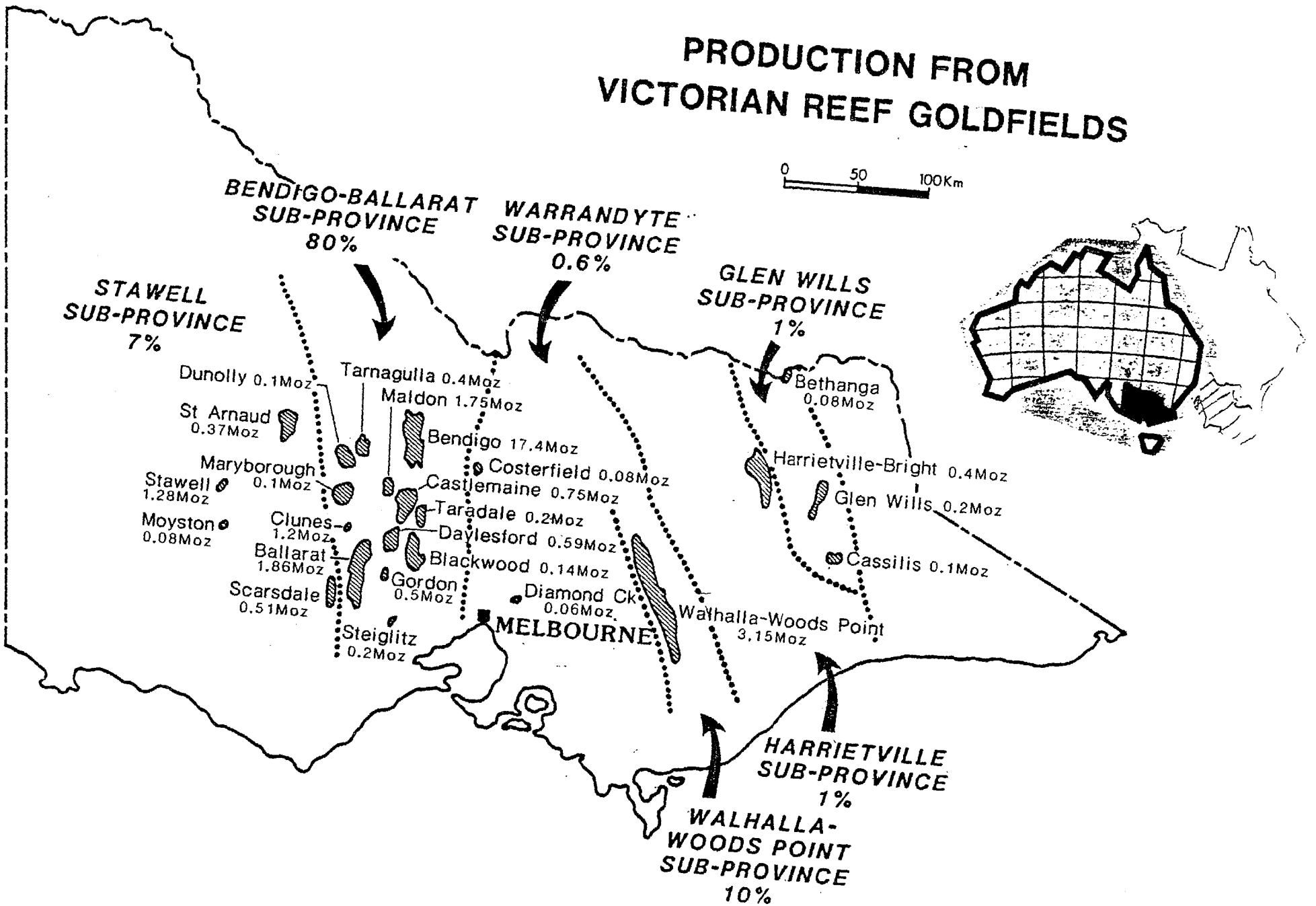
The outlook for mining in 1988 is the brightest since 1903. The value of mineral production is expected to more than double this year and a five-fold increase on 1987 production is expected in 1989.

Stawell continues to be Victoria's largest gold producer - production for the first six months of 1987 was 360 kg of gold and 53 kg of silver.

Triad Minerals at Maldon have completed construction of a minerals treatment plant and have carried out preliminary testing on the plant. Four major mining projects including Bendigo Gold Associates, Western Mining Bendigo, Ballarat Goldfields Ltd and Macquarie Resources Ltd, Benambra have recently concluded their Environmental Effects Statements and are awaiting approval to mine.

CRA have proven reserves exceeding one thousand million tonnes at over three percent heavy minerals in their primary exploration area near Horsham.

Exploration activity has increased dramatically and this trend is set to continue this year. The Victorian Chamber of Mines estimate exploration expenditure in 1988 will increase by 43 percent on 1987. Currently approximately 110 000 square kilometres are taken up by exploration licences or applications. It is anticipated that 12 000 square kilometres of this land will be relinquished this year when exploration licences expire. A further 15 000 square kilometres are likely to become available through interim relinquishments this year.


PRODUCTION FROM
VICTORIAN REEF GOLDFIELDS
0
50
100Km
BENDIGO-BALLARAT
SUB-PROVINCE
80%
WARRANDYTE
SUB-PROVINCE
0.6%
GLEN WILLS
SUB-PROVINCE
1%
STAWELL
SUB-PROVINCE
7%
Dunolly 0.1Moz
Tarnagulla 0.4Moz
Maldon 1.75Moz
St Arnaud
0.37Moz
Bendigo 17.4Moz
Bethanga
0.08Moz
Maryborough
0.1Moz
Costerfield 0.08Moz
Harrietville-Bright 0.4Moz
Stawell
1.28Moz
Castlemaine 0.75Moz
Glen Wills 0.2Moz
Taradale 0.2Moz
Moyston
0.08Moz
Clunes
1.2Moz
Daylesford 0.59Moz
Cassilis 0.1Moz
Ballarat
1.86Moz
Blackwood 0.14Moz
Gordon
0.5Moz
Scarsdale
0.51Moz
Diamond Ck
0.06Moz.
Walhalla-Woods Point
3.15Moz
MELBOURNE
Steiglitz
0.2Moz
HARRIETVILLE
SUB-PROVINCE
1%
WALHALLA-
WOODS POINT
SUB-PROVINCE
10%

Notes

Mineral exploration and development in Tasmania, 1987

M R Hargreaves, Department of Mines, Tasmania

Exploration activity continues to be focussed on the West Coast, more specifically in the Mount Read Volcanic Belt with emphasis on volcanogenic massive sulphide and gold mineralisation.

Tin/tungsten exploration is continuing at a much reduced level but new interest is being evidenced in heavy mineral sands in the extreme west.

The new conditions on Exploration Licences are beginning to take effect with areas being made available in the most prospective areas under the work-program tender system.

The agreement between Aberfoyle Ltd and the State with regard to the development of the Hellyer zinc-lead deposit has been signed and ratified by both Houses of Parliament. At full production (in 1989) 1 million tonnes per year will be mined and processed on site, and concentrates shipped by the Emu Bay Railway to Burnie for export or further processing.

The Mt Lyell mine continues operations, with development of the 50 and 60 series complete with construction of an underground crushing facility.

The Tasmanian gold mine is being opened for development by Beaconsfield Gold Mines, including dewatering and refurbishment of the shaft. Engineering problems associated with the shaft instability are being gradually overcome.

A series of new gold projects are being developed along the Henty fault system. Drilling continues on a number of these prospects and a decision to begin underground development on at least one of these is expected this year.

The Mount Read Volcanics Project has continued through the year; results will be discussed.

Notes

South Australia - Highlights of Mineral Exploration and Mining Development, 1987

R L Wildy, South Australian Department of Mines and Energy

Exploration

Total expenditure on mineral (including coal) exploration reported in calendar year 1987 was $12.6 million. This represents an effective increase of 14%, if expenditure at Olympic Dam is excluded from the 1986 total. (This is no longer reported as exploration expenditure.)

Throughout the State, metal exploration remained steady, comprising 43% of the total expenditure; coal exploration was up by 1.5% with 28% of the total, diamonds up by 39% comprising 15%, and uranium up by 188% totalling 5% of the total exploration expenditure.

Expenditure on exploration for a variety of non-metallic mineral commodities was up by 121%, comprising 9% of the total.

Of particular interest was the fact that exploration expenditure on gold rose by 80% to $1.7 million, while expenditure on the search for heavy mineral sands rose from previously negligible levels to $0.7 million.

While the area held under Exploration Licences decreased by 11% to about 197 000 km^2, the total number of Licences remained steady. A total of 110 000 metres of core and non-core drilling was reported by companies.

Notable results announced were:-

- significant gold intersections recorded from 36 of 47 reverse circulation drillholes completed in October 1987 by BHP Gold Ltd on Tarcoola Goldfield;

- further high-grade gold intersections from drilling at Tarcoola Blocks mine by Tarcoola Gold Ltd;

- encouraging gold assays from old mine dumps and soil samples over a wide area obtained by Tarcoola Gold at the Malbooma gold mine;

- surface assays conducted by Tarcoola Gold area areas of Archaean banded-iron-formation and associated greenstone show a significant gold anomaly in the Mt Finke area.

Production

The value of mineral (other than petroleum) production in 1987 is expected to decrease slightly compared to 1986, there being no contribution from copper following the closure of Mt Gunson mine in 1986. Overall, however, the total value is expected to increase due to the increasing value of petroleum.

1986 values were mineral production $244 million, (comprising construction materials $73 million, coal $81 million, metals $29 million, industrial minerals $22 million and opal estimated at $39 million) and $685 million for natural gas, crude oil, condensate and LPG.

Development

The Olympic Dam copper-uranium-gold deposit at Roxby Downs is being developed by Roxby Mining Corp Pty Ltd (a wholly-owned subsidiary of Western Mining Corp Holdings Ltd), 51%, and the British Petroleum Group, 49%, at an estimated cost of $800 million.

The scale of the resource and the development at Olympic Dam is enormous with a total resource estimated at 2000 million tonnes. Probable ore reserves are 450 million tonnes and the annual mining program calls for the processing of 1.5 million tonnes of ore which will produce 2000 tonnes of uranium oxide (yellowcake), 50 000 tonnes of copper, (30 000 tonnes initially) and 90 000 ozs of gold.

Underground development to the end of 1987 totalled:

- 22 km of driving (increasing at rate of 650 m/month)
- 3.2 km of raise boring
- 0.5 km of shaft sinking
- 3.1 km of declining.

Other major works completed underground include:

- installation of crusher and loading station
- installation of two pumping stations
- development of initial production stoping area.

On the surface the full scale metallurgical plant is nearing completion following extensive pilot plant testing.

Infrastructure completed included a power line from Pimba, a buried pipeline from the Great Artesian Basin, a pumping station and an additional desalination plant and water storage ponds.

The town of Roxby Downs was established with many community facilities and had a population of 1200 at the end of 1987. Initial planning allows for a population of about 3 500 people.

Production start-up is expected later this year.

Long-term agreements for the sale of Olympic Dam high-purity electrolytic copper cathodes have been concluded with four major overseas companies, each of whom will take 20% of initial production. The balance has been reserved for sales within Australia.

Two long-term contracts, covering about one-third of Olympic Dam initial uranium oxide production, have been signed with the approval of the Commonwealth Government.

No advance selling is necessary for gold and silver, production of which will be up to 2½ t/year and 12 t/year respectively. At these rates Olympic Dam will become one of Australia's major producers of gold and silver.

Development is proposed for the Poona copper-gold deposit on Yorke Peninsula (5 km north of Moonta) where extensive drilling by WMC has defined an in-situ undiluted ore reserve of about 180 000 tonnes averaging 7.1% copper and 2.0 g/t gold, above a 2% copper cut-off grade. The deposit is an extension of the Poona lode which was mined originally in the 1860s and was discovered from detailed follow-up of a Sirotem anomaly near the old Paramatta mine.

Following an intensive exploration program since 1978 Top Australia Ltd have identified and secured six low grade copper ore deposits in the Mt Gunson, Copley (Mountain of Light, Elsie Adair, Mt Coffin) and Lyndhurst (Lorna Doone and Lynda) areas.

With readily transportable processing equipment, sequential extraction by heap leaching of the identified reserves will provide six years' supply of raw material to the Burra cupric oxide plant.

Operations have commenced at Mount Gunson where 0.5 mt of 1.5% copper oxidised ore is being mined from the Main Open Cut.

Following further drilling and metallurgical testing of drill cuttings together with underground sampling, Tarcoola Gold Ltd, plans trial mining to confirm tonnage and grade for Wards and Imperial reefs and No 3 level of the old workings. Installation of a new headframe and winder at the main shaft is nearing completion.

A trial pit by the Electricity Trust of South Australia at the Lochiel coal deposit has been completed, providing a bulk sample for testing and establishment of mine design criteria.

A 90-hole drilling-program to establish coal quality and boundary definition was carried out at the Anna-Sedan coal deposit by CSR Limited.

The establishment of a trial pit by BHP to the north of the Iron Knob workings will enable evaluation of iron ore quality from the Iron Princess ore body as part of a strategy to maximise use of resources in the Middleback Ranges.

ACI Resources Ltd transferred glass and foundry sand production from its Normanville location to a new $3 million operation at Glenshera, 3 km west of Mount Compass. This large deposit of Permian fluvioglacial sediments, comprising many metres of sand suitable for upgrading for glass manufacture, was located by drilling after a search by ACI of thousands of microfilmed SADME logs of drillholes in the Mount Compass area, which pinpointed several promising prospects.

The Gemstone Corporation of Australia Limited has been established to develop further the only known commercial deposit of black jade in the world at Cowell in SA. The company is involved in a coordinated program to process and market Australian gemstones throughout the world.

Further development and increased production from Mintabie has established this field as the world's biggest producer of previous opal.

Bulletin 53, "The Adelaide Geosyncline", has been released by SADME. This publication details the stratigraphy, sedimentation, palaeontology and tectonics of the Adelaide Geosyncline which is one of the world's most complete sedimentary records for the late Proterozoic. It represents the distillation of many years of work by Departmental officers and a vast amount of geological data accumulated from private company exploration. It is expected to generate new concepts for exploration for stratabound deposits based on detailed studies of basin analysis/synthesis in this belt.

A lead/zinc task force was established within the Department to review open file company exploration information. The aim is to identify those areas having potential for the location of significant lead/zinc deposits in South Australia and to encourage further exploration.

A joint SADME-BMR project involving a regional magnetic, multichannel radiometric, and VLF-EM airborne survey of the west central portion of the Archaean - Proterozoic terrane on Eyre Peninsula is proposed later this year. The survey will define geophysically the tectonic boundary between the Archaean and Proterozoic domains and outline regional structures, to assist in mineral exploration.

SOUTH AUSTRALIAN MINERAL PRODUCTION

	1986		1985	
	Quantity (tonnes)	Value ($)	Quantity (tonnes)	Value ($)
Energy Minerals				
Natural gas (m^3) (a)	4 813 × 10^9	228 008 000	4 843 x 10^9	245 531 000
Condensates (kl)	781 331	107 13 000	827 587	199 040 000
Crude oil (kl)	1 491 178	241 477 000	1 262 070	333 451 000
LPG (tonnes)	504 841	108 285 000	467 189	143 919 000
Coal (b)	2 389 207	81 233 000	2 058 358	65 463 000
Metallic Minerals				
Iron ore	1 976 949	17 793 000	1 726 304	15 537 000
Jaspilite	—	—	—	—
Copper (metal content)	4 893	7 135 000	11 032	16 743 000
Zinc ore	62 708	4 092 000	30 566	3 112 000
Gold (gms)	1 603	28 000	3 831	42 000
Silver (gms)	1 800	1 000	16 000	3 000
Lead	4	1 000	15	6 000
Non Metallic Minerals				
Limesand (agricultural)	653	1 000	2 351	5 000
Limesand (flux)	15 331	263 000	15 029	248 000
Limestone	1 996 087	7 258 000	1 784 921	6 315 000
Gypsum	1 135 841	3 132 000	1 001 919	2 728 000
Salt	793 441	3 763 000	738 733	3 233 000
Dolomite	679 233	2 747 000	586 046	2 266 000
Clay (c)	731 235	2 200 000	866 043	2 332 000
Silica sand	81 409	1 272 000	76 913	1 109 00
Silica rock	59 853	239 000	66 535	266 000
Talc	18 061	1 118 000	16 804	1 099 000
Barite	4 555	225 000	21 232	768 000
Phosphate	8 346	55 000	9 316	67 000
Micaceous hematite	20	6 000	—	—
Magnesite	1 364	6 000	18 933	696 000
Sillimanite	133	15 000	428	43 000
Damourite	24	2 000	1 574	128 000
Flint (pebbles)	—	—	12	2 000
Nephrite jade (kg)	12 000	62 000	18 000	73 000
Ornamental stones (kg)	5 099	5 000	2 585	3 000
TOTAL		$817 555 000		$1 044 228 000
CONSTRUCTION MATERIALS				
Dimension stone				
Bluestone	240	7 000	230	17 000
Granite	9 410	1 367 000	5 876	896 000
Dolomite/limestone	9 705	227 000	16 682	327 000
Marble	—	—	—	—
Quartz/sandstone	1 919	84 000	783	35 000
Slate	9 749	1 020 000	10 775	724 000
Sub—Total	31 023	$2 705 000	34 346	$1 999 000
Aggregates, ballast, etc.				
Basalt	107 143	1 112 000	113 374	1 054 000
Dolomite/limestone	6 016 129	26 727 000	6 281 814	27 354 000
Gneiss	56 272	558 000	76 864	528 000
Granite	218 339	1 569 000	146 164	1 081 000
Gravels	221 093	235 000	2 258 182	1 828 000
Greywacke	127 701	818 000	129 179	680 000
Ironstone	250 839	196 000	53 988	41 000
Quartz/sandstone	3 876 630	23 173 000	3 672 236	22 278 000
Sand	4 145 444	14 500 000	2 852 074	14 990 000
Clay fill	1 536 675	768 000	1 585 099	793 000
Marble	5 187	26 000	4 968	33 000
Shale	180 510	209 000	276 843	383 000
Slate	15 206	6 000	43 726	33 000
Sub-Total	16 757 168	69 897 000	17 494 511	71 076 000
Total construction materials	16 788 191	72 602 000	17 528 857	73 075 000
Opal production estimate		38 800 000		33 430 000
TOTAL MINERAL PRODUCTION		$928 957 000		$1 150 733 000

(a) Value of gas ex—Moomba plant includes $580 273 value of CO2 from Caroline—1 well.
(b) Value of coal production estimated by this Department.
(c) Includes kaolin.

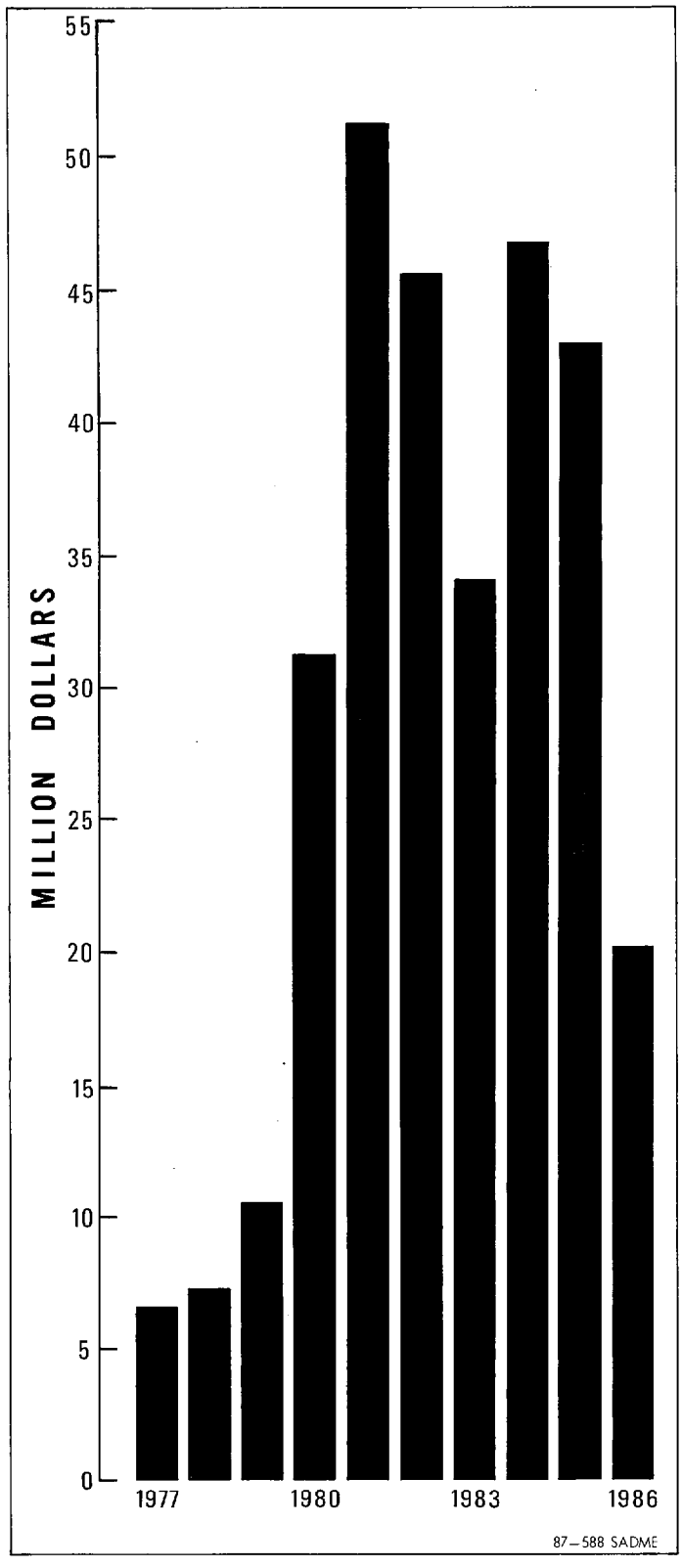


FIG. 1 Company expenditure on exploration in South Australia

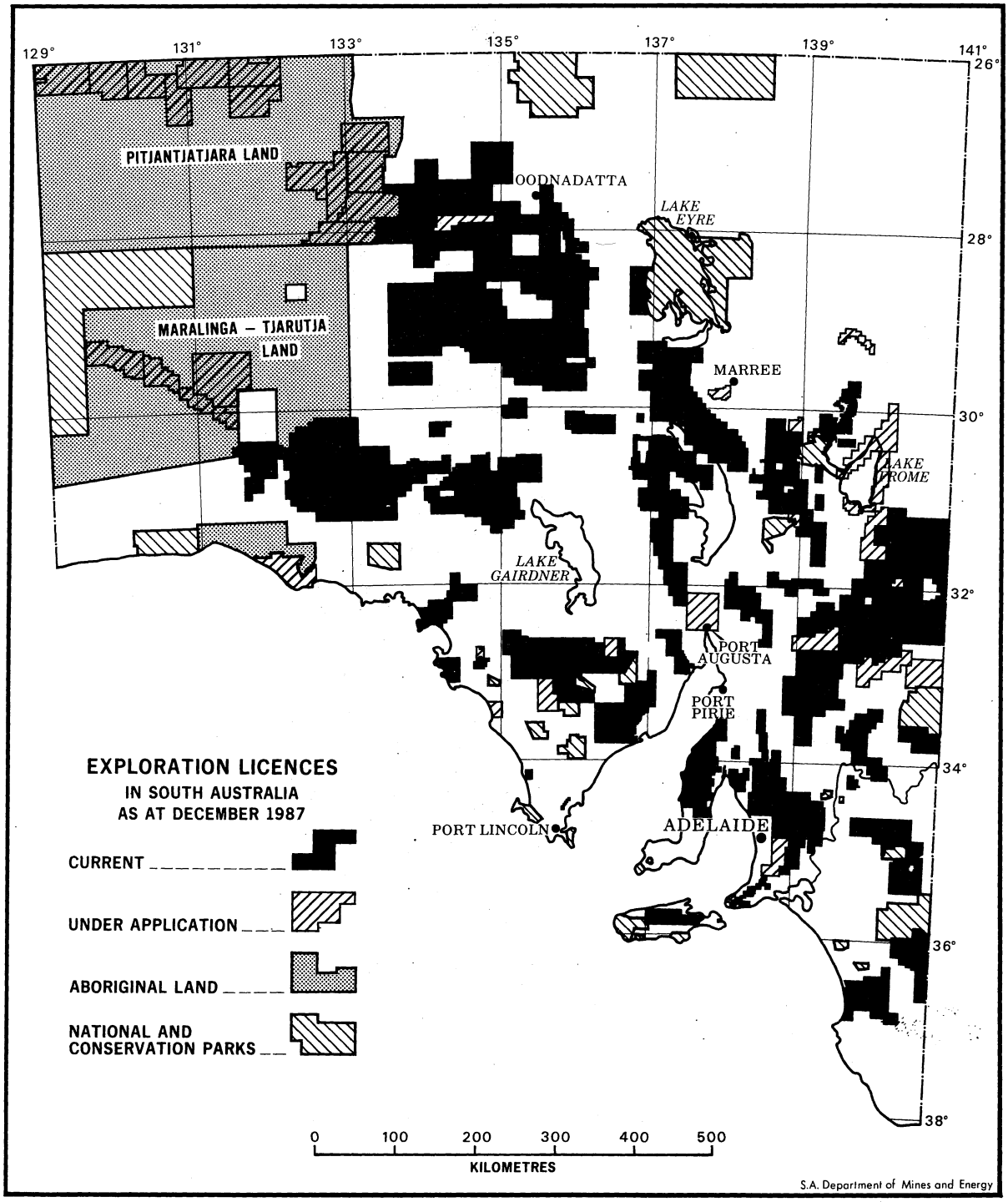


FIG. 2 Exploration Licences in South Australia as at December 31, 1987

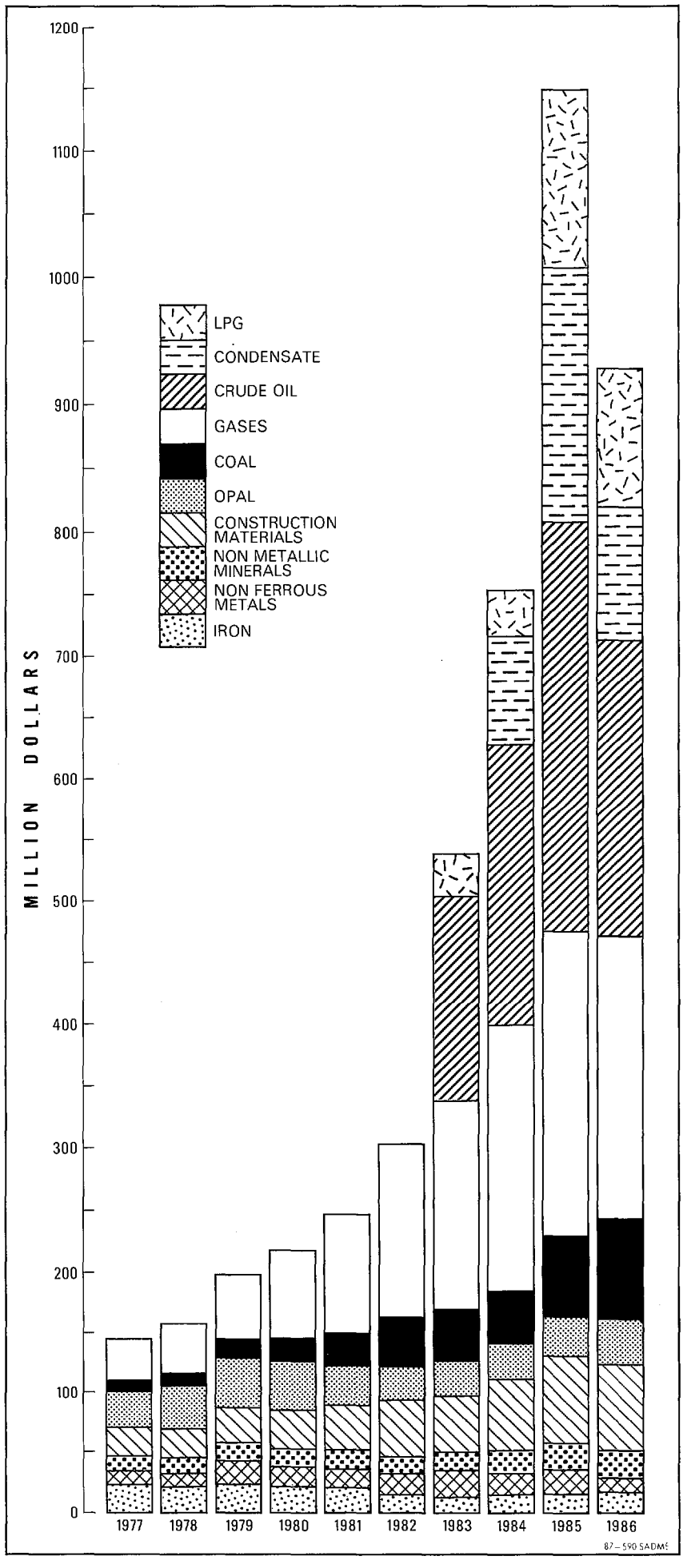


FIG. 3 Value of South Australian mineral production

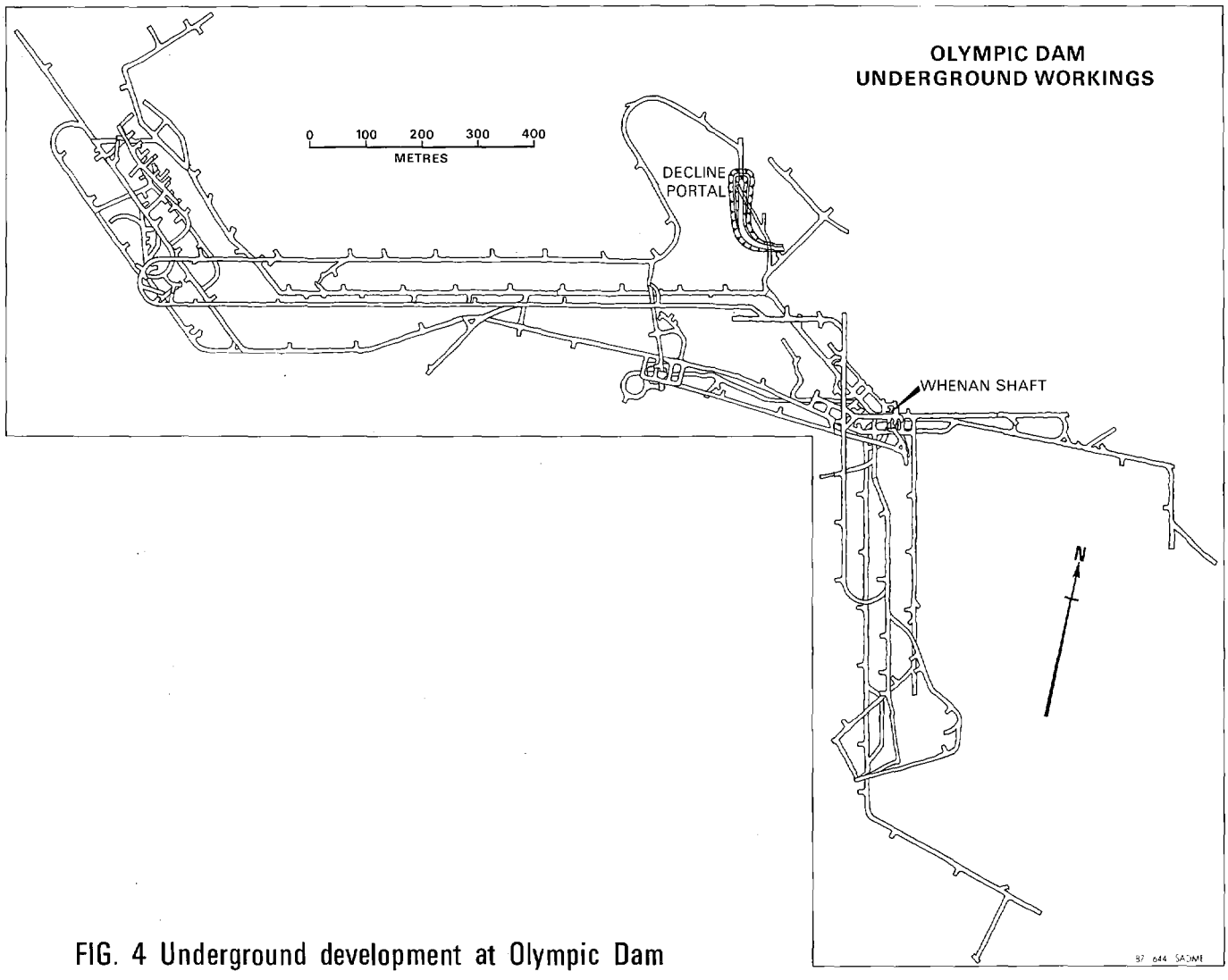


FIG. 4 Underground development at Olympic Dam

Mineral exploration and mining trends, Western Australia

P R Dunn, Geological Survey of Western Australia

The value of Western Australia's mineral production in 1986/87 was $5950 million, an increase of 11.9% on the previous year (Table 1). This increase was principally due to a further spectacular growth in gold production and price, but also assisted by full capacity output from the Argyle diamond pipe and significant price improvements from all mineral sand commodities. These improvements fully offset significant revenue reductions from the iron ore and nickel industries.

Mineral exploration expenditure in the State in 1986/87 is estimated to have increased by 10-11% on the previous year's total of $205 million and is estimated to represent just under 50% of the total exploration undertaken in Australia. Over 60% of the total expenditure was devoted to gold exploration.

Although gold exploration and development again dominated new activity in the State, 1987 was characterized by a diversity of new projects committed to production in both mining and secondary processing fields in a number of commodities, including iron ore, heavy mineral sands, base metals and diamonds. In addition, evaluation was undertaken on polymetallic/rare earth, base metal, uranium and lithium prospects.

In 1987 34 new gold mines were brought into production, representing nearly 33 000 kg of new gold capacity per annum (Table 2). Despite the stock market crash, a number of advanced-stage projects in Western Australia should see an additional 22 new gold mines, with a combined capacity of 23 000 kg per annum, coming into production in the first half of 1988 (Table 3). Although the effects of the stock market crash are still difficult to properly assess and given that the gold price does not continue its current decline, it is anticipated that a further 15 projects on top of these 22 could be developed by the end of the year.

Of the 1987 developments, Worsley's Boddington project is by far the largest, with an installed capacity of over 5 000 kg per annum and a further committed expansion to nearly 8 000 kg. In addition Alcoa is developing an extension to this deposit (the Hedges Project) with a planned output of over 4 000 kg per year. Gabanintha, Wiluna Open Pit and Jubilee are other major projects developed in 1987 and a further 8 new operations have production capacities greater than 1 000 kg per annum.

The existing operations at Gibson, Telfer, North Kalgurli Mines, New Celebration and Great Victoria are undergoing expansion and developments at WMC's Kambalda-St Ives will result in that area consolidating its position as one of the major gold-producing areas in the State (Table 4). The assumption of control of the Golden Mile and Hampton areas by the Bond group of companies is an important new development; if their 'Kalgoorlie Big Pit' goes ahead, an additional 14 000 kg of gold output could be in operation within two years, expanding to nearly 25 000 kg per annum by the early 1990s.

In 1987 gold production was approximately 72 000 kg of fine gold, significantly exceeding the State's previous maximum of 61 000 kg in 1903. In 1988 production should be in the order of 85 000 kg. The financial year's 1986/1987 figure amounts to an increased revenue of $590 million and an output increase of 40% over the previous year.

The iron ore industry has been in recession for some years, with progressive declines in negotiated prices and low levels of sales. However, five significant commitments to development were made during the year, including the signing of a sales contract with the Japanese for the sale of Marra Mamba ore (Table 5). This is the first 100% Marra Mamba ore sale and it may herald the development of several potential projects which involve mainly Marra Mamba ore.

The $215 million Channar development, a joint venture between Hamersley and China, has now been committed to come on stream at an initial 5 Mtpa capacity in 1990 with a view to future expansion as demand requires. Goldsworthy have now committed themselves to a long-term future from their existing 'northern' areas, with a 15-year plan for exploitation of 6 Mtpa from the Sunrise Hill and Nimingarra deposits. This includes a 2 Mtpa beneficiation facility for treating low-grade ore. Hancock Mining Ltd's promotion of new markets in the Eastern Bloc is slowly coming to fruition with a barter trade deal set up with Rumania and the possibility of further deals with Czechoslovakia. The deal involves the development of McCamey's Monster, although initially ore is being supplied from Mt Newman. A small scree operation is being developed at McCameys, while the feasibility of a major hard rock operation is evaluated. At Marillana Creek (formerly Yandicoogina) BHP is progressing through the approval stages for a modest 2 Mtpa operation to supply pisolites for its domestic needs, giving it a foothold for the development of export markets.

Further improvement in mineral sands prices has been the other success area in the minerals industry in Western Australia in 1987. This has resulted in a number of secondary processing facilities being completed or under development, including two synthetic rutile plants, a rare-earth extraction plant from monazite feed, a zirconia production facility and a titanium pigment plant using the chloride method. In addition two new mining operations have been announced: the long-term, large-scale Cooljarloo development to the north of Perth and Cable Sands' plan to develop the Jangerdup deposit on the Scott Coastal Plain area of the south coast.

The new Freeport-Gemex Bow River diamond project is in the process of commissioning its alluvial plant and should be in full-scale production in March 1988. The operation is planned with a life of at least 8 years. The ore is low grade, but contains a significantly higher percentage of gems than Argyle.

Although BHP/Billiton have identified 20 million tonnes of over 10% combined zinc and lead at Blendevale in the Kimberley, they have decided to develop the 3 Mt high- grade Cadjebut deposit. First zinc concentrate shipments are expected in March 1988 and lead concentrate sales are expected to follow shortly after. On the base metal exploration front, CRA have announced promising intersections of lead-zinc-silver mineralization at depth in the middle of the Canning Basin (Admiral Bay prospect). Ownership of the Golden Grove Project has changed and a new feasibility study is being undertaken with the hope that plans for development will commence in the near future.

Early stage evaluation projects to progress during the year include: CRA's Kintyre project in the Rudall River National Park where a resource of 30 000 tonnes of contained U_3O_8 has been announced; West Coast Holdings' Mt Brockman polymetallic-rare earth project in the Kimberley, on which metallurgical testing is currently being carried out; and Greenbushes/Lithium Australia's lithium marketing development where low-iron glass-grade spodumene is being promoted, as well as high-grade (7%) Li_2O concentrate and longer term plans for lithium carbonate production.

CRA have announced the expansion of coal resources in the Margaret River area to 700 million tonnes. The coal is the same Permian age as that at Collie but of a higher grade. Exploitation would involve underground mining.

TABLE 1

WA MINERAL PRODUCTION 1986/87

Commodity	Quantity	Value $AusM	% Value Change
Alumina	5.7 Mt	1091.9	+6
Coal	3.8 Mt	n.a.	-
Diamond	32.2 M cts	284.1	+92
Gold	64.9 t	1300.1	+83
Iron Ore	78.0 Mt	1889.0	-4
Mineral Beach Sand Concs			
Ilmenite *	1.1 Mt	78.8	+32
Leucoxene	13 kt	5.1	-17
Monazite	12 kt	8.4	-19
Rutile	82 kt	46.1	+50
Xenotime	43 t	0.3	-5
Zircon	311 mt	56.3	+16
Nickel Concentrate	406 kt	264.7	-16
Nickel Ore	59 kt	10.1	+19
Petroleum Products			
Condensate	512.4 ML	n.a.	-
Crude Oil	1574.7 ML	262.8	-16
Natural Gas	3199.2 Mm^3	278.0	-5
Salt	5.1 Mt	107.4	+13
Silver	11.2 t	2.0	-82
Tantalite Concentrate	108 t	4.2	-13
Tin Concentrate	731 t	4.9	-23
Others	-	37.8	-
		5950.0	+12

* includes reduced and upgraded ilmenite products
n.a. not available

TABLE 2

PRINCIPAL GOLD PROJECTS COMMENCING PRODUCTION IN 1987

	Ore Reserve Mt	Grade g/t	Capacity Output kg fine gold pa
1. Ballarat-Last Chance	0.502	3.73	480
2. Bardoc	1.370	4.22	1 260
3. Black Flag (S Resources)	0.046	21.45	320
4. Boddington	45.000	1.80	5 280
5. Bottle Creek	2.100	3.10	1 440
6. Brockman Alluvials	?	?	?
7. Callion JV	0.125	2.20	1.100
8. Copperhead	2.700	3.20	200
9. Davyhurst (WMC)	0.760	2.70	670
10. Dry Creek Alluvials	0.600 m^3	1.00/m^3	105
11. Edwards Find/Undaunted	0.180	12.00	1 120
12. Frasers - Open Cut	0.630	2.50	
Underground	1.000	11.00	190
13. Gabanintha	1.484	3.75	1 400
14. Gidgee	1.227	3.22	1 280
15. Golden Fortune	?	?	?
16. Golden Pig & Three Boys	0.154	3.92	800
17. Golden Spec - Blue Spec	0.187	23.50	550
18. Goongarrie-Camperdown	1.000	4.20	1 280
19. Grants Patch (W Coast Holdings)	0.083	2.50	640
20. Hannans South	0.180	6.20	480
21. Jubilee	3.614	2.92	1 500
22. Karonie	1.392	3.90	1 170
23. Kunanalling-Gibraltar	0.660	1.50	700
24. Kurara	2.900	2.90	1.015
25. Mikado	0.068	3.50	400
26. Mt Fisher	0.430	5.90	960
27. Mt Pleasant	3.000	5.50	1 920
28. Mt Wilkinson	?	?	1 120
29. North Morning Star	3.100	3.20	880
30. Paynes Find (Falcona)	?	?	250
31. Premier (Grosmont)	0.320	3.20	720
32. Sir Samuel (Bellevue Open Pit)	0.220	4.40	480
33. Wiluna Open Pit	2.132	3.81	1 930
34. Youanmi (Eastmet)	1.415	5.16	1 100
			32 740

TABLE 3

POSSIBLE GOLD DEVELOPMENTS, 1988

1st half 1988	Capacity Output kg fine gold pa	2nd half 1988	Capacity Output kg fine gold pa
Badgebup	250	Bangeygo (Duketon)	450
Beatons Creek	?	Butcher Well	
Blue Funnell	?	Big Bell	5 440
Borara	?	Carbine N	
Bullfinch	960	Catherwood	
Bullabulling	1 750	Comet, Cue	
Chadwin	?	Emu S (WMC)	
Cork Tree (Mt Morgans	2 000	Jasper Hill (WMC)	
Davyhurst (Gt Ophir)	640	Kaltails (Anglo)	1 280
Golden Kilometre	2 720	Kohinoor	256
Hedges	4 160	Labouchere (Whim Cr.)	960
Hopes Hill-Corinthian	1 600	Lke Darlot	1 060
Kanowna (N. Deep Leads)	830	McCaffery	480
Kanowna (Moonlight)	340	Moline	320
King of Creation	1 215	Mt McClure	
Kundip	896	Parkers Range	200
Kurnalpi	300	Johnston Range	400
Lady Bountiful Ext.	1 000	W. Black Flag	1 350
Peak Hill (Geopeko-Grants P.)	1 472	Mt Bradley	720
Pinnacles OC	800	Mt Clement	500
Randalls (Mawson)	480	Mt Crawford	
Sir Samuel UG	1 750	Mt Hope	
		Mungarri	400
		Panglo	
22	23 163	24*	15 416

* 15 of these projects have advanced to the stage where a level of output has been announced.

TABLE 4

GOLD EXPANSION PROJECT

	Additional Capacity kg of fine gold pa
Boddington	+ 2 600
Great Victoria	+ 288
Kambalda	+ 2 850 (phase 1) +740 (phase 2)
Mt Gibson	+ 1 000
NKGM	+ 1 280
Telfer	+ 1 000
Kalgoorlie 'Big Pit'	+14 000 (1989/90?) & 11 000 (1990/91?)

TABLE 5

IRON ORE PROJECTS COMMITTED IN 1987

Project	Ownership	Capacity Output Mtpa
Channar	Hamersley-China	5 (1990) --> 10/15
Sunrise Hill-Nimingarra	Goldsworthy Mining Ltd	6 (1989)
McCamey's Monster-scree development	Hancock Mining-Mt Newman	2 (1988/89) --> expansion on assessment of feasibility
Marillana Creek	BHP	2 --> expansion on market development
Newman-Marra Mamba	Mt Newman Mining	1.5 --> 3.2 (1989)

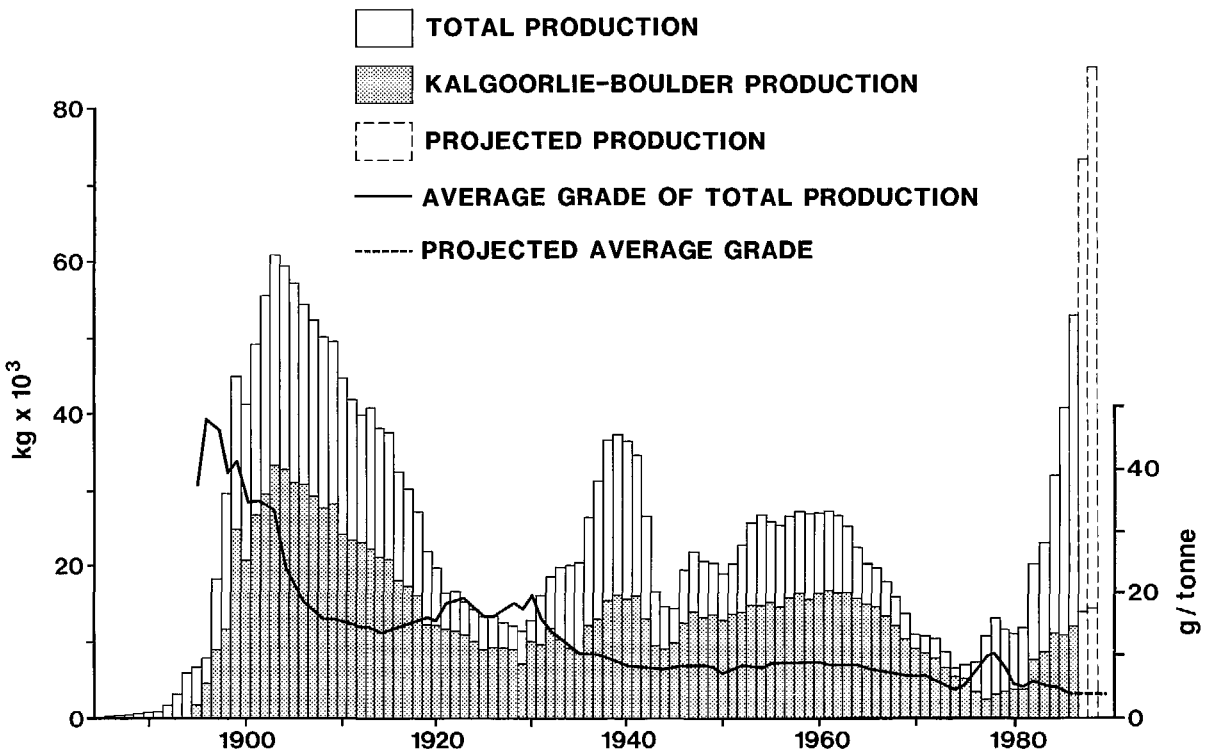


Figure 1: Gold production in Western Australia

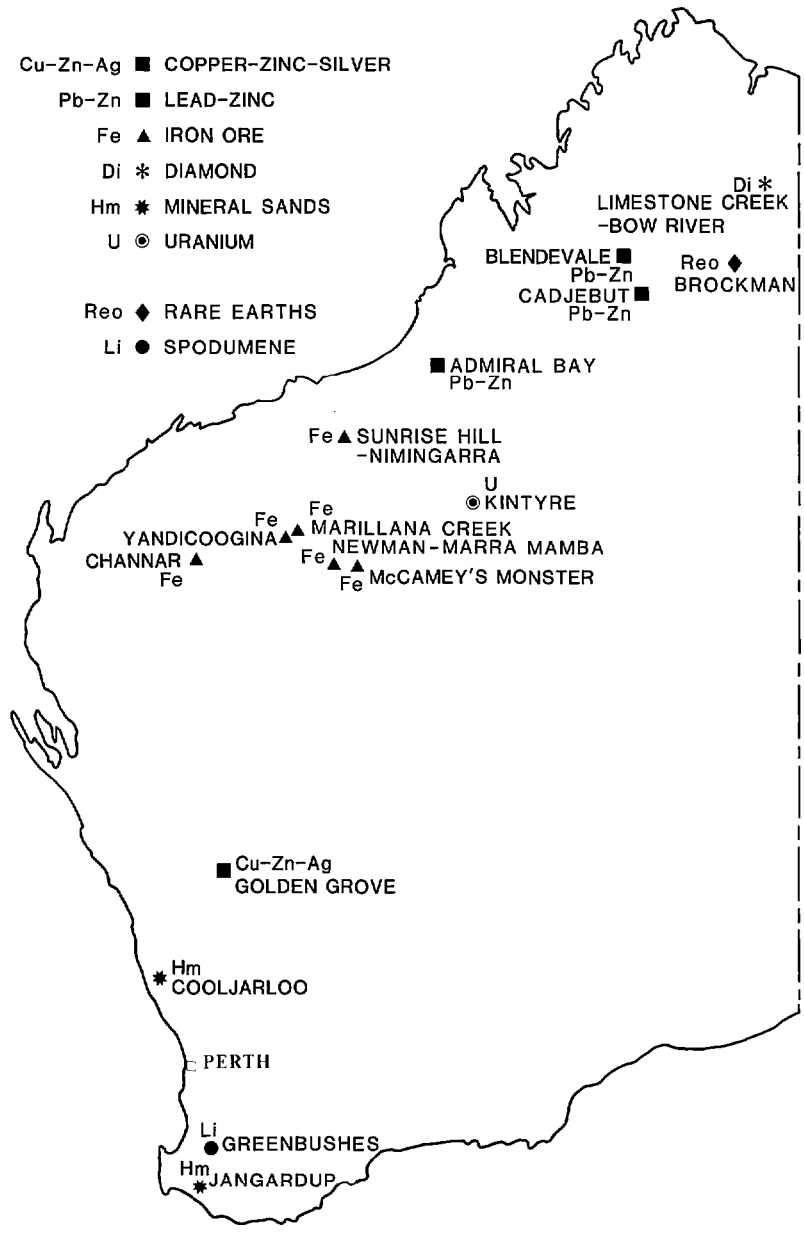


Figure 2: Mineral development and exploration projects (except gold) in Western Australia - advanced in 1987.

Notes

Northern Territory: mineral exploration and mining developments, 1987

M Ahmad, Northern Territory Geological Survey

The value of minerals produced in the Northern Territory surpassed $1.25 billion and is more than double the 1984 figure of $466 million (Figure 1). This increase has happened in nearly all minerals mined - uranium, bauxite, manganese, silver, lead and zinc - but the real interest has been in gold, production of which was valued at nearly $37 million in 1985 but jumped to $176 million in 1987.

Exploration expenditure during 1986-87 amounted to about $26 million, most of which was for gold, and was concentrated mainly in three areas, the Pine Creek Geosyncline, Tennant Creek Inlier and The Granites-Tanami Block.

There were 31 operating mines, one oil field and one gas field in 1985/86. Nine additional mines and one oil field came on stream in 1986/87. Five gold mines are expected to start production in 1988.

In the Alligator Rivers - Arnhem Land region, uranium oxide (yellowcake) production continued at the Ranger and Nabarlek deposits. Development at Jabiluka and Koongarra deposits is pending decisions by the Commonwealth Government. Although this region is possibly the most prospective uranium area in the world, mineral exploration here virtually ceased in 1974. Two important decisions were made in 1987, (a) delineation of a conservation zone in stage 3 of the Kakadu National Park where mining and exploration may be allowed and (b) an agreement between Uranerz Australia Pty Ltd and traditional owners of the Myra Falls area in Western Arnhem Land to allow mineral exploration. It has taken 10 years to reach this agreement and it involves on 64 km^2 of the Arnhem Land's 90 000 plus km^2, hopefully it augurs well for the future.

The established mines at Groote Eylandt (manganese) and Gove (bauxite) continued to provide significant contributions to the Northern Territory's mineral wealth.

At the Woodcutters lead-zinc-silver deposit the open-cut ore is now exhausted and underground development has commenced. A decline from the bottom of the open-cut has reached 600 m and is now 110 m below the surface.

The McArthur River deposit - the world's largest lead-zinc-silver deposit - continued to be the subject of negotiations between the Northern Territory Government and MIM Holdings, and an agreement involving worldwide advertising for joint venture partnership was reached.

In the Bynoe tin-tantalum mineralised area, exploration during the year continued to increase ore resources which are now considered to be of sufficient size to sustain a reasonable-sized continuous production. Trial mining is being carried out and a limited production facility has been established on the leases.

Major reconnaissance and diamond exploration programs in the past few years have outlined some promising areas in the southern McArthur Basin and Barkly Tableland. Drilling and evaluation of several magnetic anomalies is in progress and some kimberlitic bodies have been identified.

Evaluation at the Coronation Hill gold, platinum and palladium deposit continued and several ore-grade intersections have been reported.

In both exploration and mining sectors, gold continued to dominate; there are 16 producing gold mines, nine of which commenced production in 1987. The Granites mine, which began treating ore in July 1986, has become the second-largest gold mine in the Northern Territory, the Enterprise mine being the largest.

Following exhaustive consultations with Industry, major revisions to the Mineral Royalty Act were passed by the Legislative Assembly. The amendments incorporated major concessions, providing a greater incentive to Industry while maintaining a reasonable revenue for the Government.

The outlook for the mining industry in the Northern Territory continues to be encouraging. Significant additional exploration for and production of gold is forecast for the immediate future. Exploration for other minerals is expected to increase because of new provisions under the Aboriginal Land Rights Act which allow for agreed access for exploration and subsequent mining on Aboriginal land.

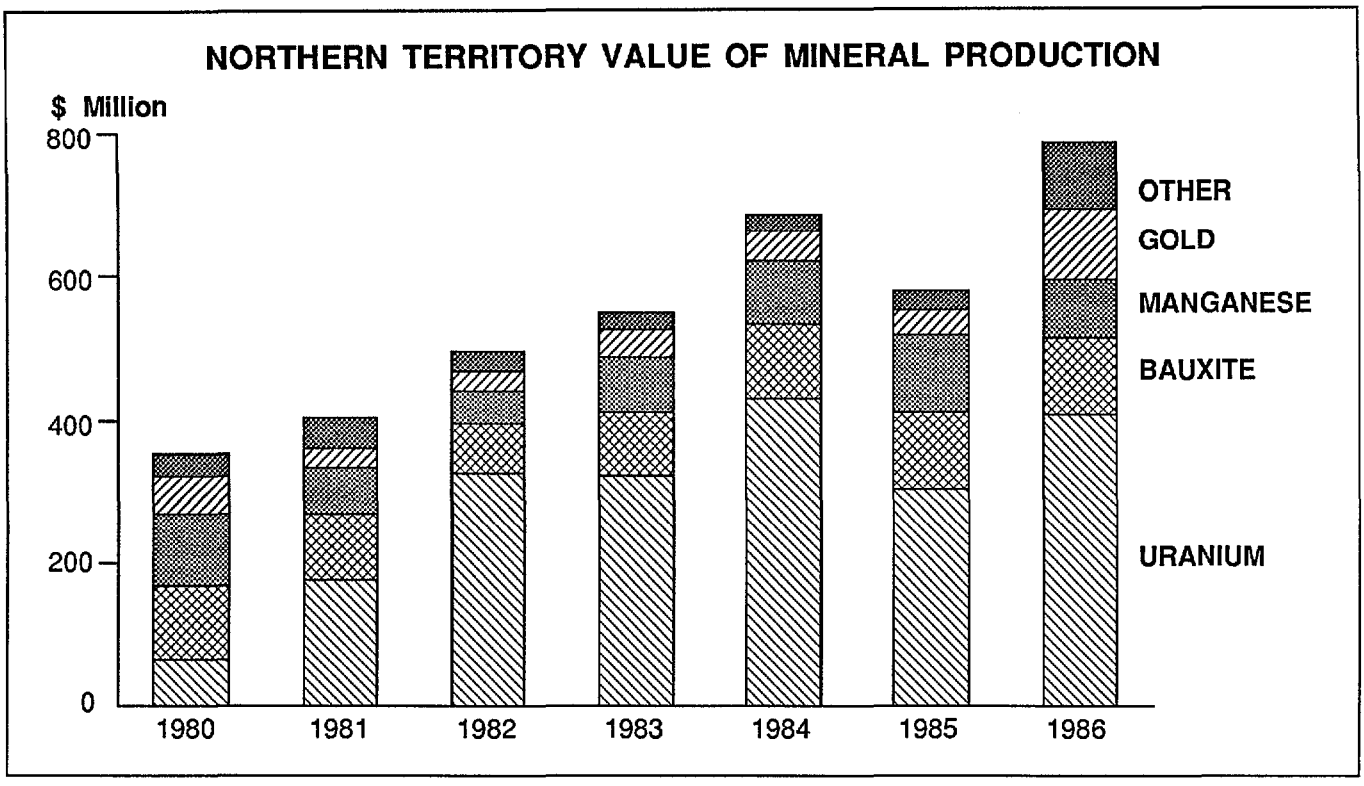
Table 1

Northern Territory of Australia
Mineral production reported 1986

Mineral Production	Quantity		Value (ex-mine site)		
Metals, minerals and petroleum:			$	$	$
Gold (MC)	5 295.851	kg		97 294 180	
Silver (MC)	18 601.605	kg		1 506 804	
Copper (MC)	2 615	tonnes		2 806 640	
Tin/Tantalite Concentrate	56 597.2	kg		491 430	
Manganese Ore: Lump 933 463 tonnes			63 565 139		
Fine 715 458 tonnes			24 815 722		
Total Manganese	1 648 921	tonnes		88 380 861	
Bauxite	5 058 964	tonnes		106 085 778	
Uranium (U_3O_8)	4 896.918	tonnes		407 299 101	
Lead (MC)	6 378	tonnes		589 221	
Zinc (MC)	18 156.8	tonnes		7 917 779	
Oil	516 597.5	kL		57 463 615	
Natural Gas	46 224 022	kL		2 977 654	
SUB TOTAL VALUE (Metals, minerals and petroleum)					772 813 143
Construction materials:					
Fine crushed rock	643 888	tonnes		6 683 064	
Limestone	1 750	tonnes		4 481	
Gravel	1 869 536	tonnes		4 385 131	
Laterite	184	tonnes		153	
Sand	396 211	tonnes		1 272 953	
Clay/Shale	50 295	tonnes		50 295	
Slate	108	tonnes		27 284	
Soil	383 209	tonnes		1 280 210	
SUB TOTAL VALUE (Construction Materials)	3 345 181	tonnes			13 703 571
TOTAL VALUE MINERAL PRODUCTION					786 516 714
Value added to processed mineral and petroleum production:					
Alumina	1 300 365	tonnes		184 767 931	
Distillate, fuel oil and naptha	25 120	kL		4 045 870	
Gold bullion, cement copper Gold leach residue and bismuth Oxychloride	NP			3 986 298	
TOTAL VALUE ADDED					192 800 099
TOTAL VALUE MINING AND PETROLEUM INDUSTRIES					979 316 813

NOTE: Australian Bureau of Statistics definitions have been used to calculate values on ex-mine site basis.

MC = Metal Content
NP = Not Published


NORTHERN TERRITORY VALUE OF MINERAL PRODUCTION
$ Million
800
600
400
200
0
1980
1981
1982
1983
1984
1985
1986
OTHER
GOLD
MANGANESE
BAUXITE
URANIUM

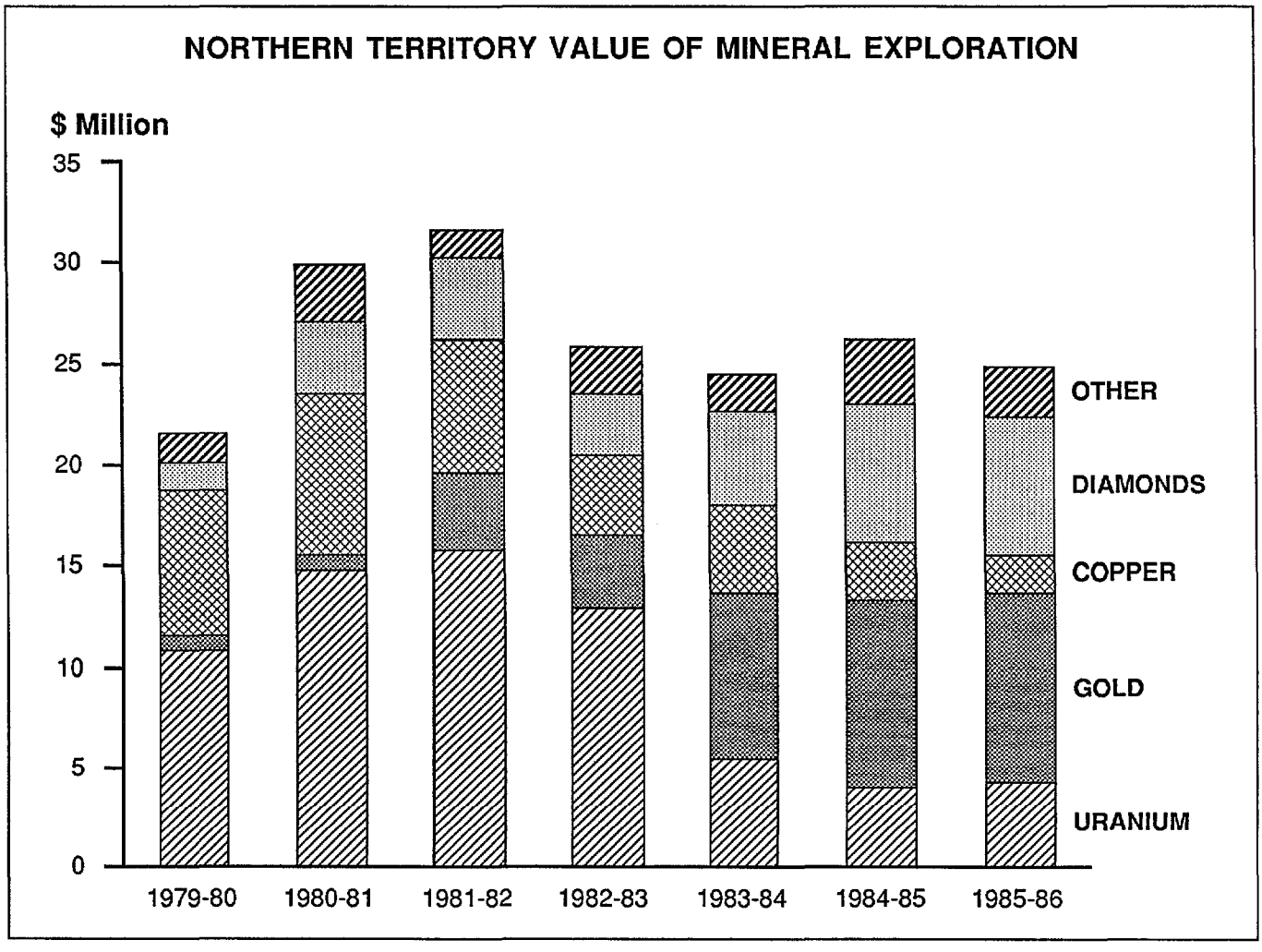

NORTHERN TERRITORY VALUE OF MINERAL EXPLORATION
$ Million
35
30
25
20
15
10
5
0
1979-80
1980-81
1981-82
1982-83
1983-84
1984-85
1985-86
OTHER
DIAMONDS
COPPER
GOLD
URANIUM

Figure 1

Aluminium overview and outlook

N. Knight, BMR

In 1987 Australia, with 13% of the Western world's total economic demonstrated resources, produced about 43% of the non-communist world's bauxite; over 85% of this was processed domestically. About 36% of non-communist world alumina production was provided by Australia, but in contrast to bauxite, only about 18% of Australia's alumina output was processed locally. However, Australia's aluminium production was 14% more than in 1986, and has more than doubled since 1983. Exports of aluminium have also more than doubled since 1983; in 1987, 70% of Australia's aluminium output was exported.

Australia currently ranks third as a Western-world producer of aluminium, a position attained since 1983 partly as a result of expanded and newly constructed smelters and partly due to the closure of older, higher-cost smelters overseas.

Non-communist world primary aluminium production rose to 12.6 Mt in 1987, an increase of 5% compared with 1986, and capacity utilisation is estimated to have risen to over 90% for the first time this decade. The main reasons for these increases were falling stocks, higher than anticipated consumption growth rates in some countries such as Japan, increased aluminium prices, and the recent dismantling of many high-cost smelters in Japan and in the USA.

In November 1987, non-communist world stocks of primary aluminium, as reported by the International Primary Aluminium Institute, were 1.39 Mt compared with 1.85 Mt in December 1986 and 2.6 Mt at the end of 1983. Annual consumption is estimated to have risen to 13.5 Mt, an increase of 1.5% compared with 1986 and 12.5% compared with 1983. This change in supply-demand fundamentals was reflected in a marked increase in aluminium prices, with some prices reaching a seven-year high. The average US market price for 1987 was 73.1 US cents/lb compared with 56.5 US cents in 1986; the average LME cash price was £955/tonne in 1987 compared with £785 in 1986.

However, many factors which have beset the aluminium industry over the past few years, such as high operating costs, exchange rate fluctuations, uncertain consumption growth rates and substitution by other materials, still remain problems. The medium to long-term outlook for the aluminium industry will depend on how producers and consumers continue to address these problems.

In the short-term, BMR estimates that Western world primary aluminium production is likely to increase by about 5% to 13.2 Mt in 1988. Consumption should be about equal to production with a fall of around 1% to 13.2 Mt. Prices are expected to fall slightly next year as supply becomes more in line with demand. BMR estimates an average LME cash price for 1988 at about £900/tonne, and an average US market price of about 70.0 US cents/lb.

Australian aluminium production is expected to increase slightly in 1988 to a little over 1 Mt, with further increases in 1990 and beyond with the expected construction of the third potline at Portland, and the possible construction of a Western Australian smelter. Alumina and bauxite production in 1988 are expected to remain at much the same levels as in 1987.

In the longer term, Australia, with its ample resources of bauxite and some of the world's most technically-efficient and low-cost refineries and smelters, is expected to continue as a major producer of aluminium, alumina, and bauxite.

Percentage Share of Non-Communist World Primary Aluminium Production by Main Producing Countries

Country	1975	1980	1985	1990
Australia	3.3	3.6	7.0	9.0
Brazil	1.2	2.1	4.0	6.0
Canada	9.0	8.5	10.0	11.0
France	3.9	3.4	2.0	2.0
Japan	10.4	8.6	2.0	0.3
Norway	6.1	5.2	6.0	8.0
US	36.0	37.0	28.0	26.0
West Germany	7.0	5.8	6.0	3.0
Other	23.1	25.8	35.0	35.0

Source: International Bauxite Association (1987)

Total World Economic Resources of Bauxite ('000) tonnes

Country	
Australia	4 215 000
Brazil	2 900 000
Greece	650 000
Guinea	5 900 000
Guyana	900 000
India	1 200 000
Jamaica	2 000 000
Suriname	600 000
United States	40 000
Venezuela	350 000
Yugoslavia	400 000
Other Market Economy Countries	2 900 000
Hungary	300 000
USSR	300 000
Other Centrally Planned Economies	200 000
World Total:	22 855 000

Source: US Bureau of Mines (1987)

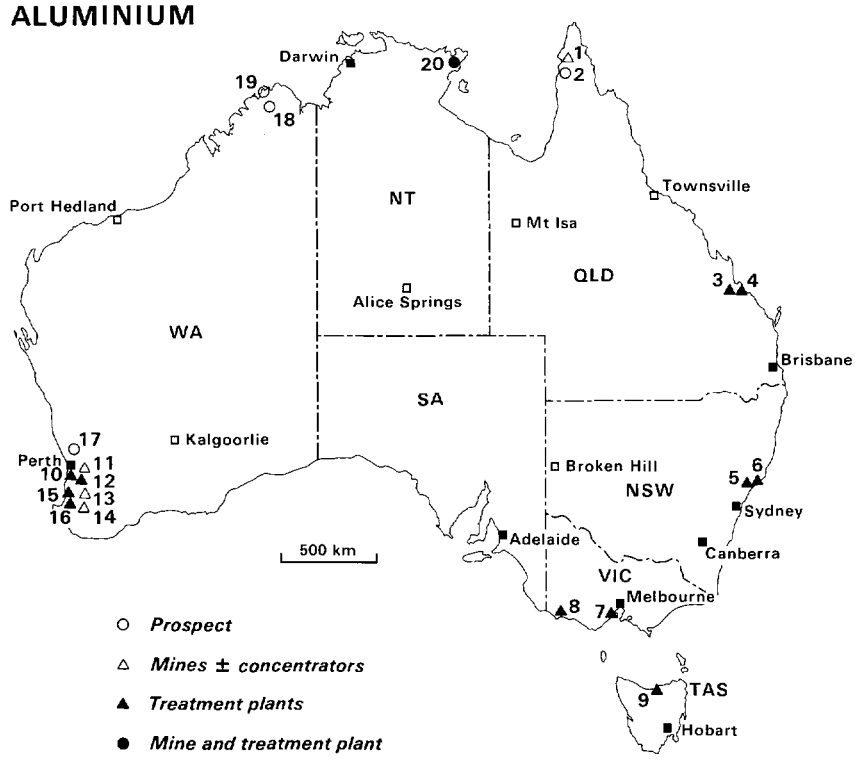
Operating Cost of Producing Primary Aluminium

(US cents/lb)

Country	1985	1986	1987
Australia	40	38	42
Brazil	40	42	38
Canada	41	39	41
France	50	50	53
Germany	44	46	50
Japan	49	na	na
Norway	40	44	47
USA	57	52	49
Venezuela	na	32	na

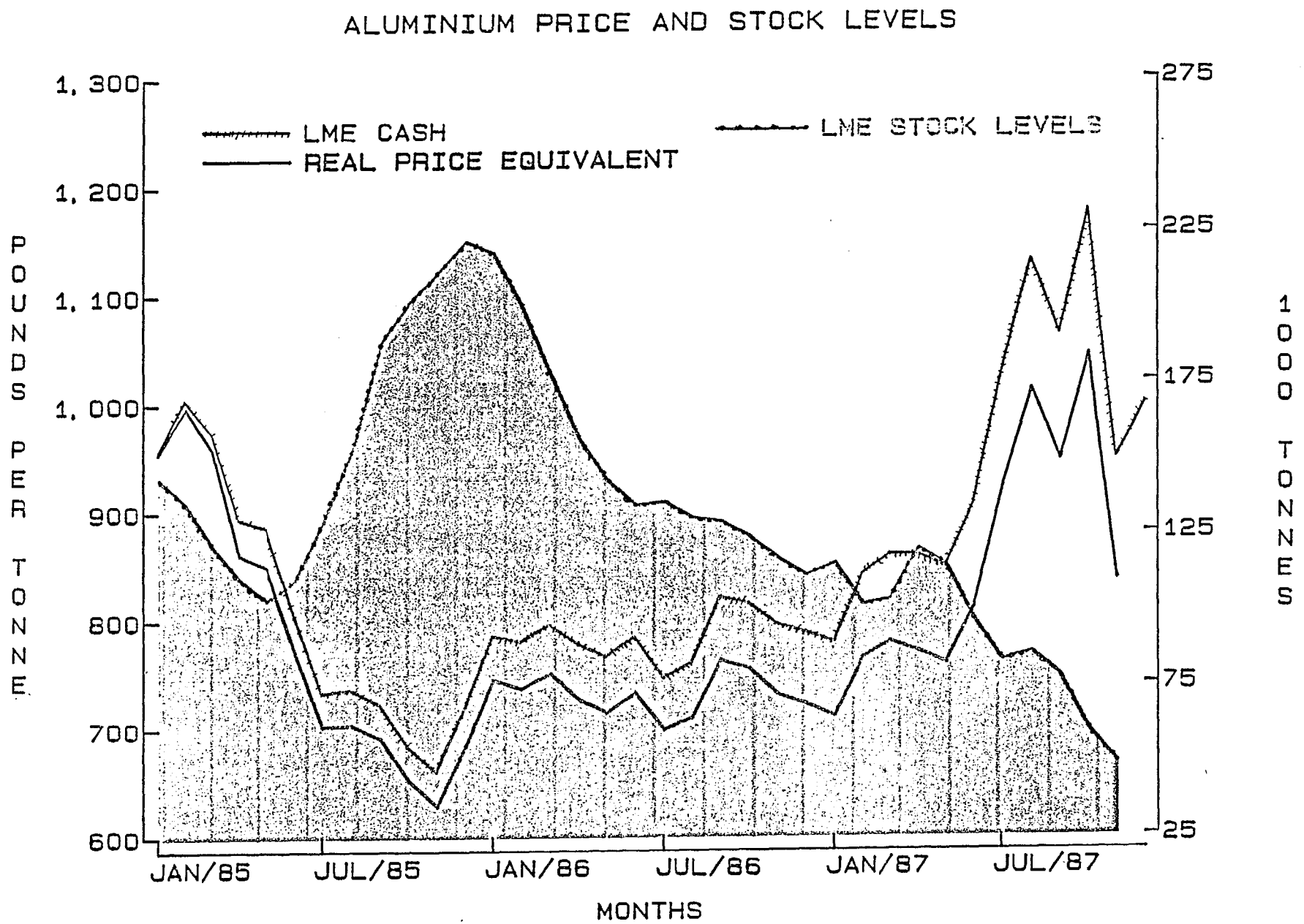
Source: International Bauxite Association (1987) n.a. (not available)

ALUMINIUM



1 Weipa 2 Aurukun 3 Gladstone (refinery) 4 Boyne Island (smelter) 5 Kurri Kurri (smelter) 6 Tomago (smelter) 7 Point Henry (smelter) 8 Portland (smelter) 9 Bell Bay (smelter) 10 Kwinana (refinery) 11 Jarrahdale, Huntly, Del Park 12 Pinjarra (refinery) 13 Mount Saddleback 14 Willowdale 15 Wagerup (refinery) 16 Worsley (refinery) 17 Chittering 18 Mitchell Plateau 19 Cape Bougainville 20 Gove (mine & refinery)

15/A/328


ALUMINIUM PRICE AND STOCK LEVELS
LME CASH
REAL PRICE EQUIVALENT
LME STOCK LEVELS
POUNDS PER TONNE
1,300
1,200
1,100
1,000
900
800
700
600
1000 TONNES
275
225
175
125
75
25
JAN/85
JUL/85
JAN/86
JUL/86
JAN/87
JUL/87
MONTHS

Nickel - into the nineties

P. Coker, BMR

Until the latter part of the 1960s Canada was responsible for most of the world's mine production of nickel, with USSR, New Caledonia, and Cuba accounting for most of the remainder. Producer prices prevailed in the nickel market and, to instill consumer confidence, suppliers kept prices relatively stable in real terms by keeping production closely in line with demand.

The annual rate of growth of nickel consumption, which had averaged 3% from 1950 to 1958, increased markedly in the 1960s and early 1970s, to average 8% in the 16 years to 1974. Stable prices coupled with strong demand encouraged nickel exploration and mine development, and a number of countries emerged as important nickel producers, notably Australia, Philippines, and Indonesia, and Canada's share of world mine production fell.

The pattern of nickel consumption changed abruptly in the early 1970s, as it did with a number of other metals. A move towards a lower intensity of nickel use occurred; annual consumption growth fell to 1% and has remained at this rate, on average, ever since. However, nickel mine - smelter capacity continued to increase and did not plateau until the early 1980s. Through this period growth in mine - smelter capacity outstripped that of consumption, so that capacity utilisation decreased, and nickel prices fell in real terms.

Western world mine - smelter capacity utilisation bottomed-out in the early 1980s at little more than 50%. Since then it has increased steadily, but real nickel prices did not reach their low point until January 1987. The US dollar equivalent of the LME cash price fell below US$1.60/lb in that month, but some twelve months later it had rebounded to over US $4.00/lb.

The reversal in the nickel price was brought about by increased demand, shortfalls in supply, and low levels of commercial stocks. Demand increased markedly in 1987, particularly by the stainless steel sector (which accounts for more than 50% of the market), and supply shortfalls occurred because USSR's nickel exports to the Western world were lower than anticipated (exports in 1986 were historically high) and because of production disruptions at Jin Chuan in China and at INCO's Creighton mine in Canada. In addition there was concern over China's embargo on nickel exports after January 1988 and the possible imposition by Dominican Republic of a high tariff on its nickel exports. Demand was well in excess of supply in 1987, putting considerable pressure on stocks; commercial stockpiles, which have been falling since 1981, are now at historically low levels.

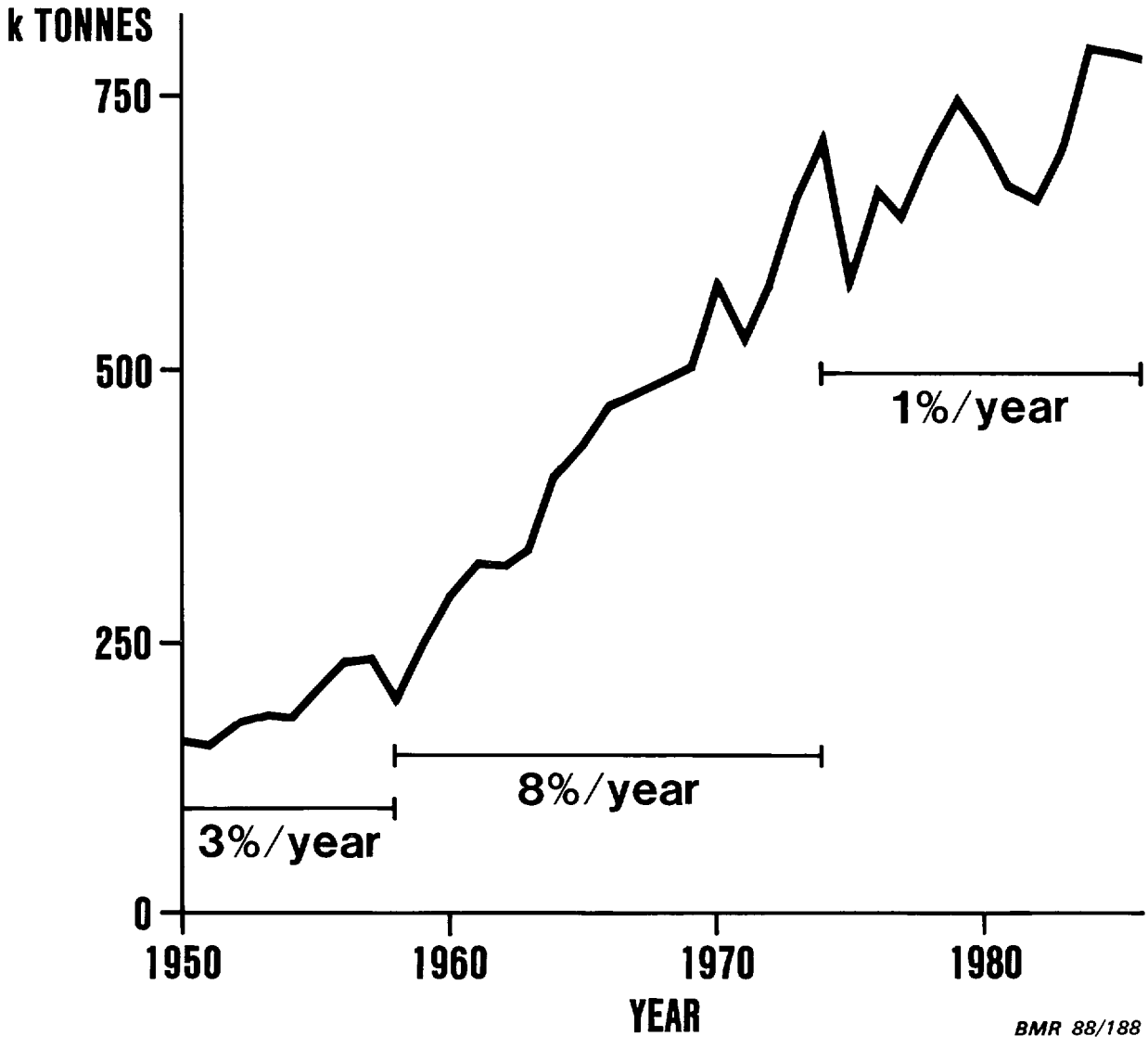
It seems likely that, for the next two or three years, commercial stocks will remain low and nickel prices will continue to be very volatile in response to short-term changes in supply and demand.

For nickel producers and consumers (and potential producers and consumers) it is the longer-term view of the nickel market which is of prime importance. The performance of the world economy is the major single factor determining demand. The outlook for the world economy can best be described as uncertain (there is certainly no consensus of opinion) and because of this a conservative estimate of consumption growth should be adopted. The 1% annual growth rate experienced since 1974 is perhaps a useful benchmark for any longer-term projection.

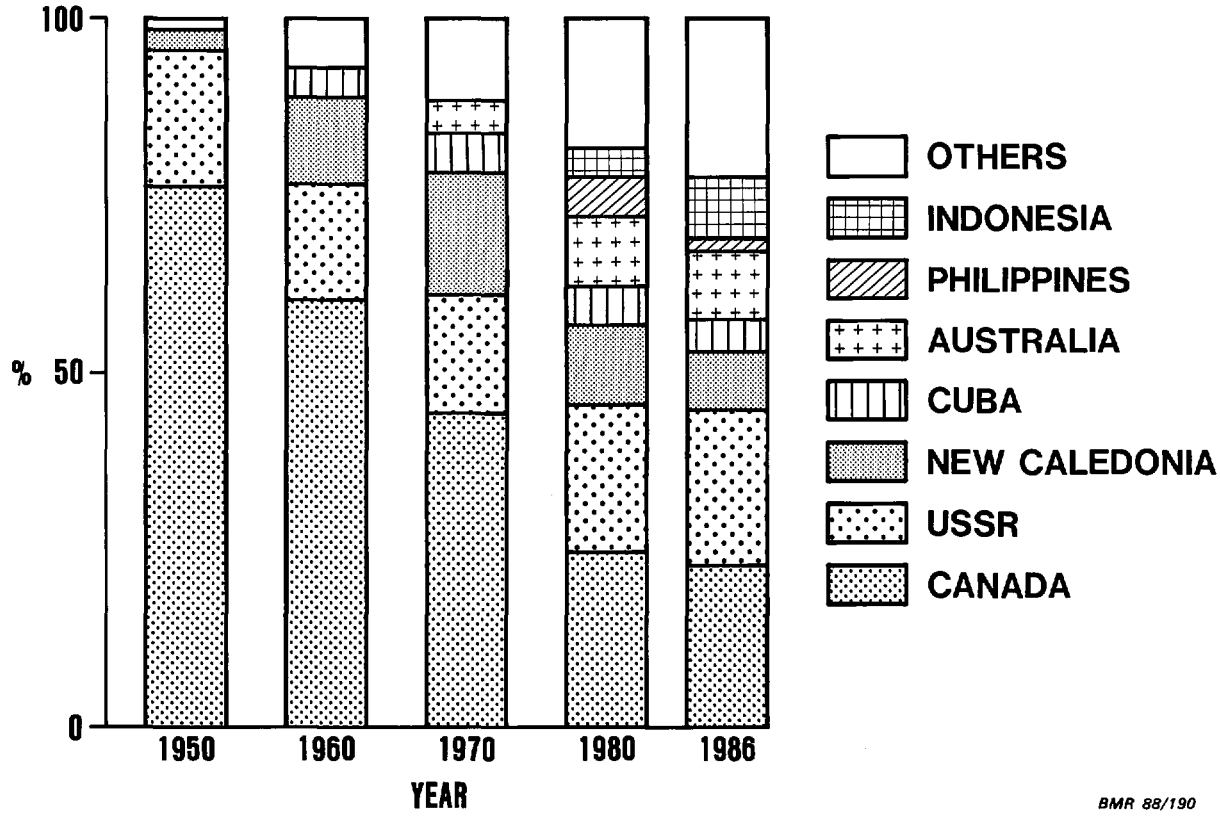
Some of the major variables in supply include the future levels of nickel exports from the USSR, and the rate of increase in mine and refinery capacity and production in Cuba and China (presuming that China's export embargo will eventually be lifted). Cuba and China are well endowed with nickel resources and both have plans for greatly increasing nickel output. Future supply from all three countries will be conditioned to some extent by the need to earn foreign exchange.

The most likely scenario in the longer term is that nickel demand will be weak and that USSR, Cuba, and China could increase their share of the nickel market. If this is so then countries such as Australia and Canada will do well to maintain their current market share. In such a scenario the prices seen in the last few months are probably not sustainable.

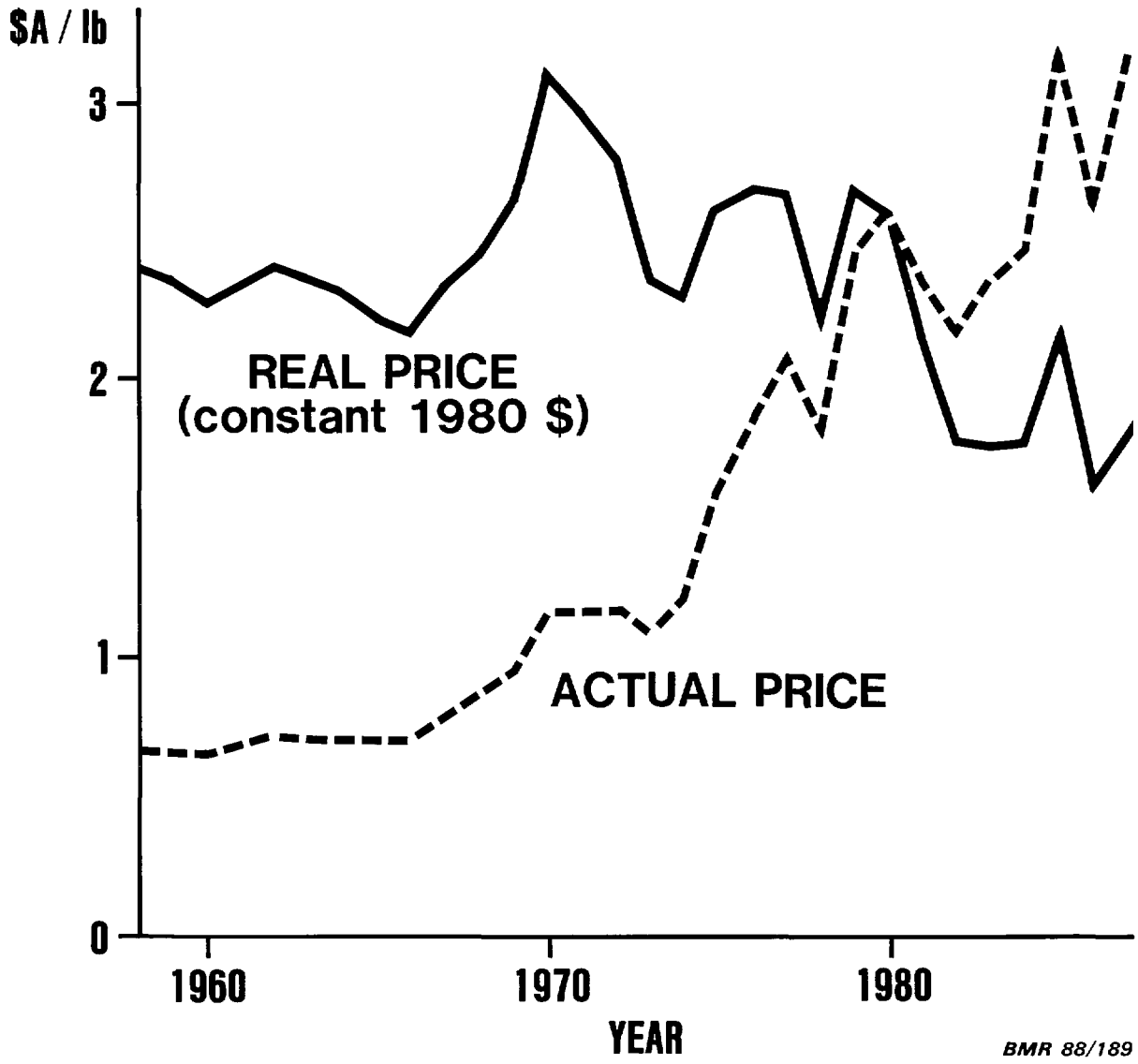
WORLD NICKEL CONSUMPTION



PROPORTION OF WORLD NICKEL MINE PRODUCTION, BY COUNTRY



COMPOSITE NICKEL PRICE



Notes

Australian copper - an expanding industry?

Mike Roarty, BMR

Australia is presently the seventh largest mine producer of copper and the tenth largest producer of refined copper in the Western world with estimated production of 223 000 t and 210 800 t respectively in 1987. Export earnings for all copper primary products were $264.9 million in 1987, 2% of Australia's total mineral export earnings.

Australian mine production of copper for 1986 and estimates for 1987 are shown in Table 1. Copper is produced both from copper orebodies (Mount Isa, Mount Lyell, Woodlawn and Cobar) and as a by-product of other metals: at Rosebery, Que River, Broken Hill, Woodlawn and Elura (lead, zinc, silver) and Kambalda (nickel). Estimated mine production for 1987 is below earlier levels as a result of lower production from the major mines at Mount Isa and Mount Lyell and from Woodlawn following the change over from an open-pit to underground operation, and because of the closure of Mount Gunson in 1986 following the exhaustion of reserves and Warrego in early 1987 because of economic circumstances.

Production from the existing mines (Table 2) is forecast to increase again in 1988 to 230 000t with higher production from both Mount Isa and Mount Lyell but will probably decline to 216 000 t by 1991 with the possible closure of Cobar unless additional reserves are outlined, and to 193 000 t by 1995 with the scheduled closure of Mount Lyell.

Additional production is expected to come from new mines as shown in Table 2. Announcements have been made to the effect that the Olympic Dam (copper), Starra, Horseshoe Lights and Hellyer (by-product copper) deposits will be developed although the levels of production past 1990 are estimates by the author. No announcements have been made on whether the development of deposits at Tennant Creek, Parkes, Scuddles, Benambra and Thalanga will proceed. The schedule that has been presented must be considered with reservations although it does provide an indication of possible production if these deposits are developed. Evaluation of the Nifty deposit is still at an early stage, and no production estimates are shown in the Table.

If the production changes occur as suggested, the net effect will be that mine production in 1995 will be nearly 30% higher than the estimate for 1988. Australia is an efficient producer of copper and both the existing and potential producers have the added advantage of substantial base and precious metal credits.

Australian refined metal production for 1986 and estimates for 1987 are shown in Table 3. Refined copper is produced at three plants, Copper Refineries Pty Ltd (CRPL) in Townsville being by far the largest; it processes all of the Mount Isa copper production. Electrolytic Refining and Smelting (ER&S) at Port Kembla produces about half of its refined product from secondary sources and Broken Hill Associated Smelters (BHAS) at Port Pirie produces copper as a by-product of their lead smelting/refining operations.

Medium term production by the three existing refineries is expected to stay around the 200 000t level to 1995 (Table 4). However this level could be reduced by some 40000t if ER&S is closed. The company is currently re-assessing its copper smelting and refining operations at Port Kembla and two options under consideration are a $120 million redevelopment or outright closure. Additional production will come from Olympic Dam, scheduled to commence production at the rate of 30 000 t/year in the second half of this year; production could increase to 55 000 t by the early 1990's.

Australia's forecast increase in mine production is possible because of a substantial increase in the resource base in recent years (Table 5). This increase results largely from the discovery and development of the Olympic Dam deposit. As at the end of December 1987, 92% of the economic demonstrated resources were in the Olympic Dam and Mount Isa deposits.

The scenario of an expanding Australian industry is set in a world context which also appears to be likely to expand. A study by Mining Annual Review indicates that scheduled new mines and extensions will add 0.65 Mt to capacity from 1987 to 1990; scheduled mine closures offset this 0.16 Mt. This suggests excess world mine capacity even allowing for the annual demand growth of 1 - 1.5% forecast by a number of industry analysts. However, this perceived excess capacity may not result in excess production as losses of production through industrial disputation were not taken into consideration, and also announcements of possible mine closures are much less likely than those about mine extensions or openings.

In an environment of a possible oversupply of copper Australia has the advantage of being an efficent producer of copper, and the economics of many of its mines are assisted by base and precious metal credits. There has been a substantial increase in economic demonstrated resources over the last few years and Australia appears set to increase both mine and metal production of copper in the short to medium-term; because most of this increase will be exported, export earnings from copper should increase considerably.

Fig1 COPPER MINES, MAJOR PROSPECTS AND TREATMENT PLANTS

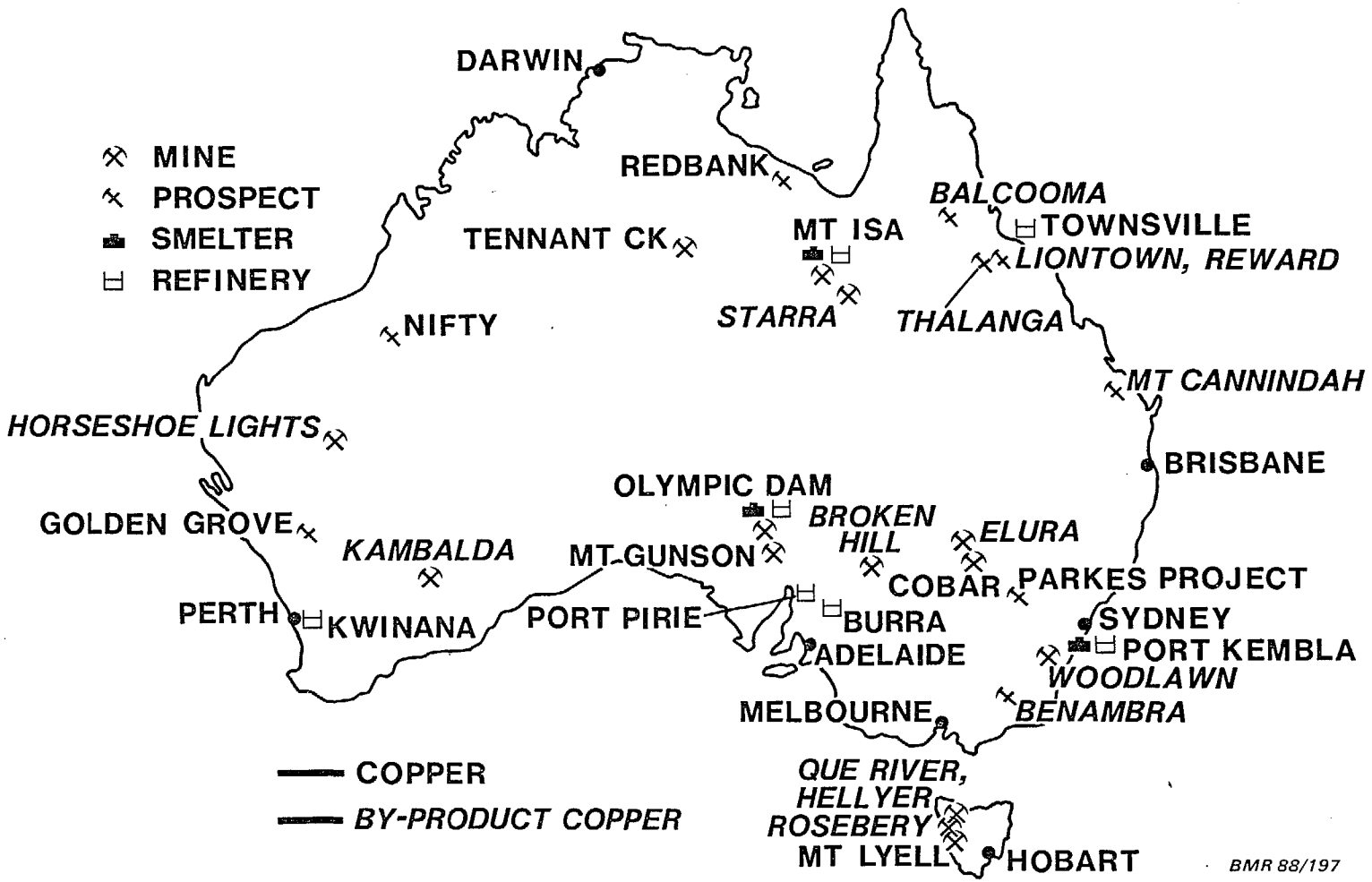


TABLE 1

AUSTRALIAN MINE PRODUCTION OF COPPER

(Contained metal t)

COMPANY	1986 t	1987 t
MT ISA	175 600	167 000
MT LYELL	23 600	22 000
WOODLAWN	15 900	8 000
COBAR	12 700	15 000
MT GUNSON	4 900 ☆	—
WARREGO	2 600 +	—
ROSEBERY, QUE RIVER	4 300	4 300
KAMBALDA	3 600	3 000
BROKEN HILL	2 700	2 700
ELURA	1 000	1 000
CLEVELAND	200 ☆	—
	247 100	223 000

☆ *CLOSED 1986* + *CLOSED 1987*

BMR 88/198

TABLE 2

PROJECTED AUSTRALIAN MINE PRODUCTION OF COPPER

(Contained metal t)

	1986	87	88	89	90	91	92	93	94	95
EXISTING MINES	247 100	223 000	230 000	230 000	230 000	216 000	216 000	216 000	216 000	193 000
NEW AND POTENTIAL MINES										
OLYMPIC DAM	-	-	8 000	30 000	35 000	40 000	45 000	55 000	55 000	55 000
(STARRA)	-	-	5 000	10 000	10 000	10 000	10 000	10 000	10 000	-
(HORSESHOE LIGHTS)	-	-	8 000	17 000	17 000	17 000	17 000	-	-	-
(HELLYER)	-	-	-	-	3 500	3 500	3 500	3 500	3 500	3 500
TENNANT CREEK	-	-	5 000	15 000	15 000	15 000	15 000	-	-	-
PARKES	-	-	-	-	20 000	28 000	28 000	40 000	40 000	40 000
SCUDDLES	-	-	-	-	6 000	12 000	12 000	12 000	12 000	12 000
(BENAMBRA)	-	-	-	-	8 000	14 000	14 000	14 000	14 000	14 000
(THALANGA)	-	-	-	-	5 000	12 000	12 000	12 000	12 000	12 000
NIFTY					?					
TOTAL	247 100	223 000	256 000	302 000	349 500	367 500	372 500	362 500	362 500	329 500

BMR 88/199

TABLE 3

AUSTRALIAN REFINED PRODUCTION OF COPPER

COMPANY	1986 t	1987 t
COPPER REFINERIES	142 000	163 000
ELECTROLYTIC REFINING & SMELTING	40 000	45 000
BROKEN HILL ASSOCIATED SMELTERS	2 900	2 800
	184 900	210 800

BMR 88/203

TABLE 4

PROJECTED AUSTRALIAN REFINED PRODUCTION OF COPPER

	1986	87	88	89	90	91	92	93	94	1995
EXISTING REFINERIES	184 900	210 800	210 000	205 000	200 000	200 000	200 000	200 000	200 000	200 000
NEW REFINERIES OLYMPIC DAM			8 000	30 000	35 000	40 000	45 000	55 000	55 000	55 000
TOTAL	184 900	210 800	218 000	235 000	235 000	240 000	245 000	255 000	255 000	255 000

BMR 88/204

AUSTRALIAN RESOURCES OF COPPER

(Mt)

TABLE 5

	1980	1987
DEMONSTRATED		
ECONOMIC	5.66	16.94
SUBECONOMIC		
PARAMARGINAL	3.41	2.06
SUBMARGINAL	1.25	1.52
INFERRED		
ECONOMIC	-	-
SUBECONOMIC	-	20.77
UNDIFFERENTIATED	0.48	1.22

BMR 86/205

Australia's position in the world lead and zinc industries

W T Wise, Electrolytic Zinc Company of Australasia Ltd

Thanks to world-class deposits like those at Mt Isa and Broken Hill, Australia's mining industry ranks first among western nations in the production of lead and second in the production of zinc. In addition it has significant smelter capacity for both metals.

The development of two new lead/zinc mines in 1987 (Hellyer in Tasmania and Cadjebut in Western Australia), together with development or potential development at seven other deposits, is certain to increase Australia's significance as a supplier of lead and zinc concentrates in future years.

Whether or not this is desirable should be viewed in light of the fact that the world lead and zinc industries have been suffering from low prices and low profits for the last decade, simply because supply has outstripped demand.

Consumption of both lead and zinc has stagnated in the developed countries, but consumption of zinc in particular has increased in the less developed countries in recent years. Zinc consumption in total is increasing at an annual rate of around 2% and lead is increasing at about 1% per annum.

With this oversupply, we have had constantly a potential surplus of 1-200 000 tonnes per annum of both lead and zinc metal worldwide.

The reason for this lies in world mine lead and zinc production, which is in oversupply because of an abundance of high-grade polymetallic deposits being mined, with zinc and lead concentrates as their main products.

Excess mine production is converted to metal by smelters which, because of high overheads, have to operate near maximum capacity. The result has been an excess of lead and zinc metal for most of the last decade at least.

It is interesting to see how the lead and zinc industries have reacted to this in Australia and elsewhere.

In Europe, where excess zinc smelting capacity is at its worst, attempts were made in both 1984 and 1987 to reduce smelting capacity by agreement and to compensate collectively the owners of the smelters to be closed. Both attempts failed.

Lead and zinc smelters and mines elsewhere in the world have been subject to considerable restructuring. Labour has been significantly reduced, lower

power costs have been negotiated in Japan and the USA, and actual wage cuts have been negotiated with Japanese unions.

In Australia, EZ's zinc smelter at Risdon is achieving significant economic and productivity improvements by virtue of a $100 million modernisation programme.

Another important recent trend has been the grouping or merging of companies from several countries into a single entity operating on a multi-national basis, either formally with cross-shareholdings, or less formally by a loose arrangement.

This provides, among other things, an opportunity for rationalisation of production levels of both mine and smelter products, or in other words, to manage supply more appropriately.

The future viability of our industry is clearly linked to the future prospects of lead and zinc and little real growth is expected in the consumption of either metal.

Zinc's main use, for galvanising, has good growth prospects, expecially in new areas such as the use of electro-galvanised sheet in the automobile industry.

Other major uses such as die-cast alloy and brass are expected to increase only modestly.

Batteries are dominant in lead's future and the lead-acid battery looks secure on both technical and economic grounds. A promising advance is the development of very large lead-acid battery installations for load levelling in power grids and a demonstration unit in California has a capacity of 10 megawatt hours and uses 2 000 tonnes of lead.

New uses for lead being developed are for specialised chemicals to prolong the life of bitumen used in road paving, for the long-term storage of nuclear waste, and for sound insulation applications.

We, therefore, as an industry, have to live with the fact of little real growth for our products and there is a general belief that there will be significant smelter closures forced by economic necessity in the not too distant future.

Nothwithstanding this, opportunities still exist for participants in the Australian lead and zinc industries over the next few years.

Australian companies could consider becoming part of a large international "group' (MIM already has cross-shareholdings with Canadian and European based companies) or even consider rationalising the remaining lead and zinc mining and smelting resources, some of which are profitable, some marginal and some unprofitable.

In addition, the next five years will probably see the Western World zinc concentrate market in structural deficit, providing an opportunity to bring a number of Australian lead/zinc deposits on line to fill the temporary vacuum.

This, however, carries with it the very real risk of significant Australian over-production after that time, affecting the viability of both new and existing zinc mines.

Also, because of the close geological association of lead and zinc, lead mine output will rise steadily over the next few years on the back of the desire to produce zinc.

These factors highlight the possibility of unmanageable over-production of lead and zinc concentrates in the next decade.

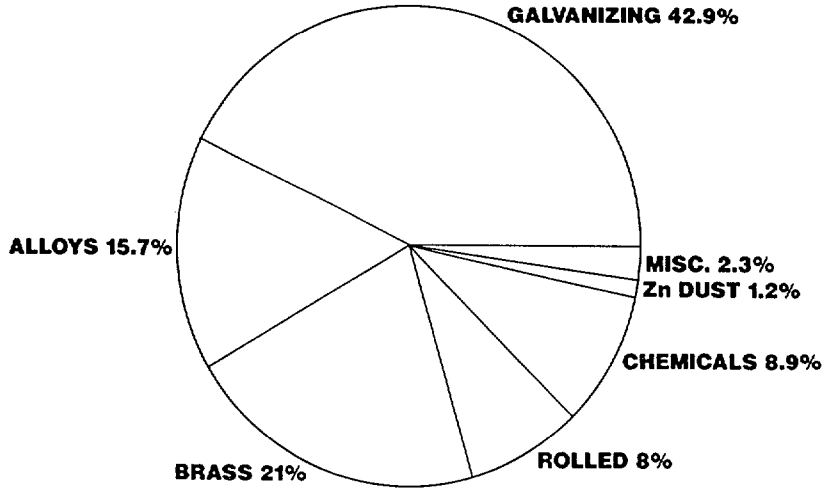
The final opportunity for the lead and zinc industry in Australia and throughout the world is through good product research and market development. Too little has been spent in these areas in recent years and we are consequently paying the price of low sustained growth for our products.

In conclusion, I would like to look to the future with some optimism and believe the 1990s will be kinder to lead and zinc than the 1980s have been.

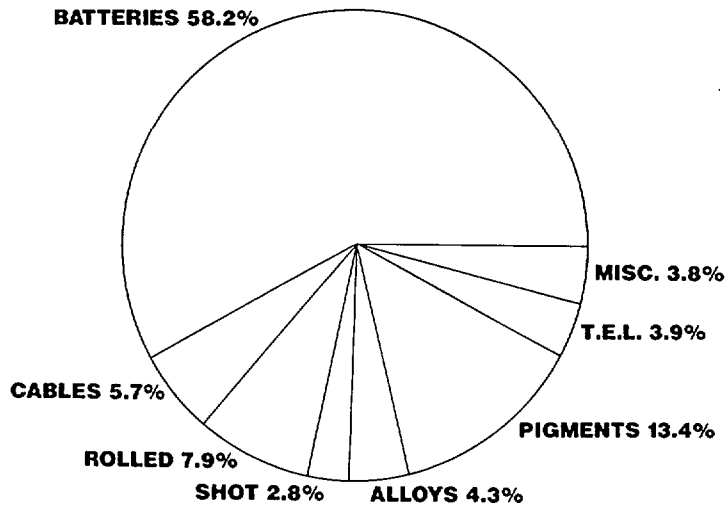
Perhaps today's oversupply will result in greater investment caution in mine and smelter capacity, producing a long-term trend which will put the lead and zinc industries in balance and provide an equitable market situation for producers and consumers alike.

AUSTRALIA'S LEAD & ZINC MINING & SMELTING FACILITIES

APPROXIMATE WESTERN WORLD ZINC CONSUMPTION BY END USE



APPROXIMATE WESTERN WORLD LEAD CONSUMPTION BY END USE



Notes

Mineral sands - will Australia retain its importance?

R.R.Towner, BMR

Despite increased production from some other countries in recent years, Australia maintained its lead in 1987 among world producers of mineral sands concentrates. Production of the titanium minerals - rutile, ilmenite and leucoxene, as well as synthetic rutile - by the seven companies currently comprising the Australian industry increased by 7% in 1987 in response to increased demand for feedstock by the pigment industry. Production of co-product zircon also increased. However, output of monazite decreased, partly reflecting declining monazite grades, and partly because of lower demand for lighter rare earth oxides.

The TiO_2 Corporation project at Cooljarloo is expected to come into operation in late 1989 increasing Australia's output of rutile and zircon by some 18 000 t year, and 40 000 t/year respectively.

Exports of mineral sands concentrates increased by about 2% in 1987; export earnings exceeded $300 million, reflecting higher prices, especially for zircon, as well as increased volumes.

In 1987 the trend of falling resources of mineral sands was reversed. Estimated economic demonstrated resources (EDR) of ilmenite, rutile, zircon and monazite combined increased by about 10% because of the proving up of additional resources in the Cooljarloo, Scott River, and Yoganup districts of Western Australia. However about 11 Mt of EDR of mineral sands remained 'frozen' by environmental considerations; these are all on the east coast and represent over 50% of east coast EDR of mineral sands.

Exploration by CRA for mineral sands deposits in the Murray Basin, which commenced in the early 1980's, resulted in the discovery of a very large deposit near Horsham in central western Victoria. The deposit is reported to consist of nearly 5 billion tonnes of sand grading on average over 2% heavy minerals (HM) within which is contained a 'core' of over 1 billion tonnes grading on average over 3% HM. In terms of contained mineral this discovery has so far increased Australia's demonstrated resources (economic + paramarginal) by about one-third for ilmenite, leucoxene, zircon, and rutile, and nearly three-fold for monazite and xenotime. At Bayfield, north of Rockhampton, Queensland, R.Z. Mines Ltd has outlined about 2.4 billion tonnes of sand containing 1.14% heavy minerals. Exploration is also continuing on deposits in the King Sound and Scott River areas in Western Australia.

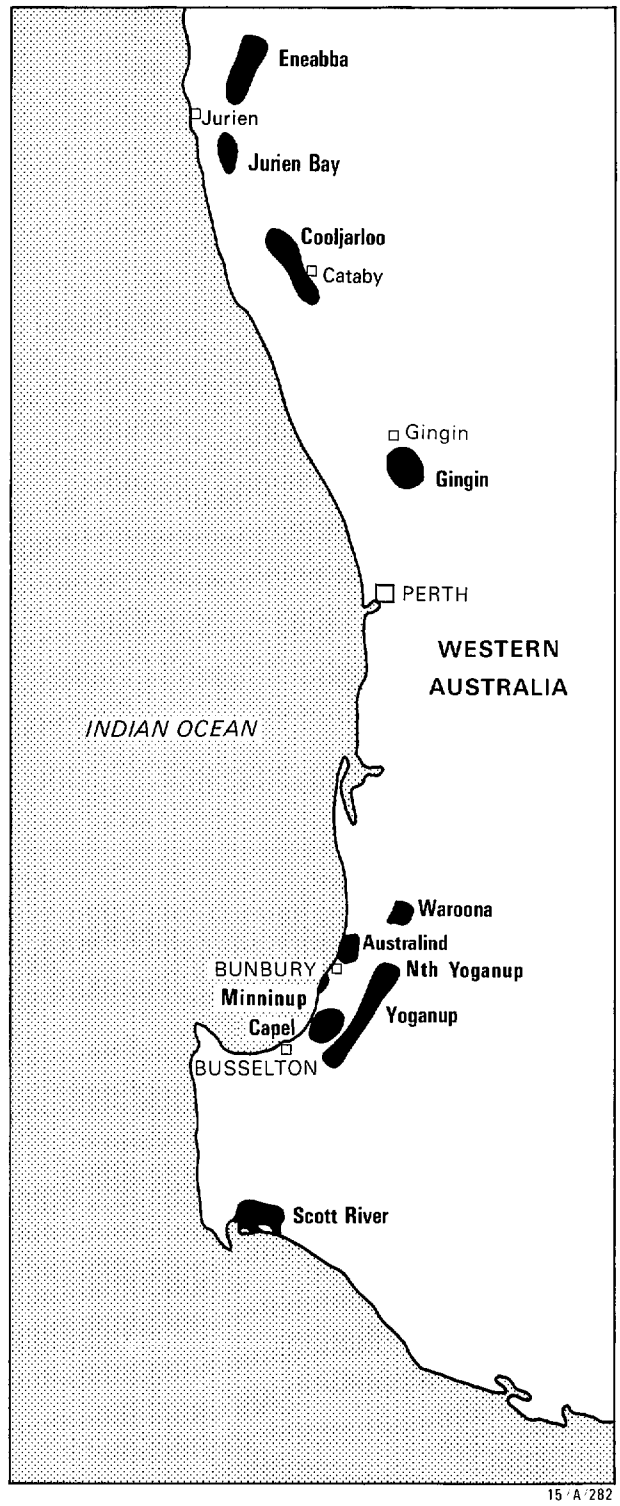
Although total economic demonstrated resources of rutile and zircon available for mining are likely to decline rapidly within the next 15 years as deposits are depleted, particularly on the east coast, the Horsham and Bayfield deposits have the potential to extend the life of these resources for some considerable period. Australia also has large hard rock deposits of titanium and rare earth minerals which are not yet regarded as economic but could be a future source of supply as low cost mineral sand deposits are depleted.

The proportion of mineral sand concentrates processed in Australia is increasing. The commissioning of two new synthetic rutile (SR) plants during the year quadrupled capacity and represents another step down the road of further processing of mineral sands concentrates. Australia is now the world's leading producer of synthetic rutile. Production of SR should reach maximum capacity of 270 000 tonnes in 1989; most of it is destined for export, although some 80000 t/year will be used locally when the choride route pigment plant near Bunbury is fully operational.

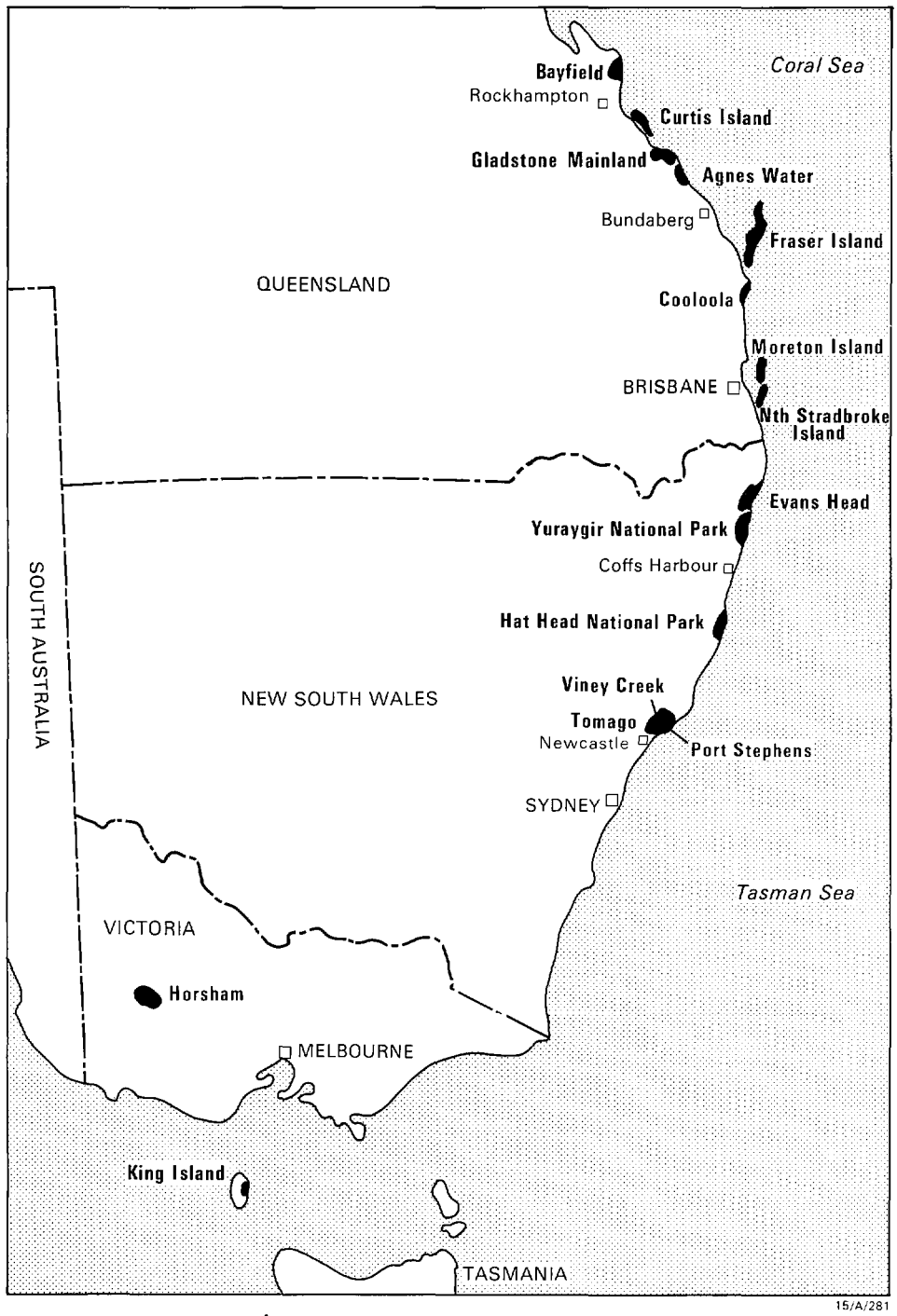
Australia's two TiO_2 pigment producers are both expanding plant capacity, one at Burnie, Tas., by more than 50% to 52 500 t/year, and the other at Bunbury, WA, by 100% to 70 000 t/year. The latter project also involves a change of processing technology from sulphate route to chloride route. ICI Australia began constructing a high-purity zirconia plant at Rockingham, WA, which is to be on stream by mid-1988.

Two monazite cracking plants could be in operation by mid 1989. Deckhand Pty Ltd has submitted its Environmental Impact Statement (EIS) for its proposed rare earth oxide plant near Lismore, NSW, and Rhone Poulenc is building a similar plant near Pinjarra, Western Australia.

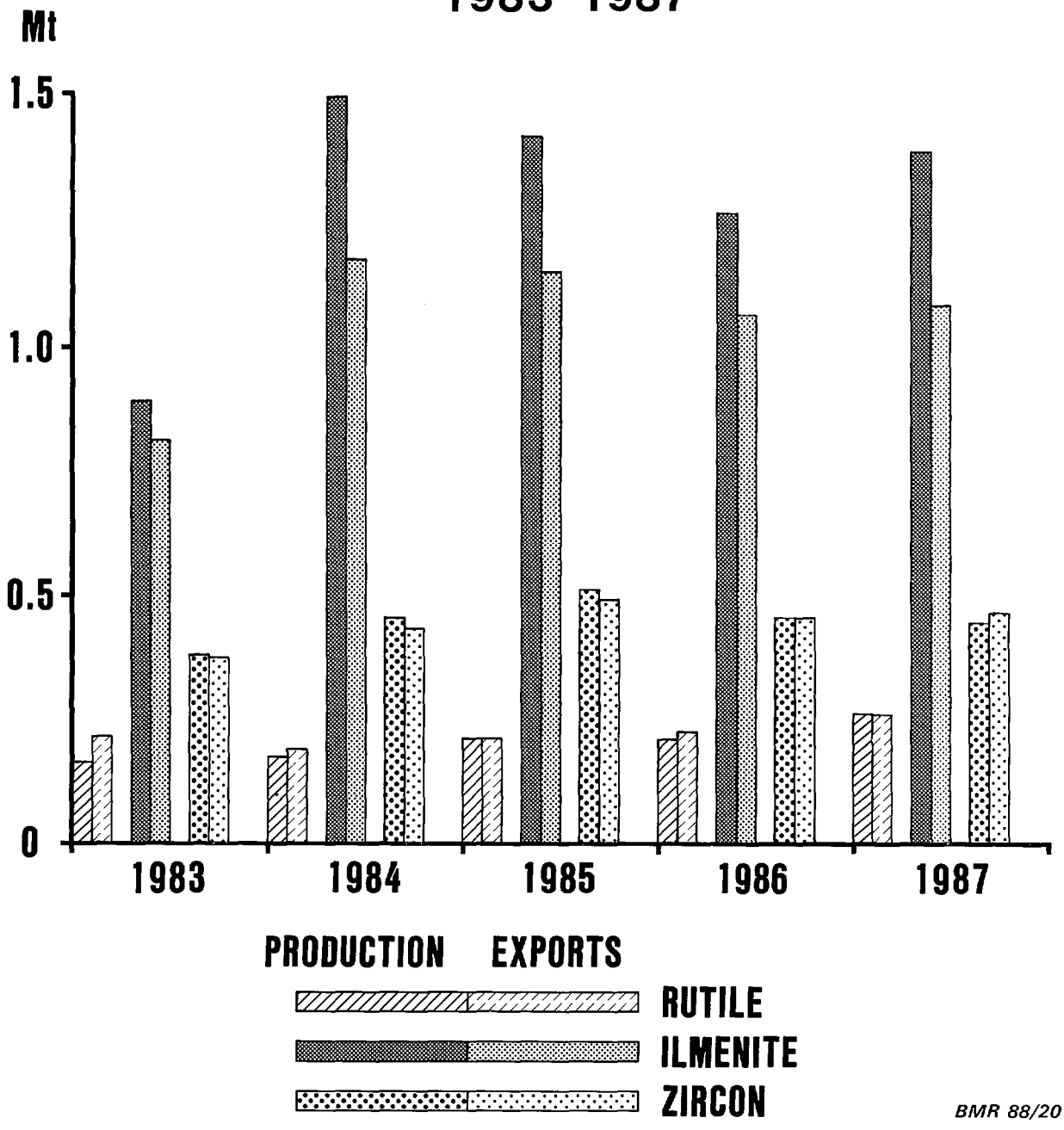
The discovery of large new resources of mineral sands and the great expansion in further processing capacities, particularly for SR and pigment, will ensure that Australia will continue as an importance source of mineral sands concentrates for the foreseeable future. This will be despite developments overseas (such as the new mineral sands discoveries in Malagasy Republic, USA and Mozambique, the further expansions by current producers e.g. in Sierra Leone and South Africa, and the increased slag production at Sorel in Canada). Exports of rutile and zircon should increase, and with the future expansion of dry plant capacities in WA, export of ilmenite should continue around the current level despite increasing use of it for SR. The increasing emphasis on the shipment of the more highly processed products, will lead to greatly increased export earnings from the mineral sands sector.



West Coast mineral sand deposits


Coral Sea
Bayfield
Rockhampton
Curtis Island
Gladstone Mainland
Agnes Water
Bundaberg
Fraser Island
QUEENSLAND
Cooloola
Moreton Island
BRISBANE
Nth Stradbroke Island
Evans Head
Yuraygir National Park
Coffs Harbour
Hat Head National Park
SOUTH AUSTRALIA
NEW SOUTH WALES
Viney Creek
Tomago
Newcastle
Port Stephens
SYDNEY
Tasman Sea
VICTORIA
Horsham
MELBOURNE
King Island
TASMANIA
15/A/281
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
ACT
VICTORIA
TASMANIA
0
300 km
Mineral Sand Deposit

MINERAL SANDS - PRODUCTION & EXPORTS 1983-1987



Notes

Tin: through turmoil, towards tranquility?

I. McNaught, BMR

Fundamental structural change has affected the world tin industry after the collapse of tin prices in October 1985 following suspension of price support by the International Tin Council (ITC).

The collapse resulted in the suspension of trading by the London Metal Exchange (LME), the Kuala Lumpur Tin Market (KLTM), the New York market, and the US General Service Administration from the strategic stockpile; publication of tin prices on these markets ceased. Although quotation of the KLTM price resumed early in 1986, turnover volumes were too low for the price to be regarded as a reliable international price indicator. Although trade journals such as Metal Bulletin, and Metals Week, published prices based on regular assessments of prices at which tin is being traded, it is not clear how representative these published prices are.

When the LME trading was suspended, hedging facilities were no longer available for tin. A result of this was that smelters preferred to toll treat rather than buy concentrates; this enabled producers and consumers to deal directly with one another, reducing the amount of tin being traded through merchants.

Before 1982, the world tin market was dominated by the ITC which tried to regulate the market through a buffer stock mechanism supported by an export quota system. Over the last decade and particularly from 1982 to 1985, the market was oversupplied largely because countries which were not producer members of the ITC were able to take advantage of the supported price and expand production, as they were not subject to the reduction of production by 40% introduced by the ITC in 1982. The effect of these expansions and the ITC reduction was that ITC producer members' share of non-Communist world mine production fell from 86% in 1982 to 54% in 1985. Supply from non-ITC member countries, particularly Brazil and China and, to a lesser extent, the US through its General Service Administration became more influential in the tin market as ITC market share decreased.

In addition, despite a halving of the tin price since early 1985, there is little indication yet that consumption is increasing. Indeed, as Table 1 indicates, over the last decade world consumption of primary tin metal has fallen overall by 10% although since 1985 it has increased slowly. Also not to be overlooked is that, despite extensive destocking having occurred elsewhere, the US strategic stockpile still contains over 170 000 t of tin, although only about 10 000 t was authorised for disposal at the end of 1987.

The export restraints by the Association of Tin Producing Countries (ATPC) and by the non-ATPC members, Brazil and China, involve agreement on production limitations by countries supplying over 80% of world tin mine production in 1987. This has led to a rundown of excessive world tin stocks, which may allow a return of normal market forces when stocks reach acceptable levels of around 30 000 t.

Although it is possible that supply and demand will approach balance by about the end of this year, and the tin market then may be governed largely by the interplay of these two factors, a changed market structure needs to be recognised. Features arising from that change are:

- with the high degree of producer to consumer trading and low visible market turnover volumes, published prices may still not provide valid signals of supply/demand relationships.
- while producers are adjusting to sustained low prices, profit levels are low, increasing producers' vulnerability to international currency fluctuations; these fluctuations add to the uncertainty of cost and revenue projections, particularly in the absence of traditional hedging mechanisms.
- since October 1985, there have been no ITC floor price and Buffer Stock manager underpinning of the world tin price.
- even though the Kuala Lumpur Commodity Exchange has operated since November 1987, hedging facilities for tin are limited, leaving both producers and consumers vulnerable to price volatility.
- Some existing producers receive debt servicing and other cost assistance making tin supply less price responsive.
- production is still limited by ATPC restraints and undertakings to the ATPC by China and Brazil.
- any large increases in production occurring when stocks return to normal levels could again destabilise markets.

Over the last decade the Australian tin industry has accounted for 3 - 5% of non-communist world tin mine production. Until mid-1986 Australia was self-sufficient in refined tin. Since late 1985, high cost producers have closed down or reduced production, smelters have reduced production of refined tin because of shortage of concentrates, and tin exploration, which was already diminishing, has decreased to virtually nothing. Although Australia in 1987 had 185 000 t of economic demonstrated resources of tin, most of this is in one deposit. A decade ago economic demonstrated resources stood at 191 600 t of tin. Several medium-sized mines have closed, including Ardlethan, Cleveland, Gibsonvale, and Great Northern; in 1985 production from these mines totalled 1950 t of tin, 30% of Australia's total production. The

numerous small mines in North Queensland ceased production or accepted combined Federal-State Government offers of assistance to relocate out of the tin industry; this meant an annual loss of more than 1000 t of tin production.

In contrast, Australia's largest tin producer, Renison, expanded production to pre-ITC export control levels. All its production is exported for toll smelting. Australia's two smelters have been affected by a lack of suitable concentrate because of mine closures and output fell to a point, where, in late 1986, consumers started to import large tonnages of metal.

The proposed new medium-sized alluvial operations of Republic Resources Australia NL at Ardlethan and North Queensland Resources NL at Wolverton give some cause for optimism that the Australian tin industry will begin to grow again despite the changed conditions and lower prices.

The tin market is emerging from the turmoil of the last two years, but into a new environment. Supply/demand relationships will be more influential and individual producers and consumers will have to be alert to changing circumstances. The rate at which decreased tin prices are translated into increased tin consumption will have a bearing on the outlook for 1988, given continued producers' restraint to decrease world metal stocks.

The need for a period of supply and price tranquility is evident in the lag in consumer response to a new tin price regime. Potentially new and returning tin consumers will take their lead for long-term decisions from their perception of the outlook as the tin market approaches balance in late 1988. The hope for the tin industry is in increasing consumption, not in limiting supply.

TIN - SALIENT STATISTICS

' 000 tonnes

	1	2	3	4	5	6	7	8
1978	169	197	86%	192	185	44	11.9	5.1
1979	173	200	86%	202	186	39	12.6	5.4
1980	171	200	86%	199	175	43	11.6	4.8
1981	174	205	85%	197	163	53	12.3	4.3
1982	129	191	68%	181	154	87	12.1	3.1
1983	101	173	58%	159	154	104	9.3	2.9
1984	98	167	59%	161	166	94	7.9	2.9
1985	86	159	54%	158	161	113	6.4	2.7
1986	81	139	58%	149	165	90	8.5	1.4
1987(e)	81	136	60%	148	166	67	7.5	0.6
1988(e)	83	140	59%	150	168	30-50	8.0	1.0

Source: ITC published statistics, or where indicated, other sources;
e - estimate

1. ITC producer member tin-in-concentrate production.(Bolivia did not rejoin in 1982.)
2. World tin-in-concentrate production (excludes Communist countries including USSR, China)
3. ITC producer member share of world tin-in-concentrate production.
4. World primary tin metal production (excludes Communist countries, as above); includes some secondary tin.
5. World consumption of primary tin metal (excluding Communist countries, as above)
6. Combined tin stocks (tin-in-concentrate and metal) (excluding Communist countries as above).
7. Australian tin-in-concentrate production (BMR)
8. Australian primary tin metal production (BMR)

Gold - the beginning of the end or the end of the beginning?

N Miskelly, Director Resources - Ord Minnett Limited

Factors affecting price

In recent years, largely due to the excellent efforts of Consolidated Gold Fields of London, statistics on annual gold supply and demand have become more reliable and hence increasingly useful and used.

Despite this, forecasting of likely gold prices has not been made any easier since, unlike other metals, gold has a multiple role for which the various demand factors can and do vary considerably over time. Gold is seldom consumed, it is bought to keep.

The demand for gold can be seen as being driven by four principal factors, which are sometimes in conflict, but occasionally work in unison. These are:

(a) gold for strict industrial uses
(b) gold as an alternative currency
(c) gold as a monetary mechanism
(d) gold as a long term alternative store of value

What can be said is that gold price forecasting is made more difficult because changes in the various demand (and sometimes supply) factors can vary over wide ranges, over both short and longer periods.

For example, the 1970s saw massive investment in gold from the oil surpluses generated by the then rapidly escalating OPEC oil price.

In the early 1980s the popularity of gold usage in coins grew, thus maintaining a consistent level of 'investment' demand, which may have otherwise displayed some slippage.

In the mid 1980s gold was characterised by increasing supply yet at the same time, first increases in price, at least in US dollars. Curiously, this tells us more about the investment perception of the US dollar than it does about gold. The nexus between the declining value of the US dollar, as expressed by comparison with the TWI exchange rate, and the rise in the gold price from 1984 to 1988, is clear - **refer Figure 1.**

The TWI exchange rate of the US dollar is driven by many factors, but perhaps the major determinant is the US inflation rate, both in absolute terms and vis-a-vis other major currencies.

A 'high' inflation rate, both absolute and relative, will cause investors to seek compensatory investments, either as a hedge situation (to quarantine losses), or to enhance profits. Sometimes other strong currencies will be preferred, while gold will also be attractive for those who have little trust in paper currencies. **Refer Figure 2.**

The gold price, as expressed in US dollars, tells us more about investors' perceptions of the value of that currency (or any other currency) than it does about the price of gold. A case can be made that, random factors aside, the price of gold remains 'constant', but the price of gold reflects more closely the declining value and investment attraction of the US dollar. In 1987 the increase in the price of gold in US dollars almost completely offset the value of the decline in the US dollar against other currencies.

This fall in investment merit can be largely linked to the growth in excess money supply in USA - **refer Figure 3.**

Supply

Demand, rather than supply, has provided the more volatile variable in the gold price equation, if for no other reasons than supply statistics are more reliable in predictability, and are less subject to large movements, except from drawn down out of inventory. Since 1980 western world gold production has grown at a compound rate of 6% per annum, with all of the increase coming from non-South African sources - **refer Figure 4.** It should be noted that in 1980 western world mine output of gold totalled 925 tonnes, or 25% less than ten years earlier, when output was 1 274 tonnes. By 1986 all the loss had been made up, and by 1990 mine output could comfortably exceed 1 600 tonnes.

However, supply should not be looked at in terms of annual increments neatly balanced, more or less, against demand - there is the stock of gold already mined, refined and, in most cases, held in 'safe' hands.

Above ground stocks in all forms are, on best estimates, between 90 000 and 100 000 tonnes. Current western world mine output of gold at around 1 500 tonnes is adding to this above ground stock of gold at a rate of less than 1.5 per cent annually. Put another way, there is over 60 years annual supply of gold already mined and refined and ready for the market, given the right stimulus.

Demand

Ord Minnett's projections for Gold Supply and Demand in 1988 are shown in **Figure 4a** (Australian Gold - The Competitive Edge, January 1988).

We see the perceived value of gold relative to alternative financial assets as being of far greater significance in the future trend of gold prices than the annual addition to above ground gold inventories.

From a short term stock adjustment approach, factors like changes in the money supply and interest rates are much more relevant (catastrophic political events, being 'random', are excluded from the forecast mode).

Gold can be seen as an alternative liquid store of wealth to currencies. However, whereas golding currencies usually returns a positive rate of interest, to hold gold actually costs the investor, at least to the extent of the opportunity cost of interest foregone. Therefore, political anxiety factors aside, gold prices tend to rise only when investors suspect the nominal rate of interest being received on their currency holdings will be exceeded by the loss in the purchasing power of those currencies. However, fears of loss of purchasing power can also typically arise during times of severe financial or political instability, which could lead to circumstances in which the value of the currency is undermined. Put simply, investors will turn to gold when they lose confidence in currencies. Gold, more than any other commodity, thrives on anxiety, uncertainty and fear.

In the aftermath of the 19 October Black Monday stock market slump, and in the context of the US twin deficits (US government revenue/expenditure gap, and the balance of payments deficiency), it is still far from clear what economic/monetary/currency scenario will develop in 1988. We believe the world economy is currently delicately poised between an inflationary and a deflationary recession.

An **inflationary recession** could arise as a result of government attempts to avert financial crisis and to support economic activity by accelerating money supply and reducing 'real' interest rates. In these circumstances, confidence in currencies could be undermined not only by the pace of monetary growth, but also by an increasing feeling that governments would find it difficult to take a stand against inflation without risking financial collapse and possibly depression.

A deflationary recession could occur if financial instability leads to a breakdown of the debt structure. This should be associated with a dearth of liquidity and high 'real' interest rates.

In the former environment, the global gold price (in terms of a basket of currencies) would be expected to perform well as investors sought to protect their wealth. In the latter, the gold price would be expected to come under pressure unless instability in the financial system became so great that confidence was lost in the capacity of the banking system and currency to act as a store of value. The precedent for this situation is the 1930s, when the US authorities raised the gold price in an effort to restore confidence in the domestic and international environment. In terms of gold's international value, the difference between an inflationary and deflationary recession may not actually be that great.

The gold market

In 1987 in New York Gold Futures trading some 10.2 million contracts, representing some 30 000 tonnes, were traded. Add to this gold trading elsewhere, plus options, the multiple of gold traded to annual output is probably well over 50 times!

Price outlook

If there is one factor which, as a single touchstone, indicates the likely trend of market sentiment towards gold, it is the trend of US money supply growth. In the short to medium term recent divergent trends in monetary growth in the US compared with other major nations argues for a rally in the US dollar and this would likely act as a dampener on the gold price in that currency. In recent months there has been significant deceleration of US money supply growth. 'Broad' money (M2 plus quasi-money) growth in the US is now running at below 4 per cent annually, whilst 'narrow' money (M1) in the late weeks of February, 1988 was just 3 to 4 per cent above levels of twelve months ago and, moreover, had been essentially flat for almost a year. This rate of growth is significantly below interest rates in the US, whereas the converse is true in many other major nations. In Japan, broad money growth of 12 per cent compares with interest rates in the 4 to 6 per cent region. Given, moreover, that Japanese economic growth is now entirely dependent on domestic expansion, with imports rising accordingly at a time when exports are experiencing increasing competitive pressure, a continuation of the rally in the US dollar does seem to be in store.

If past correlations hold good, an appreciating dollar can be expected to be associated with a declining US gold price. The extent of the latter would be exacerbated if an appreciating dollar caused investors to move out of gold on a large scale in preference for other dollar denominated financial assets.

However, as far as the price of gold in Australian dollars is concerned, the Australian currency can be expected to act as a built-in stabiliser, which dampens (but not necessarily offsets) movements in the 'global' gold price. For the circumstances in which the global gold price would be likely to decline (ie, deflation) would also be likely to place considerable pressure on the A$ as a commodity-based currency and traditional inflation hedge counter. Conversely, the circumstances which would likely provide for a rising global gold price (ie, world inflation) should see the A$ well supported by strong capital inflows as global investors sought inflation hedge investments.

Last year the gold price closed at A$675 per ounce and the exchange rate at a fraction over 72 US cents to the Australian dollar. Under an inflationary recession scenario, the latter should at least hold its end 1987 level and might conceivably appreciate to 75 US cents. Under a deflationary recession scenario we would expect the Australian dollar to retreat to around 65 US cents, the level prevailing just over one year ago. Within these two scenarios the US dollar gold price could range between US$400 and US$460 per ounce without significantly affecting the Australian dollar price from its 1987 closing level of A$675 per ounce.

Implications for Australian supply

As noted earlier, South African gold output has remained static since the early 1980s.

North American production rose 70 tonnes between 1980 and 1984 and Brazil's output passed the 60 tonne mark in that latter year. Against this, the rise in Australian production from 17 tonnes to 39 tonnes seemed fairly inconsequential. However, from the mid 1980s Australia began to emerge as a major force in the world gold mining industry as exclusive tax exemption on gold mining profits and a rising and increasingly profitable domestic gold price proved an irrestible lure to large and junior mining companies.

In 1980 Australia ranked only seventh amongst the western world gold producing nations, and accounted for less than two per cent of that year's output. By 1986 Australia had risen to be the fourth largest producer and its share of western world production had trebled to nearly six per cent. On the basis of known plans, Australia will, by the end of this decade, rate begind only South Africa and US in the production league and will account for nearly 12 per cent of total output. (**Figure 5**).

Much of the gains to date have occurred in Western Australia, where typically small scale (20 000-50 000 oz/t) open pit mines exploring near-surface deposits could (and still can) be brought to production quickly and at relatively low capital cost. More latterly, other States have attracted increasing attention and their contribution to total output is now rising (**Figure 6**).

In volume terms, Australian production will have multiplied more than tenfold from just 17 tonnes in 1980 to 186 tonnes in 1989 and 177 tonnes in 1990. The latter figure is projected on the basis of reported current ore reserves and published plans and is almost certain to be exceeded. Existing operations will, on past performance, prove up additional reserves as mining proceeds and plans to develop new mines are being announced almost daily. Since 1980 Australian mine output has grown by over 30 per cent per annum. For each of 1986 and last year, output will have risen by over 50 per cent. If the trend growth rate since 1980 is maintained, 1990 production would total 250 tonnes! An actual outcome in excess of 200 tonnes would seem to be reasonably assured.

Amongst the major producers, Australia emerged in 1986 as the country with the lowest production costs. In that year average cash operating costs were just US$179 per ounce. This compared to $195 per ounce in South Africa and over $200 per ounce in both the US and Canada. Three years earlier Australia's, the US' and Canada's average cash costs were all close to $270 per ounce and well above the South African average of $209 (**Figure 7**).

Australia also compares extremely favourably with respect to capital costs (**Figure 8**). A typical operation will have all up capital costs of not much more than $200 per annual ounce of production, ie, around $10 million for a 50 000 ounce per year operation. This compared to over $480 per annual ounce in Canada and around $410 in the US.

While such differences in capital costs reflect the varying nature of gold mining in the three countries, it does mean that Australian operations have by far the quickest capital pay back. For a 'typical' mine boasting operating costs of $200 per ounce, the capital pay back at a gold price of $450 would be less than 12 months!

At say A$600 per ounce, and cash working costs below A$250 per ounce, the high cash profit margin per ounce seems reasonably assured, thus enhancing gold's corporate investment attraction. While we maintain our expectation that Australia's annual gold production should comfortably exceed 200 tonnes by the end of this decade, the rate of growth after that time, in the absence of a higher gold price, seems certain to slow down.

Contributing factors would include:

- the likelihood of higher government take from gold mining revenues and/or profits

- depletion of reserves at some of the short life mines

- substantially higher capital costs as a higher proportion of mines go underground

- a more difficult stock market, resulting in a fall off in the ability to raise new equity funds for exploration

- more expensive exploration costs as the easy-to-find deposits become progressively harder to locate

- higher per ounce treatment costs as grades decline and as less oxidised and more sulphide ore is mined.

Conclusion

Gold mining in Australia still has a bright future, if you have the reserves and cash or cash flow. The current pause for breath as the gold price retreats from higher levels is the end of the beginning, not the beginning of the end.

US$GOLD VS US$ TWI INVERSE
Ord Minnett Research

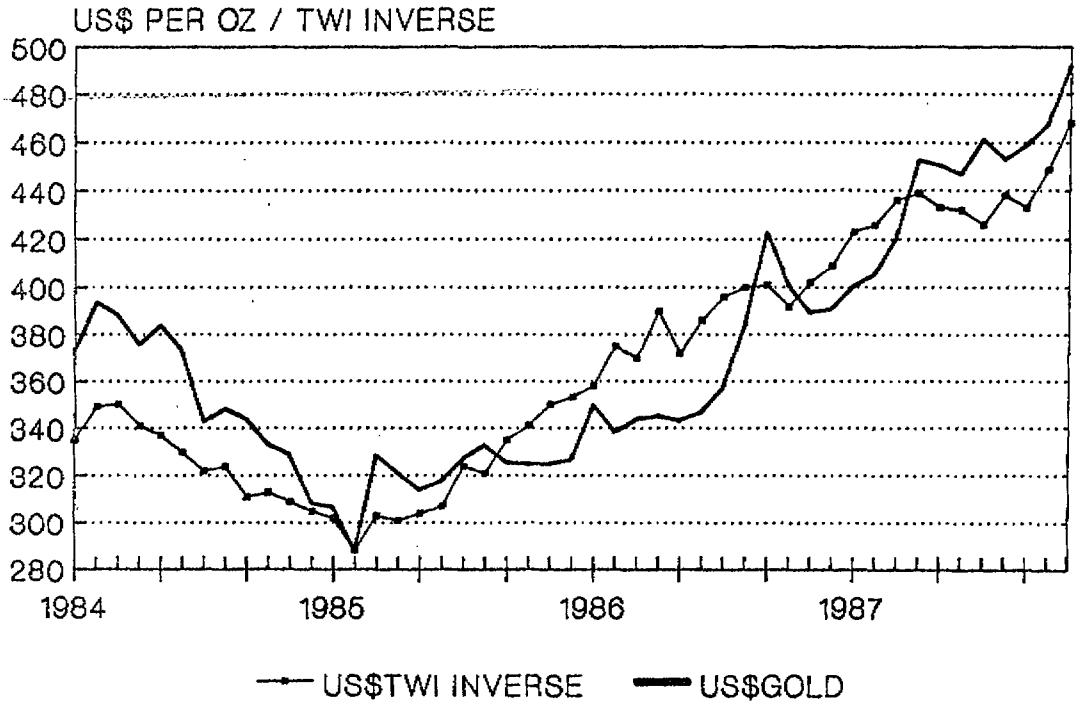
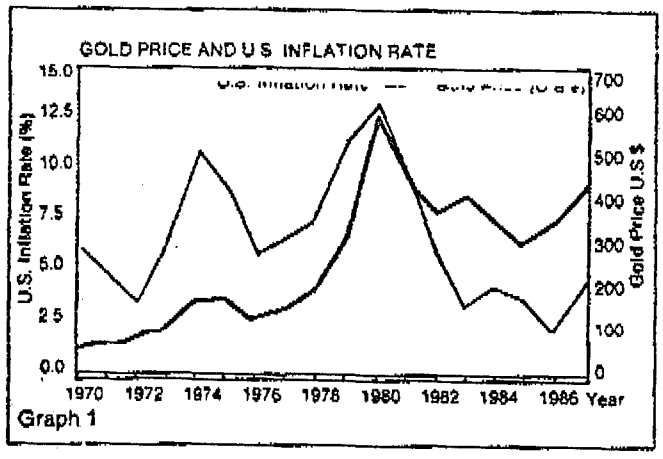


Figure 1



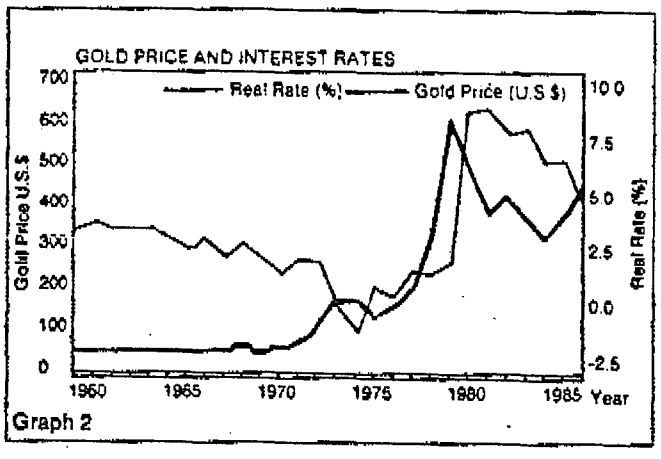


Figure 2

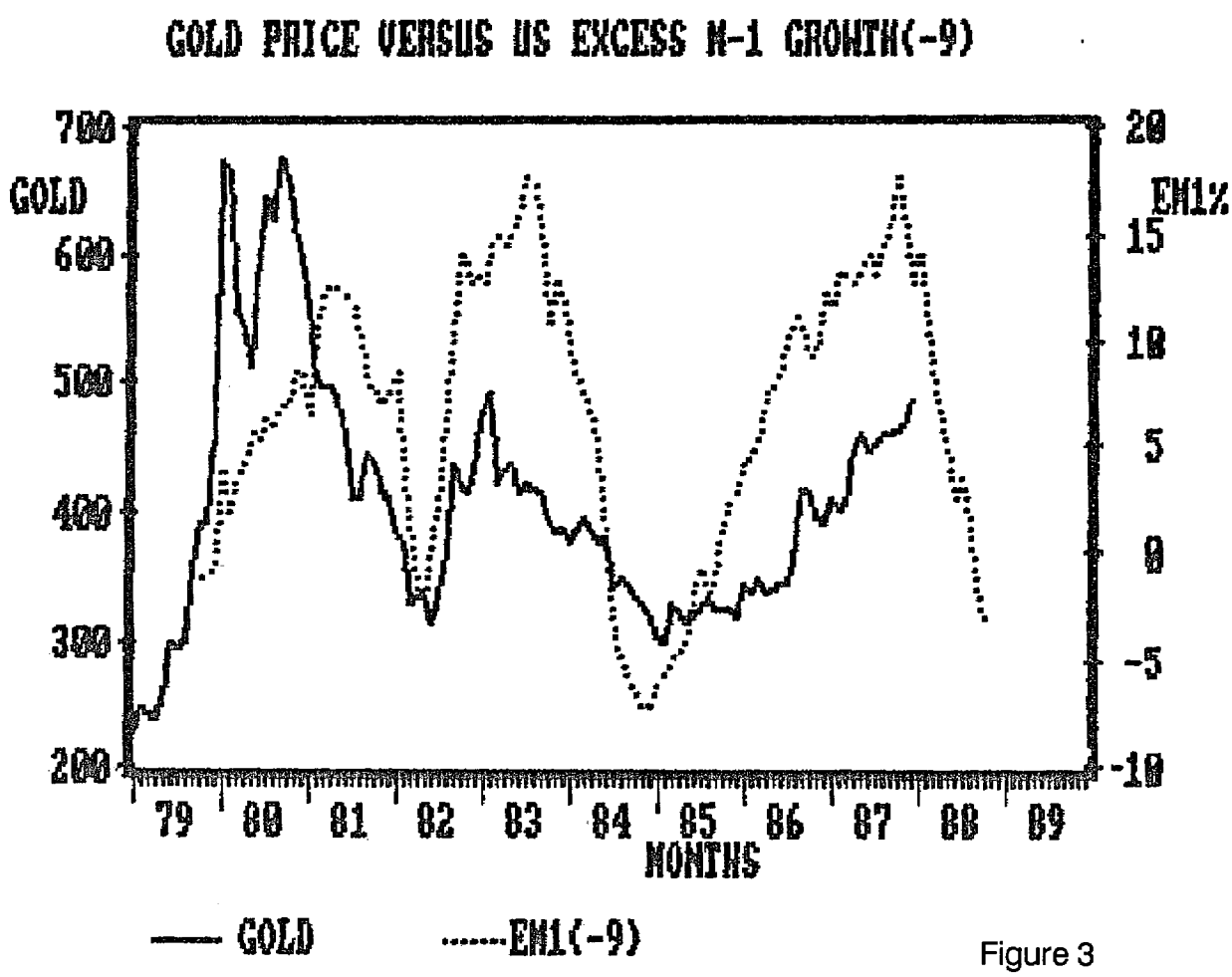


Figure 3

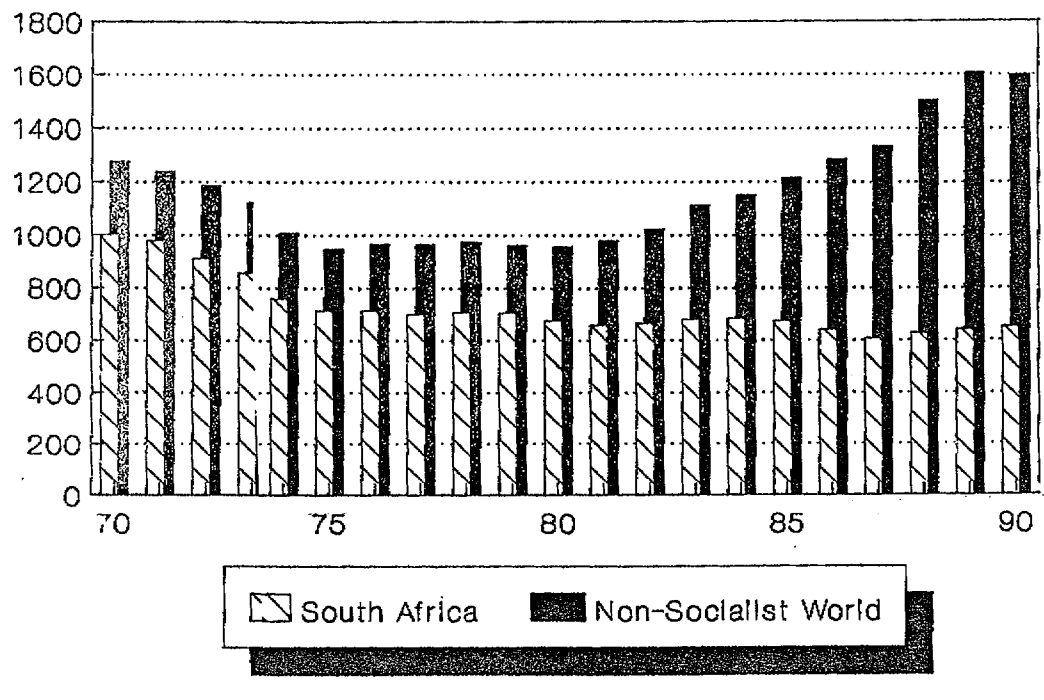


Figure 4

MMRS

Table 1: Gold Supply And Demand 1986-1988

	(tonnes)		
	1986	1987	1988
SUPPLY			
Mine Production	1281	1336	1506
Scrap Recovery	465	350	300
Net East Bloc Sales	402	275	275
Central Bank Sales	(181)	100	-
TOTAL SUPPLY	**1967**	**2061**	**2081**
DEMAND			
Jewellery	1097	1050	1000
Official Coins	327	210	220
Industrial & Commercial	243	245	245
FABRICATION DEMAND	**1666**	**1505**	**1465**
Bullion Absorption (Supply-Demand)	301	556	616

Source: 1986 Consolidated Gold Fields

1987-88 Ord Minnett estimates and forecast.

Figure 4a

AUSTRALIA'S SHARE OF WESTERN WORLD GOLD PRODUCTION

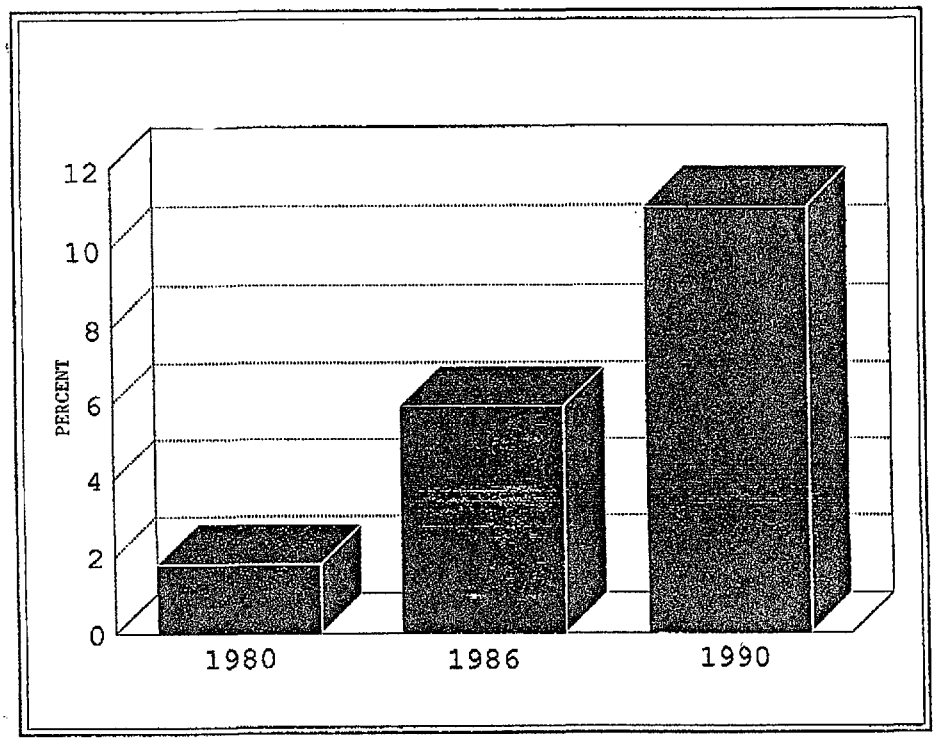


Figure 5

REGIONAL BREAKDOWN OF PRODUCTION IN AUSTRALIA

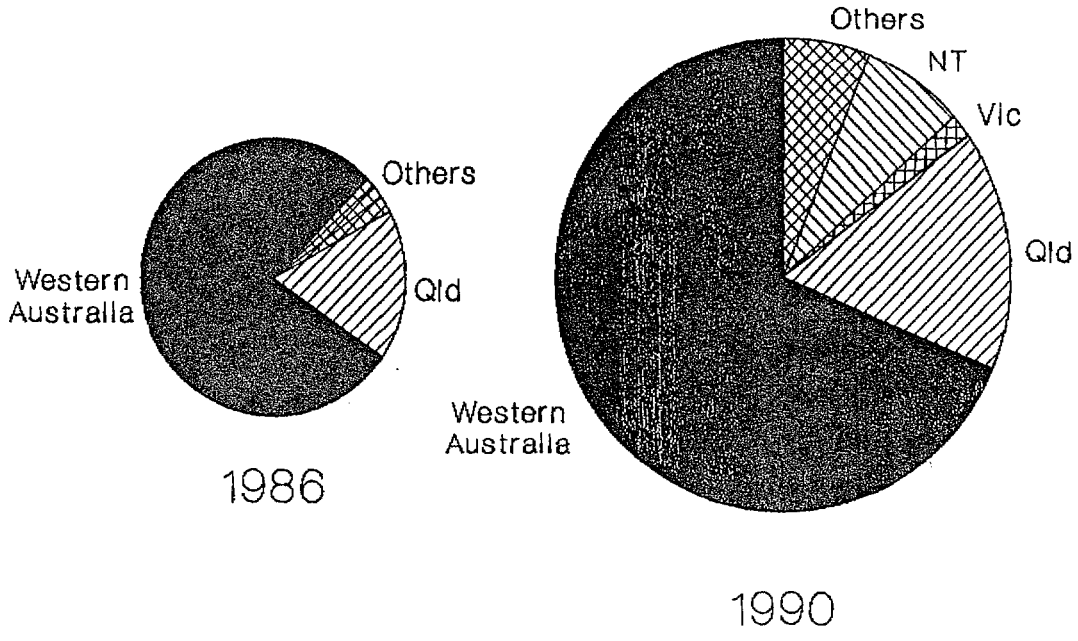
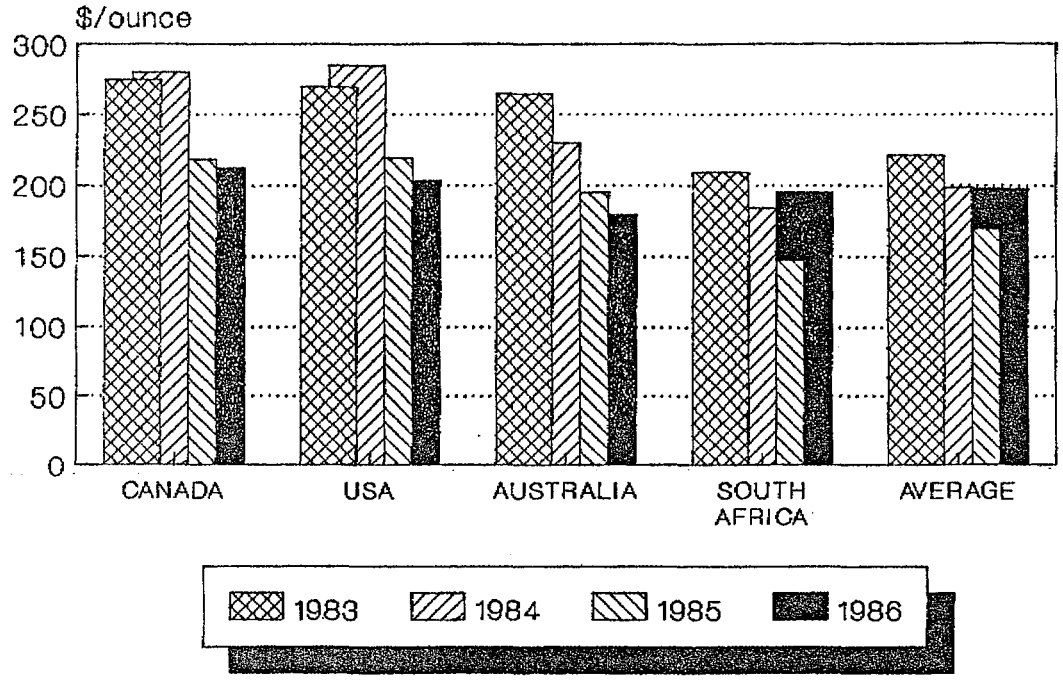


Figure 6

MMRS

RECENT TRENDS IN GOLD CASH PRODUCTION COSTS



MMRS

International Cost Curve Comparison

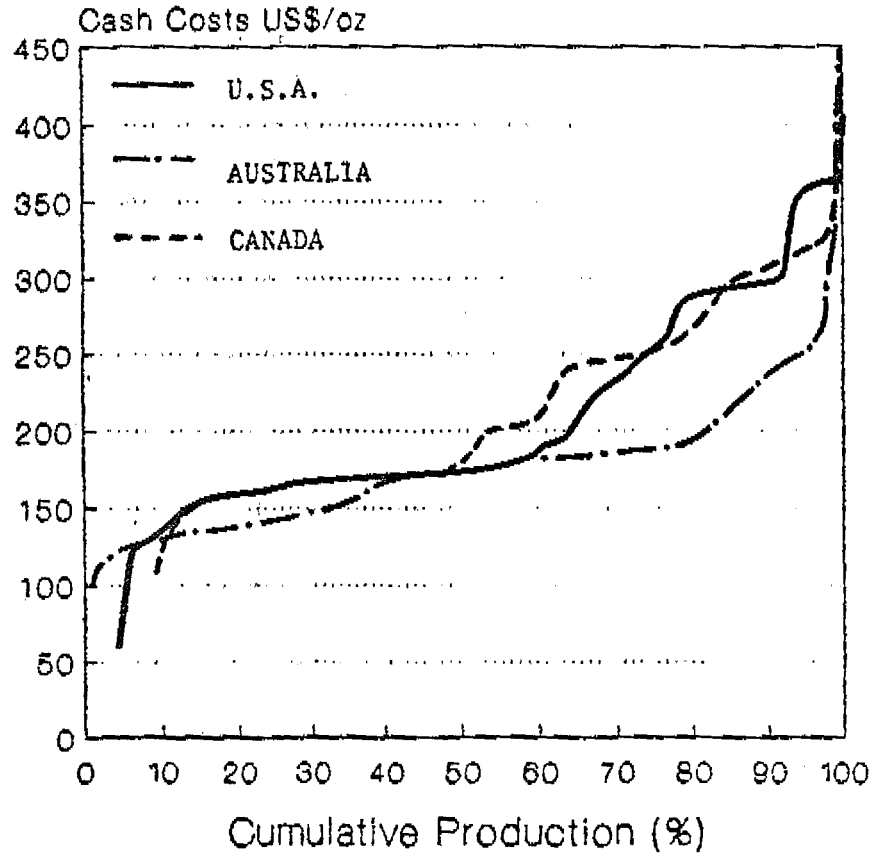
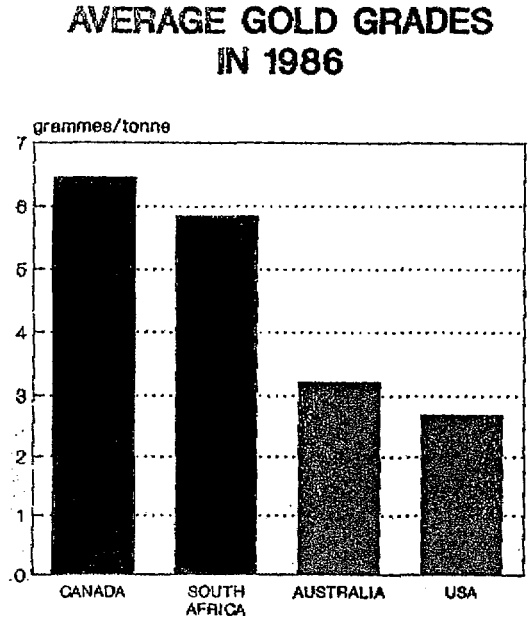


Figure 7a



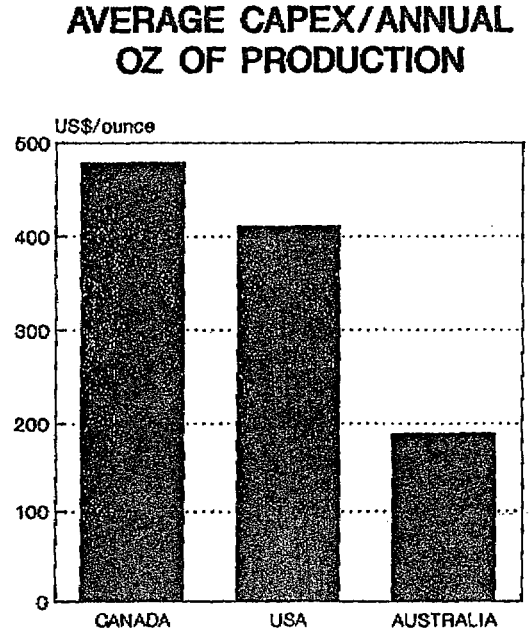


Figure 8

A review, overview, and preview of industrial minerals in Australia.

A.Driessen, BMR

Industrial minerals make a significant, albeit unobtrusive, contribution to the national economy and, in many diverse yet direct ways, to our standard of living. This paper puts a perspective on the industrial minerals sector, on the basis of statistical data. In 1986 the value of mine production of industrial minerals was $1856 million, accounting for 9% of the value of mine production of all minerals ($19 899 million, including petroleum), which in turn accounted for 11% of Gross Domestic Product (Table 1).

All three sectors of the minerals industry (industrial minerals, metals, and energy minerals) grew in terms of real (constant dollars) values of mine production over the 26-year period 1960-1986; annual average growth rates for values of mine production, exports, and imports are shown in Table 1. Comparison of the statistics for each of the decades and the period 1980-1986 shows that industrial minerals and metals both experienced their strongest growth rates in the 60s after which growth rates steadily declined.

The industrial minerals sector as discussed in this paper covers some 50 mineral and rock commodities which are grouped as follows:

(a) Construction materials - brick clay, crushed stone, dimension stone, sand and gravel.

(b) Mineral sands - ilmenite, monazite, rutile, zircon.

(c) Refractories - chromite, dolomite, fire clay, kyanite/sillimanite, magnesite, pyrophyllite.

(d) Minerals for the fertiliser and chemical industries - arsenic, beryllium, boron, bromine, fluorspar, lithium, phosphate rock, potash, salt, sulphur.

(e) Bulk commodities - asbestos, clays (attapulgite/fullers earth, bentonite, kaolin/ball clays, other clays), gypsum, limestone, manganese, silica,talc.

(f) Specialties - abrasives, barite, diatomite, felspar, graphite, magnetite, mica, mineral pigments, peat, perlite.

(g) Gem and semi-precious stones - diamond, opal, sapphire, other.

Comparative statistics for the groups of industrial minerals (Table 2) show various trends; in terms of highest annual average growth rates based on value of mine production (constant 1986 $s) for the particular time spans indicated, the following are evident:

- the highest growth rate of any group of industrial minerals in any period pertains to Specialties in the period 1980-86. The high growth rate reflects the cumulative effect of new capacity for abrasives (diamond and garnet), diatomite, and magnetite.

- high growth rates also pertain to Gemstones in the 60s (opal and sapphire) and 80s (diamond), mineral sands in the 60s, Fertiliser/chemical industry minerals in the 60s (salt), and bulk commodities in the 70s (asbestos, clays, manganese, and talc).

- the highest value group by far is Construction materials, only because they are produced in such large quantities. The average growth rate for this group follows fairly closely growth of GDP.

The growth rate of value of output of industrial minerals in the 26-year period 1960-1986 (average 5.4%/year) exceeds that for GDP (average 4.0%/year) but lags behind energy minerals (11.0%/year) and metals (7.5%/year).

Various projects, already completed but yet to impact on the statistical record, will ensure that growth rates (for values of mine production and exports) for the industrial minerals sector as a whole are at least sustained; such projects include two synthetic rutile plants, two export-oriented kaolin plants, and a silicon plant. In the medium to longer-term, various other projects, some already committed, are bound to sustain and even lift historical growth rates. Such projects include the probable development of various new mineral sands and diamond deposits and the huge Kunwarara, Qld, magnesite deposit, and construction of various processing plants to produce zirconia powder and chemicals, rare earth oxides, silicon, caustic soda, and phosphatic fertiliser.

TABLE 1. MINERAL INDUSTRY COMPARATIVE SALIENT STATISTICS
1986 CONSTANT DOLLARS (MILL.)

	1960		1970		1980		1986	
INDUSTRIAL MINERALS								
Value of mine production (ex-mine)	469		1144		1592		1856	
Average annual rate of increase		9.3(a)		3.4(a)		2.6(a)		5.4(b)
Value of exports (f.o.b.)	100		432		616		576	
Av.annual rate of increase/(decrease)		15.8		3.6		(1.0)		7.0
Value of imports (f.o.b.)	187		354		561		476	
Av.annual rate of increase/(decrease)		6.6		4.7		(2.7)		3.7
METALS								
Value of mine production (ex-mine)	865		3175		5421		5674	
Average annual rate of increase		13.9		5.5		0.8		7.5
Value of exports (f.o.b.)	954		3873		7006		7223	
Average annual rate of increase		15.0		6.1		0.5		8.1
Value of import (f.o.b.)	173		135		193		187	
Av.annual rate of increase/(decrease)		(2.5)		3.6		(0.5)		0.3
ENERGY MINERALS								
Value of mine production (ex-mine)	820		1917		5031		12 369	
Average annual rate of increase		8.9		10.1		16.2		11.0
Value of exports (f.o.b.)	452		926		4269		7537	
Average annual rate of increase		7.4		16.5		9.9		11.4
Value of imports (f.o.b.)	1139		943		3896		1532	
Av.annual rate of increase/(decrease)		(1.9)		15.2		(14.4)		1.1
ALL MINERALS								
Value of mine production (ex-mine)	2154		6231		12 045		19 899	
Average annual rate of increase		11.2		6.8		8.7		8.9
Value of exports (f.o.b.)	1513		5231		11 889		15 337	
Average annual rate of increase		13.2		8.6		4.3		9.3
Value of imports (f.o.b.)	1499		1432		4648		2195	
Av.annual rate of increase/(decrease)		(0.5)		12.5		(11.8)		1.5
Gross Domestic Product (1985-86 prices)	63 337		103 409		145 255		173 900	
Average annual rate of increase		5.0		3.5		3.0		4.0

(a) Average annual growth rates in this column refer to one of the time spans 1960--1970, 1970--1980, or 1980--1986.

(b) Average annual growth rates in this column refer to the period 1960--1986.

TABLE 2. INDUSTRIAL MINERAL GROUPS - COMPARATIVE STATISTICS

	CURRENT $S (MILL)				1986 CONSTANT $S (MILL)(a)			
	1960	1970	1980	1986	1960	1970	1980	1986
CONSTRUCTION MATERIALS								
Value of mine production	53	144	472	923	296	629	765	923
exports	..	..	..	2	..	..	..	2
imports	..	..	4	12	2	2	6	12
MINERAL SANDS								
Value of mine production	10	55	161		56	240	261	268
exports	11	56	152		61	245	246	254
imports	-	-	-		-	-	-	-
REFRACTORIES								
Value of mine production	1	2	6	7	6	9	10	7
exports	..	..	1	1	..	..	1	1
imports	1	1	17	6	6	4	28	6
FERT/CHEM INDUSTRY MINS								
Value of mine production	4	14	52	123	22	61	84	123
exports	..	9	50	106	2	39	81	106
imports	15	42	192	292	84	183	311	292
BULK COMMODITIES								
Value of mine production	13	31	213	203	73	135	345	203
exports	4	15	117	138	22	66	190	138
imports	12	23	50	59	67	100	81	59
SPECIALTIES								
value of mine production	..	1	4	28	2	4	6	28
exports	..	2	6	14	3	9	10	14
imports	2	6	25	36	11	26	41	36
GEM/SEMI-PRECIOUS STONES								
Value of mine production	1	15	75	305	6	66	122	305
exports	2	16	53	62	11	70	86	62
imports	3	8	58	69	17	35	94	69
ALL INDUSTRIAL MINERALS(b)								
Value of mine production	84	262	982	1856	469	1144	1592	1856
exports	18	99	380	576	100	432	616	576
imports	16	81	346	476	187	354	561	476

.. Less than half the unit shown.
\- Nil

(a) Current $s converted to constant $s on basis of CPI data; index numbers are as follows:
1960 - 320
1970 - 409
1980 - 1102
1986 - 1786

(b) Discrepancies in totals reflect rounding.

Minerals prices in 1988

W Davies, Australian Diversified Resources Ltd

Abstract to be provided separately

BIOGRAPHICAL NOTES ON THE SPEAKERS

M AHMAD, NORTHERN TERRITORY GEOLOGICAL SURVEY

Masood Ahmad obtained his M.Sc. (geology) degree from the Aligarh University of India in 1964 and Ph.D degree from the University of Tasmania in 1979. He has worked for several years both as mine and exploration geologist with Industry. At present he is in charge of the Metalliferous Section of the Northern Territory Geological Survey.

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.

W DAVIES, AUSTRALIAN DIVERSIFIED RESOURCES LTD

Biographical details will be provided separately.

J M DESPRETZ, PETROFINA EXPLORATION AUSTRALIA S.A.

J M Despretz is Managing Director of Petrofina Exploration Australia SA in Australia and Petrofina Far East Pty Ltd in Singapore. He has over 25 years experience in exploration mainly in West Africa, North Sea, Middle East, Caribbean, Far East and Australasia regions.

He has a PhD in Geology from the Catholic University of Louvain - UCL (Belgium) in 1965, and holds an M.Sc. degree in petroleum engineering from ENSPM, IFP, Paris in 1966. He was a scientific advisor at Polytechnic, Mons (Belgium).

A DRIESSEN, BMR

Aert Driessen graduated from Sydney University in 1960 with a B.Sc. with a double major in geology. After 12 years in industry he joined BMR's Operations Branch in 1972. In 1974 he transferred to Minerals Branch, subsequently graduated B.Ec. from the Australian National University, and is presently Principal Commodity Specialist, industrial minerals.

P R DUNN, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Peter Dunn graduated from Melbourne University and immediately joined the Bureau of Mineral Resources' Radioactive Group which was carrying out mapping of the Pine Creek Geosyncline.

Peter maintained his interests in uranium and Proterozoic geology throughout his 16½ years with BMR, during which time he was stationed in Darwin for three years and spent five months with the Geological Survey of Canada.

On leaving BMR, he joined Trend Exploration, a small Denver-based company, which joined the mineral search in Australia. During this period he was involved in the discovery of mineralisation at Blendevale (zinc-lead), Mt Brockman (niobium-rare earths) and Turee Creek (uranium).

Following the withdrawal of Trend from active exploration in Australia, Peter formed his own company, Crest Exploration, which for the next ten years was contracted to CRA Exploration and Wyoming Minerals.

Peter joined the Geological Survey of Western Australia in September 1985 as Assistant Director.

D J FORMAN, BMR

David Forman graduated with a B.Sc (Hons) degree in geology from the University of Western Australia in 1958 and added an A.M. in 1967 and a Ph.D. in structural geology in 1968 from Harvard University. 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 is Principal Research Scientist in the Petroleum Branch of the Resource Assessment Division, in charge of a research group responsible for assessing the magnitude of Australia's undiscovered petroleum resources and for estimating possible future production of crude oil from undiscovered fields.

M R HARGREAVES, DEPARTMENT OF MINES, TASMANIA

As Deputy Director of Mines, Rod Hargreaves is associated with the public service for the first time in his career. His direct responsibilities extend over the activities of the Geological Survey, Chemical and Metallurgical Laboratory and Resource Development Division.

Prior to taking up this position he was involved in mineral exploration in Africa and Australia from 1966 onwards.

W D JARVIS, ABARE

Bill Jarvis is an officer of the Canadian Department of Energy, Mines and Resources on a two-year exchange program with the Department of Primary Industries and Energy. After arriving in Australia in December 1985, Bill worked on the Energy 2000 Policy Review. When the Bureau of Resource Economics was created, he was appointed Chief Research Economist, and has since assisted in the amalgamation of that and the Bureau of Agricultural Economics which became the ABARE.

Bill worked for 10 years with a major Canadian economic consulting firm (Informetrica Ltd) before joining the Canadian Department of Energy, Mines and Resources in 1982. As the Director, Energy Market Analysis and Statistics Division, he participated in the development of the policies on oil market deregulation, natural gas deregulation and the Western Accord between the Government of Canada and the major oil and gas-producing provinces.

Bill holds degrees in economics from Queen's University (Kingston, Canada) and the University of Western Ontario (Canada). He will be returning to Canada with his family in April.

B P JONES, ABARE

Barry Jones is the Officer in Charge of the Australian Energy Industry Section of ABARE. He also has primary responsibility for preparing the longer term minerals and energy outlook analyses.

After working in a variety of research positions in the Australian Bureau of Statistics, Barry joined the then Department of National Development and Energy in 1982. He worked in a number of energy policy and research positions until joining the then Bureau of Resource Economics on its formation in May 1986. Since that time his research interests have been primarily the medium- to long-term outlook for Australian mineral exports, and trends in world demand for mineral commodities. Barry is a graduate of the Australian National University.

M G KIRBY, ABARE

Michael Kirby is Assistant Director, Economic and Policy Analysis Branch of ABARE and is responsible for macroeconomic analysis and major international trade research. He holds an honours degree in economics from the University of Sydney and postgraduate degrees in economics from the Australian National University.

Prior to joining ABARE Michael Kirby worked in the Treasury and at the Australian National University.

N D KNIGHT, BMR

Nerida Knight is the Commodity Specialist for aluminium, tungsten, and molybdenum in the Mineral Commodities Branch, Resource Assessment Division. She graduated from the Australian National University in 1963 with qualifications in Geology and Biochemistry. After working for some years in the field of medical biochemistry she joined the Exploration Department of The Broken Hill Pty Co Ltd as a research assistant in the base metals area. In 1973 she joined the Geological Branch of BMR and in 1978 moved to her present position.

J MAITLAND, MINERS' FEDERATION OF AUSTRALIA

John Maitland is General President of the Australasian Coal and Shale Employees' Federation (the Miners' Federation of Australia). He entered the Queensland coal mining industry as an underground miner at Collinsville in 1969 and in 1971 was elected Secretary of the Collinsville Branch of the Federation; he was elected Secretary of the Queensland District Branch in 1979.

In 1985 John was elected General President and Chairman of the National Liaison Committee of Coal Mining Unions.

I McNAUGHT, BMR

Ian McNaught is a Senior Commodity Specialist (tin, tantalum, niobium, lithium, and beryllium) in the Mineral Commodities Branch of the Resource Assessment Division. Since graduating with a B.Sc. (geology) degree from the University of New England in 1973, he spent 12 years as a geologist with several companies, working in all facets of the minerals industry through exploration, evaluation, and production variously for base and precious metals, and uranium. In 1985 he completed a M.Sc. (mineral economics) degree from Macquarie University. Prior to joining BMR late in 1985, he was the mining investment analyst of a Sydney life insurance company.

N MISKELLY, ORD MINNETT LTD

Norman Miskelly is Director of Resources Marketing for Ord Minnet Limited, a Member Corporation of the Australian Stock Exchange Limited. Before moving to the marketing role he was responsible for Ord Minnett's mining and petroleum research effort from 1973 to 1987. In addition to the broking research advisory role, responsibilities at Ord Minnett have embraced evaluation and marketing proposals for capital raisings in the resources sector.

Following initial experience in the oil and chemical industries, he worked for 10 years with the Consolidated Gold Fields group in Sydney, covering analysis of listed natural resource and industrial companies, and mining project evaluation.

Norman holds the degree of Bachelor of Economics (Sydney) and is the Australian Stock Exchange representative on the Joint AusIMM/AMIC Ore Reserves Committee.

T A PRATT, DEPARTMENT OF INDUSTRY, TECHNOLOGY & RESOURCES, VICTORIA

Trevor Pratt was trained as a Civil Engineer at London University and worked in hard rock tunnelling in Sweden as an undergraduate before beginning a private enterprise career in maritime engineering ports and bulk terminals in the UK and Middle East.

He came to Australia and worked in the mining industry in Queensland and Western Australia in the early 70s boom before re-establishing a career in maritime engineering in Australia and South East Asia. He set out on his own for a couple of years before joining the Department of Industry, Technology and Resources as a major project coordinator and Manager of the Investment Facilitation Group for the development of Victoria.

In September 1987 he was appointed Acting General Manager, Minerals, following the Victorian Government's announcement of economic strategy initiatives for the accelerated development of the minerals industry in Victoria.

To-day he manages a team of technical and administrative personnel which staffs the one-stop-shop for an industry which is expected to double every two to three years over the next ten years.

D H PROBERT, NSW GEOLOGICAL SURVEY

David Probert graduated B.Sc from Sydney in 1955. Since then he has worked in the engineering geology, hydrogeology, energy and mineral areas. He is at present Assistant Director (Minerals) of the Geological Survey of New South Wales in charge of the southern and central regions of the State and the specified areas of metallic and industrial minerals, petroleum and environmental geology.

C J S RENWICK, HAMERSLEY IRON PTY LTD

Chris Renwick is Commercial Director of Hamersley Iron Pty Ltd, and has been employed by the CRA group of companies since 1969. He has held the positions of Legal Officer, Company Secretary-Chief Legal Officer, and Manager-Corporate Planning with Hamersley Iron, Manager-Administration with AM&S, General Manager-Development (South East Asia) with CONZINC Asia Holdings, and Managing Director-CRA Timber Division.

He is a graduate in Arts and Law from the University of Melbourne.

J B RITCHIE, AUSTRALIAN COAL ASSOCIATION

Barry Ritchie is Executive Director of both the Australian Coal Association and the New South Wales Coal Association. He holds the degrees of Bachelor of Mechanical Engineering (Hons), and Doctor of Philosophy in Mechanical Engineering from the University of Melbourne.

He is the recipient of awards, including the Paul Henderson, Memorial Prize of the Institution of Mechanical Engineers, London (1969), and was the Australian Distinguished Speaker of the Australasian Institute of Mining and Metallurgy in 1987, Chairman of Review of the Division of Energy Chemistry, CSIRO (1987).

Barry is also Director of ACA Combustion Test Facility Ltd, Chairman and Director of Coal Training Services Pty Ltd, and Chairman of the Editorial Board of Coal Journal.

M ROARTY, BMR

Mike Roarty is the copper-lead-zinc 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 including the Alligator Rivers Province, and in administration, and after a short period with BMR Petroleum Branch joined the Minerals Branch in 1981.

C ROBERTSON, BMR

Colin Robertson graduated B.Sc (Honours) in geology and physics from Sydney University in 1952 and M.Sc (geophysics) in 1959. He worked on BMR radiometric surveys in the Northern Territory in 1953, and observatory geophysics at Macquarie Island, before joining BMR's seismic group in 1955. Between 1956 and 1968 he played a leading role in many BMR seismic surveys throughout Australia aimed at providing regional information on Australia's sedimentary basins and developing suitable seismic techniques. In 1968 he joined the Petroleum Branch of BMR where he was involved in the administration of the Petroleum Search Subsidy Acts and in regional basin studies. In 1982 he became Chief Petroleum Geoscientist in the Resource Assessment Division, responsible for the maintenance of an up-to-date assessment of Australia's petroleum prospects, and for the provision of technical advice to Government in relation to the implementation of petroleum legislation.

P RYAN, DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Pat Ryan was originally a seafarer and, following 16 years' experience in industrial relations in the stevedoring industry, joined the Australian Public Service. He has held senior positions in the Departments of Trade, Transport and Primary Industry. From 1978 to 1983 Pat was First Assistant Secretary (Head) of the Uranium and General Division in the Departments of National Development and National Development and Energy. He then became First Assistant Secretary of the Coal and Minerals Division in the Department of Resources and Energy. Pat is now First Assistant Secretary of the Coal and Nuclear Division of the Department of Primary Industries and Energy. He is also Chairman of the Advisory Committee of the Australian Coal Consultative Council.

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

J D SAWERS, QUEENSLAND DEPARTMENT OF MINES

Jim Sawers is Manager, Mineral Resources Assessment, in the recently reorganised Queensland Department of Mines. Responsibilities of his group include development of policies and strategies which promote and facilitate mineral exploration, the management of exploration tenures, and provision of mineral resource information and advice to Industry and Government.

Since graduation from the University of Queensland, employment as a geologist has enabled him to acquire an extensive knowledge of the non-fuel mineral resources of the State.

R W TOWNER, BMR

Roy Towner is Commodity Specialist (mineral sands and other 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.

T H WARING, ABARE

Tom Waring is the Assistant Director, Minerals and Energy Economics Research Branch at ABARE, responsible within the Bureau for the management of applied economic research into minerals and energy sector issues. He has been a Deputy Director of the former Bureau of Resource Economics, the economic research agency formed during 1986 within the resource and energy portfolio, prior to its amalgamation with the Bureau of Agricultural Economics in late 1987.

Prior to this, Tom worked within the Department of Resources and Energy primarily on minerals policy and macroeconomic issues, and at the Industries Assistance Commission on industry assistance measurement and evaluation. Tom is a graduate of the Australian National University (Economics) and joined the Public Service in 1973.

R L WILDY, SOUTH AUSTRALIAN DEPARTMENT OF MINES AND ENERGY

Robert Wildy is Chief Geologist of the Mineral Resources and Economics Branch within the Mineral Development Division of the South Australian Department of Mines and Energy.

He heads up a team whose objective is to encourage and foster the development of the State's mineral resources by the provision of geological information and technical advice to industry and Government.

Mr Wildy joined the Department in mid-1974 after spending 11 years with private enterprise, engaged in the search and development of a variety of metallic and non-metallic mineral commodities.

W T WISE, ELECTROLYTIC ZINC CO OF AUSTRALASIA LTD

Bill Wise has an economics degree from the University of Tasmania and has worked with EZ since he was an industrial relations cadet at the zinc smelter. He transferred to the mine at Rosebery as Industrial Officer and was actively involved in the mine's doubling of production. He returned to the Risdon smelter as Manager, Personnel and Industrial Relations. During his career in industrial relations until 1983 he was President of the Tasmanian Chamber of Industries for three years and involved with the Confederation of Australian Industries for six years.

In 1984 Bill transferred into the production and technical side of the Risdon smelter and was responsible for a large part of the Risdon operations before moving to the Company's head office in 1985 as Vice President - Minerals and Chemicals Marketing, which position he now holds. His current responsibilities are for the national and international marketing of all the Company's mine and smelter products except zinc metal.