BMR Record 1986/1

EXTENDED ABSTRACTS

PETROLEUM AND MINERALS REVIEW CONFERENCE 1986

19-20 MARCH

CANBERRA

CONTENTS

World petroleum overview

H. Denkl, Schlumberger Technical Services Inc

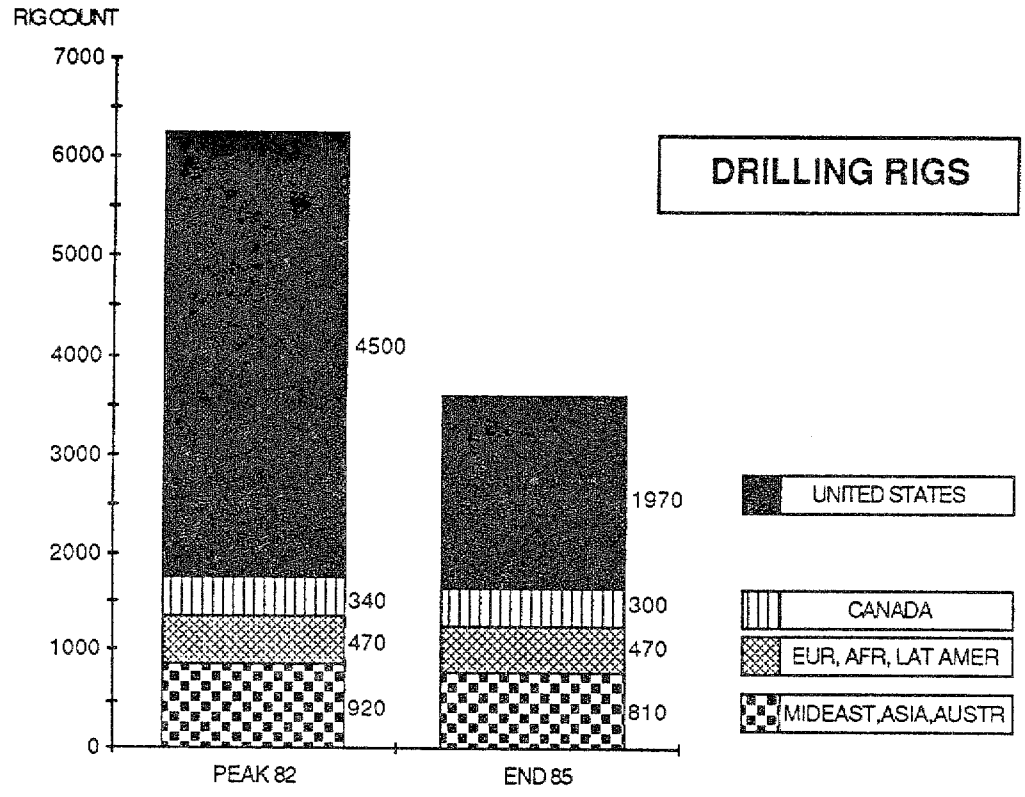
World energy demand today has surpassed the energy consumption peak of 1979. Oil, however, provided only 38% (46% in the non-communist countries) of the world's primary energy requirements in 1985, whereas this figure was 45% (52% in non-communist countries) in 1979. This is a 10% drop from the peak consumption of 64 million b/d in 1979.

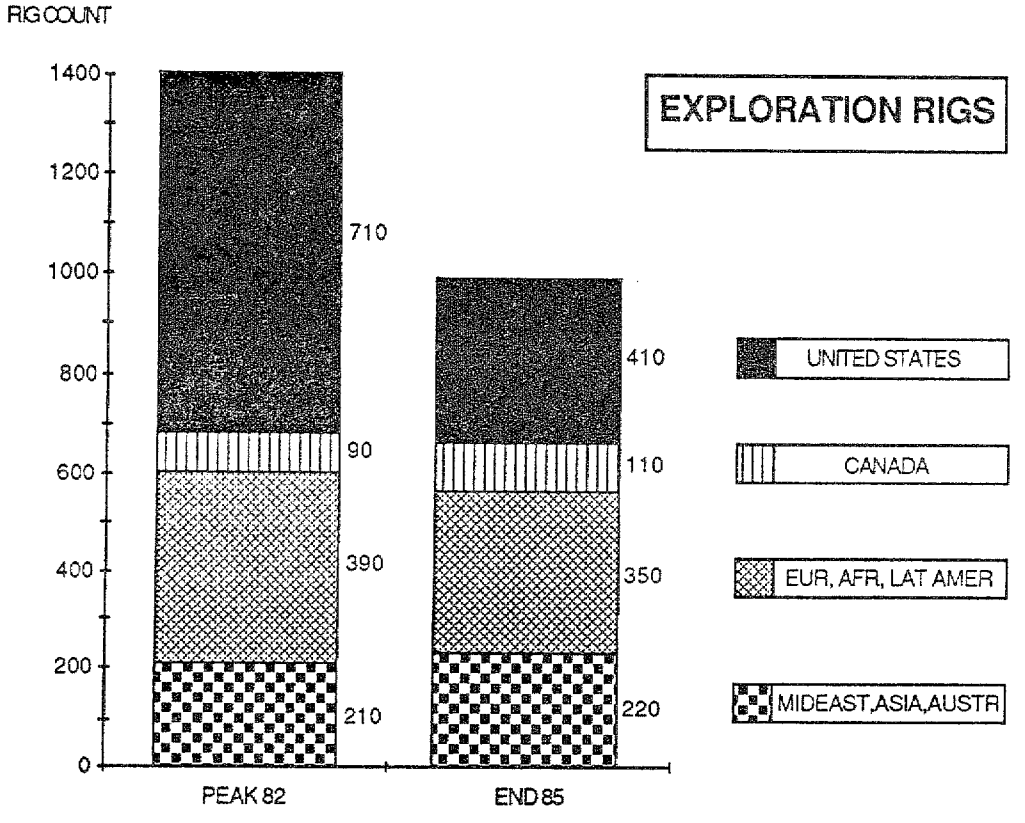
While oil consumption peaked in 1979 just before the second oil crisis, drilling activity had its all-time high at the beginning of 1982 with a total of 6 230 rigs active in the non-communist world. If we exclude the United States, the drilling-rig count has not varied appreciably since 1982. In the United States, however, the rig-count drop was dramatic, from a high of 4 500 down to 1 970 at the end of 1985. This was caused by the prospect of a decline in oil-prices, the "gas bubble", pending taxation issues and megamergers.

Pronounced exploration activity growth in the 1982-1985 period occurred only in the North Sea and in Canada. At the all-time drilling activity peak, only 22% of the 6 230 rigs were engaged in exploration work. Of the 3 550 active rigs at the end of 1985, 31% were assigned to exploration drilling. In the last few years, however, there has been a substantial shift from expensive offshore exploration to cheaper land exploration.

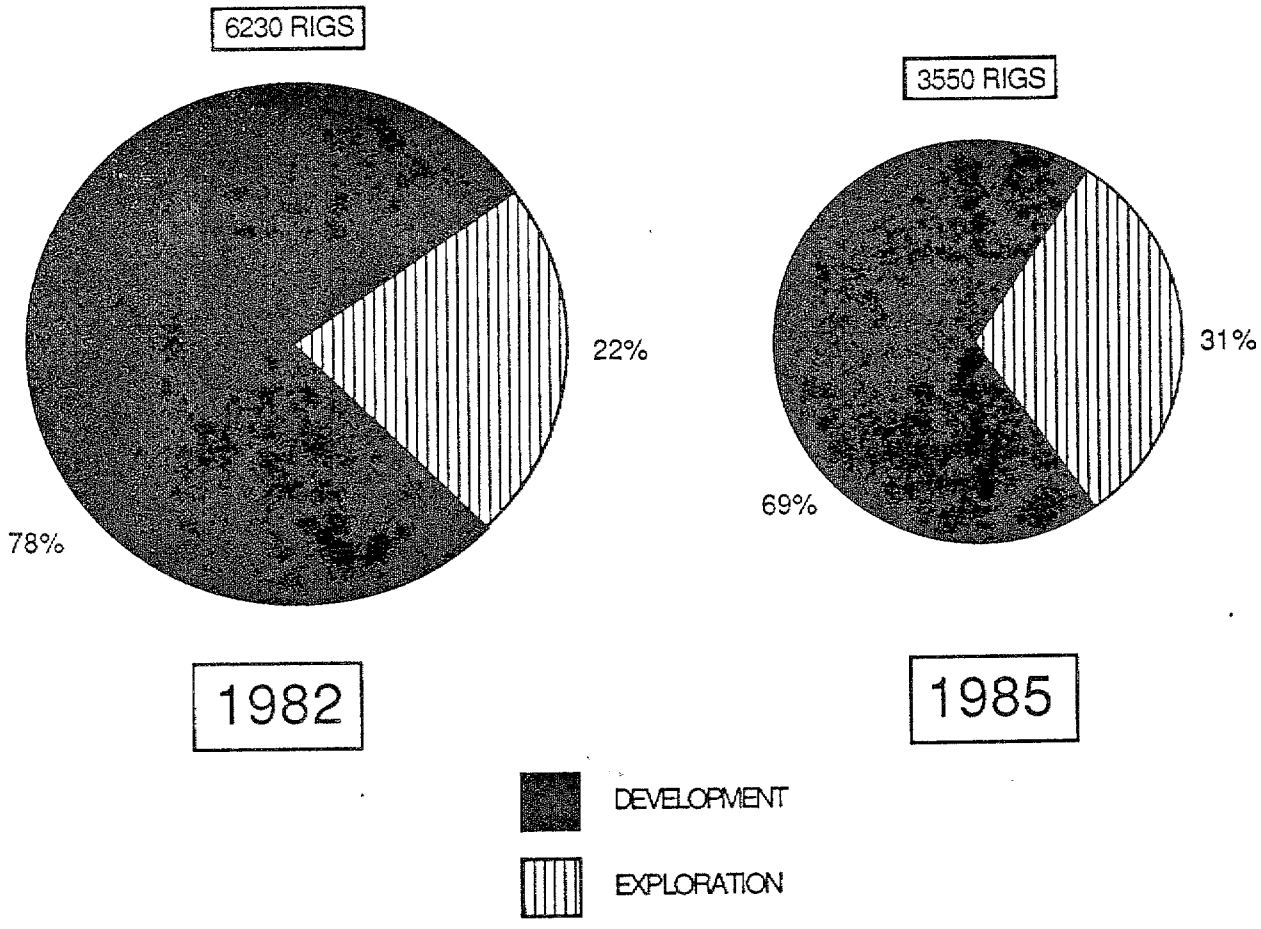
Following the recent oil-price decline and uncertainty over near-term oil-price developments, drilling activity in general, and exploration activity in particular, will overall be significantly down in 1986, although trends in different countries may vary widely because of different national priorities. In the longer term, lower oil prices should help to bring a faster equilibrium between the supply and demand of oil.

Recent technological developments that allow oil exploration in more difficult environments, such as tension leg platforms, guyed tower platforms, and Arctic cone exploration structures, will most likely not find many applications in the near future because of economic considerations. Technological advances that are expected to find immediate acceptance are those aimed at reducing dry-hole drilling in complex fields. An example is the integrated interpretation of data from surface seismic, well seismic, well logs, pressure and fluid distribution measurements.





Rig Count (Non-Communist World)



Share of Drilling Rigs Dedicated to Exploration

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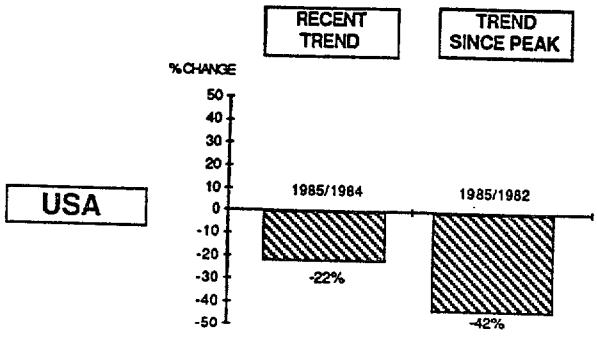
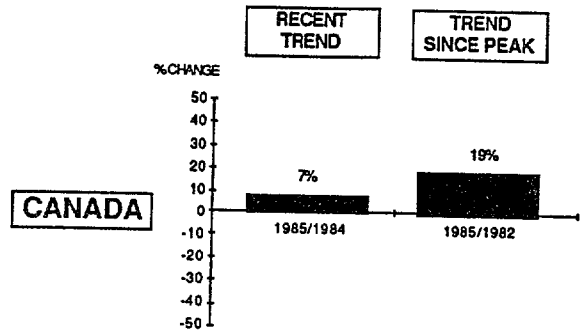
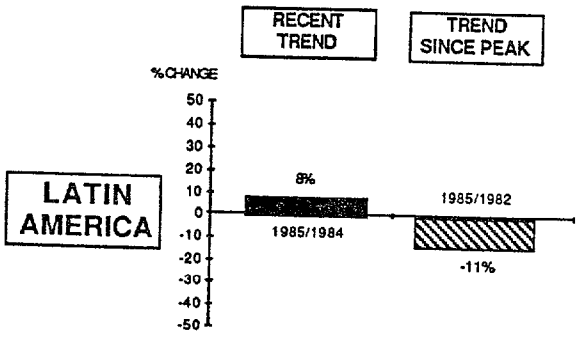
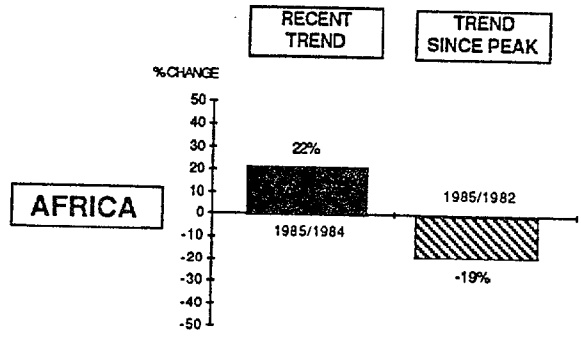
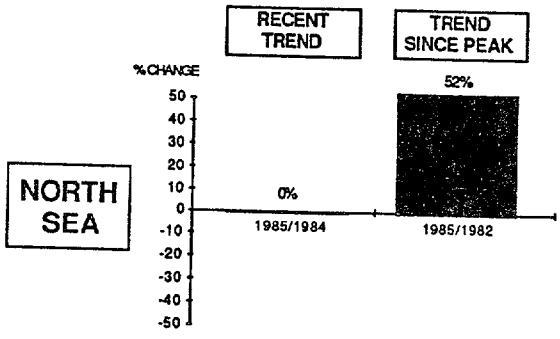
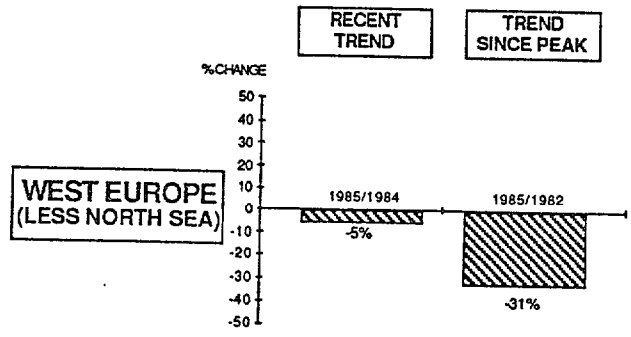


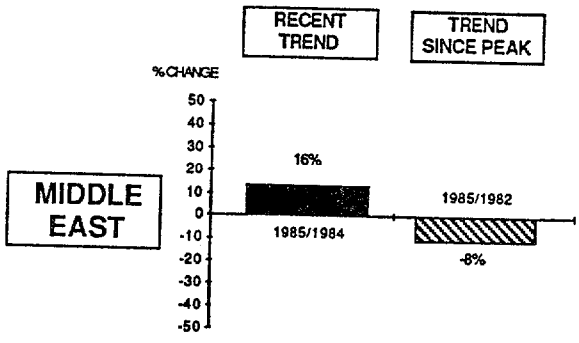


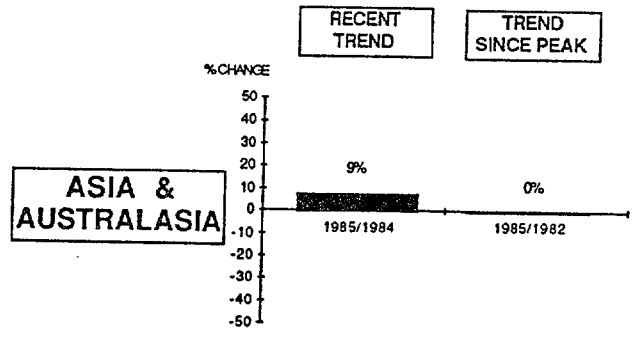




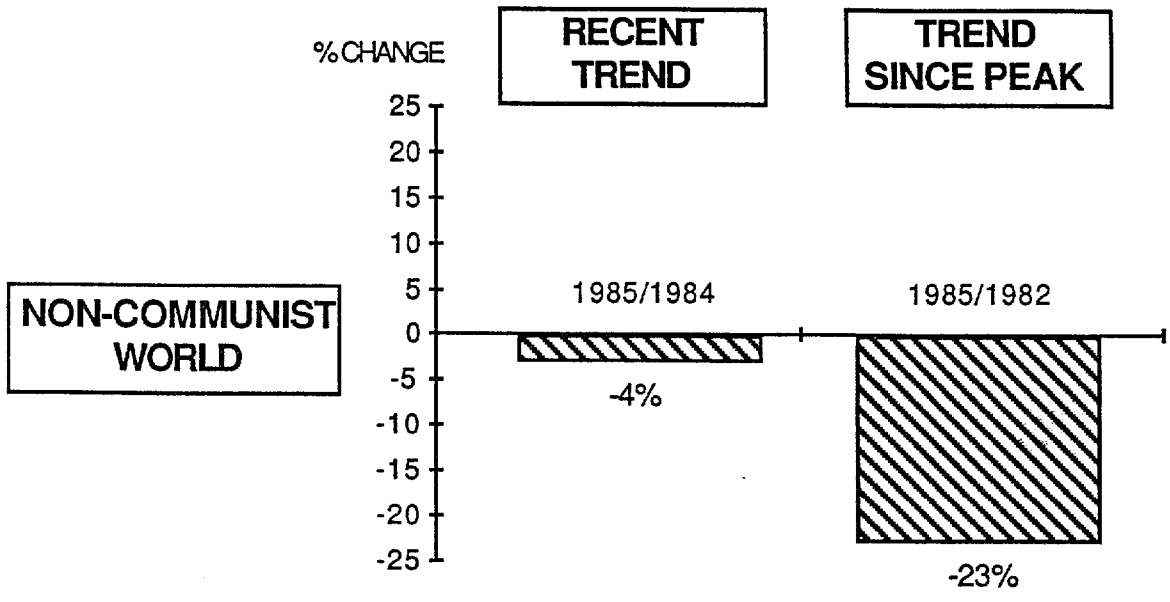


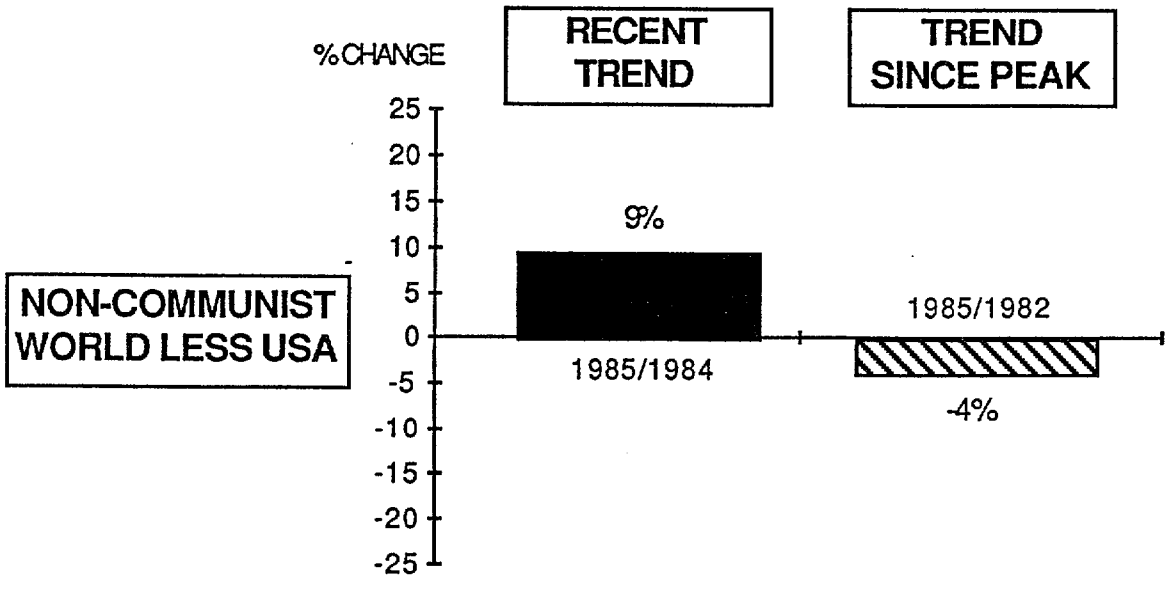






Exploration Activity Trends by Area





Exploration Activity Trends

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N O T E S

Recent developments in Australian petroleum policy

D.J. Ives, Department of Resources & Energy

Since 1983 considerable changes have occurred in the world and domestic markets for petroleum. Over this period the Government has demonstrated a continuing commitment to maintaining an appropriate policy framework within which the petroleum industry can confidently plan activities and make investment decisions. The Government has had to develop policies in the light not only of the particular conditions facing the industry, but also on the basis of international events and broader Government objectives with respect to energy generally and the overall economy.

A wide range of new policy measures have been introduced aimed at facilitating and encouraging petroleum exploration and development activity in Australia in a manner which ensures the community receives a fair share of the benefits derived from developing our petroleum resources. In particular, major reappraisals have taken place in the areas of petroleum marketing, pricing, taxation and excise arrangements and the provisions of the Petroleum (Submerged Lands) Act and associated legislation under which all petroleum exploration and development activities beyond the territorial sea are administered and regulated.

The paper examines the events that have lead to some of these policy changes and the way in which the Government has responded to the changing circumstances. That the policy initiatives introduced by the Government have provided a sound basis for the continued growth of the petroleum industry is evidenced by the strong levels of industry activity achieved in recent years, in exploration, production, processing and exports.

Recent policy developments in work program and cash bidding are discussed, as well as recent changes in import parity pricing and product excise arrangements.

N O T E S

Petroleum exploration and development in Australia, 1985

J.A.W. White, BMR

1985 was a year of expanding horizons for the petroleum exploration and development industry in Australia. Discoveries of petroleum were made in two sedimentary basins previously not known to bear hydrocarbons.

Exploration activity remained at a high level compared with the previous year; 269 exploration wells were drilled of which 226 were onshore and 43 offshore. Development wells totalled 92, with 75 onshore and 17 offshore. Total wells drilled amounted to 361.

Seismic survey work increased during the year, although still below the peak level of earlier years.

Several major new production developments were initiated during the year of which the most significant was the final go-ahead for the LNG export phase of the North West Shelf Gas Project in Western Australia. Other important projects commenced included the Palm Valley to Darwin gas pipeline, the Mereenie oil pipeline to Alice Springs and the offshore Harriet and Jabiru oilfields. Many new developments within existing projects were introduced. In the Moomba area of South Australia several significant developments took place including the installation of a sub-surface ethane storage facility.

More interest is being shown in improving the recovery efficiency of Australian oil fields. Enhanced oil recovery projects are being evaluated for application in several locations around the country, including the Cooper, Surat and Gippsland Basins.

Tertiary educational institutions in three States announced plans during the year to develop courses in various aspects of the petroleum exploration and development industry.

BMR considers that the level of petroleum exploration and development activity in 1986 will be adversely affected by the current reduction in Australian crude oil prices, and overall activity, especially onshore, will be below that of 1985.

ANNUAL HISTORICAL SUMMARY

AUSTRALIA - WELLS DRILLED - HISTORICAL

Year	Exploration Onshore	Exploration Offshore	Exploration Sub-total	Development Onshore	Development Offshore	Development Sub-total	Totals for year	Totals Cumulative
To 1970	1 396	87	1 483	768	59	827	-	2 310
1971	54	18	72	4	18	22	94	2 404
1972	62	38	100	21	12	33	133	2 537
1973	29	31	60	5	6	11	71	2 608
1974	20	31	51	8	-	8	59	2 667
1975	6	19	25	4	-	4	29	2 696
1976	16	3	19	13	-	13	32	2 728
1977	8	13	21	18	2	20	41	2 769
1978	33	22	55	24	13	37	92	2 861
1979	31	21	52	48	9	57	109	2 970
1980	77	17	94	26	7	33	127	3 097
1981	142	16	158	41	14	55	213	3 310
1982	177	44	221	95	13	108	329	3 639
1983	160	49	209	40	26	66	275	3 914
1984	221	43	264	71	38	109	373	4 287
1985*	226	43	269	75	17	92	361	4 648

* Preliminary figures subject to revision

AUSTRALIA - METRES DRILLED - HISTORICAL

Year	Exploration Onshore	Exploration Offshore	Development Onshore	Development Offshore	Totals Yearly	Totals Cumulative
To 1970	1 794 911	272 994	776 656	148 654	-	2 993 215
1971	108 683	59 860	9 359	46 453	224 355	3 217 570
1972	107 002	117 429	47 365	23 643	295 439	3 513 009
1973	50 301	80 616	11 347	9 644	151 908	3 664 917
1974	37 206	84 078	15 531	-	136 815	3 801 732
1975	12 579	35 658	10 351	-	58 588	3 860 320
1976	32 393	15 119	24 863	-	72 375	3 932 695
1977	23 675	36 827	44 508	6 419	111 429	4 044 124
1978	52 709	56 900	56 332	42 493	208 434	4 252 558
1979	59 635	76 424	44 110	36 612	216 781	4 469 339
1980	137 296	62 012	41 337	27 142	267 787	4 737 126
1981	277 258	45 126	77 602	34 473	434 459	5 171 585
1982	324 288	128 213	154 030	28 379	634 910	5 806 495
1983	273 571	137 472	82 019	86 425	579 487	6 385 982
1984	403 329	113 486	147 294	137 645	801 754	7 187 736
1985*	405 019	104 096	124 499	61 304	694 918	7 882 654

* Preliminary figures subject to revision

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The North West Shelf Project LNG phase and outlook

P.P. Tapper, Woodside Offshore Petroleum Pty Ltd

The North West Shelf Project has developed from the discovery of the remote North Rankin and Goodwyn gas fields off the north west coast of Australia in 1971-72. The recoverable reserves of the two fields are estimated at 300 billion cubic metres of natural gas and 40 million cubic metres of condensate. Following feasibility and development studies, contracts were signed in 1980 between the Joint Venture Participants at that time - Woodside, BP, California Asiatic Oil (Chevron), BHP and Shell and the State Energy Commission of Western Australia for the supply of 10.9 million cubic metres per day for 20 years, from 1985 to 2005. Domestic gas supply began in the third quarter of 1984 and the Project is now supplying 50 percent of Western Australia's non-transport energy.

In 1981, Memoranda of Intent were signed with eight Japanese utilities to supply 6 million tonnes per year of LNG. However, the downturn in energy demand and a weakening of prices brought about a restructure of the LNG Phase of the Project - both in ownership and in process configuration. Woodside sold 2/3 of its interest in the LNG Phase to MIMI (Mitsubishi and Mitsui), Shell and BHP - to bring the ownership to equal 1/6 shares. The LNG plant was also redesigned to eliminate extraction of the LPG, and to pioneer a new concept in LNG production - coupling air cooling instead of water cooling with gas turbine driven rather than steam turbine driven compressors, thus reducing the capital cost of the LNG Phase.

In July 1985, the restructuring was completed and contracts executed with the Japanese buyers for 6 million tonnes per year (15 percent of Japan's total LNG requirements) with first deliveries planned for October 1989.

Project facilities include the North Rankin 'A' platform (with the largest gas production capacity of any offshore platform in the world), a 135 km pipeline to shore and a domestic gas processing plant. Construction is now underway on the LNG plant. Two additional offshore production facilities will be required between 1993 and 2001.

The Project is the largest resource development in Australian history. A$2.2 billion was expended on the Domestic Gas Phase and a further A$9.8 billion will be required for the LNG Phase excluding the LNG carriers.

In the generally auspicious economic climate of the 1970's it took nine years from discovery to reach the decision to invest in the development. Implementation has been able to continue in the less favourable economic climate of today because of the financial strength and technical expertise of the Participants and the confidence of the Japanese in Australia as a stable supplier.

Implementation of the Project is coinciding with a downturn in the Australian metal trades industries and the businesses and unions involved in these industries are campaigning vigorously for work from the development program.

The Project demonstrated during the Domestic Gas Phase its commitment to maximising Australian participation when 72 percent of the work was sourced in Australia. The Project has supported the establishment of a National Liaison Group of business, union, Government and Project representatives to exchange information on Australian sourcing for the LNG Phase and this body is assisting the Project to achieve its objective of a continuing high level of Australian content, consistent with the essential commercial criteria of quality, reliability and cost.

However the Project is being subjected to pressure outside the forum of the National Liaison Group about Australian content. Continuing sectional pressure of this nature could jeopardise the credibility of the Project with the international business community upon which it relies for technology and finance.

The Project has or will provide a new source of energy for Western Australia; a major new export trade in petroleum for Australia coinciding with the decline in petroleum production from the Bass Strait; a 20-year capital works program with opportunities for Australian business and labour; and a significant new source of Government revenue from royalties and taxes.

Petroleum exploration around the Australian coast has discovered other very large deposits of natural gas, exceeding 1 500 billion cubic metres in total, mainly in locations remote from potential Australian markets. There is no immediate commercial use for much of this remote gas but passing time may focus more attention on it as a potential energy source. The expertise in LNG production introduced by the North West Shelf Project and the record for reliability of supply established by the Project would then be factors in encouraging utilisation of this untapped resource for the future benefit of the nation.

A new Australian LNG scheme: the Bonaparte Gulf LNG project

M. Moreau, Elf Aquitaine Petroleum Australia

Elf Aquitaine Petroleum Australia and its co-venturers are planning to develop two offshore gas fields located in the Bonaparte Gulf to supply an LNG plant to be erected in Darwin: Petrel discovered in Northern Territory waters, the likely extension of which crosses the border into Western Australian waters, and Tern in Western Australia.

To date, gas in place is assessed to be within the range of 6 to 12 TCF for the Petrel structure and 1 to 1.5 for the Tern structure.

In light of the small potential domestic gas demand, an export-oriented LNG project is under thorough analysis. Comprehensive gas market studies have identified Japan, South Korea and Taiwan as the most prospective potential LNG markets and have shown the likely emergence of a substantial deficit in these countries during the mid 1990's. In April 1985, Elf Aquitaine signed a Memorandum of Understanding with Sumitomo Corporation under which these two companies agreed to jointly promote the project on the Japanese market. Accordingly, all the potential end-users are continuously informed of the status of the project.

The Bonaparte Gulf LNG project is presently being designed to supply about 2.3 million tonnes of LNG a year from a liquefaction plant to be built on a site located in Darwin Bay. This provisional size fits the future market characteristics and is consistent with anticipated recoverable reserves for a 20 year project. Furthermore, the financing should be facilitated in designing a small-size economic LNG project.

A final appraisal phase followed by a full-scale feasibility study is still required before reaching the final decision on the development and the anticipated start-up date for the first LNG commercial production in 1994.

While being aware of the strong competition between the potential LNG schemes for supplying Asia in the 1990's, the promoters of the Bonaparte project are confident of the specific advantages of their project and their project receives full and active support from the Northern Territory Government, as well as from the Western Australian Government and the Federal Authorities.

BONAPARTE GULF LNG PROJECT
MAIN FEATURES

. Fields dedicated to the project	:	Petrel (N.T./W.A.) Tern (W.A.)
. Water depth	:	100 metres
. Production capacity	:	3.5×10^9 m^3(N)/year
. Three offshore platforms	:	2 on Petrel 1 on Tern
. Pipe length		
Tern-Petrel	:	65 km offshore
Petrel-Darwin	:	185 km offshore 110 km onshore
. LNG plant location	:	Darwin Bay
. LNG production	:	$2.3\ 10^6$ tonnes/year
. Single voyage Darwin - Tokyo		3 000 nautical miles
. Number of 130,000 m^3 LNG carriers dedicated to the project	:	2
. Production duration	:	20 years
. Investment costs (10^9 mid 1985 US$):		
- over the project life	:	3 - 3.5
- before start-up	:	1.8 - 2.1
. LNG production start-up	:	1994
. Potential LNG market window in the mid 1990's		
- Japan	:	3-7 million tonnes/year
- South-Korea	:	2-4 million tonnes/year
- Taiwan	:	ε-2 million tonnes/year

COMPETING LNG PROJECTS

NAME/COUNTRY	SAKHALIN	THAILAND	QATAR
LNG QUANTITIES	2-3 MT/Y	2-3 MT/Y	6 MT/Y
PROMOTERS	SODECO (20 JAPANESE COMPANIES LEAD BY JNOC)	THAI LNG Co AND MITSUBISHI MITSUI, SUMITOMO, MARUBENI	QATAR LIQUEFIED GAS Co (QGPC, BP, TOTAL, MARUBENI).
POSITIVE FACTORS	• HUGE GOVT. EXPLORATION COSTS TO RECOVER • PROJECT SUPPORTED BY MITI • OIL ASSOCIATED PRODUCTION	• JAPANESE POLITICAL WILLINGNESS TO INCREASE COMMERCIAL RELATIONSHIP • GEOGRAPHICAL PROXIMITY • EXISTING LIQUEFACTION ENTITY	• HUGE RESERVES • SMALL TECHNICAL COST OF FIELD DEVELOPMENT • LIQUEFACTION COMPANY ALREADY SET UP
NEGATIVE FACTORS	• BUYERS' RELUCTANCE ("RED GAS") • DIFFICULT ENVIRONMENT • COMPLEXITY OF THE JAPANESE INTERESTS • STRONG US OPPOSITION TO THE PROJECT	• FIELDS OPERATOR NON INTERESTED IN THE LNG PROJECT (TEXAS PAC.): PTT TO TAKE OVER? • INSUFFICIENT PROVEN RESERVES (1.8 T.C.F.): COSTLY APPRAISAL PROGRAMME • POOR GAS COMPOSTION • RESERVES (BLOCKS 15 AND 16) NOT YET FORMALLY DEDICATED TO AN EXPORT PROJECT	• UNCERTAINTY OF POLITICAL SITUATION • NAUTICAL DISTANCE FROM MARKETS • LNG QUANTITIES NOT FITTED WITH THE DEMAND • HIGH CONSTRUCTION COST

COMPETING LNG PROJECTS

NAME	WESTERN CANADA	PLANT EXTENSIONS			ALASKA	
LNG QUANTITIES	2.35 MT/Y	1.5 TO 2 MT/Y EACH			15-20 MT/Y	1.5 MT/Y
PROMOTERS	MOBIL/PETROCAN NIC	CURRENT PROMOTORS OF SCHEMES IN OPERATION			TAGS	ARCO
POSITIVE FACTORS	• POLITICAL STABILITY • SOME KIND OF BUYERS COMMITMENT	• RESERVES IN PLACE • EXISTING INFRASTRUCTURE • CONTRACTUAL RELATIONSHIP WITH BUYERS ALREADY EXPERIENCED			• US POLITICAL SUPPORT	• POLITICAL STABILITY • SMALL LNG QUANTITIES
NEGATIVE FACTORS	• NO DIRECT ACCESS TO GAS RESOURCES (DOWN-STREAM ENTITY) • HIGH LNG CIF PRICE (WELL ABOVE ANTICIPATED JAPANESE LNG PRICES) IF PARITY OF INLET PLANT GAS PRICE WITH GAS EXPORT PRICE TO US • MOBIL SECOND RANKING PRIORITY PROJECT	INDONESIA • HIGH DEPEN-DANCE OF SOME BUYERS TOWARDS THIS COUNTRY • POLITICAL INSTABILITY OF THIS AREA	MALAYSIA • SEVERE FISCAL CONDI-TIONS • POLITICAL RISK	AUSTRALIA ?	• HUGE INVESTMENT • TOO BIG LNG QUANTITIES • COMPETITION WITH A PIPE SCHEME (ANTGS)	• DIFFICULTY TO OBTAIN AN EXPORT LICENCE • COMPETITION WITH THE KENAI OPERATING LNG PROJECT

LNG SUPPLY/DEMAND IN JAPAN

	1983(ACTUAL)	1984 (ACTUAL)	1990	1995
MITI'S DEMAND (NOV. 1983) IN 10^6 MT = (1)	18·9	25·9	36·5	40
LNG SUPPLY PROJECTS (FULL CONTRACTED VOLUMES) (10^6MT)				
● IN OPERATION				
– ALASKA (KENAI)	1·02	1·02	–	–
– BRUNEI	5·25	5·24	5·14	–
– ABU DHABI	1·79	2·09	2·06	2·06
– INDONESIA	9·61	14·06	14·70	14·70
– MALAYSIA	1·20	3·49	6·00	6·00
SUB–TOTAL (2)	18·87	25·90	27·90	22·76
● COMMITTED				
– AUSTRALIA (NWS)	–	–	5·84	5·84
– CANADA (WESTERN CANADA LNG)	–	–	2·35	2·35
SUB–TOTAL (3)	–	–	8·19	8·19
TOTAL = (2)+(3) = (4)	18·87	25·90	36·09	30·95
BALANCE (10^6MT) = (1) – (4)	–	–	+0·41	+9·05
PROBABLE EXTENSION OF OF OPERATING CONTRACTS (10^6MT)				
– ALASKA (KENAI)	–	–	1·0	1·0
– BRUNEI	–	–	–	3·0–5·1
SUB–TOTAL = (5)	–	–	1·0	4·0–6·1
MARKET WINDOW TAKING INTO ACCOUNT KENAI AND BRUNEI EXTENSIONS = (1) – (4) – (5)	–	–	–0·59	+2·95–5·05
MARKET WINDOW EXCLUDING WESTERN CANADA LNG SUPPLY (10^6MT)	–	–	+1·6	+5·3–7·4

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N O T E S

Australian uranium: present and future market opportunities

I.J. Duncan, Western Mining Corporation Ltd

The present market for Australian uranium is characterised by the dominance of Energy Resources of Australia's Ranger Project; Queensland Mines' Nabarlek Project; long term pricing which has slipped back from US$35-40 per lb U_3O_8 in the early 80's to US$30-35; spot pricing which has fallen from the US$40-45 range in 1979 to US$15 in mid 1985 but has now risen to approx. US$17; the Australian Government's policies of three mines, no further processing in Australia and stable minimum pricing; of a world overstocked with uranium; and finally, lower-than-projected growth of nuclear power.

Against this background, Ranger and Nabarlek have demonstrated a capability of working within our industrial, environmental, health, State, Federal and international requirements and to get on with the job.

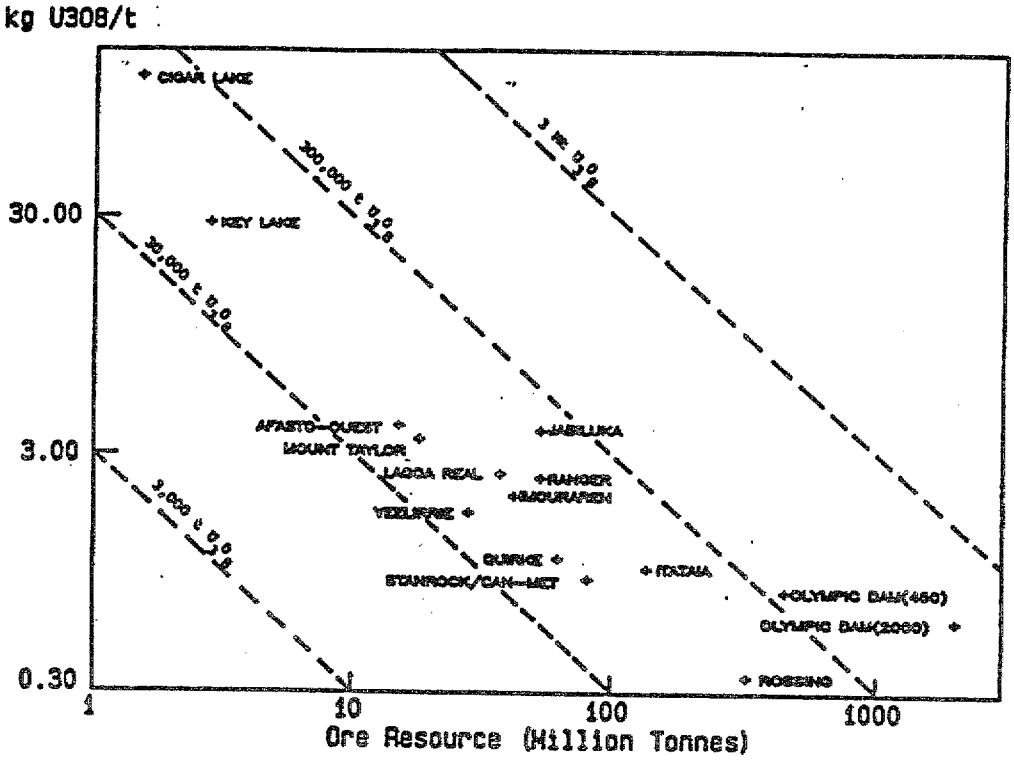
They have become dependable, low cost suppliers to the Western World and thereby conform to the overall image of Australia's minerals industry.

A superficial analysis of the current market might suggest that the projected expansion of Australia's productive capability (expansion of Ranger, development of Olympic Dam) may be premature. However, I believe the time is ripe for such developments and this judgement is based in part on the following:

> The Installed Nuclear Capacity of the Western World has doubled since 1978 and is now equal to 229 GWe (that is seven times the total Australian generating capacity from all sources). By the continued operation of existing units and completion of those units now under construction, this capacity will exceed 300 GWe by 1993 (see Tables 1 & 3).
>
> In 1985 world uranium production reduced to where it equalled consumption for the first time for 10 years. A sharp reduction in US uranium production capability and reductions from some other traditional areas suggest that Western World production will be less than true demand, causing a reduction in overhanging stocks and an improving market.

It is this projection that supports the prospect for the expansion of Ranger and the development of Olympic Dam (see Figure 2).

FIGURE 1



Tonnage/Grades of Major Uranium Resources and Districts

The Aus.I.M.M. Conference, Southern Queensland, July, 1985.

FIGURE 2

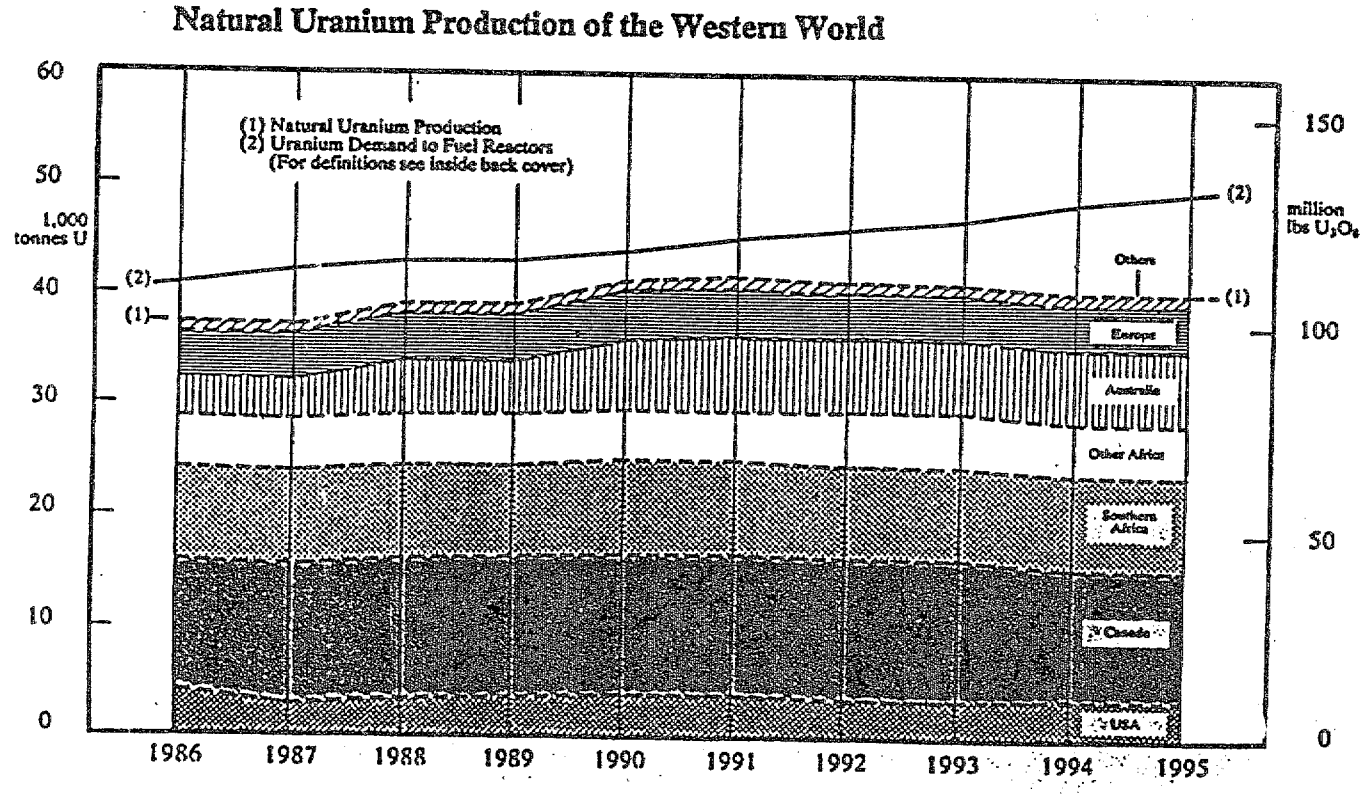


TABLE 1

INSTALLED NUCLEAR CAPACITY OF THE WESTERN WORLD
(net GWe)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Europe	68	85	95	101	105	112	117	121	121	123	124	125
USA	66	77	87	98	104	105	107	107	107	108	108	109
Far East	25	30	32	35	38	39	42	43	45	48	52	55
All Others	12	15	15	17	17	18	20	20	21	24	25	25
Total	171	207	229	251	264	274	286	291	294	303	309	314

August 1985

TABLE 2

Major Uranium Deposits of the Western World
(CRU, 1983)

Deposit/Mine	Reserves M tonnes	kg U_3O_8/t	t U_3O_8
OLYMPIC DAM, Australia	2000	0.6	1.2 million
(including	450	0.8	360,000)
Jabiluka, Australia	53	3.8	200,000
Cigar Lake, Canada	1.5	116.0	175,000
Itataia, Brazil	136	1.0	136,000
Ranger, Australia	53	2.4	127,000
Rossing, Namibia	326	0.35	114,000
Lagoa Real, Brazil	37	2.5	93,000
Imouraren, Niger	42	2.0	83,000
Key Lake, Canada	2.8	28.1	80,000
Stanrock/Can-Met, Canada	81	0.9	73,000
Quirke, Canada	62	1.1	68,000
Mount Taylor, USA	18	3.5	64,000
Afasto-Ouest, Niger	15	4.0	59,000
Yeelirrie, Australia	28	1.7	48,000

TABLE 3

Nuclear Power Plant Capacity of the Western World (GWe net)[1]

	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[2]	1995[2]	1996[2]	2000[2]	
Argentina	–	0.3	0.3	0.3	0.3	0.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.6	1.6 –	1.6 –	1.6 –	1.6 –	Argentina
Belgium	–	1.7	1.7	1.7	2.6	3.5	3.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4 –	5.4 –	5.4 –	6.7 1.3	Belgium
Brazil	–	–	–	–	–	–	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.9	1.9 –	1.9 –	3.1 –	3.1 –	Brazil
Canada	0.2	2.5	5.5	5.5	5.2	7.0	8.2	9.5	10.3	11.6	11.6	12.5	13.4	13.4	14.3	15.2	15.2 –	15.2 –	15.2 –	15.8 0.6	Canada
Egypt	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	– –	– –	0.9 0.9	1.8 1.8	Egypt
Finland	–	–	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3 –	2.3 –	2.3 –	3.3 1.0	Finland
France	1.5	2.8	12.7	20.0	20.0	24.6	29.0	34.4	38.1	43.4	46.4	48.5	52.3	54.8	54.8	56.3	57.6 –	57.6 –	58.8 –	61.6 1.5	France
Germany	0.8	3.2	8.5	8.5	9.8	9.8	12.3	16.4	17.5	19.2	19.2	21.7	22.9	22.9	22.9	22.9	22.9 –	22.9 –	22.9 –	25.6 3.0	Germany
Hongkong	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9	1.8 1.8	1.8 1.8	1.8 1.8	1.8 1.8	Hongkong
India	0.4	0.6	0.6	0.8	0.8	0.8	1.0	1.3	1.3	1.3	1.5	1.7	1.7	1.9	2.1	2.6	3.0 0.9	3.2 1.1	3.7 1.5	5.9 4.1	India
Italy	0.6	0.6	0.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	2.2	3.1	3.1	3.8 1.0	4.8 2.0	4.8 2.0	6.7 3.9	Italy
Japan	0.8	5.0	14.5	15.0	16.6	16.6	19.0	22.8	25.7	24.7	26.9	27.5	29.4	30.4	32.1	33.5	35.7 3.6	38.9 5.6	40.1 6.7	46.6 14.5	Japan
Mexico	–	–	–	–	–	–	–	–	–	0.7	0.7	0.7	1.3	1.3	1.3	1.3	1.3 –	1.3 –	1.3 –	1.3 –	Mexico
Netherlands	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5 –	0.5 –	0.5 –	2.5 2.0	Netherlands
Pakistan	–	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 –	0.1 –	0.1 –	1.1 1.0	Pakistan
Philippines	–	–	–	–	–	–	–	–	–	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6 –	0.6 –	0.6 –	1.2 0.6	Philippines
South Africa	–	–	–	–	–	–	0.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8 –	1.8 –	1.8 –	1.8 –	South Africa
South Korea	–	–	0.6	0.6	0.6	1.8	1.8	2.7	3.9	4.5	5.5	6.4	7.4	7.4	7.4	7.4	7.4 –	7.4 –	8.3 1.0	9.3 1.9	South Korea
Spain	0.2	1.1	1.1	1.1	2.0	2.0	2.8	5.5	5.9	5.5	6.5	7.5	7.5	7.5	7.5	7.5	7.5 –	8.4 –	8.4 –	10.2 –	Spain
Sweden	–	3.1	4.6	6.4	6.4	7.3	7.3	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4 –	9.4 –	9.4 –	9.4 –	Sweden
Switzerland	0.4	1.0	1.9	1.9	1.9	1.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9 –	2.9 –	2.9 –	3.5 0.9	Switzerland
Taiwan	–	–	1.2	2.2	2.2	3.1	4.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	5.8	6.7 1.8	6.7 1.8	6.7 1.8	8.7 3.8	Taiwan
Turkey	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	– –	0.7 0.7	0.7 0.7	0.7 0.7	Turkey
U.K.	3.4	4.4	6.4	6.4	6.4	6.4	6.4	7.0	10.0	10.0	10.5	11.6	12.2	12.0	11.7	11.6	11.0 –	9.7 –	9.7 –	10.3 1.1	U.K.
USA	5.6	37.0	51.1	55.3	56.4	59.3	65.7	74.8	87.5	97.7	104.2	105.5	106.6	106.6	106.6	106.6	107.8 –	107.8 –	110.2 –	110.1 –	USA
Yugoslavia	–	–	–	–	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6 –	0.6 –	0.6 –	1.6 1.0	Yugoslavia
Total	14.0	63.9	113.9	129.8	135.9	149.1	171.0	205.2	229.9	249.9	264.3	274.9	286.0	290.4	293.8	301.8	308.8 9.1	313.5 13.0	321.8 16.4	352.4 46.5	Total

Subtotal Europe	7.0	18.4	40.0	50.0	53.7	60.1	68.8	85.8	94.6	100.5	105.0	111.7	117.3	120.5	121.1	122.5	123.9 1.0	125.2 2.7	126.4 2.7	142.1 16.4	Subtotal Europe
Subtotal Far East	0.8	5.0	16.3	17.8	19.4	21.5	24.8	30.4	32.5	34.7	37.9	39.4	42.3	43.3	45.0	48.2	52.2 7.2	55.4 9.2	57.5 11.3	67.6 22.6	Subtotal Far East
Subtotal USA	5.6	37.0	51.1	55.3	56.4	59.3	65.7	74.8	87.6	97.7	104.2	105.5	106.6	106.6	106.6	106.6	107.8 –	107.8 –	110.2 –	110.1 –	Subtotal USA
Subtotal Others	0.6	3.5	6.5	6.7	6.4	8.2	11.7	14.2	15.5	17.0	17.2	18.3	19.8	20.0	21.1	24.5	24.9 0.9	25.1 1.1	27.7 2.4	32.2 7.5	Subtotal Others

Remarks:

1) The nuclear power plant capacities are assessed by NUKEM on a project-by-project basis.

2) From 1994 onwards two figures appear; the first is total projected capacity, the second shows how much of this is not yet under construction.

NUCLEAR FACTS AND FIGURES

A PWR of 1000 MWe output
requires each year 200 tonnes of yellow cake
containing 180 tonnes of uranium
valued at $20 million. Converted to
hex it fills 21 feed containers.
For enrichment 120 tonnes Separative Work is
needed resulting in 30 tonnes of product at 3.2% U235
and 150 tonnes of tails at 0.25%.
The product fills 20 international containers
each worth $1.5 million. It is converted to oxide
pellets to make 14,000 fuel pins, which are
assembled into 60 fuel elements.
After around 3 years in the reactor
they reach 30,000 MWD/te burn-up
and are then replaced.

1 tonne of natural uranium
equates to 16,000 tonnes of coal
10,000 tonnes fuel oil 80,000 Barrels
8,500 tonnes natural gas 12,000,000 cu metres

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N O T E S

Developments in the coal industry in 1985 and expectations to 1990

J.B. Thomson, Australian Coal Association

The Australian black coal industry's performance over 1985 was marked by record production and export levels. Some of the larger coal companies recorded reasonable profits; however, a significant proportion of the industry achieved only marginal profit or actually incurred losses over the period.

The coal industry has undergone several structural changes over the last ten to fifteen years. In terms of exports, the industry contributed to over 15 percent of total export revenue over 1984-85, the largest of all industry categories. Over the last five years the industry has made substantial gains in productivity and assumed greater involvement in market evaluation and technical expertise. Productivity improvements have been possible as a result of a shift in production towards open-cut mining, use of more productive mining methods such as longwall equipment, and substantial capital investment.

The orientation of the industry towards export sales requires that local producers remain competitive with other major producers, particularly in the United States, Canada, Colombia and South Africa. The Australian coal industry has a very large involvement with Governments at all levels of the mining operation. It is estimated that 44 percent of the total cost of coal production is related to ex-mine costs, essentially beyond the control of the industry. The level of government charges and taxes, as well as demands for excessive remuneration to mineworkers from labour unions, can be counterproductive to the competitiveness of company operations and thereby jeopardise the viability and stability of the industry.

It is possible, given the necessary degree of cooperation between employers, employees and Governments, that Australia can retain its position as the world's largest exporter of coal. Estimates reveal that total overseas demand will increase by 49 percent between 1984 and 1990, the majority of this increase relating to steaming coal. The ability of the industry to achieve these growth forecasts is largely contingent upon sustaining reasonable profitability. In the future, industry performance will be dependent upon reliability and quality of coal supplies and the establishment of a competitive cost environment within the international coal trade.

TABLE I : COAL EXPORTS FROM AUSTRALIA BY DESTINATION, 1979-80 TO 1984-85
(million metric tonnes)

Year	Japan	%	Europe	%	Asia	%	Others	%	Total
1980	29.0	67.2	9.0	21.0	4.8	11.2	0.2	0.6	43.2
1981	32.8	69.2	8.6	18.1	5.5	11.5	0.6	1.2	47.4
1982	32.2	68.3	7.6	16.1	6.6	13.9	0.8	1.7	47.2
1983	34.2	61.6	9.9	17.8	9.7	17.5	1.8	3.1	55.5
1984	38.1	57.3	13.8	20.7	12.6	18.9	2.0	3.1	66.5
1985	43.9	52.4	19.3	23.1	16.0	19.1	4.5	5.4	83.8

Source: Joint Coal Board "Black Coal in Australia", 1984-85.

TABLE II : COAL EXPORTS FROM AUSTRALIA, BY TYPE, SELECTED YEARS, 1964-65 TO 1984-85
(million metric tonnes)

Year	Metallurgical	%	Steaming	%	Total
1965	5.8	97.1	0.2	2.9	5.9
1970	17.1	95.1	0.9	4.9	18.0
1975	28.7	88.4	3.8	11.6	32.4
1980	36.1	83.7	7.0	16.3	43.2
1981	36.9	77.7	10.6	22.3	47.4
1982	37.4	79.3	9.8	20.7	47.2
1983	38.8	69.8	16.8	30.2	55.5
1984	44.1	66.3	22.4	33.7	66.5
1985	50.5	60.3	33.3	39.7	83.8

Source: Joint Coal Board "Black Coal in Australia", 1984-85.

TABLE III : SUMMARY OF REVENUE, EXPENDITURE AND GOVERNMENT CHARGES BETWEEN 1982-83 AND 1984-85

	$ Million			% Change Between 1983-84 and 1984-85
	1982-83	1983-84	1984-85	
Mining Sales	3,491	3,824	5,234	37↑
Capital Expenditure	1,753	819	672	18↓
Exploration Expenditure	37	13	17	3↑
Interest Expense	162	191	328	72↑
Payments for Government Services	542	700	966	38↑
Mineral Royalties, Tenements and Mining Licence Fees	120	139	172	24↑

Note: ↑ denotes increase
↓ denotes decrease

Source: Australian Coal Association, Coal Industry Financial Survey, 1985, Good News Bad News, prepared by Coopers and Lybrand.

TABLE IV : FORECAST CHANGES IN DEMAND OF METALLURGICAL AND STEAMING COAL BETWEEN 1984 AND 1990

	1984	1990	% Change 1984 to 1990
Domestic Demand	39.7	48	20.9
- metallurgical	6.6	7	4.5
- steaming	33.1	41	23.9
Overseas Demand	75.8	113	49.0
- metallurgical	47	56	19.1
- steaming	28.8	57	97.9

Source: Australian Coal Consultative Council. National Research Group Report by Working Party No. 6. A Forward Study of the NSW and Queensland Coal Industry to 1990.

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N O T E S

Policy developments relevant to the Australian coal industry

P. Ryan, Department of Resources & Energy

The philosophy behind the Government's resource policies is to encourage the efficient development of resources in a way that ensures a fair sharing of the benefits to the Australian community. The Government is intent on maintaining an efficient and profitable coal industry and adopts policies which will encourage this - providing such policies do not conflict with the welfare of the Australian economy.

The Australian coal industry is export oriented and operates in an imperfect world market: many countries subsidise their domestic production and exports and some consumers purchase coal on non-commercial bases. In spite of this, and a static world coking coal market, Australian producers increased their exports by 16% in 1985 following increases of 25% and 21% in the previous years.

Australia is now the world's largest exporter of coal yet we are still branded by some with the image of being an unreliable supplier. The Government takes every opportunity to promote a positive image of the Australian coal industry and we feel the industry can do much more in this regard. Management and unions should refrain from using confrontational approaches to disputes and make better use of the extensive consultative fora available.

While coal production and exports have reached record levels, the Australian industry is experiencing a period of low profitability. A drop in real prices and overcapacity resulting from a surge of investment between 1979 and 1981 have contributed to this situation. The Commonwealth and State Governments have been criticised for the level of taxes and charges but it is through these that the Australian community and economy benefit. The ultimate solution to improved profitability is an increase in real coal prices which should occur once current overcapacity is reduced.

In the longer term the Government favours replacing the present ad hoc taxes and charges with a resource rent taxation regime. This is an equitable form of taxation as a project only becomes liable to tax after recouping outlays plus a threshold rate of return. Marginal operations, hence employment, would not be adversely affected.

N O T E S

Coal research in Australia

J.E. Kolm, NERDDC

Australia is the second largest coal producer in the OECD and the world's largest coal exporter. This paper attempts to examine whether our research, development and demonstration (RD&D) effort is commensurate with our role as a world coal power. The paper will discuss Australian coal RD&D in national and international contexts. While Australian coal RD&D effort has been significant over the last few years (Table 1, Fig.1), it is still much lower than that of USA, FRG and UK (Tables 1, 2). Australian industry and Government performance of coal RD&D by technology area are indicated at Table 3.

The Australian coal industry has benefitted from a remarkable record of RD&D cooperation within industry. Traditionally, the industry has been a heavy industry, neither particularly high technology oriented or very research sensitive. Innovation in this capital intensive industry has been largely demand driven, although changes are emerging. For example, it is recognised that for underground coal mining to be competitive with surface mining, application of new techniques such as remote sensing, robotics and computer based information systems will be essential. RD&D is also critical in relation to a future liquefaction industry and in ensuring that Australian coals are marketable in countries with strict environmental regulations.

As the national economic importance of the coal industry has grown, so has its need for advanced RD&D. The National Energy Research, Development and Demonstration Program has taken on this challenge with excellent cooperation from the Australian coal industry and mining unions. A number of achievements under this Program has received national and international recognition, eg mine gas drainage demonstration and COALSCAN. Major recent initiatives include the funding of (a) demonstrations for automatic remote controlled roof bolting, remote controlled continuous coal transportation and automatic guidance control systems in coal mines, (b) a study on advanced information and control systems for coal mining, and (c) the establishment of a coal combustion test facility.

The national coal RD&D program is an excellent model for establishment of RD&D cooperation in other industry related areas.

Table 1: IEA GOVERNMENT RD&D BUDGETS FOR COAL IN 1983 US DOLLARS
(millions)

Year	1977	1978	1979	1980	1981	1982	1983
Australia	7.0	9.8*	14.5	19.1	22.1	24.4*	26.4
Canada	18.5	24.1	19.0	15.4	19.6	29.0	29.0
Germany	68.7	107.6	141.0	120.7	138.9	136.5	94.9
Japan	17.0	9.9	25.0	110.2	175.3	126.7	134.4
United Kingdom	5.8	11.5	16.1	6.8	8.7	6.9	8.2
United States	525.5	639.9	615.3	889.0	799.5	349.2	201.5
TOTAL IEA GOVERNMENT	653.8	808.8	859.1	1208.5	1242.2	707.7	530.1
Total Coal RD&D in Australia	13.4	18.9*	30.4	39.2	44.6	43.6*	42.6
All RD&D in Australia							
- Total Budget	1420	1451*	1482	1515*	1548*	1581	1580*
- Government Budget	1073	1096*	1118	1147*	1177*	1206	1202*

*Estimated

Table 2: TOTAL COAL RD&D EXPENDITURE PER UNIT COAL PRODUCTION IN SOME IEA COUNTRIES (1982 US$/t hard coal equivalent)

Year	1980	1982
Australia	0.44	0.42
Germany*	1.34	1.82
United Kingdom**	1.10	1.07
United States	1.45	1.00

*Industrial RD&D activity included is only for projects jointly undertaken with Government

**Industrial RD&D activity included is only for nationalised industry

Table 3: BUSINESS ENTERPRISE (BE) AND GOVERNMENT (GOVT) PERFORMANCE IN COAL RD&D

Year	1979-80			1982-83		
	$M(1982-83)		BE performance (%)	$M(1982-83)		BE performance (%)
	BE	GOVT		BE	GOVT	
Mining	3.0	3.8	44	6.6*	2.9*	69
Preparation and transport	5.3	2.3	70	5.1	4.0	56
Combustion	4.4	0.9	84	2.8	2.3	55
Conversion	3.1	7.5	29	2.5	11.1	18
Other	9.2	2.3	80	3.5	4.7	43
TOTAL	25.0	16.8	60	20.5	25.0	45

*Estimated

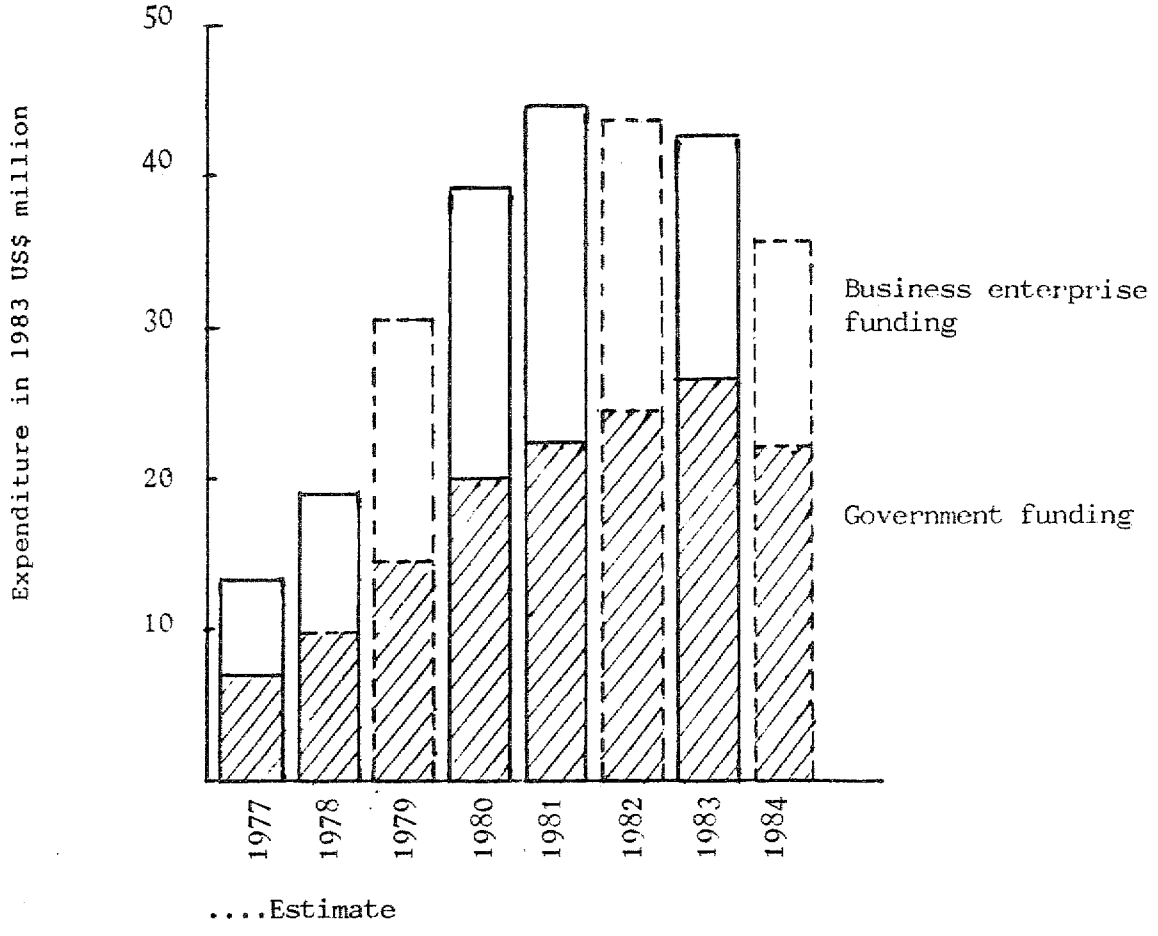

Figure 1: Australian coal RD&D expenditure in 1983 US dollars

Australian mineral industry overview

J.Ward, BMR

The level of world non-ferrous metal stocks was reduced substantially in 1985 and some excess capacity was eliminated as a result of voluntary action by producers. Nonetheless, international markets continued to be intensely competitive and metal prices remained depressed. Against this background, and in the midst of a volatile international economic environment and a major devaluation of the $A in the early part of the year, the Australian mineral industry continued to set new production and export records. Ex-mine value of production increased to an estimated $21 billion ($16 billion in 1984) with record production levels in coal, iron ore, lead-zinc-silver and petroleum and substantial increases in gold, mineral sands, nickel and manganese.

While sales of refined metals increased substantially, domestic smelting and refining remained at 1984 levels except for increases in alumina/aluminium and refined gold.

On balance the lower valued $A continues to favour Australian mineral exporters and in 1985 exports of mineral primary products established a new record of $15.2 billion compared with $11.2 billion in 1984, achieved mainly as a result of record shipments of black coal, iron ore, petroleum and aluminium. In contrast the value of crude oil imports was reduced to $1.5 billion and the balance of trade in minerals increased to a favourable $13.2 billion.

Markets closed in 1985 on a depressed note; prospects for improved demand for 1986 are not encouraging and most metals remain actually or potentially in oversupply.

Psychologically, the reduced tempo in metal trading was exacerbated by the tin crisis of October 1985 which continued through the remainder of the year and beyond. On the brighter side, modest price increases are predicted for some metals and with A/US continuing at current parity levels further production increases are expected for coal, iron ore, manganese, aluminium, gold, diamonds, base metals and mineral sands in the current year.

Understandably, the longer-term position is more difficult to predict. Two opposing scenarios for the latter half of the decade can be presented. The more pessimistic sees the continuing weakness in metal markets becoming the norm for the industry; a diminishing intensity of metal use, and concomitantly the development of a negative growth pattern in consumption; and a mining industry where only the lowest cost producers are profitable. The more optimistic scenario, while projecting only modest increases in metal consumption over the next few years, predicts upward movements in the price cycle sufficient to restore profitability to efficient producers and to warrant the commissioning of mines based on better grade ore and using advanced technology. Such a scenario could result in an expansion of Australian mineral exports to $17-18 billion/year (at 1985 values) by 1990 based on current operations and some known deposits yet to be developed.

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TABLE 1. MINE PRODUCTION OF PRINCIPAL MINERALS : AUSTRALIA

Mineral	Unit of Quantity	1982	1983	1984	1985(a)
Bauxite	'000t	23 625	24 372(g)	32 182(g)	32 400
Black Coal (b)	'000t	119 068	120 482	139 094	157 200
Brown Coal	'000t	37 821	34 191	35 108	36 000
Copper (c)	t	245 322	261 476	236 040	258 000
Gold (c)	kg	26 961	30 591	39 101	57 000
Ilmenite cons (d)	'000t	1 149	893	1 144	1 250
Iron ore and cons (f)	'000t	87 694	71 037	88 847	100 000
Lead (c)	t	455 338	480 626	440 676	491 000
Manganese ore, metallurgical	'000t	1 123	1 370	1 829	1 989
Nickel (c)	t	87 552	76 625	76 889	85 000
Petroleum					
Crude Oil	'000m^3	20 652	24 083	27 775	31 590
Natural Gas	mil m^3	11 594	11 914	12 600	13 464
Rutile cons	t	220 697	163 374	181 481	205 000
Silver (c)	kg	906 863	1 032 895(g)	970 590(g)	1 055 000
Tin (c)	t	12 126	9 275(h)	7 699	7 000
Tungsten (W)	t	2 618	2 015	1 772	1 912
Uranium (U_3O_8)	t	5 215	3 786	5 177	3 834
Zinc (c)	t	664 800	699 032	658 664	734 000
Zircon cons	t	462 476	382 005	454 534	440 000

(a) Preliminary, subject to revision; (b) Raw coal; (c) Total metallic content of minerals produced; (d) Excludes leucoxene; (f) Excludes iron oxide not intended for metal extraction; (g) Excludes Victoria; (h) Excludes tin content of copper-tin concentrates.

TABLE 2. SMELTER AND REFINERY PRODUCTION OF PRINCIPAL METALS : AUSTRALIA

Mineral	Unit of Quantity	1982	1983	1984	1985(a)
Alumina	'000t	6 631	7 231	8 781	8 792
Aluminium	t	380 796	478 190	757 798	851 286
Copper - Blister	t	175 536	173 619	179 822	166 978
- Refined	t	160 195	168 533	171 180	163 719
Gold	kg	25 711	29 646	37 003	54 223
Lead - Bullion	t	181 592	182 593	179 491	183 298
- Refined (b)	t	218 812	196 335	198 847	196 171
Pig iron	'000t	5 956	5 045	5 329	5 607
Raw steel (d)	'000t	6 371	5 625	6 299	6 577
Silver (d)	kg	348 019	323 071	301 093	287 861
Tin	t	3 105	2 913	2 899	2 683
Zinc	t	291 390	298 451	301 940	288 364

(a) Preliminary, subject to revision; (b) Includes lead content of lead alloys from primary sources; (d) Includes recovery from scrap.

TABLE 3. AUSTRALIAN OVERSEAS TRADE OF MINERAL PRIMARY PRODUCTS

	Unit of Quantity	1983 Quantity	1983 Value f.o.b. ($'000)	1984 Quantity	1984 Value f.o.b. ($'000)	1985(a) Quantity	1985(a) Value f.o.b. ($'000)
Exports							
Alumina	'000t	6 378	1 184 906	6 905	1 276 389	7 176	1 450 113
Aluminium (ingot metal)	t	234 562	332 724	404 114	637 099	559 517	858 495
Coal (Black)	'000t	60 504	3 328 749	75 856	3 905 254	87 902	5 103 829
Copper (b)(c)	t	158 835	276 453	146 197	225 648	158 885	274 406
Diamonds, gem	m.c.	3 015 385	36 541	2 682 585	25 896	2 677 941	30 209
Diamonds, industrial	m.c.	1 046 103	10 692	903 480	6 014	561 451	3 684
Gold (b)(c)	kg	20 615	270 018	31 532	418 143	52 640	665 124
Ilmenite concentrates	t	816 933	23 005	1 172 986	33 859	1 151 885	39 743
Iron ore and pellets	'000t	74 039	1 573 255	85 480	1 615 188	86 732	2 017 778
Iron, Ingot steel, ferro-alloys	'000t	903	126 393	411	81 266	668	151 284
LPG	'000t	1 453	428 448	1 441	376 304	1 609	491 912
Lead (b)(c)	t	409 732	383 291	429 192	358 568	436 676	344 598
Nickel (c)	t	n.a.	320 786	n.a.	384 586	n.a.	498 213
Oil, crude (d)	'000m³	151	32 063	3 393	684 299	6 703	1 614 271
Rutile concentrates	t	217 662	53 955	191 507	58 018	211 723	83 463
Salt	'000t	4 535	69 388	4 783	74 723	5 051	97 464
Tin (b)(c)	t	6 716	119 879	6 619	84 494	5 455	87 672
Tungsten concentrates	t	3 887	20 289	3 160	19 253	3 300	25 551
Uranium	t	3 273	296 008	3 308	312 079	3 452	314 749
Zinc (b)(c)	t	645 403	392 452	660 963	468 860	595 771	515 984
Zircon concentrates	t	379 975	44 745	437 770	51 819	518 023	67 158
Other minerals (f)	-		434 022		302 087		474 458
Total			9 710 829		11 367 936		15 210 158
Imports							
Aluminium	t	5 225	8 191	709	1 893	1 061	3 334
Asbestos, all types	t	10 113	8 776	14 432	12 145	12 194	11 386
Clays, all types	t	40 396	5 133	64 097	8 661	67 864	10 752
Diamonds, gem	m.c.	71 981	31 480	96 966	36 141	124 585	48 156
Diamonds, industrial	m.c.	1 120 405	4 162	1 471 714	5 255	1 787 159	7 938
Gold (b)	kg	3 161	27 946	3 527	38 670	7 968	89 303
Ingot steel, ferro-alloys	t	17 290	13 197	36 472	26 413	62 502	39 039
Nickel - matte, metal	t	357	1 957	1 134	5 898	859	6 076
Oil,crude (d)	'000m³	8 764	1 780 356	8 431	1 681 075	6 615	1 505 922
Phosphate rock	'000t	2 198	113 573	1 606	82 095	1 799	94 207
Potassium fertilisers	t	197 245	20 064	259 628	28 158	204 628	28 464
Sulphur, elemental	t	392 581	32 930	470 795	39 642	392 344	57 863
Other	-		73 417		97 133		128 367
Total			2 121 182		2 063 179		2 030 807

(a) Preliminary, subject to revision; (b) The quantity refers to total metallic contents contained in all ores and concentrates, drosses, lead bullion and blister copper and refined metal where applicable; (c) The values shown include the value of ore and concentrate, intermediate products and refined metal; (d) Including enriched crude and other refinery feed stock; (f) Excludes beneficiated ilmenite.

The financial performance and outlook for the Australian mineral industry

B.J. Davies, Coopers & Lybrand

This paper is based on data gathered and the commentary prepared in connection with the Minerals Industry Survey 1985 conducted by Coopers & Lybrand on behalf of the Australian Mining Industry Council.

Revenue and Production Operating revenue of the Australian minerals industry showed a welcome growth from the depressed levels of recent years with 1984/85 being up by 26% on the previous year. This was due to:-

(a) increased volumes of production largely derived from new projects (coal, alumina, aluminium and gold) which were committed by investment decision taken some years ago, together with a general growth in world demand; and

(b) increased Australian dollar prices, arising from a significant depreciation of the Australian dollar in the last two quarters of the 1984/85 financial year (total $A movement was 23% against $US over the full year) impacting on relatively steady prices expressed in the relevant pricing currencies (mostly US dollars).

Profits A large part of the increased revenue flowed through to minerals industry pre-tax profits, although part was exacerbated by additional costs. For example, volume increases gave rise to additional production costs, while exchange rate movements increased costs of overseas-sourced supplies (including interest) and exchange losses on foreign borrowings.

Foreign Exchange Differences Unrealised exchange losses on overseas borrowings of some one billion dollars continue to hang over the head of the Australian minerals industry. These losses will continue to erode the revenue gains derived from the present level of the Australian dollar. It also needs to be recognised that while increased revenue flowing from these exchange movements are subject to Australian income tax, the additional losses on foreign currency borrowings, which largely mirror those gains, are generally not allowed as a tax deduction in Australia. This anomaly impacts quite severely on the profitability of the minerals industry in this country.

Rates of Return Rates of return for the Australian minerals industry continued to be dismal, despite the continued minor improvement from the depths of 1981/82. The net profit return on average shareholders' funds increased from 4.4% to 5.7%.

Bearing in mind the greater level of risk which is perceived to exist in the minerals industry it is of relevance to compare the rates of return for the Australian minerals industry with other financial and industrial enterprises. The following summary is taken from the Reserve Bank of Australia Bulletin of January 1986, and shows the ratio of net profit to shareholders' funds. The "mining" figures in the RBA Bulletin are not strictly comparable with the AMIC Survey because of a different population in each analysis, but the trends are similar.

Net Profit Returns on Average Shareholders' Funds

	1980/81	1981/82	1982/83	1983/84	1984/85
Financial	15.2	15.5	14.1	14.8	15.1
Industrial	11.0	9.3	7.7	10.0	11.2
Mining	8.2	1.4	4.6	5.1	4.4
(AMIC)	10.9	2.2	4.1	4.4	5.7

Profitability of the minerals industry section is demonstrably poor compared to other major sectors of the Australian economy.

Capital Expenditure Capital investment by the Australian minerals industry has declined dramatically over the past two years, with the main emphasis now being on new gold mining activity and plant upgrading at established operations.

Exploration Exploration expenditure, which is the lifeblood of the minerals industry continued to fall, particularly in real terms. The forecast for 1985/86 is for a 14% fall in dollar terms as well.

Government Charges The greatest increase in the Australian minerals industry costs, in percentage terms, continues to be in the provision of Government services, such as rail facilities in Queensland and New South Wales. The Survey shows, for a constant group comparison, that revenue increased by 20% in 1984/85, of which a large part was attributable to

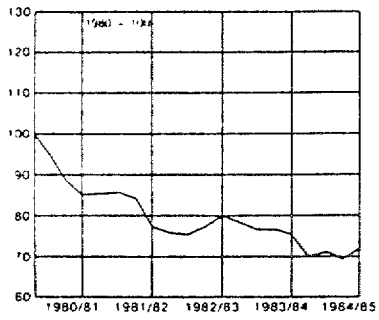
exchange rate movements, while the comparable increase in the cost of Government services was 32%. There is also a trend for a larger proportion of the overall Governments' share of the Australian minerals industry revenue dollar to be paid to the States rather than to the Commonwealth.

Conclusion While there has been some improvement in the financial performance of the Australian minerals industry in 1984/85, the overall result must still be regarded as unsatisfactory. Performance compares poorly both with other sectors of the Australian economy and with the minerals industry performance of the 1970's. While gains have been made in efficiency and cost containment (where this is with the areas of influence of management) those other costs which are determined by world-wide economic factors and Government directives continue to erode the improved revenue levels. The result is an ongoing rate of profitability, in relation to the massive amount of funds employed in the Australian minerals industry, which is not adequate for the risks involved. This must eventually be reflected in the level of future investment in the industry in this country.

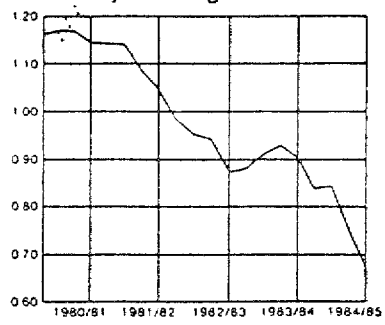
Price Data

Year ended June

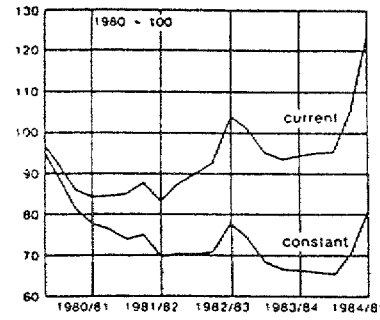
World Metal Prices $US



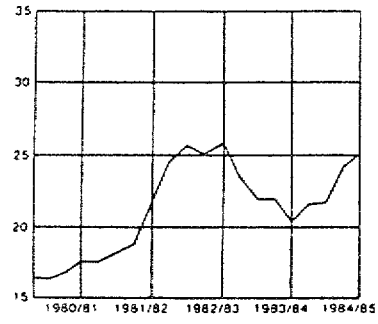
$US: $A Exchange Rate
Quarterly average



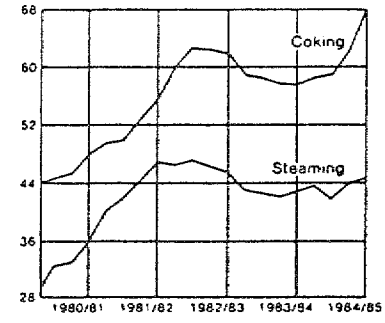
World Metal Prices $A



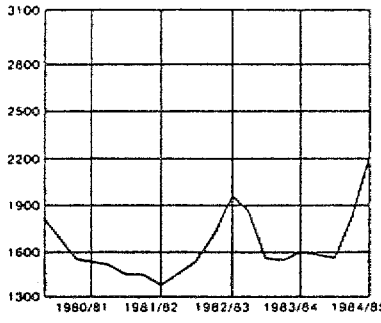
Iron Ore
$A/Tonne



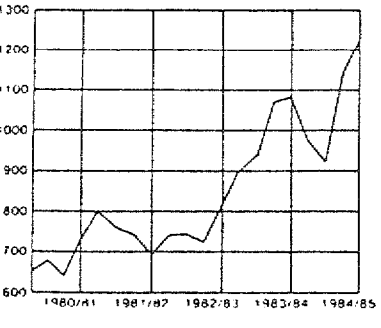
Coal
$A/Tonne



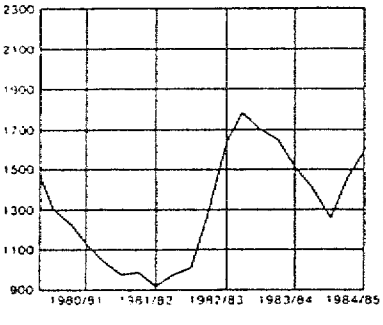
Copper LME
$A/Tonne



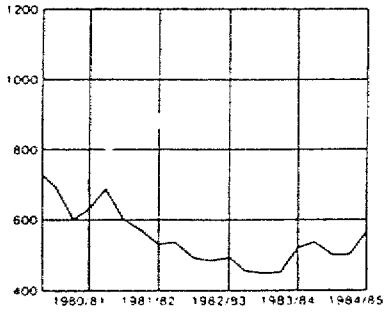
Zinc LME
$A/Tonne



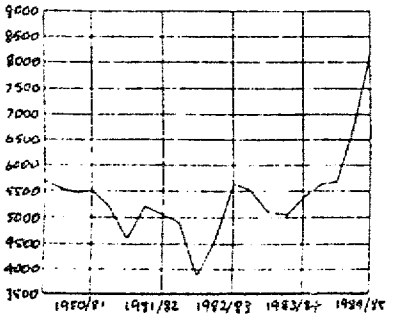
Aluminium LME
$A/Tonne



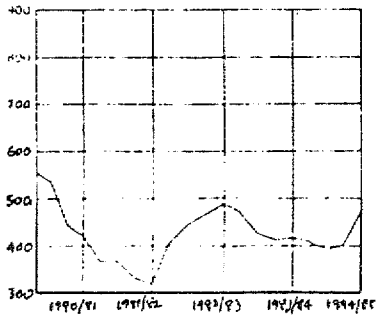
Lead LME
$A/Tonne



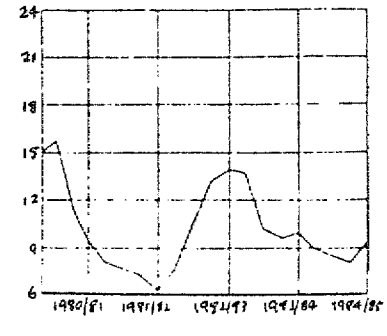
Nickel LME
SA/Tonne



Gold London Spot
$A/Troy oz



Silver London Spot
$A/Troy oz



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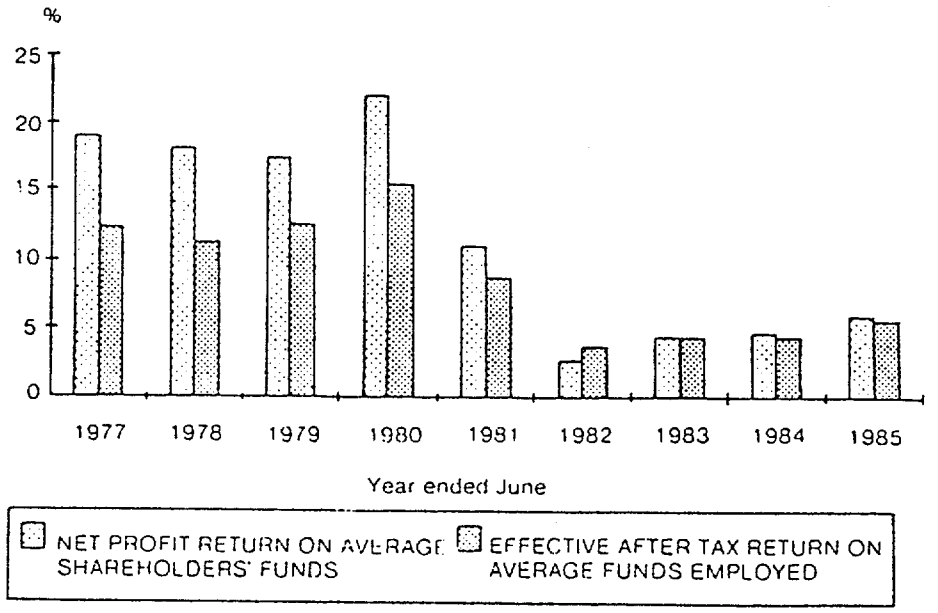
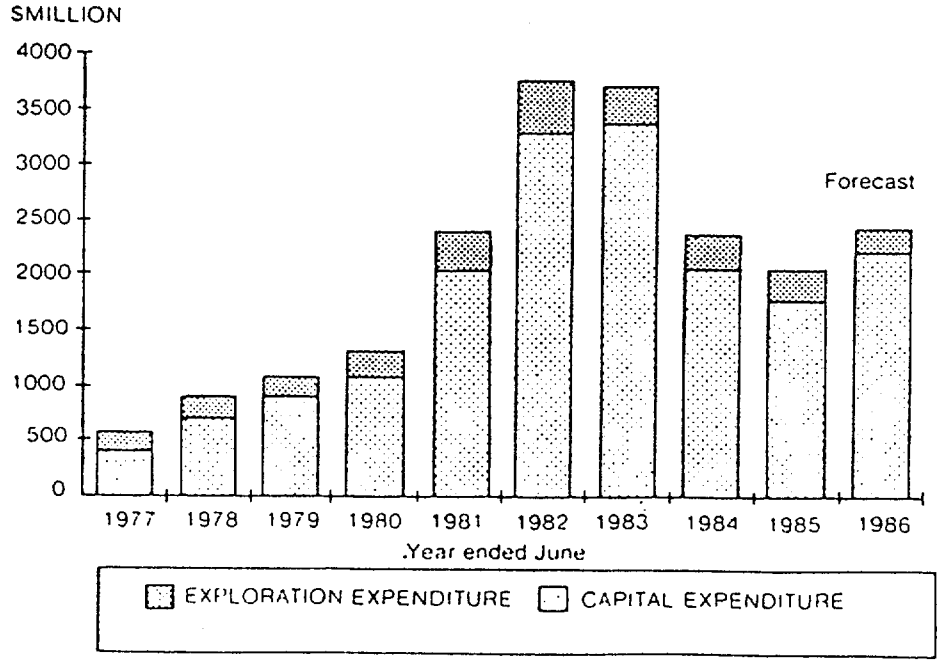
RATES OF RETURN



CAPITAL AND EXPLORATION EXPENDITURE



Survey Highlights

Items of Interest	1982/83	1983/84	1984/85
Operating Revenue ($ Million)	9874	10748	13500
Total Assets at Year End ($ Million)	23599	25401	27662
Borrowings at Year End ($ Million)	9639	10275	11964
Interest Expense ($ Million)	647	748	964
Net Profit ($ Million)	379	462	640
Net Profit Return on Average Shareholders' Funds (%)	4.1	4.4	5.7
Effective After-Tax Return on Average Funds Employed (%)	4.3	4.4	5.5
Effective After-Tax Return on Average Assets Employed (%)	3.6	3.7	4.6
Direct Taxes on Preimpost Profit (%)	65.6	63.0	58.0
Expenditure on Fixed Assets ($ Million)	3380	2075	1793
Exploration Expenditure ($ Million)	343	287	254
Employees at Year End	78821	78923	79609
Debt to Equity Ratio	0.96	0.94	1.07
No. of Responses	122	118	121

Forecasts	1984/85 Actual	1985/86 Forecast	Percentage Change
Expenditure on Fixed Assets ($ Million)	1793	2232	24.5
Exploration Expenditure ($ Million)	254	218	−14.2
Employees at Year End	79609	80406	1.0

Mineral exploration and mining developments in Queensland in 1985 and outlook for 1986

J.H. Brooks, Geological Survey of Queensland

In 1985 the most significant mineral industry event in Queensland was the start of production at Kidston, the first major metal mine to be opened since 1974. Gold completely dominated exploration activity, it being the principal metal sought in two-thirds of the current Authority to Prospect titles. The success of initial operations at Kidston has engendered confidence in considerating the development of other low-grade gold deposits. Red Dome, near Chillagoe and Mount Leyshon, near Charters Towers, are expected to be brought into production by the end of 1986, and a decision to go ahead with development of the Starra deposits, south of Cloncurry, may also be possible by that time. Following successful drill testing of the high-grade Pajingo gold discovery, south of Charters Towers, feasibility studies are in progress. In the Palmer River area a second alluvial mining operation is planned to start this year. Encouraging gold intersections have been obtained from drilling at Gympie, in the Hodgkinson-Mitchell River area, northwest of Cairns, and on Horn Island in Torres Strait.

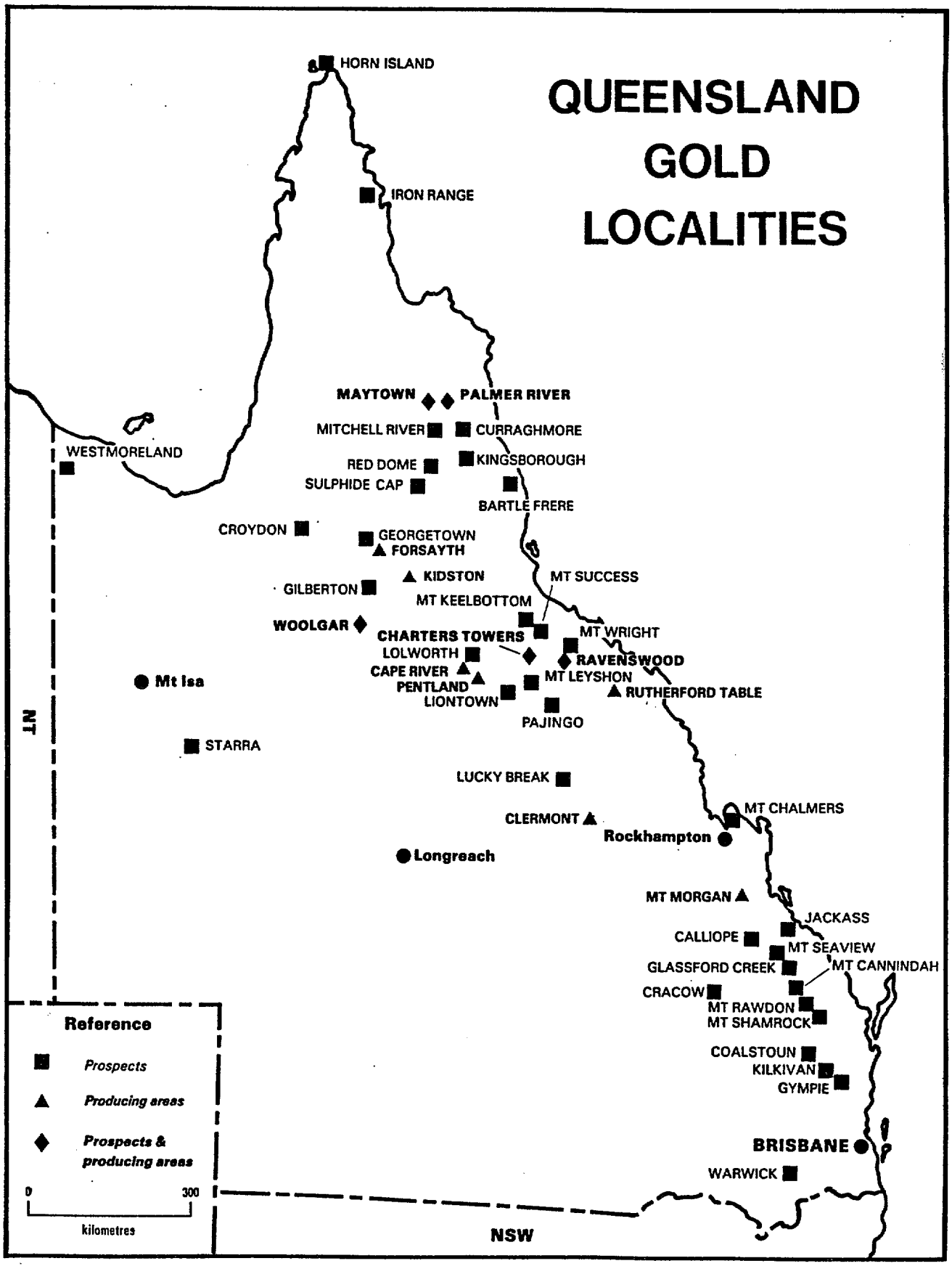
Exploration for base metals has declined. However, at the Lady Loretta zinc-lead deposit, north of Mount Isa, an underground development program will start this year. At Mount Isa, development work to access the deep 3000/3500 copper orebodies is continuing, and at the Hilton lead-zinc mine to the north, trial mining is scheduled to begin this year.

In the Cooktown area, exploration of the Collingwood and Jeannie River tin deposits has demonstrated that they are important potential sources of this metal. At the Mount Carbine tungsten mine, northwest of Cairns, plans are proceeding to go underground in 1987, following the expected exhaustion of mineable open cut reserves. Exploration of the large resource of scheelite in the Watershed prospect, in the same general area, is continuing.

On North Stradbroke Island, a new plant to develop the Gordon deposit was commissioned and further expansion is planned. Production of silica sand at Cape Flattery, north of Cooktown, is to be substantially increased in 1986, and development is planned for similar high-grade dune deposits in the Cape Grenville area on the east coast of Cape York Peninsula. Development of large reserves of paper-coating quality kaolin at Weipa is in progress, with production expected to start by mid-1986. Extensive sedimentary deposits of nodular magnesite have been found north of Rockhampton.

QUEENSLAND: MAIN GOLD PRODUCERS AND POTENTIAL PRODUCERS

Deposit	Type	Mining Operation	Production Status	Annual Production	Resource Estimates
CRACOW	- Quartz breccia lode	Tailings Open cut	Started early 1985 Feasibility study	9600 oz (300 kg) 29 000 oz (900 kg) - projected	0.8 Mt x 1.4 g/t tailings, also lode deposit, 4-7.5 g/t
CROYDON	Quartz reefs	Open cut	Started August 1984 Further feas. study	3266 oz (100 kg) 1984-85	1.2 Mt x 3.8 g/t - mineable
KIDSTON	Breccia pipe	Open cut	Started March 1985	196 000 oz (6000 kg) av. first 5 years	39.2 Mt x 1.82 g/t proved, Jan. 1986
MT LEYSHON	Breccia pipe	Open cut	Expected to start late 1986	34 000 oz (1050 kg) - projected	6.6 Mt x 1.97 g/t - mineable
MT MORGAN	-	Tailings treatment	Started December 1982	52 540 oz (1634 kg) 1984-85	26 Mt x 1.08 g/t at June 1985
PAJINGO	?	Open cut	Feasibility study	-	1.4 Mt x 12.6 g/t Au, 40 g/t Ag
PALMER R.	Placer	Alluvial	To increase in 1986	1600 oz (50 kg) 1984-85	Large, low grade
RED DOME	Skarn/ breccia	Open cut	To start late 1986	62 000 oz (2000 kg) - projected	8.6 Mt x 2.5 g/t - mineable
STARRA	Sedimentary iron fm	Open cut	Exploration to be completed 1986	-	7.2 Mt x 5 g/t - geological
MT RAWDON	Volcanogenic	Open cut	Exploration stage	-	7.1 Mt x 1.75 g/t - geological


QUEENSLAND
GOLD
LOCALITIES
HORN ISLAND
IRON RANGE
MAYTOWN
PALMER RIVER
MITCHELL RIVER
CURRAGHMORE
WESTMORELAND
RED DOME
KINGSBOROUGH
SULPHIDE CAP
BARTLE FRERE
CROYDON
GEORGETOWN
FORSAYTH
KIDSTON
MT SUCCESS
GILBERTON
MT KEELBOTTOM
WOOLGAR
CHARTERS TOWERS
MT WRIGHT
LOLWORTH
RAVENSWOOD
CAPE RIVER
MT LEYSHON
Mt Isa
PENTLAND
RUTHERFORD TABLE
LIONTOWN
PAJINGO
NT
STARRA
LUCKY BREAK
MT CHALMERS
CLERMONT
Rockhampton
Longreach
MT MORGAN
JACKASS
CALLIOPE
MT SEAVIEW
GLASSFORD CREEK
MT CANNINDAH
CRACOW
MT RAWDON
MT SHAMROCK
COALSTOUN
KILKIVAN
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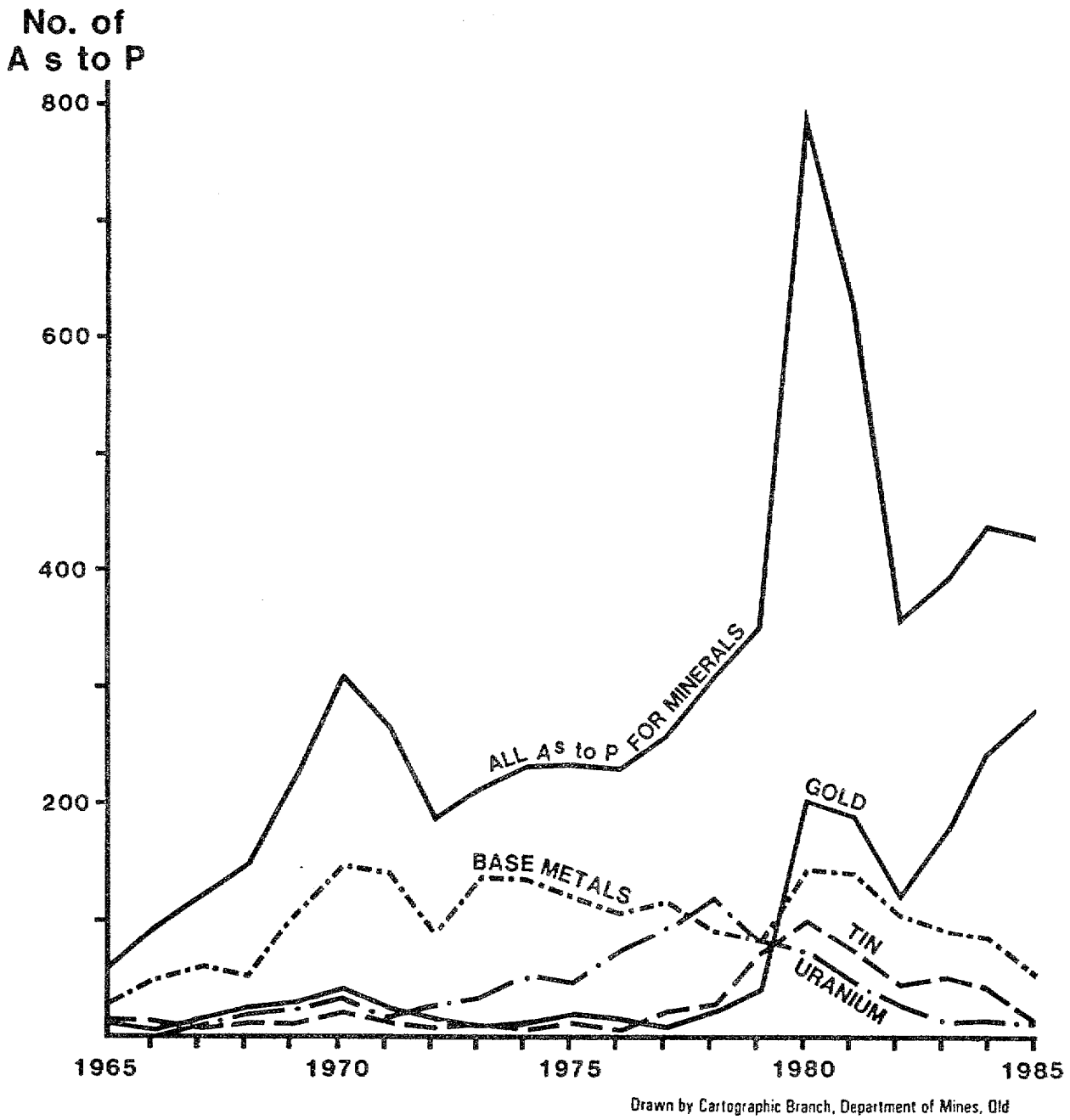

Drawn by Cartographic Branch, Department of Mines, Qld

Exploration under Authorities to Prospect, 1965-1985

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Highlights of mineral exploration and mining developments in New South Wales

N.L. Markham, NSW Department of Mineral Resources

Coal In 1985, raw coal production reached a record 74.86 mt, a 9.6% increase over the previous year. Exports reached a record level of 40.7 mt. These increases are due largely to higher coal production in the Hunter Valley resulting from expanding export markets. Further increases in production for 1986 are to be anticipated.

By contrast, coal exploration showed a significant decline. In 1984/85 coal drilling in New South Wales totalled 54 800 metres, a decrease of 35% from the previous year. This drilling was focused largely on the Gunnedah (10 170 metres) and Hunter (14 340 metres) Coalfields. A comparison of drilling meterage from 1969 to 1985 (see figure) shows a steady increase from the early 1970's to 1982, followed by a steep decline to 1985.

1985 coal exploration drilling was focused on the delineation of resources suitable for domestic power generation; exploration drilling in authorisations and mine development drilling in colliery holdings. This pattern is likely to continue in 1986.

Petroleum The level of petroleum exploration in New South Wales increased significantly in 1985. This reflected a greater awareness of geological environments similar to those of producing fields in nearby states, as well as incentives introduced by the New South Wales Government to promote a higher level of petroleum exploration. A significant gas find (Wilga Park No.1) took place in the Permo-Triassic Gunnedah Basin in the vicinity of Narrabri with initial flow rates reaching 28 300 m^3/day. Petroleum exploration is expected to further increase in 1986.

In the Southern Coalfield, drainage of methane gas from coal seams both prior to and during coal mining has been further investigated.

Metallic Minerals A major trend has been to increase production from existing mines in order to improve profitability, or to extend mine life by the treatment of lower grade ores.

At Broken Hill, the North Mine is to increase production from 460 000 to 600 000 tpa as well as develop a new open cut. Minerals, Mining and Metallurgy will also develop a new open cut while AM&S are undertaking a feasibility study to extend the life of the Zinc Corporation and NBHC mines

by expanding ore production and lowering head grades. In the Cobar field, production at both the CSA and Elura mines is to be increased. At Woodlawn, a study into the feasibility of underground mining beneath the existing open cut is underway.

(i) **Silver** Development of the Lady Hampden silver/gold deposit in the Drake field is likely to proceed in 1986.

(ii) **Copper** Evaluation of the Goonumbla porphyry gold/copper prospects near Parkes continued in 1985 and the results of a preliminary feasibility study will be available in mid 1986.

(iii) **Gold** Active exploration for gold continued in New South Wales in 1985 and a number of prospects are in various stages of evaluation and development. Significant gold prospects identified include Gidgenbung (near Temora), the Peak (Cobar field), Canbelego (tailings retreatment), Mineral Hill, London Victoria (Parkes), Peak Hill, Cowarra, Browns Creek (in production), Junction Reefs and West Wyalong (tailings retreatment).

(iv) **Antimony/Gold** Existing underground mining operations at Hillgrove include the Freehold, Garibaldi and Eleanora mines. Exploration is being continued.

(v) **Tin** Significant resources of deep lead alluvial tin have been discovered at Gibsonvale but development is being hampered by tin quotas and uncertainties in prices.

Industrial Minerals Exploration for industrial minerals in New South Wales continued at low to moderate levels in 1985, the main commodities of interest being gemstones and heavy minerals.

Heavy Mineral Sands 1985 saw a greater interest in exploration for heavy mineral sands because of higher commodity prices. Developments expected in 1986 include expansion of R&Z Mines operation at Tomago and the Stockton Bight operation of Mineral Deposits Ltd, and a new operation by Mineral Deposits Ltd at Tea Gardens.

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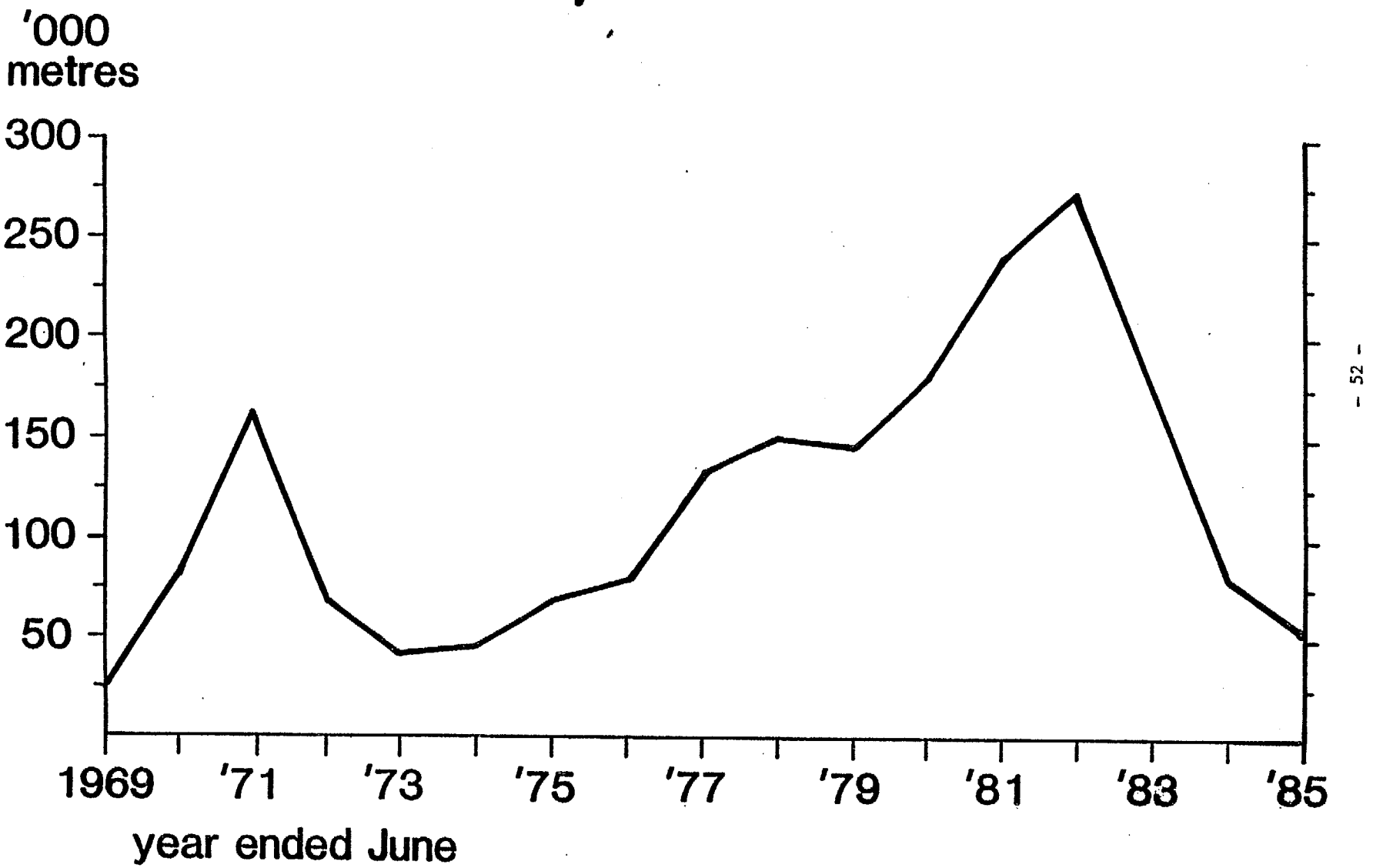
Other A high level of interest was shown in exploration for sapphires, opals, zeolites and marine aggregate. Developments forecast for 1986 include a wet kaolin processing plant near Gulgong (Australia China Clays Limited), expansion of diatomite processing at Barraba and production of magnetite for coal washery use from the Tallawang deposits near Gulgong.

COAL DRILLING, NEW SOUTH WALES



Victorian mining and mineral exploration developments, 1985

K.G. Bowen, Victorian Department of Industry, Technology & Resources

Introduction The Victorian Government believes that prospects for Victoria's mining industry, particularly the gold sector, are now better than for many years. The Government is committed to the promotion of mineral exploration and mining activity in the State. It seeks to provide an environment more conducive to the industry's development, through regulatory changes (all mining legislation and associated planning and environmental legislation is currently under review) and provision of mining and geological information and advice.

Gold Victoria is currently undergoing a significant expansion of its gold exploration and mining industries. Several major mining developments have recently commenced operations or will do so shortly. These include Stawell (WMC), Gaffney's Creek A1 and Sambas (Broken Hill Holdings), Maldon (Triad Minerals) and Walhalla (Walhalla Mining).

Current indications are that these developments will boost Victorian gold production from 0.15 tpa in 1983/84 to 2-4 tpa by 1988.

Exploration and development expenditure on gold has increased by some 30% in the last two years. Large exploration programs, for hard rock and alluvial gold, are currently underway at Bendigo (where WMC has announced plans for underground exploration), Ballarat, Rushworth, Maldon, Walhalla, Landsborough, Wood's Point and Dunolly.

A high level of gold mining and exploration activity is also being maintained by the small mining sector. A record number of Miner's Right Claims were granted in 1984/85, with gold the target mineral of the vast majority.

Coal Victoria's brown coal resource is currently estimated at 202 000 Mt, of which some 70 000 Mt are considered recoverable. Current extraction is 38 Mt pa. Extraction is predicted to grow to 54 Mt pa by 1995, as Loy Yang A and B power stations come on stream.

The major brown coal development project now underway in Victoria is a brown coal liquefaction pilot plant, being constructed and operated by Brown Coal Liquefaction Victoria, with assistance from the Victorian

Government. The first stage of the pilot plant was commissioned in December 1985. The second stage is due for commissioning in 1987. Some $400 million will have been spent on the pilot project upon completion in 1989. The pilot plant processes 50 t/day of dried brown coal. Following the pilot plant, the next phase of the project is a demonstration plant which will process 5 000 t/day.

Private brown coal exploration has fallen significantly since the early 1980's. DITR is continuing its brown coal resource investigation, with a significant assessment and drilling program underway in South Gippsland.

A joint State Electricity Commission/DITR drilling program is now underway in northeast Victoria, exploring for black coal.

Heavy minerals Continuing exploration in the Murray Basin by CRA for heavy minerals and brown coal has produced some encouraging prospects.

Base metals Base metal exploration in Victoria has wound down in the last two years, after a 10 year period of successful exploration, which resulted in WMC's discoveries of copper/zinc/silver deposits at Wilga and Currawong. WMC is continuing evaluation of these deposits.

Tasmanian mineral exploration and mining developments in 1985

P. Baillie, Tasmanian Mines Department

Although 1985 has witnessed cut-backs in Australian exploration budgets, activity in Tasmania remained at a high level, largely because of major changes to the system for allocation of exploration licences. Licences are now awarded on the basis of work programs (similar to the system in operation for offshore petroleum exploration permits), and it is now possible for intending applicants to review the results of all previous work and thus formulate an appropriate exploration program before making application. A number of important highly prospective areas, which had previously been held by a small number of companies for a long period of time, will become available in 1988.

As a result of the new work program tender system, a number of areas formerly held under one licence have been subdivided to allow licence holders to pursue individual commodity interests.

In recognition of the dependence of the Tasmanian West Coast population on mining, and also of the need to accelerate exploration and discovery of new resources so as to replace existing mines which are nearing the end of production, the Tasmanian Government approved the allocation of $2 million to a program of geological, geophysical and geochemical investigations of the economically important and highly prospective Mt Read Volcanics. The funds derive from the Australian Government compensation for the curtailed Gordon-below-Franklin power scheme.

The Mt Read Volcanics, of Cambrian age, form a more or less continuous arcuate belt 10 to 15 km wide, extending from Elliott Bay on the west coast to the Deloraine area of central northern Tasmania, and are host to three currently-operating base-metal mines and the major Hellyer prospect.

Renison Gold Fields Consolidated Limited announced that the Mt Lyell copper mine would cease operations in 1989 after production has been completed from the 40 Series stoping lift in the Prince Lyell mine. Production from 30 Series was completed late in 1985.

Cleveland Tin at Luina has fully developed all economic ore reserves and tin production is expected to cease about September 1986.

The Renison tin mine continued to produce at about 60% of capacity in consequence of quotas imposed by the International Tin Agreement.

Additional reserves have been discovered at the Hellyer prospect and are now known to be in the order of 20 million tonnes of indicated in situ reserves containing 0.4% Cu, 7% Pb, 13% Zn, 160 ppm Ag, 2.3 ppm Au.

Highlights of mineral exploration and mining development in South Australia in 1985

C.D. Branch, South Australian Department of Mines & Energy

Exploration Total expenditure on mineral (including coal) exploration in 1985 was $53.3 million which is up 24 percent on 1984 (Fig. 1). This rise is due to expenditure at Olympic Dam (up 29 percent), on coal (up 220 percent) related mainly to the cost of preparing submissions on proposed coal mines for the Future Energy Action Committee, and on non-metallics (up 9 percent): reductions were metals other than Olympic Dam (down 13 percent), uranium (down 42 percent), and diamonds (down 16 percent). The area held under Exploration Licences remains about steady at 200 000 square kilometres (Fig. 2).

Notable discoveries that have been made public are: Getty - sub-bituminous Permian coal in the Arckaringa Basin; and Billiton - Lower Proterozoic lead/zinc/silver Balmat-Edwards/Gamsburg style mineralisation on northern Eyre Peninsula.

Development The value in 1985 of mineral production (excluding oil and natural gas) is expected to remain similar to 1984 at $188 million (Fig. 3), of which $60 million was attributable to construction materials, $45 million to coal, $33 million to metallics, $30 million to opal, and $20 million to non-metallics (Table 1). In 1986 it is expected that copper will decline as Mt Gunson closes down, and that coal will increase as Leigh Creek is expanded.

At Olympic Dam, following commitment to the initial project in December 1985, activity will increase during 1986 with the intention to commence gold production by mid-1987, and copper-uranium early in 1988. Total underground development to the end of 1985 amounted to 11 kilometres of driving (increasing at the rate of 300 metres per month), 1.8 kilometres of raise boring and 0.5 kilometres of shaft sinking (Fig. 4). The Minister of Mines and Energy is established under the indenture as the Approving Authority for a whole range of issues associated with the project, including infrastructure, and he is also the focus for any application from Roxby Management Services requiring State agency approval. Officers of the Mines Inspectorate are authorised under the Radiation Protection and Control Act to carry out occupational health and environmental monitoring at the mine and to grant statutory approvals.

BHP is establishing an open-cut mine at Iron Duke-Iron Duchess in the South Middleback Ranges to replace Iron Baron as a source of high grade ore for the Whyalla steelworks. Planning consent has been granted and site development is expected to commence in 1987.

At Leigh Creek it is planned to increase the current rate of coal production of 1.75 million tonnes per year to 3.5 million tonnes by 1990 and ultimately to mine 100 million tonnes of coal (which requires the removal of 750 million cubic metres of overburden). Coal cuts will extend over 15 kilometres with a width up to 1 kilometre and a maximum depth of 200 metres. Because of the depths proposed for future mining and the steep dip of the coal seams the dragline operation has now been replaced by trucks and shovels.

The Extractive Areas Rehabilitation Fund managed by the Department of Mines and Energy and industry is being used more and more on progressive rehabilitation measures thus ensuring that environmental impacts are minimised from the outset of mining.

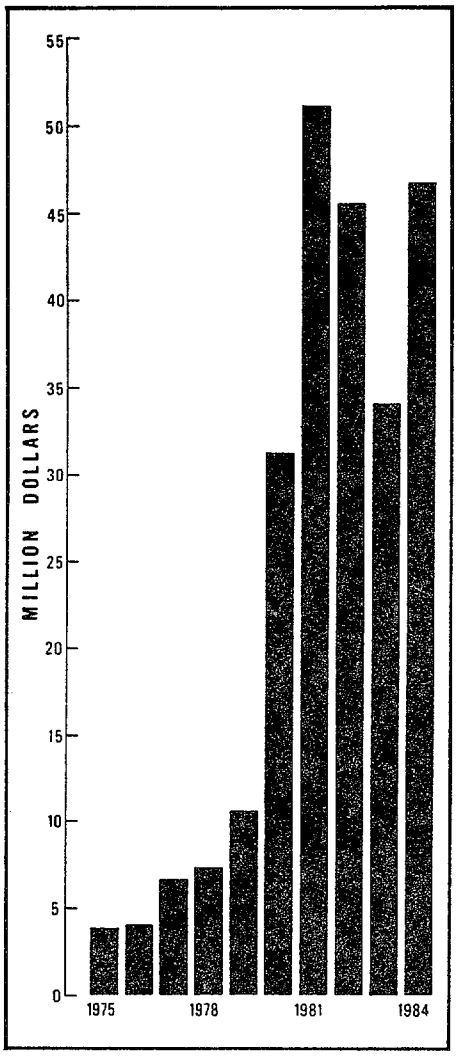


FIG. 1 Company expenditure on exploration.

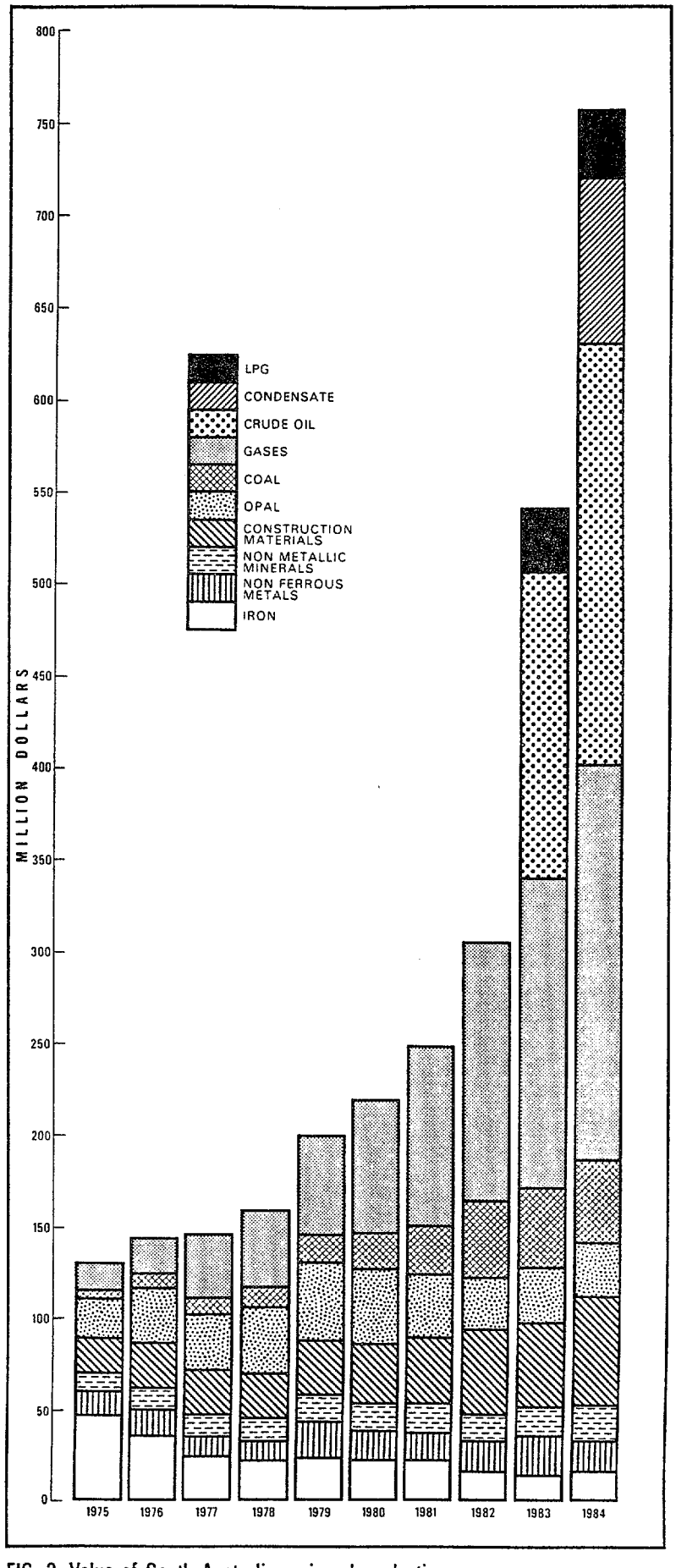


FIG. 3 Value of South Australian mineral production.

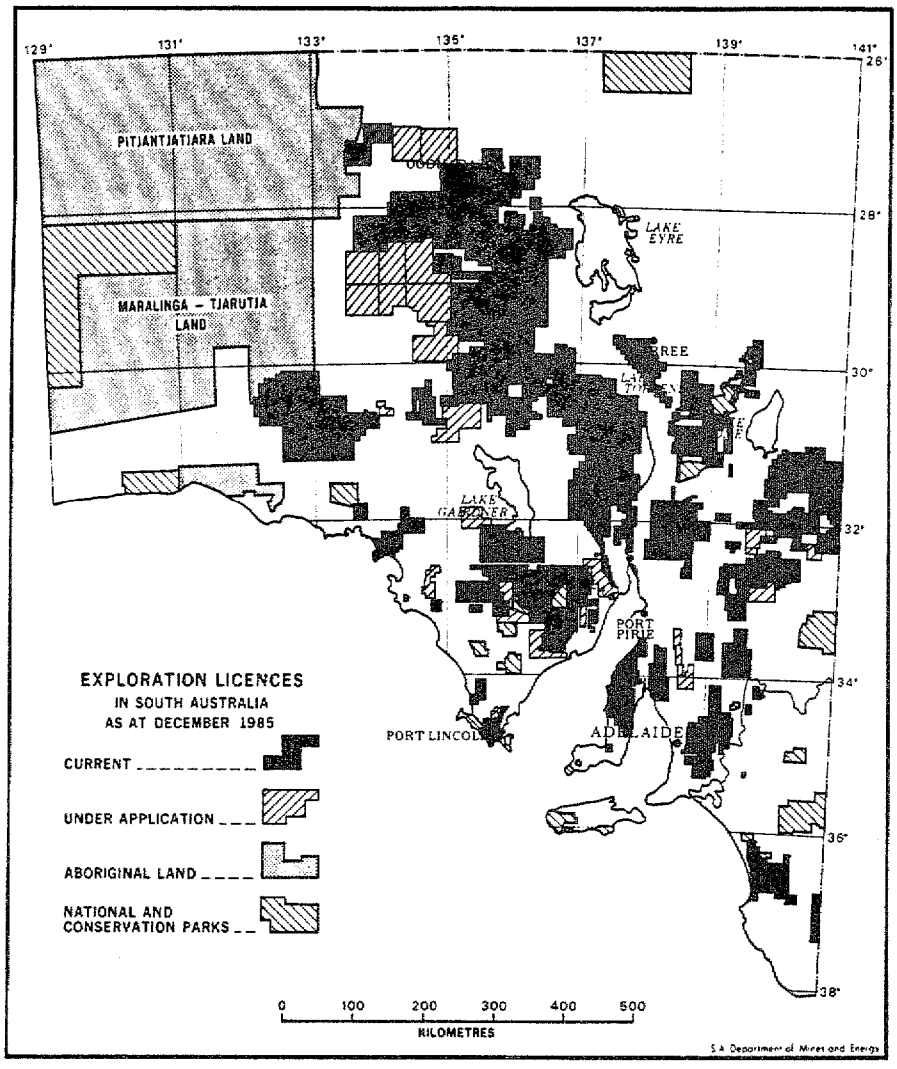


FIG. 2 Exploration Licences in South Australia as at December 1985.

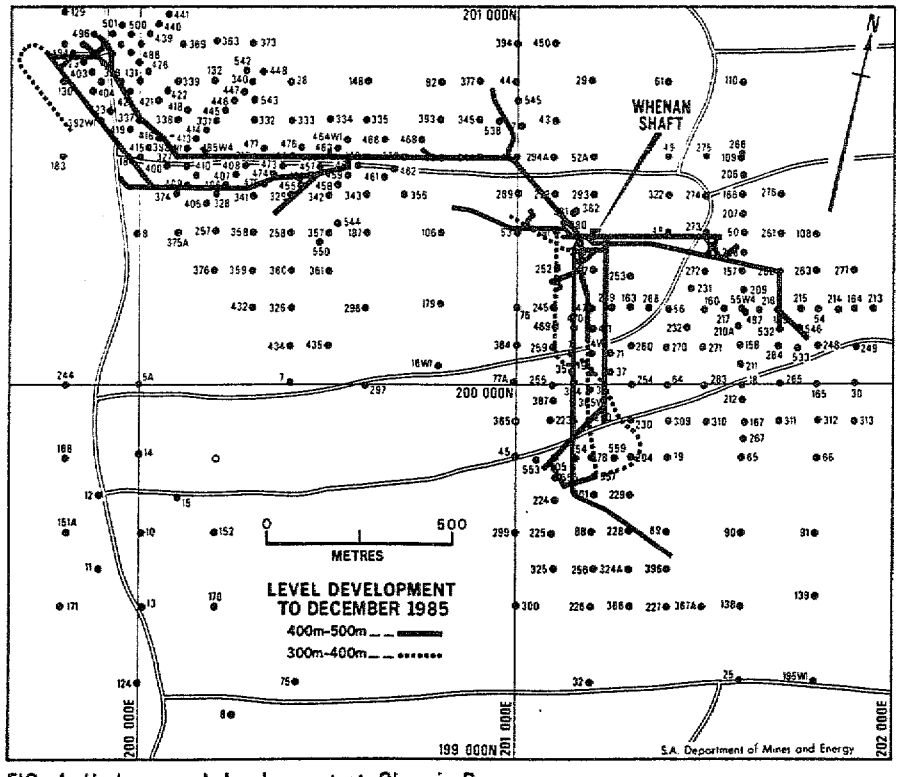


FIG. 4 Underground development at Olympic Dam.

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TABLE 1

SOUTH AUSTRALIAN MINERAL PRODUCTION

	1984		1983	
	Quantity	Value ($)	Quantity	Value
Energy	(tonnes)		(tonnes)	
Natural Gas (m^3) (a)	4.5 x 10^9	214 786 000	4.459 x 10^9	168 442 000
Condensates (kL)	430 187	88 297 000	156 752	35 044 000
Crude Oil (kL)	1 050 270	229 188 000	730 726	166 199 000
LPG	142 644	36 921 000	—	—
Coal (b)	1 323 783	45 009 000	1 329 308	43 903 000
Metallics				
Iron ore	1 752 582	15 773 000	1 496 826	13 471 000
Jaspilite	375	1 000	9 105	18 000
Copper metal content	10 500	11 895 000	14 921	19 587 000
Zinc ore	46 397	4 925 000	6 886	881 000
Gold (gms)	4 466	44 000	5 255	59 000
Silver (gms)	7 700	1 000	8 200	2 000
Lead	11	4 000	9	4 000
Non-Metallics				
Limestone	1 469 302	5 548 000	1 825 906	5 273 000
Gypsum	1 018 205	3 173 000	923 962	2 785 000
Salt	702 422	2 617 000	713 151	2 598 000
Dolomite	547 566	2 234 000	536 306	1 697 000
Clay (c)	796 953	2 362 000	590 012	1 849 000
Silica	124 431	1 483 000	114 476	1 046 000
Talc	18 588	801 000	14 913	664 000
Barite	18 130	562 000	10 878	280 000
Phosphate	7 473	49 000	4 868	36 000
Magnesite	13 664	493 000	1 460	45 000
Sillimanite	507	50 000	121	10 000
Damourite	2 164	193 000	93	8 000
Flint, pebbles	—	—	8	1 000
Nephrite jade (kg)	13 000	75 000	7 750	40 000
Ornamental stones (kg)	2 822	3 000	2 417	3 000
TOTAL		$666 487 000		463 945 000
CONSTRUCTION MATERIALS				
Dimension stones				
Bluestone	400	21 000	—	—
Granite	4 655	647 000	3 177	425 000
Dolomite/limestone	18 247	373 000	16 614	323 000
Quartz/sandstone	1 911	52 000	1 662	80 000
Slate	9 979	583 000	7 988	429 000
Sub-total	35 192	1 676 000	29 441	1 257 000
Aggregates, Ballast, etc.				
Basalt	117 398	1 184 000	91 122	877 000
Dolomite/limestone	5 617 334	21 804 000	3 991 219	17 540 000
Gneiss	21 839	180 000	—	—
Granite	534 132	1 284 000	98 010	657 000
Gravels	284 197	257 000	73 559	211 000
Greywacke	88 684	491 000	59 326	355 000
Ironstone	19 795	22 000	594	1 000
Quartz/sandstone	2 867 936	16 444 000	2 181 926	13 512 000
Sand	2 542 331	13 795 000	2 094 418	9 961 000
Clay Fill	1 732 468	866 000	2 393 369	1 197 000
Marble	5 024	26 000	4 270	25 000
Shale	638 107	1 172 000	180 306	281 000
Slate	20 852	18 000	21 546	19 000
Sub-total	14 489 897	57 543 000	11 189 665	44 636 000
Total 'Construction Materials	14 525 089	59 219 000	11 219 106	45 893 000
Opal production estimate		29 590 000		30 600 000
Total Mineral Production		755 296 000		540 438 000

(a) Value of gas 'Ex-Moomba" plant. Includes $421 105 value of CO_2 from Caroline-1 Well.
(b) Value of coal production estimated by SADME.
(c) Includes kaolin.

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N O T E S

Mineral exploration and mining trends in Western Australia in 1985

A.F. Trendall, Geological Survey of Western Australia

Expenditure on mineral exploration within Western Australian during 1984/85 increased by 2.5% to $189.8 million (around half of the total Australian expenditure). By far the most significant expenditure was on gold, which at $111 million represented almost 60% of the total.

Gold production rose by 39.2% to 37.425 tonnes, worth $508.89 million. This was the first time 1 million troy ounces had been produced since 1941 and the State, which in 1980 had 3 major producers now has over 20 producing more than 250 kg per year. In terms of value gold now ranks third, behind iron ore and alumina and accounts for 11% of production.

Several significant new mines began production during 1985. Notable are Paddington (2 800 kg gold per annum) and Harbour Lights (2 500 kg of gold per annum). Production of the Kambalda gold operations rose to 4 300 kg per annum.

The most significant new discovery announced during the year was that of Boddington, which, with a potential production of over 5 000 kg per annum may be the largest producer in the State in 3 years time and indicates a trend away from historically important areas.

Although base metal exploration declined to $32.9 million it was concentrated on a number of major projects including shaft sinking and metallurgical test-work at Golden Grove, extensive drilling on the Pillara/Blendevale area and major exploration in the Throssell Range/Rudall River area near Nifty. In this latter area a Special Agreement Act to cover exploration represents a significant new initiative.

Diamond exploration was greatly reduced, however the end of the year saw the commencement of hard rock production from the Argyle diamond pipe.

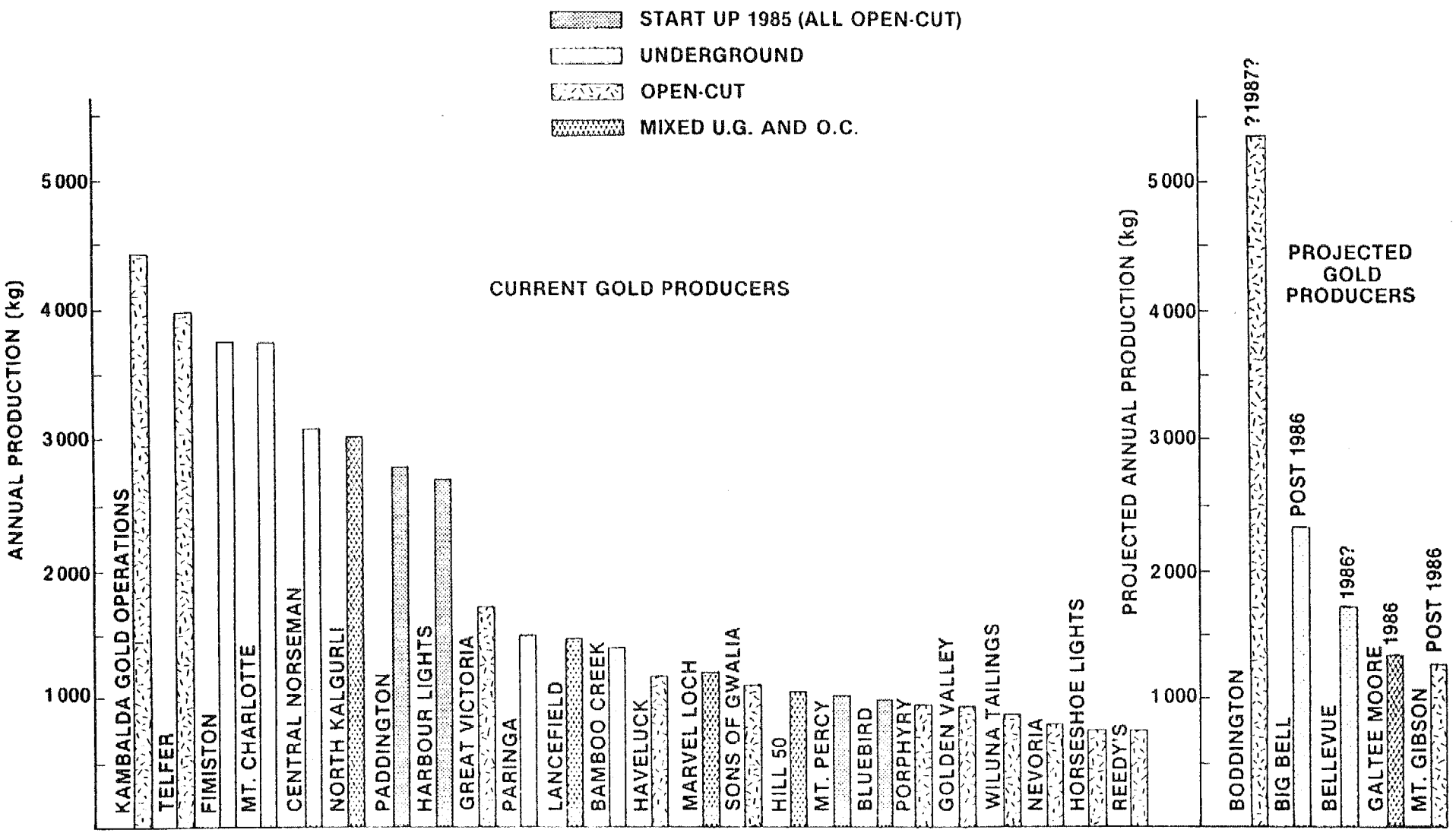
The year saw a significant increase in exploration for platinum group elements especially in the Lamboo Complex and West Pilbara. In the latter area highly anomalous values were returned from drilling in the Munni-Munni complex.

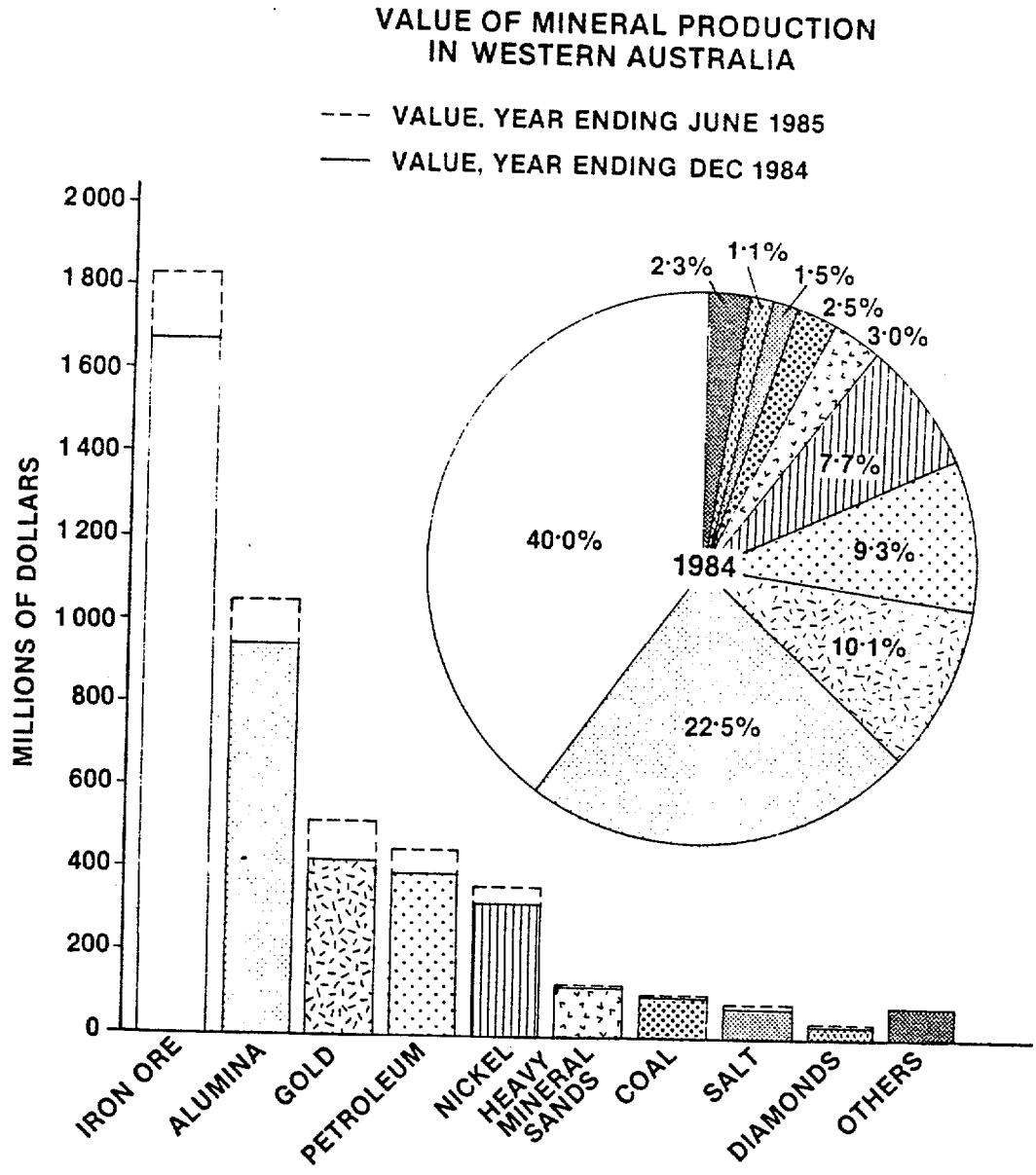
There was a revival of interest in mineral sands and plans were announced for a number of secondary processing plants. A number of potentially significant discoveries were made of several other commodities. These include: CRA's Kintyre uranium prospect, in the Paterson Province; Union Oil Development Corporation's apatite-bearing carbonatite at Mt Weld (over 100 million tonnes of medium grade phosphate ore); the Union Oil/West Coast Holdings Brockman rare-earth element deposit; and the Western Ventures NL/CRA Hill River Coal prospect.

Mineral exploration expenditure during 1986 is expected to remain about the same, at around $180 million. Exploration priorities will also remain similar with the greatest emphasis on gold but greater interest will be shown in exploration for potential underground mines.

In the mining scene gold production will show a further dramatic increase with a number of significant new mines being commissioned.

MAJOR GOLD PRODUCERS, WESTERN AUSTRALIA, 1985




VALUE OF MINERAL PRODUCTION
IN WESTERN AUSTRALIA
--- VALUE. YEAR ENDING JUNE 1985
—— VALUE, YEAR ENDING DEC 1984
MILLIONS OF DOLLARS
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
IRON ORE
ALUMINA
GOLD
PETROLEUM
NICKEL
HEAVY MINERAL SANDS
COAL
SALT
DIAMONDS
OTHERS
1984
40·0%
22·5%
10·1%
9·3%
7·7%
3·0%
2·5%
1·5%
1·1%
2·3%

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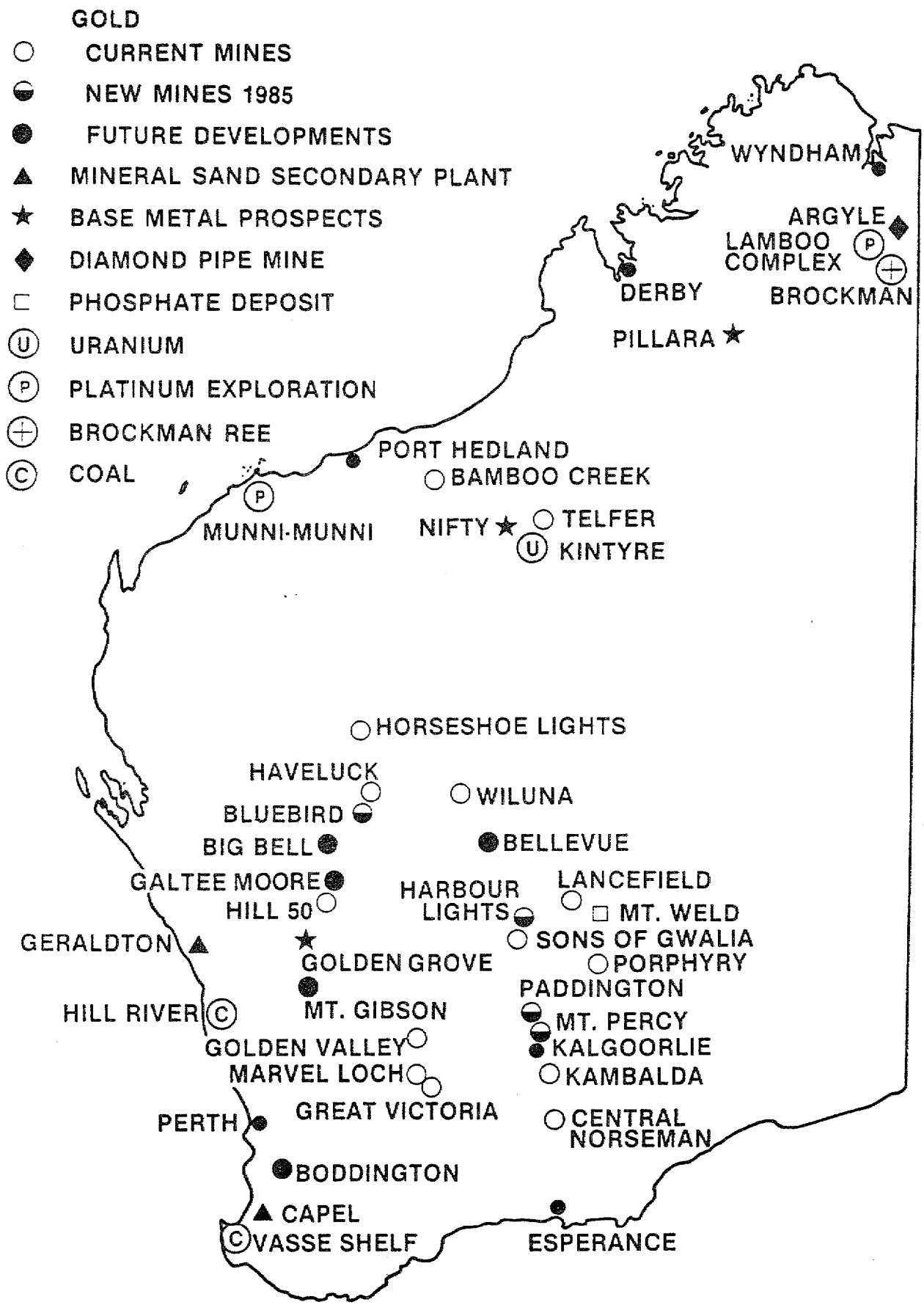
MINERAL EXPLORATION AND MINING DEVELOPMENTS IN W.A. 1985-1986



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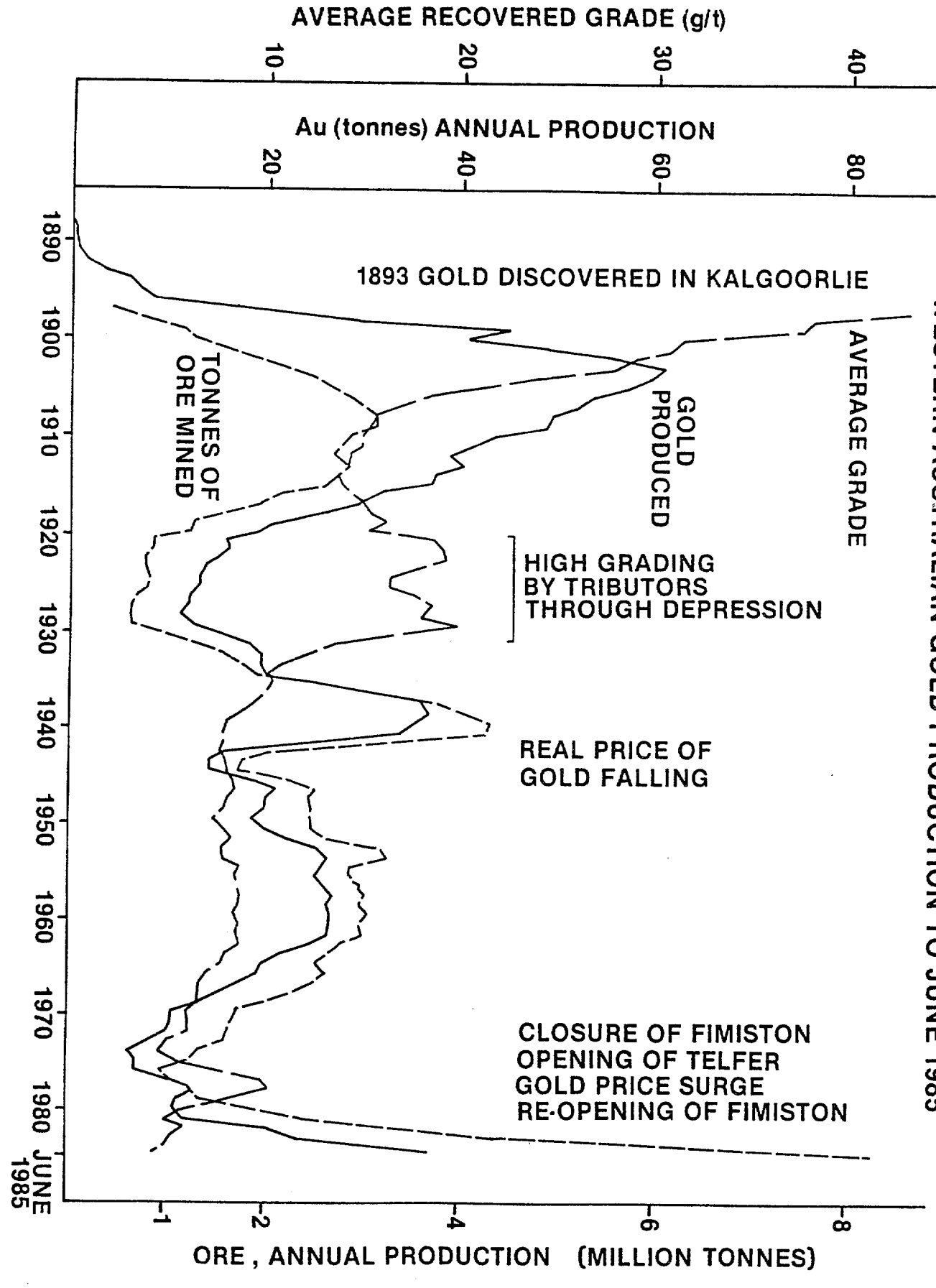

AVERAGE RECOVERED GRADE (g/t)
10
20
30
40
Au (tonnes) ANNUAL PRODUCTION
20
40
60
80
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
JUNE 1985
1893 GOLD DISCOVERED IN KALGOORLIE
TONNES OF ORE MINED
GOLD PRODUCED
AVERAGE GRADE
HIGH GRADING BY TRIBUTORS THROUGH DEPRESSION
REAL PRICE OF GOLD FALLING
CLOSURE OF FIMISTON
OPENING OF TELFER
GOLD PRICE SURGE
RE-OPENING OF FIMISTON
1
2
4
6
8
ORE, ANNUAL PRODUCTION (MILLION TONNES)
WESTERN AUSTRALIAN GOLD PRODUCTION TO JUNE 1985

Iron ore in 1985 and outlook for 1986

R. Pratt, BMR

Australian iron ore production and exports continued to increase in 1985 to meet growing demand from China, Taiwan Province, and the Republic of Korea. The value of exports increased substantially boosted by higher prices and depreciation of the Australian dollar relative to the US dollar, the currency in which most contracts are expressed. Despite a substantial increase, production only slightly exceeded demand and was not sufficient for any major replenishment of stockpiles depleted in 1984. Although private expenditure on iron ore exploration was less than at the start of the decade, Australian economic demonstrated resources were expanded in 1985 as a result of ongoing testing of known deposits near established mines, as well as for concealed orebodies elsewhere. Australia's economic demonstrated iron ore resources are sufficient for more than 160 years at the current production rate.

World steel production increased slightly in 1985 after a strong recovery in 1984. The outlook for 1986 is for world consumption to follow a similar pattern to 1985. Consumption is expected to increase slightly as a result of further increased consumption in the developing countries. The increase is likely to be reduced somewhat by decreased consumption in the Western industrialised countries, particularly in the United States.

The commissioning of major new iron ore capacity at Carajas in northern Brazil is unlikely to have a major impact on markets in 1986 because production in Minas Gerais in Southern Brazil is being scaled back to conserve high-grade resources for an expanding domestic steel industry, and because all 1986 production is already contracted for. With world steel output still less than peak output in 1979 and unlikely to exceed that level until the 1990's, world overcapacity for iron ore production is likely to remain for some years and the commissioning of full capacity at Carajas in 1987 will exacerbate this position.

Despite a projected decrease in Japanese iron ore import requirements and static steel output in Western Europe, further growth in Australian iron ore exports is expected in 1986 mainly to meet the increased requirements of China, Taiwan Province, and the Republic of Korea. These countries are also expected to account for most of the expected growth in Australian iron ore trade over the next decade.

Australia should retain the major share of future iron ore trade in the East Asian region largely because of our proximity to the market and resultant low ocean freight costs as well as the desirable physical properties of the Australian ores. However, the ready availability to consumers of the East Asian region, of high grade ores from alternative sources e.g., Brazil, requires that we remain alert to the region's future iron ore requirements and ensure that we are in a position to supply any resurgent increases in iron ore demand at short notice.

Aluminium overview and outlook

N.D. Knight, BMR

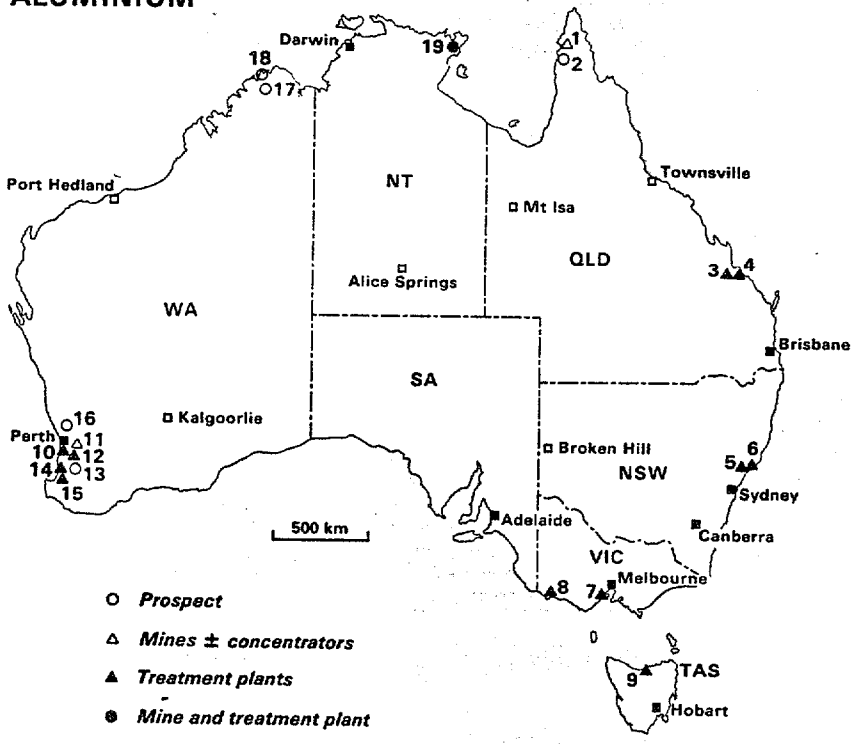
In 1985 Australia, with 13% of the non-communist world's total economic demonstrated resources, produced about 42% of non-communist world bauxite; over 80% of this was processed domestically. About 36% of non-communist world alumina production was provided by Australia, but in contrast to bauxite only about 18% of Australia's total alumina production was processed locally. Although Australia's aluminium production has increased by 12% since 1984 and by 78% since 1983, it still represents only 7% of non-communist world aluminium production. About 65% of Australia's aluminium output was exported in 1985.

Non-communist world primary aluminium production fell by 6% to about 12 Mt in 1985 and world consumption decreased about 3% to about 12.3 Mt. In November, 1985, non-communist world stocks of primary aluminium, as reported by the IPAI were 2.22 Mt compared with 2.59 Mt in December 1984. Total capacity utilization in 1985 is estimated to have been about 72%. However despite falling stocks, and smelter cutbacks, which have brought production levels more in line with demand, there has been very little improvement in aluminium prices. The average US market price for 1985 was US 49 cents/lb compared with US 53 cents in 1984 and the average LME cash price was £813/t compared with £896 in 1984.

Continuing problems which have beset the aluminium industry over the past few years include escalating energy costs, the slowdown in consumption growth rates, exchange rate fluctuations, substitution by materials such as plastics and the increased use of secondary aluminium. In addition, there are industry specific problems such as the difficulty in storing alumina and the cost and time involved in closing and re-opening potlines. The net result of these factors has been decreased demand, low and volatile prices and large supply surpluses. The medium and long term outlook for the aluminium industry depends on how producers and consumers address these problems. In the short term, BMR estimates that Western world primary aluminium production is likely to increase by about 5% to 12.7 Mt in 1986 and consumption by 1.6% to about 12.5 Mt. A slight improvement in prices is expected with an average US market price for 1986 of around 60 US cents/lb.

Australian aluminium production is expected to increase by about 1.6% to 865 000 t in 1986, with further increases in 1987 as the newly expanded Alcan smelter reaches capacity production and the newly constructed Portland smelter is progressively commissioned. Primary aluminium exports in 1986 should grow to around 590 000 t. Alumina production in 1986 is expected to increase by about 5% to 9.2 Mt and exports are expected to grow by 3% to about 740 000 t. Bauxite production in 1986 is likely to reach about 34 Mt and with exports remaining around 5 Mt.

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 under construction) 9 Bell Bay (smelter) 10 Kwinana (refinery) 11 Jarrahdale, Huntly, Del Park 12 Pinjarra (refinery) 13 Mount Saddleback 14 Wagerup (refinery) 15 Worsley (refinery) 16 Chittering 17 Mitchell Plateau 18 Cape Bougainville 19 Gove (mine & refinery)

15/A/222

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

Country	1970	1975	1980	1984
Australia	19.0	33.0	34.76	39.80
Guinea	5.1	13.3	17.79	18.23
Jamaica	24.65	18.2	15.43	10.80
Brazil	1.0	1.5	5.3	7.8
Suriname	12.36	7.5	6.3	4.17
Guyana	9.1	6.0	3.9	3.07
Greece	4.7	5.0	3.9	2.96
India	2.8	1.7	2.3	2.52
Indonesia	2.5	1.5	1.6	1.2
USA	4.3	2.8	2.0	1.0
Other	14.49	9.5	6.72	8.45

Source: BMR

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

Country	1970	1975	1980	1984
Australia	12.47	23.7	25.6	3.6
USA	35.1	23.7	24.8	16.7
Jamaica	9.8	10.4	8.5	6.1
Japan	7.4	7.2	7.8	5.3
West Germany	4.4	5.8	5.7	5.6
Suriname	6.0	5.3	5.1	4.4
Canada	6.4	5.2	4.2	4.0
Brazil	0.7	1.2	1.8	3.1
Italy	1:8	3.2	3.2	2.2
Guinea	3.5	3.0	2.5	1.9
Other	12.43	11.3	10.8	14.7

Source: BMR

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

Country	1970	1975	1980	1984
US	45.0	36.0	37.0	31.0
Canada	12.0	9.0	8.5	10.1
Australia	2.6	3.3	3.6	6.0
Norway	6.5	6.1	5.2	6.0
West Germany	3.9	7.0	5.8	6.0
Brazil	0.7	1.2	2.1	3.6
Spain	1.5	2.2	3.1	3.0
Venezuela	0.3	0.5	2.5	3.0
France	4.8	3.9	3.4	2.7
Japan	9.0	10.4	8.6	2.2
Other	13.7	20.4	20.2	26.4

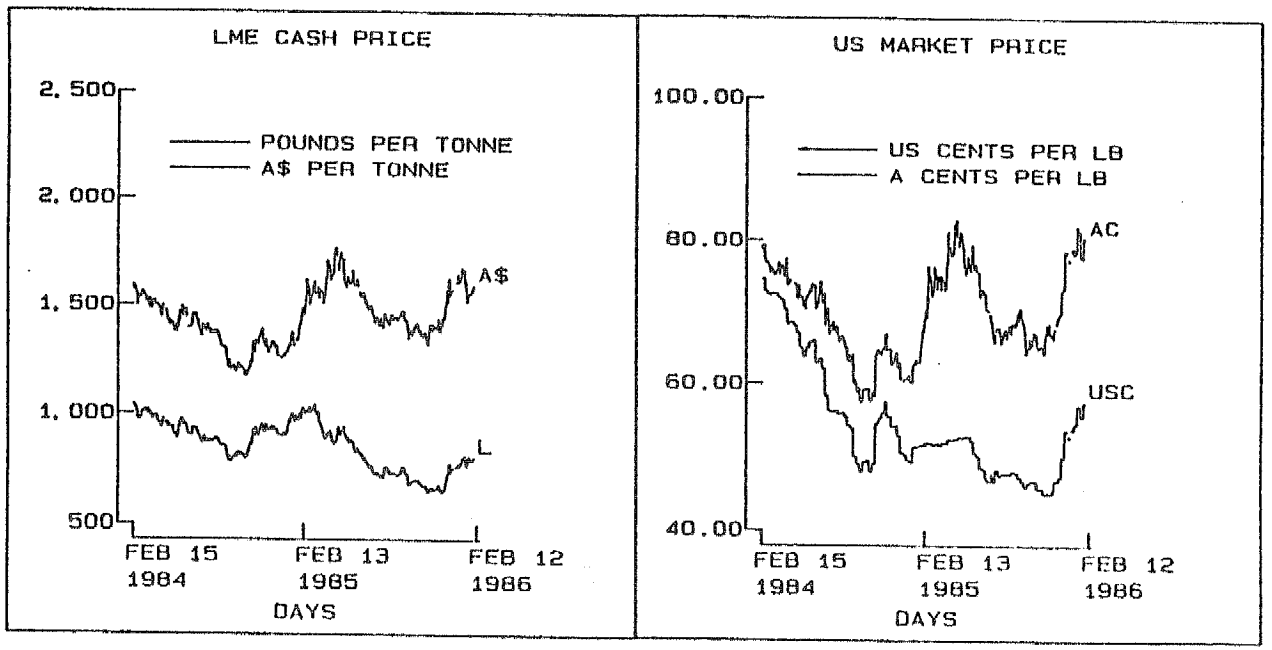
Source: BMR

Total World Economic Resources
Bauxite '000 tonnes

Country	
United States	40 000
Australia	4 600 000
Brazil	2 300 000
Greece	650 000
Guinea	5 900 000
Guyana	900 000
India	1 200 000
Jamaica	2 000 000
Suriname	600 000
Yugoslavia	400 000
Other Market Economy Countries	2 900 000
Hungary	300 000
USSR	300 000
Other Centrally Planned Economies	200 000
World Total (may be rounded)	22 290 000

Source:
US Bureau of Mines

ALUMINIUM DAILY PRICES



Mineral sands: overview of Australian resources and industry

R. Towner, BMR

Australia's share of world production of rutile, zircon and ilmenite in 1985 was 47%, 59% and 25% respectively. About 66% of the non-communist world's monazite is produced by Australia. Only 1% of rutile, 20% of ilmenite, and 4% of zircon domestic output is consumed locally; all monazite concentrates are exported.

Production of the titanium minerals - rutile, ilmenite, and leucoxene as well as synthetic rutile - increased by about 14% in 1985 in response to stronger demand for feedstock by the pigment industry. Production of co-product zircon remained at the 1984 level; output of monazite decreased mainly because of the lower percentage of monazite in the mined heavy minerals.

The current market for high TiO_2 material is characterised by inadequate supply and rapid increases in prices. The current strong demand for pigment by the major end-use markets - paints, paper and plastics - and the improvement in demand for titanium metal, and for welding rods, is expected to continue into the latter part of this decade. This will increase the demand for high TiO_2 feedstock. In Australia, this increased demand for the raw materials is expected to be met through the expansion of natural rutile mining along Australia's east coast, and by new synthetic rutile capacity currently being installed in Western Australia. Rutile prices are expected to rise further in the short term.

Zircon prices showed some gains in 1985, reflecting the improvement in demand particularly by the foundry and refractories industries. Australian zircon producers are currently operating at capacity and are expected to continue at this level in the short to medium term. Prices have firmed and are expected to maintain these gains in the medium term.

With some economic resources of mineral sands unavailable because of environmental considerations, the available economic demonstrated resources, particularly of rutile and zircon, could be depleted in about 20 years at current production rates. However, additional marginal resources are being investigated, and extensive hard-rock deposits could meet the demand for titanium ore in the longer term.

Exploration for new mineral sands deposits is continuing in Australia, especially in Western Australia, the Murray Basin in Victoria, and in western New South Wales. With the improvement in demand, and the increase in prices, some previously uneconomic deposits are now becoming more attractive for re-development. In addition, some companies are investigating hard-rock titaniferous deposits, particularly in Western Australia, although at present it seems that the mining and treatment costs of these deposits would be considerably higher than those of titaniferous mineral sands.

AUSTRALIAN MINERAL SANDS PRODUCTION (1985)

(Estimated)

Company	Location of Operations	Rutile	Ilmenite	Zircon	Monazite
			('000 t)		
Consolidated Rutile Limited	N. Stradbroke Is QLD	86	70	74	-
Associated Minerals Consolidated Ltd	Capel, Eneabba WA	44	270	133	3
Allied Eneabba Ltd	Eneabba, WA	34	210	140	8
Westralian Sands Ltd	Yoganup Extended North Capel, WA	-	495	36	3
Cable Sands Ltd	Capel, WA	-	190	10	1
RZ Mines (Newcastle) Ltd	Tomago, NSW	32	10	43	-
Mineral Deposits Ltd	Stockton, NSW	7	-	10	-
Currrumbin Minerals	Currumbin, QLD	2	-	3	-
		205	1245	449	15

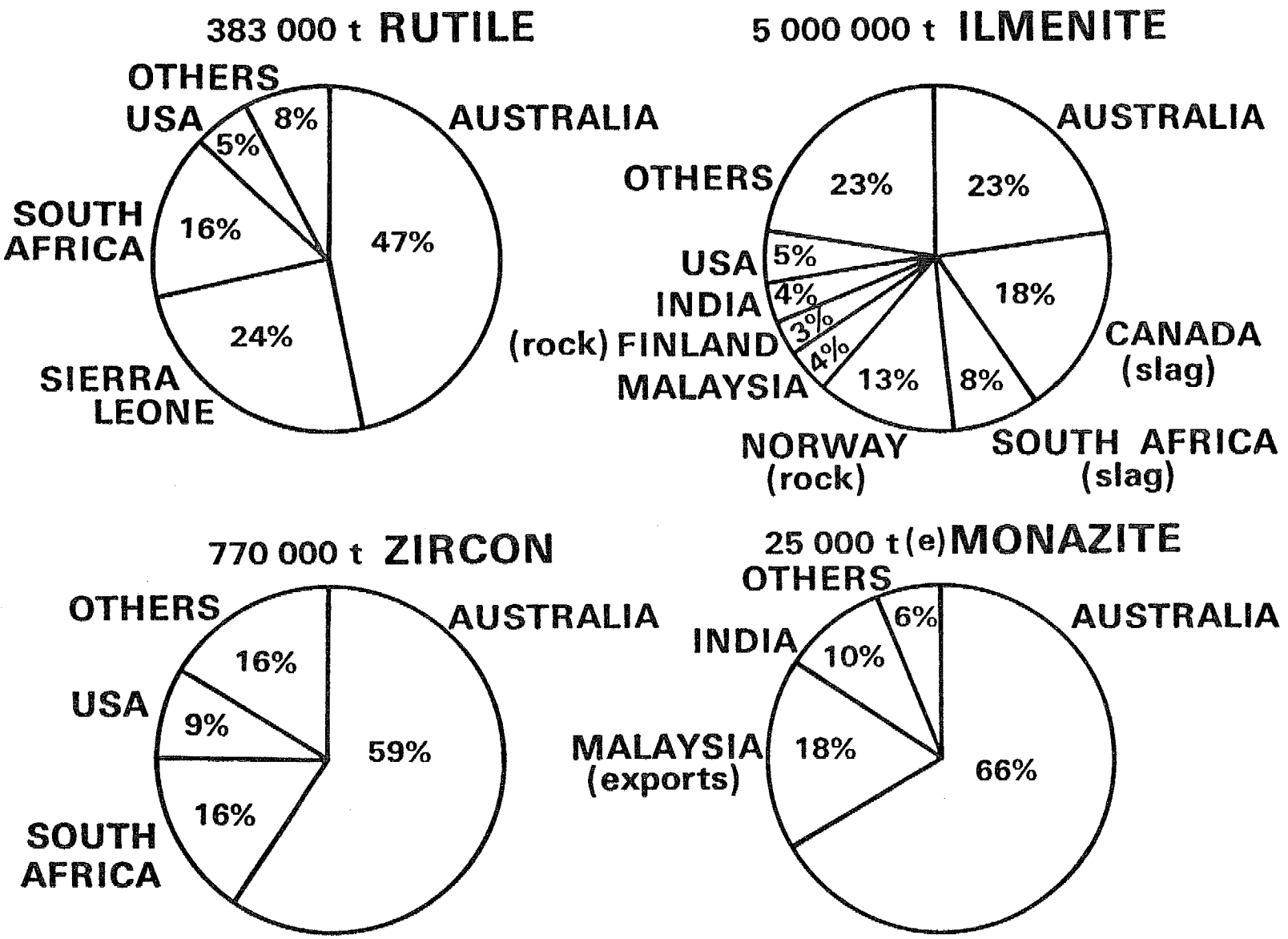
WORLD ECONOMIC DEMONSTRATED RESOURCES

	Mt		Mt
Rutile*	27	Australia	8
		Sierra Leone	3
		South Africa	5
		India/Sri Lanka	8
		USA	3

*Excluding Brazil anatase

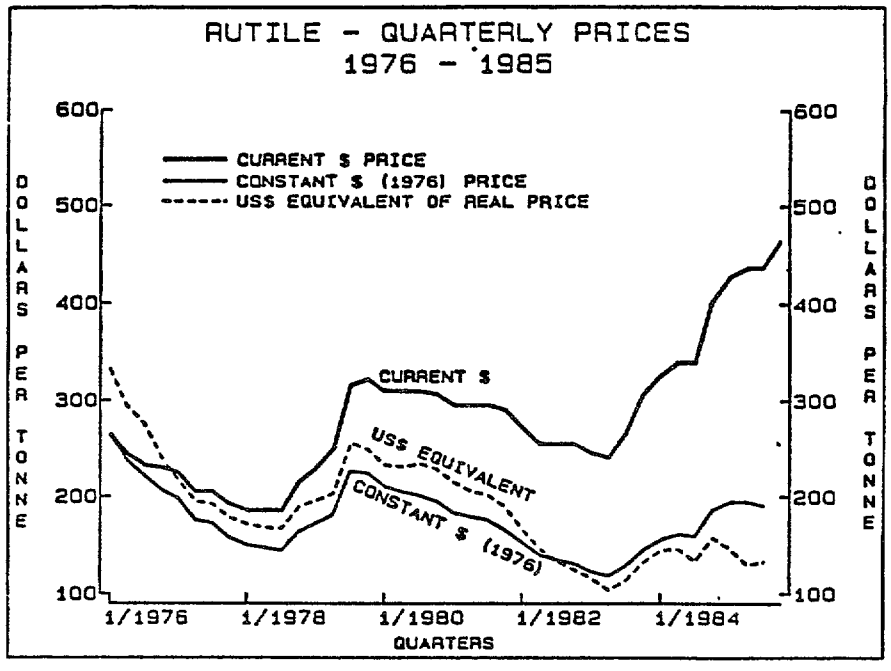
Ilmenite	908	Australia	41
		South Africa	85
		USA	54
		Canada	60
		Norway	128
		USSR	220
		India/Sri Lanka	110
		Finland	10
		China	230
Zircon	32	Australia	12
		South Africa	8
		USA	6
		Others	6

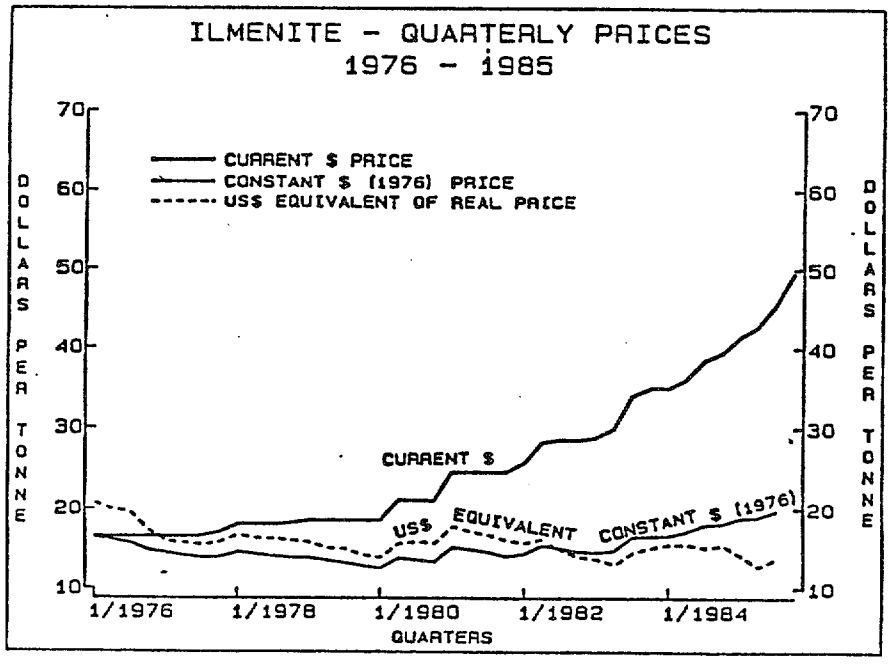
SOURCE: BMR

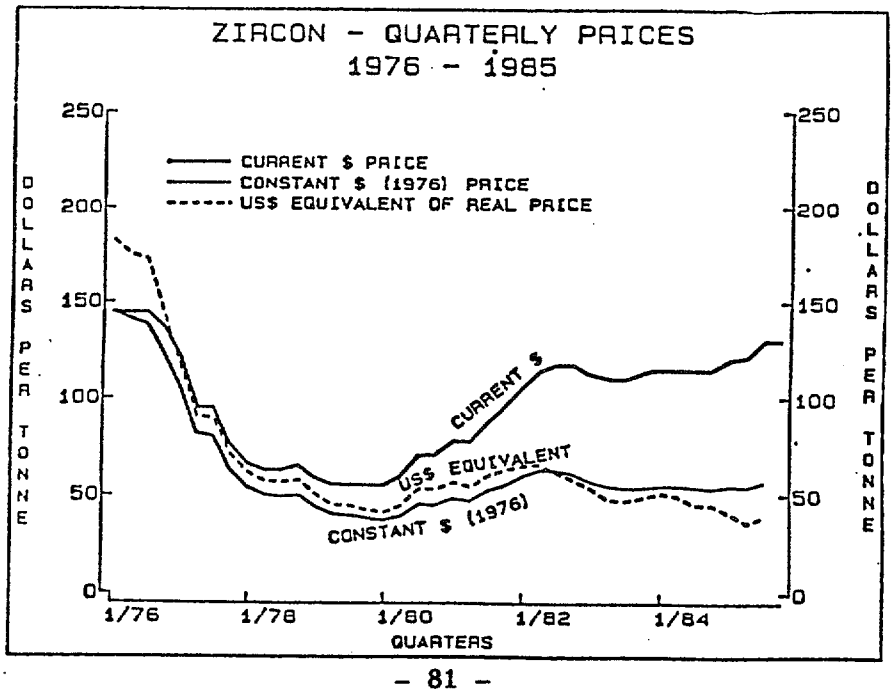


WORLD PRODUCTION OF MINERAL SANDS 86/42

SOURCE: BMR







SOURCE: BMR

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N O T E S

Mineral sands: outlook for Australian suppliers

M.H. Macpherson, Westralian Sands Ltd

Introduction The Australian mineral sands industry currently exports approximately $275 m worth of concentrates per annum.

This figure could rise to $500 m by 1988 as a result of improved commodity prices and a major expansion of synthetic rutile production capacity. Since the middle 1950's, the industry has grown rapidly, largely in response to development of the chloride process for the production of titanium dioxide pigment.

The world titanium dioxide pigment industry has grown by an average annual rate of 4% during the last 20 years.

TiO_2 pigments are made by two entirely separate processes - sulphate and chloride.

Sulphate Production capacity is in a very mature phase due mainly to environmental contracts.

Two Australian companies have decided to dedicate some of their ilmenite resources for synthetic rutile production which will reduce the availability of Australian ilmenite for this market.

This has been recognised and has resulted in significant price increases for ilmenite.

Chloride At the present time, the major pigment producers are assessing their long term feedstock requirements for expansion programs. Some are attempting to negotiate contracts that will prevent the wide fluctuations that have occurred in the chloride feedstock markets.

As increasing quantities of synthetic rutile (derived from ilmenite and slag) are used in the chloride process, forecasts for rutile prices will have to take this into greater consideration.

Just in the same way as ilmenite has strengthened markedly in Australian dollar terms, so has the price for rutile.

Australian producers are clearly benefitting from pricing their products in Australian dollar terms and will need to use international comparisons as the total world output continues to decline.

However, in real terms, these current and likely future prices are no better than those achieved in the late 1960's and certainly for rutile, well below boom prices of the 1950's.

Zircon The weakening foundry market in the United States and Europe led to a stagnation in prices from 1980-1984, however in recent times there has been some recovery in United States markets and growth in Japan.

This coupled with a contraction in supply from Australia, should lead to improved prices in 1986 and beyond.

FEEDSTOCKS FOR TiO2 PIGMENT PRODUCTION

(Chloride and Sulphate)

Feedstock	Tonnes (contained TiO2 in Feedstock)		
	1954	1973	1986
A. Sulphate			
Slag	79 000	600 000	855 000
Rock Ilmenite	314 000	767 000	350 000
Alluvial Ilmenite	172 300	636 500	600 000
Total	565 300	2 003 500	1 805 000
B. Chloride			
Slag	-	-	100 000
Alluvial Ilmenite	-	200 000	400 000
Rutile	-	290 000	200 000
Synthetic Rutile	-	10 000	200 000
Total	-	500 000	900 000
Grand Total	565 300	2 503 500	2 705 000

N O T E S

Gold: resources, developments and outlook

R.G. Dodson, BMR

The economic demonstrated resources of gold in Australia were estimated by BMR to be about 959 t as at December 1985, an increase of approximately 32% over the previous year. The increase was due partly to the transfer of about 270 t gold from the "subeconomic" to "economic" demonstrated resource category following the decision by WMC Ltd and BP Ltd to mine the Olympic Dam Cu/U/Au deposit. In addition vigorous exploration and development by the mining industry has progressively added to all resource categories during the past 5 years. BMR estimates that in 1985, 50% of expenditure on non petroleum mineral exploration was allocated to exploration for gold.

Australia's gold production increased from 39086 kg in 1984 to an estimated 57000 kg in 1985, a spectacular increase of about 46% and the highest output since 1917. However, the year's production is well below peak production of 119361 kg in 1903.

Increased gold production has been the result of expanded output from most current operations and to the commissioning of new mines: 10 in 1985. Most of the operating mines are medium-sized opencuts but at least twelve medium to small alluvial and eluvial mines (not including numerous 1-2 man operations), are operating, and over 50 mine tailings dumps are being re-treated. Of the new mines, Kidston is by far the largest; in its first 10 months of production, output was 6421 kg gold, making it Australia's biggest producer for the year.

For the past ten years or so most gold mines commissioned have been located at or near previously mined deposits; "new" mines consist of operations on extensions of previously mined orebodies or low-grade ore that could not be economically exploited in the past. However, in the past two years important new discoveries have been made: Boddington WA, Pajingo Qld, and Coronation Hill, NT.

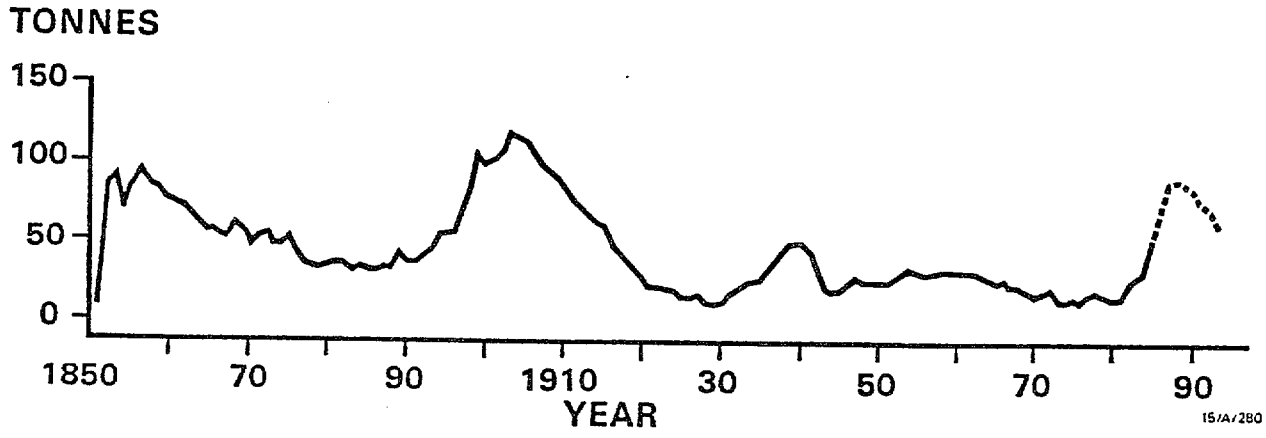
There are firm commitments to bring over 50 gold mining projects to production in the next two years. These mines, and expansion of some of the current mining operations, are considered likely to continue to

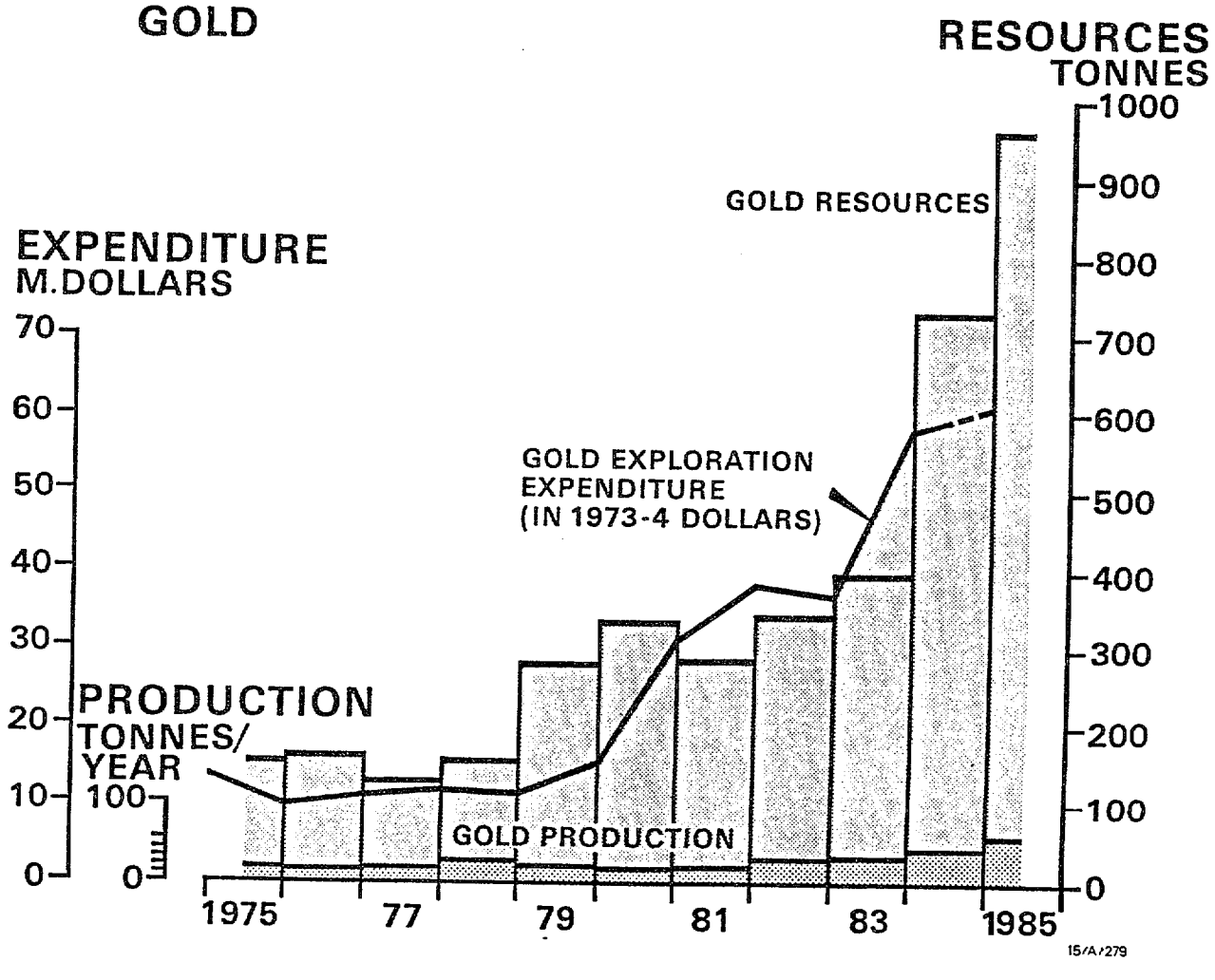
increase gold output until 1988-90 when production should top 90 t gold/year. Thereafter production seems likely to plateau and decline unless -

- the price of gold rises sufficiently to allow mining and treatment of lower grade ore
- substantial additional resources are found in known goldfields
- major new discoveries are made that would allow expansion of production to counter depletion of resources in the older mines.

Aided by improving exploration technology and increasing knowledge of the geological environments of gold mineralisation in Australia, we consider that imaginative and persistent exploration is likely to continue to add to gold resources and consequently, production.

AUSTRALIAN MINE PRODUCTION OF GOLD





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N O T E S

Copper, lead and zinc resources: developments and outlook

D.J. Perkin & M.J. Roarty, BMR

Australia is a major producer of copper, lead and zinc. A number of mines produce the three metals and in all cases lead and zinc are produced as co-products. Mine production of the three metals increased in 1985 and production of lead and zinc is forecast to increase again in 1986 whereas copper is forecast to decline because of the closure of the Teutonic Bore and Mount Gunson mines.

Refined production of copper, lead and zinc together with domestic consumption remained at roughly the same levels in 1985 as in previous years and is likely to remain so in the medium term. Australia is only a relatively small consumer in comparison to many other western countries and about two thirds of our mine and metal production is exported.

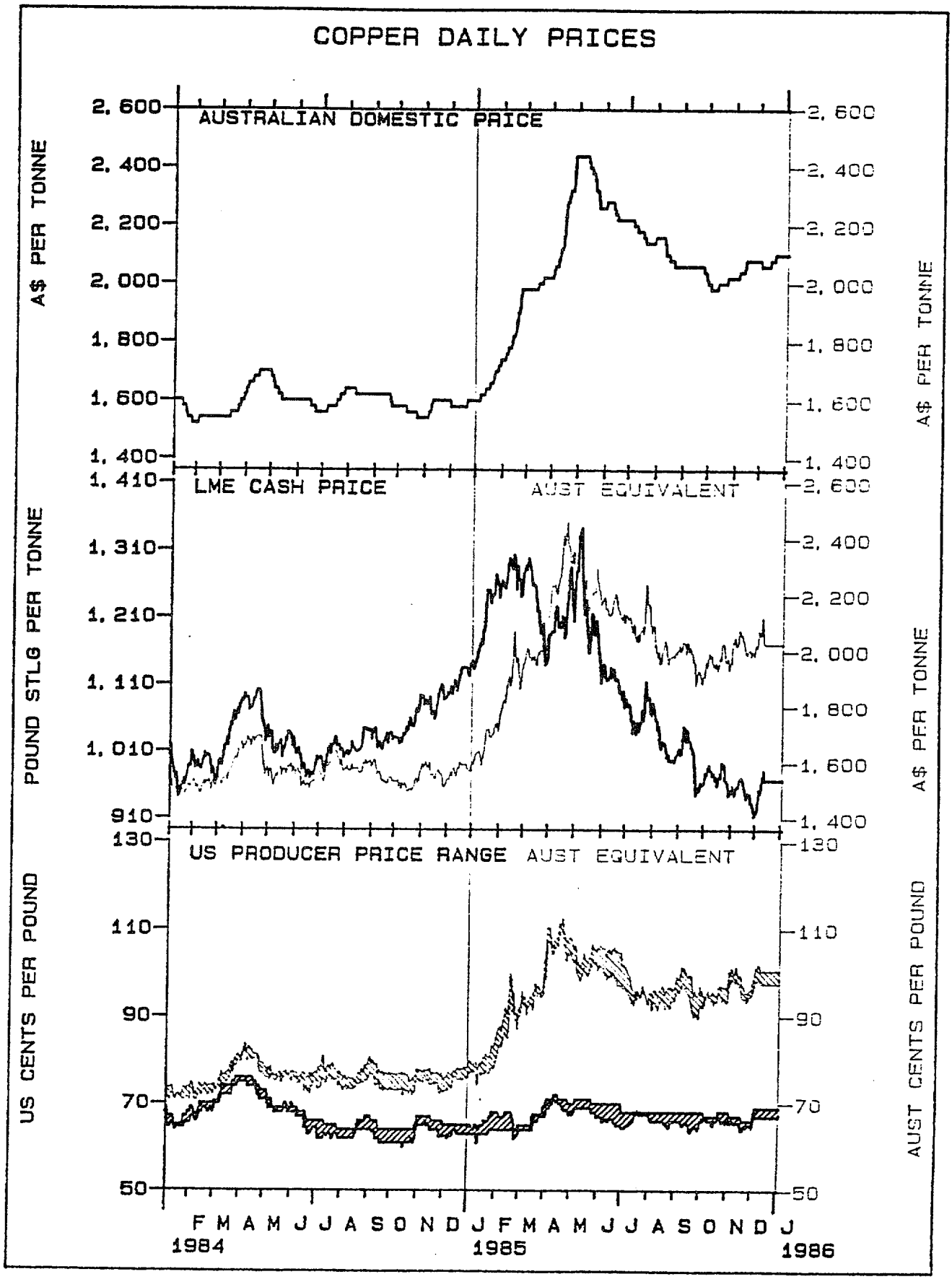
Exports of copper and lead contained in concentrate, blister, bullion and refined metal increased in 1985 because of a higher proportion of concentrate shipped, zinc exports declined because of a drawdown in stocks included in 1984 exports and not matched in 1985.

Average Australian prices for the three metals increased in 1985; much of the increase being attributed to the depreciation of the Australian dollar. World copper prices increased only slightly as a result of increased demand and declining stock levels whereas world prices for both lead and zinc declined in the face of reduced demand.

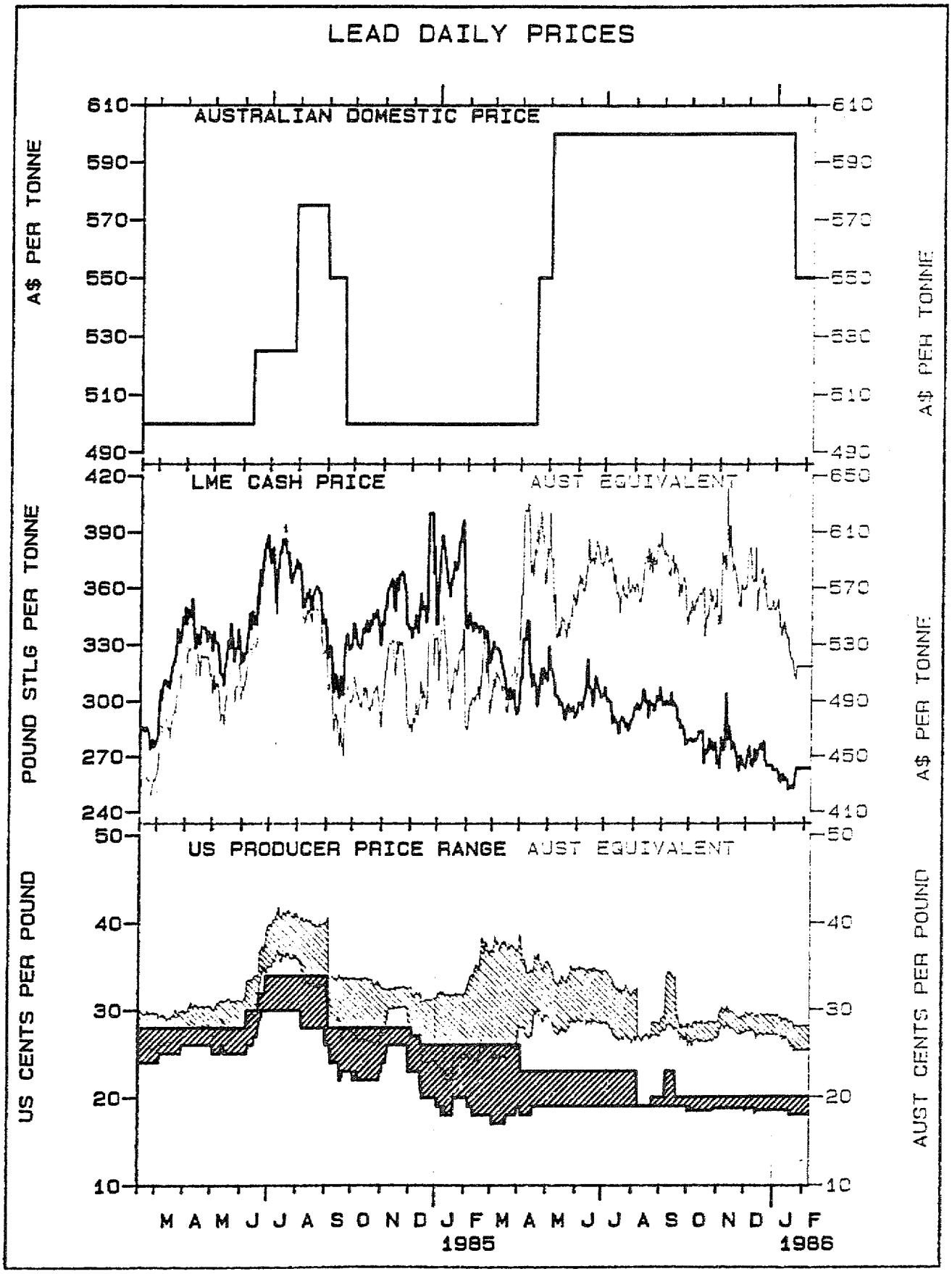
Australia's economic demonstrated resources (EDR) of lead and zinc constitute about 10% of the world's resources in that category; in addition there are substantial resources in the inferred (Hilton North and Hellyer) and subeconomic categories (McArthur River). Although Australia's EDR of copper constitute only 3% of world resources they are nonetheless significant and have increased by virtue of the fact that a substantial proportion of the resources at Olympic Dam have been declared economic. Inferred copper resources including additional mineralisation at Olympic Dam and at the Nifty prospect in WA, constitutes a further important potential source of this metal.

Important developments in the Australian base metals industry in 1985 include increases in production capacity of lead and zinc at a number of mines and the continuing exploration and development at Olympic Dam, Golden Grove, Hellyer, Blendevale and Nifty.

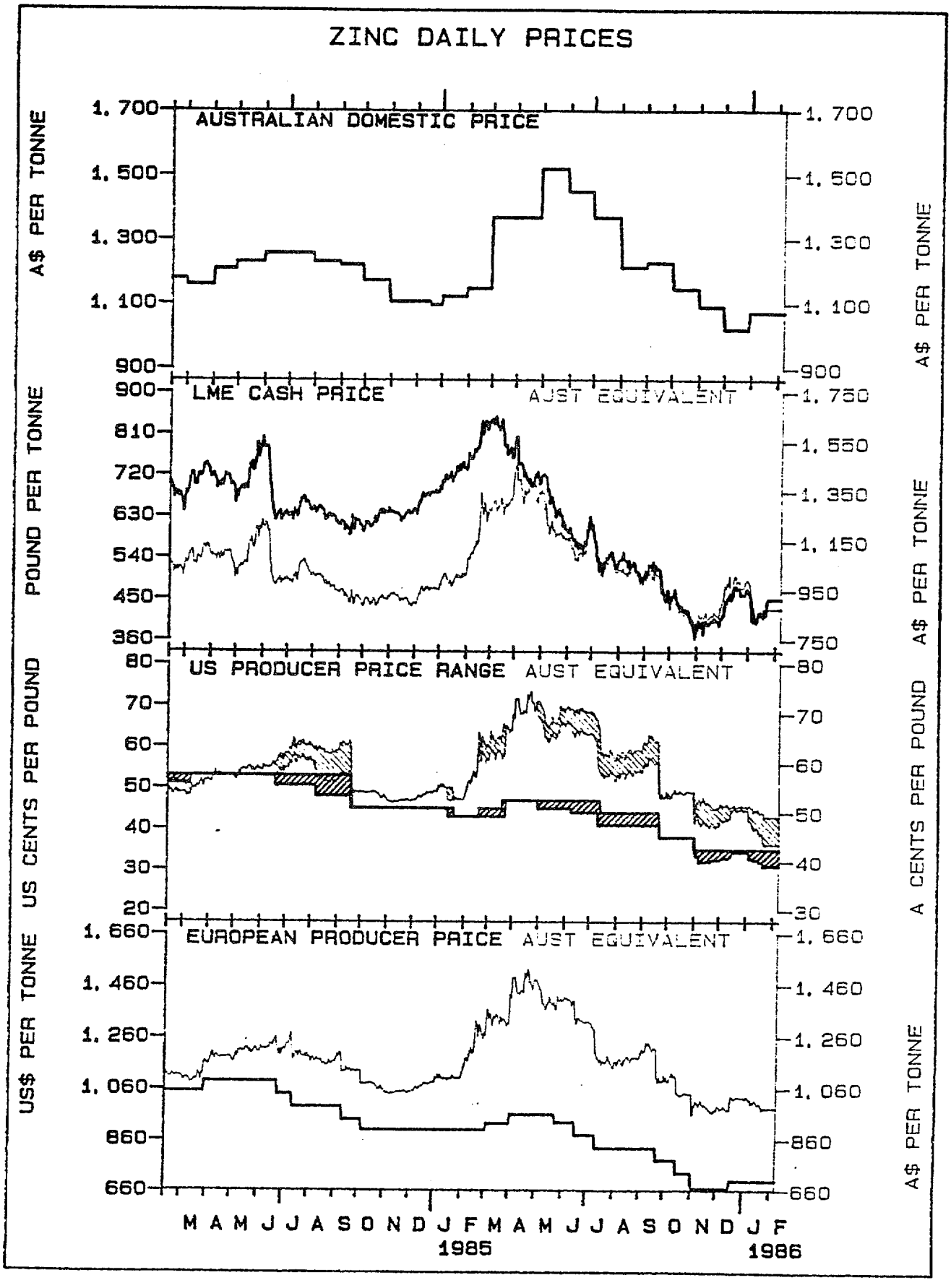
Commissioning of such new mines is expected to enable Australia to increase mine production of lead and zinc in the medium term. Mine production of copper is also expected to increase in the medium term following the commissioning of Olympic Dam. Exports of the three metals contained in all products are expected to increase concomitantly with increased mine production.


COPPER DAILY PRICES
AUSTRALIAN DOMESTIC PRICE
A$ PER TONNE
2,600
2,400
2,200
2,000
1,800
1,600
1,400
LME CASH PRICE
AUST EQUIVALENT
POUND STLG PER TONNE
1,410
1,310
1,210
1,110
1,010
910
US PRODUCER PRICE RANGE
AUST EQUIVALENT
US CENTS PER POUND
AUST CENTS PER POUND
130
110
90
70
50
F M A M J J A S O N D J F M A M J J A S O N D J
1984
1985
1986

86


LEAD DAILY PRICES
AUSTRALIAN DOMESTIC PRICE
A$ PER TONNE
610
590
570
550
530
510
490
LME CASH PRICE
AUST EQUIVALENT
POUND STLG PER TONNE
420
390
360
330
300
270
240
650
610
570
530
490
450
410
US PRODUCER PRICE RANGE
AUST EQUIVALENT
US CENTS PER POUND
AUST CENTS PER POUND
50
40
30
20
10
M A M J J A S O N D J F M A M J J A S O N D J F
1985
1986

67


ZINC DAILY PRICES
AUSTRALIAN DOMESTIC PRICE
LME CASH PRICE
AUST EQUIVALENT
US PRODUCER PRICE RANGE
AUST EQUIVALENT
EUROPEAN PRODUCER PRICE
AUST EQUIVALENT
A$ PER TONNE
POUND PER TONNE
US CENTS PER POUND
US$ PER TONNE
A CENTS PER POUND
A$ PER TONNE
1,700
1,500
1,300
1,100
900
810
720
630
540
450
360
1,750
1,550
1,350
1,150
950
750
80
70
60
50
40
30
20
1,660
1,460
1,260
1,060
860
660
M A M J J A S O N D J F M A M J J A S O N D J F
1985
1986

N O T E S

Metal prices in 1986

W. Davies, Metals & Minerals Research Services

Abstract to be provided separately.

N O T E S

BIOGRAPHICAL NOTES ON THE SPEAKERS

P. BAILLIE, TASMANIAN DEPARTMENT OF MINES

Peter Baillie completed a B.Sc. at the University of Tasmania in 1969 and is currently working towards an M.Sc. (Hons) at Macquarie University. He joined the Tasmanian Mines Department in 1970 and spent 15 years working in the Regional Mapping Section of the Geological Survey. Mapping projects included granites and associated mineralisation in northeast Tasmania and the economically important Mt Read Volcanics in western Tasmania. He is currently employed in the Economic Geology Section where his principal interest is petroleum geology although he is also responsible for administrative functions of the Section. He is a member of the Geological Society of Australia, the Australian Institute of Geoscientists and the Petroleum Exploration Society of Australia.

K. BOWEN, VICTORIAN DEPARTMENT OF INDUSTRY, TECHNOLOGY & RESOURCES

Keith Bowen graduated from Melbourne University with a major in geology in 1953. Following a period teaching mathematics and science at Bairnsdale, he joined the then Mines Department in 1958.

Since then Keith has extensive experience in the area of mineral resources with a special interest in Victorian gold deposits. He has published papers on the A1, Wattle Gully and Sambas Mines and general papers on gold deposits of Victoria.

For the period 1970 to November 1983, Keith was Assistant Director of the Geological Survey Division. Since then he has been Director of Policy and Planning, Group Manager Energy and from the final amalgamation of Minerals and Energy into the Department of Industry Technology and Resources in September is now Group Manager Minerals with responsibilities for the Mining, Drilling, Geological Survey and Oil and Gas Divisions.

C. BRANCH, SOUTH AUSTRALIAN DEPARTMENT OF MINES & ENERGY

Colin D. Branch is Director (Resources) in the South Australian Department of Mines and Energy. He is responsible for the formulation of government policy in relation to the exploration and development of the mineral and water resources of the State; and for liaison with industry in the implementation of these policies. In addition he is responsible for the professional and administrative leadership of the Resources Division which includes the Regional Geology and Technical Information Branches.

Earlier in his career Colin was a regional geologist and volcanologist in BMR, then Foundation Head of the School of Applied Geology at the South Australian Institute of Technology, and a consultant to industry on mineralisation associated with volcano-plutonic provinces. He has been President, Geological Society of Australia; and Secretary and President of the Australian Geoscience Council: currently he is Chairman, Australian Committee for the International Geological Correlation Program; and Secretary, Federation of Australian Scientific and Technological Societies.

J. BROOKS, GEOLOGICAL SURVEY OF QUEENSLAND

Jim Brooks is the Director, Metalliferous and Geological Services Branch, Geological Survey of Queensland. He is a graduate of the University of Queensland (1950). After early involvement with regional geological mapping in Northwestern Queensland, he undertook surveys and resource assessments of mineral deposits in Queensland with emphasis on copper, uranium and gold. In addition to directing one of the three branches of the GSQ, Jim has responsibility for the administration of Authorities to Prospect for Minerals.

B.J. DAVIES, COOPERS & LYBRAND

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

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

W. DAVIES, AUSTRALIAN MINERAL ECONOMICS P/L

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

H. DENKL, SCHLUMBERGER TECHNICAL SERVICES INC

Heinz Denkl is President of Schlumberger Wireline Asia based in Tokyo, Japan. He received a Master's Degree in Electronic Engineering from the Technical University in Stuttgart, Germany and joined Schlumberger in 1957 as a Field Engineer in Venezuela.

Prior to his appointment as President in 1981, Heinz held a variety of line and staff positions in some 20 different countries. He is a member of the Society of Petroleum Engineers.

R.G. DODSON, BMR

Dick Dodson is Principal Commodity Specialist (gemstones and gold) in the Mineral Commodities Branch of the Resource Assessment Division. He graduated with a B.Sc. (Hons) and later a Ph.D. degree, and worked for H.M. Overseas Colonial Survey in Kenya from 1950-63. He joined BMR in 1963 and was head of the Resident Geological Section, Northern Territory, between 1965-70. He returned to Canberra in 1970, to the Geological Branch, and joined the Mineral Commodities Branch in 1983.

I.J. DUNCAN, WESTERN MINING CORPORATION LTD

Ian Duncan joined Western Mining Corporation in 1971 as Operations Manager (Exploration Division) and later served as Vice President - WMC (North America). Ian is currently Business Manager with WMC in Melbourne, primarily involved in the development of new projects such as Yeelirrie (suspended) and now Olympic Dam. Ian is a Member of the Australian Institute of Mining and Metallurgy, an Associate Fellow of the Australian Institute of Management, and Industry Representative on the Synroc Steering Committee, Uranium Institute.

D.J. IVES, DEPARTMENT OF RESOURCES & ENERGY

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

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

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

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

N.D. KNIGHT, BMR

Nerida Knight is the Commodity Specialist for aluminium, tungsten, and tantalum 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.E. KOLM, AO, NERDDC

Jan Kolm is a graduate of the Technical University of Prague. He joined ICI Australia in 1950 and over some 30 years held a series of research and development and administrative posts. After a period as Corporate Research Manager, he was appointed to the ICI Australia Board where his responsibilities included Research and Technology, Engineering (including energy management) and Plastics.

Jan Kolm's involvement in the energy area was initially through the petrochemical industry, methanol and synthetic fuels program, as a Member of ICI UK's Research Advisory Council. He was a member of NERDDC Technical Standing Committee on Synthetic Fuels and was appointed Chairman of NERDDC in 1983.

Jan Kolm is also a Member of the CSIRO Advisory Council and Chairman of the Victorian State Committee, a Member of the Council of the Australian Academy of Technological Sciences, and a Member of the Council of Monash University. In 1983 he was made an Officer of the Order of Australia for contributions to science and industry.

M.H. MACPHERSON, WESTRALIAN SANDS LTD

Malcolm Macpherson graduated from the University of Canterbury, New Zealand in 1966 and spent a number of years working on various exploration projects in Africa and the Philippines before permanently settling in Australia in 1970.

He joined Westralian Sands Limited in 1974 and became Chief Executive in 1978. Malcolm has a particular interest in the geology of alluvial minerals and mineral processing.

N.L. MARKHAM, GEOLOGICAL SURVEY OF NSW

Neville Markham is the Director of the Geological Survey of New South Wales, Department of Mineral Resources. He has worked at the Geological Survey for the past 15 years and prior to that, lectured in Economic Geology at the Universities of New South Wales and Sydney. Neville's research interests have focussed on metalliferous ore deposits including gold mineralisation in New South Wales.

The New South Wales Department of Mineral Resources has an active program of assessment of the State's mineral resources including coal, metallic minerals, industrial minerals and petroleum, and is also seeking to promote the better utilisation and marketing of New South Wales mineral commodities.

M.R. MOREAU, ELF AQUITAINE PETROLEUM

Michel Rene Moreau is a graduate of both the 'Faculte De Droit', Paris (Bachelor or Law), and the 'Ecole Superieure De Commerce De Paris' (Master of Business Administration).

Michel commenced an early association with the oil and gas industry with the British Gas Council in the mid 1950's. He then joined the Societe Nationale Des Petroles D'Aquitaine in 1960 and was first posted to Australia in 1966 as Administration and Finance Manager for a period of five years. He has remained on the Board of the Elf Aquitaine companies in Australasia ever since.

Michel returned to France in 1971 and continued to serve the Elf Aquitaine group through a progressive career which culminated in France with his appointment as Deputy Executive Vice President (Finance) of the Elf Aquitaine Group. He has also served as a Director of Elf Aquitaine Exploration/Production companies in the USA, Great Britain, Malaysia and France. He returned to Australia early in 1983 as Managing Director of the Elf Aquitaine Group in this country and Chairman of Elf Aquitaine Petroleum Australia.

D.J. PERKIN, BMR

Don Perkin is Principal Commodity Specialist (copper) in the Mineral Commodities Branch, Resource Assessment Division. He graduated from the University of Sydney with a B.A. (Geology) and worked for a number of years with a range of mining and exploration companies throughout Australia. He graduated in Economics from James Cook University in 1975. Since joining BMR in 1978 he has worked as the tin, uranium, and copper, commodity specialist. He is currently completing his M.Sc. in Exploration and Mining Geology with James Cook University of North Queensland.

R. PRATT, BMR

Roger Pratt is a Senior Commodity Specialist in the Mineral Commodities Branch of the Resource Assessment Division. After graduating from the University of New England he worked as a geologist in iron ore mining and exploration for several years. He has worked for short periods in mineral policy and BMR planning but since joining BMR in 1965 has been mainly involved in mineral industry commodity work specialising in iron and steel and ferroalloy metal studies. He was a member of the Australian Iron Ore Industry Mission led by the Chairman of the Australian Iron Ore Industry Consultative Council which visited Brazil in July 1985 to study iron ore mining and processing operations there.

P. RYAN, DEPARTMENT OF RESOURCES & ENERGY

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

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

P.P. TAPPER, WOODSIDE OFFSHORE PETROLEUM PTY LTD

Peter Tapper is Executive General Manager of Woodside Offshore Petroleum Pty Ltd which is the delegated Operator for the North West Shelf responsible to the Participants for ongoing exploration and the design, construction and operation of both the Domestic Gas and LNG Phases of the natural gas development project both offshore and onshore.

Peter was appointed General Manager of the Company in 1982, and one of his first duties was to preside over the amalgamation of the offshore and onshore operator functions which had previously been carried out by two separate companies. He was previously Engineering Director of Shell UK Exploration & Production, London. Before that appointment, he was Technical Director and Deputy Managing Director of Shell Brunei for five years and also Deputy Chief Executive of Brunei LNG and Brunei Coldgas.

Peter is an honours graduate in Civil Engineering from Auckland University, New Zealand. He joined the Royal Dutch Shell Group in 1956 on graduation, and has since served with the Group in engineering, technical and management capacities in Brunei, Indonesia, the United States, Qatar, Africa, Canada and the Netherlands as well as in the United Kingdom.

As Executive General Manager of Woodside Offshore Petroleum, Peter presides over a staff of some 1200 people and is currently responsible for all aspects of an investment program which will total some $12 000 million in the period 1980 to 2001.

J.B. THOMSON, AUSTRALIAN COAL ASSOCIATION

Bruce Thomson is the Director and Chief General Manager of Coal and Allied Industries Limited, being appointed to this position in 1981. Since 1983, he has been the Chairman of the New South Wales Coal Association and also in 1985, became the Chairman of the Australian Coal Association.

He is a Director of Port Waratah Coal Services Limited and Kooragang Coal Loader Limited and is a member of the Australian Coal Consultative Council.

Having been involved in the coal and shipping industries since 1947, he has had considerable experience in the transportation, marketing, administration and management functions of the industry.

R.W. TOWNER, BMR

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

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A.F. TRENDALL, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

After graduation from Imperial College, London, in 1949 Alec Trendall completed his Ph.D. at Liverpool University, working on metamorphism of Dalradian rocks. Subsequent professional experience included acting as Geologist to two expeditions to South Georgia, lecturing for a year at Keele University, and eight years field mapping in Uganda. He joined the Geological Survey of Western Australia as Petrologist in 1962, and was promoted to Deputy Director in 1970, and Director in 1980; later this year he will 'retire' from administrative duties and continue geological work with the Survey as Senior Principal Geologist in the Precambrian Geology section. Alec's interest in economic geology arose through his work on banded iron-formations of the Hamersley Group, for which he was awarded a D.Sc. He is a past President of the Geological Society of Australia.

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.

J.A.W. WHITE, BMR

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