Bureau of Mineral Resources,
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EXTENDED ABSTRACTS

PETROLEUM & MINERALS REVIEW CONFERENCE 1985 CANBERRA, 20-21 MARCH

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World Petroleum Overview

S.R. McGill, Esso Australia Ltd

Esso's latest world energy outlook is based on several planning assumptions thought likely to shape the energy future for the rest of the century. They lead to one plausible energy future but not the only one. Real economic growth outside of the centrally planned economies is expected to average just under 3% a year, and energy consumption is projected to grow at about 2% a year (1.5% a year in the industrialised countries in the 1980s and less than 1% a year in the 1990s; 4% a year in the developing countries). Oil and gas accounted for 75% of world energy consumption before 1973, but their share will fall to less than 60% by 2000. Growth in the consumption of oil is projected to be about 1% a year, with oil's share of energy consumption declining from 47% in 1984 to 41% in 2000. Most of this growth will be in the developing countries. Gas consumption is expected to grow more rapidly than energy up to 1990, but then to decline slightly to 2000. The market share lost by oil and gas will be picked up by coal, nuclear energy and hydropower. Synthetics are not expected to contribute significantly to world energy consumption before 2000.

The gas discovery rate (including that in the centrally planned economies) currently exceeds the rate of production, and that is likely to continue for a few more years. International gas trade is projected to double to 8 trillion cubic feet a year by 1990, then to remain constant to 2000. Proven crude oil reserves (including those in the centrally planned economies) are estimated at nearly 700 billion barrels, and a large potential remains for discovering additional oil. However, the total discovery rate for 1984 to 2000 is likely to be well below the consumption rate of 21 to 24 billion barrels. Non-OPEC oil production is forecast to remain flat for the rest of the century, and significant spare production capacity is expected to exist within OPEC for several years. Nevertheless, demand for OPEC crude is expected to rise above current levels by 1990, and real oil prices are forecast to rise as growth in consumption absorbs OPEC spare. The oil supply outlook is in all cases highly dependent on the success of exploration.

Even though world petroleum trends are more sustaining in the longer term, the near term outlook is subject to uncertainties and is likely to remain so for several years.

Recent developments in Australian petroleum

J.C. Starkey, Department of Resources & Energy

The past few years have seen considerable change in the world and domestic outlook for petroleum supply and demand. Consequently the Government has reappraised its policies for the Australian petroleum industry with a view to bringing about a less regulated, more flexible, and more rational economic environment for the industry. This paper will cover a range of policies that have recently been announced, such as the partial allocation scheme, petroleum export arrangements, revised import parity pricing and excise arrangements, the resource rent tax, and the introduction of cash bidding and other amendments to the Petroleum (Submerged Lands) Act.

Australian petroleum exploration and development

J.A.W. White, BMR

A record level of petroleum drilling activity was achieved in Australia in 1984. A total of 374 wells were drilled for petroleum exploration and development and of these 268 were exploratory (225 onshore, 43 offshore) and 106 development (68 onshore and 38 offshore).

Seismic activity during the year was 60% more than that of 1983 but 35% less than 1982 (a record year). Present indications are that this level of seismic activity will be maintained throughout 1985.

Onshore, the most active areas were the Cooper/Eromanga Basins of Queensland and South Australia; 168 wells were drilled, most in South Australia and 28 significant discoveries were made. The Bowen/Surat Basins in Queensland yielded further oil and gas discoveries. In Western Australia, activity was at record levels in the Canning Basin which resulted in two small oil discoveries. In the Northern Territory a further two gas discoveries were made in the Amadeus Basin.

Offshore, significant discoveries of oil and gas were made in the Bonaparte Basin and the Carnarvon Basin. In the Gippsland Basin two new oil pool discoveries and four new field discoveries (2 oil/gas/condensate, 2 gas) were made.

Development projects completed during 1984 included the giant Northwest Shelf offshore gas project which now supplies gas to the Perth market. Other major projects were the supply of natural gas from Palm Valley to the Alice Springs power station, the commercial production of crude oil from the Mereenie oilfield in central Australia and an LPG gathering and processing plant at Silver Springs in the Roma area of Queensland. The small Blina and Sundown oil fields in the Canning Basin of Western Australia commenced production via a short pipeline and road tanker transport to Derby.

Australia became a member of the Enhanced Oil Recovery Research Project under the auspices of the International Energy Agency during 1985. Microbiological and carbon dioxide injection methods of enhanced oil recovery are being studied for application in Australia.

As part of BMR's activities designed to assist exploration and research a number of important databases were established during 1984; these include the National Petroleum Exploration Data Index (PEDIN), the Petroleum Source Rock Database (WLDAT) and Drilling Rigs and Contractors Database (DRLCON).

BMR has recently commenced a new marine geoscience research program to improve our understanding of Australia's continental margins. A specially designed geoscientific vessel, the RIG SEISMIC, has been chartered for 2 years in the first instance.

The forecast demand for Australian petroleum to 1993-94

Alan Smart, Department of Resources & Energy

The Department of Resources and Energy has recently completed its biennial forecasts of Australian energy demand for the next ten years. These forecasts are based on both the Fuel Use Survey conducted by the Department and the Department's econometric models of energy demand. These models both supplement the survey results and, in some cases, provide a check against the aggregate survey responses.

Total energy demand, defined as the quantity of primary and derived fuels consumed less the quantity of derived fuels produced, is forecast to increase at an average rate of 2.4% pa over the next ten years, compared with an average increase of 2.0% pa since 1973-74. The energy intensity of the economy, measured as the ratio of total energy demand to real GDP, is forecast to maintain the decline which began in the late 1970's. Although structural changes resulting from the growth of highly energy-intensive industries are expected to exert an upward influence on energy intensity in the forecast period, this influence is expected to be more than compensated by energy savings through conservation and substitution measures and the introduction of more efficient technologies elsewhere in the economy.

The share of petroleum products in total energy demand is forecast to decline to 35% by 1993-94 compared with 40% in 1983-84, and 51% in 1973-74. This reflects the expectation that the general shift away from petroleum products towards coal and natural gas will continue, with coal in particular becoming more dominant as an energy source.

Despite this declining share, the demand for petroleum products is forecast to increase at an average rate of 0.9% pa over the forecast period. This follows periods of sustained growth in petroleum products consumption up until the late 1970's, a period of decline from 1979-80 to 1982-83 and growth of 3.3% in 1983-84. This forecast of slow growth is primarily attributable to projections of continued substitution of petroleum fuels in stationary applications, improvements in vehicle fuel demand, technological improvements and continuing conservation gains.

On a sectoral basis, the transport industry is the major consumer of petroleum products, with its share increasing from 51% in 1973-74 to 64% in 1983-84. This represents an average growth rate of 2.5% pa. Although the growth for the next ten years is expected to be somewhat slower at an average 1.6% pa, the transport industry's share is forecast to increase again to 69% of total petroleum products demand by 1993-94. Within the transport industry the major feature is a forecast decline in the demand for automotive gasoline which is expected to be more than offset by a forecast increase in the demand for automotive diesel oil. This reflects expected continued improvements in vehicle fuel economy, increasing consumer preference for fuel-efficient vehicles and further penetration of the motor vehicle market by LPG and diesel powered vehicles.

The energy requirements of the non-transport sectors provide greater opportunties for substitution of petroleum fuels. Industries such as alumina refining and electricity generation are substituting natural gas and coal for fuel oil and industrial diesel fuel in their furnaces and generators. However, when compared with the last ten years, the scope for further major substitution is expected to decline with most major petroleum consumers having substituted or assumed to have substituted by the late 1980's.

Estimates of Australian production of crude oil during 1985 to 1994

David J. Forman, BMR

The Bureau of Mineral Resources has recently produced a new estimate of future oil production from fields that are likely to be discovered during the period to 1994. The possible production figures are given as high and low estimates for each year rather than the single value estimates provided in 1984.

The estimates have been prepared by two different methods using Monte Carlo simulation techniques. One set of figures has been prepared assuming that historic exploration trends will continue. Other values have been obtained by considering what might happen if these historic trends are broken by the discovery of some comparatively large fields. The total estimate of production from undiscovered fields is then obtained by adding the estimates obtained by the two methods together.

The range of estimates of future production from undiscovered fields is lower than was suggested last year. The reduction is mainly the result of the very considerable downgrading of the reserves of the Jabiru field and reinterpretation of the likely size and timing of new discoveries of oil in key areas, particularly offshore from the northwest coast of Australia. When viewed together with the production from identified fields (Figure 1), the new estimate suggests production of crude oil and condensate is likely to fall from about 185 million barrels in 1985 to a narrow range close to about 160 million barrels in 1988. Production levels in 1994 are much more uncertain, with possible future levels ranging between 130 and 200 million barrels per annum.

The most important factor in determining the width of the band of possible oil production figures is uncertainty about the size and number of the undiscovered oil fields and the timing of their discovery. Allowance has been made for uncertainty in the rate at which undiscovered fields might be developed. However, no allowance has been made for possible variations in the level of future exploration or variations in the rate at which undiscovered fields may be produced.

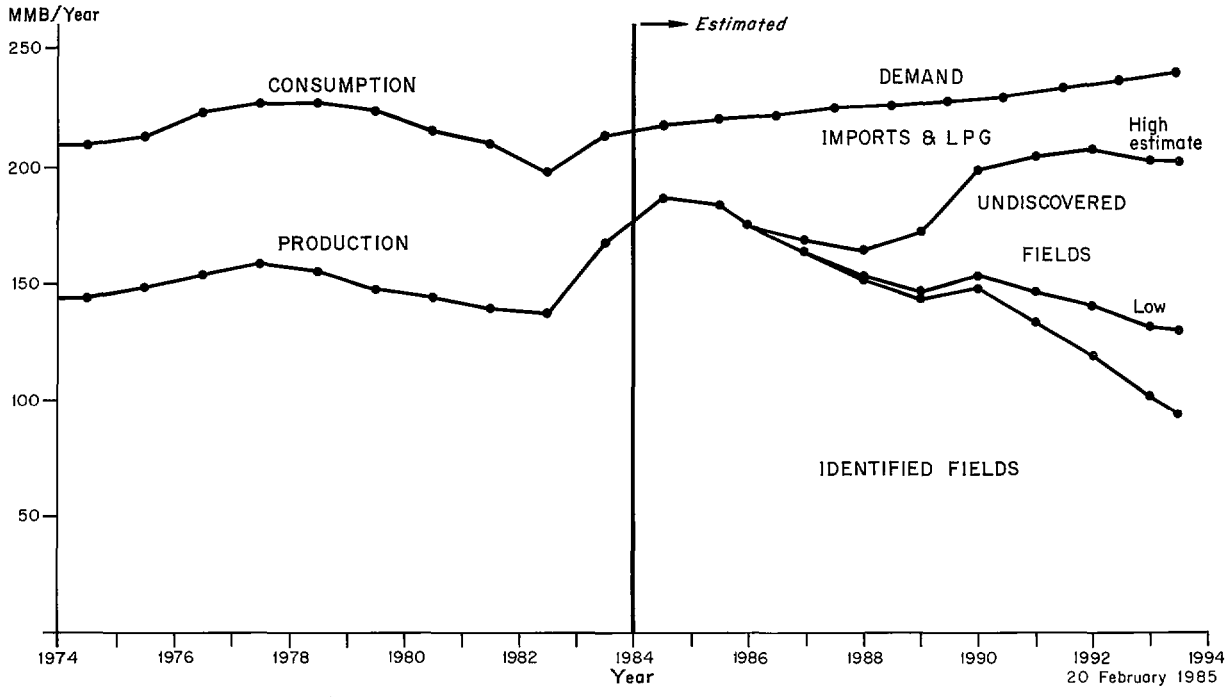

Figure 1 Production and consumption of crude oil and condensate – Australia, 1974 – 1994

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Enhanced oil recovery

W.V. Pinczewski, University of New South Wales

Conventional primary and secondary oil recovery techniques are usually very inefficient. On a world average they result in recoveries of about one-third of the original oil in place. The remaining two-thirds of the oil, residual oil, which cannot be recovered by conventional technology represents a large resource which has the potential to significantly increase declining world oil reserves. This residual resource is the target for enhanced oil recovery (EOR) technology. Although the potential benefits from the application of EOR technology are large, the technology itself is complex and not well understood. Moreover, the size of the residual oil resource is not well defined.

This paper reviews the major EOR techniques with emphasis on those techniques which are particularly suitable for the recovery of light oils which are the predominant crude type in Australia. The results from a recently completed extensive study of the potential benefits of EOR technology in the United States conducted by the National Petroleum Council are discussed. This study concludes that EOR technology could increase current US domestic crude reserves by approximately 40%. However, ultimate recovery and projected producing rates of EOR developments are highly sensitive to changes in crude oil prices and are subject to wide and varying levels of technical uncertainty. An attempt is made to place these findings in the Australian context to produce a first-order estimate of the future potential of EOR technology in Australia.

Oil shale as a future source of liquid fuels

N.J. Paterson, Southern Pacific Petroleum

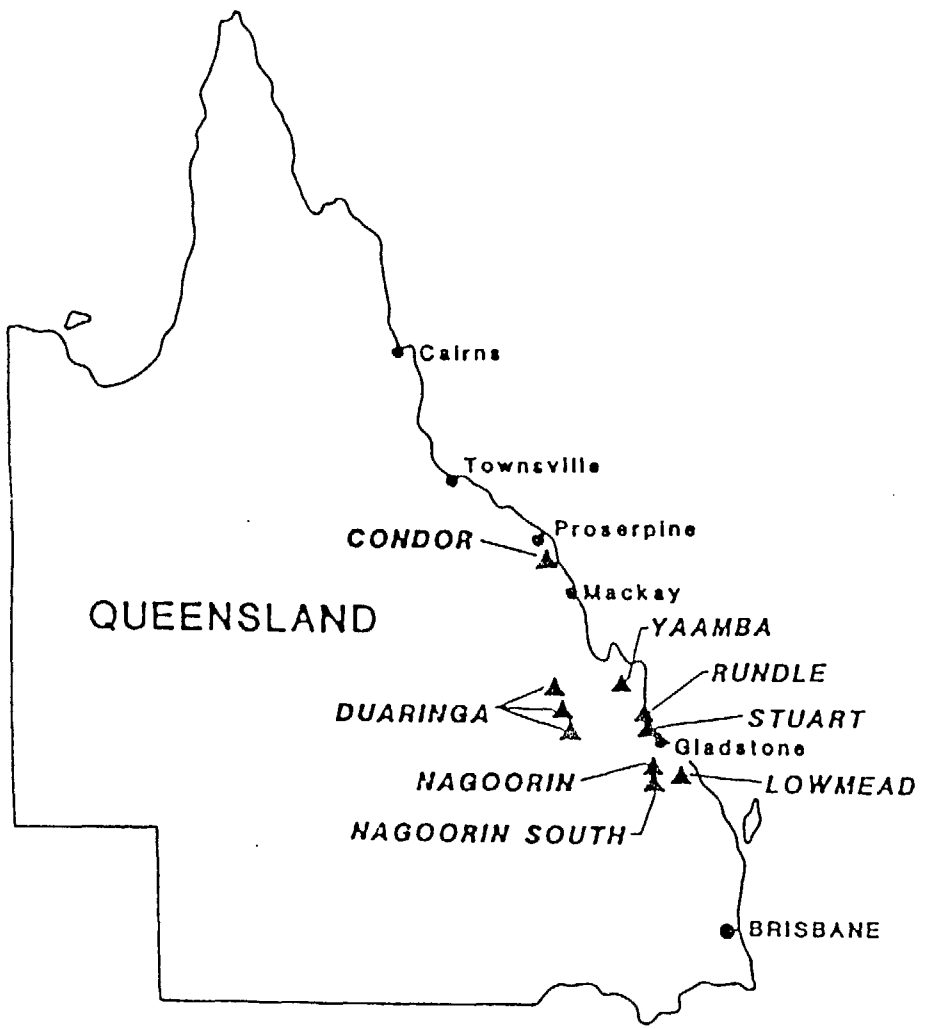
Recent Australian commercial interest in oil shale dates from 1969 when CSR began work on the Julia Creek deposit. In 1973 Southern Pacific Petroleum (SPP) and Central Pacific Minerals (CPM) were granted an Authority to Prospect over the Rundle deposit. Since that time there has been considerable exploration and development effort. The driving forces for oil shale development are the world and Australian oil markets, oil finding and development costs and the Australian balance of payments. These factors provide an inexorable incentive for fuel substitution, including synthetic fuel development over time.

The attached table lists oil shale deposits in Queensland in which SPP/CPM has an interest. The shale oil deposit sizes range from 467 million barrels at Nagoorin South to 8.1 billion barrels at Condor. Julia Creek containing about 1.7 billion barrels of oil is not included. Significant oil shale activities are underway in Brazil where a 680 barrels/day demonstration plant has accumulated the equivalent of 7+ years operation, a very successful demonstration of the particular technology involved. In Colorado the 10 000 barrels/day Union Oil plant using proprietary technology was completed in 1983 for around $US 600 million. The plant, undergoing modification and trials, awaits successful commissioning.

Two major studies have recently been completed on Australian oil shale deposits. The 3 year Rundle work program and the 2½ year Condor effort have produced capital cost estimates of $US 645 million and $US 2 300 million for 15 000 and 82 000 barrels of syncrude per day respectively. For the Condor project average cash operating cost is estimated at $US 11/barrel and taxes and royalties over the project life average $9/barrel. The economics of these projects look promising at the scales studied. An impediment to development is the financial risk associated with large capital costs. It is necessary for industry and government to minimise impediments to development and to actively promote research which can reduce costs and allow projects to begin economically at smaller capacities on reduced timescales. Over 25 billion barrels of shale oil has been delineated, its finding cost has been expended; the next stage is economic development.

AUSTRALIA

EASTERN QUEENSLAND
OIL SHALE DEPOSITS



Deposit	Insitu Resources
CONDOR	8.14 billion barrels
DUARINGA	3.72 billion barrels
LOWMEAD	738 million barrels
NAGOORIN	2.65 billion barrels
NAGOORIN STH.	467 million barrels
RUNDLE	2.65 billion barrels
STUART	2.51 billion barrels
YAAMBA	2.82 billion barrels
Total	23.695 billion barrels

Uranium resources and supply

G.C. Battey, BMR

In Australia, significant exploration for uranium did not commence until 1944, and by 1967 the nation's reserves were estimated to be 6200 tonnes of uranium. A series of major discoveries has increased Australia's resources to the December 1984 estimate of 463 000 tonnes uranium in the Reasonably Assured Resources (RAR) category, recoverable at a cost of less than US$80/kg U (US$30/lb U_3O_8). Mine production of uranium oxide commenced in 1954 and production to the end of 1984 totalled 26 166 tonnes of contained uranium.

Australia has the largest known low cost resources in the Western World, with 29% of the total. In addition, Australia has 25% of the Western World's low cost resources in the Estimated Additional Resources (EAR) - Category I.

Exploration for uranium is decreasing at the international level, having peaked with expenditure of US$913 million in 1979, and decreased to US$190 million in 1983. In Australia, exploration peaked at $38 million in 1981 and had fallen to $14 million in 1983. Expenditure in 1984 is likely to be less than in 1983. It is suggested that expenditure on exploration for uranium has declined worldwide because known uranium resources are considered to be sufficient to meet more than 30 years supply at any likely level of demand.

The annual consumption of uranium is still increasing but because of the sluggish growth of nuclear power in recent years relative to predictions made in the 1970s, mine production capability exceeds current demand and this has resulted in a fall in uranium prices in real terms. Several high cost producers have ceased operations but their place in the market has been taken by low cost producers, particularly in Canada, which was the world's largest producer in 1984.

Australian uranium production has increased in recent years; production commenced at Nabarlek in 1980 and at Ranger in 1981, and ceased at Mary Kathleen in 1982. Australian production in 1984 is estimated as 4390 tonnes of contained uranium which represents about 11% of the production in the Western World. The average value of uranium exports from Australia during 1984 was $42.79/lb U_3O_8 and the spot price quoted by the Nuclear Exchange Corporation (Nuexco) for December 1984 was US$15.25/lb U_3O_8.

Ranger and Nabarlek are the only uranium mines operating in Australia at the present time. Feasibility studies are in progress to evaluate the Olympic Dam deposit and Western Mining Corporation has indicated an initial target production rate of approximately 2000 t U_3O_8 commencing in 1988.

The Australian coal industry - current position and short-term trends

M.B. Huleatt, BMR

Raw and saleable coal production in 1984 were records at 141 Mt and 115 Mt respectively. Domestic consumption was a record 39 Mt. Exports increased by 15 Mt to a record 75.9 Mt. Exploration was severely reduced in 1983/84 as all drilling in New South Wales and government drilling in Queensland was more than halved. The Australian Coal Association reported that the 1983/84 after tax return on funds used fell to 4.9% reflecting the continued poor profitability of the industry. Borrowings rose again and the debt/equity ratio was reported by ACA to be 0.99.

Prices for coking coals sold to Japan fell in 1984. Negotiations for all coals concluded to date for 1985 have generally resulted in no changes in base prices. Changes in the relative value of the US and Australian dollars may result in de facto price rises or falls.

Growth in domestic consumption has been due to steady increased demand by the electricity industry while steel industry use has fluctuated but the overall trend has been slightly down. All other users have consumed between 3.5 and 4.5 Mt/year over the last decade. With no major new demand expected for electricity in the next year or two the established steady overall growth rate is likely to continue without gross variation.

Exports in 1984 were 66% of total saleable coal production. Despite intense international competition Australian exporters were able to increase shipments by 15 Mt. Although there has been a reduction in the proportion of coal going to Japan tonnages have continued to increase. The major growth area for exports has been other Asian markets. Exports are likely to continue to grow, but at a slower rate than occurred in 1984, provided coal can be supplied at a competitive price. Asia will continue to be the major marketing region for Australian exports and Japan remains the most important customer although the percentage of Australian coal going to Japan is declining.

Open-cut mines will almost certainly account for most of any increased production in the next few years. In Queensland open cuts dominate, supplying almost 90% of raw coal output in 1984 and in New South Wales open cuts provided some 38%, and are expected to increase this in 1985.

Demand for Australian coal increased in 1984 to the point where just over 80% of the industry's nominal production capacity was utilised. Should demand continue to rise at the expected rate existing capacity will be essentially fully utilised in the next 2 to 3 years.

NEW SOUTH WALES COAL EXPORTS
('000 t)

MARKET AREA	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
North America	107	-	107	779	52	61	15	-	21	26
Central America	-	18	-	10	56	-	-	-	-	-
South America	113	50	25	-	-	-	-	-	-	-
Europe	3 083	2 656	3 164	4 169	3 964	3 899	3 700	3 869	5 070	6 893
Africa	-	-	-	-	-	-	-	-	-	-
Middle East	88	-	-	-	-	-	175	342	479	659
Japan	10 365	11 151	12 371	12 523	12 122	15 377	15 491	15 219	17 162	18 486
Other Asia	728	1 050	1 505	2 183	3 481	3 555	3 848	5 536	8 017	9 574
Pacific	10	13	7	-	-	10	40	30	65	103
TOTAL	14 494	14 938	17 179	19 664	19 675	22 902	23 269	24 996	30 814	35 741

PERCENTAGE OF TOTAL NSW COAL EXPORTS DIRECTED TO EACH MARKET AREA

MARKET AREA	1975	1976	1977	1978	1979	1980	1981	1982	1983	9184
North America	0.7	-	0.6	4.0	0.3	0.3	0.1	-	0.1	0.1
Central America	-	0.1	-	0.1	0.3	-	-	-	-	-
South America	0.8	0.3	0.2	-	-	-	-	-	-	-
Europe	21.3	17.8	18.4	21.2	20.2	17.0	15.9	15.5	16.5	19.3
Africa	-	-	-	-	-	-	-	-	-	-
Middle East	0.6	-	-	-	-	-	0.8	1.4	1.6	1.8
Japan	71.5	74.6	72.0	63.7	61.6	67.1	66.6	60.9	55.7	51.7
Other Asia	5.0	7.0	8.8	11.1	17.7	15.5	16.5	22.2	26.0	26.8
Pacific	0.1	0.1	-	-	-	-	0.2	0.1	0.2	0.3

QUEENSLAND COAL EXPORTS
('000 t)

MARKET AREA	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
North America	-	-	-	105	104	-	-	25	-	-
Central America	-	-	45	33	-	-	-	-	-	-
South America	46	-	-	188	171	59	271	102	413	868
Europe	2 965	3 585	4 708	5 592	4 466	4 015	5 886	4 065	6 492	11 078
Africa	-	-	-	-	-	-	-	-	55	169
Middle East	-	-	-	-	43	157	342	389	807	1 083
Japan	12 340	15 544	14 012	12 674	14 809	14 726	19 475	17 119	18 820	22 490
Other Asia	16	27	257	405	1 101	834	1 723	3 100	3 128	4 408
Pacific	5	-	12	25	23	25	-	-	16	21
TOTAL	15 372	19 156	19 034	19 022	20 717	19 816	27 697	24 800	29 731	40 117

PERCENTAGE OF TOTAL QUEENSLAND COAL EXPORTS DIRECTED TO EACH MARKET AREA

MARKET AREA	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
North America	-	-	-	0.6	0.5	-	-	0.1	-	-
Central America	-	-	0.2	0.2	-	-	-	-	-	-
South America	0.3	-	-	1.0	0.8	0.3	1.0	0.4	1.4	2.2
Europe	19.3	18.7	24.7	29.4	21.6	20.3	21.2	16.4	21.8	27.6
Africa	-	-	-	-	-	-	-	-	0.2	0.4
Middle East	-	-	-	-	0.2	0.8	1.2	1.6	2.7	2.7
Japan	80.3	81.1	73.6	66.6	71.5	74.3	70.3	69.0	63.3	56.1
Other Asia	0.1	0.1	1.3	2.1	5.3	4.2	6.2	12.5	10.5	11.0
Pacific	-	-	0.1	0.1	0.1	0.1	-	-	0.1	0.1

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PRODUCTION CAPACITY : AUSTRALIAN BLACK COAL MINES

(Mt/year saleable coal)

	MARKET		
	DOMESTIC	EXPORT	TOTAL
NSW	29	44	73
QLD	12	51	63
WA	4	0	4
SA	2	0	2
	47	95	142

Tasmanian Capacity 0.5 Mt/y

Source: Curruthers (1984), Queensland Government Mines Journal, October 1984, pp. 305-387.

Policy development in the coal industry

P. Ryan, Department of Resources & Energy

The Australian black coal industry in 1984 was in many respects similar to 1983. In both years the industry experienced record levels of production and exports.

However, problems remain within the industry as it experiences structural adjustment and changing levels of employment impacting unequally on the nation's coal producing regions. Other problems have been identified and well documented by industry. These include a cost price squeeze, the heavy burden of production related charges and, for some producers, failure of buyers to honour the conditions of longer term contracts.

Against this background and recognising the significant contribution of the industry to the Australian economy, the Government saw the need to formulate a range of policies and initiatives to address industry problems, such as the mounting level of industrial unrest after a relatively quiescent period had refurbished our reputation as a reliable and stable supplier. This matter is addressed specifically in relation to the Hunter Valley "coal chain".

Over the past two years a number of initiatives have been taken to address industry-wide issues as well as specific problem areas. A significant feature of the Government's approach has, and will continue to be, the use of consultation between all major parties in the industry principally through the operation of the Australian Coal Consultative Council.

Competitiveness of the Australian coal industry

D.W. Barnett, Macquarie University

Production and exports of Australian black coal in 1984 were, yet again at record levels. Australia is now the leading coal exporter. Mine productivity is also at record levels. Why then are coal executives complaining about the 'acute problems' facing the Australian coal industry?

The problem is that over the past few years Australia has lost much of its competitive advantage. The most recent build-up in production reflects decisions made in rosier times. Over the period 1981 to 1983 rail freight charges in NSW increased by 65 percent and those in Queensland increased by 50 percent. Port and labour costs also increased sharply. In contrast the cost levels of Australia's overseas competitors increased much more slowly.

By early 1982 it was apparent that Australia's cost levels were rapidly becoming excessive but it was not until 1984 that Government acknowledged this and lowered some of its charges. By then, however the international market place had turned down drastically and the profitability of Australia's coal exporters had all but vanished.

In mid 1984 cost levels, Australia's steam coal costs were clearly more expensive than those of South Africa. Alaska could also be a formidable opponent for Australia. The remainder of the USA and Canadian steam coal producers were considerably more costly. In terms of hard coking coal Australia was still the lowest cost exporter. Industrial stoppages, however were largely negating the remaining cost advantages.

The recent devaluation of the Australian dollar, if it persists, will help Australia's exporters. However South Africa remains the lowest cost supplier of steam and soft coking coal.

1984 and Beyond - The Australian Coal Industry, A View from Within

R. Marshall, MIM Holdings

Production Most of the continuing increase in raw coal production in the last 20 years has resulted from additional production from open cut mines. In 1983/84 production from underground sources fell. Productivity as measured by output per man employed has risen. The outlook for the next year is for increased production as new open cut projects are brought fully on stream. In the medium term, a continuing increase is not at all certain.

Costs Our major costs have shifted in our new projects from labour and operating to interest on loans and capital redemption. The probable trend in the short and medium term will be expansion of existing mines rather than major new ones.

Capital Depressed returns have caused deferment of further developments and have also discouraged new entrants to the business. With the lag between deciding to progress new projects and actually spending, it is certain the rate of capital expenditure will further decline over the next few years.

Industrial Relations There has been a marked improvement in the industrial relations within the industry since the collapse of the so-called "resources boom". Expectations, which were greatly inflated at that time, have returned to more realistic levels. Our Achilles Heel is the chain from the mines to the ports.

Markets The domestic market for coal has been flat for the past 4 years. The export market for steaming coal has been the area of major growth. Any substantial increase in price will depend on the mopping up of surplus capacity, particularly in the US, and on sustained demand in that country.

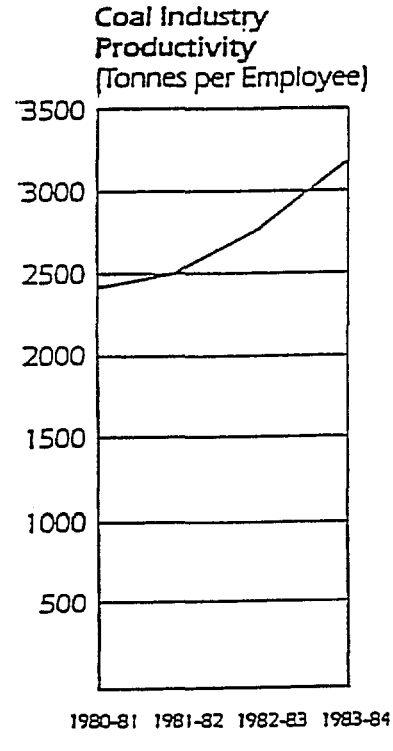
Company Reorganisation and Rationalisation In the last 3 years mines have closed and companies have reduced wages and staff employees. There will be a trend towards planning on a shorter time frame and dispensing with support facilities that are not absolutely essential.

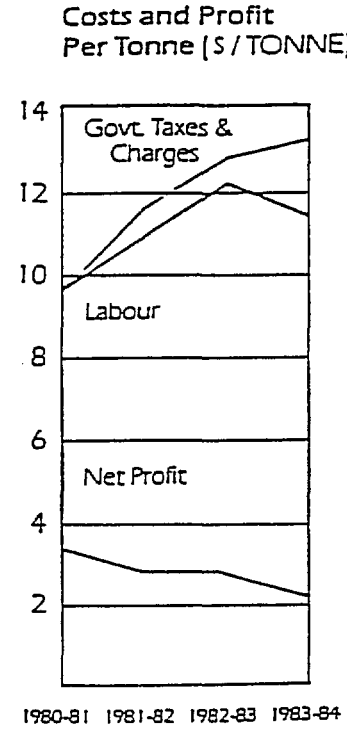
Exchange Rates A major difference in environment occured in the Industry with the floating of the Australian dollar. So far the effect has been positive but not as great in nett terms as has been reported in the media. As an Industry, we will have to learn to live not only with a weakening A$ but with the eventual strengthening against the US$.

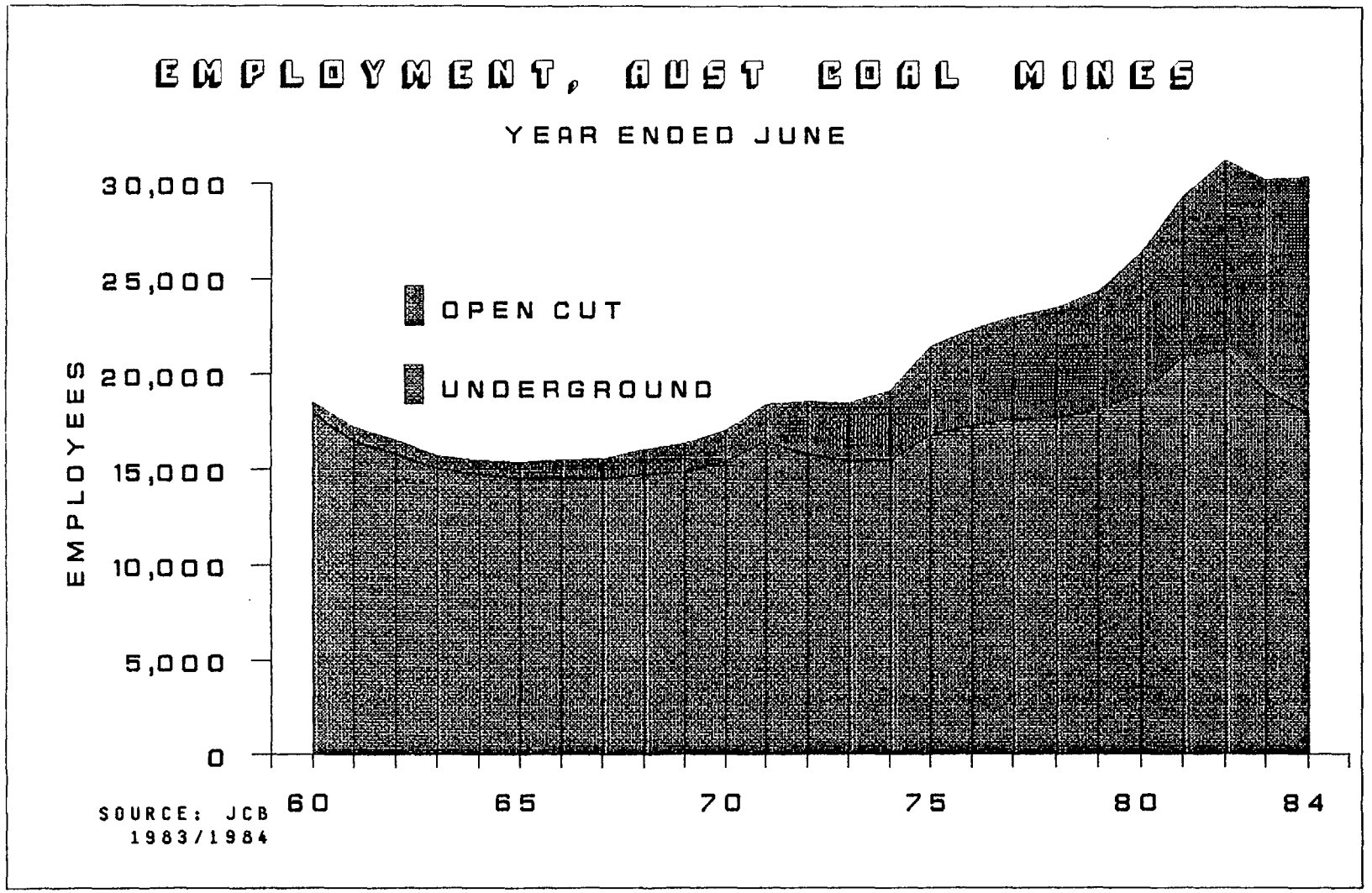
W O R L D C O A L

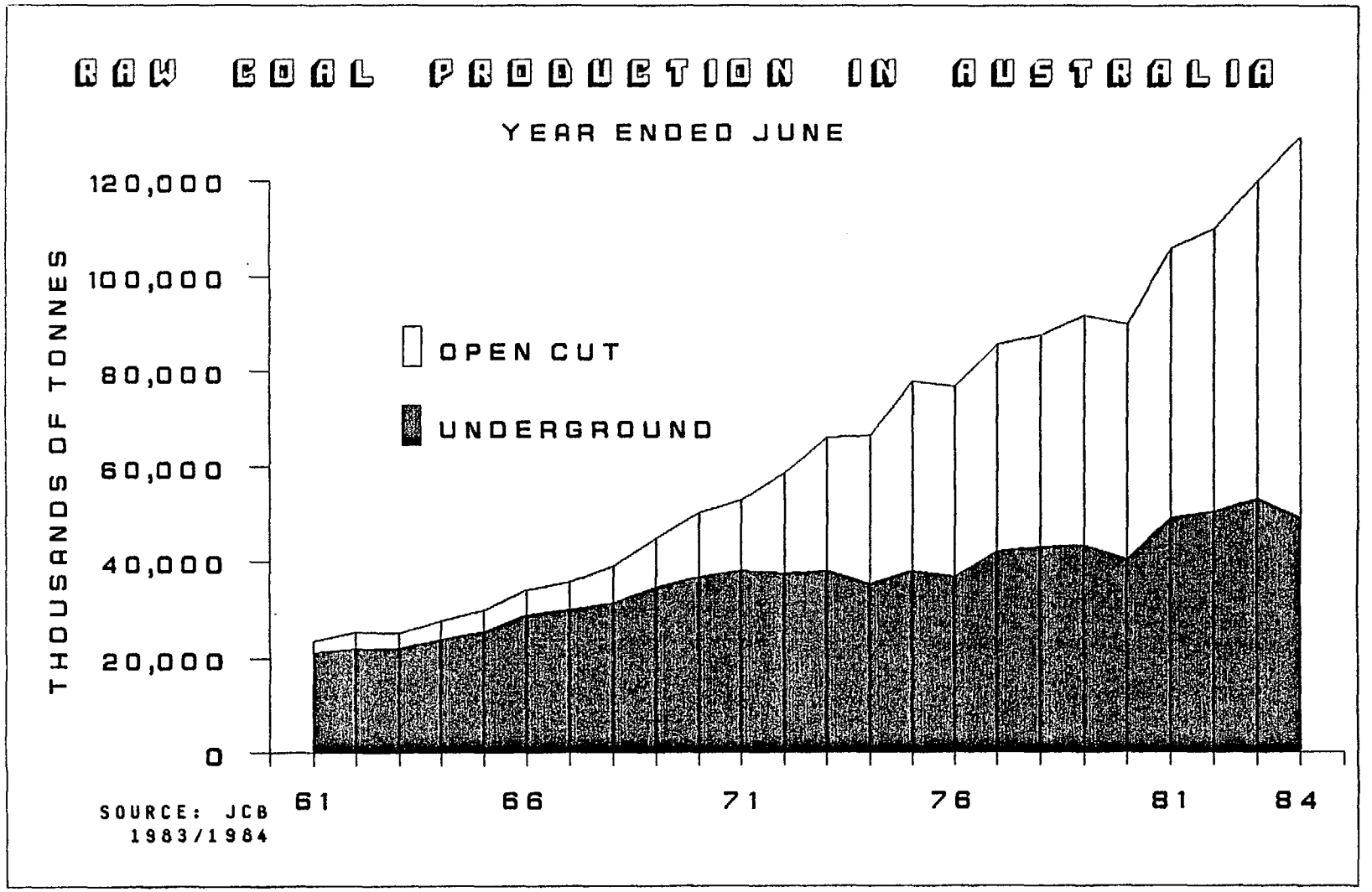
ACTUAL (MT)

YEAR	TOTAL WORLD BLACK	TOTAL WORLD BROWN	TRADE WORLD BLACK	TOTAL AUSTRALIA BLACK	TRADE AUSTRALIA BLACK
1960	1 966	655	100 (E)	22	2
1965	2 047	744	N/A	30	7
1970	2 164	792	171	45	18
1971	2 140	804	150	44	21
1972	2 167	808	161	55	24
1973	2 212	826	173	56	28
1974	2 249	843	184	58	29
1975	2 366	866	188	61	30
1976	2 420	895	189	68	34
1977	2 498	902	195	71	36
1978	2 543	920	212	72	39
1979	2 688	939	238	75	40
1980	2 740	960	258	77	43
1981	2 789	1 021	271	92	51
1982	2 866	1 054	269	98	50
1983	2 897	1 061	260	99	61
1984					






EMPLOYMENT, AUST COAL MINES
YEAR ENDED JUNE
EMPLOYEES
30,000
25,000
20,000
15,000
10,000
5,000
0
OPEN CUT
UNDERGROUND
60
65
70
75
80
84
SOURCE: JCB
1983/1984


RAW COAL PRODUCTION IN AUSTRALIA
YEAR ENDED JUNE
THOUSANDS OF TONNES
120,000
100,000
80,000
60,000
40,000
20,000
0
OPEN CUT
UNDERGROUND
61
66
71
76
81
84
SOURCE: JCB
1983/1984

CAPITAL EXPENDITURE IN MINERALS (1979/80 $ MILLION)

(EXCLUDES OIL, GAS AND BROWN COAL)

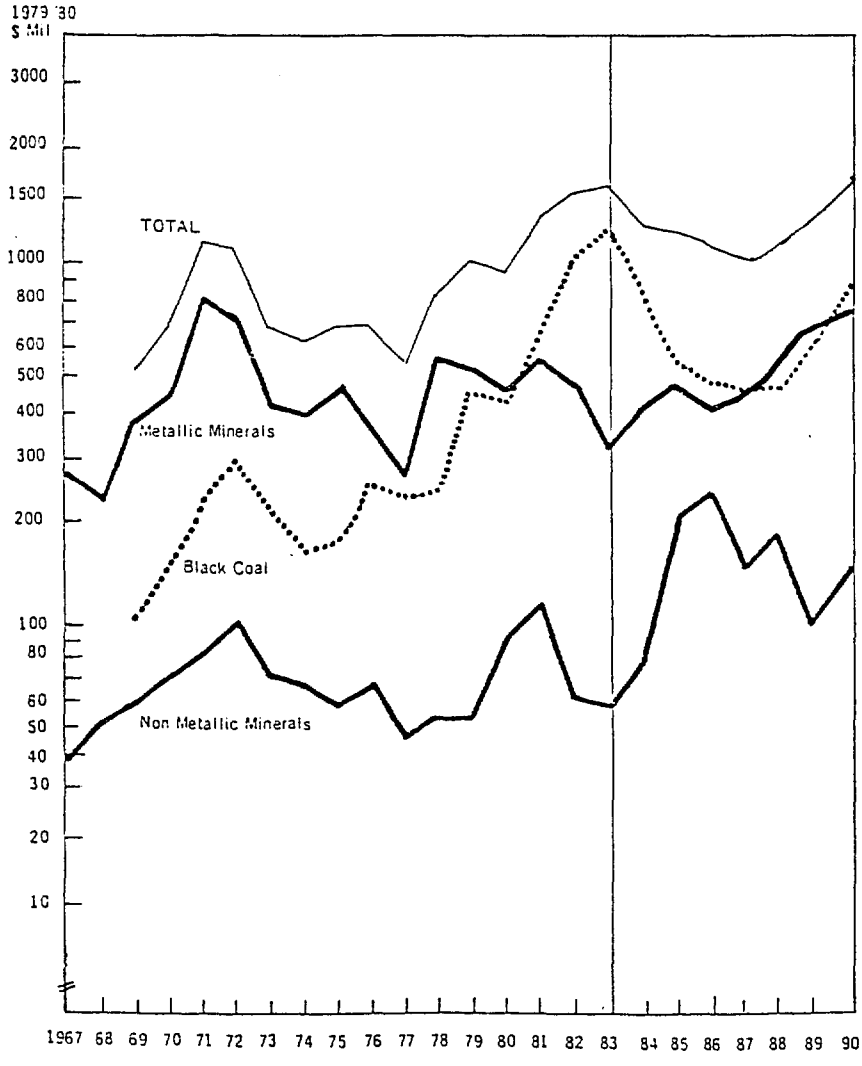


TABLE OF EXCHANGE

EXCHANGE RATE FLUCTUATIONS AFFECT:

- COSTS OF IMPORTED GOODS AND SERVICES
- PRICES OF PRODUCTS
- INTEREST PAYABLE ON OFFSHORE LOANS
- REDEMPTION OF CAPITAL PAYMENTS IN CURRENCIES OTHER THAN $A
- ABILITY OF CUSTOMERS TO PAY
- ACCURACY OF FORWARD BUDGETTING
- DECISIONS ON FORWARD COVER

Australian mineral industry overview

J. Ward, BMR

The international mineral industry reacted to improved industrial activity in 1984 and world metal consumption improved markedly. However, while the level of producer stocks was reduced substantially, 1984 average metal prices tended to be below 1983 levels, and where prices did increase such increases were the result more of parity changes in the value of US dollar rather than any substained improvement in the supply/demand position. Against this backdrop activity in the Australian mineral industry which had tended to level off in 1983 expanded with renewed strength in 1984 to set new records in both production and exports. Ex-mine value of production increased to $12.2 billion ($10.2 billion in 1983) with major increases in output of bauxite, black coal, manganese, gold, iron ore, petroleum (both crude oil and natural gas), uranium and mineral sands. While the mineral processing section operated generally at 1983 levels aluminium production almost doubled to 3/4 Mt as additional potlines were commissioned and full capacity was utilised at other smelters.

Assisted to no small extent by higher f.o.b. values resulting from a weaker Australian dollar, exports of mineral primary products increased to a record $11.3 billion ($9.7 billion in 1983). Exports of black coal increased to $4 billion and, with exports by the aluminium and iron ore sectors, were responsible for about two-thirds of total mineral export revenue. Imports of crude oil were held at 1983 reduced levels and balance of trade in minerals was a favourable $9.1 billion.

The industry enters 1985 with potential for further expansion tempered by some serious challenges. Major mining developments in gold and diamonds are in hand and aluminium smelting is to be further expanded. There is a resurgence in the steel and ferro-alloy sectors, the base metal industries are being integrated and rationalised, additional processing in the mineral sand industry is planned or underway. Improved markets for non-ferrous metals particularly zinc, nickel and copper combined with an upturn in world steel augur well for our export oriented industry. Nevertheless, unused production capacity remains available for the more important metals and world markets are becoming increasingly competitive so that our share will depend to a large extent on the ability of our mining industry to hold costs at competitive levels, and on parity changes in the Australian dollar over which the mining industry has little control.

In the longer term, profitability within the mineral industry will depend on the introduction of high technology and associated down-stream processing as well as on the discovery and development of new relatively high-grade, strategically-located mineral deposits. In this regard the downward trend in private expenditure on mineral exploration must therefore be viewed with considerable concern.

TABLE 1. MINE PRODUCTION OF PRINCIPAL MINERALS : AUSTRALIA

Mineral	Unit of Quantity	1981	1982	1983	1984(a)
Bauxite	'000t	25 441	23 625	24 550	34 500
Black Coal (b)	'000t	110 945	119 015	120 493	140 500
Brown Coal	'000t	32 959	37 821	34 191	33 500
Copper (d)	t	231 339	245 322	261 476	236 340
Gold (d)	kg	18 374	26 961	30 591	37 300
Ilmenite cons (f)	'000t	1 321	1 149	893	1 098
Iron ore and cons (g)	'000t	84 661	87 694	71 038	90 000
Lead (d)	t	388 122	455 338	480 626	445 499
Manganese ore, metallurgical	'000t	1 441	1 123	1 370	1 717
Nickel (d)	t	74 355	87 552	76 625	75 500
Petroleum					
Crude Oil	'000m^3	21 704	20 652	24 083	28 906
Natural Gas	mil m^3	11 268	11 594	11 914	12 634
Phosphate rock	t	21 997	211 463	4 868	10 000
Rutile cons	t	230 817	220 697	163 374	181 204
Silver (d)	t	743 557	906 863	(h)1 032 895	(h)926 000
Tin (d)	t	12 267	12 126	(j) 9 275	9 300
Tungsten cons (65% WO_3)	t	6 823	5 079	3 670	3 290
Uranium (U_3O_8)	t	3 446	5 215	3 786	5 177
Zinc (d)	t	518 297	664 800	699 032	666 553
Zircon cons	t	434 246	462 476	382 005	444 000

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

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

Mineral	Unit of Quantity	1981	1982	1983	1984(a)
Alumina	'000t	7 079	6 631	7 231	8 433
Aluminium	t	379 427	380 796	478 190	757 798
Copper - Blister	t	172 181	175 536	173 620	181 642
Refined	t	164 241	160 195	165 492	171 705
Gold	kg	14 991	25 711	29 646	37 003
Lead - In bullion for export	t	162 564	181 592	182 594	183 970
Refined (b)	t	207 669	218 812	196 335	196 189
Pig iron	'000t	6 830	5 956	5 045	5 328
Raw steel (d)	'000t	7 635	6 371	5 625	6 210
Silver (d)	kg	373 101	348 019	307 328	276 050
Tin	t	4 286	3 105	2 913	2 941
Zinc	t	295 852	291 390	298 518	302 062

(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	1982 Quantity	1982 Value f.o.b. ($'000)	1983 Quantity	1983 Value f.o.b. ($'000)	1984(a) Quantity	1984(a) Value f.o.b. ($'000)
Principal Exports							
Alumina	'000t	5 951	1 103 255	6 378	1 184 906	6 861	1 287 297
Aluminium (ingot metal)	t	156 068	168 253	234 562	332 724	330 848	518 583
Coal (black)	'000t	46 695	2 524 973	61 466	3 345 575	76 227	3 908 412
Copper (d)	t	115 664	156 272	157 844	274 859	151 270	224 566
Gold (b)(d)	kg	13 076	135 844	20 635	270 018	33 375	418 108
Ilmenite concentrates (f)	t	893 333	25 188	826 209	24 711	1 203 945	40 921
Iron ore and pellets	'000t	72 711	1 432 005	74 039	1 573 255	82 904	1 562 282
Iron, Ingot steel, ferro-alloys	'000t	355	58 581	903	126 410	411	81 271
LPG	'000t	1 367	327 970	1 453	428 448	1 662	432 412
Lead (b)(d)	t	412 655	336 141	409 732	383 291	397 879	348 479
Nickel(d)	t	n.a.	391 940	n.a.	320 787	n.a.	385 239
Oil Crude (h)	'000m^3	97	17 738	151	32 063	2 528	513 707
Rutile concentrates	t	199 296	50 875	217 662	53 955	189 201	57 245
Salt, bulk	'000t	4 143	54 798	4 534	68 842	3 855	77 239
Tin (b)(d)	t	7 792	92 531	6 716	119 879	6 760	86 856
Tungsten concentrates	t	4 939	35 083	3 867	20 289	3 151	18 941
Uranium and Thorium	t	5 459	415 047	3 273	296 008	3 308	312 079
Zinc (b)(d)	t	533 716	325 345	634 870	387 086	638 766	472 353
Zircon concentrates	t	405 215	43 064	379 975	44 745	440 057	54 703
Other minerals	-	-	(g) 308 887	-	(g) 440 716	-	(g) 449 882
Total	-		(g)8 003 791		(g)9 728 567		11 250 575
Principal Imports							
Aluminium	t	13 922	18 221	5 225	8 191	730	1 912
Asbestos, all types	t	20 853	15 186	10 113	8 776	14 433	
Clays, all types	t	68 105	6 872	40 397	5 133	64 042	8 656
Diamonds, gems	m.c.	75 801	32 588	71 981	31 480	97 142	36 061
Diamonds, industrial	m.c.	1 024 470	4 910	1 120 405	4 162	1 465 576	5 335
Gold (b)	kg	2 231	15 396	3 161	27 946	3 518	38 670
Ingot steel, ferro-alloys	t	18 739	15 753	17 290	13 197	36 423	26 413
Nickel - matte, metal	t	1 338	7 796	356	1 957	1 133	5 898
Oil crude (h)	'000m^3	13 857	2 808 080	8 764	1 780 356	8 414	1 677 158
Phosphate rock	'000t	1 975	102 676	2 198	113 573	1 606	82 095
Potassium fertilisers	t	236 471	23 826	197 244	20 064	259 628	28 158
Sulphur, elemental	t	459 934	39 038	392 581	32 930	470 795	39 642
Other	-	-	53 292	-	53 529	-	62 184
Total	-		3 143 634		2 101 294		2 024 327

(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; (d) The values shown include the value of ore and concentrate, intermediate products and refined metal; (e) Estimate; (f) Includes leuxocene; (g) Excludes beneficiated ilmenite; (h) Including enriched crude and other refinery feed stock.

Mineral industry financial performance and outlook

B.J. Davies, Coopers & Lybrand

This paper looks at the financial performance of the minerals industry in 1983/84 and glimpses at 1984/85 through the eyes of its many stakeholders.

Consumers benefit from lower prices With over-supply conditions generally prevailing, prices of most metals and minerals remained depressed in 1983/84.

Lenders slow up their provision of funds The increase in outstanding borrowings by the industry slowed in 1983/84. Nevertheless of the $25 billion of assets reported at year end, lenders had funded just over $10 billion, and called upon the industry to generate enough cash from profits to pay interest of $746 million.

Investors still await adequate returns Over the past three years the industry overall has recorded returns on average shareholders funds employed of 2.2%, 4.1%, and 4.4%, which are clearly far from satisfactory rates. Unless returns improve there will be obvious reluctance to invest in the minerals industry, given its perceived risk profile.

Employees see their numbers fall Doubts about continued employment and the adverse effect of redundancies hovered over parts of the industry throughout the year.

Governments continue to receive substantial benefits In 1983/84 Governments received 16 cents of every dollar of revenue of the minerals industry. By contrast profits of the companies in the industry accounted for only 4 cents of each revenue dollar.

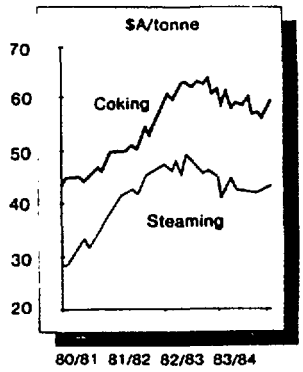
Suppliers see much less demand for their products In 1983/84 the industry completed many projects that have been in the development stage for a number of years. So despite higher payments to suppliers for ongoing operations, future demand for capital items is expected to fall dramatically from the 1983/84 level which was in turn substantially lower than in 1982/83.

Management - tough times behind and ahead Given the last few years of poor profitability increasing pressures are being placed on management to trim costs and seek out new markets for their products.

Looking ahead Ahead, little change is forecast for 1985 either in prices or employment. Obviously, continued pressure will be exerted on costs, employment and Government related costs as well as supplier costs.

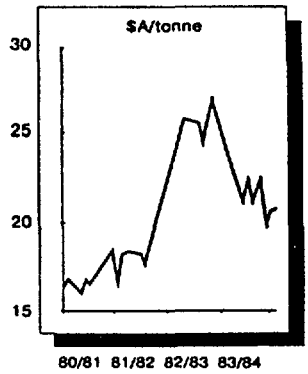
Metal and mineral prices

Coal



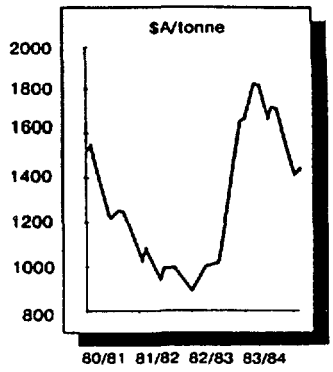
Year ended June

Iron Ore



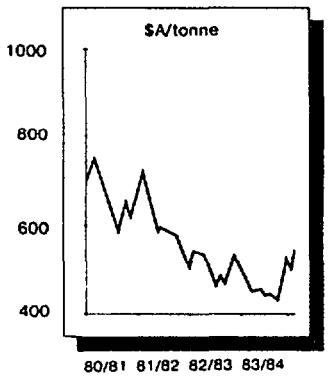
Year ended June

Aluminium LME



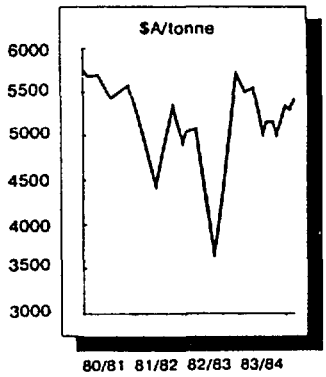
Year ended June

Lead LME



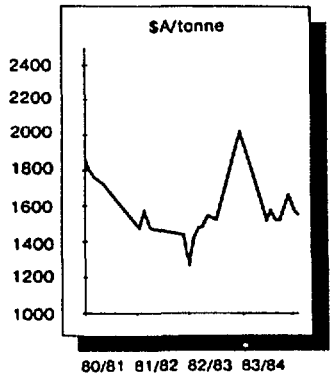
Year ended June

Nickel LME



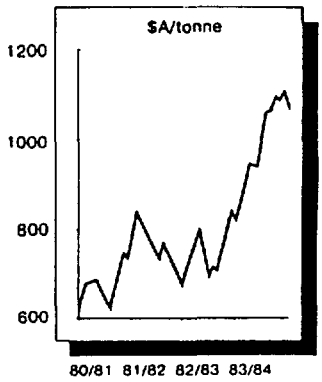
Year ended June

Copper LME



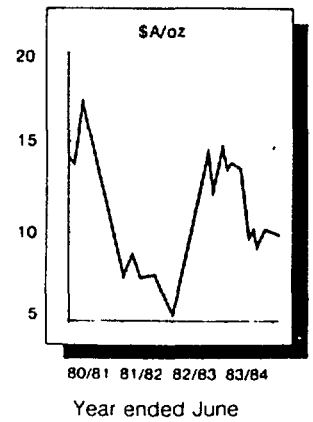
Year ended June

Zinc LME



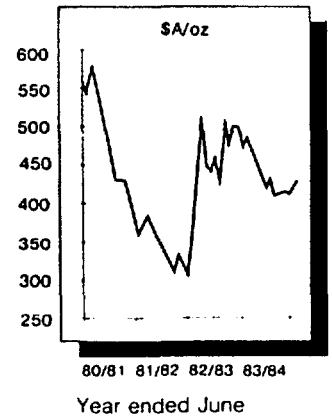
Year ended June

Silver London Spot



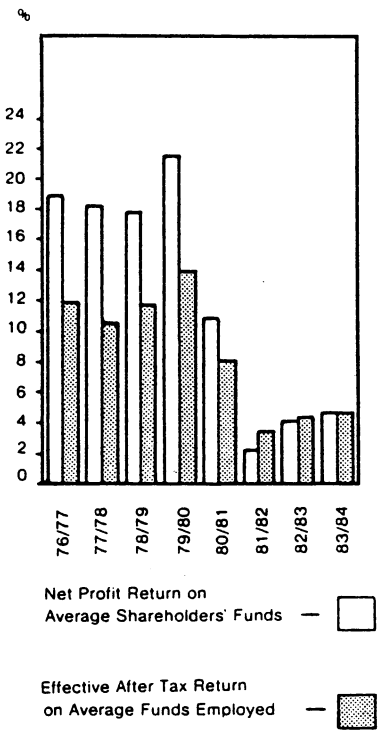
Year ended June

Gold London Spot

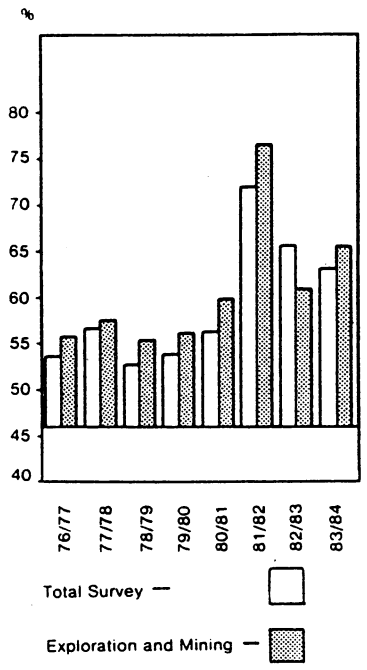


Year ended June

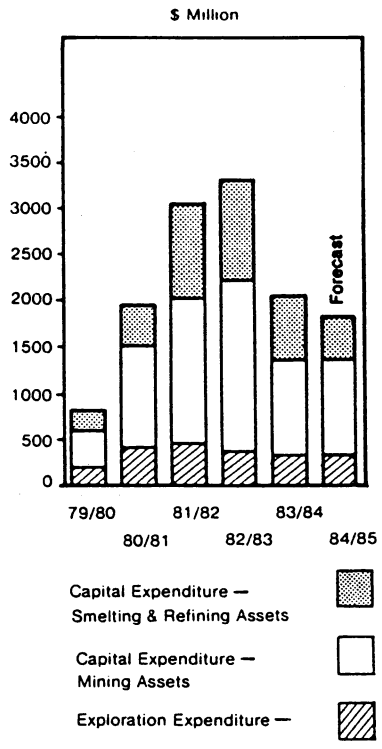
Rates of Return



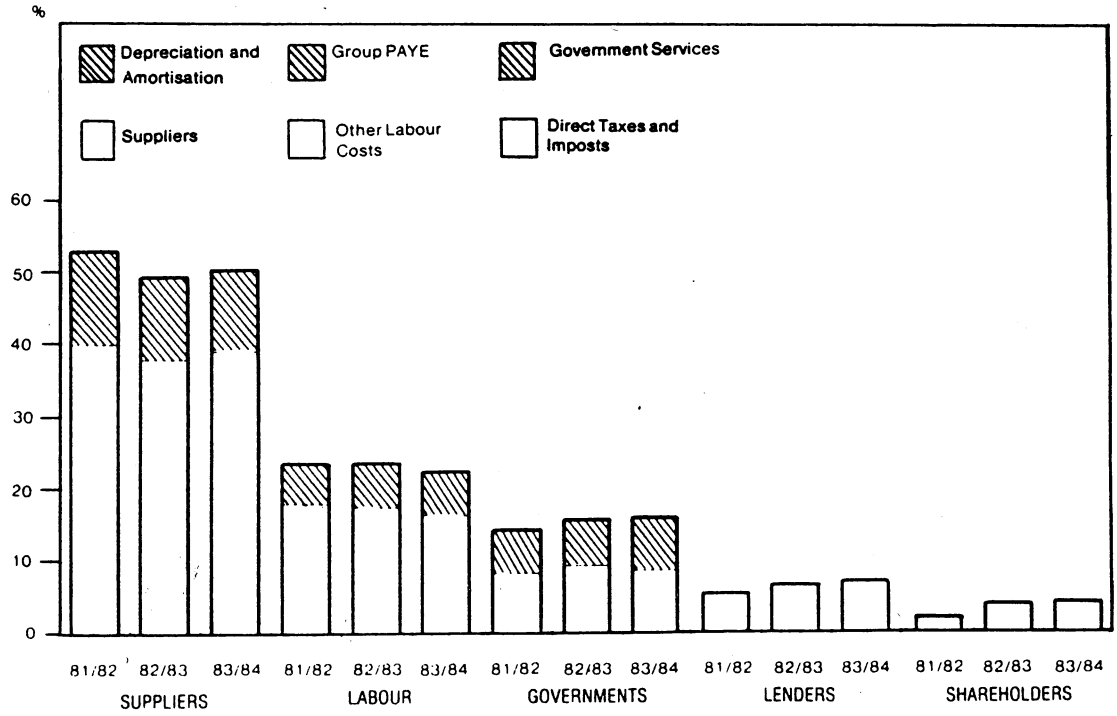
Resource Based Taxes and Income Taxes as a Percentage of Operating Profit Before Deducting Resource Based Taxes



Capital and Exploration Expenditure, and 1984/85 Forecasts



DISTRIBUTION OF TOTAL REVENUE



Australian Mining Industry Council

Minerals Industry Survey Highlights

Items of Interest	1981/2	1982/3	1983/4
Operating revenue ($ million)	8,454	9,874	10,735
Total assets at year end ($ million)	19,760	23,579	25,391
Borrowings at year end ($ million)	7,431	9,639	10,395
Interest expense ($ million)	470	644	746
Net profit ($ million)	177	381	461
Net profit return on average shareholders' funds (%)	2.2	4.1	4.4
Effective after tax return on average funds employed (%)	3.4	4.3	4.4
Effective after tax return on average assets employed (%)	2.8	3.6	3.7
Direct taxes on pre-impost profit (%)	72.0	65.6	63.0
Expenditure on fixed assets ($ million)	3,316	3,315	2,049
Exploration expenditure ($ million)	463	343	287
Employees at year end	81,083	78,765	78,816
Debt to equity ratio	0.83	0.97	0.96
No. of responses received	130	123	120

Forecasts

	1983/4 (Actual)	1984/5 (Forecast)	Percentage Change
Expenditure on fixed assets ($ million)	2,049	1,824	-11.0
Exploration expenditure ($ million)	287	275	- 4.2
Employees at year end	78,816	78,080	- 0.9

Note: Figures quoted herein have been extracted from a Minerals Industry Survey conducted by Coopers & Lybrand on behalf of the Australian Mining Industry Council.

Gold - target for exploration

R.G. Dodson, BMR

During the past four years expenditure on exploration for gold in Australia has risen from 16% of the total private exploration budget to an estimated 36% in 1984. Production of gold for the same period increased from 18.7 t to an estimated 34.5 t. Projections for the next four years indicate a continuation of both trends. The reasons for the increased exploration for gold at the expense of other minerals are:

Price In the late 1970s the price of gold soared, reaching a maximum of $843 on the London market in 1980. This price rise triggered an increased interest in gold throughout the world. During the past four years the London gold price dropped to the closing price of 1984 of US$308 but in most currencies the drop was less severe; in Australian currency the price declined to $374 during this period and in 1985 appears to have steadied at the $400 level. Most Australian miners are able to contain operating costs below this price range.

Demand The demand for gold differs from most other mineral commodities because over 80% of the annual production is acquired for investment or speculative purposes rather than for industry. Consequently, demand is governed by a perceived need to store gold in some form or another by governments, financial institutions, or by individuals, particularly in countries with a high inflation rate. Total world production until 1983 is estimated to be about 93 000 t, of which about 90% is still available so that fluctuations in annual production have little effect on supply.

Exploration The success of exploration for gold in Australia has been greatly enhanced by accumulated knowledge of the geological environments of Australian gold deposits; new exploration concepts, particularly for small to medium deposits amenable to open-cut mining; advances in geophysics technology; and improved geochemical exploration methods. Because exploration has met with a comparatively high success rate, as opposed to grass roots exploration for other commodities, it is considered a more suitable expenditure of exploration funds.

Mining Methods Improved mining methods have resulted in increased efficiency in gold production. In 1930 mining capacity in Western Australia was 200 t/man-year. By 1980 this figure had improved to 1155 t/man-year and by 1983 to 1540 t/man-year. As a result, despite a lowering of average ore grade mined from 5.2 g/t in 1980 to 4.8 g/t in 1983, average production of gold increased from 175 ozs/man-year to 230 ozs/man-year.

Ore Treatment Advances in the treatment of gold by heap leaching and carbon-in-pulp methods have lowered capital and operating costs and have proved particularly suitable for small, low grade deposits.

The Argyle diamond project in a world context

T.J. Appleby, Argyle Diamond Mines

The Argyle diamond project, which is located in the Kimberley area of Western Australia, will have a significant impact on the world diamond market when mining of the AK1 pipe commences in 1986 at a production rate of 25 million carats per annum (MCA). Proven reserves are sufficient for at least 20 years. Construction is currently on time and within budget. Extraction of alluvial diamonds commenced in early 1983 at a rate of 5-6 MCA. These diamonds have been marketed overseas since April 1983, signalling the commencement of a major new export industry for Australia.

The Argyle production is unique. Whilst some diamonds are of good quality, the production has a relatively high percentage of included and brown coloured stones. The generally low average quality of Argyle diamonds is reflected in an average value of approximately one-tenth of the world average. When operating at full capacity, Argyle will increase the value of world production by around 4-5 percent. Argyle will produce a small proportion of gem quality diamonds, by weight, but will feature an unusually high proportion of cheap gem and industrial diamonds, with the ratio being 5:40:55 respectively. In 1984 world production of natural diamonds was approximately 60 million carats (MC) of which Argyle contributed 5.7 MC. No other new mines are under construction so, at full scale production, Argyle will contribute about 30% of world production of natural diamonds. Another 100 MCA of synthetic industrial diamonds are produced which substantially ameliorates the impact of Argyle on the industrial diamond market. Viewed in these terms Argyle is expected to be a significant but not disruptive influence on the world market.

The marketing and distribution structure of the diamond industry is extremely complex. The easy transportability, labour intensive processing, segmented markets and pricing mechanisms allow scope for individual entrepreneurs to participate in conjunction with or in opposition to major multi-national corporations. The diagram on page 34 emphasises the complicated nature of the industry.

The De Beers group produces around 40% of the world value of natural diamond production and markets a further 40-45% obtained under contract from various independent producers (including Russia and Australia) and by open market purchases, giving them control over about 80% of world production. De Beers plays a significant role in balancing supply and demand and introduces an

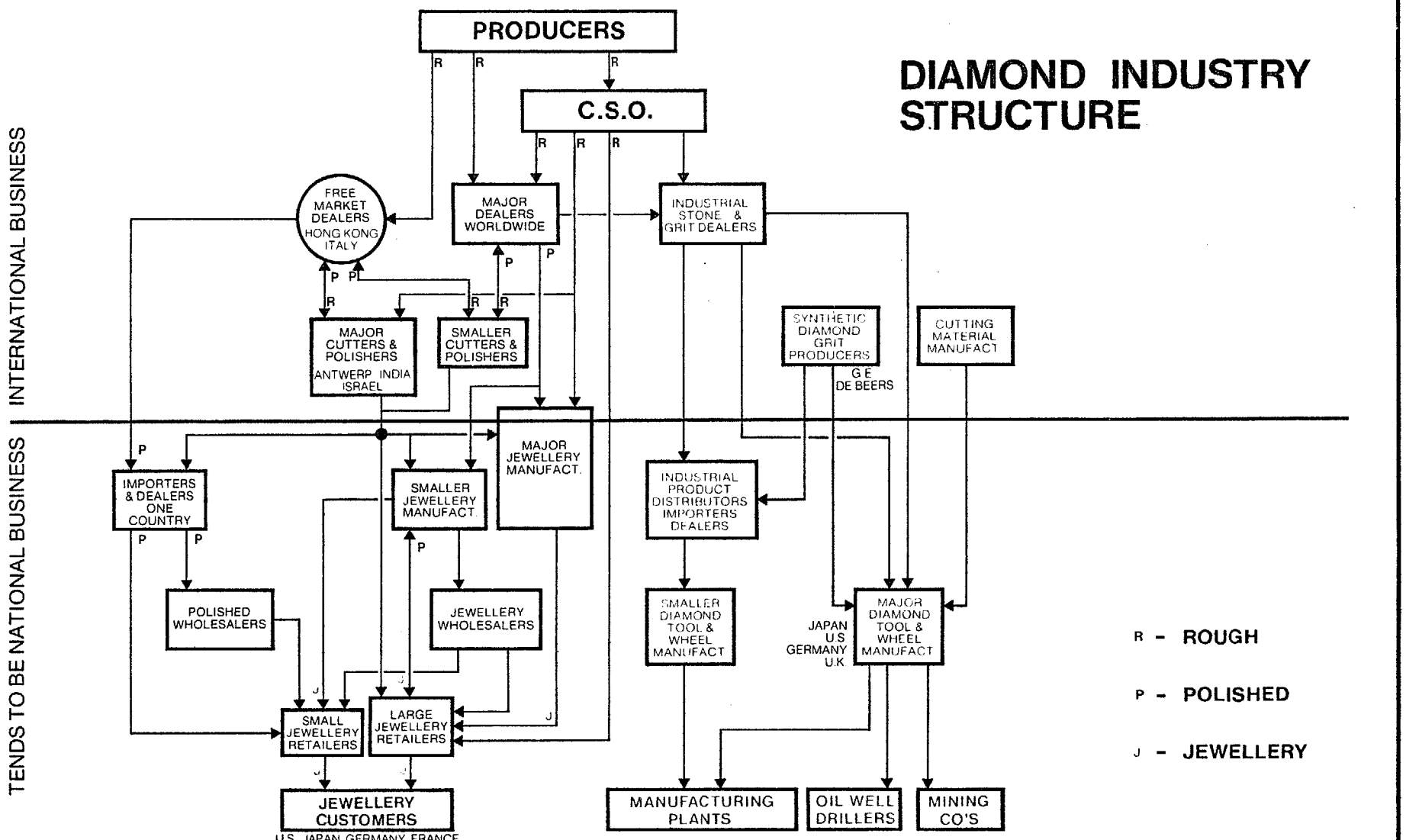
element of stability into what could otherwise be a very volatile industry. De Beers is also a major participant in the synthetic industrial diamond market, although General Electric is of equivalent stature, introducing a major element of competition.

The Argyle project is operated as a joint venture between the CRA Group (56.8%), the Ashton Mining Group (38.29%) and West Australian Trustees Limited (5%). The latter market their own production separately. CRA and Ashton's current marketing arrangements provide for 100% of gem quality rough diamonds (except for a small proportion retained for cutting and polishing in Western Australia) and 75% of cheap gem and industrial rough diamonds to be sold to a member of the De Beers group. The remainder will be sold to Argyle Diamond Sales Limited which will sell rough and polished diamonds from offices in Perth and Antwerp.

The diamonds produced at the mine are cleaned and forwarded to Perth for sorting, according to size, shape, purity and colour, into a large number of classifications known as the London Selling Assortment which sets the relationship between price in US dollars and quality, for all producers. De Beers attempts to set the relationship to match long-term demand and supply and changes are only made when fundamental market shifts occur. Short term factors are addressed by adjusting supply.

The major processing centres for gem and cheap gem diamonds are Antwerp, Tel Aviv, New York and Bombay/Surat with the latter specialising in cheap-gems because of low labour costs which allows economical processing of cheaper diamonds. Consequently, India will be an important processing centre for Argyle diamonds. A small cutting & polishing facility has been established in Perth to determine the economic and technical feasibility of processing better quality Argyle diamonds in Australia.

The Australian market for diamonds is relatively small with consumption of diamond jewellery estimated at $150 million compared with world consumption of $20 billion. Consumption of industrial diamonds, not already incorporated into imported diamond tools, is in the order of 1MCA compared with world wide consumption of 120 MCA (natural and synthetic). Consequently, Australia's new diamond industry will be heavily dependent on the international diamond market for its future viability.


DIAMOND INDUSTRY STRUCTURE
PRODUCERS
C.S.O.
FREE MARKET DEALERS HONG KONG ITALY
MAJOR DEALERS WORLDWIDE
INDUSTRIAL STONE & GRIT DEALERS
MAJOR CUTTERS & POLISHERS ANTWERP INDIA ISRAEL
SMALLER CUTTERS & POLISHERS
SYNTHETIC DIAMOND GRIT PRODUCERS
G E DE BEERS
CUTTING MATERIAL MANUFACT
INTERNATIONAL BUSINESS
TENDS TO BE NATIONAL BUSINESS
IMPORTERS & DEALERS ONE COUNTRY
SMALLER JEWELLERY MANUFACT.
MAJOR JEWELLERY MANUFACT.
INDUSTRIAL PRODUCT DISTRIBUTORS IMPORTERS DEALERS
POLISHED WHOLESALERS
JEWELLERY WHOLESALERS
SMALLER DIAMOND TOOL & WHEEL MANUFACT
JAPAN U.S GERMANY U.K
MAJOR DIAMOND TOOL & WHEEL MANUFACT
SMALL JEWELLERY RETAILERS
LARGE JEWELLERY RETAILERS
JEWELLERY CUSTOMERS
U.S. JAPAN GERMANY FRANCE
MANUFACTURING PLANTS
OIL WELL DRILLERS
MINING CO'S
R - ROUGH
P - POLISHED
J - JEWELLERY

37

Industrial minerals - recent developments and outlook

A. Driessen, BMR

Industrial minerals (in the main non-metallic, non-fuel minerals; see next page) as a whole, have responded well to the economic recovery of the past 18 months and exports were appreciably higher in 1984 than they were in 1982. The most prominent performers were the mineral sands (particularly ilmenite and zircon), talc, gypsum, diamonds, manganese, and silica sand. As well, various enterprises confirmed that opportunities also exist for exporting capital and/or expertise to industrial minerals ventures overseas; such ventures include the acquisition of cement-producing facilities in the United States, and joint venture participations in a potash project in Thailand, diamonds in West Africa, and a bleaching earth project in Malaysia.

Of the commodities presently produced mainly for domestic markets, magnesite in particular, but also diatomite, registered marked increases in mine production. The increase for magnesite stems from its new use, by Queensland Alumina, to remove organic carbon and other matter from Bayer process liquor.

The refractories industry has experienced difficult times in recent years mainly because of excess production capacity. When Morganite Australia's takeover of Kaiser Refractories and Harbison-ACI is completed, then the rationalisation of production facilities which is likely to follow will improve the industry's position. Australian Industrial Refractories remains Australia's largest producer.

Imports of high analysis fertiliser containing both nitrogen and phosphorus, both of which are now eligible for government subsidy payments, have increased about 5-fold in the last 2 years. This trend has resulted in the closure of two plants, at Kwinana in late 1982 and at Newcastle in October 1983.

Generally speaking, developments in industrial minerals over recent years show that this particular sector is fast coming of age. Several new projects, in particular the Argyle diamond mines, have come on stream thus widening the sector's base. Other projects either proceeding or being considered include Comalco's 100 000 t/year kaolin plant at Weipa and Agnew Clough's silicon smelter in Western Australia as well as proposals for increased production capacity for beneficiated ilmenite and to initiate production of rare earth oxides and zirconia. As well, rationalisation of parts of the industry (in particular refractories, but also mineral sands and gypsum) has laid the foundation for more cost-effective production. A trend towards more processing of raw materials is emerging. Company and media reports indicate a high level of exploration activity for particular commodities, particularly diamonds and sodium carbonate (trona). These and other reports of new exploration for potash all point towards sound long-term growth prospects for the industrial minerals sector.

Industrial minerals can be grouped in various ways depending on whether emphasis is placed on geological or marketing affinities. One fairly broad classification scheme used previously by BMR [1] is as follows:

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

Mineral sands - ilmenite, monazite, rutile, zircon.

Refractories - chromite, dolomite, fire clay, kyanite, magnesite, pyrophyllite, sillimanite.

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

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

Other industrials - specialties - abrasives, barite, diatomite, felspar, graphite, magnetite, mica, mineral pigments, peat, perlite.

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

(1) DRIESSEN, A., NICHOL, D., AND TOWNER, R. A perspective and historic review of industrial minerals in Australia. Abstracts, Seventh Australian Geological Convention, Sydney 1984.

Mineral sands - recent developments and outlook

R. Towner, BMR

Australia continues as the leading world producer of mineral sand concentrates. In 1984 production, as a proportion of total world output, was about 55% for rutile, 25% for ilmenite, 70% for zircon, and 60% for monazite. Only 1% of rutile, 20% of ilmenite, and 4% of zircon output is consumed locally. Currently all monazite concentrates are exported.

Australia's resources of mineral sands, prima facie, appear to be adequate to meet demand. However, the estimates include resources not presently available because of environmental considerations. Removing these resources reduces the total available for mining to 15-20 years of production at current rates.

Most operators reported increased production and sales revenues in 1984 but lower profits because of rising production costs, mainly the result of declining grades. Prices firmed to varying degrees, reflecting the diverse nature of their markets. World markets for TiO_2 pigment improved in 1984, as did other main outlets such as welding rods and titanium sponge. The improved demand and reduced inventories resulted in increased prices for rutile. In contrast, while production and exports of ilmenite also increased, ilmenite prices increased only slightly. Demand for zircon improved only slightly in 1984 and prices remained unchanged from early 1983 to the end of 1984 for standard grade material.

The health of the industry is bound up with the world's industrial activity. Indications are that economic growth will continue in the short term and the Australian mineral sands industry is expected to operate at about the same level of activity in 1985 as in 1984. With depletion of Australia's natural rutile resources, the industry is moving towards further processing, especially of ilmenite to synthetic rutile. Plans have been announced which could result in the production of a further 160 000 t of synthetic rutile by the late 1980s.

In the short term, exports of ilmenite are predicted to increase to about 1.3 Mt/year, but with further processing to synthetic rutile, the level of ilmenite exports is expected to decline after 1987. The price differential between ilmenite and synthetic rutile will increase substantially the value of exports of titanium products.

Exploration for new mineral sands deposits is continuing, especially in Western Australia and Victoria. Some companies are exploring for hard-rock titaniferous deposits, mining and treatment costs of which would be considerably higher than those for mineral sands.

Manufacture of zirconia and partially stabilised zirconia (PSZ) will require relatively small tonnages of zircon, and the level of zircon production is expected to remain at current levels in the short to medium term.

AUSTRALIAN MINERAL SANDS PRODUCTION (1984)

(Estimated)

('000 t)

Company	Location of Operations	Rutile	Ilmenite	Zircon	Monazite
Consolidated Rutile Limited	N. Stradbroke Is. Qld	50	40	45	-
Associated Minerals Consolidated Ltd	Stradbroke Is., Qld Capel, Eneabba, WA	47	140	140	2
Allied Eneabba Ltd	Eneabba, WA	38	260	155	11
Westralian Sands Ltd	Yoganup Extended, North Capel, WA	-	450	36	2
Cable Sands Ltd	Capel, WA	-	150	12	1
RZ Mines (Newcastle) Ltd	Tomago, NSW	32	15	38	-
Mineral Deposits Ltd	Bridge Hill, NSW	3	-	12	-
Currumbin Minerals	Currumbin, Qld	5	-	5	-
		175	1055	443	16

WORLD DEMONSTRATED ECONOMIC RESOURCES

	Mt		Mt
Rutile*	19	Australia	8
		Sierra Leonne	3
		South Africa	2
		India/Sri Lanka	4
		Others	2

* Excluding Brazil anatase

Ilmenite	580	Australia	40
		USA	60
		Canada	100
		Norway	100
		USSR	100
		India/Sri Lanka	30
		Finland	10
		Others	140
Zircon	36	Australia	12
		South Africa	10
		USA	6
		Others	8

RESOURCES ('000 t)

	DEMONSTRATED	
	ECONOMIC	SUBECONOMIC
Rutile	7 900	1 130
Ilmenite	39 800	6 970
Zircon	11 500	2 490
Monazite	217	103

Tin - future glut or famine

I.R. McLeod, BMR

From the late 1950s to 1979 world demand for tin exceeded production in most years, the balance being made up by sales from stockpiles. With a marked increase in the real price in the mid to late 1970s, production increased and demand fell, to the extent that the International Tin Council in 1982 imposed severe export controls on its producer members. These controls are likely to continue for several years, although the severity may be reduced. Consumption is likely to increase at less than 1%/year and with continued support of the price by the ITC, supplies will be sufficient to meet demand in the short to medium term.

Before 1982, when export controls were introduced, production was falling in Malaysia because of increasing costs and non-availability of land for mining, and in Bolivia because of increasing costs and decreasing operating efficiency; in Thailand small operators mined the richer parts of prospective dredging deposits and this will reduce future production potential from that area. Although Indonesian output could return to the pre-export control rates, aggregate production from the traditional major sources is unlikely to return to the level of the end of the 1970s. However, new sources, particularly Brazil and Canada, will more than compensate for this decrease.

In the 1970s Australia provided about 6% of world mine production. About two-thirds of this came from three deposits; economic resources at two of these are small. The proportion of production from alluvial sources will fall as grades decrease. Exploration has slackened in the last 2 to 3 years because of the uncertain outlook. Total demonstrated economic resources in operating mines have remained about the same for several years. However several undeveloped deposits, with an aggregate production potential of about 7000 t/year, are known; these are unlikely to be developed while export controls remain in force.

The increase in real prices has counteracted the effect of increasing costs, which are caused partly by decreasing grades of deposits in some countries at least. Increasing costs have been countered to some extent also by improved benefication technology, which, as well, has facilitated economic retreatment of tailings.

Higher real prices will be constrained by the possibility of substitution. Nevertheless any price increase would increase economic resources and more importantly perhaps, a price increase would open the way for wider use of technologies such as fuming processes for the treatment of metallurgically difficult ores; several undeveloped Australian deposits are in this category.

These influences combined indicate that, even with real prices at about current levels, production is likely to be adequate to meet demand in the longer term.

Australia - a world source of tantalum

J.J. Linden, Greenbushes Tin

Tantalum is a strategic metal with particular and unique physical and chemical properties that dictate its end use application in the electronics, aerospace, defence and high temperature alloy industries.

Its use as capacitors in the electronics industry account for some 50% of total demand with carbides a further 25%. The remaining consumption is in the fast growing high temperature alloy, mill products and corrosive resistant metal lining industries.

Tantalum occurs as the pentoxide (Ta_2O_5) in tantalites, columbites, struverites and tin slags ranging from a low content of a few percent Ta_2O_5 in some tin slags to as high as 60% Ta_2O_5 in some tantalites.

Annual world demand has increased from 1.8 million pounds Ta_2O_5 in ores in 1970 to more than 3.2 million pounds of Ta_2O_5 in ores in 1984. Projected growth is 4% per annum compounded due mainly to the growth in the electronics industry.

Western World production is dominated by tin slags produced as a by-product from tin smelting in Thailand and to a lesser extent Malaysia. Australia has traditionally supplied some 15% of World production and is currently the largest producer of primary tantalite concentrates. Canada has the only underground primary tantalite mine which is closed for economic reasons. Brazil and countries on the African continent produce varying amounts of tantalite and columbite.

Within Australia Greenbushes Tin Ltd is the dominant producer accounting for some 90% of all production. Greenbushes is in the process of developing an underground mining operation in the depth extension of the weathered pegmatite that has been mined for the past 15 years.

This development will increase Australia's share of the World tantalum market from the traditional 15% to approximately 30% by 1990.

Fig. 1

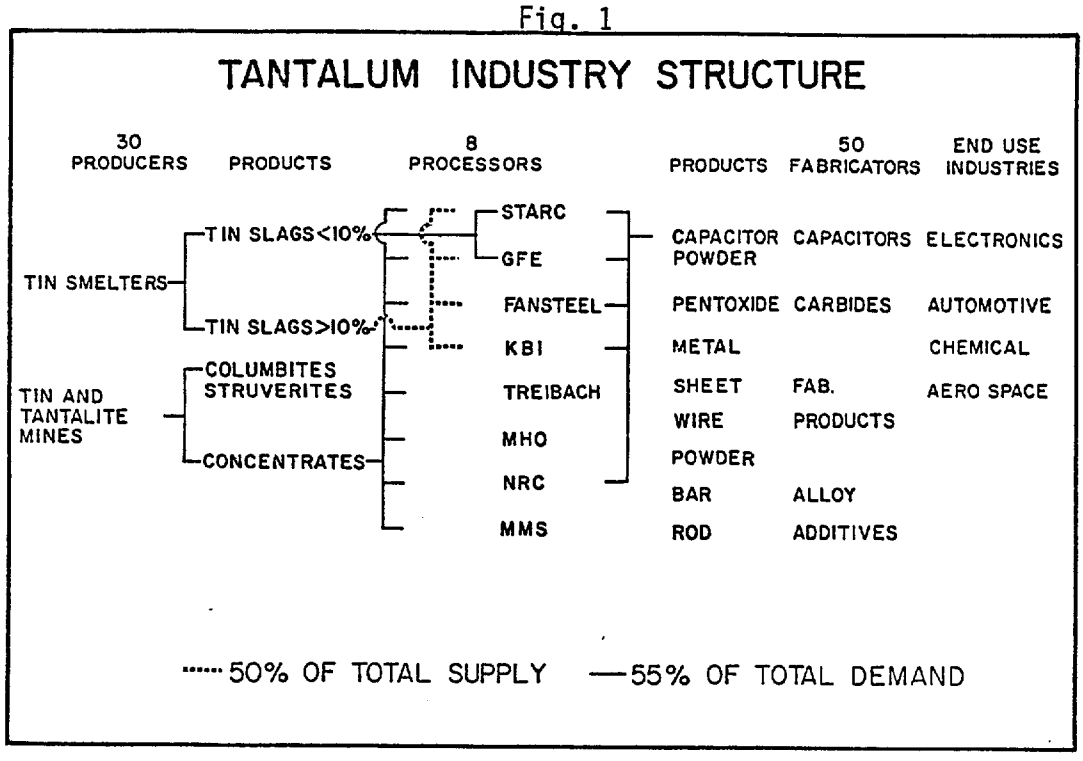
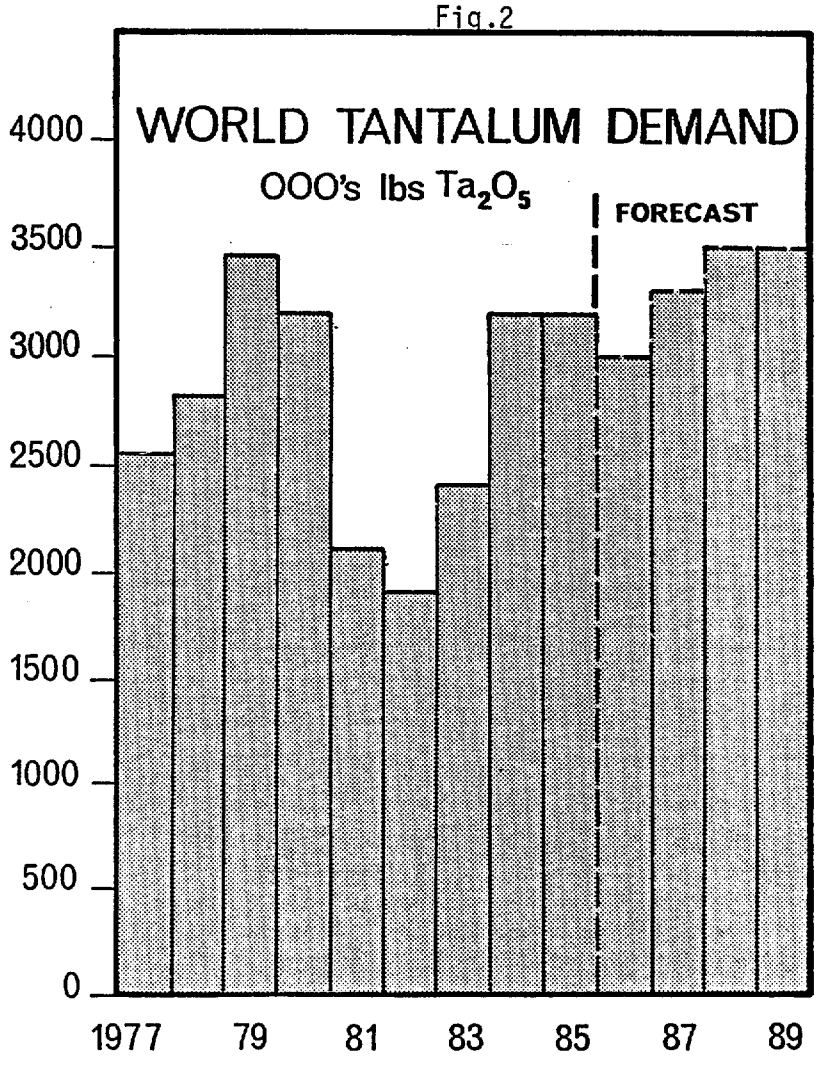

TANTALUM INDUSTRY STRUCTURE
30 PRODUCERS
PRODUCTS
8 PROCESSORS
PRODUCTS
50 FABRICATORS
END USE INDUSTRIES
TIN SMELTERS
TIN SLAGS<10%
TIN SLAGS>10%
TIN AND TANTALITE MINES
COLUMBITES
STRUVERITES
CONCENTRATES
STARC
GFE
FANSTEEL
KBI
TREIBACH
MHO
NRC
MMS
CAPACITOR POWDER
PENTOXIDE
METAL
SHEET
WIRE
POWDER
BAR
ROD
CAPACITORS
CARBIDES
FAB. PRODUCTS
ALLOY
ADDITIVES
ELECTRONICS
AUTOMOTIVE
CHEMICAL
AERO SPACE
50% OF TOTAL SUPPLY
55% OF TOTAL DEMAND

Fig.2


WORLD TANTALUM DEMAND
OOO's lbs Ta_2O_5
FORECAST
4000
3500
3000
2500
2000
1500
1000
500
0
1977
79
81
83
85
87
89

44

Fig. 3

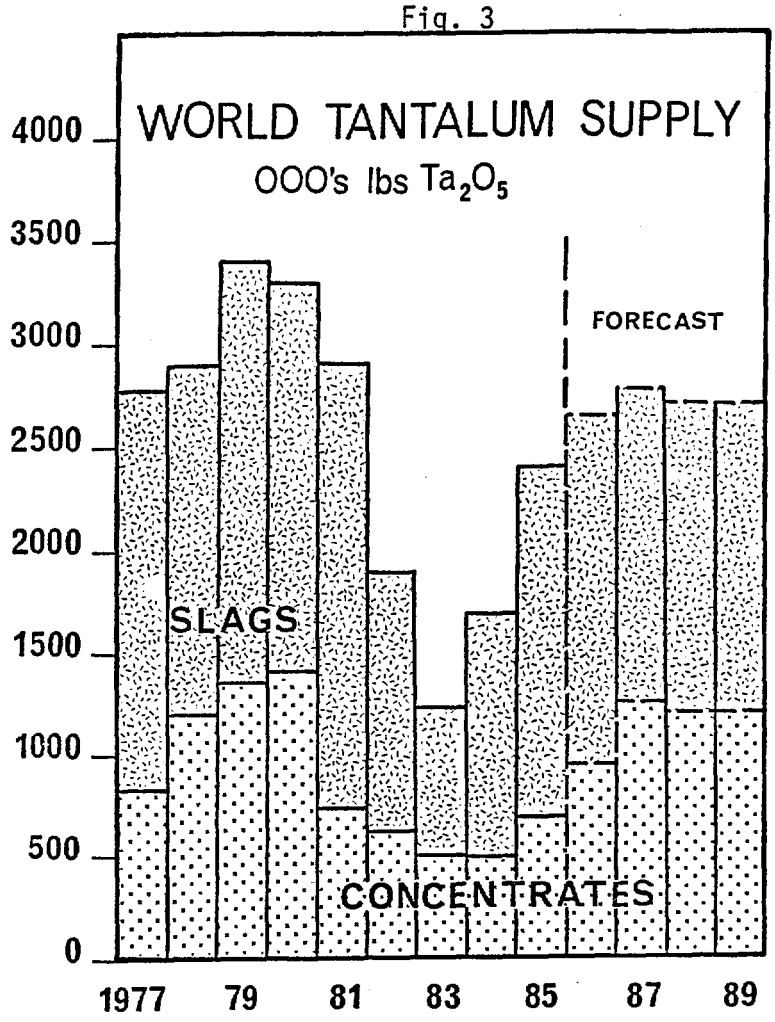
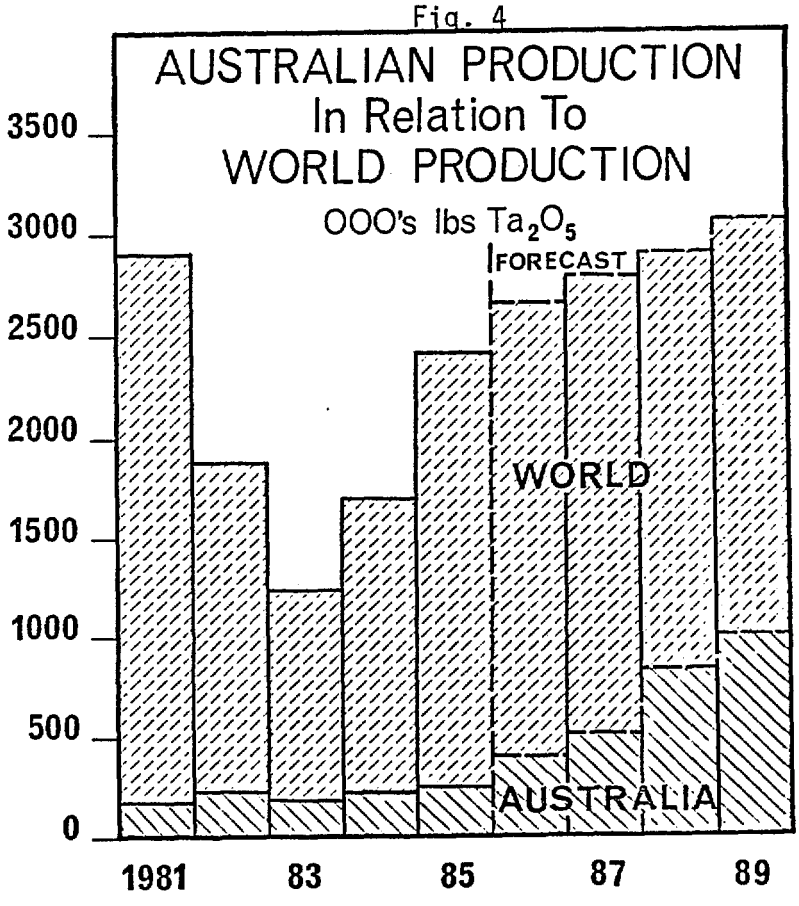

WORLD TANTALUM SUPPLY
OOO's lbs Ta_2O_5
FORECAST
SLAGS
CONCENTRATES
4000
3500
3000
2500
2000
1500
1000
500
0
1977
79
81
83
85
87
89

Fig. 4


AUSTRALIAN PRODUCTION
In Relation To
WORLD PRODUCTION
OOO's lbs Ta_2O_5
FORECAST
WORLD
AUSTRALIA
3500
3000
2500
2000
1500
1000
500
0
1981
83
85
87
89

45

Copper

D.J. Perkin, BMR

The economic recovery, led by the United States and followed by Japan and Europe at more subdued rates, resulted in stronger demand for copper in 1984. Estimated world consumption was 9.77 Mt, 7% higher than in 1983. In contrast, world refined production declined by 2% to about 9.58 Mt which resulted in a net shortfall of refined production over consumption of about 200 000 t. World stocks fell in 1984 by about 300 000 t.

World mine production however, rose in 1984 by 3% to an estimated 8.5 Mt. Western world production increased by about 3% to 6.4 Mt with the three largest producing countries, Chile, USA and Canada registering increases from 5% to 10%. Output from Peru also increased although production in Zambia, Zaire and the Philippines declined slightly.

In 1984, Australian mine production of copper declined by 10% to about 237 000 t because of partial production cuts in response to continuing depressed prices. Australia ranks seventh as a Western world copper producer and contributes about 4% to Western world output.

MIM Holdings Ltd suspended copper mining and milling operations for two weeks in April 1984 and Renison Goldfields Consolidated Ltd announced it might be forced to close the Mount Lyell mine because of continuing financial losses. In August CSR Limited sold the Mount Gunson mine to the EMAC-Gunson Partnership who continued to recover and treat remnant ore at slightly reduced rates.

Average copper prices in 1984 were lower than the historically low levels of 1983 but by the end of the year LME prices were increasing and above the price at the start of the year mainly because of an increase in demand and the relative strength of the US dollar. In the USA, the 1984 average price of 67.1 US cents/lb was 12% lower than the 1983 average price of 76.5 US cents/lb and it closed the year at a lower level than at the start at 63-65 US cents/lb.

Australian mine production should continue to decline up to about 1987 because of the expected closure of the Mount Gunson, Teutonic Bore and possibly Warrego mines as reserves are depleted. However, by 1988 Olympic Dam may have begun production at initial target rates of around 55 000 t/year copper and this new capacity, together with other possible new developments such as Scuddles at Golden Grove and Nifty in the Throssell Ranges in WA may more than offset the near term decline in production of copper.

Australia's demonstrated economic resources of copper represented about 3% of the world total at the end of 1984. These resources are more than sufficient to last beyond 2000 at expected rates of production.

Lead and zinc

M.J. Roarty, BMR

Australia is a major world producer and exporter of both lead and zinc. Production is co-product lead and zinc with one exception; the Teutonic Bore copper-zinc deposit in Western Australia; and by-product silver is a major revenue source at all mines. Mine production in Australia of both lead and zinc declined in 1984 largely because of substantial reductions in output because of industrial disputation at the two AM&S mines and the North mine at Broken Hill and at the west coast mines in Tasmania. In 1985 mine production is expected to exceed the record total of 1983 and may be maintained at this level or increase further in the medium term.

Production of refined lead and zinc has remained at the same level over the last decade and major changes are not expected in the immediate future. Domestic consumption of both lead and zinc has also remained static over the last decade but is expected to increase slightly in 1985.

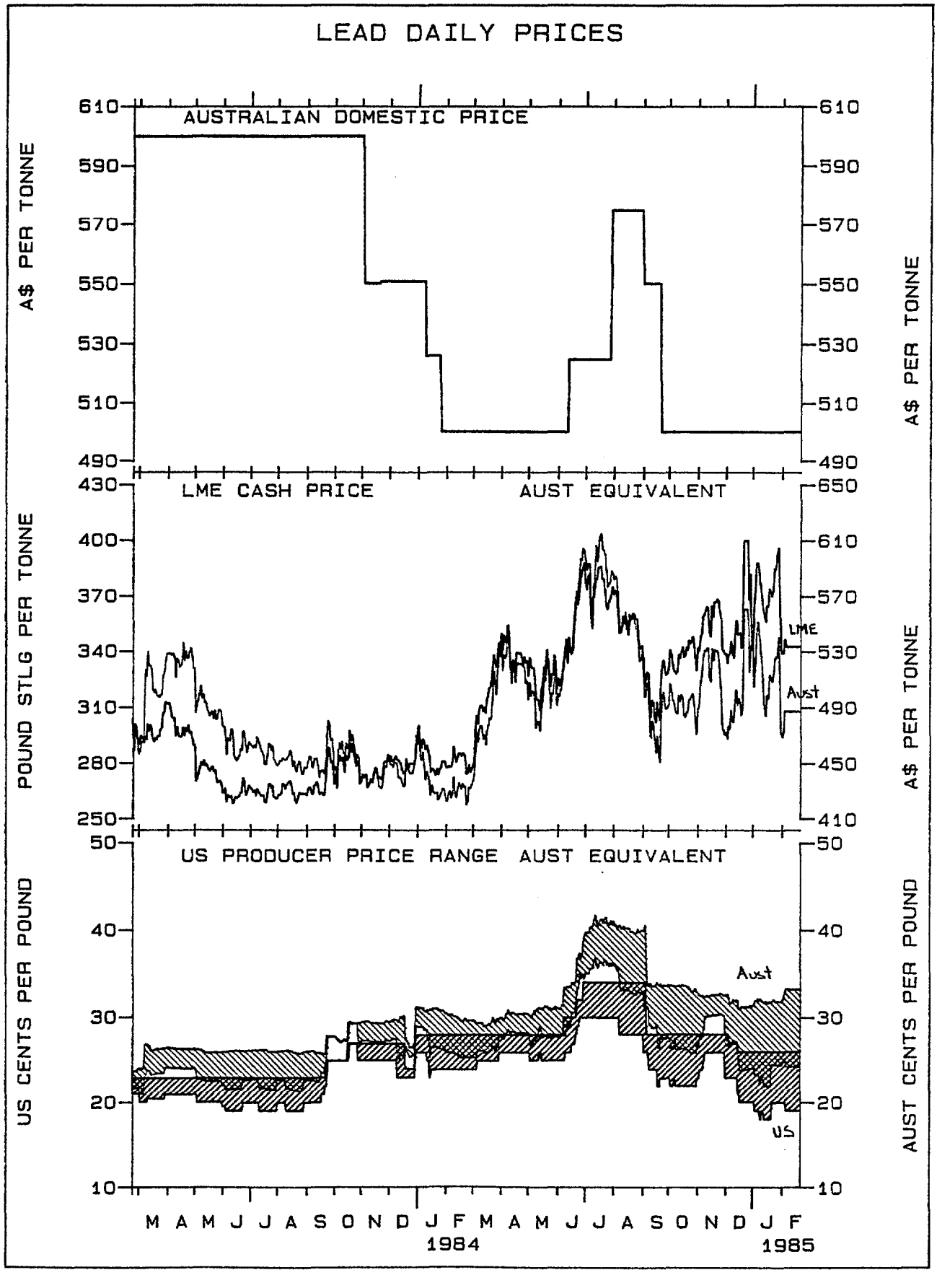
Although world lead and zinc prices increased in 1984 lead prices remain below the long-term average whilst zinc prices at best are only approaching the long-term average. A slight increase in lead and zinc prices is predicted for 1985.

Although grass roots exploration for base metals decreased in 1984 detailed prospect evaluation and development at a number of sites continued. This activity, which included shaft sinking and underground development, could result in the commissioning of additional mines and an increase in mine capacity of the order of 10% in the medium term.

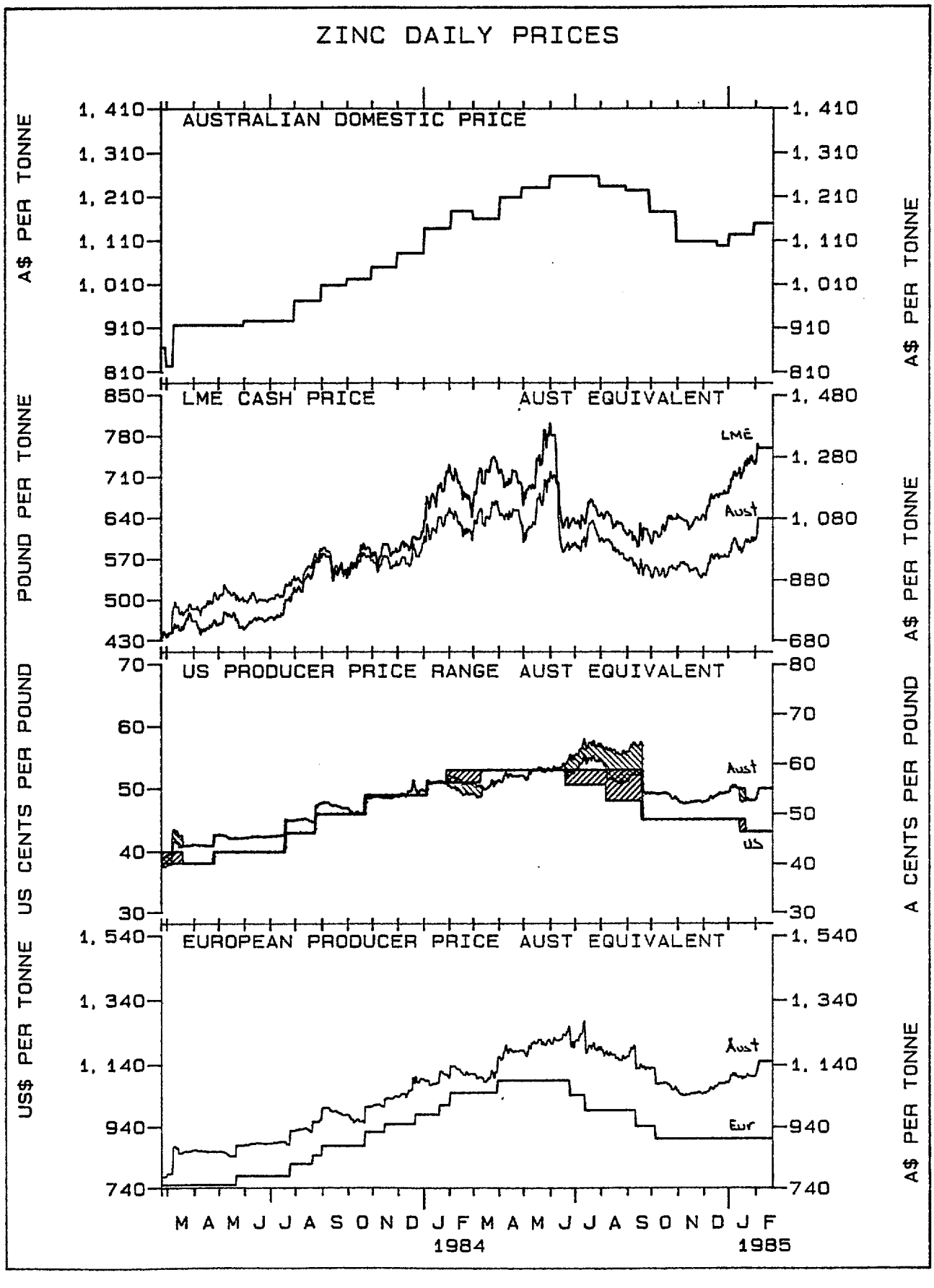
Australia's demonstrated economic resources of lead and zinc constitute about 10% of the world's resources in that category; Australia also has substantial resources in the inferred and sub economic categories. The quantity of resources included in the inferred category was increased substantially in 1984 to take account of new discoveries and new information that became available to BMR. The new royalty scheme, to operate at Broken Hill in 1985, may be an impetus to make low grade sub economic mineralisation economic and so extend the life of the field.

Australian producers have implemented a range of cost cutting measures because of their concern over profitability at current prices. The recent devaluation of the Australian dollar against the US dollar will undoubtedly assist producers by increasing sales revenue but this will be offset to some extent by higher costs.

The outlook is for Australia to remain a major supplier of lead and zinc to world markets. Exports are expected to increase slightly in line with forecast increased mine production and increased exports will be largely in the form of concentrates.


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
A$ PER TONNE
430
400
370
340
310
280
250
650
610
570
530
490
450
410
LME
Aust
US PRODUCER PRICE RANGE AUST EQUIVALENT
US CENTS PER POUND
AUST CENTS PER POUND
50
40
30
20
10
Aust
US
M A M J J A S O N D J F M A M J J A S O N D J F
1984
1985

48


ZINC DAILY PRICES
AUSTRALIAN DOMESTIC PRICE
A$ PER TONNE
1,410
1,310
1,210
1,110
1,010
910
810
LME CASH PRICE
AUST EQUIVALENT
POUND PER TONNE
A$ PER TONNE
850
780
710
640
570
500
430
1,480
1,280
1,080
880
680
LME
Aust
US PRODUCER PRICE RANGE AUST EQUIVALENT
US CENTS PER POUND
A CENTS PER POUND
70
60
50
40
30
80
Aust
US
EUROPEAN PRODUCER PRICE AUST EQUIVALENT
US$ PER TONNE
A$ PER TONNE
1,540
1,340
1,140
940
740
Aust
Eur
M A M J J A S O N D J F M A M J J A S O N D J F
1984
1985

Future technological developments and their significance to the Australian iron ore industry

I.F. Burston, Hamersley Iron

The Australian Iron Ore industry is coming under increasing pressure in the market place. In an already under-utilised industry, significant new iron ore capacity, effectively subsidised by the developed nations is being commissioned against a steel demand that at best shows flat growth. Meanwhile steel consumption in traditional markets is being eroded by substitution and higher quality steel products. These factors, combined with Australia's position with regard to iron ore reserves and quality, lack of a local market and remoteness from major steel production centres, combine to the disadvantage of the Australian iron ore producers.

Hamersley Iron, the world's largest private enterprise iron ore producer, continuously monitors technological development. It selectively utilises applicable technologies to ensure the ongoing viability of the existing operations and to provide a sound basis for future expansions. Since 1966 Hamersley has recognised, and has actively pursued, the concept of adding value to products prior to export. It has been these ongoing studies and the commitment to the Western Australian Government secondary processing obligations that has led CRA to make a series of technology based investments in the German Steel Industry.

With these investments the CRA Group is now able to

- use and provide a superior oxygen steelmaking technology
- use and provide sophisticated injection technology necessary for steel refining
- embark on a technology development program based on direct smelting.

By direct involvement with such technological development CRA-Hamersley is able to better understand the international steel industry, and is actively participating in technological applications which will ensure the long term utilisation of Australian natural resources. In the longer term the CRA Group is taking the lead in a development program for an alternative iron/steel making technology for eventual application in Australia with Australian natural resources.

Nickel

B.G. Elliott, BMR

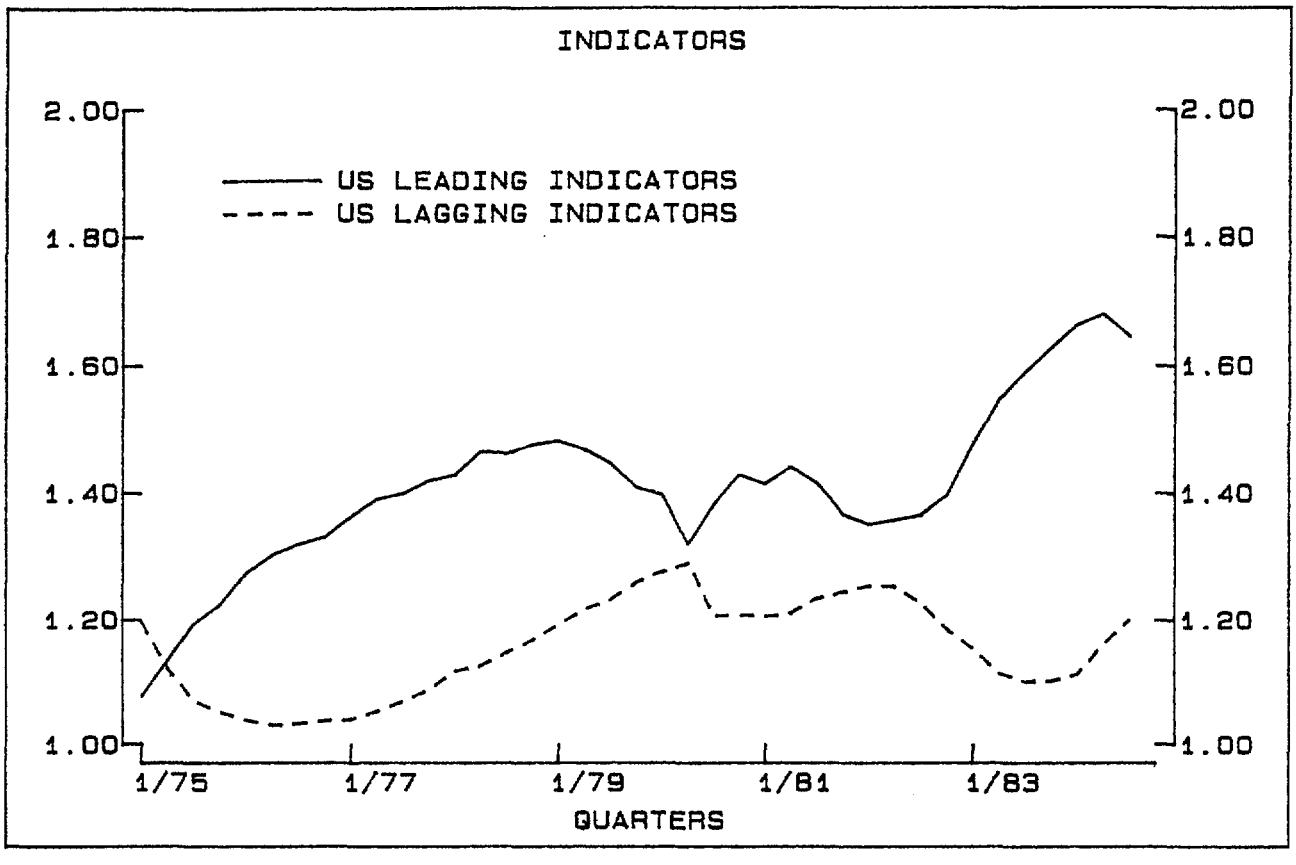
Australian mine production of nickel decreased by 2% to 75 200 t in 1984 mainly because of lower production at Greenvale and Agnew. Record production and recovery was achieved at Western Mining Corporation's (WMC) Kalgoorlie smelter and nickel oxide production at Yabulu increased reflecting improved recovery at lower throughput and higher grades of ore mined.

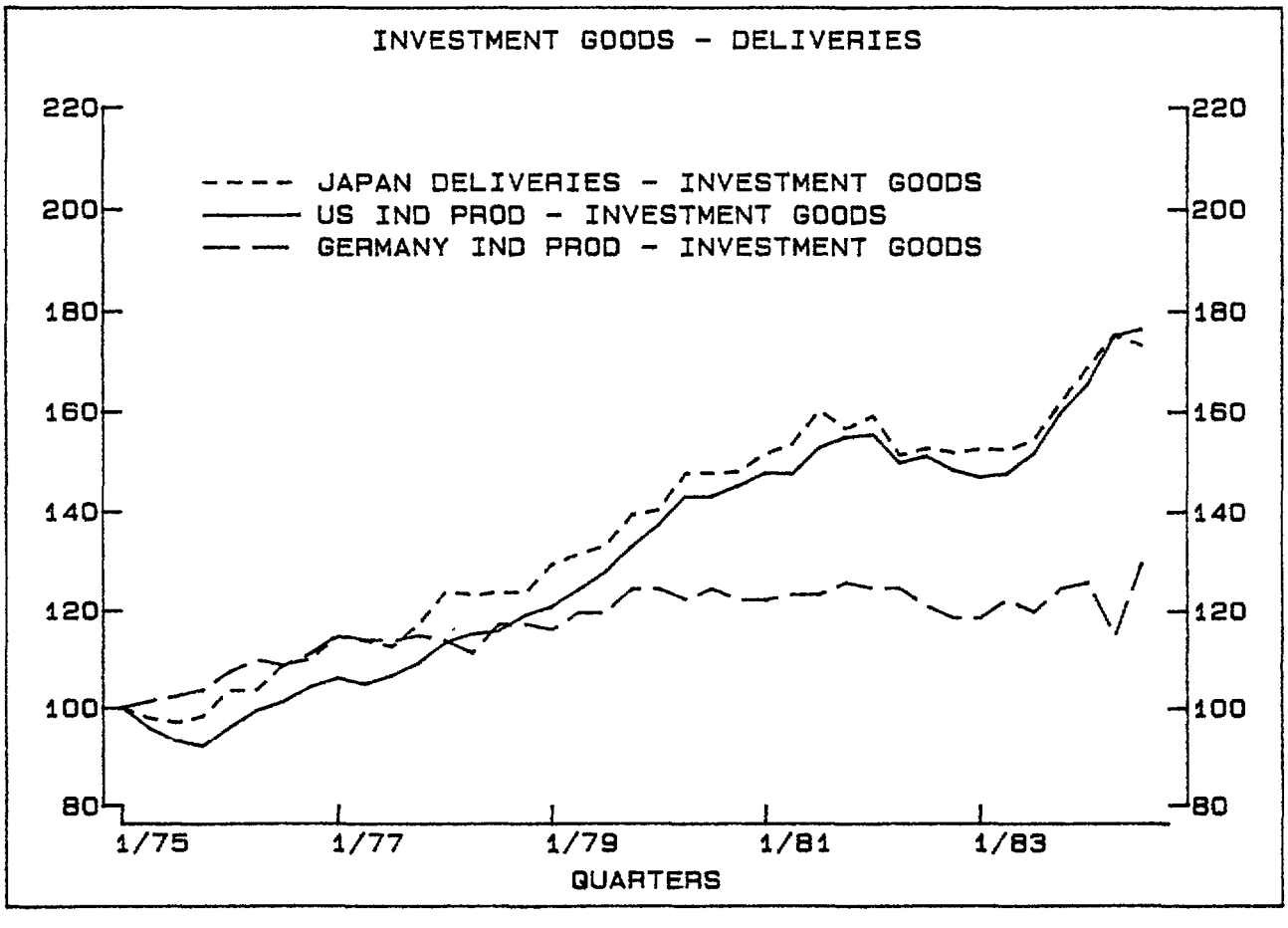
Preliminary figures indicate that total non-communist world primary refined production (465 000 t) and consumption (515 000 t) both increased in 1984. Australia contributed 8% to total production. World demand improved, with a strong recovery in the US and European stainless steel industries leading the way. Measures taken to improve productivity and reduce costs of production enabled some low-cost producers including WMC in Australia to again operate profitably. Economic indicators, particularly in the USA, are favourable; deliveries of investment goods in Japan and the United States remain strong; and there has been a strong recovery in non-communist world stainless steel production. World consumption patterns in the last decade have been characterised by major cycles about a low overall growth trend. Peak consumption in the last cycle was in 1979 and consumption in 1983 appears to be the first increase in a new cycle.

Supply-demand in the nickel industry has now reached a delicate balance. Effective production capacity exceeds current demand levels but much of the excess capacity cannot be reactivated quickly because it would require additional investment.

Nickel supply is likely to be in line with increased demand in the first half of 1985 but with the current low level of stocks and further increases in the consumption of nickel, nickel prices are expected to increase in the second half of 1985 though not sufficiently to attract high cost production facilities back into operation. Beyond 1985 the course of the world economy and the speed at which excess capacity is brought back on stream will be important factors bearing on the market. Over-production could develop into a more serious problem for market oriented producers in the long-term if planned production from non-market producers such as Cuba and USSR eventuates.

Australia is well placed to share in any substantial recovery in demand. Demonstrated economic resources are sufficient for 24 years at current rates of production and known resources in deposits currently considered to be subeconomic are relatively large. Most of Australia's economic resources are in sulphide deposits which are relatively low-cost sources of nickel. Most operations in Australia are working below capacity and production capacity could be expanded at short notice so that there is potential for substantial expansion in both mine and smelter production to meet long-term increases in demand.


INDICATORS
US LEADING INDICATORS
US LAGGING INDICATORS
2.00
1.80
1.60
1.40
1.20
1.00
1/75
1/77
1/79
1/81
1/83
QUARTERS


INVESTMENT GOODS - DELIVERIES
JAPAN DELIVERIES - INVESTMENT GOODS
US IND PROD - INVESTMENT GOODS
GERMANY IND PROD - INVESTMENT GOODS
220
200
180
160
140
120
100
80
1/75
1/77
1/79
1/81
1/83
QUARTERS

52

Aluminium

N.D. Knight, BMR

In 1984 Australia, with almost 19% of the non-communist world's total economic bauxite resources, provided 42% of non-communist world bauxite production; about 24 Mt was processed domestically and some 5 Mt was exported. About 30% of non-communist world alumina output was from Australia; over 81% of this, valued at about $1300 million f.o.b., was exported. In contrast to Australia's importance in bauxite and alumina its smelting industry which operated at about 95% of its capacity during 1984, accounted for only 6% of non-communist world primary aluminium production. About 60% of Australia's aluminium output was exported.

Non-communist world primary aluminium production rose by 14% to 12.7 Mt in 1984 and world consumption rose by 4.4% to 12.65 Mt. However, the re-opening of some idle aluminium production capacity together with production from new capacity resulted in a large stock build up which led to the reclosure of some capacity. Total capacity utilisation in 1984 is estimated at about 87%.

During 1985 a combination of production cutbacks and increased demand is expected to result in non-communist stocks falling. Aluminium prices may rise slightly in 1985 and firm further in the first half of 1986. Australian bauxite production is expected to reach 30 Mt in 1985 with exports a little below 5 Mt. Alumina production will probably fall by about 5% to around 8.0 Mt in 1985 with a corresponding decrease in exports as producer cutbacks are implemented in response to an anticipated depressed demand for alumina in 1985. Aluminium production is expected to rise to 780 000 t and exports to 470 000 t.

In the medium term Australia, with demonstrated economic resources of over 2933 Mt of bauxite, much of it high quality, is expected to continue as the world's major bauxite producer. Bauxite exports are likely to continue to decrease reflecting increasing competition in European markets from Atlantic countries and increased domestic alumina production. Australia is expected to remain the world's leading alumina producer and exports to USA, Japan and Western Europe provide the main source of these countries' imported metal grade alumina requirements.

Primary smelting capacity is likely to continue to grow in Australia and in other areas with relatively cheap raw materials and energy sources, such as Brazil and Canada. However, very few greenfields projects will be realised before 1990, given the revised annual demand growth figure of around 2%. Slight increases in demand will most likely be met by established plants with high operating rates and low production costs.

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

Country	1970	1975	1980	1983
Australia	19.0	33.0	34.76	38.57
Guinea	5.1	13.3	17.79	20.41
Jamaica	24.65	18.2	15.43	12.08
Suriname	12.36	7.5	6.3	4.7
Guyana	9.1	6.0	3.9	1.7
Greece	4.7	5.0	3.9	3.8
India	2.8	1.7	2.3	2.9
USA	4.3	2.8	2.0	1.0
Brazil	1.0	1.5	5.3	8.2
Indonesia	2.5	1.5	1.6	1.2
Other	14.49	9.5	6.72	5.44

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

Country	1970	1975	1980	1983
Australia	12.47	23.7	25.6	30.62
USA	35.1	23.7	24.8	17.87
Jamaica	9.8	10.4	8.5	8.1
Japan	7.4	7.2	7.8	5.8
West Germany	4.4	5.8	5.7	6.7
Suriname	6.0	5.3	5.1	4.9
Italy	1.8	3.2	3.2	1.7
Canada	6.4	5.2	4.2	4.7
Guinea	3.5	3.0	2.5	2.4
Brazil	.7	1.2	1.8	2.7
Other	12.43	11.3	10.8	14.51

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

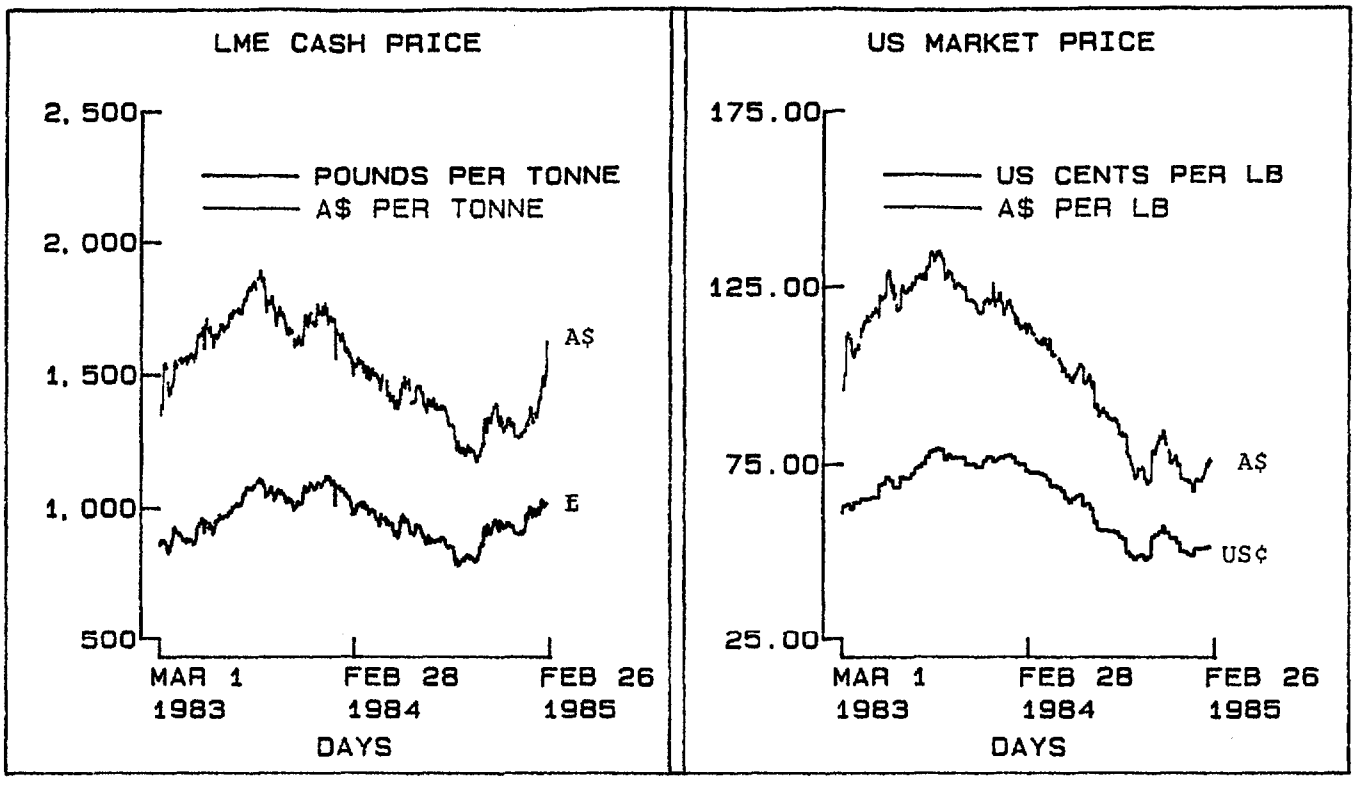
Country	1970	1975	1980	1983
US	45	36	37	31
Canada	12	9	8.5	10.1
France	4.8	3.9	3.4	3.3
Norway	6.5	6.1	5.2	6.6
Spain	1.5	2.2	3.1	3.3
West Germany	3.9	7.0	5.8	6.9
Japan	9.0	10.4	8.6	2.4
Australia	2.6	3.3	3.6	4.4
Brazil	.7	1.2	2.1	3.7
Other	14	20.9	22.7	28.3

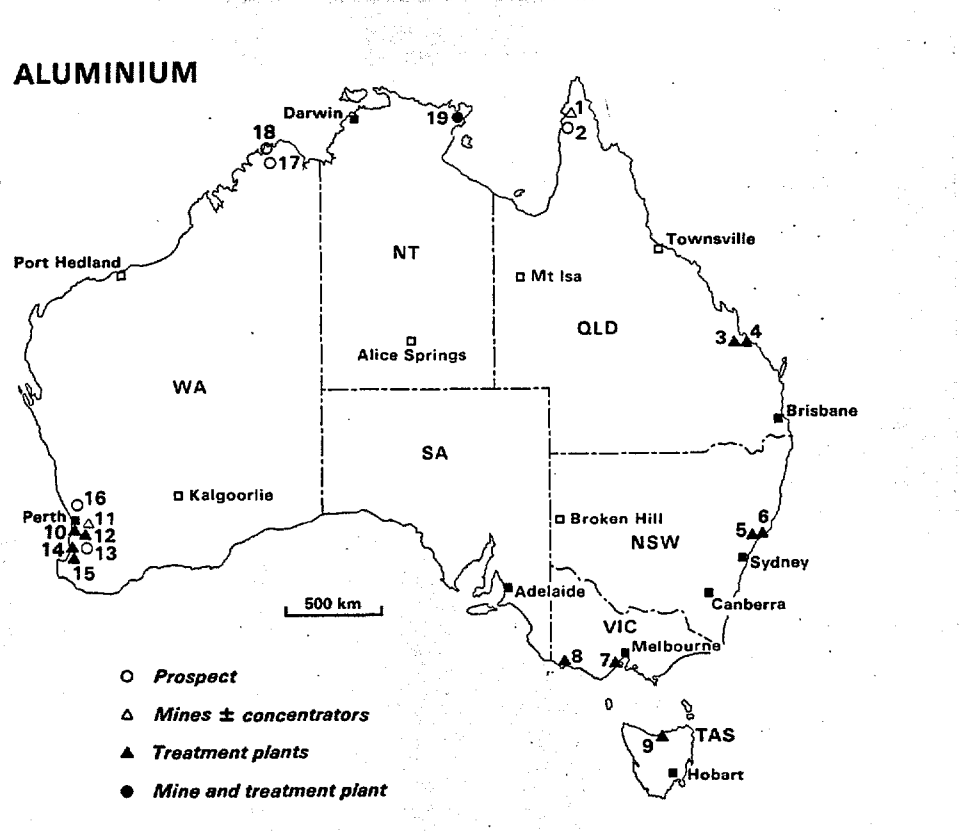
Total World Economic Resources
Bauxite '000 tonnes

Country	
United States	40,000
Australia	4,323,000
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	3,100,000
Hungary	300,000
USSR	300,000
Other Centrally Planned Economies	200,000
World Total (may be rounded)	22,213,000

Source
US Bureau of Mines

ALUMINIUM DAILY PRICES





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)

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Metal prices in 1985

W. Davies, Metals & Minerals Research Services

This abstract will be provided separately

BIOGRAPHICAL NOTES ON THE SPEAKERS

T.J. APPLEBY, ARGYLE DIAMOND SALES LTD

Terry Appleby is General Manager - Commercial of the Argyle diamond project and has held this position for eighteen months. He has responsibility for financial, marketing and further processing aspects of the project. He has held various other positions within the CRA Limited Group, primarily in finance and marketing positions.

D.W. BARNETT, MACQUARIE UNIVERSITY

Don Barnett has a Diploma in Geology from R.M.I.T., a B.A. in Economics and Geology from the University of Western Australia, and a Ph.D. in Mineral Economics from The Pennsylvania State University. He worked as a geologist for seven years with BHP and has been at Macquarie University since 1975 where he is Associate Professor of Mineral Economics in the School of Earth Science. In 1979/80 he was Visiting Specialist with the Mineral Policy Sector, Energy, Mines and Resources, Ottawa and in 1983/4 he was Visiting Professor, The Pennsylvania State University. He has been a consultant to The Asian Development Bank, the International Energy Agency, the Australian and New South Wales Coal Associations and to Australian and US energy companies. He was an expert witness for the mining and coal industries at the 1985 National Wages hearings.

G.C. BATTEY, BMR

Gordon Battey graduated in Science from the University of Queensland in 1953. He worked both underground and in exploration for MIM until 1967, and then as exploration manager for Noranda Australia until 1975. He then joined AAEC as Exploration Manager and was transferred to BMR as Head, Uranium Resources Evaluation Unit in 1983. He has been involved with uranium since early 1954 and is currently a member of the NEA Uranium Group, which prepares the international biennial publication on uranium resources.

I.F. BURSTON, HAMERSLEY IRON PTY LTD

Ian Burston, Managing Director of Hamersley Iron and Hamersley Holdings, holds a Diploma in Aeronautical Engineering from R.M.I.T. and is a Bachelor of Engineering (Mechanical) from University of Melbourne. He has been with Hamersley Iron since 1970 and until 1982 held the positions of Chief Engineer at Paraburdoo and subsequently Mount Tom Price (selecting and commissioning the mining plant, and establishing the mine), General Superintendent - Mining at Tom Price (production and engineering supervision of the Tom Price and Paraburdoo Mines), Manager at Tom Price, Operations Manager at Dampier (responsible for direct shipping of ore, pellet plant, etc.), and General Manager - Operations, Dampier.

B. 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 Committee 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 Mineral Industry Survey on behalf of the Australian Mining Council since its inception in 1977.

W. DAVIES, METALS AND MINERALS RESEARCH SERVICES

Biographical Notes will be provided separately.

R.G. DODSON, BMR

Dick Dodson is Principal Commodity Specialist (gemstones and gold) in the Minerals 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 Minerals Branch in 1983.

A. DRIESSEN, BMR

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

B.G. ELLIOTT, BMR

Brian Elliott is Principal Commodity Specialist in the Minerals Branch of the Resource Assessment Division. He graduated with qualifications in Mining Geology and after some years in the mining and exploration industry in Canada and Australia, joined BMR in 1972. In 1978 he transferred to the Department of National Development and Energy where he worked as oil shale specialist with the Oil and Gas Division, and in the Research and Development Division before rejoining BMR in 1983 as commodity specialist for nickel, cobalt and oil shale.

D.J. FORMAN, BMR

David Forman graduated with a B.Sc (Hons) degree in geology from the University of Western Australia in 1958. Except for a year with the former Petroleum and Minerals Authority in 1975, he gained experience in field mapping, sedimentary basin studies, and assessment of

undiscovered petroleum resources with BMR. He gained an A.M. in 1967 and a Ph.D. in structural geology in 1968 from Harvard University. He is Principal Research Scientist in the Petroleum Branch of the Resource Assessment Division, in charge of a research group responsible for the assessment of undiscovered petroleum resources and the estimation of possible future supply.

M.B. HULEATT, BMR

Mike Huleatt is Senior Commodity Specialist (coal) in the Minerals Branch of the Resource Assessment Division. He is a graduate in geology of the Australian National and Macquarie Universities. Prior to joining BMR in 1974 he worked for four years as a geologist with the Mount Newman Mining Co Ltd in Western Australia. From 1976 to early 1980 he worked in the Departments of National Resources, and Trade and Resources on policy and economic matters relating to Australia's iron ore, uranium and coal industries. Since rejoining BMR in 1980 his main interest has been the assessment of Australia's coal resources and the factors that govern their development.

N.D. KNIGHT, BMR

Nerida Knight is the Commodity Specialist for aluminium, tungsten, and tantalum in the Minerals 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.J. LINDEN, GREENBUSHES TIN LTD

John Linden graduated in 1967 from the University of Western Australia with a Bachelor of Science degree with majors in Geology and Inorganic Chemistry, and completed an Honours degree in Geology in 1968. He worked in industry from 1969 until 1973, and was appointed Director of Greenbushes Tin Ltd in 1974 and Managing Director two years later. John was President of the Tantalum Producers International Study Center (TIC) from November 1982 to November 1983.

R. MARSHALL, MIM HOLDINGS LTD

Roger Marshall graduated from the University of Queensland in 1960 with a Bachelor of Mining Engineering degree. He was employed by Huntley Collieries (a subsidiary of The New South Wales Electricity Commission) in 1967 as a Mine Manager, but transferred to Coalcliff Collieries later that year. In 1974 he joined Utah Development Company and was Manager, Underground Mining before being promoted to Manager of Peak Downs Mine.

He commenced with Clutha Development Pty Limited in January 1979 as General Manager of Operations, and was promoted to Managing Director in February 1980. In late 1981, with the establishment of a Coal Department within Clutha's parent company, BP Australia Limited, Roger was appointed General Manager of the new organisation.

In 1982 he was appointed by MIM Holdings Limited as Executive General Manager - Coal Division and joined the Board of Directors in July 1984. He is responsible for the management of all MIM's coal interests, and is Chairman of the Boards of Collinsville Coal Company Pty Ltd, Newlands Coal Pty Ltd, Oaky Creek Coal Pty Ltd, and Dalrymple Bay Coal Terminal Pty Ltd. He is also a member of the Board of Abbot Point Bulkcoal Pty Ltd and Brigalow Mines Pty Ltd.

S.R. McGILL, ESSO AUSTRALIA LTD

Stuart McGill attended Sydney University and obtained a Bachelor of Engineering Degree with Honours, and subsequently in 1968 a Ph.D. in Chemical Engineering. He joined Esso as a Petroleum Engineer in the Production Department in Melbourne in 1969 and transferred to Sale as a Senior Petroleum Engineer in 1978.

He worked in Houston, Texas in 1971 with Exxon USA and EPRCo and returned to Australia in 1972 as a Senior Staff Engineer in Production, Head Office, Sydney and the following year he transferred to Sale, on this occasion as a Supervisory Engineer. In 1974 he became a Senior Supervisory Engineer at Longford responsible for Gas Engineering.

Since his return to Australia in 1972, Stuart has worked as a Senior Staff Engineer in Production (Head Office, Sydney), Supervisory Engineer (Sale), Senior Supervisory Engineer (Longford - responsible for Gas Engineering), Planning Manager (Corporate Planning and Finance Department, Head Office), Assistant Area Production Manager, and Area Manager (Sale), Division Operations Manager (New Orleans, Exxon Co USA Southeastern Division), and Business Strategy Development Coordinator (Houston, Exxon).

In 1980, Stuart was appointed Managing Director, Esso Production Malaysia Inc (Kuala Lumpur), and returned to Sydney in early 1983 as Director, Esso Australia Ltd.

I.R. McLEOD, BMR

Ian McLeod is Chief Commodity Specialist in the Minerals Branch, Resource Assessment Division, and is responsible also for tin commodity studies. He graduated with an M.Sc in geology from the University of Queensland. After a period in industry he joined BMR and was seconded as geologist to the Australian National Antarctic Research Expeditions. After returning to BMR he worked mainly on Australian mineral resources, Antarctic geology, and information services before taking up his present position.

N.J. PATERSON, SOUTHERN PACIFIC PETROLEUM NL

Neil Paterson holds the Degrees of Bachelor of Economics, and Bachelor of Arts from the University of Sydney, and Master of Arts (in economics) from American University, Washington, D.C. He is Deputy Chairman Southern Pacific Petroleum NL, Director of Central Pacific Minerals NL, Director of Barclays International Australia Limited, Director of Jaakko Poyry International (a Scandinavian consulting engineering company), Chairman of Biomecca Pty Ltd, Director of Bute Pty Ltd, and Consultant to the World Bank.

He previously served with the World Bank in Washington, becoming Director of Operations, Europe, Director of Operations, Latin America in the International Finance Corporation. In this capacity he had principal line responsibility for investments totalling about US$2 000 million, and was also Chairman of the Staff/Investment Committee of I.F.C. and a Member of the Investment Committee - Pension Fund World Bank Group.

D.J. PERKIN, BMR

Don Perkin is Principal Commodity Specialist (copper) in the Minerals Branch, Resource Assessment Division. He graduated from the University of Sydney with a BA (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.

W.V. PINCZEWSKI, UNIVERSITY OF NEW SOUTH WALES

Val Pinczewski is an Associate Professor in the School of Chemical Engineering and Industrial Chemistry at the University of New South Wales. He is Director of the Centre for Petroleum Engineering Studies which was established by the University to coordinate petroleum related studies and research within the University. The Centre conducts basic and applied research programs in the application of EOR technology in the Australian context and as part of these programs, operates a PVT laboratory for the study of Australian crude oils as a joint facility with the Bureau of Mineral Resources, Geology and Geophysics.

Professor Pinczewski has worked as a petroleum engineer with ESSO Australia and is an active consultant in the area of petroleum recovery. He has recently returned from a visit to the US where he presented technical papers concerned with EOR technology and where he had the opportunity of observing at first-hand some of the more recent technical developments in EOR.

M. ROARTY, BMR

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

PATRICK 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.

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

A.C. SMART, DEPARTMENT OF RESOURCES & ENERGY

Alan Smart is currently Assistant Secretary, Domestic Energy Policy Branch of the Department of Resources and Energy. He has worked since 1978 in the energy field in areas covering energy policy, research and development, pricing and taxation and energy forecasting and modelling. Prior to that he followed a career in engineering and economics associated with resource projects and infrastructure financing. He holds qualifications in Engineering and Economics.

J.C. STARKEY, DEPARTMENT OF RESOURCES & ENERGY

Jim Starkey is a graduate in economics from the Australian National University in Canberra. He has worked in several departments since joining the Commonwealth Public Service in 1959, including the Prime Minister's Department, Treasury and the Department of Environment. He joined the Department of National Development and Energy in 1978, soon after its formation, as Assistant Secretary, Economic and General Branch. He was appointed First Assistant Secretary in charge of the Regional Development Division in 1980 and 1981 as head of the Department's Oil and Gas Division.

In 1984 he was appointed to his current position of First Assistant Secretary in charge of the Petroleum Division in the Department of Resources and Energy. The Petroleum Division administers the Commonwealth's responsibilities and formulates policy advice in relation to a range of matters concerning the Petroleum industry. These include exploration, development, pricing and disposal of Australia's petroleum resources, the contribution of the oil and gas sector to Commonwealth excise and royalty revenues, safety and security of oil supplies, and refining, marketing and distribution of petroleum and petroleum products.

R.W. TOWNER, BMR

Roy Towner is Commodity Specialist (mineral sands and industrial minerals) in the Minerals 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 Minerals Branch, after graduating Bachelor of Economics from the Australian National University.

J. WARD, BMR

Jack Ward graduated in Science from the University of Queensland in the mid-1940's. He was employed by Zinc Corporation Limited in connection with the development of mineral sand deposits on North Stradbroke Island before joining BMR in charge of laboratory investigations on mineral sands along the east coast from Fraser Island to Coffs Harbour. From 1952-1957 he was engaged mainly on the assessment of uranium reserves in the Northern Territory. He also acted as Resident Geologist in Darwin and was responsible for the day-to-day planning and direction of geological reserves 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, Minerals 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.

PETROLEUM & MINERALS REVIEW CONFERENCE 1985

ABSTRACTS

Metal markets in 1985 and beyond

W. Davies, Australian Mineral Economics P/L

While certain fundamental aspects of the metal markets are moving in favour of a continued recovery in metal prices, the prospects for decelerating and convergent economic growth suggest that the magnitude of the recovery may still leave many unfulfilled. Looking ahead, although economic fundamentals are pre-eminent in setting price trends, the regional aberrations produced by currency exchange rates are themselves having a marked impact on the behaviour of 'local' metal prices and producer/consumer responses to them. Overall, despite the cyclical recovery in train, the challenge for those operating in the metals industries remains to learn to operate without the benefit of rapidly rising prices.

Iron and steel 1984 - a recovery?

C.R. Pratt, BMR

World steel consumption and output increased in 1984 because of a further increase in demand from the consumer durable industries and a higher level of business investment. This is the second year in succession consumption and output have increased following a marked 3-year downturn between 1980 and 1982.

A resurgence in Australian iron ore production in 1984 reflected a substantial increase in export demand and contrasted with the low level of output in the previous year which was adversely affected by prolonged industrial disputes. Iron ore exports recovered to levels of the mid-1970s but lower prices caused the FOB value to fall slightly. Prospects for the further development of Australia's world ranking iron ore resources (which exceed 40 000 Mt if high phosphorus ores are included) improved substantially in 1984 as deposits were appraised or re-appraised either as possible sources of iron ore for the Chinese steel industry or to meet higher demand now projected. Iron ore exploration expenditure increased and aimed mainly at delineating existing known resources rather than increasing them.

Continued over